NORTHWIN LANDFILL 2024 ANNUAL OPERATIONS & MONITORING REPORT







Prepared for:

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PRJ24074

March 31st, 2025

SPERLING HANSEN ASSOCIATES

- Landfill Engineering
- Solid Waste Planning
- Environmental Monitoring
- Landfill Fire Control

March 28th, 2025 PRJ24074

Terry Stuart
Operations Project Manager
Northwin Environmental, Ltd.
Suite 315, 1432 Ironwood Street
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Re: Northwin Landfill 2024 Annual Operations & Monitoring Report

Dear Mr. Stuart,

Sperling Hansen Associates (SHA) is pleased to submit the finalized and authenticated 2024 Northwin Landfill Annual Operations and Monitoring Report, which includes all required sections and supporting data from the provided documents to comply with permit requirements for your facility. The 2024 Annual Operations and Monitoring Report is being submitted to the British Columbia Ministry of Environment and Climate Change Strategy on or before March 31st, 2025, in accordance with Upland Excavating Ltd. Operational Certificate 107689.

Since our engagement in August 2024, our team has greatly enjoyed collaborating with Northwin Environmental as your Landfill Engineering Consultants. We look forward to continuing our work with you on this project in the foreseeable future.

Should you have any questions, concerns, or require any further information regarding this report, please feel free to contact the undersigned at **604-986-7723**.

Yours truly,
SPERLING HANSEN ASSOCIATES
EGBC Permit Number 1003066



Dr. Tony Sperling, P.Eng. (EGBC Licence 17,621)
President



March 28th, 2025

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EXECUTIVE SUMMARY

The Northwin Landfill, located in Campbell River, British Columbia, serves as a modern waste management facility replacing the Original Landfill, which was decommissioned in 2023. The transition to the New Landfill was necessary to comply with modern environmental regulations, improve waste management efficiency, and mitigate environmental risks associated with leachate contamination and landfill gas emissions. The site is operated by Northwin Environmental Ltd. and regulated under Operational Certificate (OC) 107689, ensuring compliance with the BC Landfill Criteria for Municipal Solid Waste (2016) and the Environmental Management Act.

The opportunity presented by the New Landfill is to enhance environmental sustainability, ensure regulatory compliance, and maintain operational efficiency through effective leachate management, landfill gas monitoring, and strategic waste disposal. The New Landfill comprises two cells, Cell 1 East (operational since 2021) and Cell 1 West (completed in 2023) known as Phase 1. Phase 1 was designed with advanced liner and leachate collection systems to minimize environmental impact. This 2024 Annual Report provides an overview of landfill operations, environmental monitoring results, leachate treatment performance, and regulatory compliance for the past year.

The construction and commissioning of Phase 1 have been completed, with both landfill cells now fully operational. The double-liner system with a leak detection layer ensures effective containment of waste and leachate, protecting groundwater and surrounding ecosystems. As of January 29th, 2025, the landfill contains 140,252 m³ of waste, with 67,532 m³ of remaining airspace for the first phase of disposal. Meanwhile, the Original Landfill was fully decommissioned, and all waste was successfully relocated to the New Landfill. A confirmatory soil sampling program verified site closure compliance, and decommissioning of the original leachate management system was completed.

The leachate treatment system has been fully commissioned, treating leachate in batches ranging from 625 m³ to 980 m³ per cycle. The treated leachate met BC Contaminated Sites Regulation (CSR) Schedule 3.2 Drinking Water Standards, ensuring compliance with regulatory requirements. The leak detection monitoring system confirmed that no leaks were detected in the landfill liner, reinforcing the effectiveness of containment measures. Additionally, groundwater monitoring through quarterly sampling at 18 monitoring wells showed no significant contamination trends, while stormwater was properly managed, preventing leachate discharge into natural water bodies. Furthermore, no public complaints were received regarding landfill operations during the reporting period.

Despite these achievements, several operational challenges were encountered and addressed. The effluent holding pond capacity was initially undersized, but an expansion was completed in November 2021 to accommodate peak flows. Minor liner damage during Cell 1 construction was identified and immediately repaired before landfill operations began. Occasional leachate exceedances for sulfate and boron required additional treatment cycles and chemical dosing adjustments to ensure compliance. According to Northwin Environmental, landfill gas monitoring was not conducted this year, so methane concentrations could not be confirmed whether below regulatory thresholds which would indicate stable landfill gas conditions. Furthermore, the remaining airspace in Phase 1 of the New Landfill is limited, necessitating the initiation of Phase 2 expansion planning to ensure continued disposal capacity.

For 2025, recommendations focus on optimizing landfill operations and ensuring long-term sustainability. Continued leachate treatment optimization through sampling and chemical adjustments will maintain compliance with water quality standards. Landfill gas monitoring will be conducted in Q1 of 2025, to establish whether methane concentrations are below regulatory thresholds, as expected based on the nature of the waste being disposed of in this landfill. Landfill expansion planning will progress to Phase 2 development, ensuring that future waste disposal needs are met without capacity constraints. Additionally, efforts will be made to enhance stormwater management, improve liner integrity inspections, and refine waste compaction strategies to maximize landfill airspace utilization. To maintain regulatory compliance, scheduled reporting and environmental audits will continue to ensure community transparency and address any potential concerns.

Overall, the Northwin Landfill remains an environmentally responsible and fully compliant waste management facility with environmental regulations and successful implementation of the New Landfill (a modern, engineered landfill system). The completion of New landfill Phase 1 included the effective implementation of the leachate treatment facility, and ongoing environmental monitoring efforts that reflect the site's commitment to sustainable waste management and regulatory compliance. The 2025 operational focus will be on expanding landfill capacity, optimizing treatment processes, and ensuring continued environmental protection.

1. INTRODUCTION

1.1 Background

The Northwin Landfill**,** located in Campbell River, British Columbia, was developed to replace the Original Landfill, which had been in operation since 1992. The transition to the New Landfill was undertaken to comply with modern environmental standards and enhance waste management practices.

The site is owned by Upland Excavating Ltd. and operated by Northwin Environmental Ltd., functioning as both a waste disposal facility and an aggregate extraction site (GHD O&M Report, 2023).

1.2 Project Description

Under Operational Certificate (OC) 107689, the New Landfill was authorized to begin accepting waste in Phase 1 as of November 2021 for the last 4 years. Phase 1 featured a double-liner system, leak detection layer, and leachate management works.

Northwin Landfill is designed to accept:

- Construction & Demolition (C&D) Waste
- Landfill Clearing Waste
- Industrial Quality Soil that is not considered hazardous waste (IL+)
- Sludge from leachate and water treatment works

The New Leachate Management System includes collection, extraction, storage, treatment, and infiltration processes to ensure environmental compliance (GHD O&M Report, 2023).

1.3 Regulatory Requirements

Northwin Landfill operates under the BC Landfill Criteria for Municipal Solid Waste (2016) and the Environmental Management Act.

Key regulatory approvals include:

- Operational Certificate (OC) 107689, issued in 2019 and amended in 2022, which governs waste acceptance, leachate management, and environmental monitoring (GHD O&M Report, 2023).
- Approval for soil that is non-hazardous waste; soil acceptance granted in April 2022.
- Ministry of Environment oversight, requiring annual environmental monitoring reports and adherence to groundwater and surface water protection measures.

Quarterly monitoring and reporting ensure compliance with BC's Contaminated Sites Regulation, with detailed evaluations submitted annually to the Ministry of Environment and Climate Change Strategy.

1.4 Site Location

The landfill is situated at 7295 and 7311 Gold River Highway, approximately 7 km west of Campbell River as shown in **Figure 1**.

Site Boundaries:

- North – Gold River Highway (Highway 28).
- East – Forested and industrial land.
- West – Rico Lake, a construction storage yard, and an undeveloped industrial lot.
- South – Strathcona Regional District, including forestry industry land.

The total site area is approximately 48 hectares, encompassing:

- A sand and gravel pit
- The New Landfill (Phase 1)
- Leachate treatment works

The site is accessed via Gold River Highway and is equipped with internal roads and site infrastructure to support landfill and quarry operations.

1.5 Site Security

To ensure safety, regulatory compliance, and protection from unauthorized access, Northwin Landfill has implemented a comprehensive security system.

- Signage: Clearly marked signs at the main entrance and all access points, stating:
  - "Industrial Site – No Trespassing"
  - "Property Under Video Surveillance"

- 24-Hour Surveillance:
  - Security cameras monitored around the clock by a professional security company.

- Restricted Access:
  - Only authorized personnel and waste haulers are permitted entry.

- Night time Illumination:
  - Outdoor lighting ensures visibility and security at night.

These security measures are aligned with Section 6.10 of the BC Landfill Criteria to maintain compliance and prevent unauthorized dumping or trespassing.

The Northwin Landfill represents a modern, environmentally responsible waste management facility that aligns with provincial regulations and sustainability goals. The site's state-of-the-art design, regulatory compliance, and security measures ensure that waste is managed efficiently while minimizing environmental impact.

2. SITE PHYSICAL SETTING

2.1 Climate

The climate in the vicinity of the Northwin Landfill is characterized by mild, wet winters and warmer, drier summers, consistent with the east coast of mid-Vancouver Island. Climate data recorded at Environment Canada's Campbell River Airport Climate Station (ID 1021261), approximately 8 km southeast of the site, indicates an average annual precipitation of 1,489 mm. Over 75% of this precipitation occurs between October and March, with the heaviest rainfall recorded in November and December. Annual snowfall averages 84 mm.

Projected climate changes for the region, as modeled using the Pacific Climate Impacts Consortium's Plan2Adapt tool, suggest a 2.7% increase in total annual precipitation by the 2050s. Seasonal changes indicate that summer precipitation could decrease by up to 15%, while winter precipitation may increase by approximately 5.2% (GHD DOCP, 2021).

2.2 Topography and Drainage

The Northwin Landfill is located on a terrace partially surrounded by mountainous terrain to the south and southwest. The terrace slopes gradually downward towards the Quinsam River, which lies approximately 3.8 km southeast of the eastern site boundary. The Quinsam River's channel elevation is more than 100 m below the landfill, meaning there is no direct overland drainage to the river.

There are no natural surface watercourses on the site. Surface drainage is managed through a stormwater management plan, as outlined in the Design, Operations, and Closure Plan (DOCP). Perimeter berms have been constructed around landfill cells to ensure that precipitation landing within the landfill footprint is collected and treated as leachate. Rainfall outside the landfill footprint infiltrates naturally into the subsurface sand and gravel aquifer.

Two significant water bodies are located near the site:

- Rico Lake, situated to the west, is within a natural depression. Its elevation ranges between 168 m and 172 m above mean sea level (AMSL).

- McIvor Lake, located north of the site, is hydrologically connected to Campbell Lake and influenced by BC Hydro's Ladore Dam, which maintains an operational water elevation of 174-178 m AMSL.

The site lies within two watershed areas: the Campbell River Watershed and the Quinsam River Watershed, which are separated by a watershed divide running through the southwestern portion of the site.

2.3 Geologic Setting

The regional geology of the Northwin Landfill site has been influenced by multiple glaciation events during the Pleistocene Epoch. Vancouver Island was covered by ice sheets up to 2 km thick, leading to the deposition of various glacial and glacio-fluvial sediments. These deposits include:

- Glacial Till: Comprised of a mix of clay, silt, sand, gravel, and boulders deposited directly by glaciers.

- Glacial Outwash: Poorly sorted coarse-grained sand and gravel deposited by glacial meltwater.

The landfill is predominantly underlain by interbedded sand and gravel with occasional layers of silty sand. These deposits exceed 40 m in thickness directly beneath the landfill footprint.

2.3.1 Bedrock Geology

The site is underlain by the Karmutsen Formation, part of the Wrangellia Terrane. The formation consists mainly of submarine flood basalts, which can reach thicknesses of up to 6 km. Site investigations confirm that the bedrock beneath the landfill is competent igneous basalt, with the surface located at least 50 m below ground level (GHD O&M Report, 2023).

A significant bedrock ridge exists between Rico Lake and the landfill excavation pit, forming a surface water and groundwater flow divide. This geological feature influences local drainage and hydrogeologic conditions.

2.4 Hydrogeologic Settings

The hydrogeologic setting of the site consists of three primary aquifer units:

1. Sand and Gravel Aquifer – This unconfined aquifer exists within the sand and gravel deposits overlying bedrock and is the dominant groundwater flow zone at the site. The water table is typically 13–18 meters below the top of the monitoring well risers in the landfill area. Groundwater flow is predominantly northwest to southeast, toward the Quinsam River.

2. Shallow Aquifer – This discontinuous aquifer exists in certain areas of the site, particularly in the northern section and the southwest corner. Groundwater flow in this zone is primarily controlled by bedrock topography.

3. Bedrock Aquifer – Fractured basalt within the Karmutsen Formation hosts a deeper bedrock aquifer, which interacts with the overlying sand and gravel aquifer through upward hydraulic gradients.

Hydraulic conductivity tests indicate that the sand and gravel aquifer has an estimated conductivity of 1.8×10^{-2} cm/sec, signifying a relatively high permeability and potential for groundwater movement (GHD O&M Report, 2023).

Groundwater monitoring and hydrogeologic assessments confirm that:

- The aquifer is classified as a major aquifer (Aquifer 975 IIA) under the BC Water Resource Atlas.

- Groundwater flow patterns are influenced by local bedrock structures, with McIvor Lake serving as the primary recharge source.
-

- No surface water bodies are downgradient within 500 m of the landfill, negating the need for aquatic life standards in groundwater assessments.

Ongoing hydrogeologic monitoring is conducted to assess potential impacts from landfill operations, particularly concerning groundwater quality and migration of contaminants.

3. 2024 ENVIRONMENTAL MONITORING PLAN

3.1 Groundwater Monitoring Program

The main objective for this monitoring program is to detect the extent and magnitude of potential landfill-derived impacts to the underlying aquifer, and to monitor the groundwater flow direction across the Site.

The groundwater monitoring program consists of quarterly monitoring of eighteen (18) groundwater monitoring wells located upgradient, cross-gradient, and downgradient of the Site. Hydraulic monitoring is done on all eighteen wells, and eleven of the wells are included in the sampling program.

The groundwater samples are analyzed for general chemistry parameters, anions, nutrients, dissolved metals and LEPH, HEPH, and PAHs.

The locations of the groundwater monitoring locations for the Site can be seen on **Figure 4**.

Table 3-1: New Landfill Groundwater Monitoring Locations

Groundwater	Location	Monitoring
MW6-17	Upgradient well	Quarterly Sampling
MW9-17	Upgradient well	Quarterly Sampling
MW1-14	Upgradient well	Quarterly Sampling
MW4A-15	Upgradient well	Quarterly Sampling
MW4B-15	Upgradient well	Quarterly Sampling
MW2-14	Cross-gradient well	Quarterly Sampling
MW2A-16	Cross-gradient well	Quarterly Sampling
MW3-14	Downgradient well	Quarterly Sampling
MW10-17	Downgradient well	Quarterly Sampling
MW11-19	Downgradient well	Quarterly Sampling
MW12-22	Downgradient well	Quarterly Sampling
MW7-17	Upgradient well	Water Levels Only
MW8-17	Upgradient well	Water Levels Only
MW5A-15	Cross-gradient well	Water Levels Only
MW5B-15	Cross-gradient well	Water Levels Only
MW15A-18	Cross-gradient well	Water Levels Only
MW15B-18	Cross-gradient well	Water Levels Only
PZ1-19	Cross-gradient well	Water Levels Only

3.2 Surface Water Monitoring Program

The surface water monitoring program consists of quarterly water level monitoring, and annual sampling of Rico Lake and McIvor Lake. The water levels in Rico Lake are read on a surface water gauge at the north end of the lake, while water level readings for McIvor Lake are obtained from BC Hydro's database for the Ladore Dam. The water samples are collected from surface water monitoring locations SW15-1

and SW15-2 respectively. Samples are analyzed for general chemistry parameters, nutrients, anions, total metals, and dissolved hardness. The locations for SW15-1 and SW15-2 can be seen on **Figure 4**.

Table 3-2: Surface Water Monitoring Locations

Surface Water Monitoring Stations	Location
SW15-01	McIvor Lake north of the New Landfill
SW15-02	Rico Lake west of the New Landfill

3.3 Landfill Gas Monitoring

The objective for the landfill gas (LFG) monitoring program is to detect if there is any lateral migration of LFG at the site. The 2021 GHD DOCP recommend monitoring at the perimeter of the Site, as well as monitoring of existing on-site buildings (occupied by operational personnel) for potential landfill gas migration. The BC Landfill Criteria requires that soil gas concentrations at the Site boundary must not exceed the lower explosive limit of methane (5% by volume). The soil gas concentrations in on-site buildings must not exceed 20% of the lower explosive limit of methane (1% by volume) at all times.

In accordance with the above-mentioned requirements, the 2021 GHD DOCP recommended that soil vapor monitoring probes be installed at the site as part of the construction of the new cells. The two recommended probes were installed in 2022, with their locations shown in **Figure 4**.

Table 3-3: Landfill Gas Monitoring Locations

Surface Water Monitoring Stations	Location
LFG1-22	Near Wash Plant
LFG2-22	Southern property boundary (monitor LFG migration offsite)

The monitoring program for 2024 stipulates that landfill gas monitoring be conducted annually using the two gas monitoring probes and be consistent with the BC Landfill Gas Management Facilities Design Guidelines, Section 6 of the Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills, and Sections 4.2 and 9.3 of the Landfill Criteria.

3.4 Stormwater Monitoring

According to Operational Certificate (OC 107689), the site operator must ensure that stormwater does not include leachate, and the concentration of any substances in the stormwater not exceed the Contaminated Sites Regulated Generic Numerical Water Standards for Drinking Water (DW).

Drainage within the New Landfill area is managed according to the stormwater management plan provided in the DOCP. Perimeter berms have been constructed around the landfill cells to ensure that precipitation that falls on the landfill footprints remains within the footprint and managed as leachate. Precipitation that falls outside of the landfill footprint is considered clean water and infiltrates into the groundwater aquifer below the Site. Stormwater monitoring is currently not part of the monitoring

program as contact water is kept within the lined areas, and precipitation falling outside of the lined areas rapidly infiltrates with no surface runoff at the site.

3.5 Leachate Monitoring

In order to prevent leachate from migrating to the underlying aquifers, nearby lakes and rivers, the New Landfill (Cell 1 East and Cell 1 West) have lined cells with perforated pipes installed at the base of the cell that discharge to a leachate sump as shown in **Figure 7**. The New Landfill includes leachate collection, extraction, storage, treatment, and infiltration or recirculation through the Granular Activated Carbon (GAC) system. The treatment process continues until treated effluent concentrations meet the British Columbia Contaminated Sites Regulations (BC CSR) Schedule 3.2 DW standards.

The New Landfill leachate management system process begins with filling the aerated equalization pond, whereafter the aeration system is switched on. Following aeration, the leachate is pumped through pipes to the leachate treatment container, where chemicals can be added inline through injection ports. After chemical addition, leachate can be recirculated to the equalization pond or sent through a series of sand filters before entering the effluent holding pond. The effluent batch is held in the effluent holding pond and sampled with a 3-day turnaround on the laboratory analysis. Following receipt of sample results, the batch is then be pumped to the infiltration pond or recirculated through the GAC, if polycyclic aromatic hydrocarbons (PAHs) did not meet discharge criteria. During operations the batches are tested periodically to confirm discharge criteria are being met. The treatment process continues until treated effluent concentrations meet the BC CSR Schedule 3.2 DW standards.

Table 3-4 shown below lists the three current leachate sampling locations at the Site. The raw leachate from the leachate collection sumps (S06-21 and S07-24) is sampled on a quarterly basis, and samples tested for general chemistry parameters, anions, nutrients, total metals, LEPH, HEPH, and PAHs. Leachate sump S07-24 was not sampled in 2024 as Cell 1 West had not received any waste at that time. The treated leachate in the Treated Leachate Infiltration Pond (TLIP) is being tested batch by batch for the following parameters: hardness, sulphate, dissolved metals, volatile organic compounds (VOCs), PAHs, light extractable petroleum hydrocarbons (LEPH), and heavy extractable petroleum hydrocarbons (HEPH).

Table 3-4: Leachate Monitoring

Surface Water Monitoring Stations	Location	Monitoring
S06-21	Raw leachate sump at northeast end of Cell 1 East	Quarterly Sampling
S07-24	Raw leachate from liner in Cell 1 West (implemented in 2025)	Quarterly Sampling (2025)
TLIP	Treated leachate discharged to the infiltration pit	Batch by batch

3.6 Liner Leakage Detection Monitoring

The New Landfill cells, as well as the leachate treatment and holding ponds are all double lined with a liner leakage detection system under the primary liner. The leakage detection system has two leakage

detection sumps (LDS-E and LDS-W) located under each of the two leachate collection sumps. Each leakage detection sump is connected with pipes to each of the two leachate pumping sheds. This allows for inspection for presence of water between the primary and secondary liners as well as pumping out water for sampling should water be detected. The seven liner leakage detection ports are part of the Trigger Level Response Plan and assist in identifying which area of the cells that could have a compromised primary liner. In the event that water is detected in any of the two liner leakage detection sumps, samples are collected and analyzed for the same parameters as the leachate monitoring program. Monitoring of the liner leakage detection system is conducted on a quarterly basis. Monitoring locations S07-24 and LDMP-5 will become part of the monitoring program in 2025, which is located on the west side of Phase 1. The locations of the liner leakage detection monitoring points can be seen in **Figure 7**.

Table 3-5: Liner Leak Detection Monitoring Locations

Liner Leakage Monitoring Locations	Location
LDS-E	Liner leakage detection sump (Cell 1 East)
LDS-W	Liner leakage detection sump (Cell 1 West)
LDMP-1	Liner leakage detection port (accessed from north side cell 1 east)
LDMP-2	Liner leakage detection port (accessed from north side cell 1 east)
LDMP-3	Liner leakage detection port (accessed from east side cell 1 east)
LDMP-4	Liner leakage detection port (accessed from east side cell 1 east)
LDMP-5	Liner leakage detection port (accessed from north side cell 1 west) (2025)
LDMP-6	Liner leakage detection port (accessed from north side cell 1 west) (2025)
LDMP-7	Liner leakage detection port for aeration pond

The head of the liner is being monitored with leachate level transducers in the two leachate collection sumps to ensure that leachate levels do not exceed 30 cm.

3.7 Leachate Indicator Parameters

The following section provides a summary of leachate indicator parameters that are typically used when identifying leachate impact on ground and surface water at landfill sites.

Table 3-6: Typical Leachate Indicator Parameters

Parameter	Description
Alkalinity	Alkalinity typically increases down-gradient of landfills primarily due to elevated levels of dissolved carbon dioxide in affected water.
Ammonia	High concentrations of ammonia are often observed in landfill leachate, especially sites receiving waste with high organic content. Municipal Solid Waste (MSW) landfills often see concentrations above 500 mg/L, while DLC landfill such as this site have much lower concentrations in the untreated leachate.

Boron	Boron can be a useful leachate indicator parameter as it is not subject to retardation processes and is therefore a conservative tracer.
Chloride	Chloride is often found at significantly elevated levels in landfill leachate. This is particularly the case for MSW sites, but elevated levels are frequently noted at DLC sites as well. Chloride can be a very useful leachate indicator parameter as it is not subject to retardation processes and is therefore a conservative tracer.
Conductivity	Specific conductivity increases in leachate-affected groundwater due to the increased conductive capacity of water as a result of increased dissolved ions.
Hardness	Caused by the increased concentrations of calcium and magnesium ions due to the waste materials and more acidic pH breaking down the native lime-rich soils.
Hydrogen Sulphide	Hydrogen sulphide levels can be particularly high in both the leachate and in the landfill gas at sites receiving gypsum type waste such as drywall. Under anaerobic conditions, sulphide (as H2S) is observed through the reduction of sulphur species.
Iron and Manganese	Concentrations typically increase in landfill-affected groundwater due to the alteration of redox conditions within the groundwater. The breakdown of dissolved organic matter within leachate consumes dissolved oxygen in groundwater and creates reducing conditions. Where conditions are reducing, naturally-occurring iron and manganese oxides within the geologic material are reduced to more soluble forms.
ORP	Oxidation-Reduction Potential (Redox Potential) is often a useful indicator parameter as the ORP values in leachate impacted water is noticeably lower than in unimpacted water.
Petroleum hydrocarbons (including PAHs)	Waste in the form of creosote timbers and IL+ soil can contain petroleum hydrocarbons including polycyclic aromatic hydrocarbons (PAHs). It is therefore a useful indicator parameter since petroleum hydrocarbons are not naturally present in groundwater on-site.
Sulphate	Construction and demolition waste landfills often generate elevated concentrations of sulphate in leachate due to the abundance of sulphate available from gypsum in drywall and other building materials in the waste stream.

3.8 Applicable Water Quality Standards

Environmental standards in British Columbia (BC) are governed under the Contaminated Sites Regulation (CSR), which is a key component of the Environmental Management Act (EMA). The applicable standards are determined based on the site's land use and groundwater utilization. According to prior reports from GHD, the following environmental standard has been applied at the site:

- Schedule 3.2 – Generic Numerical Water Standards, Column 6: Drinking Water (DW)

Although the groundwater at the site is not currently used for drinking water, the BC ENV Protocol 21 requires that drinking water use standards be considered by default unless site-specific conditions justify their exclusion. To formally exclude drinking water standards, additional hydraulic response testing would be necessary.

Standards for aquatic life, irrigation, and livestock use were deemed unnecessary based on the following justifications:

- A hydrogeological assessment cited in GHD's 2023 Operations and Monitoring Report and the Hydrogeology and Hydrology Characterization Report (HHCR) (originally issued May 27, 2016, and last updated May 4, 2021) established that groundwater at the site does not discharge into any surface water bodies within 500 meters. As a result, aquatic life standards were not applied.
- No agricultural activities, including groundwater extraction for irrigation or livestock watering, are known to be occurring within 500 meters of the site, thereby excluding the need for irrigation and livestock standards.

As a result, the BC CSR Drinking Water (DW) standards were applied when evaluating groundwater quality at the site. While these standards are not directly applicable to surface water and raw leachate, they were used as a reference point to assess whether surface water and leachate quality might impact groundwater conditions. The groundwater and surface water analytical results were assessed in accordance with BC CSR DW standards as outlined in Section 3.5 of the Operational Certificate (OC). These standards are recognized as appropriate benchmarks for monitoring water quality at permitted landfills, as stated by the BC Ministry of Environment (MOE) that is outlined in 2024 EnviroChem – Field Inspection & Sampling Report in **Appendix E**.

3.9 Sampling and Analytical Procedures

The first three quarterly sampling events in 2024 were completed by GHD, while the fourth quarterly sampling event was completed by EnviroChem Services Inc. (EnviroChem). Based on the information provided in the last three annual reports that GHD completed for this Site, it is SHA's understanding that GHD completed the first three sampling events in 2024 in accordance with the BC Ministry of Environment and Climate Change Strategy (2020) British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air Emission, Water, Wastewater, Soil, Sediment and Biological Samples (British Columbia, Ministry of Environment, 2013) (BC Field Sampling Manual).

It is noted in EnviroChem's field inspection and sampling report (**Appendix E**), that they also completed the fourth sampling event in 2024 in accordance with the BC Field Sampling Manual.

3.10 Data Quality Assessment and Verification

As information regarding data verification and QA/QC review for the Q1-Q3 2024 data by GHD could not be verified, it is not known whether this was completed. Based on the information provided in the

last three annual reports that GHD has completed for this Site, it is SHA's understanding that data verification and assessment of the QA/QC information was completed.

EnviroChem completed data verification to assess laboratory and field QA/QC measures for the Q4 2024 sampling event. The QA/QC results are presented in the EnviroChem's field inspection and sampling report in **Appendix E** which indicates that data exhibits acceptable levels of accuracy and precision with the qualifications noted.

3.11 Laboratory Program

All samples collected in 2024 were submitted to accredited laboratories for analysis. Samples collected from the leachate treatment system by Northwin staff were submitted to ALS Environmental Inc. in Burnaby BC for analysis, and samples collected by GHD (Q1-Q3) and EnviroChem (Q4) were submitted to Bureau Veritas in Burnaby BC.

4. WATER LEVEL MONITORING RESULTS

EnviroChem conducted a groundwater level survey at the Q4 2024 monitoring event, with the results from the survey shown in **Table 4-1** (EnviroChem, 2024). The water level measurements for McIvor and Rico Lake were recorded on January 27, 2025. **Figure 5** shows the groundwater contours and the inferred flow direction at the Q4 2024 monitoring event. As can be seen in the figure, the groundwater gradient across the site is relatively steep at approximately 4%, with an inferred flow direction towards the southeast. Groundwater level data was not available for the Q1-Q3 period at the time of preparation of this report. The Q4 2024 results are consistent with historical results for the Site.

Table 4-1: Water Level Survey Data December 2024 and January 2025

Monitoring Location	Depth to Bottom (m BGS)	Reference Elevation TOR (m AMSL)	Depth to Water (m BTOR)	Water Table Elevation (m AMSL)
	Monitoring Date: December 18-20th, 2024 & January 27th, 2025			
MW1-14	11.0	172.9	7.65	165.2
MW2-14	21.6	173.8	16.81	157.0
MW2A-16	45.4	173.9	16.73	157.2
MW3-14	18.6	168.6	14.66	153.9
MW4A-15	21.3	169.3	7.00	162.3
MW4B-15	18.3	169.3	7.15	162.1
MW5A-15	10.7	191.9	-	-
MW5B-15	8.2	192.0	-	-
MW6-17	11.3	*185.4*	7.50	177.9
MW7-17	4.3	*187.5*	-	-
MW8-17	18.8	*192.5*	-	-
MW9-17	33.5	*191.7*	24.41	167.3
MW10-17	46.3	*189.1*	42.34	146.8
MW11-19	54.9	194.8	48.54	146.3
MW12-22	45.1	N/A	40.98	-
MW15A-18	15.2	183.1	-	-
MW15B-18	9.0	183.2	-	-
PZ1-19	20.4	192.1	-	-
McIvor Lake*	-	-		177.3
Rico Lake**	-	180.3	0.40	

Notes:

191.88	Surveys completed by McElhanney on April 6, 2016, and March 16 and 31, 2017.
185.4	Survey completed by Upland Excavating Ltd. on January 29th, 2015, March 8, 2016, and April 6th, 2016.
m BGS	metres below ground surface.
m AMSL	metres above mean sea level (WGS1984).
TOR	top of riser.
m BTOR	meters below top of riser
*	McIvor Lake elevations are based on BC Hydro record of water elevations at Ladore Dam recorded every three hours.
**	Surface water gauge reference elevation refers to the bottom of the gauge (0 m on gauge = 180.33 m AMSL).

5. EMP RESULTS AND WATER QUALITY ASSESSMENT

5.1 Leachate Quality and Quantity

5.1.1 Raw Leachate (S06-21)

The chemistry of the raw leachate as collected at S06-1was evaluated by EnviroChem, and is presented in **Appendix E**. In their report they conclude that the raw leachate is consistent with historical results, with no major changes in the chemistry.

5.1.2 Treated Leachate

In 2024, a total of 4,500 m^3 of treated leachate was discharged to the infiltration pond, which is within the max volume of leachate effluent discharge of 7,139 m^3/calendar year stipulated in the OC. As shown in Table 1, all treated discharged leachate met CSR–DW criteria, except for Quinoline (Feb. 14th, 2024), Boron (Oct. 31, Nov. 07, Nov. 18 and Dec. 16, 2024). Treated leachate was discharged on the following dates as shown in **Table 1**:

- Feb. 14th, 2024 – discharged – Exceedances of Quinoline of 0.096 µg/L (CSR-DW limit of 0.05 µg/L)
- Feb. 16th, 2024 – discharged – No exceedances
- Oct. 31st, 2024 – discharged – Exceedances of Boron of 6.88 mg/L (CSR-DW limit of 5 mg/L)
- Nov. 7th, 2024 – discharged – Exceedances of Boron of 6.64 mg/L (CSR-DW limit of 5 mg/L)
- Nov. 18th, 2024 – discharged – Exceedances of Boron of 6.72 mg/L (CSR-DW limit of 5 mg/L)
- Dec. 16th, 2024 – discharged – Exceedances of Boron of 5.26 mg/L (CSR-DW limit of 5 mg/L)

As mentioned in Chapter 8 & 9, Northwin Environmental is in the process of redesigning and improving the existing leachate treatment process to mitigate exceedance of CSR-DW criteria and protect against potential adverse environmental impacts.

5.2 Landfill Leak Detection System Water Quality

As was mentioned in Chapter 3, the New Landfill is outfitted with a liner leakage detection system. There are a total of seven leachate leakage detection monitoring ports (LDMPs), with two ports on the east side of Cell 1, four ports on the north side of Cell 1, and one port at the aeration pond. In addition, there is one leakage detection port located under each of the two leachate collection sumps.

As reported by EnviroChem, all leakage detection points were dry at the Q4 2024 monitoring event. No field notes for the Q1-Q3 2024 sampling events were available at the time of preparation of this report, so the status of the leakage detection system for this period is unknown. As GHD reported in the annual report for 2023 that all leakage detection points were dry during Q1-Q4 2023, it is reasonable to believe that they were also dry during the Q1-Q3 2024 period.

5.3 Groundwater Quality

The groundwater results from 2024 are presented in Table 3 in EnviroChem's report found in **Appendix E.** In this report, EnviroChem evaluates all groundwater results against the water quality standards that are applicable for the Site (CSR-DW), and compares the data against leachate indicator parameters.

EnviroChem concluded that with only one exception (benzo(a)pyrene in MW6-17 (upgradient well location) at the Q1 2024 sampling event), the results from the 2024 sampling events were all below the BC CSR-DW standards. EnviroChem stated that the elevated level of benzo(a)pyrene that was noted in MW6-17 was likely caused by elevated turbidity which can create false positive results for hydrocarbons.

As the EnviroChem report fully covers the regulatory aspects of groundwater monitoring for the Site, this section will therefore be limited to historical trends and spatial variance across the site.

5.3.1 Conductivity Heat Map

One of the first parameters that is often used as a leachate indicator is electrical conductivity (EC) as leachate impacted water always has elevated EC values. The EC values can also be naturally elevated due to elevated levels of dissolved minerals such as calcium and magnesium. SHA generated a "heatmap" for EC from the Q4 2024 results, and it is shown on Figure 6. Surprisingly, the heatmap shows elevated EC in the northwestern corner of the site at monitoring well MW6-17, which is upgradient of the landfill. The borehole log for MW6-17 shows that this is a relatively shallow well, with top two meters of the borehole consisting of fill, and not native soil. The elevated EC observed in this corner is most likely attributable to non-native fill or de-icing salts from the nearby road, as there is little evidence to suggest that the landfill is the source. There is also a sliver in the southeastern corner with slightly higher EC values. This could be the result from the old landfill that was located in this corner. The figure also shows that the EC values around the new landfill cell, leachate treatment ponds, and the infiltration pond are not elevated, which suggests that the landfilling activities are currently not contributing to dissolved ion loading of the groundwater at the site.

5.3.2 Long Term Trends

SHA compiled all available historical data and generated time vs concentration graphs for the following leachate indicator parameters: ORP, alkalinity, chloride, conductivity, hardness, sulphide, sulphate, TDS, ammonia, boron, calcium, iron, magnesium and manganese. All graphs are shown in **Appendix D**, with the D1 series covering the last four years of data (2021 to 2024), and the D2 series covering all the years with data (2015 to 2024).

None of the plotted parameters display any definitive trends. ORP had stable readings between 2015 and 2021, followed by variable results during 2021 and 2022. As the variability was noted even at the upgradient wells during this period, the variability was likely related to sampling procedures and/or instrument calibration. The latest event in December 2024 showed unusually low ORP values for eight of the eleven wells that were tested. These low values were likely a result of an instrument malfunction rather than actual changes in the groundwater conditions. The chloride concentrations in the groundwater at the site are low with most wells having less than 20 mg/L. As was noted in section 5.3.1 above, monitoring well MW06-17 had higher conductivity than all the other wells. This can be explained by the well consistently having noticeably higher concentrations of chloride, dissolved calcium, magnesium and manganese than the other wells. This suggests that this well is installed in a different type of soil formation than the other wells at the site. Leachate indicator parameters such as ammonia, hydrogen sulphide, sulphate, TDS, and dissolved iron have remained very low across the entire site.

Overall, no noticeable changes in the groundwater chemistry can be seen which indicate that the landfill has none to minimal impacts to the local ground water quality.

5.4 Stormwater

Stormwater monitoring is currently not required at the site since precipitation that falls on areas outside the landfill footprint rapidly infiltrates into the ground, and precipitation that falls within the lined cells is collected and treated as leachate.

5.5 Surface Water

The chemistry of the surface water samples collected from SW15-1 and SW15-2 was evaluated by EnviroChem, and is presented in **Appendix E**. In their report they conclude that the surface water in the two lakes is consistent with historical results, with no major changes in the chemistry.

5.6 Landfill Gas

As described in chapter 3, there are two landfill gas migration monitoring probes (LFG1-22 and LFG2-22) at the Site. There is one on the southern property line, and one beside the wash plant at the centre of the Site. The locations are shown on Figure 4. Due to miscommunication during the switch of the monitoring consultant mid 2024, the landfill gas monitoring was not completed in 2024. The November 2022 results showed no methane in LFG1-22, and 0.2% methane in LFG2-22. No methane was detected in the two probes in 2023. Monitoring probe LFG2-22 was monitored in March 2025 with no detectable levels of methane. Monitoring probe LFG22-1 could not be located at the Q1 2025 sampling event. Given that only one probe reading has shown detectable level (0.2%) of methane in the past three years, it is reasonable to assume that the landfill gas levels in the two probes were well below the 5% (v/v) criteria in 2024.

6. CONCLUSION AND RECOMMNEDATIONS –ENVIRONMENTAL MONITORING

6.1 Conclusions

The groundwater level measurements collected in 2024 show a relatively steep groundwater gradient across the site, with an inferred flow direction towards the southeast. This consistent with historical data.

The raw leachate samples collected from leachate sump S06-21 in 2024 would be considered relatively weak compared to many other landfills. In 2024, the ammonia levels ranged between 3.7 and 42 mg/L, BOD ranged between non detectable and 36 mg/L and conductivity ranged between 2,620 and 3,770 µS/cm. All results were consistent with historical data for leachate collected at Cell 1.

Landfill gas monitoring was not completed in 2024 due to miscommunication during the transition to a new environmental consultant overseeing the Site. As only occurrence with detectable level (0.2%) of methane was noted in LFG22-2 in 2022, non-detectable levels in 2023, and non-detectable at the Q1 2025 sampling event, it is reasonable to assume that in 2024, the gas concentrations in the two probes also was below the criteria of 5% (v/v).

6.2 Recommendations

It is recommended that the EMP for 2025 follows the 2024 program with only a few modifications. It is recommended that the new monitoring well (MW13) proposed by GHD in 2023 be installed and added to the monitoring program. In addition, it is recommended that the liner leakage monitoring probe (LDMP-7) for the leachate treatment pond also be added the EMP for 2025. The sampling parameters, sampling frequency, sampling locations for the 2025 EMP Plan can be seen in **Table 2**.

7. OPERATIONS AND DEVELOPMENT – ORIGINAL LANDFILL

7.1 Original Landfill

Permit PR-10807 was issued on June 1, 1992, for the Original Landfill. As the Comox Valley Regional District included this facility in their approved Solid Waste Management Plan, the Ministry of Environment and Climate change Strategy (ENV) issued the Operational Certificate (OC) on August 1, 2019, authorizing disposal of waste at the lined New Landfill. The OC authorized continued discharge to the existing Original Landfill lined cell prior to construction of the New Landfill.

7.2 Original Landfill Closure & Decommission

The Original Landfill includes an un-lined cell with an area of 0.7 ha and a lined cell with an area of 0.7 ha (85 m x 85 m) located at the southeast corner of the waste management area of the site as shown in **Figure 3**. The Original Landfill within the existing waste management area also included a material sorting area, leachate treatment equipment and related appurtenances.

The un-lined cell received wood waste, ash and burning residue, and construction and demolition waste since 1990s until the lined cell was constructed in April 2015. The liner system of the Original Landfill lined cell was constructed with two layers of 20 mil Coated Woven Polyethylene (CWPE) and a leak detection system in between. The leak detection layer consists of a 300 mm thick gravel drainage layer with a 100 mm PVC pipe at both ends as rises from the toe of the slope to the top of the north and east berms to check water level for the leak detection.

The leachate collection system in the lined cell includes leachate sumps, leachate extraction chamber located within the west side of the cell and a series of tanks for temporary storage and leachate treatment.

Waste was not discharged into the Original Landfill lined cell in 2022 which was covered by a tarp until November of the year when decommissioning of the Original Landfill began as shown in **Table 7-1**. During that period, the old landfill was fully decommissioned, all required sampling was conducted, and the necessary reporting was submitted to satisfy the Ministry of Environment (MoE). The original leachate management works were fully decommissioned in 2023, but the new leachate management works started in 2022.

Table 7-1: Original Landfill Waste Volumes (metric tonnes) by Year

Dates	Un-lined Cell (m^3)	Lined Cell (m^3)	Total Original Landfill (m^3)
Historical to Oct 4, 2019	35,000	4,446	39,446
Oct 5 thru December 31, 2019	0	5,445	5,445
January 1 thru December 31, 2020	0	7,812	7,812
January 1 thru December 31, 2021	0	4,464	4,464
January 1 thru December 31, 2022	0	0	0

Total Volumes by Year	**35,000**	**22,167**	**57,167**

Waste from the lined and un-lined Original Landfill was segregated by category (soil, fine debris and coarse debris) for relocation to the New Landfill as per Section 2.9 (b) of the OC. The segregation of the materials allowed for the protection of the liner by placement of only the fine waste and soil into first lift of the lined cell of the New Landfill with the coarse debris held back to be placed only in the second lift. Material from the Original Landfill lined cell was excavated until a clean base was encountered through visual inspection. The estimated volume of waste relocated from the Original Landfill to the New Landfill Cell 1 East is 74,746 m^3 (GHD, 2021).

The CWPE liners were also disposed of in the New Landfill with other waste. The original leachate management works were also decommissioned while some of the components were salvaged for reuse in the New Leachate Management System.

A confirmatory soil sampling program was carried out to ensure clean closure of the entire Original Landfill and the adjacent buffer zone. It was also ensured that the soils in place meet the applicable IL standard.

8. OPERATIONS AND DEVELOPMENT – NEW LANDFILL

8.1 New Landfill

The New Landfill includes two cells: Cell 1 East and Cell 1 West. Cell 1 East construction was completed in October 19, 2021 and started accepting waste on November 24, 2021 (GHD O & M Report, 2023). Cell 1 West construction activities began on October 12, 2022 and were completed on September 22, 2023 (GHD West Construction Report, 2024).

As per the 2021 DOCP, the design capacity of the New Landfill is 532,365 m^3 or 692,076 tonnes with an apparent density of 1.3 tonnes/m^3 (GHD DOCP, 2021). It was estimated in the 2021 DOCP that the New Landfill has an approximate lifespan of 13.3 years.

Cell 1 East and Cell 1 West have both been constructed with a primary and secondary base liner. The primary base liner comprises of a composite liner system consisting of a 60 mil HDPE textured geomembrane liner and a geosynthetic clay liner (GCL) beneath the leachate collection system while the secondary base liner composite liner system comprises of a 60 mil HDPE textured geomembrane liner and GCL below the leak detection system in between the two liner systems.

As per the 2021 DOCP development sequence, the landfill is proposed to be developed in three phases with a number of stages in each phase.

Phase 1: Consists of two stages - Stage 1 East and Stage 1 West – with a total capacity of 207,784 m^3
Phase 2: Consists of three stages – Stage 2A, Stage 2B, Stage 2C – with a total capacity of 178,280 m^3
Phase 3: Consists of three stages – Stage 3A, Stage 3B, Stage 3C – with a total capacity of 145,761 m^3

As per the survey completed on January 29th, 2025, Cell 1 West has 47,425 m^3 of waste in place while Cell 1 East has 92,827 m^3 of waste in place with a total of 140,252 m^3 and the remaining capacity of 67,532 m^3 for the two stages of Phase 1 as presented above.

The new leachate system has been successfully commissioned. A Registered Site Number (RS#) has been assigned. Demolition waste has been placed in Cell 1 East and West, with leachate collection active from both cells.

8.2 New Leachate Management Works

Leachate works for Cell 1 West were completed, and leachate is now being treated along with that from Cell 1 East that was previously completed. The leachate treatment system was commissioned as per the 2021 DOCP.

8.3 Summary of DOCP Implementation

The latest 2021 GHD DOCP will be under review in 2025 and a new revised DOCP will be prepared no later than December, 2026.

8.4 2024 Significant Works

No significant works conducted or completed in 2024.

8.5 Construction Reports

The Northwin Landfill expansion included the construction and commissioning of Cell 1 East, Cell 1 West, and associated leachate management ponds to improve waste containment, leachate treatment, and environmental compliance (**Appendix C**). The project followed rigorous engineering, quality control, and regulatory requirements, ensuring the safe operation and long-term sustainability of the landfill.

8.5.1 Completed Phases

Site Preparation & Excavation: Completed for both cells, including subgrade preparation and berm construction.

1. Cell 1 East Construction (March 2021 – October 2021)
   - Double liner system with leachate collection and leak detection layers.
   - Leachate treatment facility (LTF) and infiltration ponds built for water management.
   - Initial commissioning of leachate treatment system with compliance testing.
   - QA/QC inspections and final deficiency corrections completed.

2. Cell 1 West Construction (October 2022 – September 2023)
   - Integrated with Cell 1 East's leachate treatment system.
   - Double liner and leachate collection system installed.
   - QA/QC inspections and final deficiency corrections completed.

3. Leachate Treatment Facility (LTF) & Ponds
   - Aeration Pond:
     Includes aeration, filtration, and chemical treatment for contaminants removal.
     Adjustment made to batch size, pH levels, chemical dosing.
   - Effluent Holding Pond:
     Initial construction in October 2021, expanded in November 2021 due to under sizing issues.
     Functionality confirmed through pump tests and sampling.
   - Infiltration Pond:
     - Treated effluent tested before discharge into the infiltration pond.
     - Receives treated leachate from the LTF.
     - Regular monitoring ensures compliance with BC Contaminated Sites Regulation (CSR) Schedule 3.2 Drinking Water Criteria.

8.5.2 Ongoing Projects

- Leachate Monitoring & Treatment Adjustments
  - Periodic sampling and chemical dosing optimization to maintain CSR Drinking Water Criteria compliance.
  - Monitoring of pH, dissolved metals, sulfate, boron, and PAHs as primary contaminants.
  - Adjustments to chemical treatment and aeration levels as needed.

- QA/QC for Leachate Collection & Leak Detection System

- Continued inspections and data collection to ensure adequate drainage and liner integrity.
- Refinement of leachate recirculation and pumping strategies.

8.5.3 Planned Developments

- Final Approval & Certification
  Submission of the commissioning report to the Ministry of Environment to certify compliance.
- Expansion of Landfill Operations
  Preparation for future cells and capacity expansion.
  Enhanced stormwater and leachate diversion strategies.
- Operational Optimization
  Adjustments to treatment cycles and aeration efficiency.
  Implementation of performance monitoring plans to ensure long-term stability.
- Long-Term Environmental Compliance & Reporting
  Scheduled compliance reporting to regulatory agencies.
  Continued leachate treatment efficiency assessments.

8.5.4 Key Metrics

- Construction Timeline:
  - Cell 1 East: March 2021 – October 2021.
  - Cell 1 West: October 2022 – September 2023.
  - Ponds Expansion: October 2021 – November 2021.
  - Leachate Treatment Facility: Commissioned between 2021 – 2023.
- Leachate Treatment Capacity:
  - Average batch size: 625 m^3, maximum 980 m^3 per cycle.
- Quality Compliance:
  - Over 24 sampling events completed between 2021-2023.
  - Treated leachate was discharged when compliant, otherwise recirculated.
  - Primary contaminants monitored: Sulfates, metals, PAHs, and pH levels.

8.5.5 Challenges & Resolutions

1. Historical Data Delays
   - Challenge: Slow acquisition of historical leachate treatment data.
   - Resolution: Additional sampling and QA/QC verification.

2. Effluent Holding Pond Under sizing (2021)
   - Challenge: Initial pond size insufficient for peak flows.
   - Resolution: Expansion completed in November 2021 to meet storage needs.

3. Liner Damage During Installation & Repairs (2022)
   - Challenge: Minor liner damage observed during installation.
   - Resolution: Immediate repairs & QA/QC re-inspections.

4. Leachate Exceedances
    - Challenge: Occasional elevated sulfate, boron, and PAHs in treated effluent.
    - Resolution: Additional treatment cycles & chemical dosing optimizations.

5. Construction Delays (Winter 2022)
- Challenge: Seasonal construction delays in the winter of 2022
- Resolution: Resumed June 2023, completed by September 2023

The construction and commissioning of Cell 1 East, Cell 1 West, and associated ponds have significantly enhanced landfill leachate containment and treatment at Northwin Landfill. The leachate treatment facility has been optimized to meet strict environmental regulations, ensuring safe and sustainable landfill operations. Continued monitoring and system refinements will further improve treatment efficiency and long-term environmental protection.

8.6 Waste Tonnage and Volume

In 2024, the New Landfill accepted a total 26,285 tonnes of waste for discharge to the New Landfill:

Table 8-1: 2024 New Landfill Waste Tonnage and Volume

Material Type	Tonnage (m^3)
Asbestos	266 (204)
Creosote	37 (28)
Demo	10,456 (8,043)
Soil	15,485 (11,912)
Other (Unspecified)	42 (32)
Grand Total	**26,285 (20,219)**

No recyclable material was diverted from the landfill in 2024 as the landfill only received residual material.

No hazardous waste, controlled waste, and attractants were received in 2024.

8.7 Airspace Consumption, Remaining Volume, and Remaining Life

As shown in Table 8.2, the design capacity of Cell 1 East and Cell 1 West is 207,784 m^3. The total airspace consumption from January 1 to December 31, 2024 was approximately 20,219 m^3. The total air space consumed to date is 140,252 m^3. The total landfill capacity is 532,365 m^3. Using the maximum allowable discharge rate of 45,000 tonnes per year the annual fill rate is about 34,615 m^3 per year. The remaining airspace capacity of the New Landfill is approximately 392,113 m^3. The remaining lifespan of the facility at a fill rate of 34,615 m^3/year is 11.3 years.

As per the survey completed on January 29th, 2025, Cell 1 West has 47,425 m^3 of waste in place while Cell 1 East has 92,827 m^3 of waste in place with a total of 140,252 m^3 and the remaining capacity of 67,532 m^3 for the two stages of Phase 1 as presented above. The remaining life of the constructed cells is approximately 1.9-years effective January 29th, 2025.

Table 8-2: New Landfill Airspace Consumption, Remaining Volume, And Remaining Life

	Total New Landfill (m^3)
November 24 thru December 31, 2021 (estimated)	2,262
January 1 thru December 31, 2022 (estimated)	34,472
January 1 thru December 31, 2023 (estimated)	29,482
Relocation of Original Landfill (estimated)	57,167
January 1 thru December 31, 2024 (estimated)	20,219
Total Waste Discharged to Cell 1 East and Cell 1 West	**140,252 Surveyed**
Cell 1 East and Cell 1 West Capacity	**207,784**
Airspace Remaining	**67,532**
Remaining Life in Constructed Cells	**1.9-years**

8.8 Leachate Treatment

As per the leachate treatment concept outlined in the commissioning report, below is a summary of the new leachate treatment concept:

Leachate is collected from the landfill cells via a series of perforated leachate collector pipes installed at the base liner system of the New Landfill cells and conveyed to two sumps: Cell 1 East Sump and Cell 1 West Sump. Leachate from the sumps is pumped to the New Leachate Treatment Facility.

The New Leachate Treatment Facility begins with pumping the leachate to the aerated treatment pond with submerged aeration diffusers, which also serves as a flow equalization pond. The treatment operation is performed as a weekly batch at the estimated peak daily rates with an average batch size ranging from 625 m^3 to 1,400 m^3. The leachate undergoes aeration in the equalization pond as filling continues for one batch. Once the aeration cycle is complete, leachate is then pumped through a shipping container where chemicals for oxidization (Hydrogen Peroxide - H_2O_2), Chemical for pH adjustment (lime) and coagulants and flocculants are added through injection ports. After addition of chemicals in the shipping container, leachate continues to be mixed for the target treatment cycle and then tested. The leachate is then pumped through a series of sand filters. If the leachate meets field testing parameters it is then discharged to the effluent holding pond, otherwise it is recirculated back into the aeration treatment pond for additional treatment.

The effluent batch is held in the effluent holding pond until the effluent quality meets discharge criteria based on sampling and laboratory analysis. If excessive levels of hydrocarbons are detected during testing, the leachate is recirculated through granular activated carbon filters back into the effluent holding pond. The leachate continues to be recirculated through the activated charcoal filters, as required, until the effluent quality meets the discharge criteria. Once the leachate meets all discharge criteria it is then discharged into the infiltration pond.

The target discharge criteria from the Effluent Pond is the CSR Schedule 3.2 Drinking Water Criteria.

Figure 8-1 below depicts the leachate treatment process:

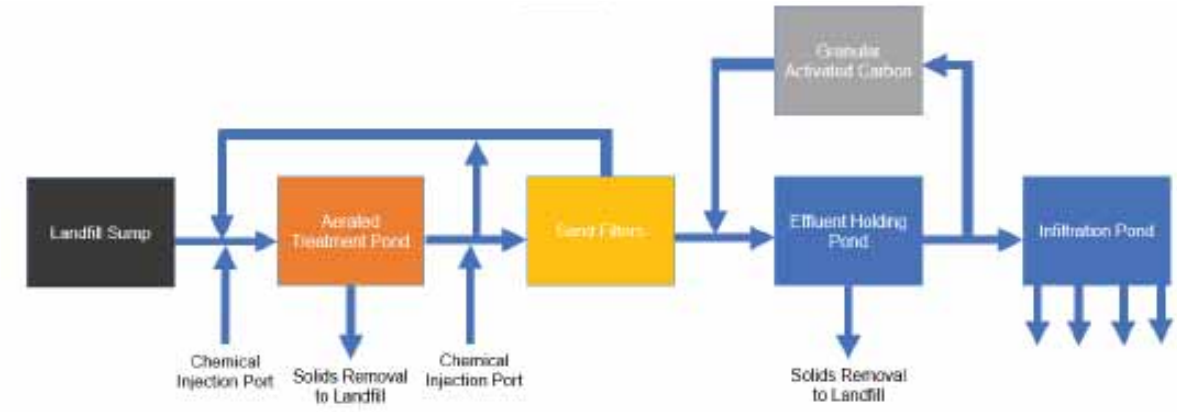


Figure 8-1: Leachate Treatment Process Diagram (Source: GHD West & Ponds Commissioning Report, 2024)

Currently leachate continues to be treated and sampled in batches, with results compared to standards prior to discharge. There have been no instances of untreated leachate discharges.

8.9 Addressing Non-Compliance

There were non-compliances outlined in the Ministry's (ENV) Advisory letter addressed to the permit holder dated July 16, 2024.

8.10 Public Complaints

There were no public complaints received during this reporting period in accordance with the management of Northwin Landfill.

9. SUMMARY AND RECOMMENDATIONS – OPERATIONS

9.1 Conclusions

The Original Landfill was effectively decommissioned following the completion of waste segregation, leachate system decommissioning, and confirmatory soil sampling. All waste, including materials from both lined and unlined cells, was relocated to the New Landfill, ensuring compliance with regulatory standards. The site was fully cleared, and the liner system, where applicable, was also disposed of at the New Landfill, completing the closure process.

The New Landfill, with its Cell 1 East and Cell 1 West, has been successfully constructed and is operational, featuring an advanced liner and leachate collection system to minimize environmental risks. The landfill was originally designed for 13.3 years of operational capacity. Based on the January 29th, 2025 survey, it was determined that the remaining lifespan is 11.3 years.

The landfill is being developed in three phases, ensuring adequate capacity for future waste disposal needs. The leachate treatment facility has been commissioned and is meeting discharge criteria under regulatory guidelines. Additionally, the relocation of waste from the Original Landfill to the New Landfill was carried out efficiently, with careful placement to protect the integrity of the new liner.

Key Achievements Include:

- Full decommissioning of the Original Landfill, including leachate system decommissioning.
- Completion of Cell 1 East and Cell 1 West lined cells at the New Landfill.
- Implementation of a double-liner leachate collection and leak detection system.
- Construction of a functional leachate treatment facility, ensuring compliance with water quality standards.
- No recorded incidents of untreated leachate discharges.
- No public complaints during the reporting period.

Despite these achievements, there are remaining operational challenges to be addressed, including airspace limitations, ongoing leachate treatment adjustments, and future capacity expansion.

9.2 Recommendations

- Leachate Treatment Optimization
    - Continue regular sampling and monitoring to ensure compliance with environmental regulations.
    - Implement periodic adjustments to chemical dosing and aeration efficiency based on leachate composition.
    - Consider additional filtration systems or treatment expansion as leachate volume increases.

- Future Capacity Planning
    - Given the 1.9-year remaining life in the current landfill cells, initiate planning for Phase 2 development to prevent capacity constraints.

    - Continue with the three-phase landfill expansion plan while assessing new technologies for waste volume reduction.

- Operational Adjustments & Efficiency Improvements
    - Enhance stormwater and leachate diversion strategies to reduce treatment demands.
    - Improve liner integrity inspections and quality control processes during future construction to prevent any future damage.
    - Monitor airspace consumption closely to optimize waste compaction and maximize landfill lifespan.

- Environmental & Regulatory Compliance
    - Address any outstanding non-compliance issues as outlined in the Ministry's Advisory letter.
    - Maintain transparency with regulatory agencies through scheduled reporting and environmental audits.

- Public Awareness & Community Engagement
    - Continue proactive public engagement efforts to maintain community trust and transparency.
    - Establish an open feedback mechanism to address potential public concerns before they escalate.

By following these strategic recommendations, the New Landfill will continue to operate efficiently, maintain compliance with environmental standards, and ensure long-term sustainability in waste management.

10. LIMITATIONS

This report has been prepared by Sperling Hansen Associates (SHA) on behalf of Northwin Environmental Ltd. in accordance with generally accepted engineering practices to a level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions in British Columbia, subject to the time limits and financial and physical constraints applicable to the services.

The report, which specifically includes all tables and figures, is based on engineering analysis by SHA staff of data compiled during the course of the project. Except where specifically stated to the contrary, the information on which this study is based has been obtained from external sources. This external information has not been independently verified or otherwise examined by Sperling Hansen Associates to determine its accuracy and completeness. Sperling Hansen Associates has relied in good faith on this information and does not accept responsibility of any deficiency, misstatements or inaccuracies contained in the reports as a result of omissions, misinterpretation and/or fraudulent acts of the persons interviewed or contacted, or errors or omissions in the reviewed documentation.

The report is intended solely for the use of Northwin Environmental Ltd. Any use which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Sperling Hansen Associates does not accept any responsibility for other uses of the material contained herein nor for damages, if any, suffered by any third party because of decisions made or actions based on this report. Copying of this intellectual property for other purposes is not permitted.

The findings and conclusions of this report are valid only as of the date of this report. The interpretations presented in this report and the conclusions and recommendations that are drawn are based on information that was made available to Sperling Hansen Associates during the course of this project. Should additional new data become available in the future, Sperling Hansen Associates should be requested to re-evaluate the findings of this report and modify the conclusions and recommendations drawn, as required.

Sperling Hansen Associates has enjoyed working on this project with Northwin Environmental Limited and looks forward to continuing to work with you on this project. Should you have any questions or concerns regarding this report, or require any further information please feel free to contact the undersigned at 604-986-7723.

Report Prepared by:

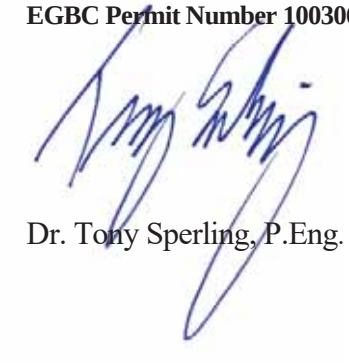


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March 28th, 2025

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TABLES

Table 1: Discharged Treated Leachate

SampleType:			Discharged Treated Leachate					
Sample ID:			New Landfill Holding Pond Feb 14, 2024	New Landfill Aeration Pond Feb 16, 2024	Aeration Pond Pre Sample	Aeration Pond Post Sample	Aertation Pond Post Sample	Aeration Pond
Sample Date:		**BC CSR[1]**	14-Feb-2024	16-Feb-2024	31-Oct-2024	07-Nov-2024	18-Nov-2024	16-Dec-2024
Physical Tests (Matrix: Water)								
Hardness (as CaCO3), dissolved	mg/L				301			
Anions and Nutrients (Matrix: Water)								
Sulfate (as SO4)	mg/L	500	280	264	260	224	167	104
Dissolved Metals (Matrix: Water)								
Aluminum, dissolved	mg/L	9.5	0.0377	0.0551	0.122	0.0416	0.0754	0.0834
Antimony, dissolved	mg/L	0.006	0.00193	0.00415	0.00108	0.00105	0.00106	0.00107
Arsenic, dissolved	mg/L	0.01	0.00207	0.00438	0.00389	0.00402	0.00332	0.00364
Barium, dissolved	mg/L	1.00	0.0195	0.0373	0.014	0.0131	0.0162	0.00768
Beryllium, dissolved	mg/L	0.008	<0.000040	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100
Bismuth, dissolved	mg/L	--	<0.000100	<0.000250	<0.000250	<0.000250	<0.000250	<0.000250
Boron, dissolved	mg/L	5	4.53	4.20	**6.88**	**6.64**	**6.72**	**5.26**
Cadmium, dissolved	mg/L	0.005	0.0000418	0.0000958	0.0000567	0.0000473	<0.0000250	0.0000272
Calcium, dissolved	mg/L	--	73.1	151	77.4	80.7	79.4	38.4
Cesium, dissolved	mg/L	--	0.000075	0.000179	0.000106	0.000109	0.000104	0.000092
Chromium, dissolved	mg/L	0.05	0.00229	0.00488	0.00337	0.00319	0.0039	0.00404
Cobalt, dissolved	mg/L	0.02	0.0019	0.0042	0.00163	0.00155	0.00141	0.00091
Copper, dissolved	mg/L	1.5	0.0205	0.0456	0.0161	0.0168	0.0164	0.0068
Iron, dissolved	mg/L	6.50	0.199	0.364	0.115	0.115	0.115	0.081
Lead, dissolved	mg/L	0.01	0.000118	<0.000250	<0.000250	<0.000250	<0.000250	<0.000250
Lithium, dissolved	mg/L	0.008	0.0022	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Magnesium, dissolved	mg/L	--	19.7	41.9	26.2	27.2	25.9	23.5
Manganese, dissolved	mg/L	1.50	0.201	0.43	0.0293	0.0457	0.0682	0.0154
Mercury, dissolved	mg/L	0.001	0.00	0.00	<0.0000050	0.0000075	0.00	<0.0000050
Molybdenum, dissolved	mg/L	0.25	0.00309	0.00675	0.00254	0.00244	0.00238	0.00112
Nickel, dissolved	mg/L	0.08	0.00432	0.00936	0.00498	0.00475	0.0043	0.00365
Phosphorus, dissolved	mg/L	--	<0.100	<0.250	<0.250	<0.250	<0.250	<0.250
Potassium, dissolved	mg/L	--	15	33	21.2	19.4	22.2	18.1
Rubidium, dissolved	mg/L	--	0.011	0.024	0.0152	0.0146	0.0164	0.0134
Selenium, dissolved	mg/L	0.01	0.000115	0.000274	<0.000250	<0.000250	<0.000250	<0.000250
Silicon, dissolved	mg/L	--	5.63	9.84	8.48	8.25	9.15	7.93
Silver, dissolved	mg/L	0.02	<0.000020	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Sodium, dissolved	mg/L	200	102	119	151	142	141	115
Strontium, dissolved	mg/L	2.50	0.463	0.979	0.526	0.485	0.527	0.288
Sulfur, dissolved	mg/L	--	86.4	186	86	83	58.4	37.2
Tellurium, dissolved	mg/L	--	<0.00040	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100
Thallium, dissolved	mg/L	--	<0.000020	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Thorium, dissolved	mg/L	--	<0.00020	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Tin, dissolved	mg/L	2.5	<0.00020	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Titanium, dissolved	mg/L	--	0.00091	0.0016	0.00178	<0.00150	0.00218	0.00231
Tungsten, dissolved	mg/L	0.003	<0.00020	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Uranium, dissolved	mg/L	0.02	0.00062	0.00134	0.000457	0.000452	0.00042	0.000343
Vanadium, dissolved	mg/L	0.02	0.00205	0.00413	0.00584	0.00471	0.00681	0.00904
Zinc, dissolved	mg/L	3.00	0.0217	0.0459	0.0071	0.0081	0.0074	0.0065
Zirconium, dissolved	mg/L	--	<0.00040	<0.00100	<0.00100	<0.00100	<0.00100	<0.00100

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Sample Date:		BC CSR[1]	14-Feb-2024	16-Feb-2024	31-Oct-2024	07-Nov-2024	18-Nov-2024	16-Dec-2024
Volatile Organic Compounds (Matrix: Water)								
Chlorobenzene	µg/L	80	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Chloromethane	µg/L	--	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Dichlorobenzene, 1,2-	µg/L	200	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dichlorobenzene, 1,3-	µg/L	--	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dichlorobenzene, 1,4-	µg/L	5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dichloropropane, 1,2-	µg/L	4.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dichloropropylene, cis+trans-1,3-	µg/L	1.5	<0.75	<0.75	<0.75	<0.75	<0.75	<0.75
Dichloropropylene, cis-1,3-	µg/L	--	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Tetrachloroethane, 1,1,1,2-	µg/L	6	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Tetrachloroethane, 1,1,2,2-	µg/L	0.80	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Trichloroethane, 1,1,2-	µg/L	3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Trichlorofluoromethane	µg/L	1000	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Volatile Organic Compounds [Drycleaning] (Matrix: Water)								
Carbon tetrachloride	µg/L	2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Chloroethane	µg/L	--	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dichloroethane, 1,1-	µg/L	30	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dichloroethane, 1,2-	µg/L	5.00	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dichloroethylene, 1,1-	µg/L	14	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dichloroethylene, cis-1,2-	µg/L	8	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dichloroethylene, trans-1,2-	µg/L	80	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dichloromethane	µg/L	50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dichloropropylene, trans-1,3-	µg/L	1.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Tetrachloroethylene	µg/L	30	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Trichloroethane, 1,1,1-	µg/L	8000	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Trichloroethylene	µg/L	5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Vinyl chloride	µg/L	2	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Volatile Organic Compounds [Fuels] (Matrix: Water)								
Benzene	µg/L	5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Ethylbenzene	µg/L	140	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Methyl-tert-butyl ether [MTBE]	µg/L	95	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Styrene	µg/L	800	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Toluene	µg/L	60	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Xylene, m+p-	µg/L	--	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Xylene, o-	µg/L	--	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Xylenes, total	µg/L	90	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Volatile Organic Compounds [THMs] (Matrix: Water)								
Bromodichloromethane	µg/L	100 (2)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bromoform	µg/L	100 (2)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Chloroform	µg/L	100 (2)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dibromochloromethane	µg/L	100 (2)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Hydrocarbons (Matrix: Water)		--						
EPH (C10-C19)	µg/L	5000	<250	<250	<250	<250	<250	<250
EPH (C19-C32)	µg/L	--	<250	<250	<250	<250	<250	<250
LEPHw	µg/L	--	<250	<250	<250	<250	<250	<250
HEPHw	µg/L	--	<250	<250	<250	<250	<250	<250

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SampleType:			Discharged Treated Leachate					
Sample ID:			New Landfill Holding Pond Feb 14, 2024	New Landfill Aeration Pond Feb 16, 2024	Aeration Pond Pre Sample	Aeration Pond Post Sample	Aertation Pond Post Sample	Aeration Pond
Sample Date:		BC CSR[1]	14-Feb-2024	16-Feb-2024	31-Oct-2024	07-Nov-2024	18-Nov-2024	16-Dec-2024
Polycyclic Aromatic Hydrocarbons (Matrix: Water)								
Acenaphthene	µg/L	--	<0.012	0.066	0.146	<0.010	<0.010	0.069
Acenaphthylene	µg/L	250	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Acridine	µg/L	--	0.039	0.052	0.11	<0.010	0.113	0.08
Anthracene	µg/L	1,000	0.012	0.015	<0.013	<0.010	<0.010	<0.010
Benz(a)anthracene	µg/L	0.07	0.01	<0.015	<0.010	<0.010	<0.010	<0.010
Benzo(a)pyrene	µg/L	0.01	0.0058	0.0086	<0.0050	<0.0050	<0.0050	<0.0050
Benzo(b+j)fluoranthene	µg/L	0.07	0.014	0.014	<0.010	<0.010	<0.010	<0.010
Benzo(b+j+k)fluoranthene	µg/L	--	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Benzo(g,h,i)perylene	µg/L	--	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(k)fluoranthene	µg/L	--	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene	µg/L	7	<0.014	<0.015	<0.010	<0.010	<0.010	<0.010
Dibenz(a,h)anthracene	µg/L	0.01	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Fluoranthene	µg/L	150	0.062	0.074	0.058	<0.010	<0.010	0.018
Fluorene	µg/L	150	0.012	0.026	0.115	<0.010	<0.010	0.043
Indeno(1,2,3-c,d)pyrene	µg/L	--	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Methylnaphthalene, 1-	µg/L	--	<0.010	<0.014	0.011	<0.010	<0.010	<0.010
Methylnaphthalene, 2-	µg/L	--	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Naphthalene	µg/L	80	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Phenanthrene	µg/L	--	0.024	<0.020	0.047	<0.020	<0.020	<0.020
Pyrene	µg/L	100	0.055	0.066	0.041	<0.010	0.024	0.018
Quinoline	µg/L	0.05	<0.050	**0.096**	<0.050	<0.050	<0.050	<0.050

1 - British Columbia Approved Water Quality Guidelines, 2018 Edition or Canadian Drinking Guidelines unless otherwise stated.
2 - Standard is for sum of concentrations of Bromodichloromethane, Bromoform, Chloroform and Dibromochloromethane
ND - Not detected at the associated reporting limit.
J - Estimated concentration.

ND (50)[a]	- Laboratory detection limit exceeds guideline
2890[a]	- Concentration exceeds standard.
--	- Currently no standard.
-	- Not analyzed.
µS/cm	- Microsiemens per centimetre
mg/L	- Milligrams per litre
mg/L	- Micrograms per litre
Deg C	- Degrees Celcius
NTU	- Nephelometric turbidity units
ppm	- parts per million
%v/v	- Percent volume.

Table 2

2025 Monitoring / Sampling Plan - Q1
New Landfill
Campbell River, British Columbia

Monitoring Location / Sample ID	Monitoring Wells																									Surface Water		Leachate					Leak Detection										Landfill Gas	
	Up-Gradient					Cross-Gradient		Down-Gradient					QA/QC Samples		Other											McIvor	Rico	S06-21	S07-24	TLIP[1]	QA/QC Samples		LDS-E	LDS-W	LDMP-1	LDMP-2	LDMP-3	LDMP-4	LDMP-5	LDMP-6	LDMP-7	LFG1-22	LFG2-22
	MW1-14	MW4A-15	MW4B-15	MW6-17	MW9-17	MW2-14	MW2A-16	MW3-14	MW10-17	MW11-19	MW12-22	MW13-25[5]	Field Blank	Field Dup	MW5A-15	MW5B-15	MW7-17	MW8-17	MW15A-18	MW15B-18	PZ1-19					SW15-01	SW15-02				Trip Blank	Field Dup											
Water Level Monitoring																																											
Depth to Water (m)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-	-
Depth to Bottom (m)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Elevation - McIvor Lake[2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Level - Rico Lake Gauge[3]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Field Parameters																																										
Conductivity (µS/cm)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	X	X	X	X	X	X	X	-	-
Dissolved Oxygen (DO) (mg/L)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	X	X	X	X	X	X	X	-	-
Oxidation Reduction Potential (ORP) (mV)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	X	X	X	X	X	X	X	-	-
pH	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	X	X	X	X	X	X	X	-	-
Temperature (°C)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	X	X	X	X	X	X	X	-	-
Total Dissolved Solids (TDS) (mg/L)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	X	X	X	X	X	X	X	-	-
Turbidity (NTU)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	X	X	X	X	X	X	X	-	-
Landfill Gases (Methane, etc.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X
Analytical Parameters																																										
General Chemistry																																										
Alkalinity (as CaCO3 pH=8.3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Alkalinity, total (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Bicarbonate (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Carbonate (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Hydroxide (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Chloride (dissolved)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Conductivity	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Hardness	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Hardness (dissolved)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Orthophosphate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Sulphate (Dissolved)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Total Un-ionized Hydrogen Sulfide as S	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Total Un-ionized Hydrogen Sulfide as H2S	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Total Sulfide as H2S	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Total Sulfide as S	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Total dissolved solids (TDS)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Total suspended solids (TSS)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Biochemical oxygen demand (BOD)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Chemical oxygen demand (COD)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Nutrients																																										
Ammonia-N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Nitrate (as N)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Nitrite (as N)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Nitrite/Nitrate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Metals																																										
Dissolved Metals (CSR incl. Hg)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Total Metals (CSR incl. Hg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
Petroleum Hydrocarbons / VOC																																										
LEPH / HEPH / PAH / EPH[4]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	X	-	-
BTEXSM / VPH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenols																																										
Chlorinated phenols	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-chlorinated phenols	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrophenols	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydroxy phenols	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table Notes:

1 - Sample collection performed by Northwin personnel.

2 - McIvor Lake elevation obtained online from: BC Hydro Ladore (LDR) Reservoir Surface Elevation

3 - Rico Lake surface elevation obtained from gauge at sampling location (Note: the reference elevation for "0" on the gauge is 180.3 m)

4 - If Leachate concentrations for LEPH / HEPH are 80% of CSR Schedule 3.2 Aquatic Life Criteria, include LEPH / HEPH analysis for Surface Water during next sampling event.

5 - Monitoring well MW13-25 not yet installed.

Table 2

2025 Monitoring / Sampling Plan - Q2
New Landfill
Campbell River, British Columbia

Monitoring Location / Sample ID	Monitoring Wells																									Surface Water		Leachate					Leak Detection										Landfill Gas	
	Up-Gradient					Cross-Gradient		Down-Gradient					QA/QC Samples		Other																															
	MW1-14	MW4A-15	MW4B-15	MW6-17	MW9-17	MW2-14	MW2A-16	MW3-14	MW10-17	MW11-19	MW12-22	MW13-25[5]	Field Blank	Field Dup	MW5A-15	MW5B-15	MW7-17	MW8-17	MW15A-18	MW15B-18	PZ1-19	McIvor SW15-01	Rico SW15-02	S06-21	S07-24	TLIP[1]	QA/QC Samples		LDS-E	LDS-W	LDMP-1	LDMP-2	LDMP-3	LDMP-4	LDMP-5	LDMP-6	LDMP-7	LFG1-22	LFG2-22																		

Table 2

2025 Monitoring / Sampling Plan - Q3
New Landfill
Campbell River, British Columbia

Monitoring Location / Sample ID	Monitoring Wells																									Surface Water		Leachate					Leak Detection										Landfill Gas	
	Up-Gradient					Cross-Gradient		Down-Gradient					QA/QC Samples		Other											McIvor	Rico	S06-21	S07-24	TLIP[1]	QA/QC Samples		LDS-E	LDS-W	LDMP-1	LDMP-2	LDMP-3	LDMP-4	LDMP-5	LDMP-6	LDMP-7	LFG1-22	LFG2-22
	MW1-14	MW4A-15	MW4B-15	MW6-17	MW9-17	MW2-14	MW2A-16	MW3-14	MW10-17	MW11-19	MW12-22	MW13-25[5]	Field Blank	Field Dup	MW5A-15	MW5B-15	MW7-17	MW8-17	MW15A-18	MW15B-18	PZ1-19					SW15-01	SW15-02				Trip Blank	Field Dup											
Water Level Monitoring																																											
Depth to Water (m)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-	-
Depth to Bottom (m)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Elevation - McIvor Lake[2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Level - Rico Lake Gauge[3]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Field Parameters																																										
Conductivity (µS/cm)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	X	X	X	X	X	X	X	-	-
Dissolved Oxygen (DO) (mg/L)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	X	X	X	X	X	X	X	-	-
Oxidation Reduction Potential (ORP) (mV)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	X	X	X	X	X	X	X	-	-
pH	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	X	X	X	X	X	X	X	-	-
Temperature (°C)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	X	X	X	X	X	X	X	-	-
Total Dissolved Solids (TDS) (mg/L)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	X	X	X	X	X	X	X	-	-
Turbidity (NTU)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	X	X	X	X	X	X	X	-	-
Landfill Gases (Methane, etc.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Analytical Parameters																																										
General Chemistry																																										
Alkalinity (as CaCO3 pH=8.3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Alkalinity, total (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Bicarbonate (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Carbonate (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Hydroxide (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Chloride (dissolved)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Conductivity	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Hardness	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Hardness (dissolved)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Orthophosphate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Sulphate (Dissolved)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Total Un-ionized Hydrogen Sulfide as S	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Total Un-ionized Hydrogen Sulfide as H2S	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Total Sulfide as H2S	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Total Sulfide as S	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Total dissolved solids (TDS)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Total suspended solids (TSS)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Biochemical oxygen demand (BOD)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Chemical oxygen demand (COD)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Nutrients																																										
Ammonia-N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Nitrate (as N)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Nitrite (as N)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Nitrite/Nitrate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Metals																																										
Dissolved Metals (CSR incl. Hg)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Total Metals (CSR incl. Hg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
Petroleum Hydrocarbons / VOC																																										
LEPH / HEPH / PAH / EPH[4]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	-	X	X	X	X	X	X	X	X	-	-
BTEXSM / VPH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenols																																										
Chlorinated phenols	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-chlorinated phenols	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrophenols	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydroxy phenols	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table Notes:

1 - Sample collection performed by Northwin personnel.

2 - McIvor Lake elevation obtained online from: BC Hydro Ladore (LDR) Reservoir Surface Elevation

3 - Rico Lake surface elevation obtained from gauge at sampling location (Note: the reference elevation for "0" on the gauge is 180.3 m)

4 - If Leachate concentrations for LEPH / HEPH are 80% of CSR Schedule 3.2 Aquatic Life Criteria, include LEPH / HEPH analysis for Surface Water during next sampling event.

5 - Monitoring well MW13-25 not yet installed.

Table 2

2025 Monitoring / Sampling Plan - Q4
New Landfill
Campbell River, British Columbia

Monitoring Location / Sample ID	Monitoring Wells																									Surface Water		Leachate					Leak Detection										Landfill Gas	
	Up-Gradient					Cross-Gradient		Down-Gradient					QA/QC Samples		Other																															
	MW1-14	MW4A-15	MW4B-15	MW6-17	MW9-17	MW2-14	MW2A-16	MW3-14	MW10-17	MW11-19	MW12-22	MW13-25[5]	Field Blank	Field Dup	MW5A-15	MW5B-15	MW7-17	MW8-17	MW15A-18	MW15B-18	PZ1-19	McIvor SW15-01	Rico SW15-02	S06-21	S07-24	TLIP[1]	QA/QC Samples		LDS-E	LDS-W	LDMP-1	LDMP-2	LDMP-3	LDMP-4	LDMP-5	LDMP-6	LDMP-7	LFG1-22	LFG2-22
																												Trip Blank	Field Dup												
Water Level Monitoring																																											
Depth to Water (m)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-	-	-	-	-	-	X	X	X	X	X	X	X	X	X	-	-
Depth to Bottom (m)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Elevation - McIvor Lake[2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Level - Rico Lake Gauge[3]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Field Parameters																																										
Conductivity (µS/cm)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Dissolved Oxygen (DO) (mg/L)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Oxidation Reduction Potential (ORP) (mV)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
pH	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Temperature (°C)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Total Dissolved Solids (TDS) (mg/L)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Turbidity (NTU)	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Landfill Gases (Methane, etc.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Analytical Parameters																																										
General Chemistry																																										
Alkalinity (as CaCO3 pH=8.3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Alkalinity, total (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Bicarbonate (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Carbonate (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Hydroxide (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Chloride (dissolved)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Conductivity	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Hardness	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Hardness (dissolved)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Orthophosphate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Sulphate (Dissolved)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Total Un-ionized Hydrogen Sulfide as S	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Total Un-ionized Hydrogen Sulfide as H2S	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Total Sulfide as H2S	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Total Sulfide as S	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Total dissolved solids (TDS)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Total suspended solids (TSS)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Biochemical oxygen demand (BOD)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Chemical oxygen demand (COD)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Nutrients																																										
Ammonia-N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Nitrate (as N)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Nitrite (as N)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Nitrite/Nitrate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Metals																																										
Dissolved Metals (CSR incl. Hg)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Total Metals (CSR incl. Hg)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Petroleum Hydrocarbons / VOC																																										
LEPH / HEPH / PAH / EPH[4]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
BTEXSM / VPH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	X	X	X	X	X	X	X	X	X	X	-	-
Phenols																																										
Chlorinated phenols	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Non-chlorinated phenols	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Nitrophenols	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-
Hydroxy phenols	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	X	X	X	X	X	X	X	X	X	-	-

Table Notes:

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5 - Monitoring well MW13-25 not yet installed.

FIGURES



X:\PRJ\PRJ24\PRJ24074 - NORTHWIN LANDFILL 2024 ENGINEERING\06_AUTOCAD DRAWINGS\01_DRAWINGS\PRJ24074 SITE LOCATION MAP.DWG

SPERLING HANSEN ASSOCIATES

Landfill Services Group

- Landfill Siting
- Design & Operations Plans
- Landfill Closure
- Environmental Monitoring

#8 - 1225 Keith Road East
North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723

LEGEND:

- UTM GRIDLINE
- PROPERTY BOUNDARY
- ROAD

CLIENT: NORTHWIN ENVIRONMENTAL LTD

PROJECT: NORTHWIN LANDFILLL 2024 ENGINEERING

TITLE: SITE LOCATION MAP

SCALE:	DATE:	PROJECT NO:
1:40,000	2025/03/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO:
DRAWN	NL	**FIGURE 1**
CHECKED	TS	



X:\PRJ\PRJ24\PRJ24074 - NORTHWIN LANDFILL 2024 ENGINEERING\06_AUTOCAD DRAWINGS\01_DRAWINGS\PRJ24074 PLAN.DWG

SPERLING HANSEN ASSOCIATES

Landfill Services Group

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- Design & Operations Plans
- Landfill Closure
- Environmental Monitoring

#8 - 1225 Keith Road East
North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723

LEGEND:

- UTM GRID LINE
- CONTOUR - EXISTING (5m)
- PROPERTY BOUNDARY
- LEACHATE TREATMENT SYSTEM
- LANDFILL BASE LINER EXTENTS
- SURVEY CONTROL POINT

TOPO SURFACE SURVEYED JANUARY 29, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

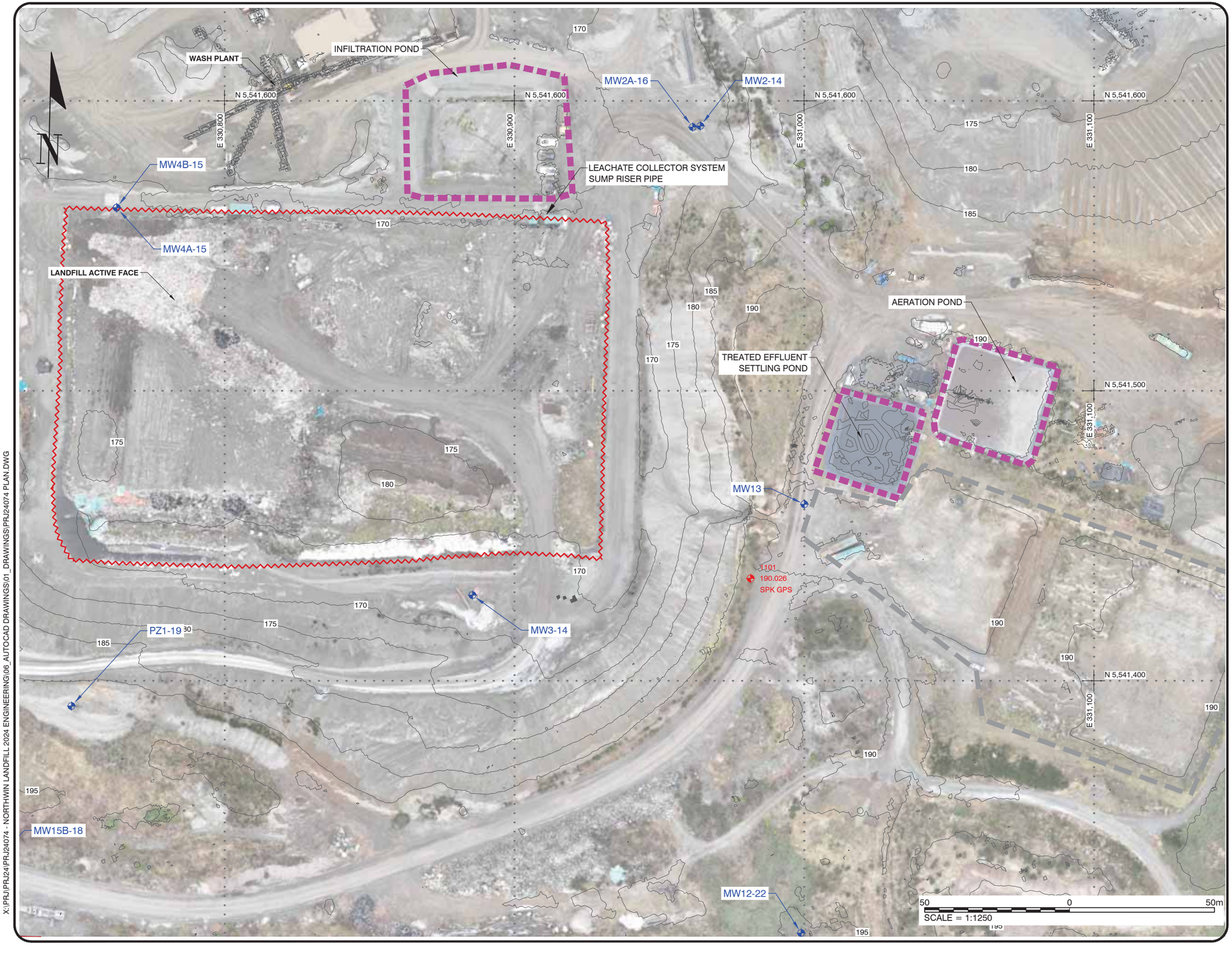
SITE ORTHO IMAGE BY NORTHWIN - JAN 29, 2025
OTHER IMAGE BY BING MAPS

CLIENT: NORTHWIN ENVIRONMENTAL LTD

PROJECT: NORTHWIN LANDFILLL 2024 ENGINEERING

TITLE: SITE PLAN

SCALE:	DATE:	PROJECT NO:
1:3000	2025/03/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO:
DRAWN	NL	**FIGURE 2**
CHECKED	TS	



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SPERLING HANSEN ASSOCIATES

Landfill Services Group
- Landfill Siting
- Design & Operations Plans
- Landfill Closure
- Environmental Monitoring

#8 - 1225 Keith Road East
North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723

LEGEND:

- UTM GRID LINE
- CONTOUR - EXISTING (5m)
- PROPERTY BOUNDARY
- LEACHATE TREATMENT SYSTEM
- ORIGINAL LANDFILL (DECOMMISSIONED)
- LANDFILL BASE LINER EXTENTS
- MONITORING WELL
- SURVEY CONTROL POINT

TOPO SURFACE SURVEYED JANUARY 29, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

SITE ORTHO IMAGE BY NORTHWIN - JAN 29, 2025

CLIENT: NORTHWIN ENVIRONMENTAL LTD

PROJECT: NORTHWIN LANDFILLL 2024 ENGINEERING

TITLE: NEW LANDFILL SITE PLAN - EXISTING TOPO JAN. 29, 2025

SCALE:	DATE:	PROJECT NO:
1:1250	2025/03/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO:
DRAWN	NL	**FIGURE 3**
CHECKED	TS	



X:\PRJ\PRJ24\PRJ24074 - NORTHWIN LANDFILL 2024 ENGINEERING\06_AUTOCAD DRAWINGS\01_DRAWINGS\PRJ24074 MONITORING LOCATIONS.DWG

SPERLING HANSEN ASSOCIATES

Landfill Services Group
- Landfill Siting
- Design & Operations Plans
- Landfill Closure
- Environmental Monitoring

#8 - 1225 Keith Road East
North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723

LEGEND:

- UTM GRID LINE
- CONTOUR - EXISTING (5m)
- PROPERTY BOUNDARY
- LEACHATE TREATMENT SYSTEM
- LANDFILL BASE LINER EXTENTS
- EXISTING MONITORING WELL
- PROPOSED MONITORING WELL
- EXISTING SURFACE WATER MONITORING LOCATION
- EXISTING BOREHOLE
- SOIL VAPOUR PROBE

TOPO SURFACE SURVEYED JANUARY 29, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

SITE ORTHO IMAGE BY NORTHWIN - JAN 29, 2025
OTHER IMAGE BY BING MAPS

CLIENT: NORTHWIN ENVIRONMENTAL LTD

PROJECT:

NORTHWIN LANDFILLL 2024 ENGINEERING

TITLE:

MONITORING LOCATIONS

SCALE:	DATE:	PROJECT NO:
1:5000	2025/03/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO:
DRAWN	NL	**FIGURE 4**
CHECKED	TS	



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SPERLING HANSEN ASSOCIATES

Landfill Services Group

- Landfill Siting
- Design & Operations Plans
- Landfill Closure
- Environmental Monitoring

#8 - 1225 Keith Road East
North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723

LEGEND:

- UTM GRID LINE
- CONTOUR - EXISTING (5m)
- PROPERTY BOUNDARY
- LEACHATE TREATMENT SYSTEM
- LANDFILL BASE LINER EXTENTS
- MONITORING WELL
- GROUNDWATER LEVEL CONTOURS (5m)

TOPO SURFACE SURVEYED JANUARY 29, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

SITE ORTHO IMAGE BY NORTHWIN - JAN 29, 2025
OTHER IMAGE BY BING MAPS

CLIENT: NORTHWIN ENVIRONMENTAL LTD

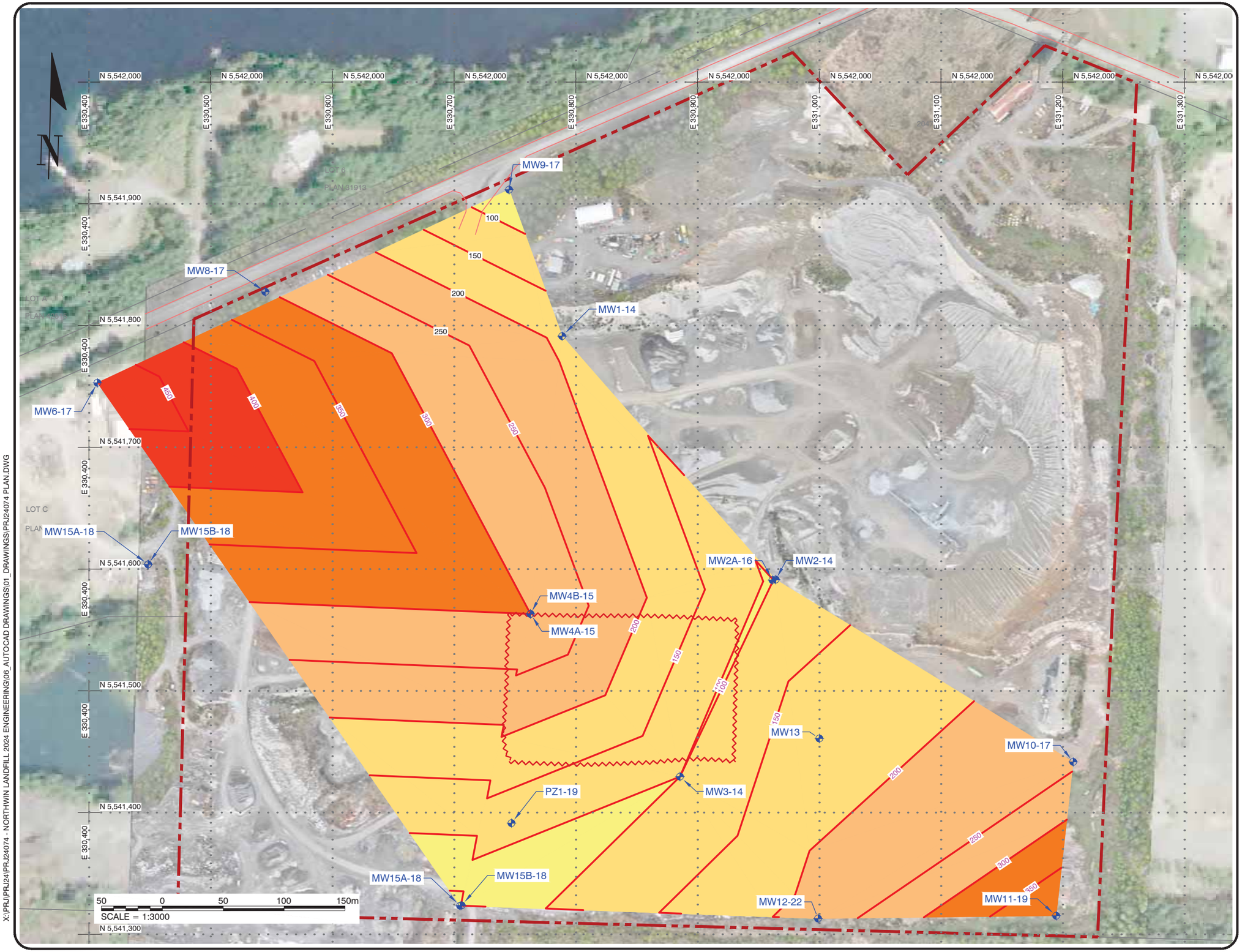
PROJECT:

NORTHWIN LANDFILLL 2024 ENGINEERING

TITLE:

GROUNDWATER ELEVATION CONTOURS DECEMBER 2024

SCALE:	DATE: yyyy/mm/dd	PROJECT NO:
1:3000	2025/03/11	PRJ 24074
DESIGNED	-	DRAWING NO:
DRAWN	NL	**FIGURE 5**
CHECKED	TS	



X:\PRJ\PRJ24\PRJ24074 - NORTHWIN LANDFILL 2024 ENGINEERING\06_AUTOCAD DRAWINGS\01_DRAWINGS\PRJ24074 PLAN.DWG

SPERLING HANSEN ASSOCIATES

Landfill Services Group

- Landfill Siting
- Design & Operations Plans
- Landfill Closure
- Environmental Monitoring

#8 - 1225 Keith Road East
North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723

LEGEND:

- UTM GRID LINE
- CONTOUR - EXISTING (5m)
- PROPERTY BOUNDARY
- LEACHATE TREATMENT SYSTEM
- LANDFILL BASE LINER EXTENTS
- MONITORING WELL

Conductivity Table

MIN. CONDUCTIVITY	MAX. CONDUCTIVITY	COLOUR
0.0 uS/cm	100 uS/cm	
100.0 uS/cm	200 uS/cm	
200.0 uS/cm	300 uS/cm	
300.0 uS/cm	400 uS/cm	
400.0 uS/cm	500 uS/cm	

TOPO SURFACE SURVEYED JANUARY 29, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

SITE ORTHO IMAGE BY NORTHWIN - JAN 29, 2025
OTHER IMAGE BY BING MAPS

CLIENT: NORTHWIN ENVIRONMENTAL LTD

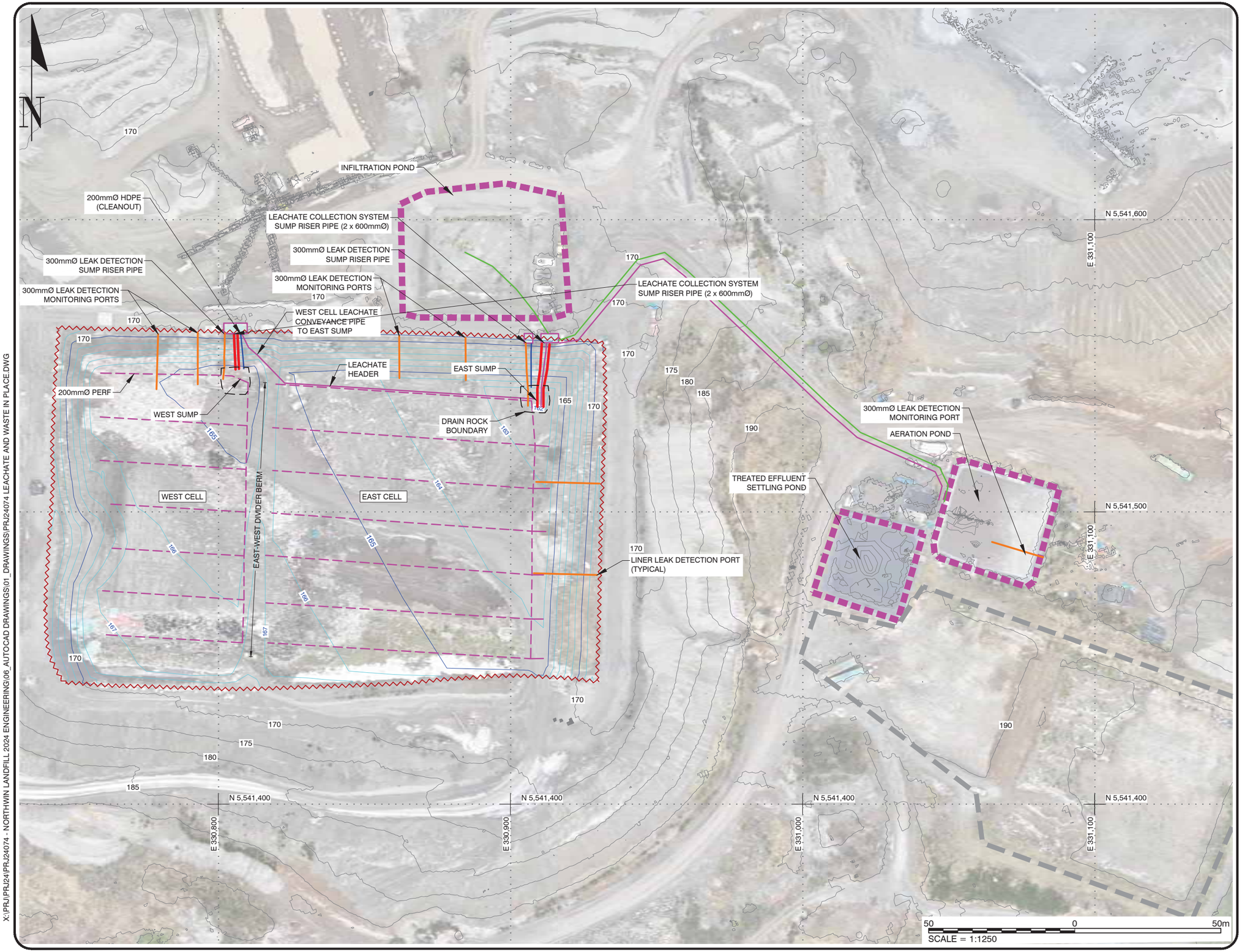
PROJECT:

NORTHWIN LANDFILLL 2024 ENGINEERING

TITLE:

CONDUCTIVITY LEVELS
DECEMBER 2024

SCALE:	DATE:	PROJECT NO:
1:3000	2025/03/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO:
DRAWN	NL	**FIGURE 6**
CHECKED	TS	



X:\PRJ\PRJ24\PRJ24074 - NORTHWIN LANDFILL 2024 ENGINEERING\06_AUTOCAD DRAWINGS\01_DRAWINGS\PRJ24074 LEACHATE AND WASTE IN PLACE.DWG

SPERLING HANSEN ASSOCIATES

Landfill Services Group

- Landfill Siting
- Design & Operations Plans
- Landfill Closure
- Environmental Monitoring

#8 - 1225 Keith Road East
North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723

LEGEND:

- UTM GRID LINE
- CONTOUR - EXISTING (5m)
- CONTOUR - BASE LINER (5m)
- CONTOUR - BASE LINER (1m)
- PROPERTY BOUNDARY
- LEACHATE TREATMENT SYSTEM
- ORIGINAL LANDFILL (DECOMMISSIONED)
- LANDFILL BASE LINER EXTENTS
- SOLID LEACHATE PIPE
- SLOTTED LEACHATE COLLECTOR
- INFILTRATION POND PIPE
- 600mmØ HDPE RISER
- 300mmØ LEAK DETECTION MONITORING PORT

TOPO SURFACE SURVEYED JANUARY 29, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

SITE ORTHO IMAGE BY NORTHWIN - JAN 29, 2025

CLIENT: NORTHWIN ENVIRONMENTAL LTD

PROJECT:

NORTHWIN LANDFILLL 2024 ENGINEERING

TITLE:

EXISTING LEACHATE COLLECTION SYSTEM

SCALE:	DATE:	PROJECT NO:
1:1250	2025/03/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO:
DRAWN	NL	**FIGURE 7**
CHECKED	TS	



X:\PRJ\PRJ24\PRJ24074 - NORTHWIN LANDFILL 2024 ENGINEERING\06_AUTOCAD DRAWINGS\01_DRAWINGS\PRJ24074 LEACHATE AND WASTE IN PLACE.DWG

SPERLING HANSEN ASSOCIATES

Landfill Services Group
- Landfill Siting
- Design & Operations Plans
- Landfill Closure
- Environmental Monitoring

#8 - 1225 Keith Road East
North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723

LEGEND:

- UTM GRID LINE
- CONTOUR - EXISTING (5m)
- LEACHATE TREATMENT SYSTEM
- LANDFILL BASE LINER EXTENTS

Elevations Table

MIN. ELEVATION	MAX. ELEVATION	COLOUR
-1.0m	1.0m	
1.0m	3.0m	
3.0m	5.0m	
5.0m	7.0m	
7.0m	9.0m	
9.0m	11.0m	
11.0m	13.0m	
13.0m	15.0m	
15.0m	17.0m	

STAGE 1 EAST & WEST
NET FILL: 140,252 m³
CAPACITY: 207,784 m³
REMAINING: 67,532 m³
EXPECTED FILL VOLUME/YEAR: 34,615 m³
LIFESPAN REMAINING = 2.0 YEARS

BASE SURFACE: STAGE 1 LINER
COMPARISON SURFACE: EXISTING TOPOGRAPHY JANUARY 26, 2025

TOPO SURFACE SURVEYED JANUARY 29, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

CLIENT: NORTHWIN ENVIRONMENTAL LTD

PROJECT: NORTHWIN LANDFILLL 2024 ENGINEERING

TITLE: CUT AND FILL - WASTE IN PLACE

SCALE:	DATE:	PROJECT NO:
1:1250	2025/03/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO:
DRAWN	NL	**FIGURE 8**
CHECKED	TS	

APPENDICES

APPENDIX A

Ministry of Environment
Lands & Parks
Permit

Province of British Columbia

Ministry of Environment, Lands and Parks

BC Environment

Vancouver Island Region 1
Regional Headquarters
2569 Kenworth Road
Nanaimo
British Columbia
V9T 4P7
Telephone: (604) 751-3100

JUN 01 1992

File: PR-10807

REGISTERED MAIL

Upland Excavating Ltd.
480 - 10th Avenue
Campbell River, British Columbia
V9W 4E3

Gentlemen:

Enclosed is a copy of Permit No. PR-10807 issued under the provisions of the Waste Management Act, in the name of Upland Excavating Ltd. Your attention is respectfully directed to the terms and conditions outlined in the Permit.

The administration of this Permit will be carried out by staff from our Regional Office located at 2569 Kenworth Road, Nanaimo, British Columbia, V9T 4P7 (telephone 751-3100). Plans, data and reports pertinent to the Permit are to be submitted to the Regional Waste Manager at this address.

Yours truly,

G.E. Oldham, P. Eng.
Regional Waste Manager

Enclosure

Printed on Recycled Paper

British Columbia Handle with care

PROVINCE OF
BRITISH COLUMBIA

ENVIRONMENTAL PROTECTION
2569 Kenworth Road
Nanaimo, British Columbia
V9T 4P7
Telephone:(604) 751-3100

MINISTRY OF ENVIRONMENT,
LANDS AND PARKS

PERMIT

Under the Provisions of the Waste Management Act

Upland Excavating Ltd.

480 - 10th Avenue

Campbell River, British Columbia

V9W 4E3

is authorized to discharge refuse from Campbell River and the surrounding area to the land and air contaminants from a regulated open burning operation.

An annual fee will be determined on the basis of your industrial code and capacity in accordance with the Waste Management Fees Regulation.

This Permit does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority shall rest with the Permittee.

G. E. Oldham, P. Eng.
Regional Waste Manager

Date issued: JUN 01 1992

Date amended:
(most recent)

Permit No. PR-10807

1. AUTHORIZED DISCHARGES AND RELATED REQUIREMENTS

1.1 Refuse

1.1.1 The maximum rate at which refuse may be discharged is 3200 m^3/year.

1.1.2 The type of refuse which may be discharged is inert municipal.

1.1.3 The components of the refuse which may be discharged are stumps, trees, land clearing waste, selected building demolition debris, and residue of combustion from the open burning of woodwaste.

1.1.4 The works authorized are a landfill operation as directed, located approximately as shown on the attached Appendix A-1.

1.1.5 The works authorized must be complete and in operation on and from the date of this permit.

1.2 Emissions

1.2.1 The works authorized are a regulated open burning operation, as directed, located approximately as shown on the attached Appendix A-1.

1.2.2 The works authorized must be complete and in operation on and from the date of this permit.

2. LOCATION OF THE FACILITIES

Lot A, District Lot 85, Plan 30709, Sayward District.

G. E. Oldham

G. E. Oldham, P. Eng.
Regional Waste Manager

Date issued: JUN 01 1992

Date amended:
(most recent)

3. LANDFILL OPERATION

The Permittee shall maintain the landfill as a Level E operation in accordance with the Pollution Control Objectives for Municipal Type Waste Discharges in British Columbia, dated September 1975, which, in normal conditions, requires that cover material be applied once per forty days of operation and at least once every two months. The Regional Waste Manager may vary the frequency of covering when freezing conditions or other circumstances affect normal operation.

4. SITE PREPARATION AND RESTORATION

Provision of fencing, site access, vehicle safety barriers, surface water diversionary works, firebreaks and site restoration as required, shall be carried out to the satisfaction of the Regional Waste Manager.

5. PUTRESCIBLE WASTE

No putrescible wastes shall be discharged at this site.

6. OPERATIONAL REQUIREMENTS FOR REGULATED OPEN BURNING

(a) Area

The operation shall be restricted to an area on the site which is satisfactory to the Regional Waste Manager. If required, this area shall be fenced to restrict access to the burn area stockpile.

G. E. Oldham, P. Eng.
Regional Waste Manager

Date issued: JUN 01 1992

Date amended:
(most recent)

Permit No. PR-10807

(b) Quantity and Frequency

The maximum quantity of wastes to be treated is 750 m^3 per burn at a frequency not to exceed four burns per year. Each burn shall comprise one continuous period necessary to reduce the stockpiled waste to ashes, and shall not exceed 48 hours.

(c) Nature of Wastes

Generally, no waste shall be burned which is unacceptable to the Regional Waste Manager. Acceptable materials may include stumps, trees and similar items, but exclude nuisance causing combustibles such as rubber, plastics, tars, insulation, etc. Demolition debris, excepting wood products, shall not be burned at this site. Burning of any antisapstain treated wood products is prohibited.

(d) Timing

Burning shall take place only when an attendant is on duty and when conditions promote rapid combustion and dispersion of combustion products with a wind direction that conveys the resulting gases away from McIvor Lake and Highway #28 (Gold River Highway). Burning shall take place only when the ventilation index for the Campbell River area is forecasted to exceed 33 for the period of the burn. The ventilation index is issued by the Pacific Weather Centre, Environment Canada, Vancouver, telephone 664-9032. Materials shall be charged to the facility in a manner to promote best combustion and restrict the uplift of lighter constituents. No burning shall take place during periods of fire hazard or when burning is prohibited by other government agencies.

G. E. Oldham, P. Eng.
Regional Waste Manager

Date issued: JUN 01 1992

Date amended:
(most recent)

(e) Fire Control

Suitable approved devices shall be available for extinguishing fires to prevent them from spreading to surrounding areas. Such devices may include a pressurized water supply, chemical type fire extinguishers, or an earth stockpile. If an earth stockpile is contemplated for fire control, earth moving equipment shall be available at the site during burning. A fireguard shall be cleared and maintained free of combustible materials.

(f) Residue of Combustion

As soon as the residue of combustion has cooled to ambient temperature, it shall be incorporated into the adjacent landfill.

(g) Other Requirements

The Ministry of Environment, Lands and Parks has established a Smoke Management Steering Committee to review the present practice of burning wood residue. A need for additional controls, such as auxiliary forced air, or other requirements, may result from the recommendations of the Steering Committee or following the observation of any burning episode, and the Permittee shall install such equipment or take measures as may be required by the Regional Waste Manager.

The Ministry is also in the process of revising the existing pollution control objectives for municipal landfills. Based on the provisions of the new criteria, the Permittee may be required to terminate open burning at this site.

7. GROUNDWATER MONITORING WELLS

The Permittee shall install not more than two groundwater monitoring wells. The number, locations and structural details of these facilities are subject to the approval of the Regional Waste Manager.

G. E. Oldham, P. Eng.
Regional Waste Manager

Date issued: JUN 01 1992

Date amended:
(most recent)

8. WASTE REDUCTION

The Ministry of Environment, Lands and Parks has developed a policy to reduce, recycle and reuse solid wastes. The Permittee is encouraged to segregate for recycling and reuse, where possible, materials destined for disposal at this site.

In certain landfill environments, some construction and demolition debris, may create air and water quality concerns. If problems arise at this site that are attributable to specific wastes, the Regional Waste Manager may require that alternate disposal procedures be implemented.

9. WASTE MANAGEMENT PLANNING

The Permittee is advised that the Regional District of Comox-Strathcona is developing a Solid Waste Management Plan which may have an impact on the discharge authorized by this Permit.

G. E. Oldham, P. Eng.
Regional Waste Manager

Date issued: JUN 01 1992

Date amended:
(most recent)

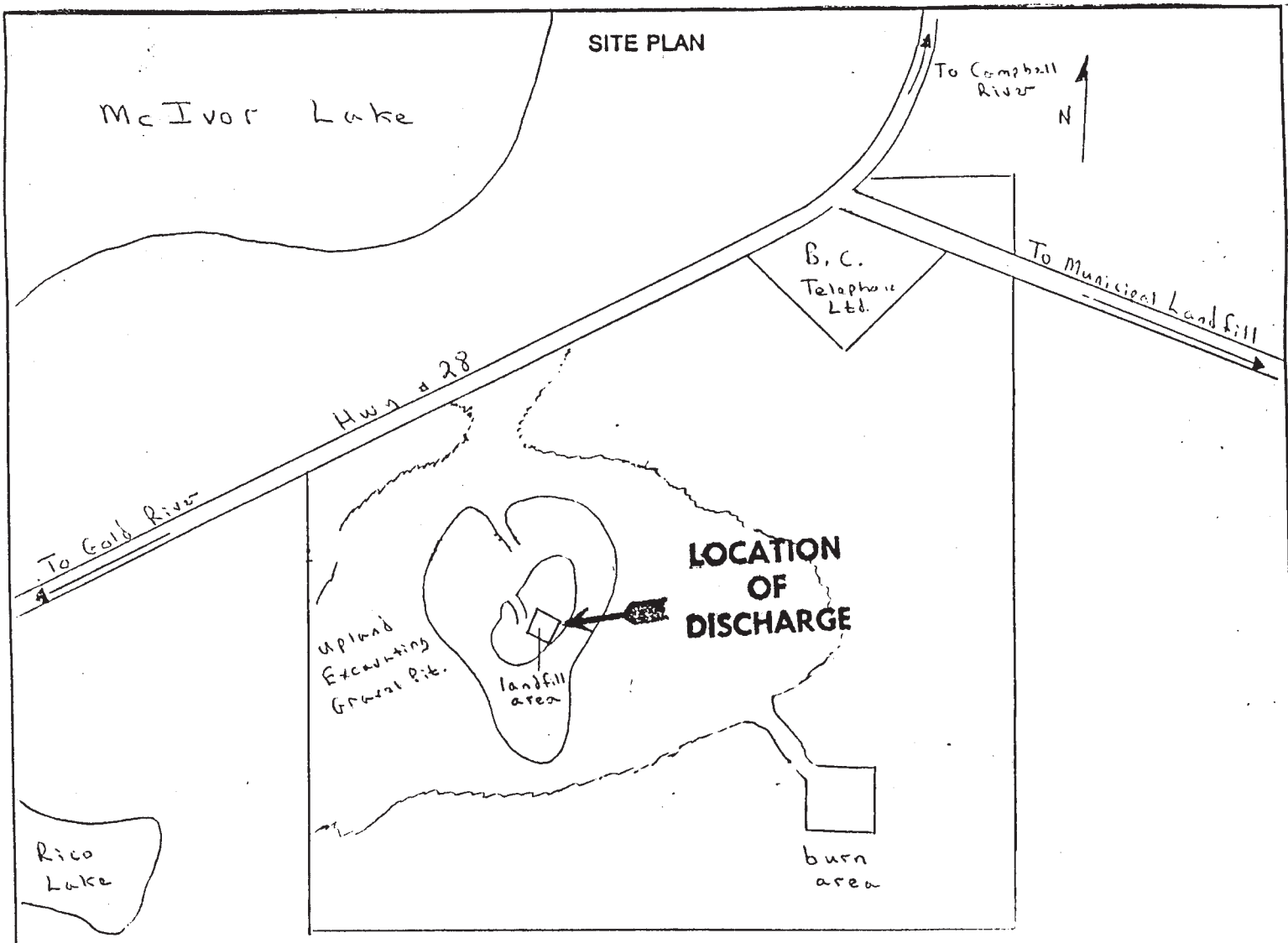
Permit No. PR-10807

Province of British Columbia

Ministry of Environment Lands and Parks

ENVIRONMENTAL PROTECTION

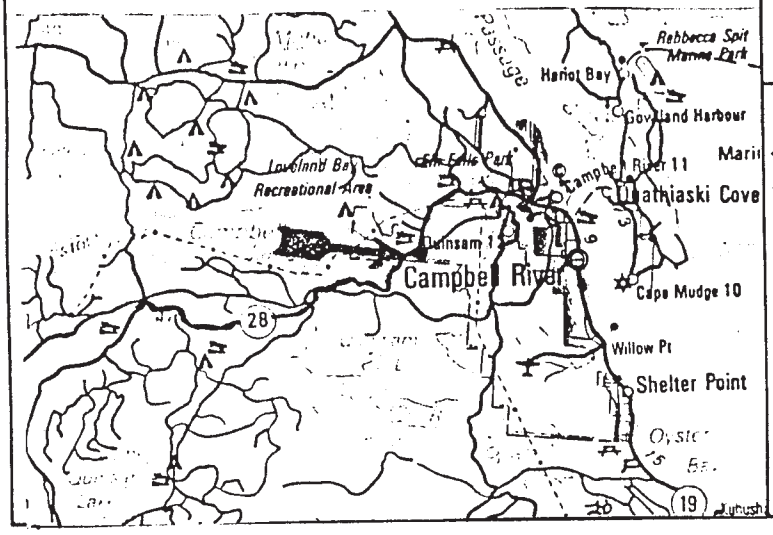
SITE PLAN



SCALE: ≃ 1 : 8,500

LEGAL DESCRIPTION: Lot A, District Lot 85, Plan 30709, Sayward District

LOCATION MAP



Upland Excavating Ltd.

Name of Permittee

Appendix A-1 to Permit No. PR-10807

Approval No. _____

Date Issued JUN 01 1992

Date Amended _____

Regional Waste Manager _____

Ministry of Environment
&
Climate Change Strategy
Operational Certificate

August 1, 2019

Tracking Number: 335965
Authorization Number: 107689

REGISTERED MAIL

UPLAND EXCAVATING LTD.
#201-909 ISLAND HIGHWAY
CAMPBELL RIVER BC V9W 2C2

Dear operational certificate holder:

Enclosed is Operational Certificate 107689 issued under the provisions of the *Environmental Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the operational certificate. An annual fee will be determined according to the Permit and Approval Fees and Charges Regulation.

This operational certificate does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the operational certificate holder. It is also the responsibility of the operational certificate holder to ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties, and comply with other applicable legislation that may be in force.

Requirements may also be specified by the *Environmental Management Act* and regulations including, but not limited to, the Contaminated Sites Regulation, Environmental Data Quality Assurance Regulation, Hazardous Waste Regulation, Landfill Gas Management Regulation, Organic Matter Recycling Regulation, Ozone Depleting Substances and Other Halocarbons Regulation, Recycling Regulation, Spill Reporting Regulation, Storage of Recyclable Material Regulation, Waste Discharge Regulation and Codes of Practice.

This decision may be appealed to the Environmental Appeal Board in accordance with Part 8 of the *Environmental Management Act*. An appeal must be delivered within 30 days from the date that notice of this decision is given. For further information, please contact the Environmental Appeal Board at (250) 387-3464.

Administration of this operational certificate will be carried out by staff from the Environmental Protection Division's Regional Operations Branch. Documents pertinent to the operational certificate are to be submitted by email or electronic transfer to the director, in accordance with the ministry Data & Report Submissions website at: http://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions, or as further instructed.

If you have any questions or concerns, please contact Authorizations - South at Authorizations.South@gov.bc.ca.

Yours truly,



Luc Lachance, P.Eng
for Director, *Environmental Management Act*
Authorizations - South Region

Enclosure

MINISTRY OF ENVIRONMENT &
CLIMATE CHANGE STRATEGY

OPERATIONAL CERTIFICATE

107689

Under the Provisions of the Environmental Management Act

Pursuant to the Approved

Comox Valley Regional District Solid Waste Management Plan

UPLAND EXCAVATING LTD.

#201-909 ISLAND HIGHWAY
CAMPBELL RIVER BC V9W 2C2

Is authorized to manage waste at the Facility located in Campbell River, British Columbia, subject to the requirements listed below. Contravention of any of these requirements is a violation of the *Environmental Management Act* and may lead to prosecution.

Pursuant to section 24(10) of the *Environmental Management Act*, this operational certificate supersedes and cancels Permit PR-10807 issued under section 14 of the *Environmental Management Act*.

1. AUTHORIZED DISCHARGES, FACILITIES AND WORKS

1.1 Original Landfill

This section applies to the Original Landfill.

1.1.1 The maximum rate of waste discharge to the Original Lined Cell is 45,000 tonnes per calendar year.

1.1.2 The characteristics of the waste discharge to the Original Lined Cell must be:

(a) demolition waste,
(b) construction waste,
(c) land clearing waste,
(d) soil in which the concentrations of all substances are less than the lowest applicable industrial land use standard specified for those substances in
  (i) the generic numerical soil standards,
  (ii) the matrix numerical soil standards, or

Date issued: August 1, 2019

Luc Lachance, P.Eng
for Director, *Environmental Management Act*
Authorizations - South Region

(iii) a director's interim standard for soil,
referred to in section 41(1)(a) of the Contaminated Sites Regulation, B.C. Reg. 375/96,
(e) sludge from the Original Leachate Management Works, or,
(f) other waste as authorized in writing by the director,
but does not include:
(g) hazardous waste except as authorized pursuant to the Hazardous Waste Regulation, controlled waste, Attractants, and,
(h) waste and/or recyclable material prohibited in writing by the director.

1.1.3 The waste discharge is authorized to the Original Lined Cell approximately located as shown on Site Plan A. Waste discharge to the Original Un-Lined Cell is not authorized.

1.1.4 Authorization to discharge waste to the Original Lined Cell ceases on the earlier of:
(i) the date the Original Lined Cell is filled to capacity with grades not steeper than 3H:1V (33%),
(ii) the date of commencement of waste discharge to the New Landfill.

1.1.5 The authorized works are:
(i) a lined landfill footprint with a maximum area of 0.72 ha (85 m x 85 m) including from bottom to top a base with perimeter berm, 0.3 m sand cushion layer, 0.5 mm thick coated woven polyethylene liner, 0.3 m granular leak detection layer, leak detection riser pipe, 0.5 mm thick coated woven polyethylene liner, 0.3 m sand protection layer, leachate extraction chamber, final cover, and,
(ii) an un-lined landfill footprint with an approximate area of 0.7 ha, final cover,
and related appurtenances, approximately located as shown on Site Plan A.

1.1.6 The operational certificate holder must ensure the Original Landfill, excluding final cover, is complete and fully operational on or before the date of issuance of this operational certificate, and at all times thereafter, until the Original Landfill is decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.

1.2 **Original Leachate Management Works**

This section applies to the management of leachate from the Original Lined Cell.

1.2.1 The operational certificate holder must convey the leachate from the Original Lined Cell, that is to be discharged on the Facility site, to the Original Leachate Management Works.

1.2.2 The maximum rate of treated leachate effluent discharge to the treated leachate infiltration pond is 7,139 m^3 per calendar year.

Date issued: August 1, 2019

Luc Lachance, P.Eng
for Director, *Environmental Management Act*
Authorizations - South Region

1.2.3 The concentration of any substance in the treated leachate effluent discharge to the treated leachate infiltration pond must not be greater than the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance.

1.2.4 The treated leachate effluent is authorized to be discharged to the treated leachate infiltration pond and infiltrated into the ground. This authorization ceases on the date the Original Leachate Management Works are decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.

1.2.5 The authorized works are leachate conveyance, storage, treatment and discharge works including pumps, pipes, leachate storage and treatment tanks, treated leachate infiltration pond, flow monitoring works, and related appurtenances approximately located as shown on Site Plan A.

1.2.6 Minimum Freeboard must be maintained at all times as follows:
treated leachate infiltration pond: 0.6 m

1.2.7 The operational certificate holder must ensure the Original Leachate Management Works are complete and fully operational on or before the date of commencement of discharge to the treated leachate infiltration pond, and at all times thereafter, until the Original Leachate Management Works are decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.

1.3 **New Landfill**

This section applies to the New Landfill.

1.3.1 The maximum rate of waste discharge to the New Landfill is: (45,000 minus the waste discharge to the Original Lined Cell) tonnes per calendar year.

1.3.2 The characteristics of the waste discharge to the New Landfill must be:
(a) demolition waste,
(b) construction waste,
(c) land clearing waste,
(d) soil in which the concentrations of all substances are less than the lowest applicable industrial land use standard specified for those substances in
(i) the generic numerical soil standards,
(ii) the matrix numerical soil standards, or
(iii) a director's interim standard for soil,
referred to in section 41(1)(a) of the Contaminated Sites Regulation, B.C. Reg. 375/96,
(e) sludge from the New Leachate Management Works or the New Stormwater

Management Works, or,

(f) other waste as authorized in writing by the director,

but does not include:

(g) hazardous waste except as authorized pursuant to the Hazardous Waste Regulation, controlled waste, Attractants, and,

(h) waste and/or recyclable material prohibited in writing by the director.

1.3.3 The waste discharge is authorized to the New Landfill approximately located as shown on Site Plan A.

1.3.4 The authorized works are a lined landfill footprint with a maximum area of 3.60 ha including from bottom to top a base with perimeter berm, secondary base liner, leak detection drainage layer and leak collection pipes and sump, primary base liner, leachate collection drainage layer and leachate collection pipes and sump, pumps, pipes, final cover, and related appurtenances, approximately located as shown on Site Plan A.

1.3.5 The secondary base liner and the primary base liner must each include an upper high density polyethylene double sided textured geomembrane of minimum 1.5 mm thickness and a lower geosynthetic clay liner of hydraulic conductivity less than or equal to 1×10^{-7} cm/s. However, on the south slope of the base more than 1 m above the primary base liner, the geosynthetic clay liners are not required.

1.3.6 The operational certificate holder must ensure the New Landfill, excluding final cover, is complete and fully operational on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

1.4 New Leachate Management Works

This section applies to the management of leachate from the New Landfill.

1.4.1 The operational certificate holder must convey the leachate from the New Landfill, that is to be discharged on the Facility site, to the New Leachate Management Works.

1.4.2 The maximum rate of treated leachate effluent discharge to the treated leachate infiltration pond is 24,633 m^3 per calendar year.

1.4.3 The concentration of any substance in the treated leachate effluent discharge to the treated leachate infiltration pond must not be greater than the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance.

1.4.4 The treated leachate effluent is authorized to be discharged to the treated leachate infiltration

pond and infiltrated into the ground.

1.4.5 The authorized works are leachate conveyance, treatment and discharge works including pumps, pipes, leachate treatment pond(s), treated leachate infiltration pond, flow monitoring works, and related appurtenances approximately located as shown on Site Plan A.

1.4.6 The leachate treatment pond(s) must include from bottom to top a secondary base liner, leak detection drainage layer and leak collection pipe(s), and a primary base liner. The secondary base liner and the primary base liner must each include an upper high density polyethylene double sided textured geomembrane of minimum 1.5 mm thickness and a lower geosynthetic clay liner of hydraulic conductivity less than or equal to 1×10^{-7} cm/s.

1.4.7 Minimum Freeboard must be maintained at all times as follows:
leachate treatment pond(s): 0.6 m
treated leachate infiltration pond: 0.6 m

1.4.8 The operational certificate holder must ensure the New Leachate Management Works are complete and fully operational on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

1.5 New Stormwater Management Works

This section applies to the management of stormwater from the New Landfill.

1.5.1 The operational certificate holder must manage stormwater from the New Landfill such that stormwater is infiltrated into the ground with the authorized works.

1.5.2 The stormwater must not include leachate and the concentration of any substance in the stormwater must not be greater than the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance.

1.5.3 The authorized works are diversion berm, perimeter berm, mid slope swales, drop down channels, ditches, energy dissipation and sediment traps, stormwater infiltration area, and related appurtenances approximately located as shown on Site Plan A.

1.5.4 Minimum Freeboard must be maintained at all times as follows:
stormwater infiltration area: 0.6 m
all other authorized works: 0.3 m

1.5.5 The operational certificate holder must ensure that adequate authorized works to manage stormwater, such that stormwater is infiltrated into the ground with the authorized works, are

complete and fully operational on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

1.6 Facility Entrance

This section applies to the Facility entrance.

1.6.1 The authorized works are sign(s), gate, fence, weigh scale, and related appurtenances approximately located as shown on Site Plan A.

1.6.2 The operational certificate holder must ensure the authorized works are complete and fully operational on or before the date of issuance of this operational certificate and at all times thereafter.

1.7 Location of Facility

This section applies to the location of the Facility.

1.7.1 The location of the Facility is PID 001-223-321, LOT A, DISTRICT LOT 85, SAYWARD DISTRICT, PLAN 30709 EXCEPT PART IN PLAN EPP15087, approximately located as shown on Site Plan A.

2. GENERAL REQUIREMENTS

2.1 Glossary

The following capitalized terms referred to in this authorization are defined in the Glossary below. Other terms used in this authorization have the same meaning as those defined in the *Environmental Management Act*, applicable regulations, and the Landfill Criteria;

"Attractant" means food or food waste, compost, carcass or part of an animal, fish, or other meat, or other waste or garbage, that could attract bears, birds, rodents, insects, vectors or wildlife, but does not include grass, leaves, weeds, branches and woodwaste;

"Facility" means the Original Landfill, Original Leachate Management Works, New Landfill, New Leachate Management Works, New Stormwater Management Works and the authorized works in section 1.6.1 (Facility Entrance) of this operational certificate;

"Freeboard" means the difference in elevation between the contained liquid level and the top of the containment works at its lowest point;

"Landfill Criteria" means the Landfill Criteria for Municipal Solid Waste Second Edition June 2016, as amended or replaced from time to time;

"New Landfill" means the authorized works in section 1.3.4 of this operational certificate;

"New Leachate Management Works" means the authorized works in section 1.4.5 of this operational certificate;

"New Stormwater Management Works" means the authorized works in section 1.5.3 of this operational certificate;

"Original Landfill" means the Original Lined Cell and the Original Un-Lined Cell;

"Original Leachate Management Works" means the authorized works in section 1.2.5 of this operational certificate;

"Original Lined Cell" means the authorized works in section 1.1.5(i) of this operational certificate;

"Original Un-Lined Cell" means the authorized works in section 1.1.5(ii) of this operational certificate;

"Province" means Her Majesty the Queen in right of British Columbia;

"Regulatory Document" means any document that the operational certificate holder is required to cause to be prepared, prepare or submit to the director or the Province, pursuant to: (i) this authorization; (ii) any regulation made under the *Environmental Management Act* that regulates the Facility described in this authorization or the discharge of waste from that Facility; or (iii) any order issued under the *Environmental Management Act* directed against the operational certificate holder that is related to the Facility described in this authorization or the discharge of waste from that Facility;

"Significant Works" means the Facility excluding the authorized works in section 1.6.1 (Facility Entrance) of this operational certificate.

2.2 **Use of Qualified Professional(s)**

The operational certificate holder must cause a Qualified Professional to:

(a) Design and inspect the construction of the Facility, and,

(b) Certify documents related to the Facility including plans, specifications, drawings, construction

reports, assessments, reviews, investigations, studies, surveys, programs, reports and as-built record drawings.

(d) Submit a completed Declaration of Competency and a Conflict of Interest Disclosure Statement with each document.

2.3 Operations and Closure Plan (OCP)

(a) The operational certificate holder must cause a Qualified Professional to certify and submit an up to date OCP for the Original Landfill and the Original Leachate Management Works, to the director, on or before the earlier of:

(i) 30 days before the date of commencement of waste discharge to the Original Lined Cell,
(ii) 30 days after the date of issuance of this operational certificate.

(b) The OCP must comply with the requirements of this operational certificate, include information specified in relevant items listed in the Landfill Criteria Section 10.3 Design, Operations and Closure Plan including a site layout plan, a filling plan, a lifespan analysis table, a stormwater management plan, a leachate management plan, an environmental monitoring plan, an operations plan, a closure plan, and the information specified in the following sections of this operational certificate:

2.7(a) (soil acceptance plan), and,
2.10(a) (financial security plan).

(c) The operational certificate holder must carry out the most recent OCP and design, construct, operate, inspect, maintain, monitor and close the Original Landfill and the Original Leachate Management Works, in compliance with the most recent OCP and this operational certificate, until the Original Landfill and the Original Leachate Management Works are decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.

2.4 Hydrogeology and Hydrology Characterization Report (HHCR)

(a) The operational certificate holder must cause a Qualified Professional to certify and submit an up to date HHCR, to the director, on or before 90 days before the date of commencement of waste discharge to the New Landfill.

(b) The HHCR must include characterization of the geology, hydrogeology, and surface hydrology at and near the Facility site, and the information specified in all the items listed in the Landfill Criteria, section 10.1 Hydrogeology and Hydrology Characterization Report.

(c) The operational certificate holder must cause a Qualified Professional to certify and submit an updated HHCR to the director, at least once every five years after the date of commencement of waste

discharge to the New Landfill.

2.5 Design, Operations and Closure Plan (DOCP)

(a) The operational certificate holder must cause a Qualified Professional to certify and submit an up to date DOCP, for the Facility, to the director, on or before 90 days before the date of commencement of waste discharge to the New Landfill.

(b) The DOCP must comply with the requirements of this operational certificate, include the information specified in all the items listed in the Landfill Criteria Section 10.3 Design, Operations and Closure Plan, and the information specified in the following sections of this operational certificate:

2.6(a) (New Leachate Management Works commissioning plan),
2.7(a) (soil acceptance plan),
2.8(a) (trigger level assessment plan),
2.9(a) (plan to remove all waste from the Original Landfill), and,
2.10(b) (financial security plan).

(c) The operational certificate holder must cause a Qualified Professional to certify and submit an updated DOCP to the director, as necessary to keep the DOCP up to date, at least once every five years after the date of commencement of waste discharge to the New Landfill.

(d) The operational certificate holder must carry out the most recent DOCP and design, construct, operate, inspect, maintain, monitor, and close the Facility, in compliance with most recent DOCP and this operational certificate.

2.6 New Leachate Management Works Commissioning Plan and Report

(a) The DOCP submitted pursuant to section 2.5 of this operational certificate must include a New Leachate Management Works commissioning plan that includes:

(i) the expected duration of the New Leachate Management Works commissioning period,
(ii) description of the New Leachate Management Works and design, including treatment of leachate from soil and treated leachate infiltration pond design and infiltration tests,
(iii) the monitoring, sampling and analyses that will be carried out during the New Leachate Management Works commissioning period including the quantity and quality of leachate and treated leachate effluent, and confirmatory sampling before the discharge of any treated leachate effluent to the treated leachate infiltration pond,
(iv) operating procedures that will be carried out during the New Leachate Management Works commissioning period including review of confirmatory sampling results before the discharge of any treated leachate effluent to the treated leachate infiltration pond,
(v) contingency measures that will be carried out during the New Leachate Management Works

commissioning period if the treated leachate effluent quality does not comply with this operational certificate, including storage, retreatment, and transport to an off-site authorized treatment facility,
(vi) New Leachate Management Works commissioning report description, table of contents and summary of contents.

(b) The operational certificate holder must cause a Qualified Professional to certify and submit a New Leachate Management Works commissioning report, that includes the information contemplated in section 2.6(a)(vi) of this operational certificate, to the director, on or before 30 days after the completion of the New Leachate Management Works commissioning period, or as specified by the director.

2.7 Soil Acceptance Plan

(a) The OCP submitted pursuant to section 2.3, and the DOCP submitted pursuant to section 2.5, of this operational certificate, must include a soil acceptance plan that includes procedures that will be carried out before soil is accepted at the Facility including receipt and review of documents required by section 2.7(b) of this operational certificate, and consideration of the applicable Original Leachate Management Works or New Leachate Management Works adequacy to treat leachate from the soil.

(b) Before a specific quantity of soil is accepted at the Facility, the operational certificate holder must cause a Qualified Professional to certify and submit to the operational certificate holder, a document pertaining to the specific quantity of soil that includes:
(i) the soil tonnage(s) and soil quality class(es) as described in the most recent version of Technical Guidance 1 on Contaminated Sites Site Characterization and Confirmation Testing,
(ii) the soil origin including applicable civic address, site identification number, parcel identifier, parcel identification number, legal description, and,
(iii) characterization of the soil in accordance with ministry procedures and applicable Contaminated Sites Regulation Guidance, Protocols and Procedures.

2.8 Trigger Level Assessment Plan

(a) The DOCP submitted pursuant to section 2.5 of this operational certificate must include a trigger level assessment plan that includes:
(i) Description of the routine monitoring of the quantity and quality of leachate leakage through the primary liner and into the leak detection layer for the New Landfill, and for the leachate treatment pond(s), and related leachate leakage quantities and qualities that will trigger corresponding described increased monitoring, investigations, contingency measures and actions.
(ii) Description of the routine monitoring of groundwater quality immediately downgradient of the New Landfill, the leachate treatment pond(s), and the treated leachate infiltration pond, and related groundwater substance concentrations that will trigger corresponding described increased

monitoring, investigations, contingency measures and actions.

2.9 Plan to Remove all Waste from the Original Landfill

(a) The DOCP submitted pursuant to section 2.5 of this operational certificate must include a plan to remove all waste from the Original Landfill, categorize such waste, discharge all such waste to the New Landfill or to other identified and authorized waste management facility(ies), carry out sampling to confirm all such waste has been removed, and decommission the Original Landfill and the Original Leachate Management Works.

(b) Subject to section 1.3.2 of this operational certificate, waste removed from the Original Landfill is authorized to be discharged to the New Landfill. The tonnage of such waste must not be included for the purpose of determining compliance with section 1.3.1 of this operational certificate.

(c) The director may require the operational certificate holder to carry out and complete the plan referred to in section 2.9(a) of this operational certificate, in accordance with the director's requirements.

(d) If the plan referred to in section 2.9(a) of this operational certificate is carried out, the operational certificate holder must cause a Qualified Professional to certify and submit a report to the director that confirms that the plan has been carried out and completed in accordance with the director's requirements, describes the plan implementation, describes and provides the waste categorization, describes and provides the sampling and results, describes the decommissioning of the Original Landfill and the Original Leachate Management Works, provides photos documenting the implementation of the plan referred to in section 2.9(a) of this operational certificate, and lists the tonnages or volumes, and categories of waste removed and discharged to the New Landfill and to other identified and authorized waste management facility(ies), on or before 60 days after the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed.

2.10 Financial Security

(a) The OCP submitted pursuant to section 2.3 of this operational certificate must include a financial security plan that includes:

(i) the calculations of the amounts of financial security and time periods for each phase of development for the Original Landfill in accordance with the Landfill Criteria Section 8.0 Financial Security, and,

(ii) the amounts of financial security for the corresponding time periods.

(b) The DOCP submitted pursuant to section 2.5 of this operational certificate must include a financial security plan that includes:

(i) the tasks, estimated costs, contingency costs, calculations of the amounts of financial security

and time periods, to carry out and complete the plan referred to in section 2.9(a) of this operational certificate (plan to remove all waste from the Original Landfill),
(ii) the calculations of the amounts of financial security and time periods for each phase of development for the New Landfill in accordance with the Landfill Criteria Section 8.0 Financial Security, and,
(iii) the amounts of financial security for the corresponding time periods.

(c) The operational certificate holder must provide the director with financial security, on or before the earlier of:
(i) 30 days before the date of commencement of waste discharge to the Original Lined Cell,
(ii) 30 days after the date of issuance of this operational certificate,
(iii) 90 days before the date of commencement of waste discharge to the New Landfill,
and at all times thereafter.

(d) The amount of financial security at any time must be equal to or greater than:
(i) Before the report referred to in section 2.9(d) (report that confirms that the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed) of this operational certificate is submitted to the director, the greater amount specified for the corresponding time period in:
- the financial security plan in the most recent OCP,
- the financial security plan in the most recent DOCP.
(ii) On and after the report referred to in section 2.9(d) (report that confirms that the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed) of this operational certificate is submitted to the director, the amount specified for the corresponding time period in the financial security plan in the most recent DOCP.

(e) The form of financial security must be satisfactory to the director.

(f) At the discretion of the director, such financial security may be used among other things:
(i) to correct any inadequacy of the Facility relating to its design, construction, operation, inspection, maintenance, monitoring, closure, and post-closure;
(ii) to correct any default in compliance with this operational certificate or the *Environmental Management Act*; and,
(iii) for remediation of the Facility.

(g) The operational certificate holder must replenish any amounts drawn from the posted financial security within 60 days of such amounts being drawn or as otherwise specified by the director.

2.11 **Construction Report(s)**

(a) The operational certificate holder must cause a Qualified Professional to carry out inspections

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Luc Lachance, P.Eng
for Director, *Environmental Management Act*
Authorizations - South Region

before and during the construction or modification of Significant Works, and, after the completion of construction or modification of Significant Works, to certify and submit construction report(s) to the director:

(i) for construction of the New Landfill and the New Leachate Management Works, on or before 30 days before the date of commencement of waste discharge to those new Significant Works, and,
(ii) for all Significant Works, on or before 60 days after the completion of construction or modification of the Significant Works.

(b) The construction report(s) must demonstrate that the Significant Works have been constructed in accordance with this operational certificate and the applicable most recent OCP or DOCP, describe any technical concerns that arose from the inspections and testing and how they were addressed, and include as-built record drawings of the constructed Significant Works, all the inspection and testing reports and results including geologic inspection report, quality control and quality assurance testing, soil test data including field and laboratory data, as described in the Landfill Criteria section 10.2 Construction Report(s).

2.12 **Notification of Commencement of Waste Discharge**

The operational certificate holder must notify the director of:
(a) the date of commencement of waste discharge to the Original Lined Cell, on that date,
(b) the date of commencement of waste discharge to the New Landfill, on that date,
(c) the date the Original Lined Cell has reached capacity, on that date, and,
(d) the date the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed, on that date.

2.13 **Buffer Zone**

The operational certificate holder must ensure that the New Landfill, New Leachate Management Works, and New Stormwater Management Works, are located a minimum of 50 m from the Facility site boundary.

2.14 **Depth to Groundwater**

The operational certificate holder must ensure that the New Landfill secondary base liner, and the New Leachate Management Works leachate treatment pond(s) secondary base liner, are a minimum of 1.5 m above groundwater at all times.

2.15 **Covenant**

On or before the date of commencement of waste discharge to the New Landfill, the operational certificate holder must register a covenant under section 219 (1) of the *Land Title Act*, in a form

acceptable to the director, that binds successors in title to uphold the continued implementation of the closure plan in the most recent DOCP, and prohibits development of the Facility other than as contemplated by this operational certificate or approved by the director. Such covenant must include an acknowledgement that the property was used for the purpose of waste disposal, must be registered as a charge against title to the property on which the facility is located and must be registered in priority to all charges except charges which do not give the holders any rights which might conflict with the covenant.

2.16 Additional Requirements

The director may require the operational certificate holder to:

(a) Cause a Qualified Professional to certify and submit to the director additional, amended or improved documents of the Facility including plans, specifications, drawings, construction reports, assessments, reviews, investigations, studies, surveys, programs, reports and as-built record drawings.

(b) Carry out actions in accordance with the additional, amended or improved documents submitted, and additional actions as specified.

(c) Repair, alter, remove, improve or add to existing facilities and works, or construct new facilities and works, at the Facility.

(d) Temporarily or permanently cease waste discharge to the Original Lined Cell and/or the New Landfill, cover part(s) or all of the Original Landfill and/or the New Landfill with final cover, and close and decommission the Facility, as specified.

2.17 Authorization Requirements

Where this authorization provides that the director may specify a matter or require an action to be carried out, the operational certificate holder must comply with the specification and carry out the action in accordance with the requirements of the director.

3. OPERATING AND PERFORMANCE REQUIREMENTS

3.1 Multiple and/or Spare Works and Auxiliary Power Facilities

The operational certificate holder must provide and install multiple and/or spare works and auxiliary power facilities to ensure the Original Lined Cell, Original Leachate Management Works, New Landfill, New Leachate Management Works, and New Stormwater Management Works, are complete and fully operational as specified in this operational certificate, including during maintenance, breakdowns and electrical power outages.

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3.2 **Maintenance of the Facility**

(a) The operational certificate holder must cause persons that are qualified and trained to operate, regularly inspect, and maintain the Facility, in good working order. If components of the Facility have a manufacturer's recommended maintenance schedule, then those components must, at a minimum, be maintained in accordance with that schedule.

(b) The operational certificate holder must prepare documents of the qualification and training of the persons operating, inspecting and maintaining the Facility, and of Facility inspections, operation and maintenance.

3.3 **Facility Manager and Operator Certification**

(a) The operational certificate holder must ensure that at least one person responsible for the management of the Facility is certified, and maintains certification, by The Solid Waste Association of North America (SWANA) as a Manager of Landfill Operations, and at least one person responsible for the operation of the Facility has, within the preceding five years, successfully completed the SWANA Landfill Operations Basics course, on or before the earlier of:

(i) the date of commencement of waste discharge to the Original Lined Cell,

(ii) the date of commencement of waste discharge to the New Landfill,

and at all times thereafter.

(b) The operational certificate holder must prepare documents of the SWANA certification and training of the person(s) responsible for the management and operation of the Facility.

3.4 **New Leachate Management Works Classification and Operator Certification**

(a) The operational certificate holder must have the New Leachate Management Works classified by the Environmental Operators Certification Program (EOCP), on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

(b) The operational certificate holder must ensure that the person(s) responsible for the operation and maintenance of the New Leachate Management Works is(are) certified at an EOCP certification level equivalent to or higher than the EOCP classification level of the New Leachate Management Works, on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

(c) The operational certificate holder must prepare documents of the EOCP classification level of the New Leachate Management Works and the EOCP certification level(s) of the person(s) responsible for the operation and maintenance of the New Leachate Management Works.

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3.5 Groundwater Quality

(a) The operational certificate holder must ensure that the Facility does not cause the concentration of any substance in groundwater flowing from the Facility site boundary to be greater than:

(i) the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance,

or,

(ii) if the local background concentration of any substance is greater than (i), the local background concentration of that substance.

(b) If section 3.5(a)(ii) of this operational certificate is being used, the operational certificate holder must cause a Qualified Professional to determine the local background concentration of substance(s) in (a), in accordance with the latest approved version of Protocol 9 for Contaminated Sites, Determining Background Groundwater Quality, and include such determination(s) in the Annual Operations and Monitoring Report.

(c) The director may specify more stringent groundwater quality standards than those set out in this section.

3.6 Landfill Gas Management

The operational certificate holder must ensure that:

(a) The Facility does not cause:

(i) combustible gas concentrations to exceed the lower explosive limit of methane (5 percent by volume), or a lower concentration specified by the director, in soil at the Facility site boundary;

(ii) combustible gas concentrations to exceed 20 percent of the lower explosive limit of methane (1 percent by volume) in any building; and

(iii) federal, provincial, or local ambient air quality objectives and standards to be exceeded in air at the Facility site boundary.

(b) Landfill gas is managed in accordance with all migration and health and safety requirements.

3.7 Nuisance

The operational certificate holder must ensure that the Facility does not cause a nuisance including with regard to birds, rodents, insects, odour, noise, dust, litter, vector and wildlife attraction.

3.8 Complaints

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The operational certificate holder must prepare documents of complaints with regard to matters relevant to this operational certificate, including environmental and nuisance complaints. These documents must include the source and nature of the complaint, actions, responses, and corresponding dates and times.

3.9 Regulatory Documents

(a) The operational certificate holder must retain all Regulatory Documents.

(b) The operational certificate holder must retain all Regulatory Documents for the last seven years at the Facility and such documents must be available for immediate inspection at the Facility by a director or an officer.

(c) If requested by a director or an officer, the operational certificate holder must submit the requested Regulatory Documents to the director or officer within 14 days of the request.

4. SAMPLING REQUIREMENTS

4.1 Sampling Procedures

The operational certificate holder must carry out required sampling in accordance with the procedures described in the "British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples, 2013 Edition (Permittee)" or most recent edition, or by alternative procedures as authorized by the director. A copy of the above manual is available on the Ministry web page at https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance.

4.2 Analytical Procedures

The operational certificate holder must carry out required analyses in accordance with procedures described in the "British Columbia Laboratory Manual (2015 Permittee Edition)", or the most recent edition or by alternative procedures as authorized by the director. A copy of the above manual is available on the Ministry web page at https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance.

4.3 Quality Assurance

(a) The operational certificate holder must obtain from the analytical laboratory(ies) their precision, accuracy and blank data for each sample set submitted by the operational certificate holder and an evaluation of the data acceptability, based on criteria set by such laboratory.

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(b) The operational certificate holder must submit samples to analytical laboratory(ies) that meet the definition of a qualified laboratory under the Environmental Data Quality Assurance Regulation.

(c) The operational certificate holder must collect, prepare and submit for analysis by the analytical laboratory(ies) quality control (QC) samples for each parameter. As a minimum,

(i) The number of QC samples should be 20% of all samples collected (environmental + QC samples) within 48 hours of each other, and

(ii) Include duplicate, field and trip blank samples for each parameter.

5. REPORTING REQUIREMENTS

5.1 Routine Reporting

The operational certificate holder must submit all routine Regulatory Documents required by this operational certificate by email to the Ministry's Routine Environmental Reporting Submission Mailbox at EnvAuthorizationsReporting@gov.bc.ca or as otherwise instructed by the director. For guidelines on how to properly name the files and email subject lines or for more information visit the Ministry website http://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/routine-environmental-reporting-submission-mailbox.

5.2 Non-compliance Notification

(a) The operational certificate holder must immediately notify the director or designate by email at EnvironmentalCompliance@gov.bc.ca, or as otherwise instructed by the director of any non-compliance with the requirements of this authorization by the operational certificate holder and must take remedial action to remedy any effects of such non-compliance.

(b) The operational certificate holder must provide the director with written confirmation of all such non-compliance events, including available test results within 24 hours of the original notification by email at EnvironmentalCompliance@gov.bc.ca, or as otherwise instructed by the director.

5.3. Non-compliance Reporting

(a) If the operational certificate holder fails to comply with any of the requirements of this authorization, the operational certificate holder must, within 30 days of such non-compliance, submit to the director a written report that is satisfactory to the director and includes, but is not necessarily limited to, the following:

(i) all relevant test results obtained by the operational certificate holder related to the non-compliance,

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(ii) an explanation of the most probable cause(s) of the non-compliance, and
(iii) a description of remedial action planned and/or taken by the operational certificate holder to prevent similar non-compliance(s) in the future.

(b) The operational certificate holder must submit all non-compliance reporting required to be submitted under this section by email to the Ministry's Compliance Reporting Submission Mailbox at EnvironmentalCompliance@gov.bc.ca or as otherwise instructed by the director. For guidelines on how to report a non-compliance or for more information visit the Ministry website http://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/non-compliance-reporting-mailbox.

5.4 Annual Operations and Monitoring Report

(a) The operational certificate holder must cause a Qualified Professional to certify and submit an Annual Operations and Monitoring Report in a format suitable for public release, for the preceding calendar year, to the director on or before March 31 of each year. On or before March 31 of each year, the operational certificate holder must post a copy of the Annual Operations and Monitoring Report online, on a website accessible to the public, and in accordance with any requirements of the director.

(b) The Annual Operations and Monitoring Report must include the following information:
Operations Report:
(i) Summary of OCP implementation that addresses the information in section 2.3(b), and summary of DOCP implementation that addresses the information in 2.5(b), of this operational certificate,
(ii) Summary of construction report(s),
(iii) Annual and cumulative tonnages and categories of waste including soil tonnage(s) and soil quality class(es) discharged to the Original Lined Cell and to the New Landfill,
(iv) Remaining volume and life of the Original Lined Cell and of the New Landfill,
(v) Summary of treated leachate effluent quantity and quality discharged to the treated leachate infiltration pond,
(vi) Summary of complaints and nuisances and description of remedial action planned and/or taken by the operational certificate holder to prevent similar complaints and nuisances in the future,
(vii) Summary of non-compliance notifications and non-compliance reporting and description of remedial action planned and/or taken by the operational certificate holder to prevent similar non-compliance(s) in the future ,
(viii) Annual status form in accordance with the instructions and template at the ministry website https://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/annual-status-form
(ix) Summary of OCP and DOCP implementation, and construction of Significant Works, planned for the next calendar year,

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Environmental Monitoring Plan Report:

(x) Site plan(s), sampling locations, stormwater flow paths, groundwater elevations, gradients and flow directions,
(xi) Sampling facilities, frequencies, substances, sampling and analytical procedures,
(xii) Data including laboratory analysis and quality assurance and quality control results,
(xiii) Data tabulation, trend analysis, graphs, diagrams, and interpretation,
(xiv) Trigger level assessment plan monitoring, data, results and interpretation,
(xv) Any determination(s) of the local background concentration of substance(s) in accordance with section 3.5 of this operational certificate,
(xvi) Comparison of the data with the standards for treated leachate effluent discharge, stormwater quality, groundwater quality, and landfill gas management, specified in sections 1.2, 1.4, 1.5, 3.5 and 3.6 of this operational certificate, and identification of any non-compliance and predicted future non-compliance,
(xvii) Results, conclusions, recommendations and changes to the environmental monitoring plan.

(c) The operational certificate holder must upload monitoring data associated with this operational certificate to the Ministry's Environmental Monitoring System (EMS) database, within 45 days of the end of the 3 month period in which the data is collected.

5.5 **Licence to Publish Documents**

(a) Subject to paragraph (b), the operational certificate holder authorizes the Province to publish on the Ministry of Environment and Climate Change Strategy website the entirety of any Regulatory Document.

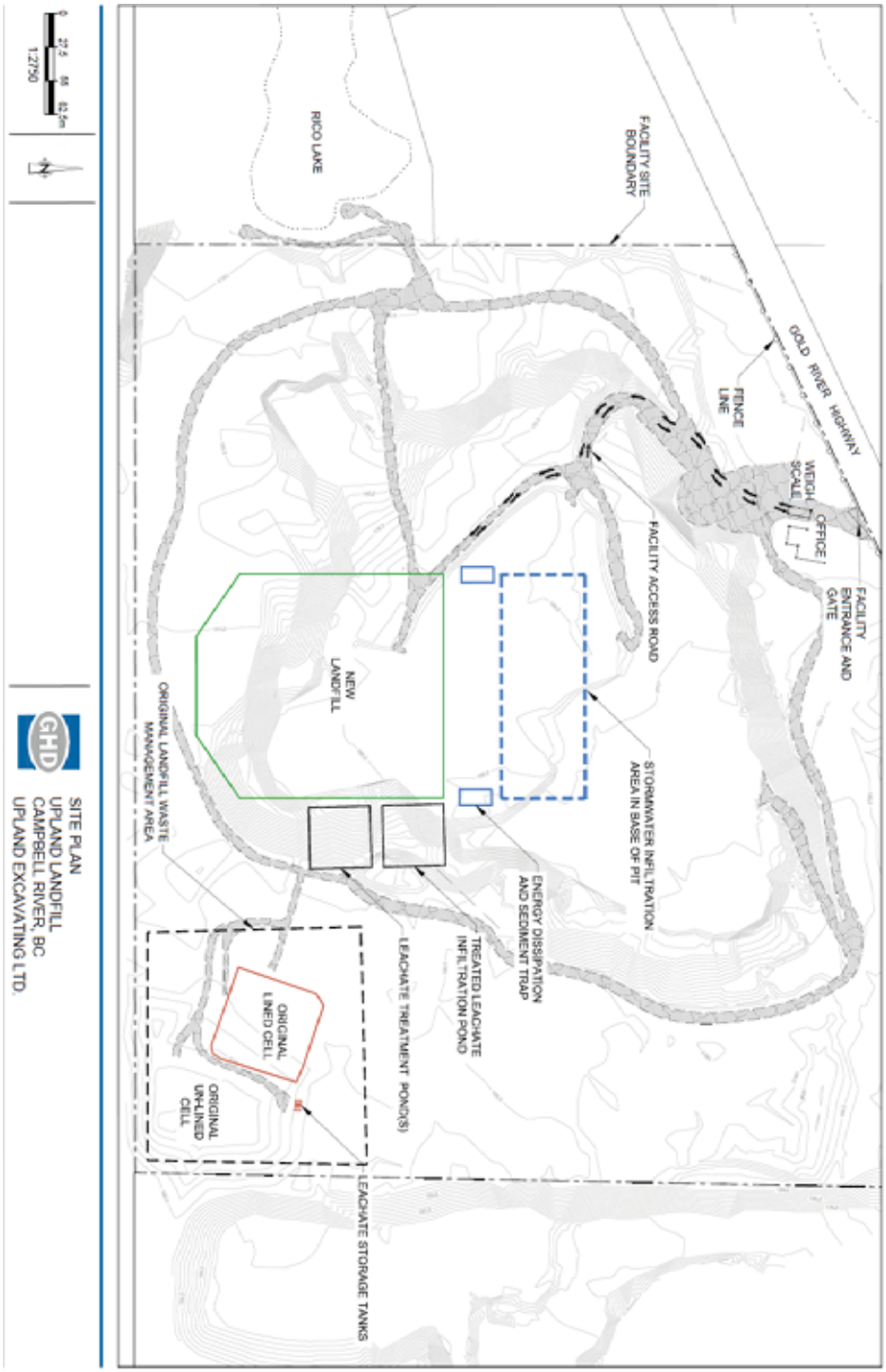
(b) The Province will not publish any information that could not, if it were subject to a request under section 5 of the *Freedom of Information and Protection of Privacy Act*, be disclosed under that Act.

(c) The operational certificate holder will indemnify and save harmless the Province and the Province's employees and agents from any claim for infringement of copyright or other intellectual property rights that the Province or any of the Province's employees or agents may sustain, incur, suffer or be put to at any time that arise from the publication of a Regulatory Document.

Date issued: August 1, 2019

Luc Lachance, P.Eng
for Director, *Environmental Management Act*
Authorizations - South Region

Site Plan A



Date issued: August 1, 2019

Luc Lachance, P.Eng
for Director, *Environmental Management Act*
Authorizations - South Region

Amendments to the Operational Certificate

April 26, 2022

Tracking Number: 405141
Authorization Number: 107689

UPLAND EXCAVATING LTD.
#201-909 ISLAND HIGHWAY
CAMPBELL RIVER BC V9W 2C2

Re: Your application dated June 07, 2021, for amendments to Operational Certificate 107689, under the *Environmental Management Act*

In response to the subject application, and pursuant to Section 16 of the *Environmental Management Act*, Operational Certificate 107689 is hereby amended as follows:

The subject part of the preamble page 1 is amended from:

> Is authorized to manage waste at the Facility located in Campbell River, British Columbia, subject to the requirements listed below. Contravention of any of these requirements is a violation of the *Environmental Management Act* and may lead to prosecution.

to:

> Is authorized to manage waste at the Facility located in Campbell River, British Columbia, provided that the operational certificate holder complies with all provisions of this operational certificate. Unless a contrary intention appears, the provisions of this operational certificate are requirements that must be complied with regardless of whether the operational certificate holder introduces waste to the environment. Contravention of any of these requirements, and any discharge of waste while out of compliance with any provisions of this operational certificate, is a violation of the *Environmental Management Act*, and may lead to prosecution.

Sub-section 1.3.2 (d) is amended to:

> (d) soil that is not hazardous waste,

Sub-section 1.4.5 is amended after "leachate treatment pond(s)" by adding:

> treated leachate holding pond or tank,

Sub-section 1.4.6 is amended after "1x 10^{-7} cm/s." by adding:

> The treated leachate holding pond must include from bottom to top a secondary base liner, leak detection drainage layer and leak collection pipe(s), and a primary base liner. The treated leachate holding pond secondary base liner and the primary base liner must each include a coated woven polyethylene geomembrane of minimum 0.75 mm thickness.

Sub-section 1.4.7 is amended after “treated leachate infiltration pond: 0.6 m” by adding:

treated leachate holding pond: 0.6 m.

4. Sub-sections 2.9(c) and 2.9(d) are amended to:

(c) The operational certificate holder must carry out and complete the plan referred to in section 2.9(a) of this operational certificate, on or before one year after the date of this letter.

(d) The operational certificate holder must cause a Qualified Professional to certify and submit a report to the director that confirms that the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed, describes the plan implementation, describes and provides the waste categorization, describes and provides the sampling and results, describes the decommissioning of the Original Landfill and the Original Leachate Management Works, provides photos documenting the implementation of the plan referred to in section 2.9(a) of this operational certificate, and lists the tonnages or volumes, and categories of waste removed and discharged to the New Landfill and to other identified and authorized waste management facility(ies), on or before 60 days after the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed.

5. Site Plan A is amended to the enclosed Site Plan A.

All other terms and conditions of the operational certificate remain in full force and effect.

Please note that although a revised operational certificate document has not been produced at this time a copy of this letter is being placed on the operational certificate file, as an addendum to the operational certificate, to formally reflect the change.

This operational certificate does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the operational certificate holder. This operational certificate is issued pursuant to the provisions of the *Environmental Management Act* to ensure compliance with Section 120(3) of that statute, which makes it an offence to discharge waste, from a prescribed industry or activity, without proper authorization. It is also the responsibility of the operational certificate holder to ensure that all activities conducted under this operational certificate are carried out with regard to the rights of third parties, and comply with other applicable legislation that may be in force.

This decision may be appealed to the Environmental Appeal Board in accordance with Part 8 of the *Environmental Management Act*. An appeal must be delivered within 30 days from the date that notice of this decision is given. For further information, please contact the Environmental Appeal Board at (250) 387-3464.

Administration of this operational certificate will be carried out by staff from the Environmental Protection Division's Regional Operations Branch. For guidance regarding how to comply with a waste discharge authorization including submitting reports and reporting non-compliance, please refer to the ministry website at: https://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/comply, or as further instructed.

For more information about how the Ministry will assess compliance with your operational certificate please refer to gov.bc.ca/environmentalcompliance.

For more information about how to make changes to your operational certificate and to access waste discharge amendment forms and guidance, please refer to gov.bc.ca/wastedischarge-authorizations.

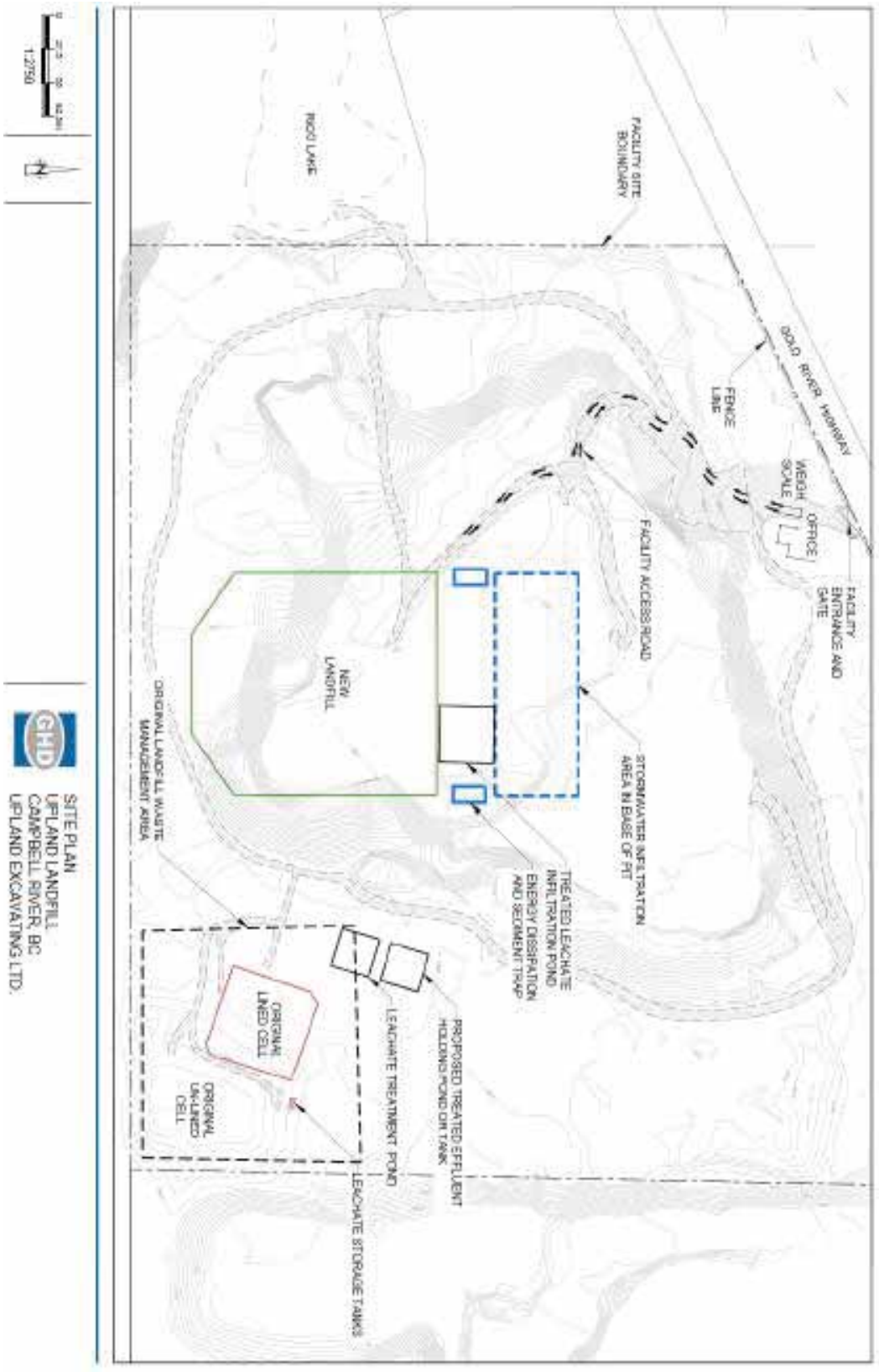
Sincerely,



Carol Danyluk, P.Eng.
Director's Designate
Environmental Management Act

ENCL: None

Site Plan A


1:2750
SITE PLAN
UPLAND LANDFILL
CAMPBELL RIVER, BC
UPLAND EXCAVATING LTD.
GHD
RIGG LAKE
FACILITY SITE BOUNDARY
GOLD RIVER HIGHWAY
FENCE LINE
WEIGH SCALE
OFFICE
FACILITY ENTRANCE AND GATE
FACILITY ACCESS ROAD
NEW LANDFILL
ORIGINAL LANDFILL WASTE MANAGEMENT AREA
STORMWATER INFILTRATION AREA IN BASE OF PIT
TREATED LEACHATE INFILTRATION POND ENERGY DISSIPATION AND SEDIMENT TRAP
ORIGINAL LINED CELL
ORIGINAL UNLINED CELL
LEACHATE TREATMENT POND
PROPOSED TREATED EFFLUENT HOLDING POND OR TANK
LEACHATE STORAGE TANKS

APPENDIX B:
IFC Record Drawings

New Landfill
Phase 1 East - Cell & Landfill Ponds

UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

NEW LANDFILL (NORTHWIN LANDFILL)
PHASE 1 EAST - CELL AND LANDFILL PONDS
JULY 2021



LOCATION MAP

DRAWING LIST

DWG. No.	DRAWING TITLE
G-01	COVER
C-01	EXISTING CONDITIONS
C-02	SITE OPERATIONS
C-03	TOP OF SUBGRADE
C-04	TOP OF DOUBLE LINER SYSTEM
C-05	TOP OF DRAINAGE LAYER
C-06	STAGE 1 EAST CROSS-SECTIONS
C-07	LEACHATE TREATMENT POND AND EFFLUENT HOLDING POND CROSS SECTIONS
C-08	DETAILS - LINER DETAILS
C-09	DETAILS - LEACHATE COLLECTION SUMP
C-10	DETAILS - LEACHATE LEAK DETECTION SUMP
C-11	DETAILS - LEACHATE COLLECTION SYSTEM
C-12	DETAILS - PERIMETER TIE-IN DETAILS
C-13	DETAILS - LEACHATE TREATMENT AND EFFLUENT STORAGE PONDS DETAILS

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0 250 500 750m

Client
UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

Project
PHASE 1 EAST
CELL AND LANDFILL PONDS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR CONSTRUCTION	T.W.	R.H.	07-21-2021

Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	March 30, 2021
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Original Size ANSI D		Bar is 20mm on original size drawing 0 20mm	

Project No. 88877-11

Title
COVER

Sheet No.
G-01

Sheet 1 of 19

Plot Date: 19 July 2021 - 1:55 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(015)\88877-11(015)GN\88877-11(015)GN-WA001.dwg



LEGEND

- 165 — EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPERTY LINE
- EXISTING LAKE SHORELINE
- EXISTING ACCESS ROADWAY
- MW3-14 — EXISTING MONITORING WELL

SOURCE: TOPOGRAPHICAL SURVEY RECEIVED FROM UPLAND CONTRACTING LTD. , MARCH 3, 2020.

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Client
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CAMPBELL RIVER, B.C.

Project
PHASE 1 EAST
CELL AND LANDFILL PONDS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR CONSTRUCTION	T.W.	R.H.	07-21-2021

Drawn	T.WAGSTAFF	Designer	S.KEMP
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Project Manager	D. LIDDY	Date	July 16, 2021
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Original Size	ANSI D	Bar is 20mm on original size drawing	0 20mm

Project No. 88877-11

Title
EXISTING CONDITIONS

Sheet No.
C-01

Sheet 2 of 19

Plot Date: 19 July 2021 - 2:00 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(015)\88877-11(015)CI\88877-11(015)CI-WA001.dwg



LEGEND

- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPERTY LINE
- EXISTING LAKE SHORELINE
- EXISTING ACCESS ROADWAY
- LIMIT OF WASTE
- LIMIT OF EXCAVATION
- NEW LEACHATE CONVEYANCE PIPE - OUT OF SCOPE
- NEW TREATED EFFLUENT CONVEYANCE PIPE - OUT OF SCOPE
- MW3-14 EXISTING MONITORING WELL
- PZ1-19 EXISTING PIEZOMETER

SOURCE: TOPOGRAPHICAL SURVEY RECEIVED FROM UPLAND CONTRACTING LTD. , MARCH 3, 2020. UPDATED WITH SEPTEMBER 2020 SURVEY.

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Project
PHASE 1 EAST
CELL AND LANDFILL PONDS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR CONSTRUCTION	T.W.	R.H.	07-21-2021

Drawn	T.WAGSTAFF	Designer	S.KEMP
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Project Manager	D. LIDDY	Date	July 19, 2021
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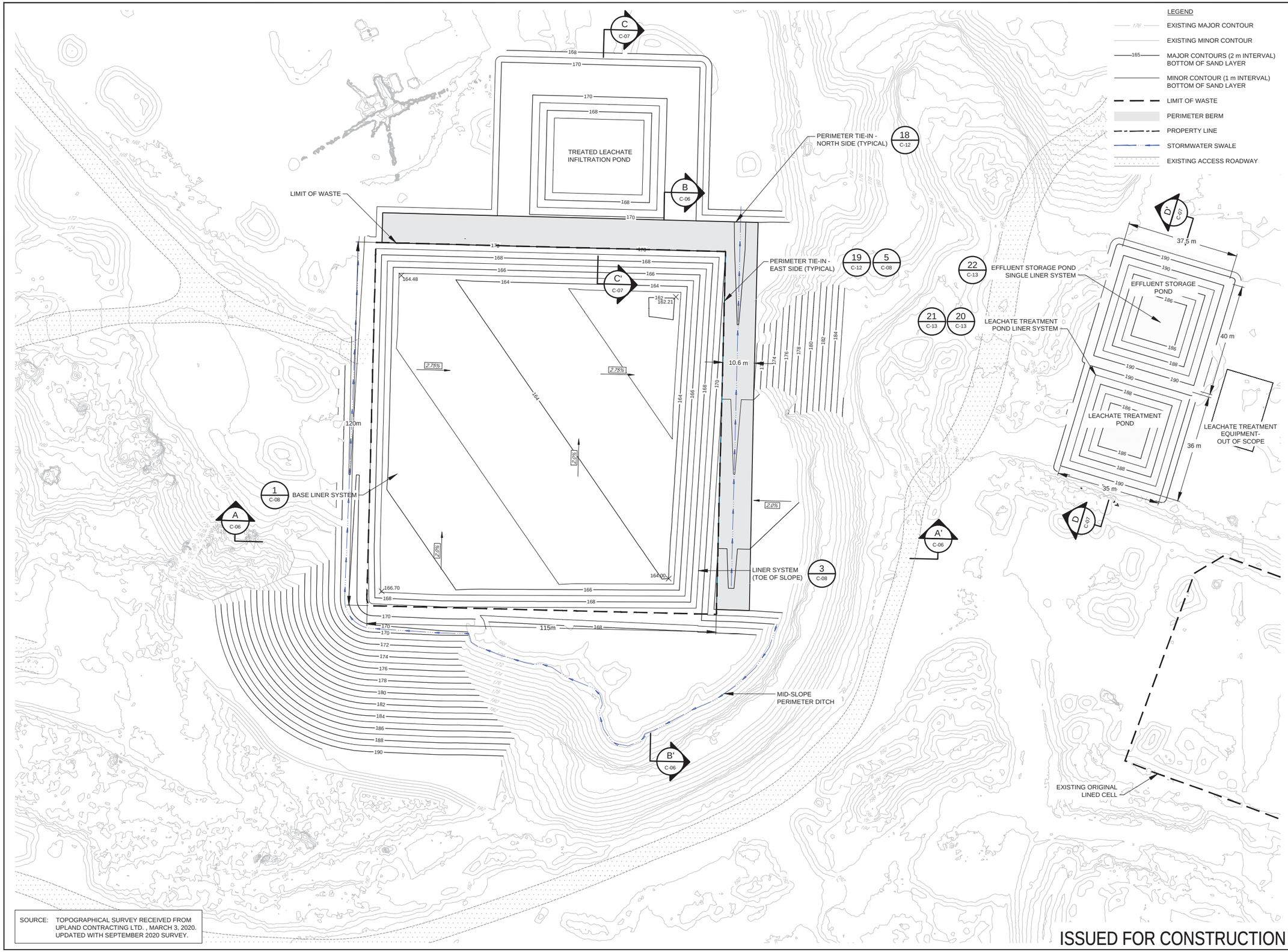
Project No. 88877-11

Title
SITE OPERATIONS

Sheet No.
C-02

Sheet 3 of 19

Plot Date: 19 July 2021 - 1:57 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(015)\88877-11(015)CI-WA002.dwg



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Project
PHASE 1 EAST
CELL AND LANDFILL PONDS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR CONSTRUCTION	T.W.	R.H.	07-21-2021

Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	July 19, 2021
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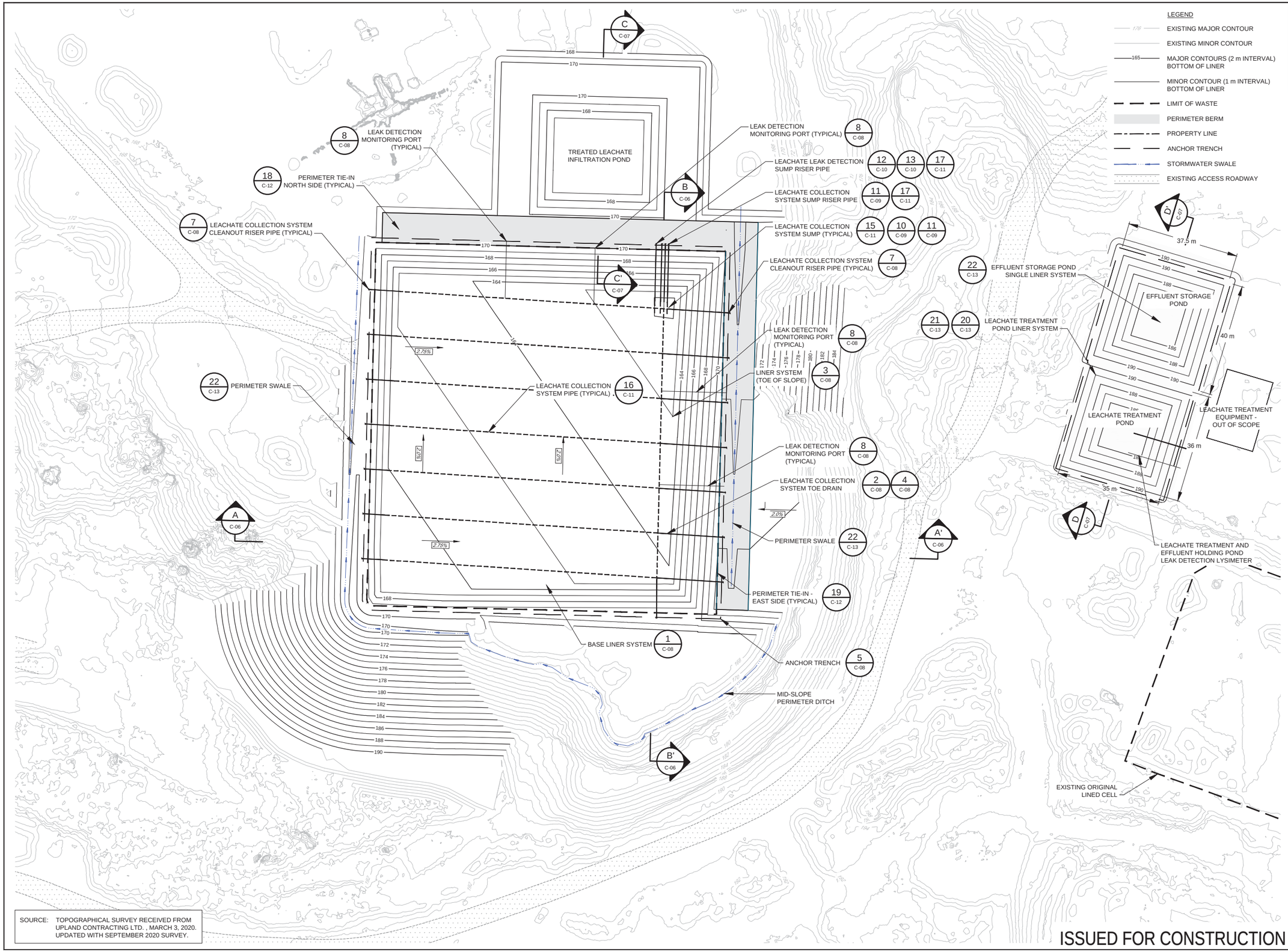
Project No. 88877-11

Title
TOP OF SUBGRADE

Sheet No.
C-03

Sheet 4 of 19

Plot Date: 19 July 2021 - 1:46 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(015)\88877-11(015)CI\88877-11(015)CI-WA003.dwg



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Project
PHASE 1 EAST
CELL AND LANDFILL PONDS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR CONSTRUCTION	T.W.	R.H.	07-21-2021

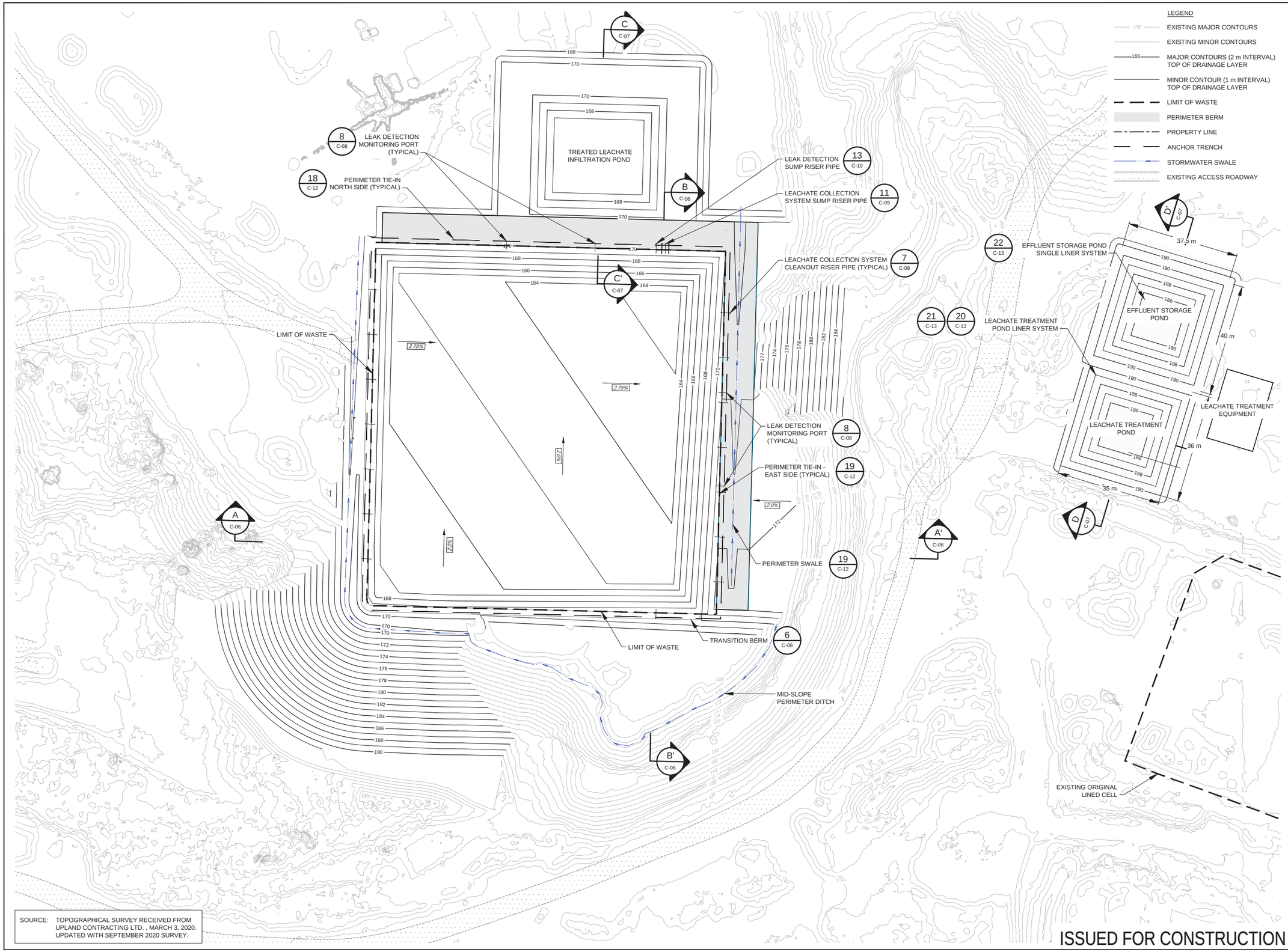
Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	July 19, 2021
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Original Size	ANSI D	Bar is 20mm on original size drawing	0 20mm

Project No. 88877-11

Title
TOP OF DOUBLE
LINER SYSTEM

Sheet No.
C-04

Sheet 5 of 19



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Project
PHASE 1 EAST
CELL AND LANDFILL PONDS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR CONSTRUCTION	T.W.	R.H.	07-21-2021

Drawn	T.WAGSTAFF	Designer	S.KEMP
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Project Manager	D. LIDDY	Date	July 19, 2021
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Original Size	ANSI D	Bar is 20mm on original size drawing	0 20mm

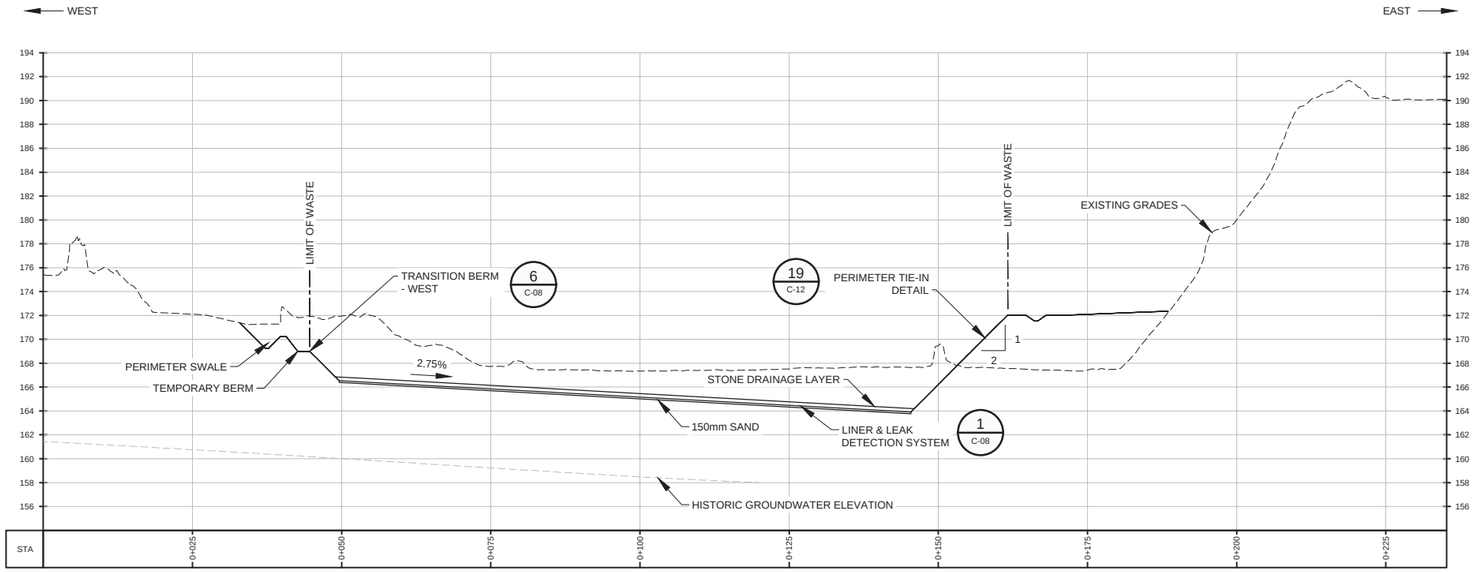
Project No. 88877-11

Title
TOP OF
DRAINAGE LAYER

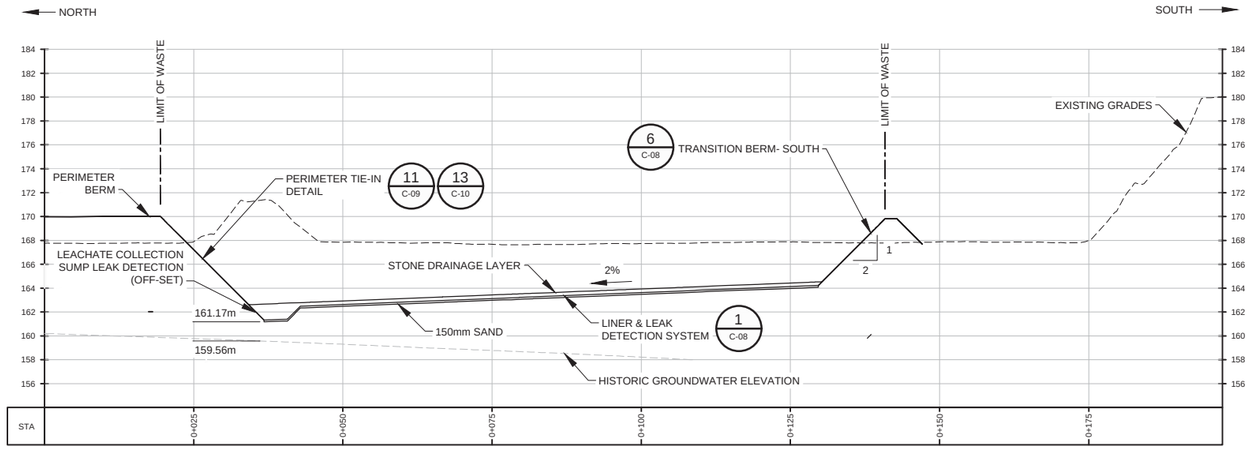
Sheet No.
C-05

Sheet 4 of 19

Plot Date: 19 July 2021 - 1:52 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(015)\88877-11(015)Cl\88877-11(015)Cl-WA005.dwg



SECTION A-A'
C-03
HORZ: 1:500
VERT: 1:250



SECTION B-B'
C-03
HORZ: 1:500
VERT: 1:250

SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY McELHANNEY ASSOCIATES LAND SURVEYING LTD. , DECEMBER 18, 2018.

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Project
PHASE 1 EAST
CELL AND LANDFILL PONDS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR CONSTRUCTION	T.W.	R.H.	07-21-2021

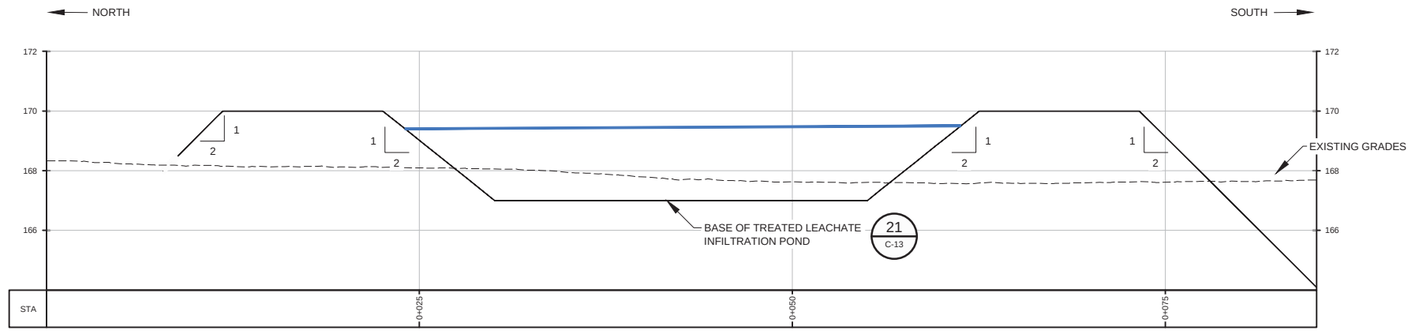
Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	July 20, 2021
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Original Size	ANSI D	Bar is 20mm on original size drawing	0 20mm

Project No. 88877-11

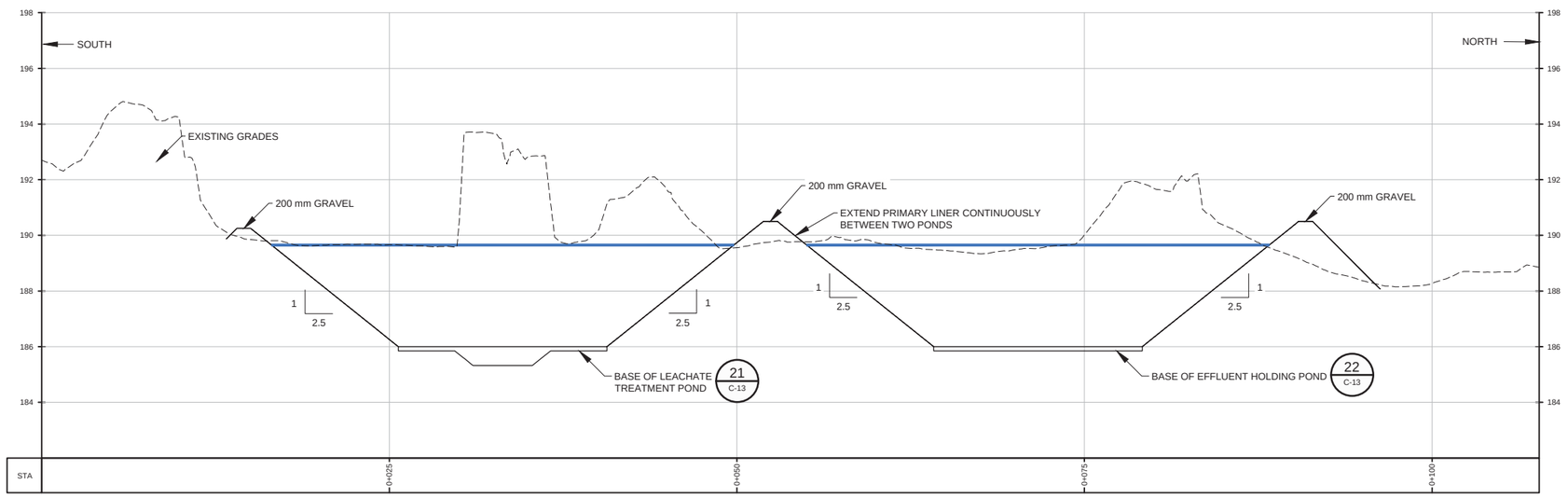
Title
STAGE 1 EAST
CROSS-SECTIONS

Sheet No.
C-06

Plot Date: 20 July 2021 - 9:41 AM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(015)\88877-11(015)CI\88877-11(015)CI-WA006.dwg



SECTION C-C' TREATED LEACHATE INFILTRATION POND
HORZ: 1:200
VERT: 1:100
C-03



SECTION D-D' LEACHATE TREATMENT POND AND EFFLUENT HOLDING POND
HORZ: 1:200
VERT: 1:100
C-03

SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY McELHANNEY ASSOCIATES LAND SURVEYING LTD. , DECEMBER 18, 2018.

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2021-07-20

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Project
PHASE 1 EAST
CELL AND LANDFILL PONDS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR CONSTRUCTION	T.W.	R.H.	07-21-2021

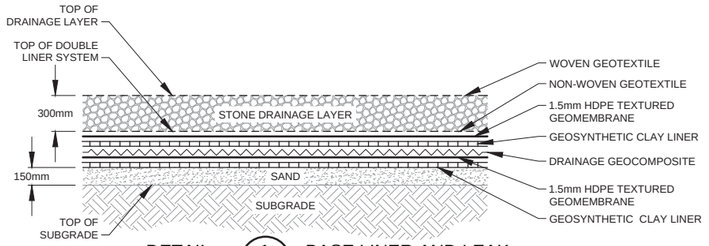
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Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	July 20, 2021
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Original Size	ANSI D	Bar is 20mm on original size drawing	0 20mm

Project No. 88877-11

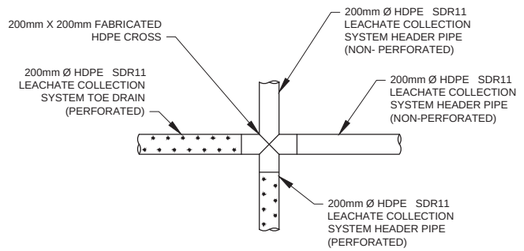
Title
LEACHATE TREATMENT POND AND EFFLUENT HOLDING POND CROSS-SECTIONS

Sheet No.
C-07

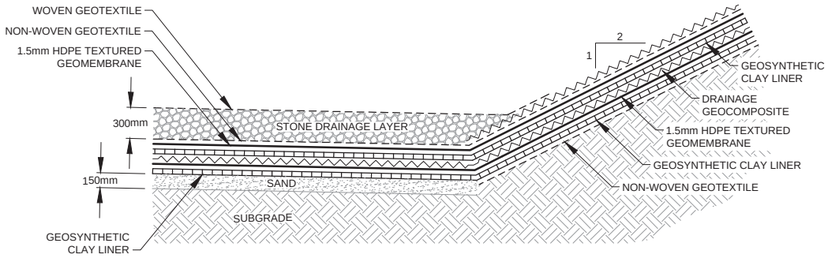
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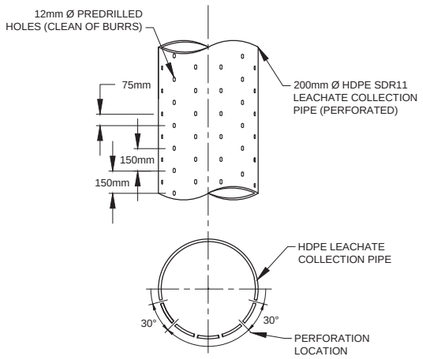
DETAIL 1 (C-03,04,12) — 1:25
BASE LINER AND LEAK DETECTION SYSTEM



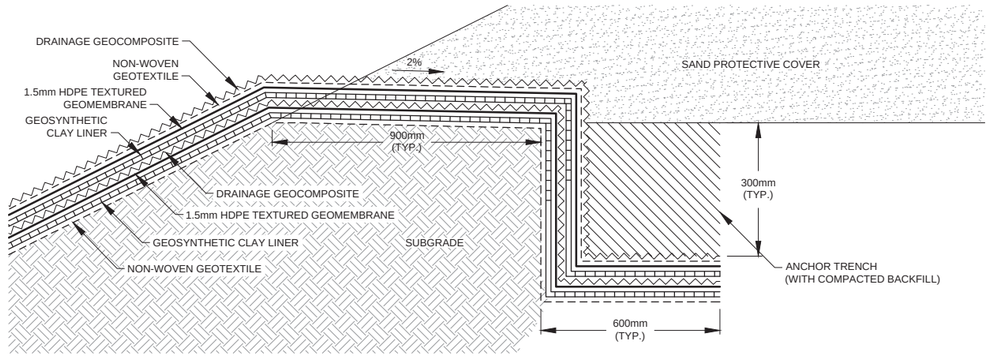
DETAIL 2 (C-04) — 1:30
LEACHATE COLLECTION SYSTEM TOE DRAIN / LEACHATE COLLECTION SYSTEM PIPE CONNECTION



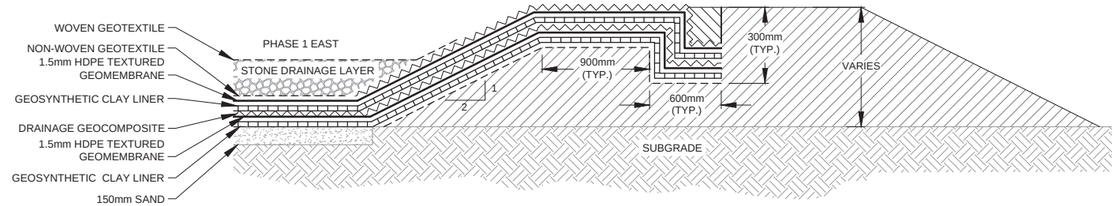
DETAIL 3 (C-04) — 1:30
LINER SYSTEM (TOE OF SLOPE) NORTH AND EAST (TYP.)



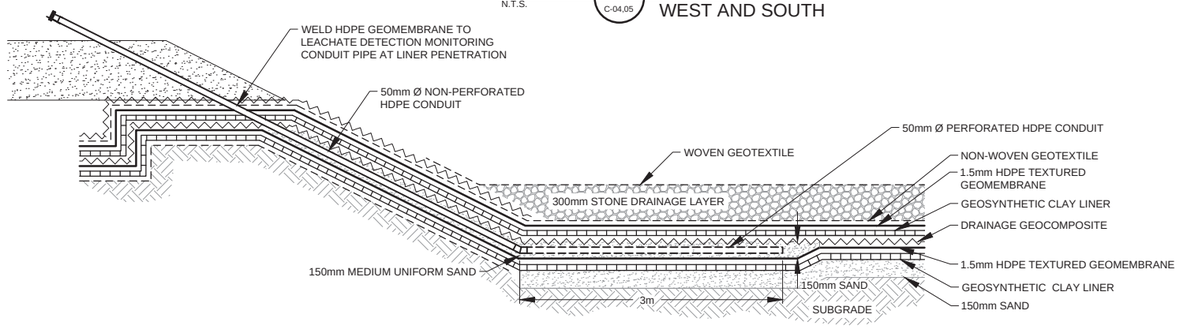
DETAIL 4 (C-04) — N.T.S.
LEACHATE COLLECTION SYSTEM TOE DRAIN / LEACHATE COLLECTION SYSTEM PIPE PERFORATIONS



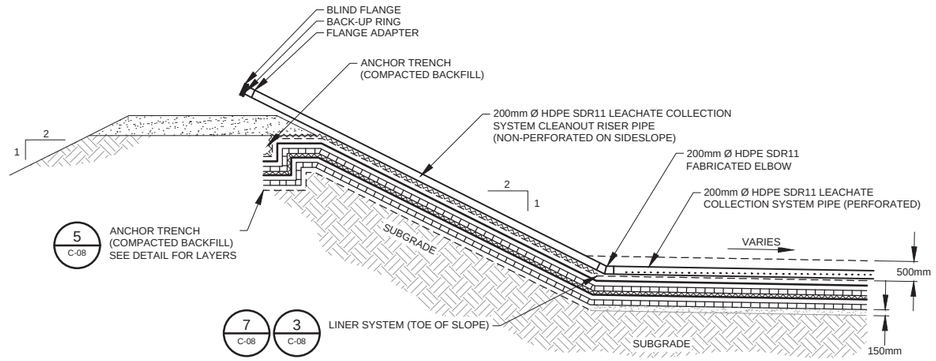
DETAIL 5 (C-03, C-04, C-16, C-17) — 1:10
ANCHOR TRENCH (TYPICAL) NORTH AND EAST



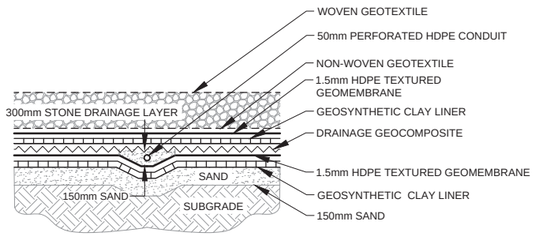
DETAIL 6 (C-04.05) — N.T.S.
TRANSITION BERM WEST AND SOUTH



DETAIL 8 (C-04,05) — N.T.S.
LEAK DETECTION DETECTION PORT (TYP.) PROFILE



DETAIL 7 (C-04,05) — 1:75
LEACHATE COLLECTION SYSTEM CLEANOUT RISER PIPE (TYPICAL)



DETAIL 9 (C-04,05) — 1:25
LEAK DETECTION MONITORING PORT (TYP.) CROSS-SECTION

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CAMPBELL RIVER, B.C.

Project
PHASE 1 EAST
CELL AND LANDFILL PONDS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR CONSTRUCTION	T.W.	R.H.	07-21-2021

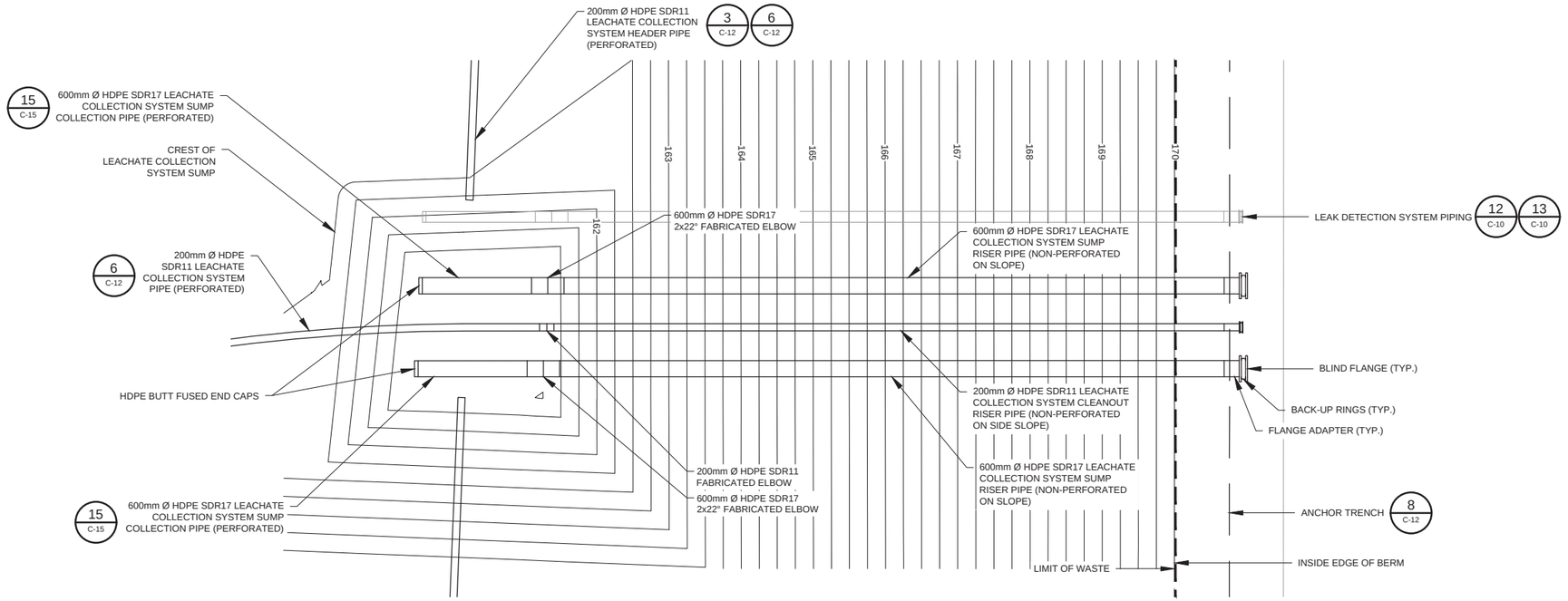
Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	July 19, 2021
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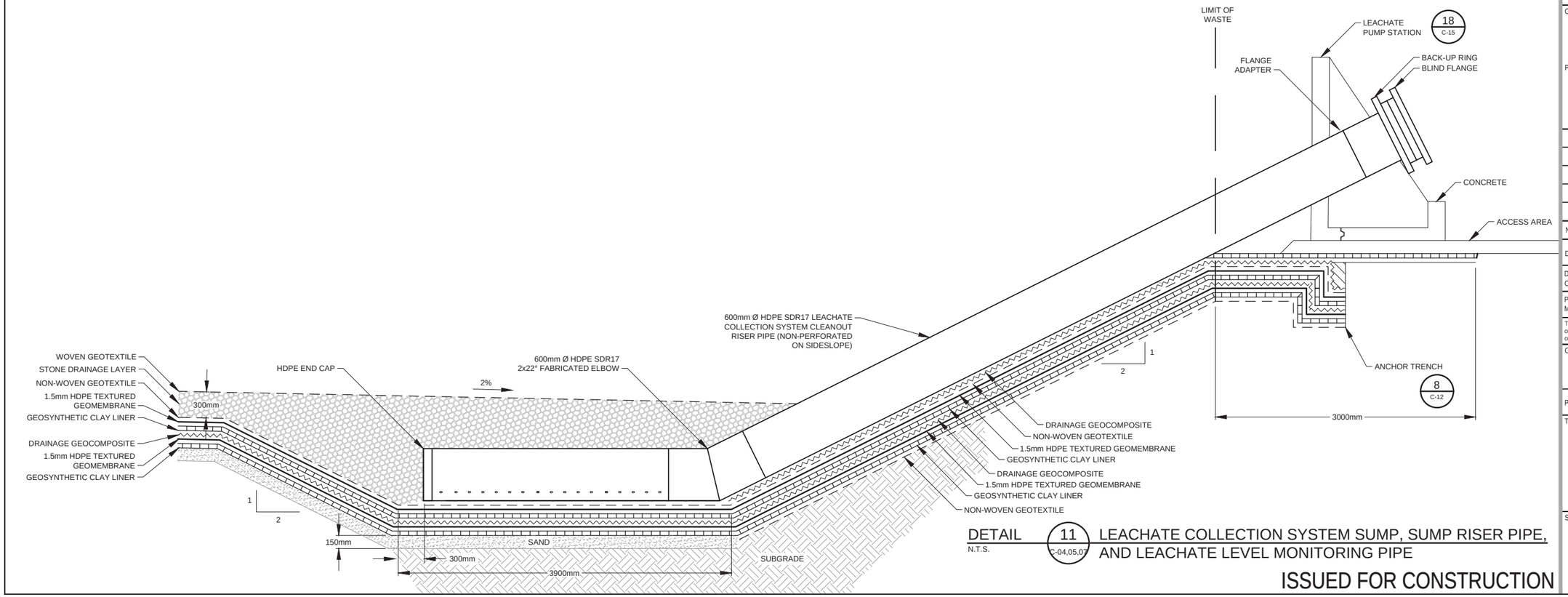
Title
DETAILS
LINER DETAILS

Sheet No.
C-08

Sheet 13 of 19



DETAIL 10 C-04 — LEACHATE COLLECTION SYSTEM SUMP (TOP OF LINER)
1:75



DETAIL 11 C-04,05,07 — LEACHATE COLLECTION SYSTEM SUMP, SUMP RISER PIPE, AND LEACHATE LEVEL MONITORING PIPE
N.T.S.

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Project
PHASE 1 EAST
CELL AND LANDFILL PONDS

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Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	July 19, 2021
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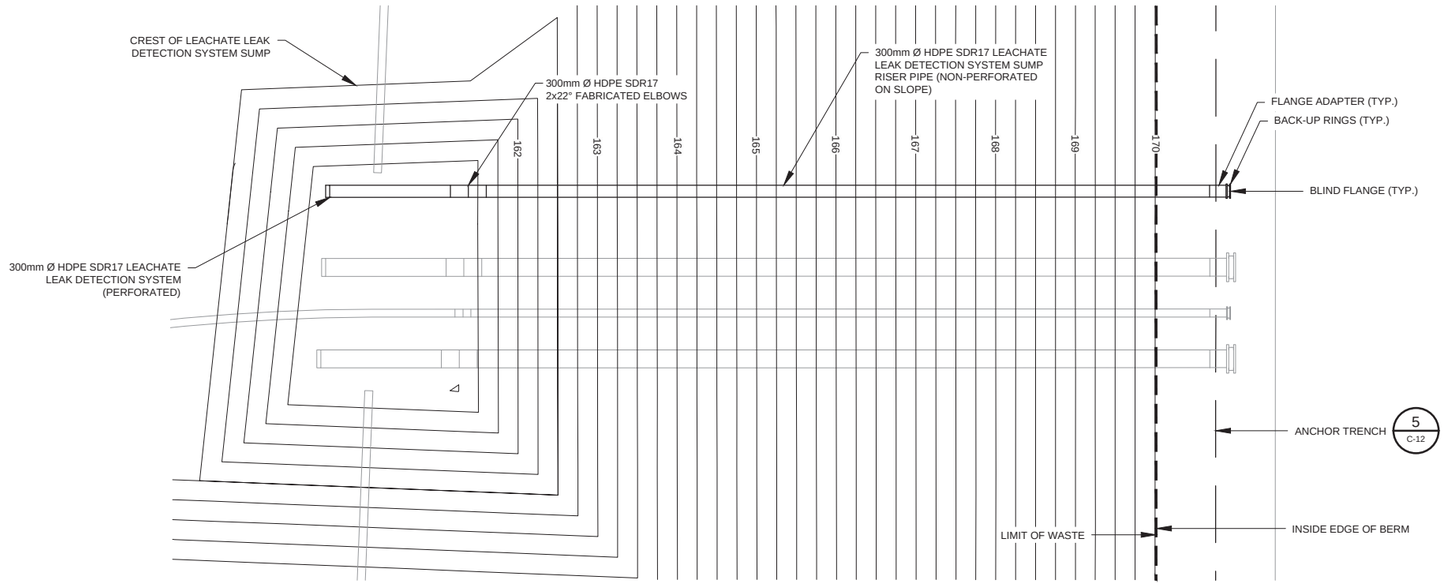
Project No. 88877-11

Title
DETAILS
LEACHATE
COLLECTION SUMP

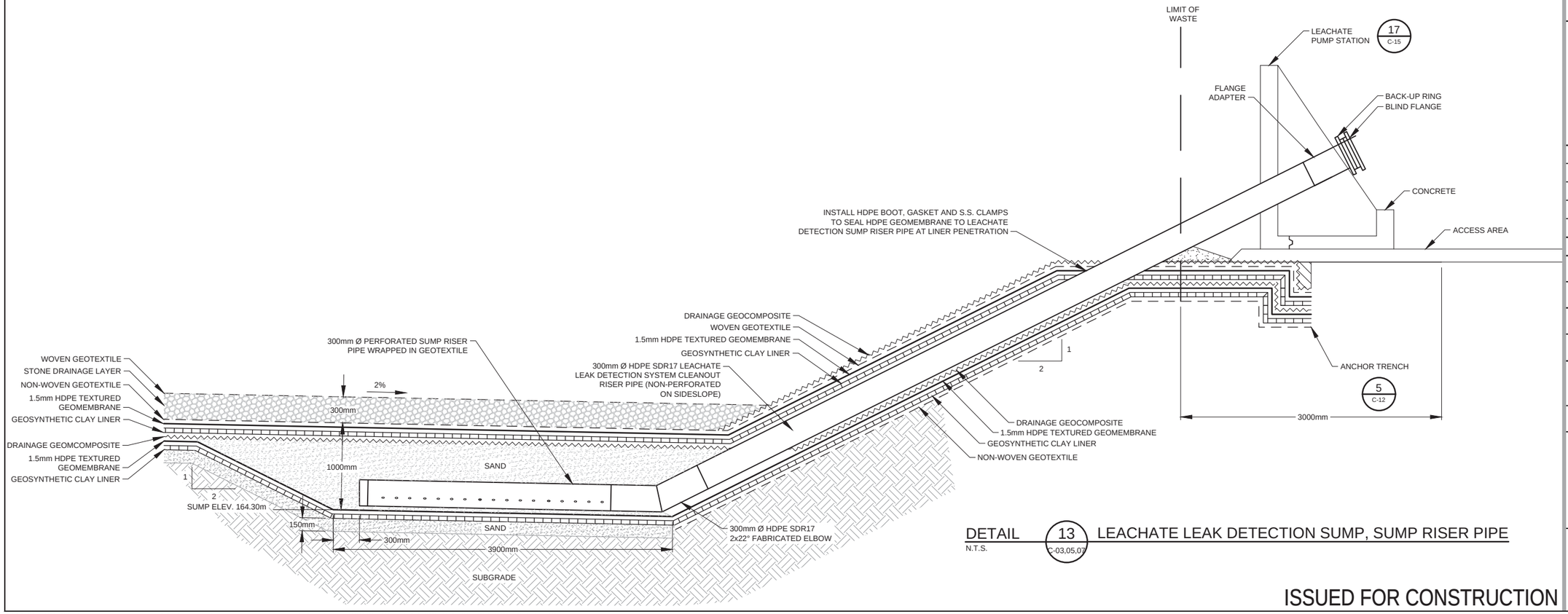
Sheet No.
C-09

Sheet 14 of 19

Plot Date: 19 July 2021 - 12:37 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(015)\88877-11(015)CI\88877-11(015)CI-WA009.dwg



DETAIL 12 (C-03) LEACHATE LEAK DETECTION SUMP
1:75



DETAIL 13 (C-03,05,07) LEACHATE LEAK DETECTION SUMP, SUMP RISER PIPE
N.T.S.

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PROVINCE OF BRITISH COLUMBIA
D. J. LIDDY
33360
2021-07-20

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Client
UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

Project
PHASE 1 EAST
CELL AND LANDFILL PONDS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR CONSTRUCTION	T.W.	R.H.	07-21-2021

Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	July 19, 2021
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Original Size	ANSI D	Bar is 20mm on original size drawing	0 20mm

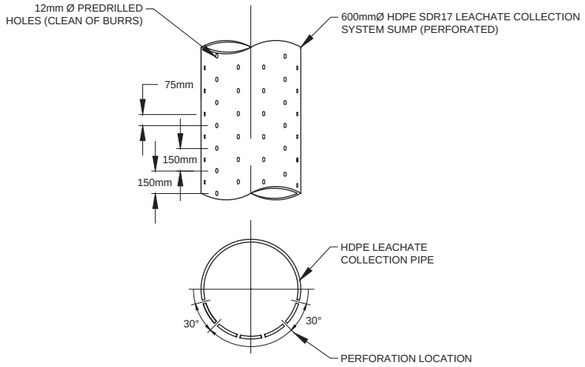
Project No. 88877-11

Title
DETAILS
LEACHATE LEAK
DETECTION SUMP

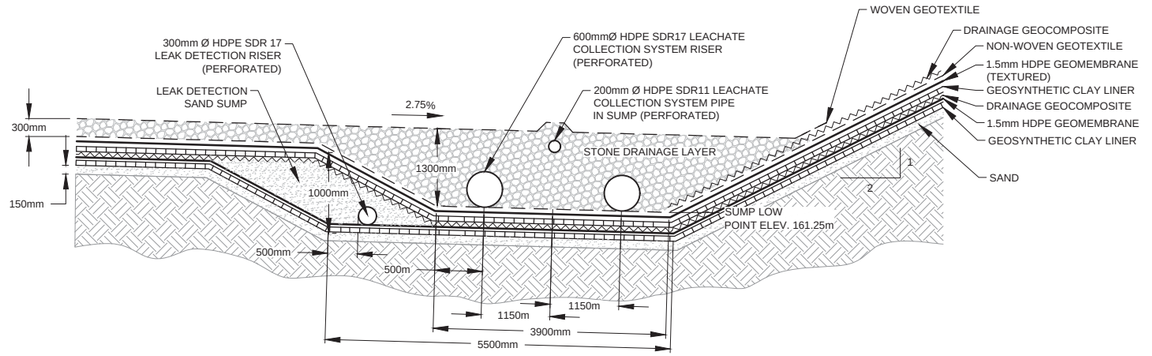
Sheet No.
C-10

Sheet 15 of 19

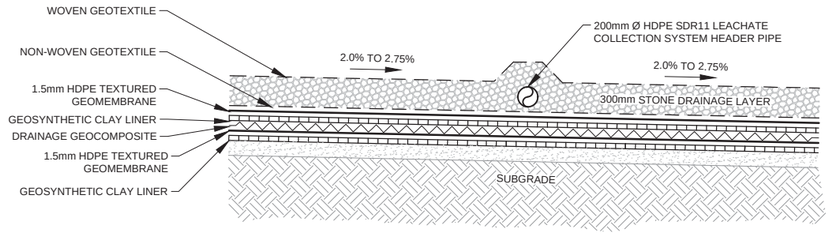
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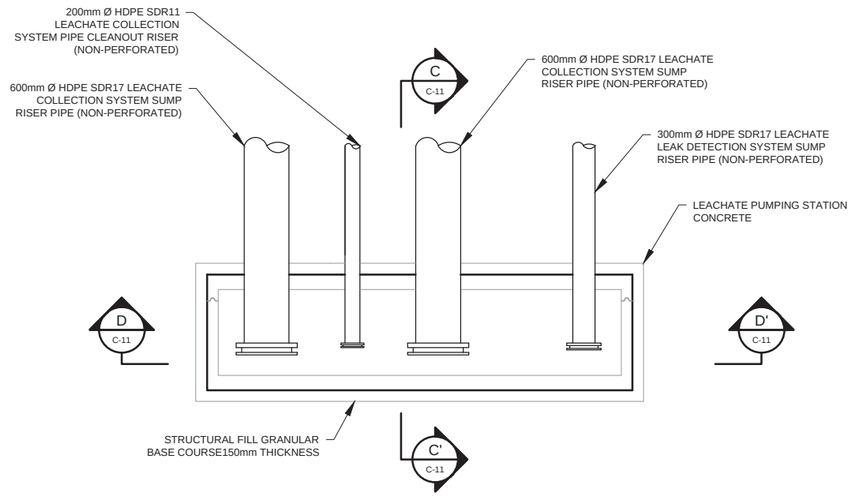
DETAIL 14 (C-04) 600mmØ LEACHATE COLLECTION SYSTEM SUMP PIPE PERFORATIONS
NTS



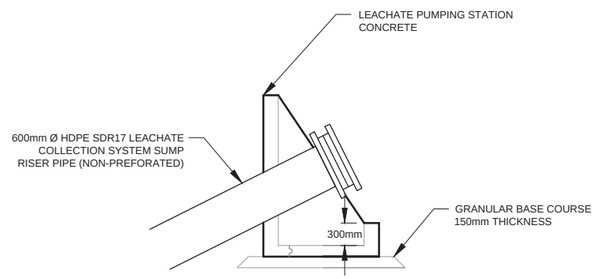
DETAIL 15 (C-03.04.07) LEACHATE COLLECTION SYSTEM SUMP
1:50



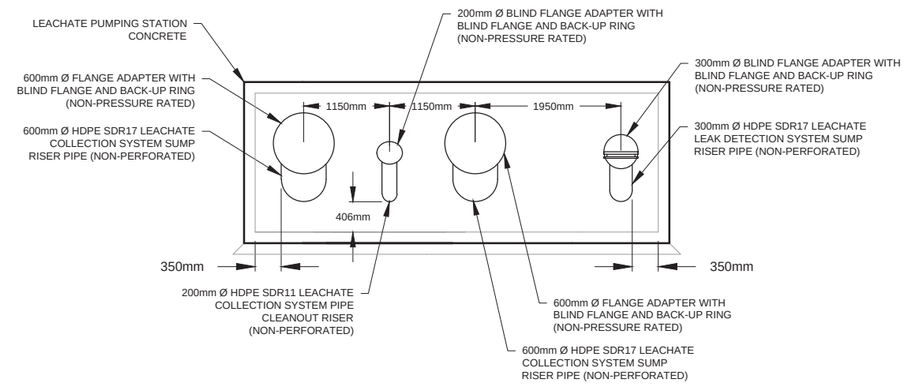
DETAIL 16 (C-04) LEACHATE COLLECTION SYSTEM TOE DRAIN/ LEACHATE COLLECTION SYSTEM PIPE
1:30



DETAIL 17 (C-03) LEACHATE PUMP STATION (PLAN VIEW)
1:40



SECTION C-C' (C-11)
1:40



SECTION D-D' (C-11)
1:40

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PROFESSIONAL ENGINEER
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Client
UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

Project
PHASE 1 EAST
CELL AND LANDFILL PONDS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR CONSTRUCTION	T.W.	R.H.	07-21-2021

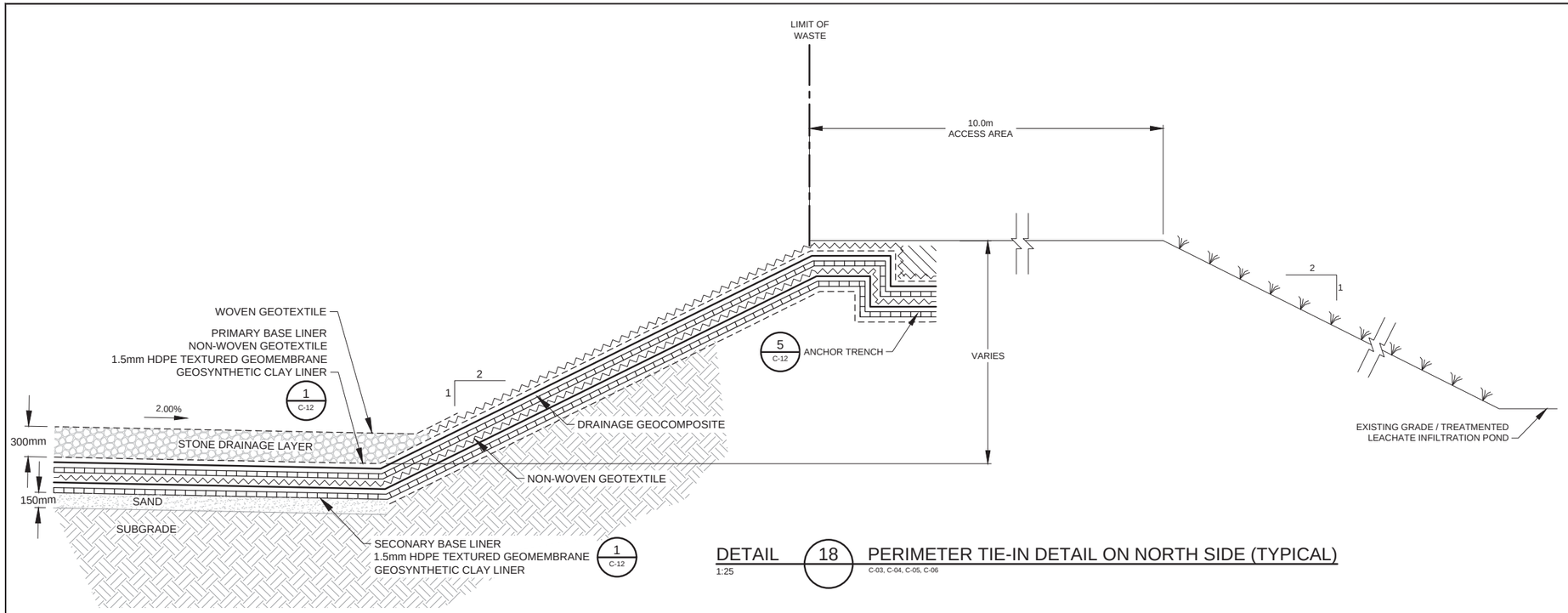
Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	July 19, 2021
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Project No. 88877-11

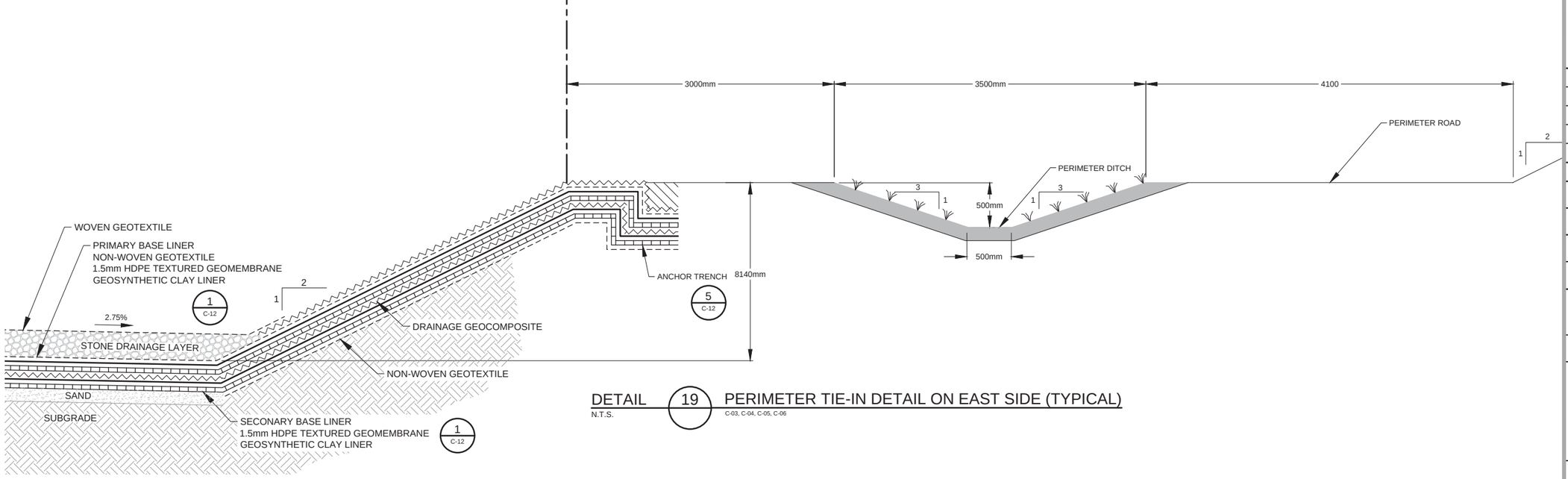
Title
DETAILS
LEACHATE COLLECTION SYSTEM

Sheet No.
C-11

Sheet 16 of 19



DETAIL 18 PERIMETER TIE-IN DETAIL ON NORTH SIDE (TYPICAL)
1:25 C-03, C-04, C-05, C-06



DETAIL 19 PERIMETER TIE-IN DETAIL ON EAST SIDE (TYPICAL)
N.T.S. C-03, C-04, C-05, C-06

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Project
PHASE 1 EAST
CELL AND LANDFILL PONDS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR CONSTRUCTION	T.W.	R.H.	07-21-2021

Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	July 19, 2021
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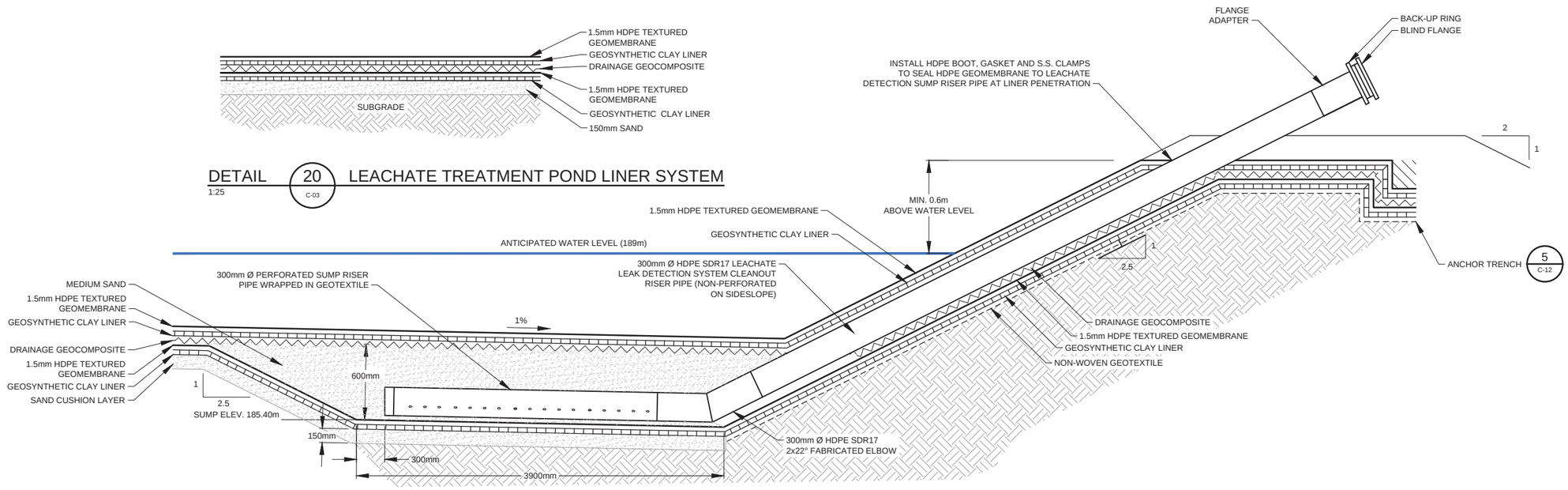
Project No. 88877-11

Title
DETAILS
PERIMETER TIE-IN DETAILS

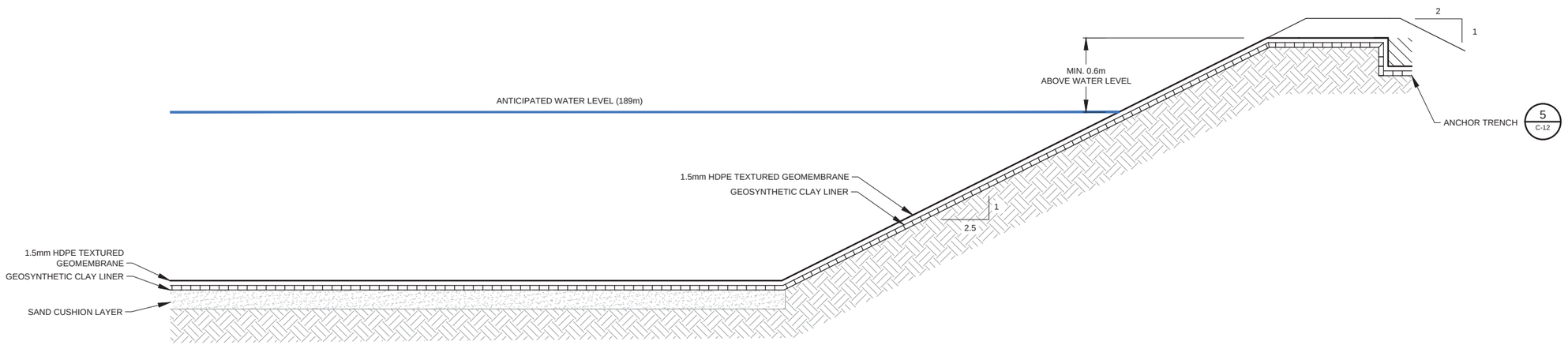
Sheet No.
C-12

Sheet 17 of 19

Plot Date: 19 July 2021 - 12:41 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(015)\88877-11(015)C\88877-11(015)CI-WA010.dwg



DETAIL 20 C-03 — LEACHATE TREATMENT POND LINER SYSTEM
1:25



DETAIL 21 C-03 — LEACHATE TREATMENT POND LEAK DETECTION SUMP RISER PIPE
N.T.S.

DETAIL 22 C-03 — EFFLUENT STORAGE POND SINGLE LINER SYSTEM
N.T.S.

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CAMPBELL RIVER, B.C.

Project
PHASE 1 EAST
CELL AND LANDFILL PONDS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR CONSTRUCTION	T.W.	R.H.	07-21-2021

Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	July 20, 2021
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Project No. 88877-11

Title
LEACHATE TREATMENT AND EFFLUENT STORAGE PONDS, TREATED LEACHATE INFILTRATION POND AND LYSIMETER DETAILS

Sheet No.
C-13

Plot Date: 20 July 2021 - 9:37 AM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(015)\88877-11(015)C\88877-11(015)CI-WA011.dwg

New Landfill
Stage 1 West - Detailed Design Drawings

UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

NEW LANDFILL (NORTHWIN LANDFILL)
STAGE 1 WEST - DETAILED DESIGN DRAWINGS
MAY 2022

SOURCE:
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LOCATION MAP

SOURCE:
JANUARY 01, 2007. GOVERNMENT OF CANADA, NATURAL RESOURCES CANADA.



AREA MAP

DRAWING LIST

DWG NO	DRAWING TITLE
GN-0001	COVER AND INDEX
CI-0101	EXISTING CONDITIONS
CI-0102	FINAL CONDITIONS
CI-0103	TOP OF SUBGRADE
CI-0104	TOP OF DOUBLE LINER SYSTEM
CI-0105	TOP OF DRAINAGE LAYER
CI-0301	STAGE 1 WEST CROSS-SECTIONS
CI-0501	LINER SYSTEM DETAILS
CI-0502	PERIMETER TIE-IN DETAILS

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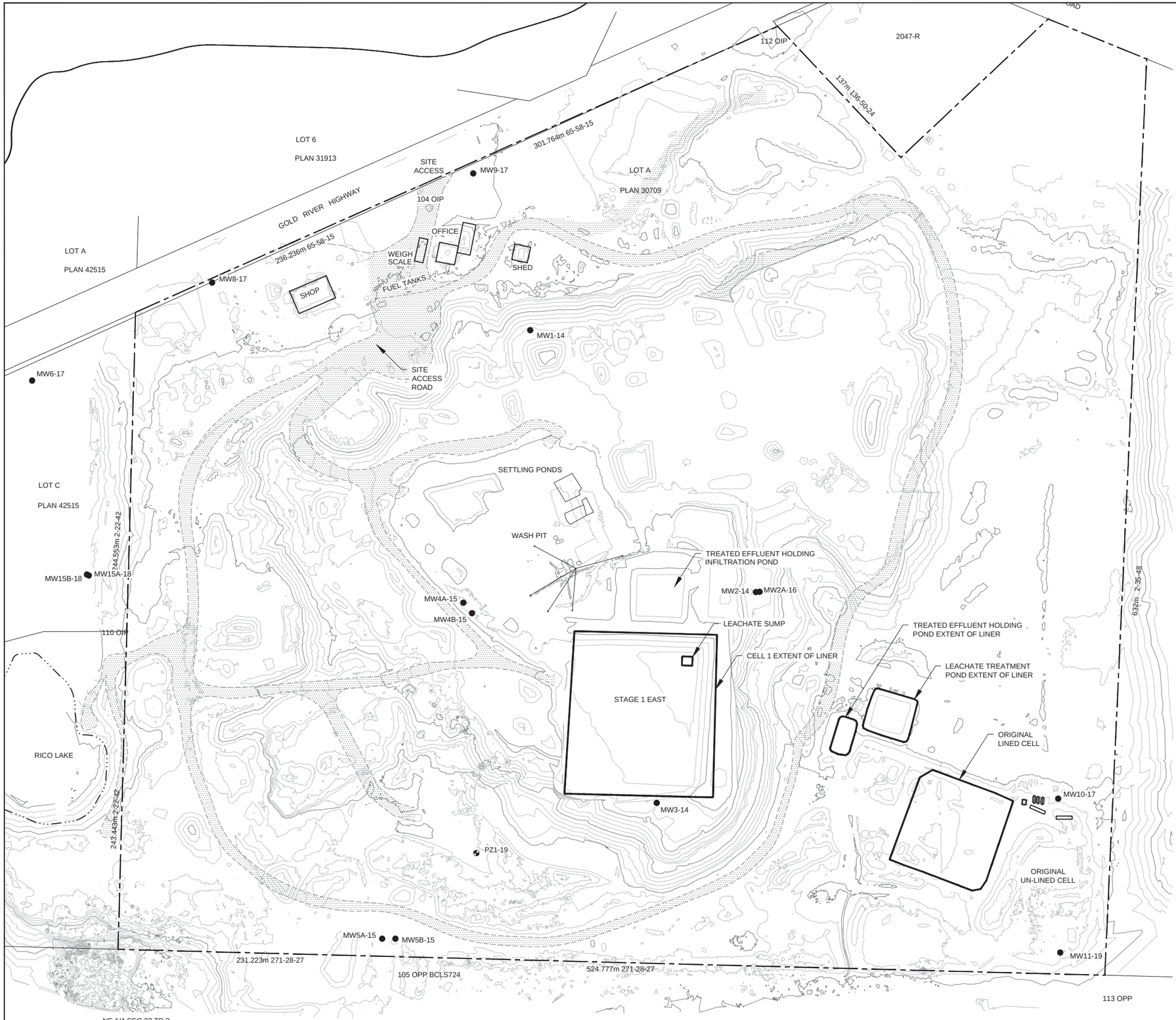
No.	Issue	Checked	Approved	Date
-	-	-	-	-

Author T.WAGSTAFF
Designer
Drafting
Design
Check
Check
Project Manager
Project Director

Client
UPLAND EXAVATING LTD.
CAMPBELL RIVER, B.C.

Project
STAGE 1 WEST
DETAILED DESIGN

Date 2022-05-06
Scale N.T.S.
Project No. 11222680
Title COVER AND INDEX
Size ANSI D
Status Code
Sheet No. GN-0001
Sheet 1 of 10



N

0 15 30 45m

LEGEND

- 625 — EXISTING CONTOUR (MAJOR) - 10m
- EXISTING CONTOUR (MINOR) - 2m
- PROPERTY BOUNDARY
- EXISTING LAKE SHORELINE
- EXISTING ROADWAY
- MW1-14 — EXISTING MONITORING WELL

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No.	Issue	Checked	Approved	Date

Author	T.WAGSTAFF	Designer	
Drafting		Design	
Check		Check	
Project Manager		Project Director	

Client
UPLAND EXAVATING LTD.
CAMPBELL RIVER, B.C.

Project
STAGE 1 WEST
DETAILED DESIGN

Date	Scale
2022-05-06	1:1500

Project No.
11222680

Title
EXISTING CONDITIONS

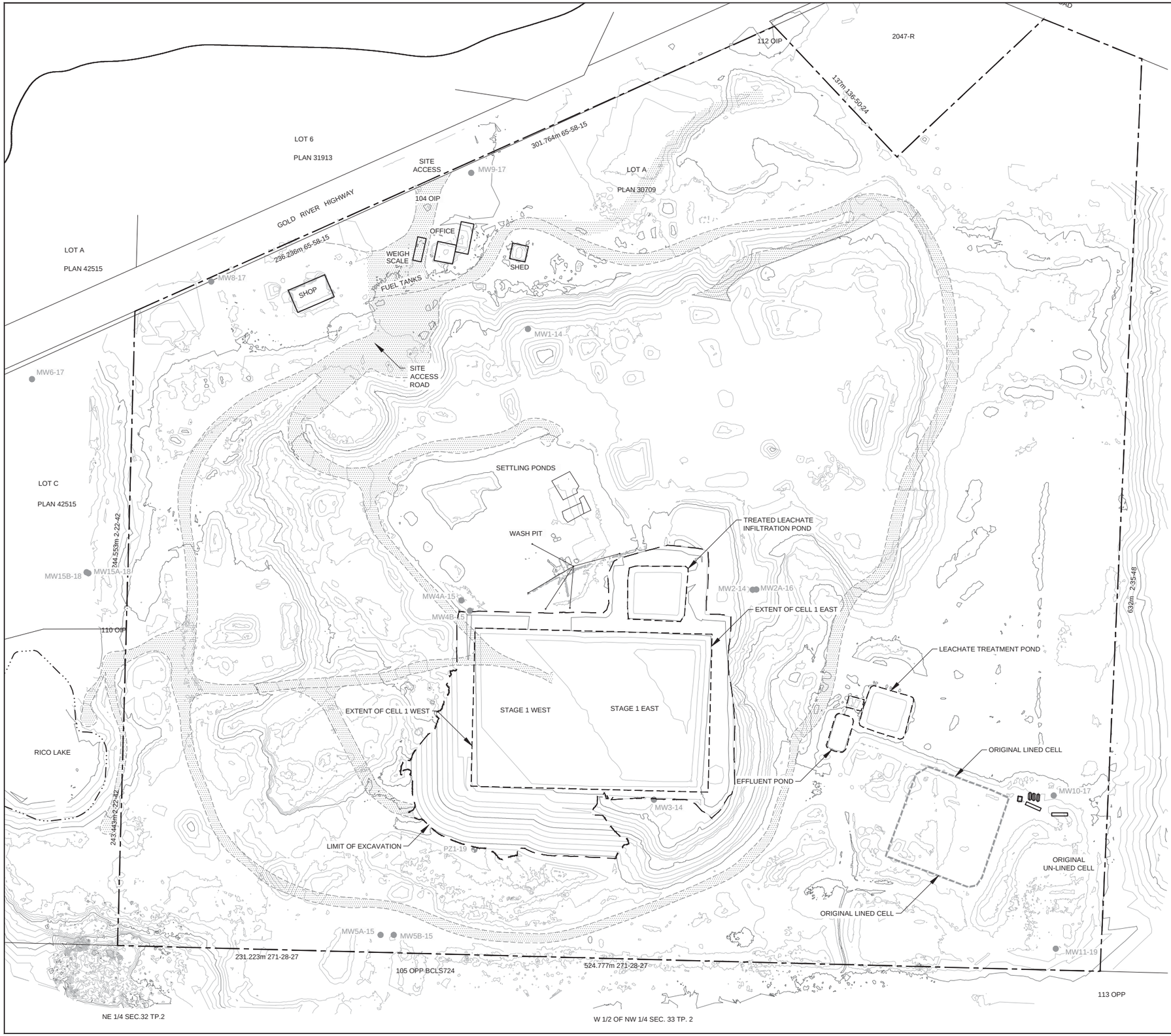
Size
ANSI D

Status Code

Sheet No.
CI-0101

Sheet
1 of 10

Plot Date: 10 May 2022 - 10:41 AM
Plotted By: Tyler Wagstaff
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N

0 15 30 45m

LEGEND

- 625 — EXISTING CONTOUR (MAJOR) - 10m
- EXISTING CONTOUR (MINOR) - 2m
- PROPERTY BOUNDARY
- EXISTING LAKE SHORELINE
- EXISTING ROADWAY
- MW1-14 — EXISTING MONITORING WELL
- LIMIT OF EXCAVATION
- EXTENT OF CELL / POND

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Author	T.WAGSTAFF	Designer	
Drafting		Design	
Check		Check	
Project Manager		Project Director	

Client
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CAMPBELL RIVER, B.C.

Project
STAGE 1 WEST
DETAILED DESIGN

Date	Scale
2022-05-06	1:1500

Project No.
11222680

Title
FINAL CONDITIONS

Size
ANSI D

Status Code

Sheet No.
CI-0102

Sheet
1 of 10

Plot Date: 10 May 2022 - 10:51 AM
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N

0 5 10 15m

LEGEND

- 625 — EXISTING CONTOUR (MAJOR) - 4m
- EXISTING CONTOUR (MINOR) - 1m
- 625 — TOP OF SUBGRADE CONTOUR (MAJOR) - 4m
- TOP OF SUBGRADE CONTOUR (MINOR) - 1m
- PROPERTY BOUNDARY
- EXISTING ROADWAY
- LIMIT OF WASTE
- EXTENT OF CELL 1 WEST AND EXCAVATION
- SWALE

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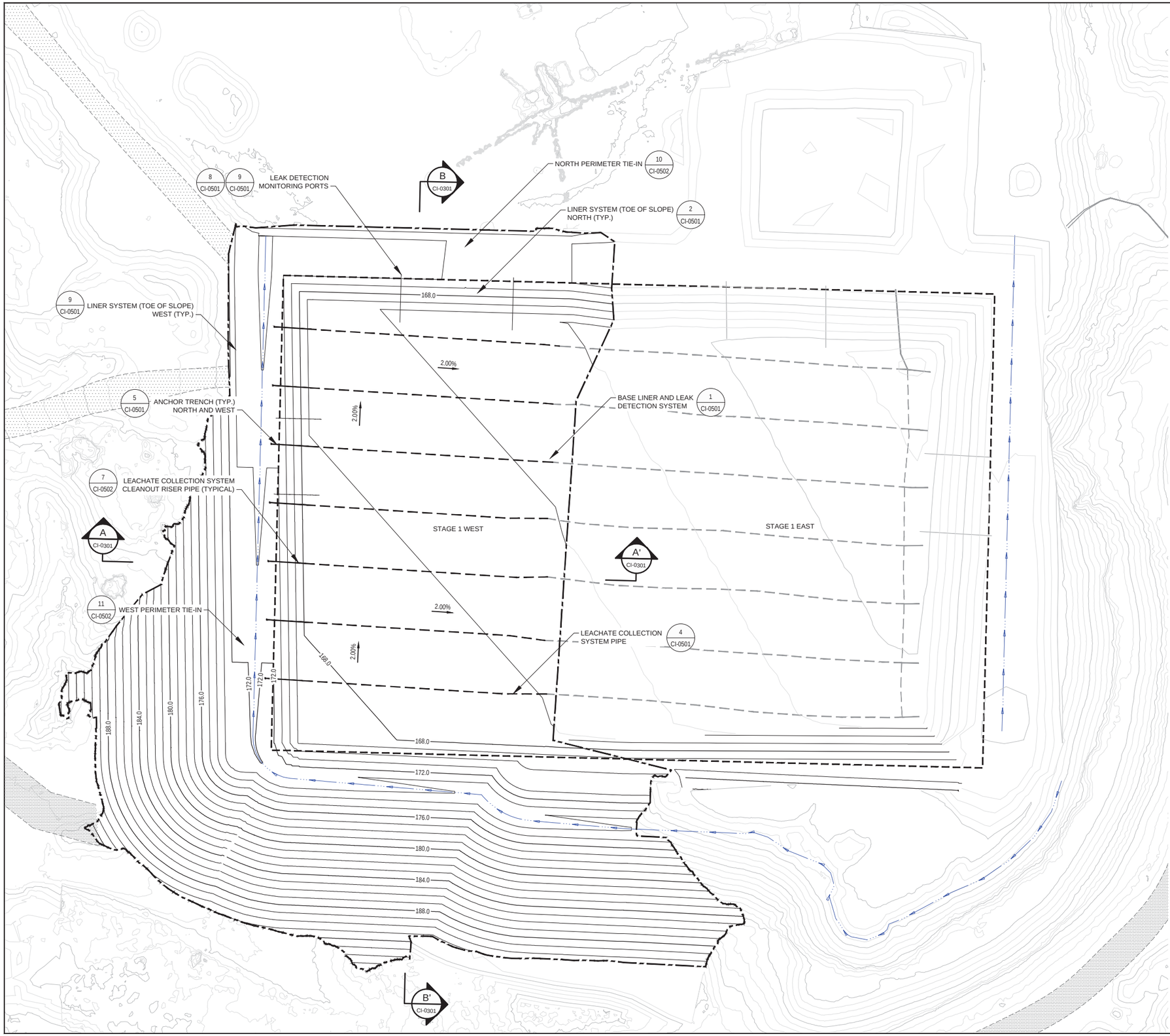
Author T.WAGSTAFF
Designer
Drafting Check
Design Check
Project Manager
Project Director

Client
UPLAND EXAVATING LTD.
CAMPBELL RIVER, B.C.

Project
STAGE 1 WEST
DETAILED DESIGN

Date 2022-05-06
Scale 1:500
Project No. 11222680
Title TOP OF SUBGRADE
Size ANSI D
Status Code
Sheet No. CI-0103
Sheet 1 of 10

Plot Date: 10 May 2022 - 1:42 PM
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DRAFT

N

0 5 10 15m

LEGEND

- 625 — EXISTING CONTOUR (MAJOR) - 4m
- EXISTING CONTOUR (MINOR) - 1m
- 625 — BOTTOM OF LINER CONTOUR (MAJOR) - 4m
- BOTTOM OF LINER CONTOUR (MINOR) - 1m
- PROPERTY BOUNDARY
- LEACHATE COLLECTION SYSTEM PIPE (PERFORATED)
- LEACHATE COLLECTION SYSTEM PIPE (NON-PERFORATED)
- EXISTING ROADWAY
- LIMIT OF WASTE
- EXTENT OF CELL 1 WEST AND EXCAVATION
- SWALE

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No.	Issue	Checked	Approved	Date
		-	-	-

Author	T.WAGSTAFF	Designer	
Drafting		Design	
Check		Check	
Project Manager		Project Director	

Client
UPLAND EXAVATING LTD.
CAMPBELL RIVER, B.C.

Project
STAGE 1 WEST
DETAILED DESIGN

Date	Scale
2022-05-06	1:500

Project No.
11222680

Title
TOP OF DOUBLE LINER SYSTEM

Size
ANSI D

Status Code

Sheet No.
CI-0104

Sheet
1 of 10

Plot Date: 10 May 2022 - 3:01 PM
Plotted By: Tyler Wagstaff
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N

0 5 10 15m

LEGEND

- 625 — EXISTING CONTOUR (MAJOR) - 4m
- EXISTING CONTOUR (MINOR) - 1m
- 625 — TOP OF DRAINAGE LAYER CONTOUR (MAJOR) - 4m
- TOP OF DRAINAGE LAYER CONTOUR (MINOR) - 1m
- PROPERTY BOUNDARY
- EXISTING ROADWAY
- LIMIT OF WASTE
- EXTENT OF CELL 1 WEST AND EXCAVATION
- SWALE

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Drafting Check		Design Check	
Project Manager		Project Director	

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Project

STAGE 1 WEST
DETAILED DESIGN

Date	Scale
2022-05-06	1:500

Project No.
11222680

Title
TOP OF DRAINAGE LAYER

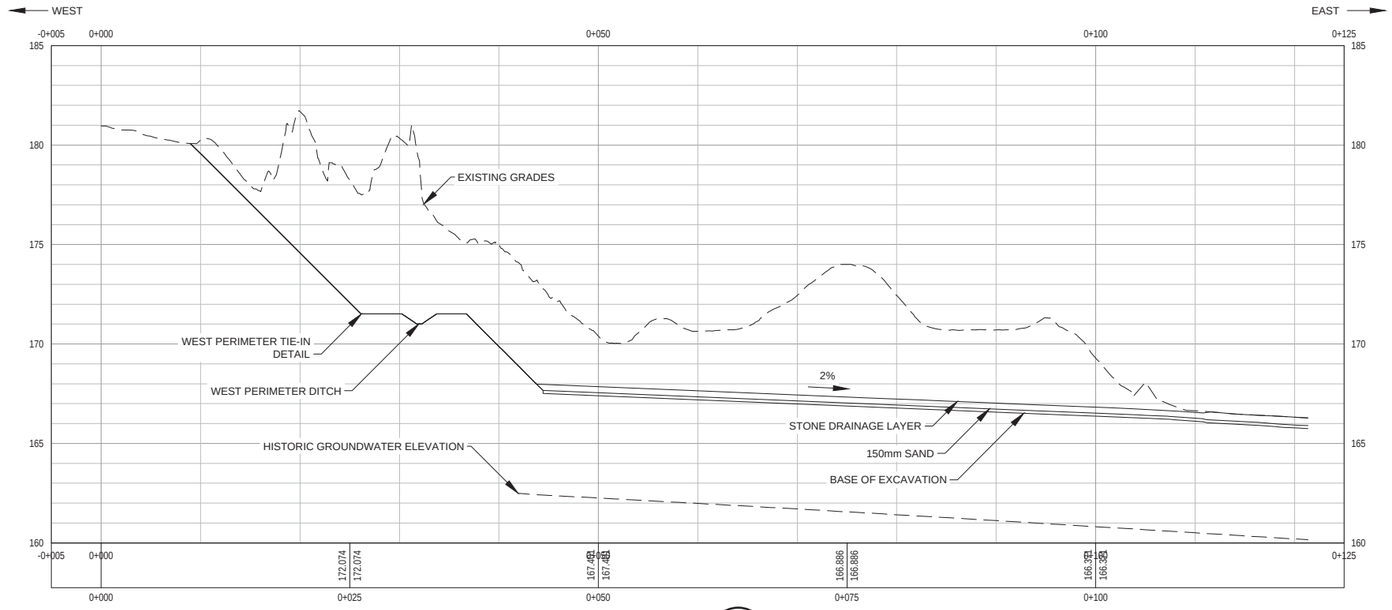
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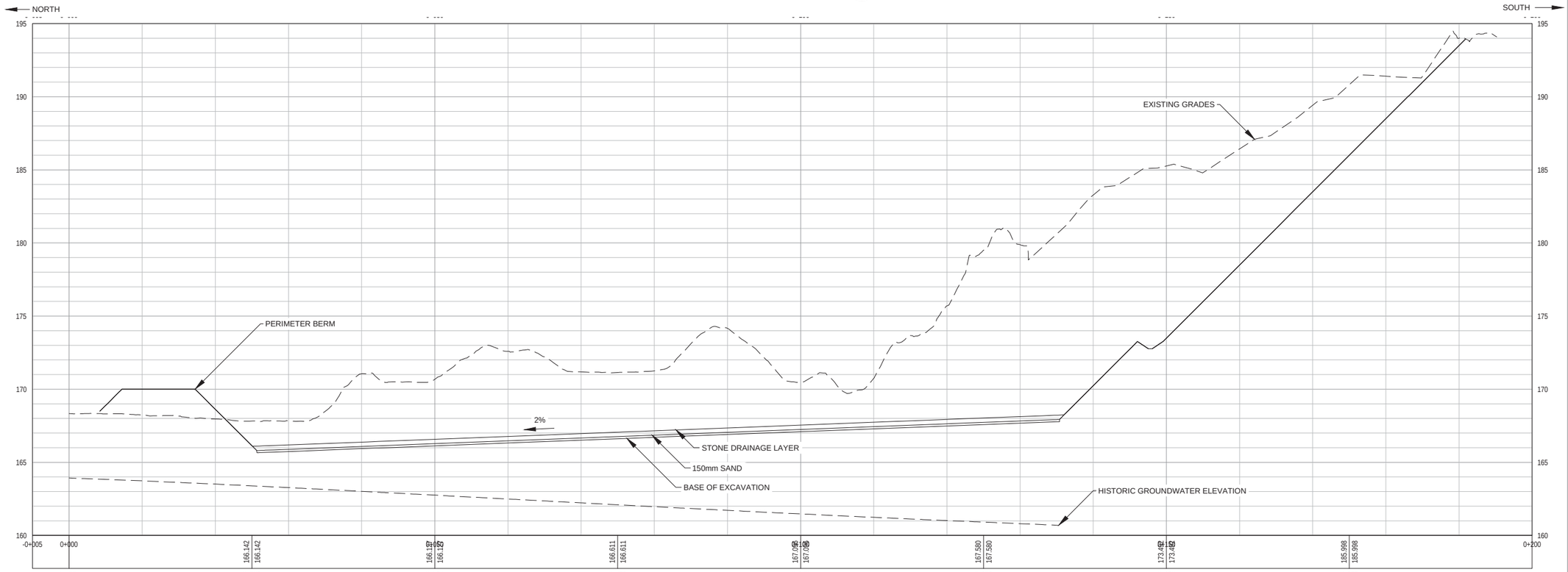
Sheet No.
CI-0105

Sheet
1 of 10

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SECTION A-A'
HORZ: 1:300
VERT: 1:150
CI-0103



SECTION B-B'
HORZ: 1:300
VERT: 1:150
CI-0103

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Author T.WAGSTAFF
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Design
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UPLAND EXAVATING LTD.
CAMPBELL RIVER, B.C.

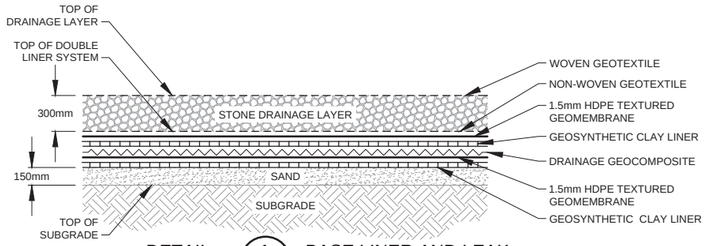
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DETAILED DESIGN

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Project No. 11222680

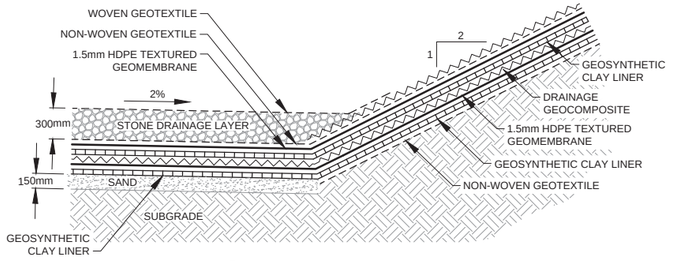
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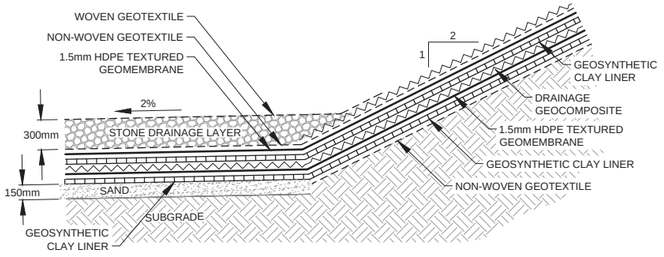
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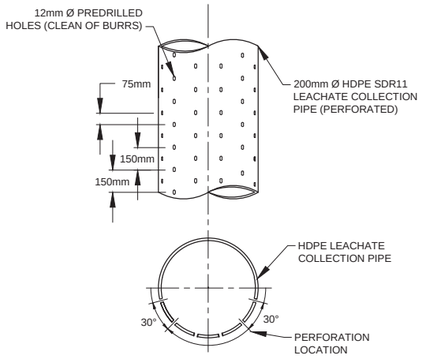
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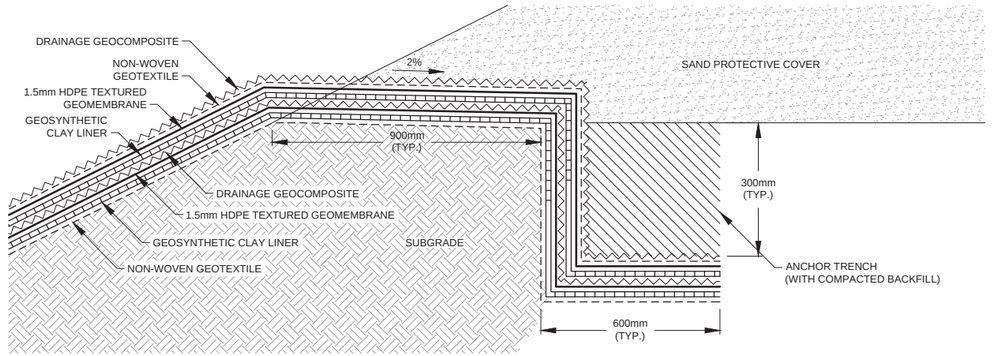
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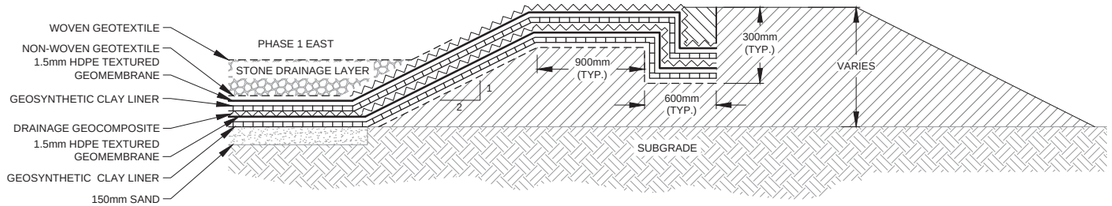
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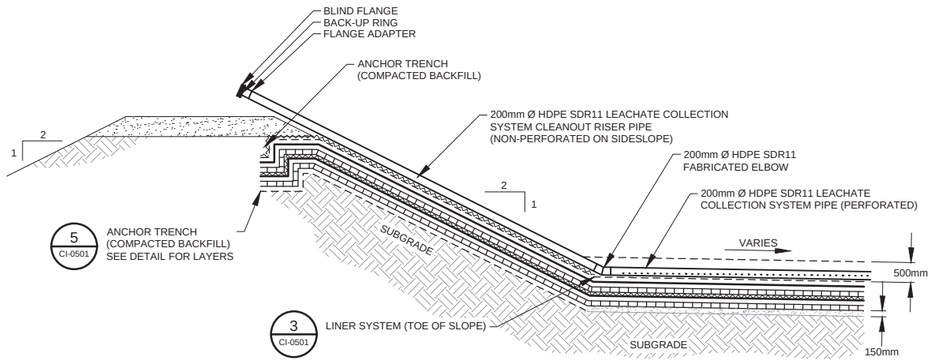
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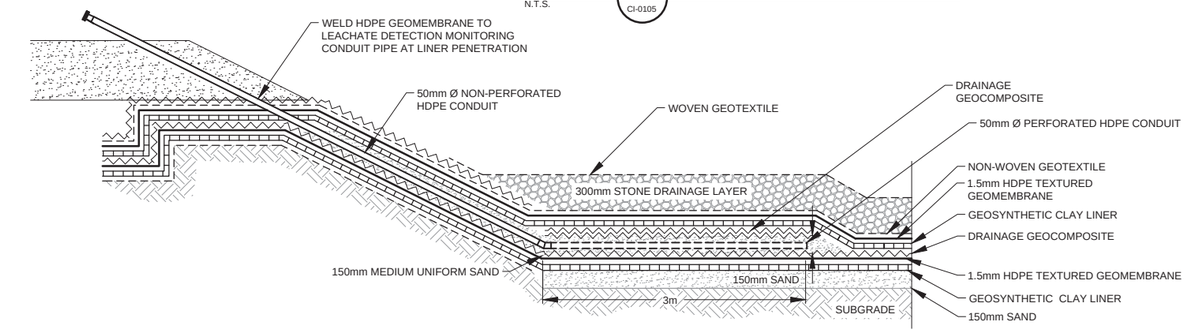
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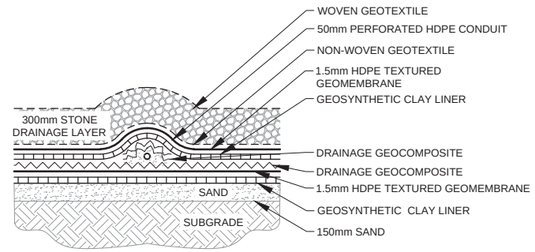
DETAIL 6 (CI-0105) — N.T.S. — SOUTHERN TRANSITION BERM



DETAIL 7 (CI-0104) — 1:75 — LEACHATE COLLECTION SYSTEM CLEANOUT RISER PIPE (TYPICAL)



DETAIL 8 (CI-0103) — N.T.S. — LEAK DETECTION DETECTION PORT (TYP.) PROFILE



DETAIL 9 (CI-0103) — 1:25 — LEAK DETECTION MONITORING PORT (TYP.) CROSS-SECTION

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Project
STAGE 1 WEST
DETAILED DESIGN

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LINER SYSTEM DETAILS

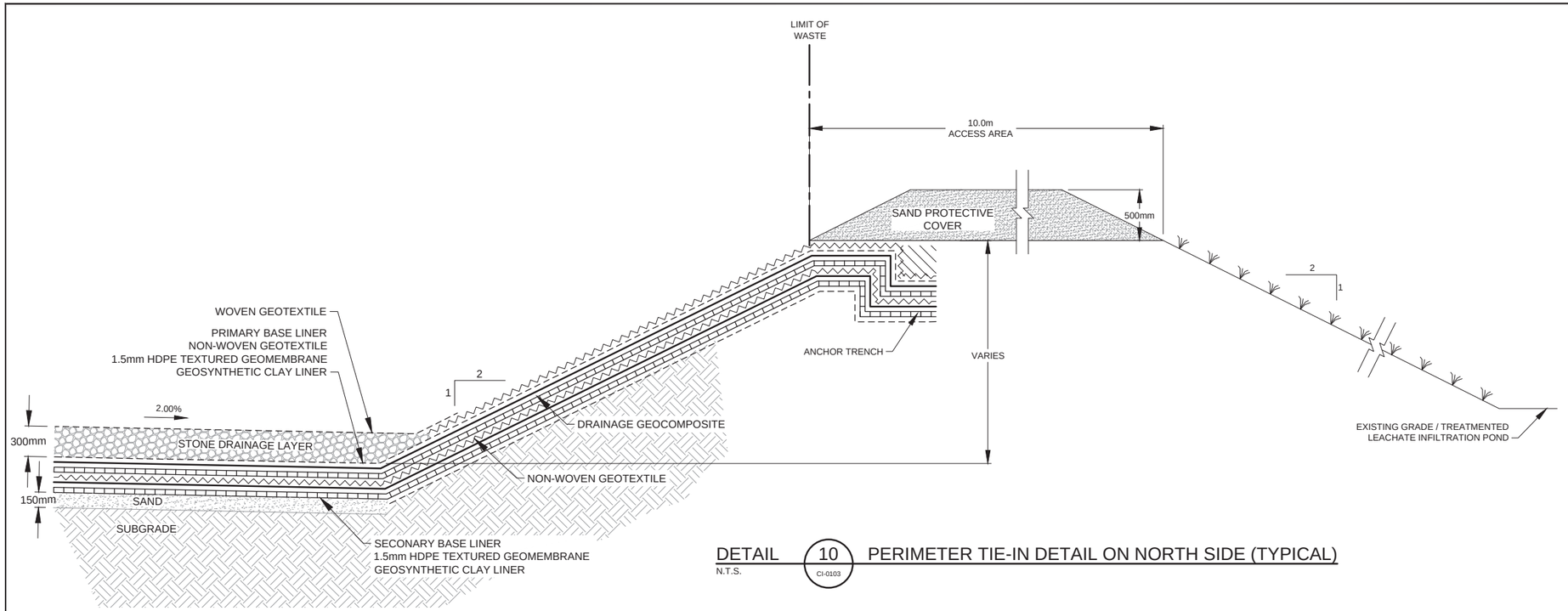
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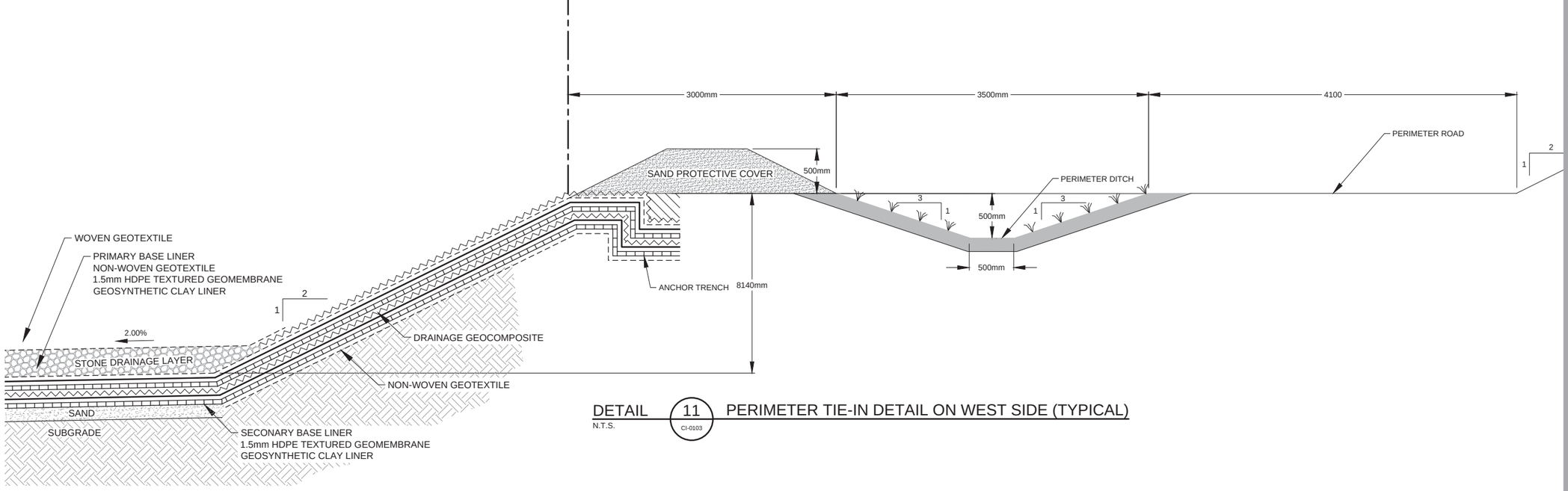
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DETAIL 10 PERIMETER TIE-IN DETAIL ON NORTH SIDE (TYPICAL)
N.T.S. CI-0103



DETAIL 11 PERIMETER TIE-IN DETAIL ON WEST SIDE (TYPICAL)
N.T.S. CI-0103

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Project
STAGE 1 WEST
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Project No. 11222680
Title PERIMETER TIE-IN DETAILS
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Sheet 1 of 10

APPENDIX C

Cell 1 East & Ponds
Construction Report

Cell 1 East & Ponds Construction Report

Northwin Landfill

Upland Excavating Ltd.

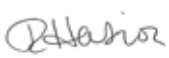
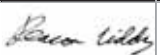
19 October 2021



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Vancouver, BC V5T 1M6, Canada

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Last saved date	19 October 2021 6:26 PM
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Author	David Barbour
Project manager	Deacon Liddy
Client name	Upland Excavating Ltd.
Project name	Cell 1 East & Pond
Document title	Cell 1 East & Ponds Construction Report | Northwin Landfill
Revision version	Rev [00]
Project number	11223708

Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
Final	00	David Barbour	Roxy Hasior		Deacon Liddy		Oct 19, 2021

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This document is in draft form. The contents, including any opinions, conclusions or recommendations contained in, or which may be implied from, this draft document must not be relied upon. GHD reserves the right, at any time, without notice, to modify or retract any part or all of the draft document. To the maximum extent permitted by law, GHD disclaims any responsibility or liability arising from or in connection with this draft document.

1. Introduction

The Northwin Landfill (Landfill or Site) is owned by Upland Excavating Ltd. (Upland) and operated by Northwin Environmental (Northwin). The Site has an area of approximately 48 hectares (ha) and is located at civic address 7295 and 7311 Gold River Highway, Campbell River, BC, approximately 7 kilometers (km) southwest of Campbell River city centre. The Site operates as a sand, gravel and rock quarry and a waste management facility.

This Construction Report (Report) documents the construction of Cell 1 East, as well as the civil construction for the leachate treatment pond, the treated effluent holding pond and infiltration pond (collectively, ponds) carried out by Upland Contracting Ltd. (Contractor), Northwin and other contractors hired by Upland.

The Report has been prepared by GHD for Upland for submission to the Ministry of Environment and Climate Change Strategy (ENV) in accordance with Section 2.4 and 2.11 of the Landfill's OC and satisfies the requirements of the Landfill Criteria for Municipal Solid Waste (Second Edition), BC Ministry of Environment, June 2016 (the Criteria):

Construction report(s) shall be prepared after the construction and/or significant modification of landfill facilities. Construction report(s) shall demonstrate the landfill has been constructed in accordance with the plans and reports and confirm that the geologic conditions encountered are as expected and used in a Groundwater and Surface water impact assessment. Construction report(s) shall include all inspection and quality assurance/quality control testing results, and as-built record drawings showing the lines, grades, and as-built elevations of the landfill.

Upland, as the OC holder retained GHD to act as the Qualified Professional (QP) for this project scope. In this capacity, GHD designed the civil work for Cell 1 East and the ponds and carried out inspections during construction.

1.1 Project Scope

Cell 1 East is the first landfill cell and establishes the initial footprint of the Landfill. In accordance with the 2021 Design Operations and Closure Plan (DOCP) for the Landfill and the detailed design, the Cell 1 East base is double liner system and includes a leak detection layer. Leachate generated from the landfill will be collected within the cell and conveyed to the leachate treatment system. The leachate treatment system is batch treatment system and includes the leachate collection system, aerated equalization pond, a treated leachate holding pond and an infiltration pond.

The composite double liner system for Cell 1 East is comprised of a primary and secondary base liner. The primary base liner refers to the composite liner system that consists of an HDPE geomembrane liner and geosynthetic clay liner (GCL) which underlies the leachate collection system, and the secondary base liner refers to the composite liner system comprised from of an HDPE geomembrane liner and GCL which underlies the leak detection system.

The leachate collection system includes perforated leachate collection pipes within a stone drainage blanket sloped towards the leachate sump, with the following components:

- 300 mm thick, 50 mm diameter, clear, round stone drainage blanket, with minimal fines
- Perforated leachate collection pipes (LCP) with minimum diameter of 200 mm
- Maximum 15 m lateral spacing between leachate collection pipes (LCP) running south to north
- Maximum 50 m drainage path for leachate to travel before it is intercepted by the LCPs
- Clean-outs at each end of the LCPs
- Leachate collection header pipe at the east end of the Landfill running towards the leachate collection sump at a minimum slope of 2 percent

- Leachate sump at elevation 161.1 m AMSL with two leachate sump riser pipes with minimum diameters of 600 mm

The aerated equalization pond, also referred to as the leachate treatment pond is double lined with HDPE and includes a leak detection system. The treated leachate holding pond is double lined with coated woven polyethylene and includes a leak detection system. The infiltration pond is unlined and allows treated effluent to infiltrate into the aquifer underlying the site.

2. Construction Narrative

The following sections provide the construction narrative for Cell 1 East and ponds. Record Drawings are provided in Appendix A.

Construction activities began on March 19, 2021 and were complete on October 19, 2021.

In general, construction generally progressed as follows:

- Site preparation and excavation
- Leachate treatment pond double liner installation
- Cell 1 East double liner installation
- Cell 1 East leachate collection system
- Treated leachate effluent holding pond double liner installation

2.1 Site Preparation & Excavation

Site preparation and excavation activities included construction of berms around the Cell 1 East perimeter, excavation of the Cell 1 East base, excavation of the infiltration pond and placement of the Cell 1 East sand cushion in preparation for liner placement.

Construction activities began with the construction of the east and north Cell 1 East berms on March 19th. The north and east Berm were built in 300 mm lifts. GHD and McElhanney (geotechnical subcontractor) witnessed compaction activities and, with the Contractor established the minimum number of passes with the compactor required to ensure compaction criteria were met. McElhanney performed density testing on March 22 to confirm the compaction results.

Excavation of Cell 1 East to subgrade contours began on April 7 and continued through May 7th. A 150 mm protective layer of screened sand was placed and compacted with a vibrator packer.

Excavation of the leachate treatment pond began after the Landfill earthworks were complete. The excavation was below grade and did not require construction of any structural berms, so no compaction testing was required.

2.2 Leachate Treatment Pond Composite Double Liner

Joe Cassidy (Liner Installer) was hired as an independent contractor to oversee the geosynthetic installation. Mr. Cassidy is an experienced liner installer with over thirty years of experience in the industry. Several experienced liner technicians were also hired for the installation and worked alongside Upland's (the Contractor's) employees with Mr. Cassidy overseeing the work. The geosynthetic installation crew mobilized to site on July 28th and the installers met with GHD to confirm QA/QC requirements.

Deployment of geotextile on the leachate treatment pond slopes and GCL began on July 29th. GHD carried out a daily site inspection each day that geosynthetics were being installed until completion to verify that QC requirements were being met.

The first roll of Geomembrane was deployed on July 30th. GHD witnessed roll deployment and field sheer and peel tests. The Liner Installer performed QC on the liner and provided documentation to GHD for review. Results of the Liner Installers QA/QC are found in Appendix E. During installation, two destructive tests were collected of the Geomembrane, one from the primary and one for the secondary layer and sent to a lab for peel and sheer testing.

This exceeded the minimum requirement of one destructive test per 300 m of seaming and the results from the tests were acceptable.

Installation of Geosynthetics were completed in the leachate treatment pond on August 6th. On that date David Barbour (GHD), Terry Stuart (Upland) and Joe Cassidy (Liner Installer) inspected each panel for defects and were satisfied that no defects were found.

2.3 Cell 1 East - Composite Double Liner

Installation of geosynthetics in the Cell 1 East began on August 9th by the same personnel that installed the leachate treatment pond geosynthetics with Mr. Cassidy's oversight. Similarly, GHD inspected the bedding sand before the first roll of GCL was deployed and made inspections each day the geosynthetics were placed. The QA/QC program for the construction of the base liner systems included non-destructive testing of each seam. Details of the QA/QC program are described in Section 3.

The geosynthetic deployment began with the GCL being installed on the floor of the landfill cell near the toe of the North Berm. Rolls were deployed using an excavator in the east/west direction working from the north end of the landfill to the south. The seams of the GCL were overlapped, with the crew using factory provided indicating lines that marked the minimum overlap. The seams were heat seamed shortly after the GCL deployment. In general, the geomembrane was installed on top of the GCL as soon as the width of GCL panels would allow. This process continued until the primary GCL and geomembrane layer was installed across the landfill floor.

Geocomposite installation began after the primary geomembrane installation on the landfill floor. The geocomposite was installed with panels in the same east-west direction starting near the north toe working south. A skid-steer with smooth rubber tracks was used to deploy the geocomposite on the liner while an excavator held the rolls. GHD observed the procedures being followed by the operators and determined they were acceptable to avoid damage to the liner. The deployment procedure involved using a leaf blower to remove any debris from the area being driven on, having a spotter observe the geomembrane between the skid-steer tracks and the geo-composite, and skid steer operator never turning the equipment on the exposed geomembrane. Nylon cable ties were applied at 1.5 m intervals at the edge netting and the overlapping geotextile was heat seamed.

As the geocomposite was being placed on the base of the landfill, the crew began deploying non-woven geotextile on the slopes of the landfill. The geotextile rolls were held with an excavator while the crew placed the material manually on the slopes. The geotextile was heat seamed shortly after deployment. The GCL was placed on the slopes after the geotextile using the same method. GCL was heat seamed shortly after it was placed and covered with the second layer of Geomembrane. The primary layer of GCL and geomembrane was completed and tied into the geosynthetics on the floor of the landfill before the secondary containment layers were installed. The same procedures were followed to install the secondary geosynthetics. The smooth tracked skid steer was used to pull the geosynthetics on the base of the landfill and while the excavator held the rolls and materials were pulled by hand down the slopes. Installation of geosynthetics was completed on August 27th with the final placement of non-woven geotextile on the floor of the landfill.

2.4 Leachate Collection System

The Contractor began installing the leachate collection pipes and stone drainage layer after completion of the geosynthetics. To facilitate installation over the liner system, the contractor initially placed the stone drainage layer in 3 rows of 900 mm high lifts to form roadways from the west to the east side of the landfill cell. The material was hauled with rock trucks and placed with an excavator. Traffic cones were used for visual aids to ensure the minimum 900mm depth of material was placed. After the drain rock roads were built the contractor fused and placed perforated leachate collection pipe on the base of the landfill. A Caterpillar D5 dozer was then used to spread the drain rock in 300 mm lifts across the floor of the landfill. The contractor placed woven geotextile on top of the drain rock, completing the leachate collection system installation.

GHD made regular site inspections during the installation of the leachate collection system.

2.5 Treated Effluent Pond Double Liner

The treated effluent pond was constructed with a double layer of coated woven polyethylene and geocomposite leak detection system between the two layers. Construction commenced on Oct 15th with placement of the protective geotextile and was completed on October 19th. A leak detection sump was installed with a 50 mm HDPE perforated riser pipe.

2.6 Close-Out

GHD performed a final inspection of the Cell 1 East Works on October 5th and created a deficiency list which was provided to the Contractor. All deficiencies were addressed to the satisfaction of GHD and Upland by October 15th. The completion of the treated effluent pond double liner was inspected on October 19th. No deficiencies were found at the time.

3. Construction Quality Assurance & Quality Control

GHD carried out regular daily inspections throughout the duration of the construction to assure construction quality and quality control (QA/QC). The QA/QC program included soil density testing for compaction, product data review and geosynthetics installation QA/QC according to the design specifications.

McElhanney performed density testing with a nuclear densometer with GHD present on March 22, 2021 while fill material was being placed on the North and East Berms. Results of the test results along with the sieve analysis of the material placed are provided in Appendix C. The results of the testing were reviewed by GHD, and a procedure was established to ensure minimum density requirements would be exceeded during the placement of fill on the berms

A photo log with select photographs from throughout the construction is provided in Appendix B. Appendix C provides the material test results. Product data and submittal review logs are provided in Appendix D. Appendix E provides geosynthetics QA/QC information including the results of destructive and non-destructive quality testing. GHD's notes from select field inspections during liner installation are included in Appendix F.

3.1 Earthworks QA/QC

During site preparation and excavation activities, GHD carried out daily inspections to confirm that materials were installed according to design specifications. Inspection activities included:

- Observation of proof rolling during construction of the north and east berms
- Observation of compaction effort with McElhanney to establish minimum number of passes with the compactor required to ensure compaction criteria were met
- Confirmation that the onsite stockpiled clean screened sand was acceptable for the GCL protection layer.
- Witnessing dozer equipped with a laser level placing 150 mm screened sand and vibrator packer compacting the sand to ensure adequate protective layer

3.2 Leachate Collection System & Leak Detection Piping

QA/QC activities carried out during leachate collection system installation include the following:

- Daily inspection to witness placement of materials
- Review of submittals for pipe materials
- Review of results of sieve analysis performed on samples of drain rock material collected by Contractor. A total of 4 samples were collected and analysed.

3.3 Geosynthetics QA/QC

The Geosynthetic Installer performed QA/QC according to the design specification on all geomembrane installed. QC included performing field sheer and peel on a test weld before welding began and whenever conditions changed, pressure testing each welded seam, recording roll number and location of each panel placed, location of each repair. After each repair was made the weld was tested with a vacuum box.

GHD collected samples of welds at intervals less than 300 m of seams. The samples were sent to a lab for peel and sheer testing and the results were reviewed by GHD.

4. Conformance with Design

In general, the construction of the Cell 1 East landfill cell and ponds was carried out according to the design and specifications prepared by GHD. The below documents conformance with the original design.

4.1 Earthworks

Construction of the berms and sub-base excavations for Cell 1 East, the leachate infiltration pond and the leachate treatment pond conform with the design. No field adjustments were made for the earthworks portion.

4.2 Leachate Collection System & Leak Detection Piping

A field adjustment was made to the 300 mm HDPE leak detection system riser (see Appendix A). Adjustments from design included wrapping the perforated portion of the pipe in geo-composite and placing sandbags on the east side of the pipe to secure the pipe in place. Wrapping the pipe in geo-composite ensured there was hydraulic connectivity around the pipe. GHD witnessed the sand being placed in the leak detection portion of the sump and observed that the sump would function as intended with the modifications made. (Aug. 25 field notes)

The leak detection ports were installed differently than designed by GHD. No depression was established beneath the leak detection port as shown in Appendix A. Without the depression, the leak detection pipe could not be buried in sand as originally designed. Instead, two layers of geocomposite were installed on top of the leak detection pipe to prevent the GCL layer from deflecting around the pipe and to ensure a hydraulic connection (Field Notes Aug 21 & 23). This change was approved by GHD.

The results of the sieve analysis performed on drain rock showed fines content above the design specification for 3 out of the 4 samples. The fines content was less than or equal to 1% for all samples and the material was accepted by GHD.

The two north most leachate collection pipes on the west transition berm had perforations installed at approximately 90 degrees from the intended orientation. The Contractor provided camera footage of the inside of the pipe for GHD to review and it was determined that the perforations are orientated in the intended direction a short distance into the landfill.

4.3 Geosynthetics

Construction of the geosynthetics for Cell 1 East and the leachate treatment pond were completed according to design.

The treated effluent holding pond was originally designed to have a single HDPE liner, however the liner system design was substituted for a double coated woven polyethylene liner with a geocomposite leak detection system (double liner). The substitution was accepted by GHD on the basis that the base liner material is acceptable for the application of the pond usage. Further, the performance of the primary liner can be monitored using the leak detection layer and replaced with little effort in the future.

5. Certification

This construction report dated October 19, 2021, demonstrates that the Cell 1 East and Ponds have been constructed in accordance with OC and the most recent DOCP, with the changes noted below and approved by the undersigned during construction. Qualified Professionals completed inspections before and during construction of Cell 1 East and the Ponds.

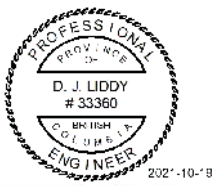
This construction report includes the information described in Section 10.2 Construction Report(s) of the Landfill Criteria and Section 2.11 of the OC, specifically:

- Changes from the original design that were approved during construction
- As-built record drawings of Cell 1 East and the Ponds
- All inspection and testing reports
- Quality control and quality testing results
- Soil test data including field and laboratory testing

As per Section 2.11 of the OC, with the submission of this report on October 19, 2021, waste discharge to Cell 1 East may commence 30 days after the date of this report (November 18, 2021).

All of Which is Respectfully Certified and Submitted by:

GHD



Deacon Liddy, P.Eng.

David Barbour, P.Eng.

Roxy Hasior, P. Eng

Appendices

Appendix A

Record Drawings

UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

NEW LANDFILL (NORTHWIN LANDFILL)
AS-BUILT RECORD DRAWINGS
OCTOBER 2021



LOCATION MAP

DRAWING LIST

DWG. No.	DRAWING TITLE
GN-0001	COVER
CI-0002	BASE OF LINER (TOP OF SAND)
CI-0003	TOP OF DRAINAGE LAYER
CI-0004	DETAILS - LINER DETAILS
CI-0005	DETAILS - LEACHATE COLLECTION SUMP
CI-0006	DETAILS - LEACHATE LEAK DETECTION SUMP
CI-0007	DETAILS - LEACHATE COLLECTION SYSTEM
CI-0008	DETAILS - PERIMETER TIE-IN DETAILS
CI-0009	DETAILS - LEACHATE TREATMENT AND EFFLUENT STORAGE PONDS DETAILS

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0 250 500 750m

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Project
AS-BUILT
RECORD DRAWINGS

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR RECORD	T.W.	R.H.	10-19-2021

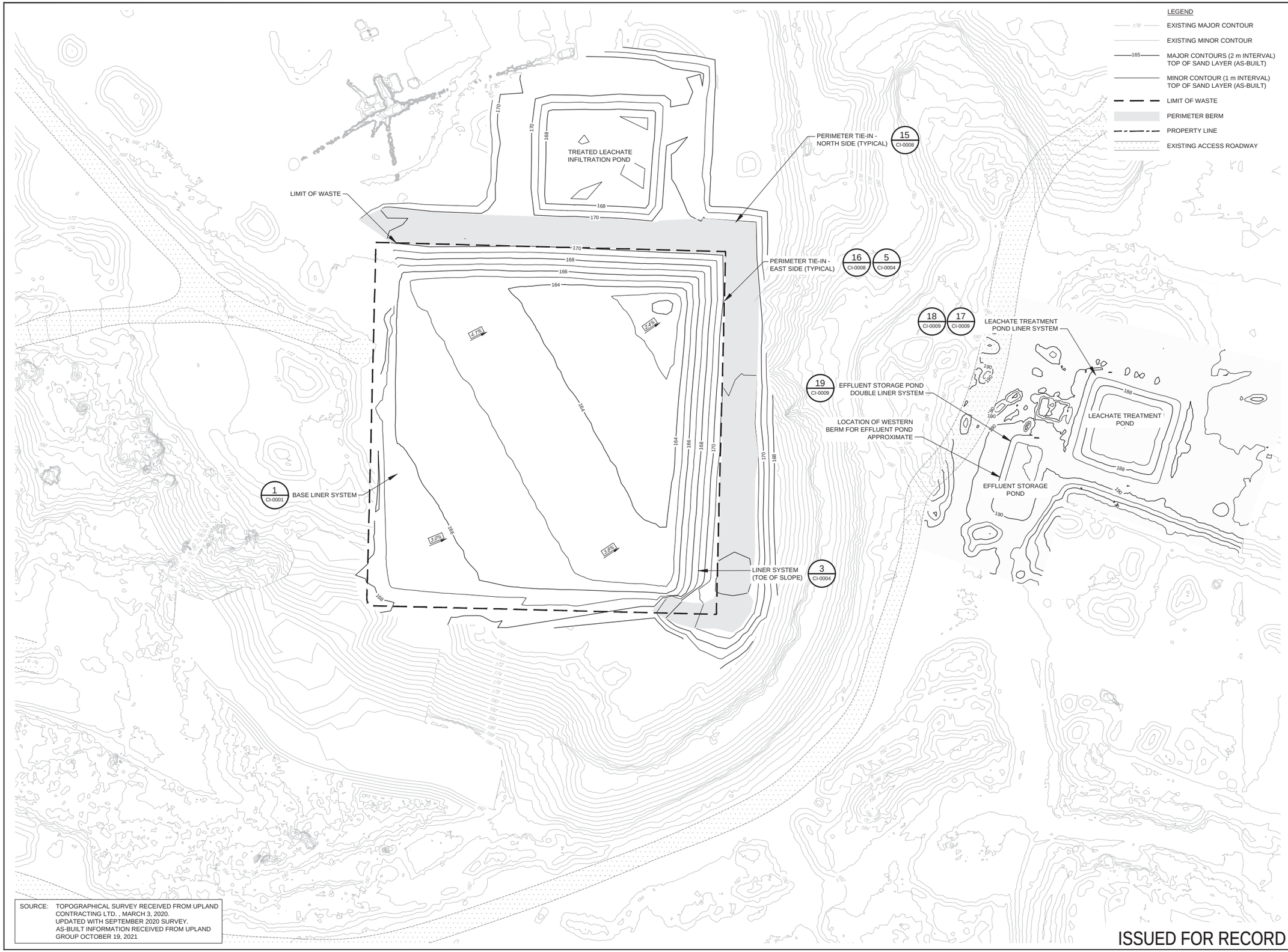
Drawn T.WAGSTAFF	Designer S.KEMP
Drafting Check S.KEMP	Design Check R.HASIOR
Project Manager D. LIDDY	Date Oct 19, 2021
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Original Size ANSI D	Bar is 20mm on original size drawing 0 20mm

Project No. 11222680

Title
COVER

Sheet No.
GN-0001

Sheet 1 of 9



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0 6 12 18m

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Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	October 20, 2021
This document shall not be used for construction unless signed and sealed for construction.		Scale	1:600
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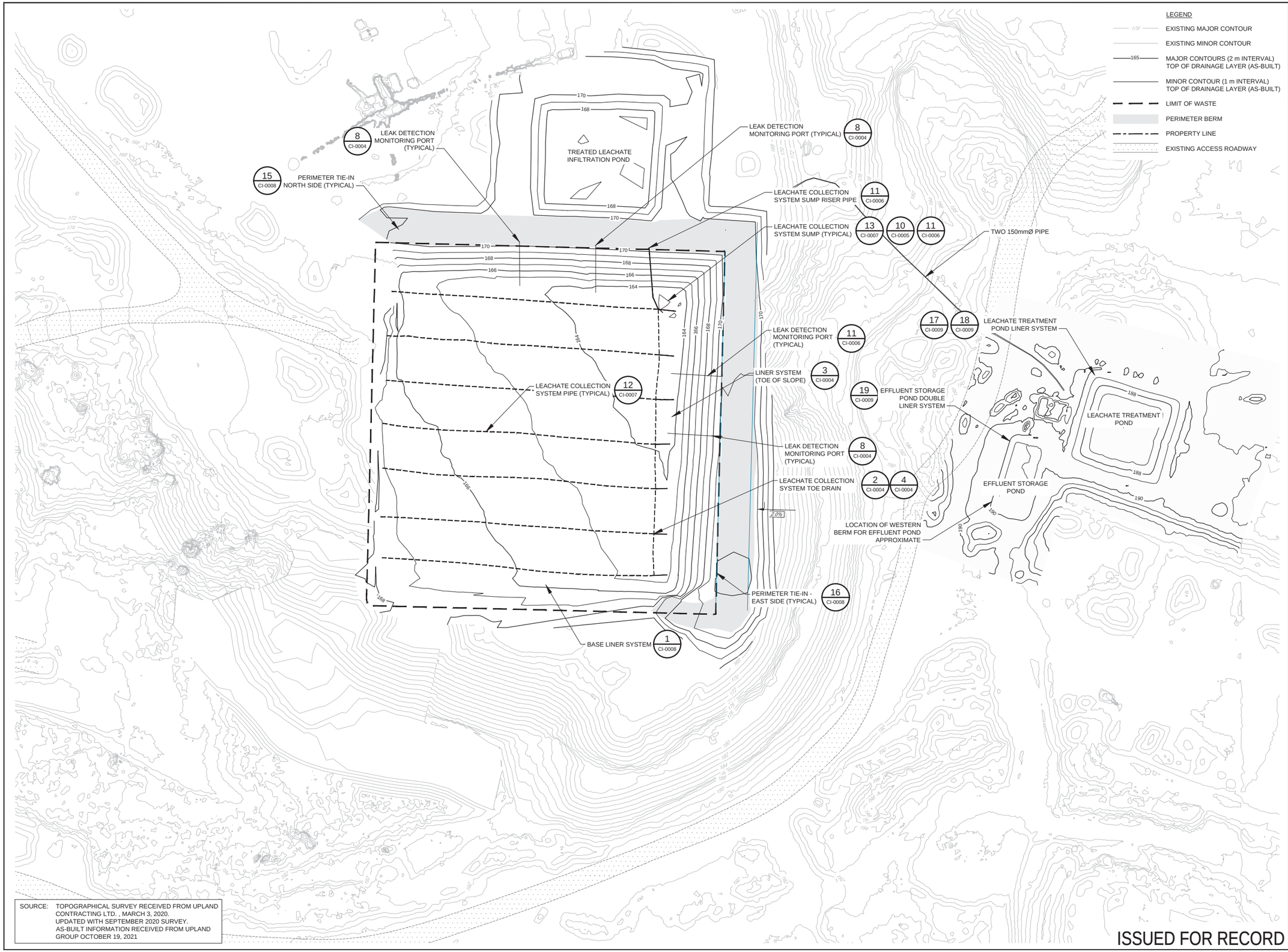
Project No. 11222680

Title
BASE OF LINER
(TOP OF SAND)

Sheet No.
CI-0002

Sheet 2 of 9

Plot Date: 20 October 2021 - 12:29 AM Plotted By: Tyler Wagstaff CAD File: N:\CA\Vancouver\Projects\663\11222680\Digital_Design\ACAD\Sheets\11222680-GHD-RPT 2\11222680-GHD-0000-DWG-CI-0002.dwg



SOURCE: TOPOGRAPHICAL SURVEY RECEIVED FROM UPLAND CONTRACTING LTD. , MARCH 3, 2020.
UPDATED WITH SEPTEMBER 2020 SURVEY.
AS-BUILT INFORMATION RECEIVED FROM UPLAND GROUP OCTOBER 19, 2021

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Drafting Check S.KEMP	Design Check R.HASIOR
Project Manager D. LIDDY	Date October 20, 2021
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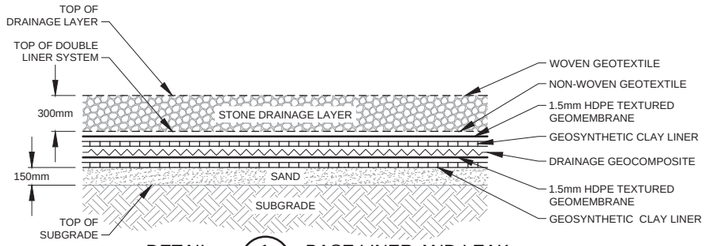
Project No. 11222680

Title
TOP OF DRAINAGE LAYER

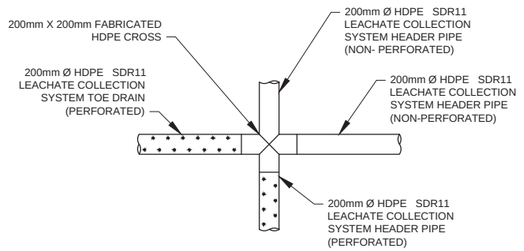
Sheet No.
CI-0003

Sheet 3 of 9

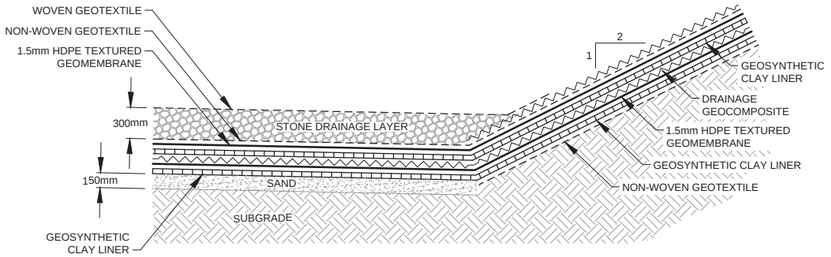
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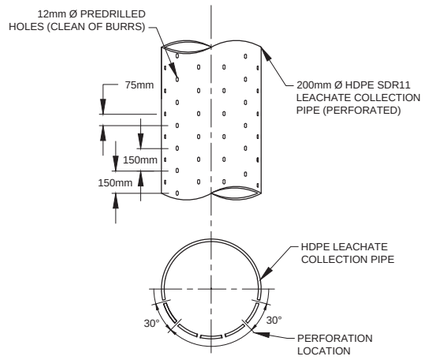
DETAIL 1 (CI-0001) — 1:25 — BASE LINER AND LEAK DETECTION SYSTEM



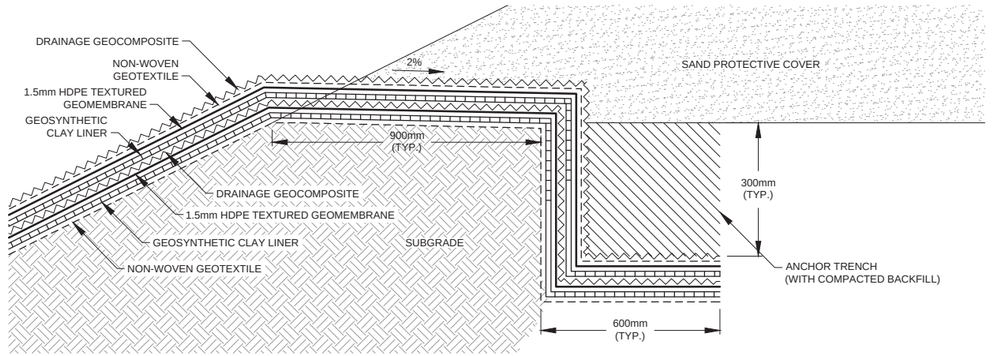
DETAIL 2 (CI-0002) — 1:30 — LEACHATE COLLECTION SYSTEM TOE DRAIN / LEACHATE COLLECTION SYSTEM PIPE CONNECTION



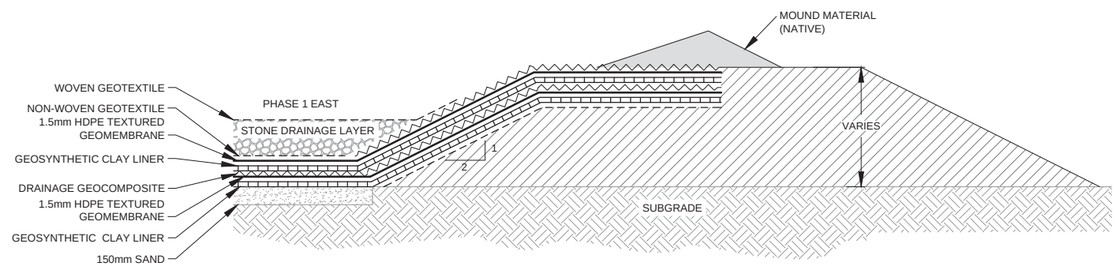
DETAIL 3 (CI-0002) — 1:30 — LINER SYSTEM (TOE OF SLOPE) NORTH AND EAST (TYP.)



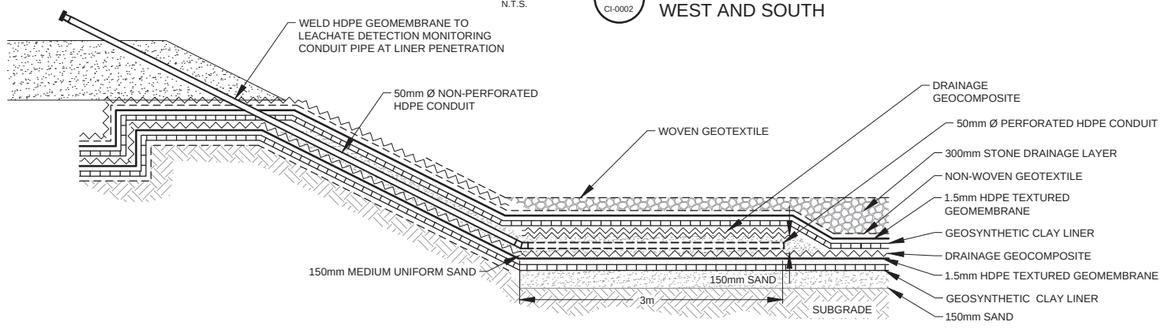
DETAIL 4 (CI-0002) — N.T.S. — LEACHATE COLLECTION SYSTEM TOE DRAIN / LEACHATE COLLECTION SYSTEM PIPE PERFORATIONS



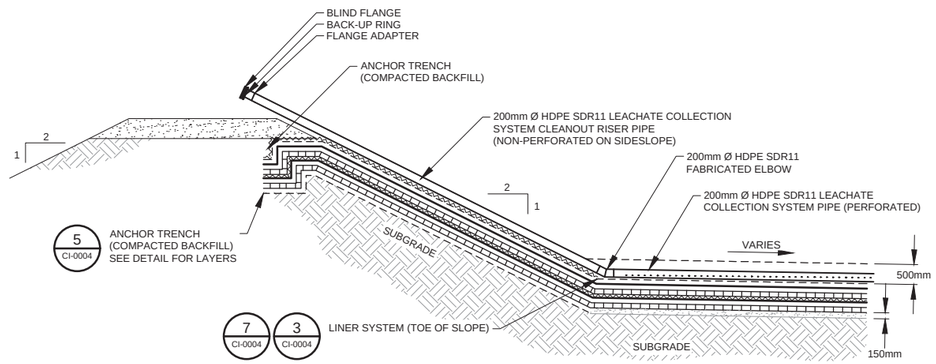
DETAIL 5 (CI-0002) — 1:10 — ANCHOR TRENCH (TYPICAL) NORTH AND EAST



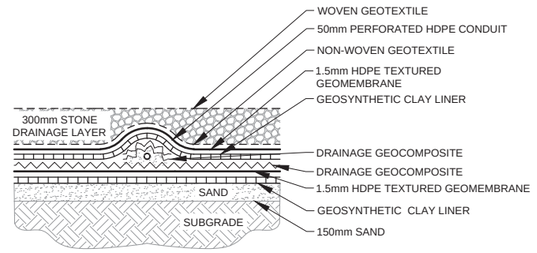
DETAIL 6 (CI-0002) — N.T.S. — TRANSITION BERM WEST AND SOUTH



DETAIL 8 (CI-0003) — N.T.S. — LEAK DETECTION DETECTION PORT (TYP.) PROFILE



DETAIL 7 (CI-0002) — 1:75 — LEACHATE COLLECTION SYSTEM CLEANOUT RISER PIPE (TYPICAL)



DETAIL 9 (CI-0003) — 1:25 — LEAK DETECTION MONITORING PORT (TYP.) CROSS-SECTION

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Project
AS-BUILT
RECORD DRAWINGS

No.	Issue	Drawn	Approved	Date
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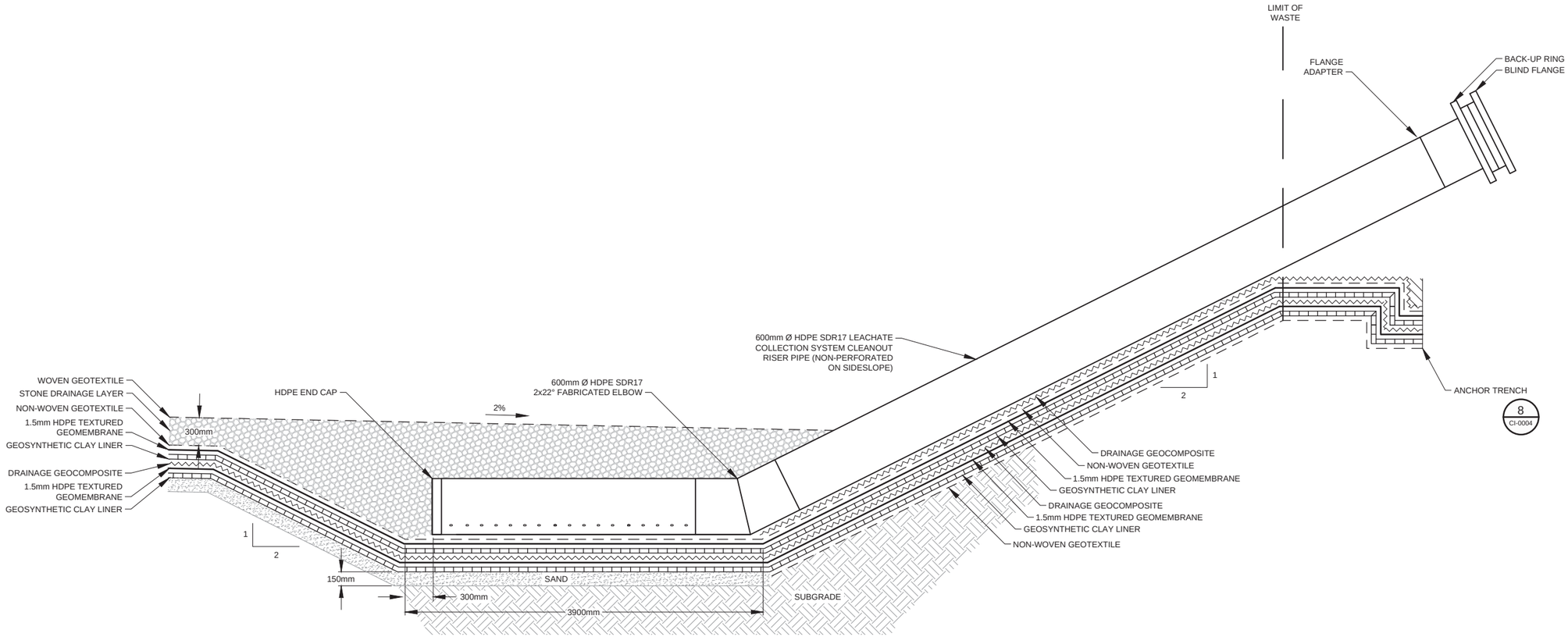
Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	October 19, 2021
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Project No. 11222680

Title
DETAILS
LINER DETAILS

Sheet No.
CI-0004

Sheet 4 of 9



DETAIL 10 (CI-0003) N.T.S. — LEACHATE COLLECTION SYSTEM SUMP, SUMP RISER PIPE, AND LEACHATE LEVEL MONITORING PIPE

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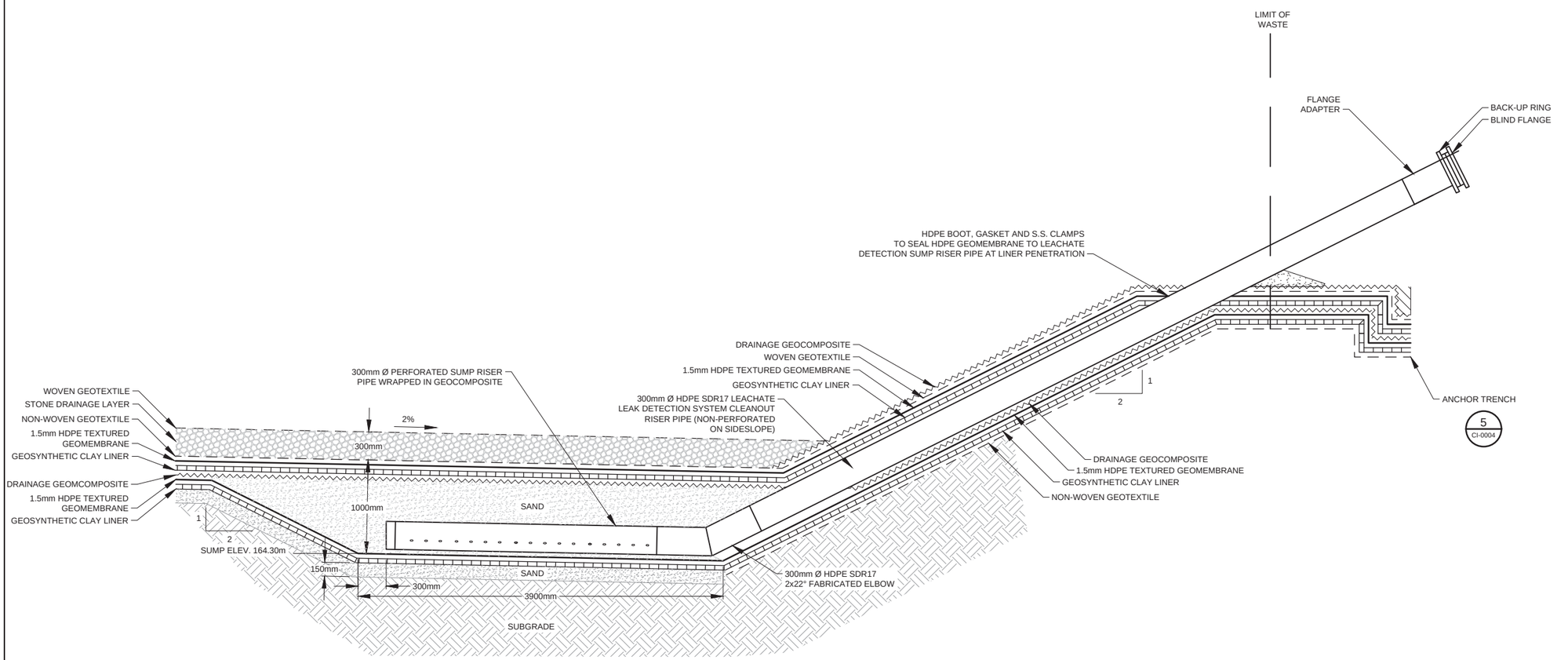
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Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	October 19, 2021
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Original Size: ANSI D		Bar is 20mm on original size drawing: 0 — 20mm	

Project No. 11222680

Title: DETAILS LEACHATE COLLECTION SUMP

Sheet No. CI-0005

Sheet 5 of 9



DETAIL 11 LEACHATE LEAK DETECTION SUMP, SUMP RISER PIPE
N.T.S. CI-0003

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Original Size
ANSI D

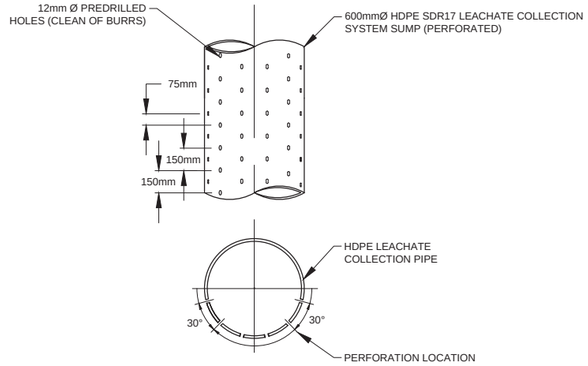
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Project No. 11222680

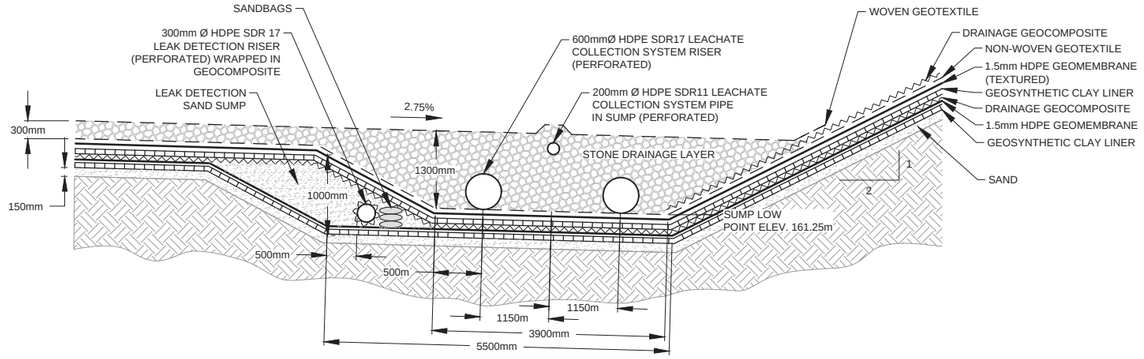
Title
DETAILS
LEACHATE LEAK
DETECTION SUMP

Sheet No.
CI-0006

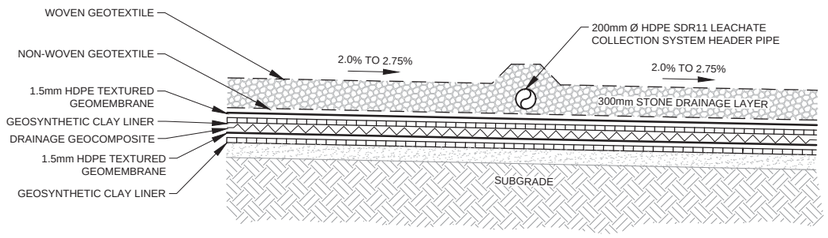
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DETAIL 12 (CI-0003) 600mmØ LEACHATE COLLECTION SYSTEM SUMP PIPE PERFORATIONS
NTS



DETAIL 13 (CI-0003) LEACHATE COLLECTION SYSTEM SUMP
1:50



DETAIL 14 (CI-0003) LEACHATE COLLECTION SYSTEM TOE DRAIN/ LEACHATE COLLECTION SYSTEM PIPE
1:30

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Project
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RECORD DRAWINGS

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Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	October 19, 2021
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Original Size
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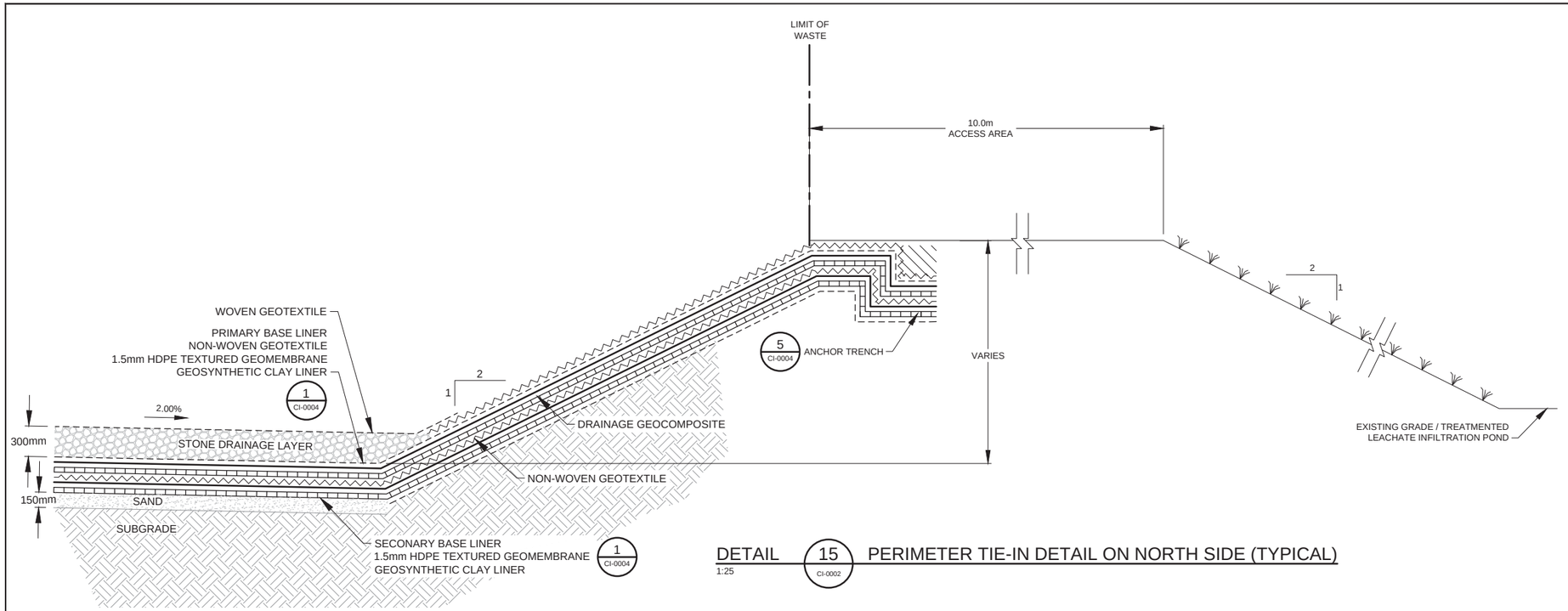
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Project No. 11222680

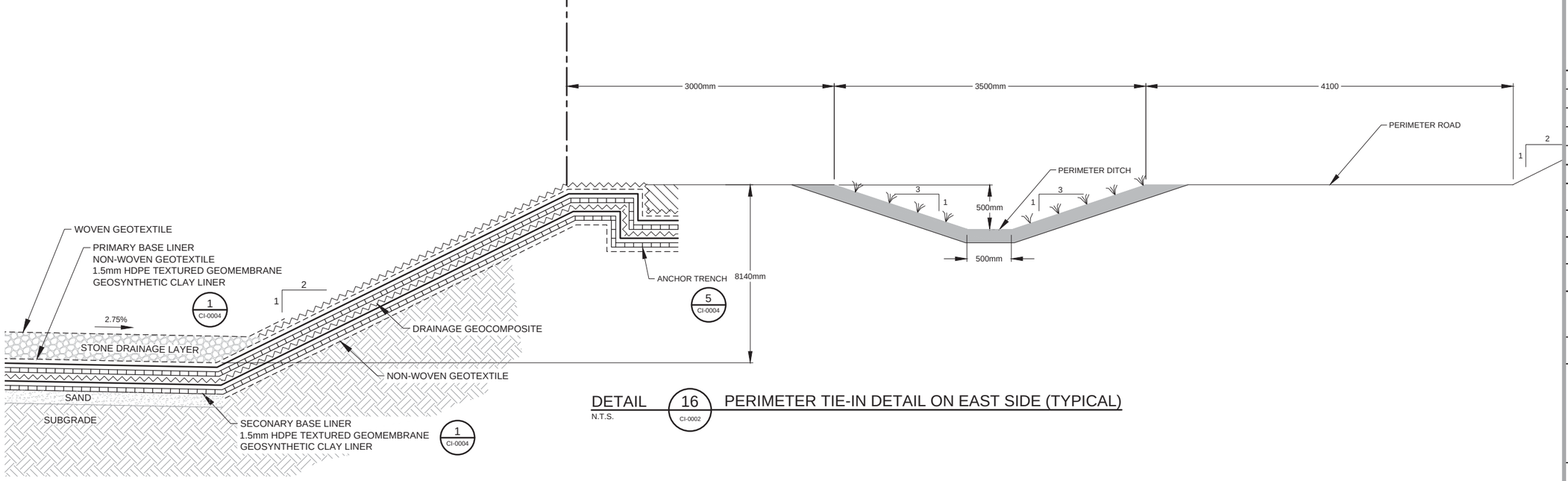
Title
DETAILS
LEACHATE COLLECTION
SYSTEM

Sheet No.
CI-0007

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DETAIL 15 CI-0002 PERIMETER TIE-IN DETAIL ON NORTH SIDE (TYPICAL)
1:25



DETAIL 16 CI-0002 PERIMETER TIE-IN DETAIL ON EAST SIDE (TYPICAL)
N.T.S.

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Project
AS-BUILT
RECORD DRAWINGS

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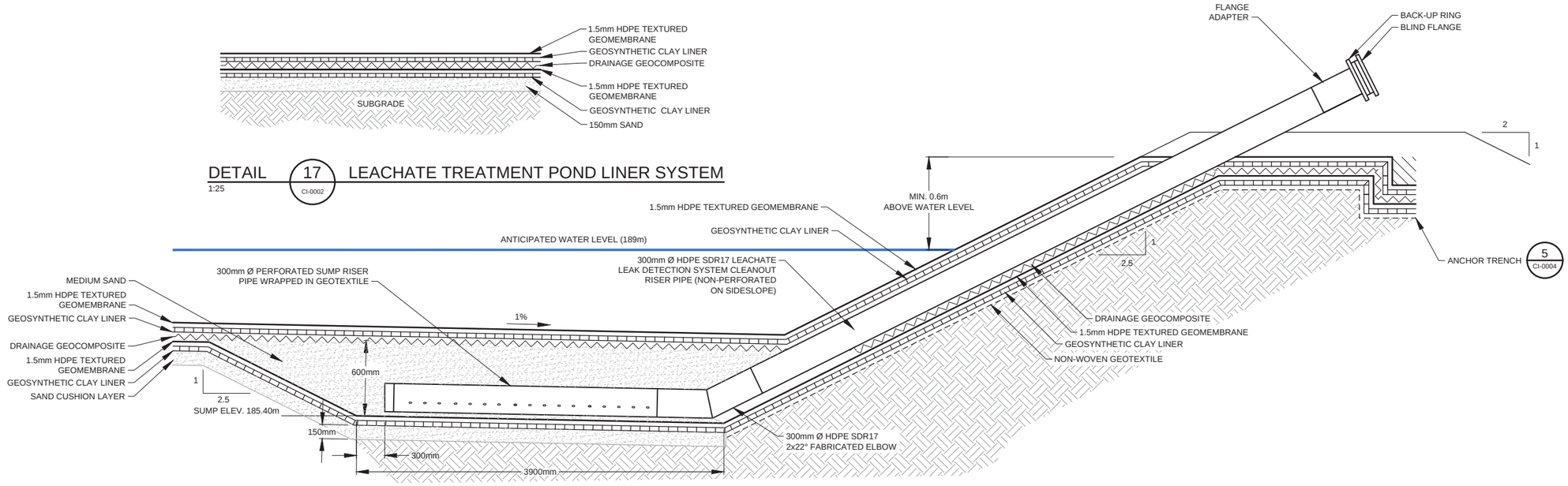
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Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	October 19, 2021
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Project No. 11222680

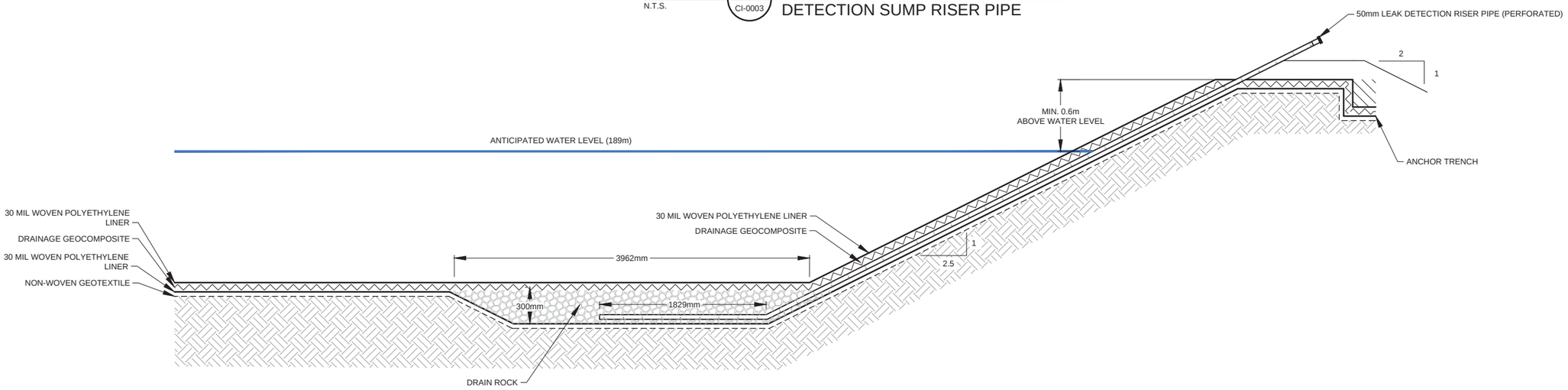
Title
DETAILS
PERIMETER TIE-IN DETAILS

Sheet No.
CI-0008

Sheet 8 of 9



DETAIL 17 CI-0002 — LEACHATE TREATMENT POND LINER SYSTEM
1:25



DETAIL 18 CI-0003 — LEACHATE TREATMENT POND LEAK DETECTION SUMP RISER PIPE
N.T.S.

DETAIL 19 CI-0003 — EFFLUENT STORAGE POND DOUBLE LINER & LEAK DETECTION
N.T.S.

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2021-10-19

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Project
AS-BUILT
RECORD DRAWINGS

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Drawn	T.WAGSTAFF	Designer	S.KEMP
Drafting Check	S.KEMP	Design Check	R.HASIOR
Project Manager	D. LIDDY	Date	October 19, 2021
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Project No. 11222680

Title
LEACHATE TREATMENT AND EFFLUENT STORAGE PONDS, TREATED LEACHATE INFILTRATION POND AND LYSIMETER DETAILS

Sheet No.
CI-0009

Sheet 9 of 9

Plot Date: 19 October 2021 - 11:14 PM
Plotted By: Tyler Wagstaff
CAD File: N:\CA\Vancouver\Projects\663\11222680\Digital_Design\ACAD\Sheets\11222680-GHD-RPT 2\11222680-GHD-0000-DWG-CI-0007.dwg

Appendix B

Photograph Log

Site Photographs



Photo 1 *Leachate Treatment Pond Excavation*



Photo 2 *Leachate Treatment Pond Excavation Complete*



Photo 3 *Leachate Treatment Pond GCL Installation*

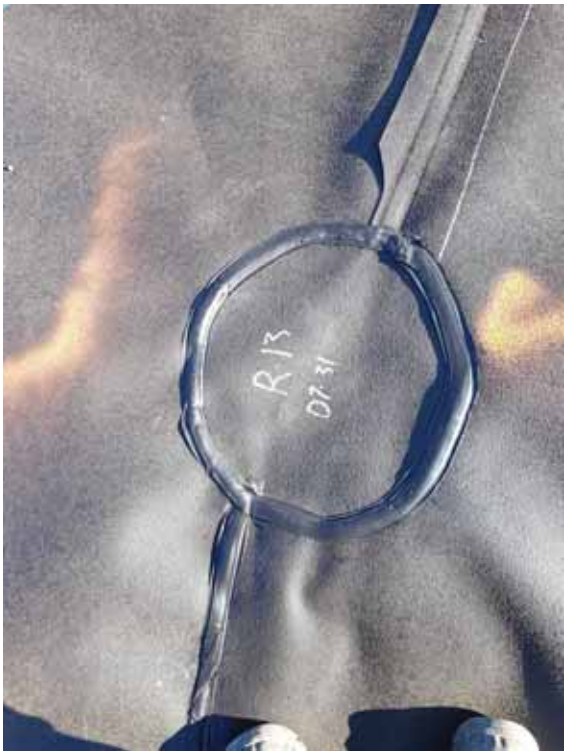


Photo 4 *Leachate Treatment Pond Typical Repair*



Photo 5 *HDPE Fusion Machine*



Photo 6 *Leachate Treatment Pond GCL Placement*



Photo 7 *Leachate Treatment Pond Geomembrane Deployment*



Photo 8 *Leachate Treatment Pond Geomembrane Installation Complete*



Photo 9 *Treated Effluent Holding Pond Geotextile*



Photo 10 *Treated Effluent Holding Pond Leak Detection*

Site Photographs



Photo 1 *Constructing East and West Berm*



Photo 2 *Constructing West Berm*



Photo 3 Placing Bedding Sand



Photo 4 Field Tensiometer



Photo 5 Field Tensiometer



Photo 6 Sub-base Before GCL Installation



Photo 7 GCL Installation



Photo 8 Typical Geomembrane Tag



Photo 9 *Primary Geomembrane Installation*



Photo 10 *Typical Destructive Samples of Geomembrane Seams for Lab Testing*



Photo 11 *Primary Geomembrane*



Photo 12 *Drainage Geocomposite on top of Primary Geomembrane*



Photo 13 Typical Drainage Geocomposite Cable Ties



Photo 14 Installing Geomembrane on North Berm



Photo 15 Installing GCL on top of Geocomposite



Photo 16 Leachate Sump with Primary Geomembrane

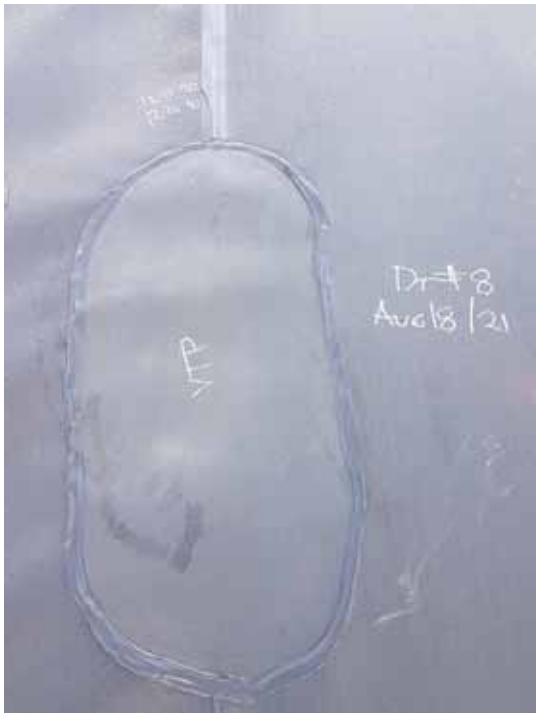


Photo 17 Typical Geomembrane Repair



Photo 18 Geomembrane Seam Pressure Test



Photo 19 HDPE Pipe Fusion Machine



Photo 20 Deploying Geomembrane on North Berm



Photo 21 Leachate Sump with Leak Detection Riser



Photo 22 Seaming Geocomposite above Sump



Photo 23 Complete Installation of Geosynthetics



Photo 24 Initial Placement of Drainage Layer in 900 mm Lifts



Photo 25 Completing Third 900 mm Drainage Layer Lift



Photo 26 Infiltration Pond



Photo 27 Spreading 300 mm of Drainrock



Photo 28 Typical Geomembrane Penetration Boot

Appendix C

Material Test Results

McElhanney Ltd.
1196 Dogwood Street
Campbell River, BC
Tel: (250) 287-7799

Report of:

Field Density Report
Nuclear Densometer

ASTM Ref: *D6938*

Project: Upland Pit Berm
Client: Upland Contracting Ltd.

Project Number: 2221-49292-00
Report Date: March 22, 2021
Report Number: 1

Test Date: March 22, 2021

Material Description: Proctor #5 - 75mm Pitrun

Project Specific Location: Landfill Berm in Pit #1

Tested By: JDC
Specification: 95%
ASTM: D698 *(D698 Standard, D1557 Modified)*

Test No.	Test Location	Elevation (m)	Test Depth (mm)	Proctor No.	Field Dry Density (kg/m^3)	Percent Moisture (%)	Max. Proctor Dry Density (kg/m^3)	Optimum Moisture (%)	Percent Compact. (%)	Spec. (%)
	South end of berm Multiple passes									
1	SEE MAP OF BERM	Subbase	300	1	2234	4.7	2260	8.0	99%	95%
2	SEE MAP OF BERM	Subbase	300	1	2350	4.1	2260	8.0	104%	95%
3	SEE MAP OF BERM	Subbase	300	1	2269	4.7	2260	8.0	100%	95%
4	SEE MAP OF BERM	Subbase	300	1	2223	5.1	2260	8.0	98%	95%
	North end of berm after 6 passes									
5	SEE MAP OF BERM	Subbase	300	1	2280	5.3	2260	8.0	101%	95%
6	SEE MAP OF BERM	Subbase	300	1	2270	5.3	2260	8.0	100%	95%
	North end of berm after another 4 passes									
7	SEE MAP OF BERM	Subbase	300	1	2221	5.0	2260	8.0	98%	95%
8	SEE MAP OF BERM	Subbase	300	1	2248	5.3	2260	8.0	99%	95%
9	SEE MAP OF BERM	Subbase	300	1	2345	3.5	2260	8.0	104%	95%
	North end of berm after another 4 passes									
10	SEE MAP OF BERM	Subbase	300	1	2323	4.8	2230	8.0	104%	95%
11	SEE MAP OF BERM	Subbase	300	1	2192	5.4	2230	8.0	98%	95%

Comments:

Reviewed by:

McElhanney Ltd.
1196 Dogwood Street
Campbell River, BC
Tel: (250) 287-7799

Report of:

Field Density Report
Nuclear Densometer

ASTM Ref: *D6938*

Project: Upland Pit Berm
Client: Upland Contracting

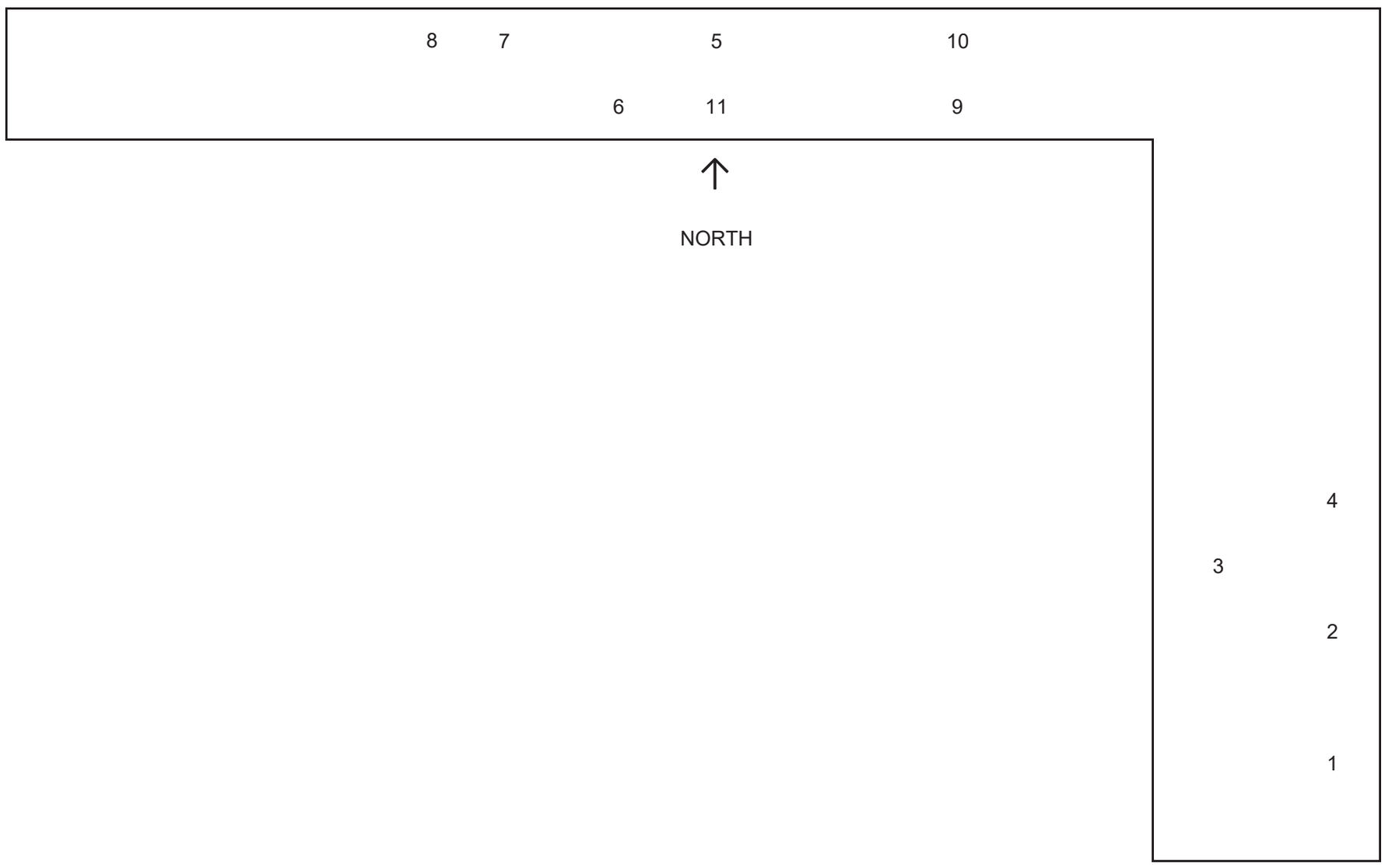
Project Number: 2221-49292-00
Report Date: March 22, 2021
Report Number: 1

Test Date: March 22, 2021

Material Description: Proctor #5 - 75mm Pitrun

Project Specific Location: Landfill Berm in Pit #1

Tested By: JDC
Specification: 95%
ASTM: D698 *(D698 Standard, D1557 Modified)*



Comments:

Reviewed by:

McElhanney Ltd.
1211 Ryan Road
Courtenay, BC

MOISTURE - DENSITY RELATIONSHIP REPORT

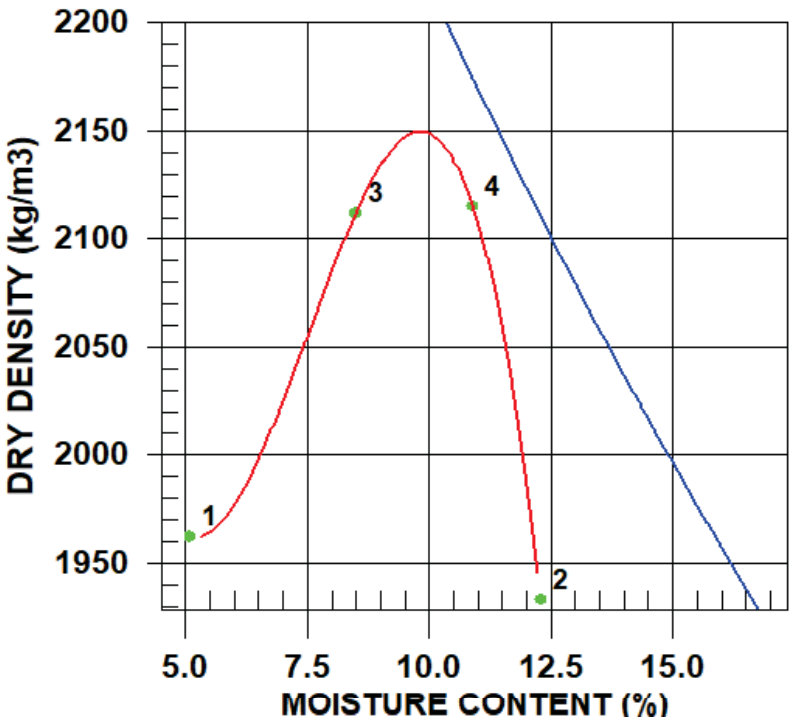
PROJECT NO. 2221-49292-08
CLIENT Upland Contracting Ltd.
C.C.

TO
Upland Contracting Ltd.
7295 Gold River Hwy.
Campbell River, BC
V9H 1P1

PROJECT Upland Misc 2020 — Campbell River
CONTRACTOR — Campbell River

PROCTOR NO. 5 DATE TESTED 24-Mar-2021 DATE RECEIVED 24-Mar-2021 DATE SAMPLED 22-Mar-2021

INSITU MOISTURE	7.0 %	COMPACTION STANDARD	Standard Proctor, ASTM D698
SAMPLED BY	JC	COMPACTION PROCEDURE	C: 152.4mm Mold, Passing 19mm
TESTED BY	TI	RAMMER TYPE	Automatic
SUPPLIER	Upland Contracting Ltd.	PREPARATION	Moist
SOURCE	Upland Pit #1	OVERSIZE CORRECTION METHOD	ASTM 4718
MATERIAL IDENTIFICATION		RETAINED 19mm SCREEN	20.0 %
MAJOR COMPONENT	PIT RUN	OVERSIZE SPECIFIC GRAVITY	2.85
SIZE	75MM	TOTAL NUMBER OF TRIALS	4
DESCRIPTION			
ROCK TYPE			



TRIAL NUMBER	WET DENSITY (kg/m3)	DRY DENSITY (kg/m3)	MOISTURE CONTENT (%)
1	2062	1962	5.1
2	2171	1933	12.3
3	2291	2112	8.5
4	2346	2115	10.9

ZERO AIR VOIDS CURVE FOR ESTIMATED SPECIFIC GRAVITY OF 2.85	MAXIMUM DRY DENSITY (kg/m3)	OPTIMUM MOISTURE CONTENT (%)
CALCULATED	2150	10.0
OVERSIZE CORRECTED	2260	8.0

COMMENTS
Lab ID: 21-086
Corresponds With: Sieve #26

 29-Mar-2021 McElhanney Ltd.

Reviewed By: _____

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of test results is provided only on written request.

McElhanney Ltd.
1211 Ryan Road
Courtenay, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2221-49292-08
CLIENT Upland Contracting Ltd.
C.C.

TO
Upland Contracting Ltd.
7295 Gold River Hwy.
Campbell River, BC
V9H 1P1

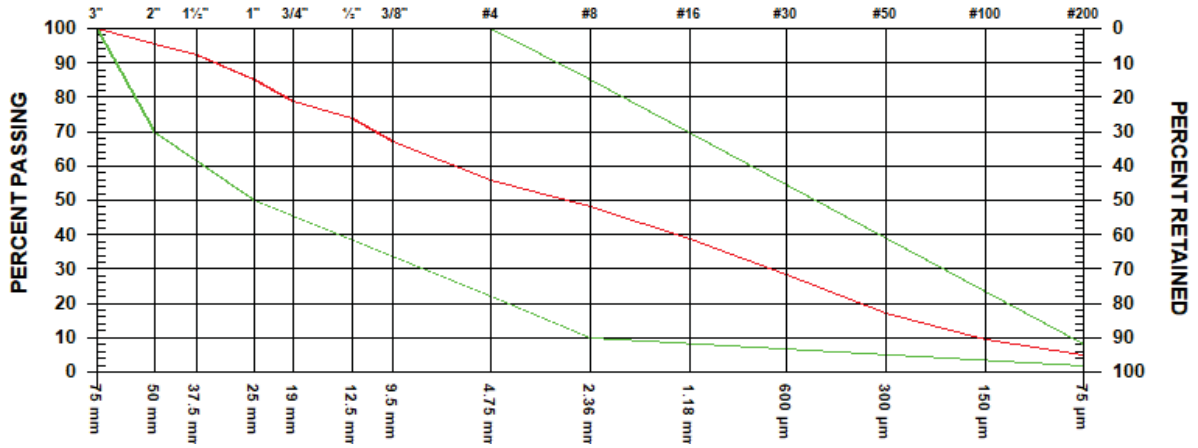
PROJECT Upland Misc 2020 — Campbell River
Campbell River

CONTRACTOR

SIEVE TEST NO. 26 DATE RECEIVED 24-Mar-2021 DATE TESTED 24-Mar-2021 DATE SAMPLED 22-Mar-2021

SUPPLIER Upland Contracting Ltd.
SOURCE Upland Pit #1
SPECIFICATION MMCD 2.3.1 Pit Run Gravel
MATERIAL TYPE Pit Run

SAMPLED BY JC
TESTED BY TI
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm	100.0	100.0-100.0
2"	50 mm	95.7	70.0-100.0
1 1/2"	37.5 mm	92.3	
1"	25 mm	85.2	50.0-100.0
3/4"	19 mm	78.9	
1/2"	12.5 mm	73.7	
3/8"	9.5 mm	67.3	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	56.1	22.0-100.0
No. 8	2.36 mm	48.0	10.0-85.0
No. 16	1.18 mm	38.7	
No. 30	600 µm	28.5	
No. 50	300 µm	17.2	
No. 100	150 µm	9.3	
No. 200	75 µm	5.0	2.0-8.0

MOISTURE CONTENT 7.0%

COMMENTS
Lab ID: 21-086
Corresponds With: Proctor #5

 29-Mar-2021 McElhanney Ltd.

Reviewed By: _____

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1211 Ryan Road
Courtenay, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2221-49292-08
CLIENT Upland Contracting Ltd.
C.C.

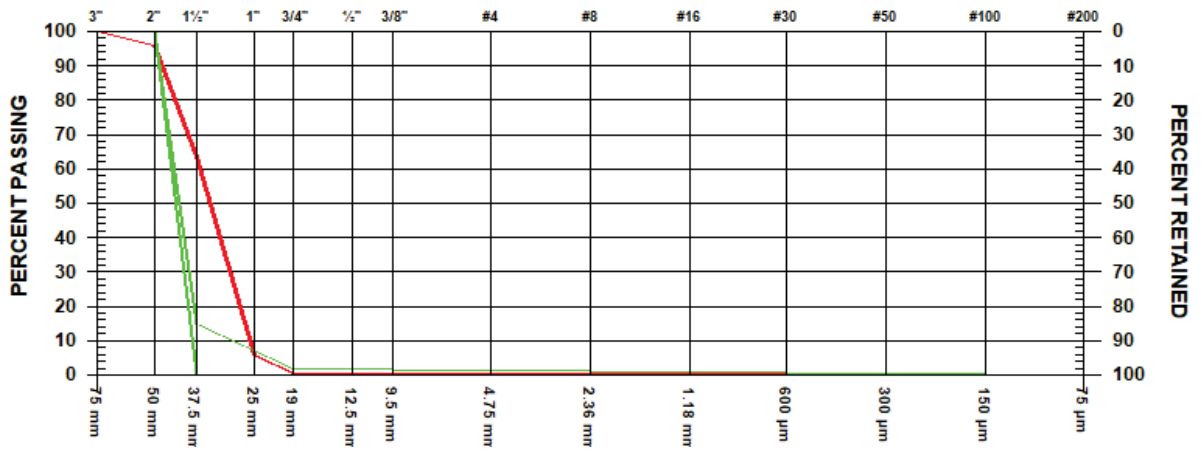
TO
Upland Contracting Ltd.
7295 Gold River Hwy.
Campbell River, BC
V9H 1P1

PROJECT Upland Misc 2020 — Campbell River
CONTRACTOR — Campbell River

SIEVE TEST NO. 31 DATE RECEIVED 24-Sep-2021 DATE TESTED 27-Sep-2021 DATE SAMPLED 09-Sep-2021

SUPPLIER Upland Contracting Ltd.
SOURCE Upland Pit #1
SPECIFICATION Stone Drainage Layer
MATERIAL TYPE 1-2" Drain Rock

SAMPLED BY Client
TESTED BY JY
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm	100.0	
2"	50 mm	96.0	100.0-100.0
1 1/2"	37.5 mm	63.6	0.0-15.0
1"	25 mm	5.8	
3/4"	19 mm	0.4	0.0-2.0
1/2"	12.5 mm	0.4	
3/8"	9.5 mm	0.4	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	0.4	
No. 8	2.36 mm	0.4	
No. 16	1.18 mm	0.4	
No. 30	600 µm	0.4	
No. 50	300 µm	0.3	
No. 100	150 µm	0.2	
No. 200	75 µm	0.1	

MOISTURE CONTENT 4.3%

COMMENTS
Sample ID: #21-420A

 29-Sep-2021 McElhanney Ltd. Reviewed By:

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of test results is provided only on written request.

McElhanney Ltd.
1211 Ryan Road
Courtenay, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2221-49292-08
CLIENT Upland Contracting Ltd.
C.C.

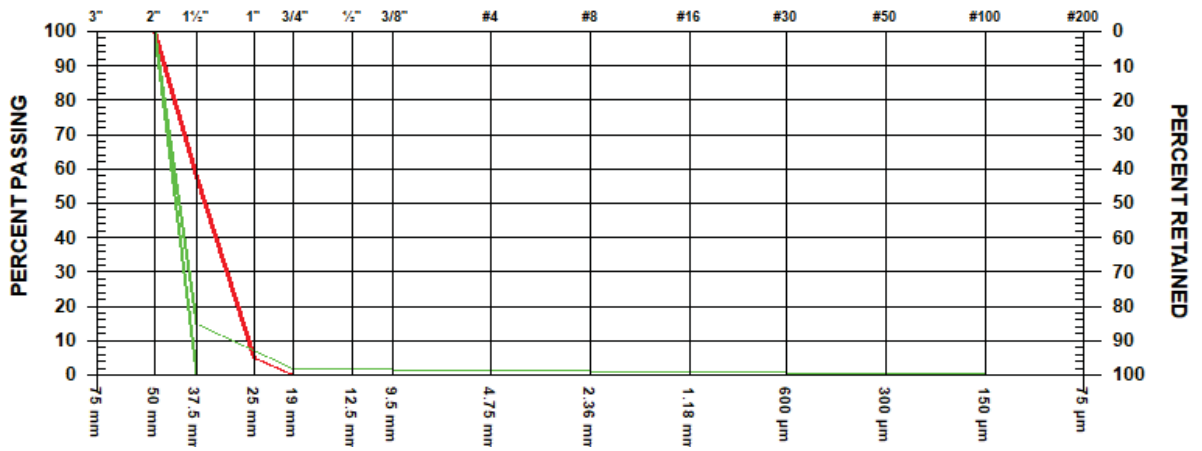
TO
Upland Contracting Ltd.
7295 Gold River Hwy.
Campbell River, BC
V9H 1P1

PROJECT Upland Misc 2020 — Campbell River
CONTRACTOR — Campbell River

SIEVE TEST NO. 32 DATE RECEIVED 24-Sep-2021 DATE TESTED 27-Sep-2021 DATE SAMPLED 07-Sep-2021

SUPPLIER Upland Contracting Ltd.
SOURCE Upland Pit #1
SPECIFICATION Stone Drainage Layer
MATERIAL TYPE 1-2" Drain Rock

SAMPLED BY Client
TESTED BY JY
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm	100.0	
2"	50 mm	100.0	100.0-100.0
1 1/2"	37.5 mm	57.5	0.0-15.0
1"	25 mm	4.8	
3/4"	19 mm	0.1	0.0-2.0
1/2"	12.5 mm	0.1	
3/8"	9.5 mm	0.1	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	0.1	
No. 8	2.36 mm	0.1	
No. 16	1.18 mm	0.1	
No. 30	600 µm	0.1	
No. 50	300 µm	0.1	
No. 100	150 µm	0.1	
No. 200	75 µm	0.1	

MOISTURE CONTENT 1.7%

COMMENTS
Sample ID: #21-420B

 29-Sep-2021 McElhanney Ltd. Reviewed By:

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of test results is provided only on written request.
Report System Software Registered to: McElhanney Consulting Services, Courtenay

McElhanney Ltd.
1211 Ryan Road
Courtenay, BC

SIEVE ANALYSIS REPORT
8 16 30 50 SERIES

PROJECT NO. 2221-49292-08
CLIENT Upland Contracting Ltd.
C.C.

TO
Upland Contracting Ltd.
7295 Gold River Hwy.
Campbell River, BC
V9H 1P1

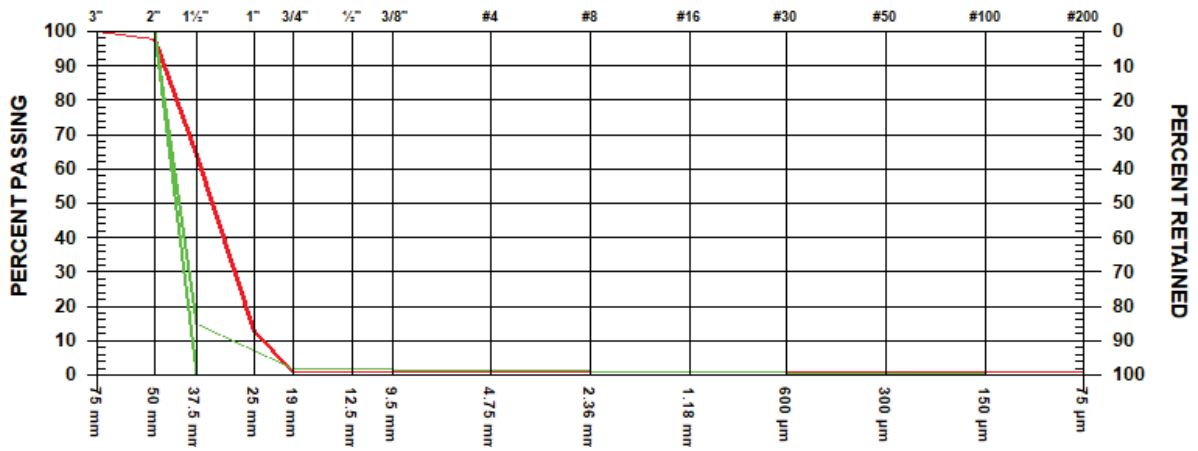
PROJECT Upland Misc 2020 Campbell River
Campbell River

CONTRACTOR

SIEVE TEST NO. 33 DATE RECEIVED 24-Sep-2021 DATE TESTED 27-Sep-2021 DATE SAMPLED 07-Sep-2021

SUPPLIER Upland Contracting Ltd.
SOURCE Upland Pit #1
SPECIFICATION Stone Drainage Layer
MATERIAL TYPE 1-2" Drain Rock

SAMPLED BY Client
TESTED BY JY
TEST METHOD WASHED



GRAVEL SIZES		PERCENT PASSING	GRADATION LIMITS
3"	75 mm	100.0	
2"	50 mm	97.7	100.0-100.0
1 1/2"	37.5 mm	64.1	0.0-15.0
1"	25 mm	12.4	
3/4"	19 mm	1.0	0.0-2.0
1/2"	12.5 mm	1.0	
3/8"	9.5 mm	1.0	

SAND SIZES AND FINES		PERCENT PASSING	GRADATION LIMITS
No. 4	4.75 mm	1.0	
No. 8	2.36 mm	1.0	
No. 16	1.18 mm	0.9	
No. 30	600 µm	0.9	
No. 50	300 µm	0.9	
No. 100	150 µm	0.9	
No. 200	75 µm	0.9	

MOISTURE CONTENT 3.1%

COMMENTS
Sample ID: #21-420C

 29-Sep-2021 McElhanney Ltd. Reviewed By:

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of test results is provided only on written request.
Report System Software Registered to: McElhanney Consulting Services, Courtenay

Appendix D

Product Data

Submittal Transmittal Form

DATE: May 3, 2021 GHD PROJECT NO.: 088877

PROJECT NAME: Northwin Landfill Phase 1 East CONTRACT NO.:

CONTRACTOR: Upland Contracting Ltd.

Certification By Contractor:

I hereby represent that I have satisfied CONTRACTOR's obligations under the Contract Documents including but not limited to review and approval, verification of products required, field dimensions, adjacent construction work, and coordination of information with respect to CONTRACTOR's review and approval of that submittal.	Contractor's Signature or Stamp

Contractor Submittal No.: 001 -1

GHD Submittal No.: 001 -1

Spec Section No./Drawing No.:

Page No.	Item No.	Description
		Bentomat DN (Geosythetic clay liner) SKAPS W13 (Woven Geotextile) SKAPS GE200 (Non-woven Geotextile) Interdrain GM (Drainage Geocomposite) Alvatech (Geomembrane)

Submittal Type:

- ☐ A - Test Results and/or Certificates
- ☒ B - Manufacturer's Literature or Data
- ☐ C - Shop Drawings
- ☐ D - Operation & Maintenance Instructions
- ☐ E - Samples
- ☐ F - Alternative Product Supporting Data
- ☐ G - Administrative (Schedules, etc.)

Notes: **Bolded** text show updates from Submittal 001.

Review Comments:

- Bentomat DN
  - Peel strength Spec: 2100 N/m, Sumbittal: 610 N/m
  - **Based on manufacture provided information and supported by GRI-GCL3-Spec SI (attached) Bentomat DN is accepted**
- Skaps W315
  - Puncture strength: Spec ASTM D4833, Submittal ASTM 6241
  - **ASTM 6241 acceptable for testing puncture strength of geotextile**
- Skaps GE200
  - Puncture strength Spec: 2420 N , Submittal 1.99 kN
  - **Puncture strength was reviewed and found to be acceptable**
  - Puncture strength Spec: ASTM D4833, Submittal ASTM 6241
  - **ASTM D6241 is acceptable for testing puncture strength of geotextile**
- Alvatech
  - Tensile and elongation strength Spec test method: ASTM D638, Submittal ASTM D 6693 **Acceptable test method supported by GRI-HDPE-Spec (attached)**
  - Carbon black content: Spec test method: ASTM D1603, Submittal ASTM 4218 **Acceptable test method supported by GRI-HDPE-Spec (attached)**
  - Asperity height: GRI test method GM12, Submittal ASTM D7466 **Acceptable test method supported by GRI-HDPE-Spec (attached)**

REVIEWED BY:

REVIEWED BY: David Barbour

SUBMITTAL REVIEW

GHD Submittal No. **001-1**
Contractor Submittal No.
Contract No.

ENGINEER's review is for the sole purpose of ascertaining conformance with general design concepts expressed in the Contract Documents and in no way constitutes approval of the detail design inherent in CONTRACTOR's Submittal responsibility for which remains solely with CONTRACTOR submitting same. Review does not authorize changes to Contract Documents.

- [x] Reviewed
- [ ] Reviewed as Noted
- [ ] Revise and Resubmit
- [ ] Not Subject to Review
- [ ] Other

Name: **David Barbour**

Signed: D Barbour

Date: **May 3, 2021**

BENTOMAT® DN CERTIFIED PROPERTIES

CETCO® Bentomat® DN is a reinforced geosynthetic clay liner (GCL) consisting of a layer of sodium bentonite between two polypropylene nonwoven geotextiles, which are needle-punched together.

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY	CERTIFIED VALUES
Nonwoven Base Geotextile Mass/Area[1]	ASTM D5261	200,000 ft^2 (20,000 m^2)	6.0 oz/yd^2 (203 g/m^2) min.
Nonwoven Cap Geotextile Mass/Area[1]	ASTM D5261	200,000 ft^2 (20,000 m^2)	6.0 oz/yd^2 (203 g/m^2) min.
Bentonite Moisture Content[2]	ASTM D2216	1 per 50 tonnes	12% max.
Bentonite Swell Index[2]	ASTM D5890	1 per 50 tonnes	24 mL/2g min.
Bentonite Fluid Loss[2]	ASTM D5891	1 per 50 tonnes	18 mL max.
Bentonite Mass/Area[3]	ASTM D5993	40,000 ft^2 (4,000 m^2)	0.75 lb/ft^2 (3.7 kg/m^2) min.
Total Mass/Area[3]	ASTM D5993	40,000 ft^2 (4,000 m^2)	0.83 lb/ft^2 (4.1 kg/m^2) min.
GCL Moisture Content	ASTM D5993	40,000 ft^2 (4,000 m^2)	35% max.
GCL Grab Strength[4]	ASTM D6768	200,000 ft^2 (20,000 m^2)	50 lbs/in (8.8 kN/m) min.
GCL Peel Strength	ASTM D6496	40,000 ft^2 (4,000 m^2)	3.5 lbs/in (610 N/m) min.
GCL Hydraulic Conductivity[5]	ASTM D5887	250,000 ft^2 (25,000 m^2)	5 x 10^{-11} m/s max.
GCL Index Flux[5]	ASTM D5887	250,000 ft^2 (25,000 m^2)	1 x 10^{-8} $m^3/m^2/s$ max.
GCL Hydrated Internal Shear Strength[6]	ASTM D6243	1,000,000 ft^2 (100,000 m^2)	500 psf (24 kPa) typ.@ 200 psf (9.6 kPa)

Notes:

[1] Geotextile property tests performed on the geotextile components before they are incorporated into the finished GCL product.

[2] Bentonite property tests performed before the bentonite is incorporated into the finished GCL product.

[3] Reported at 0% moisture content.

[4] All tensile strength testing is performed in the machine direction using ASTM D6768.

[5] Index flux and hydraulic conductivity testing with deaired distilled/deionized water at 80 psi (550 kPa) cell pressure, 77 psi (530 kPa) headwater pressure and 75 psi (515 kPa) tailwater pressure.

[6] Peak values measured at 200 psf (9.6 kPa) normal stress for a specimen hydrated for 48 hours. Site-specific materials, GCL products, and test conditions must be used to verify internal and interface strength of the proposed design.

TR 401 BDN-3.5lb/in-D5889/GRI-GCL3
05/2018

www.CETCO.com | contact@cetco.com

IMPORTANT: The information contained herein supersedes all previous printed versions, and is believed to be accurate and reliable. For the most up-to-date information, please contact CETCO sales team. CETCO accepts no responsibility for the results obtained through application of this product. CETCO reserves the right to update information without notice.

MINERALS TECHNOLOGIES CETCO®

Table 1(a) – Specification for Geosynthetic Clay Liners (GCLs)

Property	ASTM Test Method	Reinforced GCL			Non-Reinforced GCL			Testing Frequency
		GT-Related	GT Polymer Coated	GM-GF Related	GT-Related	GT Polymer Coated	GM-GF Related	
Clay (as received)								
swell index (ml/2g)	D5890	24	24	24	24	24	24	50 tonnes
fluid loss (ml)(1)	D5891	18	18	18	18	18	18	50 tonnes
Geotextiles (as received)								
cap fabric (nonwoven) - mass/unit area (g/m^2)(2)	D5261	200	200	200	100	100	n/a/100	20,000 m^2
cap fabric -(woven) - mass/unit area (g/m^2)	D5261	100	100	100	100	100	100	20,000 m^2
carrier fabric (nonwoven composite) - mass/(g/m^2)(2)	D5261	200	200	200	100	100	n/a/100	20,000 m^2
carrier fabric (woven) - mass/unit area (g/m^2)	D5261	100	100	100	-	-	-	20,000 m^2
coating - mass/unit area (g/m^2)(3)	D5261	n/a	200	n/a	n/a	200	n/a	4,000 m^2
Geomembrane/Geofilm (as received)								
thickness(4) (mm)	D5199/D5994	n/a	n/a	0.40/0.50/0.10	n/a	n/a	0.40/0.75/0.10	20,000 m^2
density (g/cc)	D1505/D792	n/a	n/a	0.92	n/a	n/a	0.92	20,000 m^2
break tensile strength, MD&XMD (kN/m)	D6693	n/a	n/a	n/a	n/a	n/a	6.0	20,000 m^2
break tensile strength, MD (kN/m)	D882	n/a	n/a	2.5	n/a	n/a	2.5	20,000 m^2
GCL (as manufactured)								
mass of GCL (g/m^2)(5)	D5993	4000	4050	4100	4000	4050	4100	4,000 m^2
mass of bentonite (g/m^2)(5)	D5993	3700	3700	3700	3700	3700	3700	4,000 m^2
moisture content(1) (%)	D5993	35	35	35	35	35	35	4,000 m^2
tensile str., MD (kN/m)	D6768	4.0	4.0	4.0	4.0	4.0	4.0	20,000 m^2
peel strength (N/m)	D6496	360	360	360	n/a	n/a	n/a	4,000 m^2
permeability(1) (m/sec), "or"	D5887	5×10^{-11}	n/a	n/a	5×10^{-11}	n/a	n/a	25,000 m^2
flux(1) ($m^3/sec\text{-}m^2$),	D5887	1×10^{-8}	n/a	n/a	1×10^{-8}	n/a	n/a	25,000 m^2
GCL permeability(1),(6),(7),(8) ($m^3/m^2/s$) (max. at 35 kPa)	D6766	1×10^{-7}	n/a	n/a	1×10^{-7}	n/a	n/a	yearly
Component Durability								
geotextile and reinforcing yarns (9) (% strength retained)	See § 5.6.2	65	65	n/a	65	65	n/a	yearly
geomembrane	See § 5.6.3	n/a	n/a	GM Spec(10)	n/a	n/a	GM Spec(10)	yearly
geofilm/polymer treated(9) (% strength retained)	See § 5.6.4	n/a	85	80	n/a	85	80	yearly

n/a = not applicable with respect to this property

(1) These values are maximum (all others are minimum).

(2) For both cap and carrier fabrics for nonwoven reinforced GCLs; one, or the other, must contain a scrim component of mass ≥ 100 g/m^2 for dimensional stability. This only applies to GM/GCL composites which are exposed to the atmosphere for several months or longer so as to mitigate panel separation.

(3) Calculated value obtained from difference of coated fabric to as-received fabric.

(4) First value is for smooth geomembrane; second for textured geomembrane; third for geofilm.

(5) Mass of the GCL and bentonite is measured after oven drying per the stated test method.

(6) Value represents GCL permeability after permeation with a 0.05 M calcium chloride solution; for termination criterion see § 5.6.1.

(7) The specimen is saturated with DI water until steady flow is obtained. $CaCL_2$ saturation at 0.05 M added after, minimum flow conditions exist as per the standard requirement.

(8) Test should be run on the pure bentonite only. Not on polymer modified bentonites.

(9) Value represents the minimum percent strength retained from the as-manufactured value after oven aging at 60°C for 50 days tested per ASTM D5035.

(10) Durability criteria should follow the appropriate specification for the geomembrane type used; i.e., GRI GM-13 for HDPE, GRI GM-17 for LLDPE or GRI GM-18 for fPP.

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Geotextile Product Description Sheet

SKAPS W315

SKAPS woven geotextile fabrics are woven polypropylene materials offering optimum performance when used in stabilization applications. Produced from first quality raw materials, they provide the perfect balance of strength and separation in styles capable of functioning exceptionally well in a wide range of performance requirements. Unless indicated below, all listed properties are Minimum Average Roll Values:

PROPERTY	TEST METHOD	UNIT	M.A.R.V. (Minimum Average Roll Value)
Weight	ASTM D 5261	oz/sy (g/m^2)	6.3 (214)
Grab Tensile	ASTM D 4632	lbs (kN)	315 (1.40)
Grab Elongation	ASTM D 4632	%	15
Trapezoid Tear Strength	ASTM D 4533	lbs (kN)	120 (.533)
CBR Puncture Resistance	ASTM D 6241	lbs (kN)	1000 (4.45)
Permittivity*	ASTM D 4491	sec^{-1}	0.05
Water Flow*	ASTM D 4491	gpm/sf (l/min/m^2)	4 (163)
AOS*	ASTM D 4751	US Sieve (mm)	40 (.425)
UV Resistance	ASTM D 4355	%/hrs	70/500

* At the time of manufacturing. Handling, storage, and shipping may change these properties.

PACKAGING	
Roll Dimensions (W x L) – ft	12.5 x 360 / 17.5 x 258
Square Yards Per Roll	500
Estimated Roll Weight - lbs	210

This information is provided for reference purposes only and is not intended as a warranty or guarantee. SKAPS assumes no liability in connection with the use of this information.

SKAPS Industries,
316 S. Holland Dr., Pendergrass, GA 30567,
Phone: (706)-693-3440, Fax (706)-693-3450,
www.skaps.com

Made in U.S.A.

SKAPS GE-200 is a needle-punched nonwoven geotextile made of 100% polypropylene staple fibers, which are formed into a random network for dimensional stability. SKAPS GE-200 resists ultraviolet deterioration, rotting, biological degradation, naturally encountered basics and acids. Polypropylene is stable within a pH range of 2 to 13.

DOWNLOAD DATA SHEET

SKAPS GE-200 conforms to the physical property values listed below:

Property	**Method**	**English (MARV^2)**	**Metric (MARV^2)**
Weight	ASTM D 5261	20 oz/yd^2	675 g/m^2
Grab Tensile Strength	ASTM D 4632	450 lbs	1.99 kN
Grab Elongation	ASTM D 4632	50%	50%
Trapezoid Tear Strength	ASTM D 4533	125 lbs	0.55 kN
CBR Puncture Resistance	ASTM D 6241	1437 lbs	1.67 kN
UV Resistance	ASTM D 4355	70%/500 hrs.	70%/500 hrs.

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INTERDRAIN GM & GMG 30.8

Drainage Geocomposite

High-density polyethylene (HDPE) geonet with one or two polypropylene (PP) geotextiles heat laminated, respectively. The geonet is made with 2 overcrossed strands, whose geometry creates channels with a high flow capacity, also under high pressures and at very low gradients.



FUNCTIONS:
DRAINAGE, FILTRATION, SEPARATION and PROTECTION.

MAIN USES:
Landfill cappings, new landfills, water reservoirs, horizontal drainage in embankments and platforms of roads, railways, trams and other trafficked areas, retaining structures, bridges, foundations, basements, canals, cut-and-cover tunnels, tunnels and other underground structures, gardens and sport fields.

Properties	Values	Units	Qualifiers	Standards
Geonet [1]				
Polymer		High-density polyethylene (HDPE)		
Carbon black	2	%	Min	ASTM D4218
Density	0,94	g / cm³	Min	ASTM D1505
Thickness	300 (7,6)	mil (mm)	MAV	ASTM D5199
Transmissivity, MD	8×10^{-3}	m² / s [2]	MARV	ASTM D4716 [3]
Tensile strength, MD	75 (13,1)	lb / in (kN / m)	Min	ASTM D7179
Geotextile [1]				
Polymer		Polypropylene (PP)		
Mass per unit area	8 (270)	oz / yd² (g / m²)	MARV	ASTM D5261
CBR Puncture	600 (2.670)	lb (N)	MARV	ASTM D6241
AOS	80 (180)	US Sieve (µm)	MaxARV	ASTM D4751
Grab strength	225 (1.000)	lb (N)	MARV	ASTM D4632
Grab elongation	50	%	MARV	ASTM D4632
Tear strength	90 (400)	lb (N)	MARV	ASTM D4533
Permeability	100 (4.074)	gal / ft²·min (l / m²·min)	MARV	ASTM D4491
Permittivity	1,26	s^{-1}	MARV	ASTM D4491
UV resistance	70	% ret. 500h	MARV	ASTM D4355
Drainage geocomposite				
Ply adhesion, MD	1 (178)	lb / in (g / cm)	Min	ASTM D7005
Transmissivity, MD (SS)	3×10^{-3}	m² / s [2]	MARV	ASTM D4716 [3]
Transmissivity, MD (DS)	9×10^{-4}	m² / s [2]	MARV	ASTM D4716 [3]
Remarks				
- Standard roll format is 12,5 feet (3,8 meters) wide.				
- Has a geotextile overlap at one side, which eases the installation and prevents soil intrusion.				
- Has to be covered within 14 days after installation.				

[1] Geonet and geotextile listed properties are prior to lamination
[2] 10^{-3} m² / s = l / m·s
[3] Transmissivity measured under an hydraulic gradient of 0.1, normal load of 10,000 psf (480 kPa), water at 70 °F (21 °C) between HDPE plates (H/H) for 15 minutes

MD : Machine Direction (longitudinal)
SS : Single-Sided Geocomposite
DS : Double-Sided Geocomposite
MARV : Minimum Average Roll Value
MAV : Minimum Average Value
Min : Minimum Value
MAX : Maximum Value
MaxARV : Maximum Average Roll Value

CE Certificate of conformity
0099/CPR/A42/0124
0099/CPR/A42/0127

January 2020

These specifications are based on our present state of knowledge.
INTERMAS declines any responsibility due to their use in projects or civil works and hands them for informative purposes only.

ALVATECH FIX
High-Density Polyethylene Waterproofing Geomembrane

ALVATECH FIX is manufactured by SOTRAFA (Almería – Spain), a company of the Armando Alvarez Group.

ALVATECH FIX is a High-Density Polyethylene liner, structured on one (FIX 1F) or both sides (FIX 2F), available in 7.5 m and manufactured with the latest cast system technology.

SOTRAFA certifies that HDPE Geomembrane Alvatech FIX, satisfactorily meets Standard GRI GM-13.

PROPERTIES	UNIT	GEOMEMBRANE ALVATECH FIX 1F – 2F			Test Method
		Geo. 1.5	Geo. 2.0	Geo. 2.5	
Thickness (minimum average)		**1.50** (±5%)	**2.00** (±5%)	**2.50** (±5%)	
• Lowest individual for 8 out of 10 values	mm	-10%	-10%	-10%	ASTM D 5994
• Lowest individual for any of the 10 values		-15%	-15%	-15%	
Asperity Height (2)	mm	**≥ 0.80** (≥ 0,40)			ASTM D7466
Density with Carbon Black	g/cm^3	**≥ 0.940**			ASTM D 1505
Yield Strength (1)	kN/m	**24** (≥ 22)	**32** (≥ 29)	**40** (≥ 37)	
Break Strength (1)	kN/m	**19** (≥ 16)	**26** (≥ 21)	**32** (≥ 26)	ASTM D 6693
Yield Elongation (1)	%	**13** (≥ 12)	**13** (≥ 12)	**13** (≥12)	Type IV
Break Elongation (1)	%	**150** (≥ 100)	**200** (≥ 100)	**200** (≥ 100)	
Tear Resistance (1)	N	**200** (≥ 187)	**270** (≥ 249)	**335** (≥ 311)	ASTM D 1004
Puncture Resistance (2)	N	**450** (≥400)	**600** (≥534)	**750** (≥667)	ASTM D 4833
Stress Crack Resistance (SP-NCTL) (3)	h	**≥ 500**			ASTM D 5397
Carbon Black					
Carbon Black Content	%	**2 - 3**			ASTM D 4218
Carbon Black Dispersion	Category	**1 - 2**			ASTM D 5596
Oxidative Induction Time (4)					
Standard OIT	min	**≥ 100**			ASTM D 3895
--- or ---					
HPOIT		**≥ 400**			ASTM D 5885
OVEN AGEING AT 85 º C (4)					ASTM D 5721
Standard OIT - % Retained after 90 days	% retained	**≥ 55**			ASTM D 3895
--- or ---					
HPOIT - % Retained after 90 days		**≥ 80**			ASTN D 5885
U.V. RESISTANCE					ASTM D7238
High Pressure OIT - % Retained after 1600hours	% retained	**≥ 50**			ASTM D5885

(1) Both directions (machine direction and cross machine direction) (2) Both sides. (3) SP-NTCL must be evaluated in the smooth area.

(4) Sotrafa reserves the right to evaluate the antioxidant content with one or any other oxidation induction method.

All the values are nominal. Those values between parentheses are the minimum ones required by the norm GM-13.

This Information is provided for reference purposes only. The values are not guaranteed. SOTRAFA is not responsible for improper use of this information or for the final use of the product if that use is not the normal application of the geomembrane. This information is subject to change without prior notice. Please contact Sotrafa for any updated information.

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ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) - mils	D 5994	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	per roll
• lowest individual for 8 out of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
• lowest individual for any of the 10 values - %		-15	-15	-15	-15	-15	-15	-15	
Asperity Height mils (min. ave.) - mils	D 7466	16	16	16	16	16	16	16	every 2nd roll *(1)*
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	200,000 lb
Tensile Properties (min. ave.) *(2)*	D 6693								20,000 lb
• yield strength - lb/in.	Type IV	63	84	105	126	168	210	252	
• break strength - lb/in.		45	60	75	90	120	150	180	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		100	100	100	100	100	100	100	
Tear Resistance (min. ave.) - lb	D 1004	21	28	35	42	56	70	84	45,000 lb
Puncture Resistance (min. ave.) - lb	D 4833	45	60	75	90	120	150	180	45,000 lb
Stress Crack Resistance *(3)* - hr.	D 5397 (App.)	500	500	500	500	500	500	500	per GRI GM10
Carbon Black Content (range) - %	D 4218 *(4)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	20,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(6)*									200,000 lb
(a) Standard OIT - min.	D 8117	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(6), (7)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 8117	55	55	55	55	55	55	55	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(8)*	D 7238								
(a) Standard OIT (min. ave.)	D 8117	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 5885	50	50	50	50	50	50	50	

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches

(3) SP-NCTL per ASTM D5397 Appendix, is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

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Revision 16: March 17, 2021
Revision schedule on pg. 11

GRI - GM13 Standard Specification*

Standard Specification for

"Test Methods, Test Properties and Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes" SM

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm (30 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.

1.2 This specification sets forth a set of minimum, physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.

1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

1.4 This standard specification is intended to ensure good quality and performance of HDPE geomembranes in general applications, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive

*This GRI standard specification is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version and it is kept current on the Institute's Website <<geosynthetic-institute.org>>.

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values for test indicated, may be necessary under conditions of a particular application.

Note 2: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement
D 1004 Test Method for Initial Tear Resistance of Plastics Film and Sheeting
D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
D 1603 Test Method for Carbon Black in Olefin Plastics
D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5397 Procedure to Perform a Single Point Notched Constant Tensile Load – (SP-NCTL) Test: Appendix
D 5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
D 5994 Test Method for Measuring the Core Thickness of Textured Geomembranes
D 6370 Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)
D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
D 7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
D 7466 Test Method for Measuring the Asperity Height of Textured Geomembranes
D 8117 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by Differential Scanning Calorimetry

2.2 GRI Standards

GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet

2.3 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.
ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.
ref. EPA/600/R-93/182

Formulation - The mixture of a unique combination of ingredients identified by type, properties and quantity. For HDPE polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

Nominal - Representative value of a measurable property determined under a set of conditions, by which a product may be described. Abbreviated as nom. in Tables 1 and 2.

4. Material Classification and Formulation

4.1 This specification covers high density polyethylene geomembranes with a formulated sheet density of 0.940 g/ml, or higher. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.

4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min.

4.3 The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

5. Physical, Mechanical and Chemical Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth HDPE geomembranes and Table 2 is for single and double sided textured HDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is soft.

Note 3: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of 23°C ± 2°C. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of 21°C ± 2°C. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of 23°C ± 2°C should be utilized for testing purposes.

Note 4: There are several tests often included in other HDPE specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- Volatile Loss
- Dimensional Stability
- Coeff. of Linear Expansion
- Resistance to Soil Burial
- Low Temperature Impact
- ESCR Test (D 1693)
- Wide Width Tensile
- Water Vapor Transmission
- Water Absorption
- Ozone Resistance
- Modulus of Elasticity
- Hydrostatic Resistance
- Tensile Impact
- Field Seam Strength
- Multi-Axial Burst
- Various Toxicity Tests

Note 5: There are several tests which are included in this standard (that are not customarily required in other HDPE specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet (see Note 6)

Note 6: The minimum average value of asperity height does not represent an expected value of interface shear strength. Shear strength associated with geomembranes is both site-specific and product-specific and should be determined by direct shear testing using ASTM D5321/ASTM D6243 as prescribed. This testing should be included in the particular site's CQA conformance testing protocol for the geosynthetic materials involved, or formally waived by the Design Engineer, with concurrence from the Owner prior to the deployment of the geosynthetic materials.

Note 7: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Puncture Resistance
- Stress Crack Resistance
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The properties of the HDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

Note 8: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer, respectively.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

6.2 Textured geomembrane shall generally have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marketing

9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

ENGLISH UNITS

Table 1(a) – High Density Polyethylene (HDPE) Geomembrane -Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.) - mils	D5199	nom.	nom.	nom.	nom.	nom.	nom.	nom.	per roll
• lowest individual of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	200,000 lb
Tensile Properties *(1)* (min. ave.)	D 6693								20,000 lb
• yield strength - lb/in.	Type IV	63	84	105	126	168	210	252	
• break strength - lb/in.		114	152	190	228	304	380	456	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		700	700	700	700	700	700	700	
Tear Resistance (min. ave.) - lb	D 1004	21	28	35	42	56	70	84	45,000 lb
Puncture Resistance (min. ave.) - lb	D 4833	54	72	90	108	144	180	216	45,000 lb
Stress Crack Resistance *(2)* - hr.	D5397 (App.)	500	500	500	500	500	500	500	per GRI-GM10
Carbon Black Content (range) - %	D 4218 *(3)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	20,000 lb
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(5)*									200,000 lb
(a) Standard OIT - min.	D 8117	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(5), (6)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 8117	55	55	55	55	55	55	55	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(7)*	D 7238								
(a) Standard OIT (min. ave.)	D 8117	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 5885	50	50	50	50	50	50	50	

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC) UNITS

Table 1(b) – High Density Polyethylene (HPDE) Geomembrane - Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness - (min. ave.) - mm	D5199	nom.	nom.	nom.	nom.	nom.	nom.	nom.	per roll
• lowest individual of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	90,000 kg
Tensile Properties *(1)* (min. ave.)	D 6693								9,000 kg
• yield strength - kN/m	Type IV	11	15	18	22	29	37	44	
• break strength - kN/m		20	27	33	40	53	67	80	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		700	700	700	700	700	700	700	
Tear Resistance (min. ave.) - N	D 1004	93	125	156	187	249	311	374	20,000 kg
Puncture Resistance (min. ave.) - N	D 4833	240	320	400	480	640	800	960	20,000 kg
Stress Crack Resistance *(2)* - hr.	D 5397 (App.)	500	500	500	500	500	500	500	per GRI GM-10
Carbon Black Content (range) - %	D 4218 *(3)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	9,000 kg
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(5)*									90,000 kg
(a) Standard OIT - min.	D 8117	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(5), (6)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 8117	55	55	55	55	55	55	55	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(7)*	D 7238								
(a) Standard OIT (min. ave.)	D 8117	N. R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 5885	50	50	50	50	50	50	50	

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) - mils	D 5994	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	per roll
• lowest individual for 8 out of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
• lowest individual for any of the 10 values - %		-15	-15	-15	-15	-15	-15	-15	
Asperity Height mils (min. ave.) - mils	D 7466	16	16	16	16	16	16	16	every 2nd roll *(1)*
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	200,000 lb
Tensile Properties (min. ave.) *(2)*	D 6693								20,000 lb
• yield strength - lb/in.	Type IV	63	84	105	126	168	210	252	
• break strength - lb/in.		45	60	75	90	120	150	180	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		100	100	100	100	100	100	100	
Tear Resistance (min. ave.) - lb	D 1004	21	28	35	42	56	70	84	45,000 lb
Puncture Resistance (min. ave.) - lb	D 4833	45	60	75	90	120	150	180	45,000 lb
Stress Crack Resistance *(3)* - hr.	D 5397 (App.)	500	500	500	500	500	500	500	per GRI GM10
Carbon Black Content (range) - %	D 4218 *(4)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	20,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(6)*									200,000 lb
(a) Standard OIT - min.	D 8117	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(6), (7)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 8117	55	55	55	55	55	55	55	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(8)*	D 7238								
(a) Standard OIT (min. ave.)	D 8117	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 5885	50	50	50	50	50	50	50	

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches

(3) SP-NCTL per ASTM D5397 Appendix, is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC UNITS)

Table 2(b) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness (min. ave.) - mm	D 5994	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	per roll
• lowest individual for 8 out of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
• lowest individual for any of the 10 values - %		-15	-15	-15	-15	-15	-15	-15	
Asperity Height mils (min. ave.) - mm	D 7466	0.40	0.40	0.40	0.40	0.40	0.40	0.40	every 2nd roll *(1)*
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	90,000 kg
Tensile Properties (min. ave.) *(2)*	D 6693								9,000 kg
• yield strength - kN/m	Type IV	11	15	18	22	29	37	44	
• break strength - kN/m		8	10	13	16	21	26	32	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		100	100	100	100	100	100	100	
Tear Resistance (min. ave.) - N	D 1004	93	125	156	187	249	311	374	20,000 kg
Puncture Resistance (min. ave.) - N	D 4833	200	267	333	400	534	667	800	20,000 kg
Stress Crack Resistance *(3)* - hr.	D 5397 (App.)	500	500	500	500	500	500	500	per GRI GM10
Carbon Black Content (range) - %	D 4218 *(4)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	9,000 kg
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(6)*									90,000 kg
(a) Standard OIT - min.	D 8117	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(6), (7)*	D 5721								per each formulation
(a) Standard OIT (min. ave.) - % retained after 90 days	D 8117	55	55	55	55	55	55	55	
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(8)*	D 7238								per each formulation
(a) Standard OIT (min. ave.)	D 8117	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 5885	50	50	50	50	50	50	50	

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(3) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Adoption and Revision Schedule
for
HDPE Specification per GRI-GM13

"Test Methods, Test Properties, Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

Adopted:	June 17, 1997
Revision 1:	November 20, 1998; changed CB dispersion from allowing 2 views to be in Category 3 to requiring all 10 views to be in Category 1 or 2. Also reduced UV percent retained from 60% to 50%.
Revision 2:	April 29, 1999: added to Note 5 after the listing of Carbon Black Dispersion the following: "(In the viewing and subsequent quantitative interpretation of ASTM D5596 only near spherical agglomerates shall be included in the assessment)" and to Note (4) in the property tables.
Revision 3:	June 28, 2000: added a new Section 5.2 that the numeric table values are neither MARV or MaxARV. They are to be interpreted per the the designated test method.
Revision 4:	December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to "strength" and "elongation".
Revision 5:	May 15, 2003: Increased minimum acceptable stress crack resistance time from 200 hrs to 300 hrs.
Revision 6:	June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 2.
Revision 7:	February 20, 2006: Added Note 6 on Asperity Height clarification with respect to shear strength.
Revision 8:	Removed recommended warranty from specification.
Revision 9:	June 1, 2009: Replaced GRI-GM12 test for asperity height of textured geomembranes with ASTM D 7466.
Revision 10	April 11, 2011: Added alternative carbon black content test methods
Revision 11	December 13, 2012: Replaced GRI-GM11 with the equivalent ASTM D 7238.
Revision 12	November 14, 2014: Increased minimum acceptable stress crack resistance time from 300 to 500 hours. Also, increased asperity height of textured sheet from 10 to 16 mils (0.25 to 0.40 mm).
Revision 13	November 4, 2015: Removed Footnote (1) on asperity height from tables.
Revision 14	January 6, 2016: Removed Trouser Tear from Note 5.
Revision 15:	September 9, 2019: Editorial update to harmonize tables.
Revision 16:	March 17, 2021: Updated Standard OIT Test from ASTM D3895 to D8117

Submittal Transmittal Form

DATE: May 3, 2021 GHD PROJECT NO.: 088877

PROJECT NAME: Northwin Landfill Phase 1 East CONTRACT NO.:

CONTRACTOR: Upland Contracting Ltd.

Certification By Contractor:

I hereby represent that I have satisfied CONTRACTOR's obligations under the Contract Documents including but not limited to review and approval, verification of products required, field dimensions, adjacent construction work, and coordination of information with respect to CONTRACTOR's review and approval of that submittal.	Contractor's Signature or Stamp

Contractor Submittal No.: 002

GHD Submittal No.: 002

Spec Section No./Drawing No.:

Page No.	Item No.	Description
		Perforated HDPE Pipe

Submittal Type:

- ☐ A - Test Results and/or Certificates
- ☒ B - Manufacturer's Literature or Data
- ☐ C - Shop Drawings
- ☐ D - Operation & Maintenance Instructions
- ☐ E - Samples
- ☐ F - Alternative Product Supporting Data
- ☐ G - Administrative (Schedules, etc.)

Notes:

Review Comments:

SUBMITTAL REVIEW

GHD Submittal No. **002**
Contractor Submittal No.
Contract No.

ENGINEER's review is for the sole purpose of ascertaining conformance with general design concepts expressed in the Contract Documents and in no way constitutes approval of the detail design inherent in CONTRACTOR's Submittal responsibility for which remains solely with CONTRACTOR submitting same. Review does not authorize changes to Contract Documents.

- [x] Reviewed
- [ ] Reviewed as Noted
- [ ] Revise and Resubmit
- [ ] Not Subject to Review
- [ ] Other

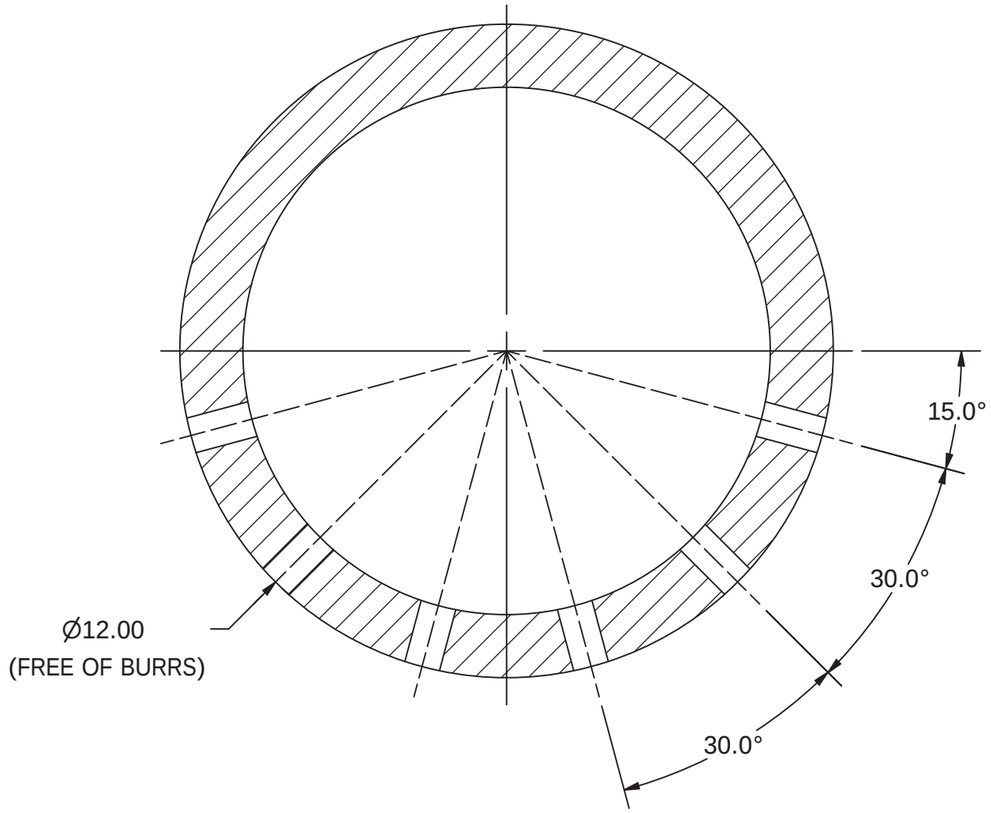
Name: **David Barbour**

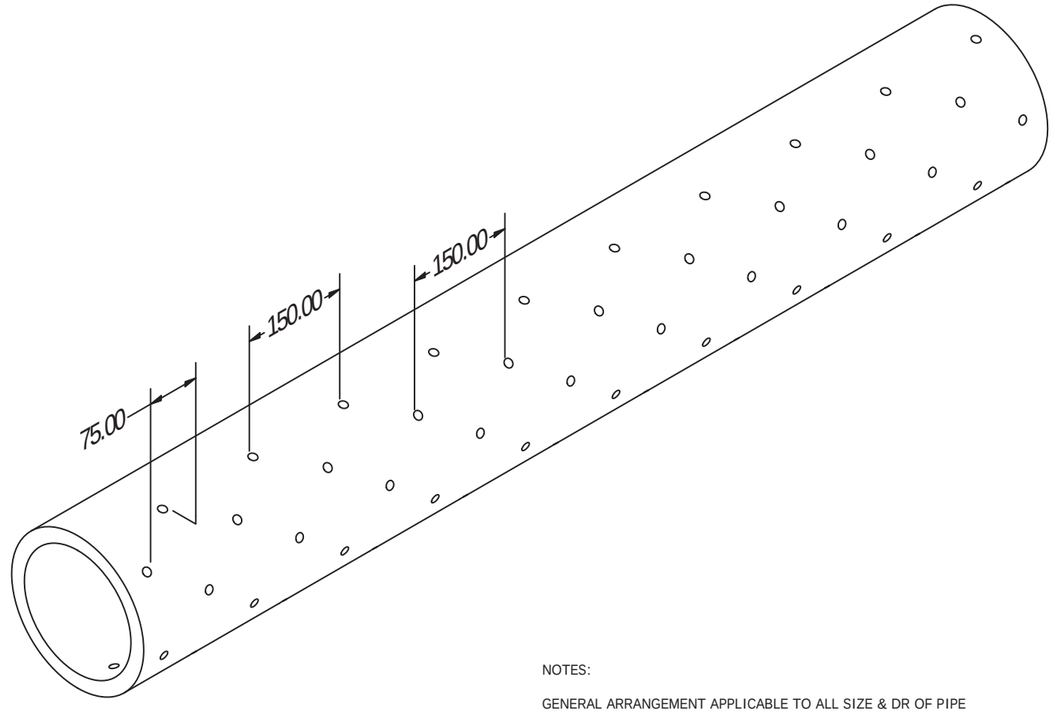
Signed: D Barbour

Date: **May 3, 2021**

REVIEWED BY:

REVIEWED BY: David Barbour





NOTES:

GENERAL ARRANGEMENT APPLICABLE TO ALL SIZE & DR OF PIPE

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED

SHIPPING:
PARTIALLY ASSEMBLED BEFORE SHIPMENT TO SITE. INSTALLATION ON SITE BY OTHERS

DISCLAIMER:
ALL DIMENSIONS APPROXIMATE, SUBJECT TO CHANGE WITHOUT NOTICE
ANGLE TOLERANCE IS ±2° @ 23°C
ALL OTHER DIMENSIONS TO ±25mm" @ 23°C
THIS DRAWING IS ONLY APPLICABLE IF A SIGNED COPY IS REFERENCED AT TIME OF ORDER
SUBJECT TO ICONIX WATERWORKS STANDARD TERMS AND CONDITION

ICONIX waterworks

		DESCRIPTION: Peferated HDPE Pipe General Arrangment
QUOTE#:	SO#:	PROJECT: Campbell River Land Fill
SCALE:NTS	SHEET 1 OF 1	
DRAWING NO:		REV: 0

THIS DRAWING IS THE PROPERTY OF ICONIX WATERWORKS, AND CONTAINS PROPRIETARY AND CONFIDENTIAL INFORMATION WHICH MUST NOT BE DUPLICATED, USED OR DISCLOSED OTHER THAN EXPRESSLY AUTHORIZED BY ICONIX.

Submittal Transmittal Form

DATE: May 6, 2021 GHD PROJECT NO.: 088877

PROJECT NAME: Northwin Landfill Phase 1 East CONTRACT NO.:

CONTRACTOR: Upland Contracting Ltd.

Certification By Contractor:

I hereby represent that I have satisfied CONTRACTOR's obligations under the Contract Documents including but not limited to review and approval, verification of products required, field dimensions, adjacent construction work, and coordination of information with respect to CONTRACTOR's review and approval of that submittal.	Contractor's Signature or Stamp

Contractor Submittal No.: 003

GHD Submittal No.: 003

Spec Section No./Drawing No.:

Page No.	Item No.	Description
		WovenSpec

Submittal Type:

- ☐ A - Test Results and/or Certificates
- ☒ B - Manufacturer's Literature or Data
- ☐ C - Shop Drawings
- ☐ D - Operation & Maintenance Instructions
- ☐ E - Samples
- ☐ F - Alternative Product Supporting Data
- ☐ G - Administrative (Schedules, etc.)

Notes:

Review Comments:

SUBMITTAL REVIEW

GHD Submittal No. **003**
Contractor Submittal No.
Contract No.

ENGINEER's review is for the sole purpose of ascertaining conformance with general design concepts expressed in the Contract Documents and in no way constitutes approval of the detail design inherent in CONTRACTOR's Submittal responsibility for which remains solely with CONTRACTOR submitting same. Review does not authorize changes to Contract Documents.

- [x] Reviewed
- [ ] Reviewed as Noted
- [ ] Revise and Resubmit
- [ ] Not Subject to Review
- [ ] Other

Name: **David Barbour**

Signed: D Barbour

Date: **May 6, 2021**

REVIEWED BY:

REVIEWED BY: David Barbour

US 800-277-8298
CAN 866-567-7112

Woven Geotextiles

1. Product Description

Standard woven slit-film polypropylene geotextiles, usually called "wovens" are an economical range of geotextiles that combine high strength with low cost. These materials are made by weaving pre-stressed polypropylene tapes in a simple weave pattern. The resulting fabric has a high strength to weight ratio. Slit-film wovens are primarily used in roadbuilding and embankment construction but can be used in most applications requiring the separation of one type of soil from another. Slit-film wovens help to speed construction with short term reinforcement of the base. Slit film wovens can also be used in sediment control products such as floating silt curtains and silt fence.

2. Technical Data

Materials information is on page 2.

3. Installation

General Installation: Place the roll of woven geotextile at the top of the slope/grade and roll down grade, over lap successive and adjacent rolls by 450mm minimum. Do not allow vehicles to drive directly on the geotextile. Geotextile should be stored such that it is protected from rain and direct sunlight. Geotexile Separation: Ensure subgrade is rolled flat and compacted to engineer's specifications with no sharp objects or protrusions. Install geotextile as per General Installation above.



4. Availability and Cost

Available from Layfield or distributors. Call
425-254-1075 Pacific time
780-453-6731 Mountain time, or
905-761-9123 Eastern time

5. Manufactured For

Layfield USA Corp.
Layfield Canada Ltd.

6. Warranty

Products sold will meet Layfield's published specifications at time of sale. Full warranty details are available from Layfield.

7. Maintenance

Once geotextiles and geogrids are installed and carefully backfilled they do not require ongoing maintenance.

8. Filing Systems

https://www.layfieldgroup.com/Geosynthetics/Geotext-Products/Woven-Geotextiles.aspx

9.

25 Oct. 2011	Woven Geotextiles - US Values[1]			
	ASTM	**LP 200**	**LP 250**	**LP 315**
Grab Tensile (lbs)	D4632	200	250	315
Elongation (%)	D4632	15	15	15
Trapezoid Tear (lbs)	D4533	75	90	120
CBR Puncture Strength (lbs)	D6241	700	900	1000
AOS (sieve size)	D4751	40	40	40
Permittivity (sec^{-1})	D4491	0.05	0.05	0.05
Weight (oz/yd^2) (Typical)	D5261	4.0	5.0	6.3
UV Resistance (500 hrs)	D4355	70	70	70
Roll Size (ft) Typical)		15 x 360 17.5 x 309	15 x 360 17.5 x 309	15 x 300 17.5 x 258
Roll Weight (lbs) (Typical)		205	215	220
Note[1] - The physical properties presented in the table above are Minimum Average Roll Values or otherwise indicated.				

10.

25 Oct 2011	Woven Geotextiles - Metric Values[1]			
	ASTM	**LP 200**	**LP 250**	**LP 315**
Grab Tensile (N)	D4632	889	1110	1400
Elongation (%)	D4632	15	15	15
Trapezoid Tear (N)	D4533	333	400	533
CBR Puncture Strength (N)	D6241	3120	4005	4450
AOS (Microns)	D4751	425	425	425
Permittivity (sec^{-1})	D4491	0.05	0.05	0.05
Weight (g/m^2) (Typical)	D5261	136	170	214
UV Resistance (500 hrs)	D4355	70	70	70
Roll Size (m) (Typical)		4.6 x 110 5.3 x 94	4.6 x 110 5.3 x 94	4.6 x 91 5.3 x 79
Roll Weight (kg) (Typical)		92	97.5	100
Note[1] - The physical properties provided in the table above are Minimum Average Roll Values or otherwise indicated.				

WE PROTECT
www.LayfieldConstructionProducts.com
customerservice@layfieldconstructionproducts.com

Appendix E

Geosynthetics QA/QC Information

Date: 2021-08-06

Mail To:
Roxy Hasior
GHD Services
138 East 7th Ave Suite 100
Vancouver , BC , V9T 1M6

Bill To:

GHD Services
11222680-7-1

e-mail:
roxanne.hasior@ghd.com david.barbour@ghd.com rosemarie.rocca@ghd.com

Dear Ms. Hasior,

Thank you for consulting with TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report for laboratory testing.

Project:	**Upland LF - Northwin LF Phase 1 East**
TRI Job Reference Number:	**66011**
Material(s) Tested:	(1) Heat Fusion Weld Seam(s)
Test(s) Requested:	SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)

Codes:	
AD	Adhesion Failure (100% Peel)
BRK	Break in sheeting away from Seam edge.
SE	Break in sheeting at edge of seam.
AD-BRK	Break in sheeting after some adhesion failure - partial peel.
SIP	Separation in the plane of the sheet (leaving the bond intact).
FTB	Film tearing bond (all non "AD" failures).
NON-FTB	100% peel.

If you have any questions or require any additional information, please call us at 1-800-880-8378.
Sincerely,

Jarrett A. Nelson

Jarret Nelson
Project Manager
Geosynthetic Services Division
http://www.geosyntheticstestinc.com

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

DESTRUCTIVE SEAM QUALITY ASSURANCE TEST RESULTS
TRI Client: GHD Services
Project: Upland LF - Northwin LF Phase 1 East

Material: 60 mil. HDPE
SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)
TRI Log#: 66011

	TEST REPLICATE NUMBER					
PARAMETER	1	2	3	4	5	MEAN
Sample ID: DT-1 | Weld: Heat Fusion						
Side: A						**Peel A**
Peel Strength (ppi)	143	138	149	146	148	**145**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Side: B						**Peel B**
Peel Strength (ppi)	135	146	145	139	155	**144**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Shear						**Shear**
Shear Strength (ppi)	194	197	188	189	189	**191**
Shear Elongation @ Break (%)	>50	>50	>50	>50	>50	

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

Date: 2021-08-09

Mail To:
Roxy Hasior
GHD Services
138 East 7th Ave Suite 100
Vancouver , BC , V9T 1M6

Bill To:

GHD Services
11222680-7-1

e-mail:
roxanne.hasior@ghd.com david.barbour@ghd.com rosemarie.rocca@ghd.com

Dear Ms. Hasior,

Thank you for consulting with TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report for laboratory testing.

Project:	**Upland LF - Northwin LF Phase 1 East**
TRI Job Reference Number:	**66061**
Material(s) Tested:	(1) Heat Fusion Weld Seam(s)
Test(s) Requested:	SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)

Codes:	
AD	Adhesion Failure (100% Peel)
BRK	Break in sheeting away from Seam edge.
SE	Break in sheeting at edge of seam.
AD-BRK	Break in sheeting after some adhesion failure - partial peel.
SIP	Separation in the plane of the sheet (leaving the bond intact).
FTB	Film tearing bond (all non "AD" failures).
NON-FTB	100% peel.

If you have any questions or require any additional information, please call us at 1-800-880-8378.
Sincerely,

Jarrett A. Nelson

Jarret Nelson
Project Manager
Geosynthetic Services Division
http://www.geosyntheticstestinc.com

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DESTRUCTIVE SEAM QUALITY ASSURANCE TEST RESULTS
TRI Client: GHD Services
Project: Upland LF - Northwin LF Phase 1 East

Material: 60 mil. HDPE
SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)
TRI Log#: 66061

	TEST REPLICATE NUMBER					
PARAMETER	1	2	3	4	5	MEAN
Sample ID: DT-2 | Weld: Heat Fusion						
Side: A						**Peel A**
Peel Strength (ppi)	145	159	136	142	151	**147**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Side: B						**Peel B**
Peel Strength (ppi)	138	140	136	142	146	**140**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Shear						**Shear**
Shear Strength (ppi)	194	194	197	202	199	**197**
Shear Elongation @ Break (%)	>50	>50	>50	>50	>50	

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

Date: 2021-08-11

Mail To:
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138 East 7th Ave Suite 100
Vancouver , BC , V9T 1M6

Bill To:

GHD Services
11222680-7-1

e-mail:
roxanne.hasior@ghd.com david.barbour@ghd.com rosemarie.rocca@ghd.com

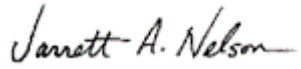
Dear Ms. Hasior,

Thank you for consulting with TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report for laboratory testing.

Project:	**Upland LF - Northwin LF Phase 1 East**
TRI Job Reference Number:	**66141**
Material(s) Tested:	(2) Heat Fusion Weld Seam(s)
Test(s) Requested:	SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)

Codes:	
AD	Adhesion Failure (100% Peel)
BRK	Break in sheeting away from Seam edge.
SE	Break in sheeting at edge of seam.
AD-BRK	Break in sheeting after some adhesion failure - partial peel.
SIP	Separation in the plane of the sheet (leaving the bond intact).
FTB	Film tearing bond (all non "AD" failures).
NON-FTB	100% peel.

If you have any questions or require any additional information, please call us at 1-800-880-8378.
Sincerely,



Jarret Nelson
Project Manager
Geosynthetic Services Division
http://www.geosyntheticstestinc.com

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DESTRUCTIVE SEAM QUALITY ASSURANCE TEST RESULTS
TRI Client: GHD Services
Project: Upland LF - Northwin LF Phase 1 East

Material: 60 mil. HDPE
SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)
TRI Log#: 66141

	TEST REPLICATE NUMBER					
PARAMETER	1	2	3	4	5	MEAN
Sample ID: DT-1 | Weld: Heat Fusion						
Side: A						**Peel A**
Peel Strength (ppi)	135	144	139	153	137	**142**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Side: B						**Peel B**
Peel Strength (ppi)	131	131	131	134	134	**132**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Shear						**Shear**
Shear Strength (ppi)	200	194	191	191	197	**195**
Shear Elongation @ Break (%)	>50	>50	>50	>50	>50	
Sample ID: DT-2 | Weld: Heat Fusion						
Side: A						**Peel A**
Peel Strength (ppi)	141	140	133	137	155	**141**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Side: B						**Peel B**
Peel Strength (ppi)	161	137	158	147	150	**151**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Shear						**Shear**
Shear Strength (ppi)	193	194	190	195	191	**193**
Shear Elongation @ Break (%)	>50	>50	>50	>50	>50	

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Date: 2021-08-12

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Dear Ms. Hasior,

Thank you for consulting with TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report for laboratory testing.

Project:	**Upland LF - Northwin LF Phase 1 East**
TRI Job Reference Number:	**66171**
Material(s) Tested:	(2) Heat Fusion Weld Seam(s)
Test(s) Requested:	SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)

Codes:	
AD	Adhesion Failure (100% Peel)
BRK	Break in sheeting away from Seam edge.
SE	Break in sheeting at edge of seam.
AD-BRK	Break in sheeting after some adhesion failure - partial peel.
SIP	Separation in the plane of the sheet (leaving the bond intact).
FTB	Film tearing bond (all non "AD" failures).
NON-FTB	100% peel.

If you have any questions or require any additional information, please call us at 1-800-880-8378.
Sincerely,

Jarrett A. Nelson

Jarret Nelson
Project Manager
Geosynthetic Services Division
http://www.geosyntheticstestinc.com

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DESTRUCTIVE SEAM QUALITY ASSURANCE TEST RESULTS
TRI Client: GHD Services
Project: Upland LF - Northwin LF Phase 1 East

Material: 60 mil. HDPE
SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)
TRI Log#: 66171

	TEST REPLICATE NUMBER					
PARAMETER	1	2	3	4	5	MEAN
Sample ID: DT-3 | Weld: Heat Fusion						
Side: A						**Peel A**
Peel Strength (ppi)	136	142	141	136	129	**137**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Side: B						**Peel B**
Peel Strength (ppi)	145	147	149	153	162	**151**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Shear						**Shear**
Shear Strength (ppi)	190	192	183	183	184	**186**
Shear Elongation @ Break (%)	>50	>50	>50	>50	>50	
Sample ID: DT-4 | Weld: Heat Fusion						
Side: A						**Peel A**
Peel Strength (ppi)	135	142	158	137	117	**138**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Side: B						**Peel B**
Peel Strength (ppi)	130	133	126	120	126	**127**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Shear						**Shear**
Shear Strength (ppi)	185	185	181	179	181	**182**
Shear Elongation @ Break (%)	>50	>50	>50	>50	>50	

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

Date: 2021-08-17

Mail To:
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Vancouver , BC , V9T 1M6

Bill To:

GHD Services
11222680-7-1

e-mail:
roxanne.hasior@ghd.com david.barbour@ghd.com rosemarie.rocca@ghd.com

Dear Ms. Hasior,

Thank you for consulting with TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report for laboratory testing.

Project:	**Upland LF - Northwin LF Phase 1 East**
TRI Job Reference Number:	**66271**
Material(s) Tested:	(2) Heat Fusion Weld Seam(s)
Test(s) Requested:	SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)

Codes:	
AD	Adhesion Failure (100% Peel)
BRK	Break in sheeting away from Seam edge.
SE	Break in sheeting at edge of seam.
AD-BRK	Break in sheeting after some adhesion failure - partial peel.
SIP	Separation in the plane of the sheet (leaving the bond intact).
FTB	Film tearing bond (all non "AD" failures).
NON-FTB	100% peel.

If you have any questions or require any additional information, please call us at 1-800-880-8378.
Sincerely,

Jarrett A. Nelson

Jarret Nelson
Project Manager
Geosynthetic Services Division
http://www.geosyntheticstestinc.com

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DESTRUCTIVE SEAM QUALITY ASSURANCE TEST RESULTS
TRI Client: GHD Services
Project: Upland LF - Northwin LF Phase 1 East

Material: 60 mil. HDPE
SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)
TRI Log#: 66271

	TEST REPLICATE NUMBER					
PARAMETER	1	2	3	4	5	MEAN
Sample ID: DT-5 | Weld: Heat Fusion						
Side: A						**Peel A**
Peel Strength (ppi)	151	158	131	133	132	**141**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Side: B						**Peel B**
Peel Strength (ppi)	152	146	140	143	142	**145**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Shear						**Shear**
Shear Strength (ppi)	196	199	186	194	190	**193**
Shear Elongation @ Break (%)	>50	>50	>50	>50	>50	
Sample ID: DT-6 | Weld: Heat Fusion						
Side: A						**Peel A**
Peel Strength (ppi)	140	148	127	127	114	**131**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Side: B						**Peel B**
Peel Strength (ppi)	148	135	144	149	153	**146**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Shear						**Shear**
Shear Strength (ppi)	194	186	191	189	187	**189**
Shear Elongation @ Break (%)	>50	>50	>50	>50	>50	

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Date: 2021-08-18

Mail To:
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Vancouver , BC , V9T 1M6

Bill To:

GHD Services
11222680-7-1

e-mail:
roxanne.hasior@ghd.com david.barbour@ghd.com rosemarie.rocca@ghd.com

Dear Ms. Hasior,

Thank you for consulting with TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report for laboratory testing.

Project:	**Upland LF - Northwin LF Phase 1 East**
TRI Job Reference Number:	**66309**
Material(s) Tested:	(1) Heat Fusion Weld Seam(s)
Test(s) Requested:	SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)

Codes:	
AD	Adhesion Failure (100% Peel)
BRK	Break in sheeting away from Seam edge.
SE	Break in sheeting at edge of seam.
AD-BRK	Break in sheeting after some adhesion failure - partial peel.
SIP	Separation in the plane of the sheet (leaving the bond intact).
FTB	Film tearing bond (all non "AD" failures).
NON-FTB	100% peel.

If you have any questions or require any additional information, please call us at 1-800-880-8378.
Sincerely,

Jarrett A. Nelson

Jarret Nelson
Project Manager
Geosynthetic Services Division
http://www.geosyntheticstestinc.com

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DESTRUCTIVE SEAM QUALITY ASSURANCE TEST RESULTS
TRI Client: GHD Services
Project: Upland LF - Northwin LF Phase 1 East

Material: 60 mil. HDPE
SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)
TRI Log#: 66309

	TEST REPLICATE NUMBER					
PARAMETER	1	2	3	4	5	MEAN
Sample ID: DT-7 | Weld: Heat Fusion						
Side: A						**Peel A**
Peel Strength (ppi)	140	140	147	162	140	**146**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Side: B						**Peel B**
Peel Strength (ppi)	128	122	120	126	155	**130**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Shear						**Shear**
Shear Strength (ppi)	191	184	185	184	183	**185**
Shear Elongation @ Break (%)	>50	>50	>50	>50	>50	

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

Date: 2021-08-23

Mail To:
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Bill To:

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11222680-7-1

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Dear Ms. Hasior,

Thank you for consulting with TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report for laboratory testing.

Project:	**Upland LF - Northwin LF Phase 1 East**
TRI Job Reference Number:	**66389**
Material(s) Tested:	(1) Heat Fusion Weld Seam(s)
Test(s) Requested:	SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)

Codes:	
AD	Adhesion Failure (100% Peel)
BRK	Break in sheeting away from Seam edge.
SE	Break in sheeting at edge of seam.
AD-BRK	Break in sheeting after some adhesion failure - partial peel.
SIP	Separation in the plane of the sheet (leaving the bond intact).
FTB	Film tearing bond (all non "AD" failures).
NON-FTB	100% peel.

If you have any questions or require any additional information, please call us at 1-800-880-8378.
Sincerely,

Jarrett A. Nelson

Jarret Nelson
Project Manager
Geosynthetic Services Division
http://www.geosyntheticstestinc.com

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DESTRUCTIVE SEAM QUALITY ASSURANCE TEST RESULTS
TRI Client: GHD Services
Project: Upland LF - Northwin LF Phase 1 East

Material: 60 mil. HDPE
SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)
TRI Log#: 66389

	TEST REPLICATE NUMBER					
PARAMETER	1	2	3	4	5	MEAN
Sample ID: DT-8 | Weld: Heat Fusion						
Side: A						**Peel A**
Peel Strength (ppi)	129	131	135	127	133	**131**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Side: B						**Peel B**
Peel Strength (ppi)	154	147	152	154	156	**153**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Shear						**Shear**
Shear Strength (ppi)	198	190	196	192	194	**194**
Shear Elongation @ Break (%)	>50	>50	>50	>50	>50	

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

Date: 2021-08-26

Mail To:
Roxy Hasior
GHD Services
138 East 7th Ave Suite 100
Vancouver , BC , V9T 1M6

Bill To:

GHD Services
11222680-7-1

e-mail:
roxanne.hasior@ghd.com david.barbour@ghd.com rosemarie.rocca@ghd.com deacon.liddy@ghd.com

Dear Ms. Hasior,

Thank you for consulting with TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report for laboratory testing.

Project:	**Upland LF - Northwin LF Phase 1 East**
TRI Job Reference Number:	**66469**
Material(s) Tested:	(1) Heat Fusion Weld Seam(s)
Test(s) Requested:	SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)

Codes:	
AD	Adhesion Failure (100% Peel)
BRK	Break in sheeting away from Seam edge.
SE	Break in sheeting at edge of seam.
AD-BRK	Break in sheeting after some adhesion failure - partial peel.
SIP	Separation in the plane of the sheet (leaving the bond intact).
FTB	Film tearing bond (all non "AD" failures).
NON-FTB	100% peel.

If you have any questions or require any additional information, please call us at 1-800-880-8378.
Sincerely,

Jarrett A. Nelson

Jarret Nelson
Project Manager
Geosynthetic Services Division
http://www.geosyntheticstestinc.com

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DESTRUCTIVE SEAM QUALITY ASSURANCE TEST RESULTS
TRI Client: GHD Services
Project: Upland LF - Northwin LF Phase 1 East

Material: 60 mil. HDPE
SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)
TRI Log#: 66469

	TEST REPLICATE NUMBER					
PARAMETER	1	2	3	4	5	MEAN
Sample ID: DT-12 | Weld: Heat Fusion						
Side: A						**Peel A**
Peel Strength (ppi)	142	138	148	137	119	**137**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Side: B						**Peel B**
Peel Strength (ppi)	154	153	153	154	150	**153**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Shear						**Shear**
Shear Strength (ppi)	176	169	167	167	166	**169**
Shear Elongation @ Break (%)	>50	>50	>50	>50	>50	

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Date: 2021-08-27

Mail To:
Roxy Hasior
GHD Services
138 East 7th Ave Suite 100
Vancouver , BC , V9T 1M6

Bill To:

GHD Services
11222680-7-1

e-mail:
roxanne.hasior@ghd.com david.barbour@ghd.com rosemarie.rocca@ghd.com deacon.liddy@ghd.com

Dear Ms. Hasior,

Thank you for consulting with TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report for laboratory testing.

Project:	**Upland LF - Northwin LF Phase 1 East**
TRI Job Reference Number:	**66509**
Material(s) Tested:	(1) Heat Fusion Weld Seam(s)
Test(s) Requested:	SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)

Codes:	
AD	Adhesion Failure (100% Peel)
BRK	Break in sheeting away from Seam edge.
SE	Break in sheeting at edge of seam.
AD-BRK	Break in sheeting after some adhesion failure - partial peel.
SIP	Separation in the plane of the sheet (leaving the bond intact).
FTB	Film tearing bond (all non "AD" failures).
NON-FTB	100% peel.

If you have any questions or require any additional information, please call us at 1-800-880-8378.
Sincerely,

Jarrett A. Nelson

Jarret Nelson
Project Manager
Geosynthetic Services Division
http://www.geosyntheticstestinc.com

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DESTRUCTIVE SEAM QUALITY ASSURANCE TEST RESULTS
TRI Client: GHD Services
Project: Upland LF - Northwin LF Phase 1 East

Material: 60 mil. HDPE
SAME DAY Peel and Shear (ASTM D 6392/GRI GM19/D 4437/NSF 54/882 mod.)
TRI Log#: 66509

	TEST REPLICATE NUMBER					
PARAMETER	1	2	3	4	5	MEAN
Sample ID: DT-13 | Weld: Heat Fusion						
Side: A						**Peel A**
Peel Strength (ppi)	159	133	154	158	158	**152**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Side: B						**Peel B**
Peel Strength (ppi)	126	145	122	143	150	**137**
Peel Incursion (%)	<5	<5	<5	<5	<5	
Peel Locus Of Failure Code	SE	SE	SE	SE	SE	
Peel NSF Failure Code	FTB	FTB	FTB	FTB	FTB	
Shear						**Shear**
Shear Strength (ppi)	193	186	186	187	193	**189**
Shear Elongation @ Break (%)	>50	>50	>50	>50	>50	

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

C.J. Cassidy
Consulting Inc.

NORTHWIN LANDFILL
CAMPBELL RIVER, B.C. – 2021
EFFLUENT POND AND LANDFILL CELL#1



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    b. Welder Qualifications
    c. Panel Placement Logs
    d. Non-Destructive Testing – Seamlogs
    e. Extrusion Weld Report
    f. Destructive Testing Report

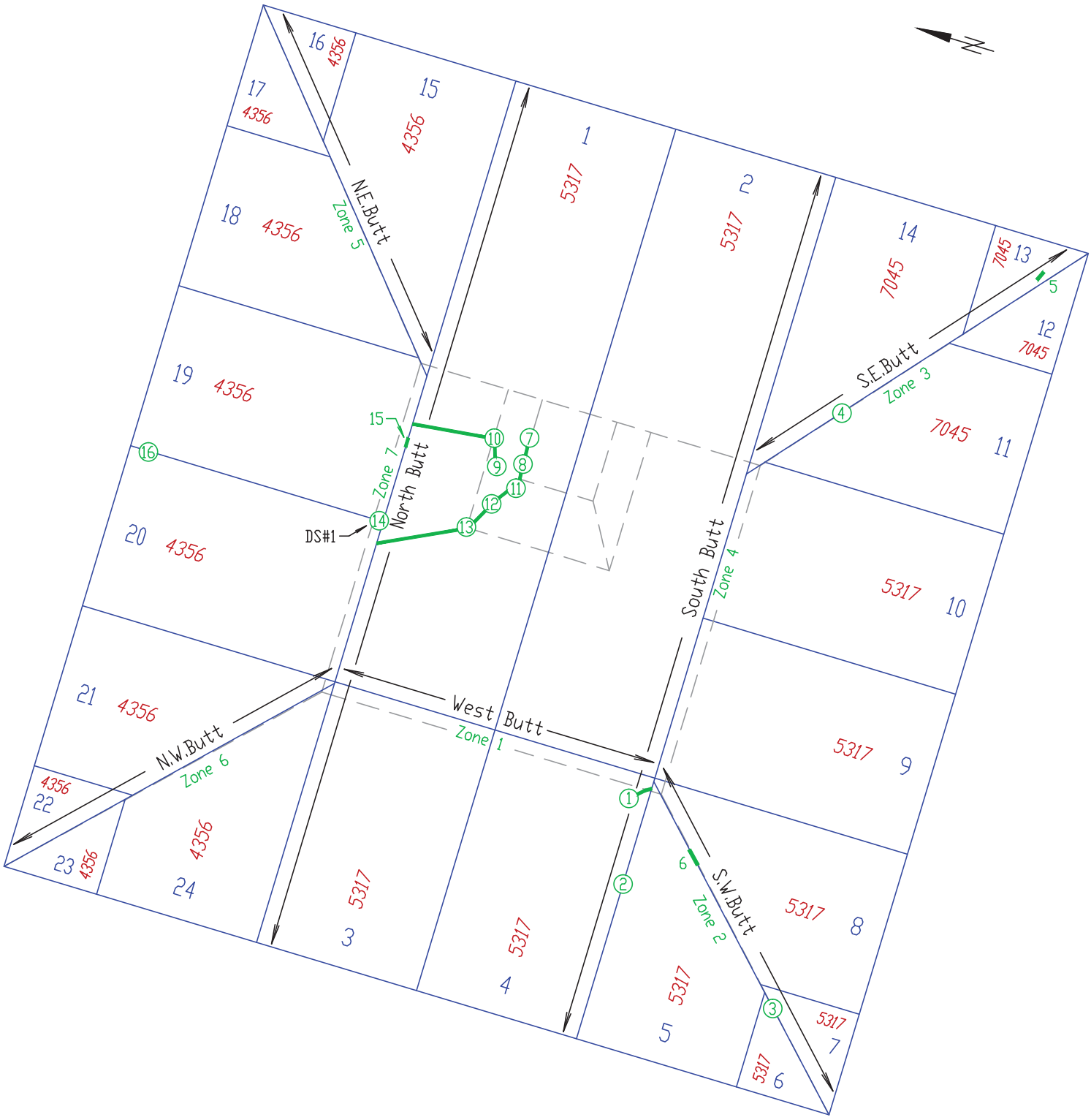
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    b. Welder Qualifications
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3. Landfill Cell #1 – Secondary Liner
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    c. Panel Placement Logs
    d. Non-Destructive Testing – Seamlogs
    e. Extrusion Weld Report
    f. Destructive Testing Report

4. Landfill Cell #1 – Primary Liner
    a. Secondary Liner Representative Drawing
    b. Welder Qualifications
    c. Panel Placement Logs
    d. Non-Destructive Testing – Seamlogs
    e. Extrusion Weld Report
    f. Destructive Testing Report

EFFLUENT STORAGE POND

SECONDARY LINER



DATE: August 30 2021	Cassidy Consulting Inc.	NORTHWIN LANDFILL CAMPBELL RIVER, B.C. - 2021
SCALE: NTS		EFFLUENT STORAGE POND
FILE NAME: EffluentStoragePond-Secondary		Secondary Liner Representative Drawing
DRAWN BY: SSC		
CHECKED BY: CJC		

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Tuesday, August 03, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - EFFLUENT POND - 2021**

MATERIAL 60mil HDPE DTEX - Secondary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
6:30	9	JC			860ºF		430	1	115	1	134	1	196	CC	
6:30	9	JC			860ºF		430	2	100	2	146	2	198	CC	
6:30	9	JC			860ºF		430	3	124	3	151	3	198	CC	
6:30	9	JC			860ºF		430	4	112	4	139	4	197	CC	
6:30	9	JC			860ºF		430	5	113	5	146	5	198	CC	

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Wednesday, August 04, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - EFFLUENT POND - 2021**

MATERIAL 60mil HDPE DTEX - Secondary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
6:33	9	JC			860ºF		430ºF	1	118	1	123	1	187	CC	
6:33	9	JC			860ºF		430ºF	2	114	2	118	2	184	CC	
6:33	9	JC			860ºF		430ºF	3	135	3	132	3	184	CC	
6:33	9	JC			860ºF		430ºF	4	135	4	122	4	185	CC	
6:33	9	JC			860ºF		430ºF	5	110	5	128	5	186	CC	
8:00	X2	JC	500ºC	500ºC				1	96	1		1	154	CC	
8:00	X2	JC	500ºC	500ºC				2	92	2		2	154	CC	
8:00	X2	JC	500ºC	500ºC				3	87	3		3	159	CC	
8:00	X2	JC	500ºC	500ºC				4	87	4		4	166	CC	
8:00	X2	JC	500ºC	500ºC				5	111	5		5	167	CC	
12:30	9	JC			860ºF		600ºF	1	123	1	129	1	154	CC	
12:30	9	JC			860ºF		600ºF	2	121	2	134	2	143	CC	
12:30	9	JC			860ºF		600ºF	3	111	3	139	3	158	CC	
12:30	9	JC			860ºF		600ºF	4	117	4	147	4	159	CC	
12:30	9	JC			860ºF		600ºF	5	127	5	142	5	158	CC	

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Thursday, August 05, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - EFFLUENT POND - 2021**

MATERIAL 60mil HDPE DTEX - Secondary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
7:42	9	JC			860ºF		430ºF	1	128	1	150	1	189	CC	
7:42	9	JC			860ºF		430ºF	2	150	2	138	2	188	CC	
7:42	9	JC			860ºF		430ºF	3	128	3	136	3	193	CC	
7:42	9	JC			860ºF		430ºF	4	148	4	142	4	186	CC	
7:42	9	JC			860ºF		430ºF	5	136	5	152	5	181	CC	
1:37	X2	MC	500ºC	500ºC				1	109	1		1	162	CC	
1:37	X2	MC	500ºC	500ºC				2	137	2		2	164	CC	
1:37	X2	MC	500ºC	500ºC				3	129	3		3	161	CC	
1:37	X2	MC	500ºC	500ºC				4	124	4		4	162	CC	
1:37	X2	MC	500ºC	500ºC				5	133	5		5	162	CC	
8:18	9	JC			860ºF		430ºF	1	113	1	131	1	174	CC	
8:18	9	JC			860ºF		430ºF	2	120	2	132	2	168	CC	
8:18	9	JC			860ºF		430ºF	3	127	3	144	3	170	CC	
8:18	9	JC			860ºF		430ºF	4	133	4	134	4	171	CC	
8:18	9	JC			860ºF		430ºF	5	128	5	133	5	158	CC	

PANEL PLACEMENT LOG

Cassidy
Consulting Inc.

DATE August 3 to August 5, 2021

PROJECT NORTHWIN ENVIRONMENTAL LANDFILL - EFFLUENT POND - 2021

MATERIAL 60mil HDPE DTEX - Secondary Liner

PANEL NUMBER	ROLL NUMBER	WORK AREA	PANEL LENGTH	PANEL WIDTH	PANEL AREA	COMMENTS:
1	5317	E.Slope & Floor	29.00	7.30	211.70	Layout - August 3
2	5317	E.Slope & Floor	29.00	7.30	211.70	Layout - August 3
3	5317	West Slope	15.00	7.30	109.50	Layout - August 3
4	5317	West Slope	15.00	7.30	109.50	Layout - August 3
5	5317	S.W.Corner	15.00	7.30	109.50	Layout - August 4
6	5317	S.W.Corner	3.00	3.00	9.00	Layout - August 4
7	5317	S.W.Corner	4.00	4.00	16.00	Layout - August 4
8	5317	S.W.Corner	12.00	7.30	87.60	Layout - August 4
9	5317	South Slope	12.00	7.30	87.60	Layout - August 4
10	5317	South Slope	13.00	7.30	94.90	Layout - August 4
11	7045	S.E.Corner	13.00	7.30	94.90	Layout - August 4
12	7045	S.E.Corner	3.00	4.00	12.00	Layout - August 4
13	7054	S.E.Corner	4.00	3.00	12.00	Layout - August 4
14	7045	S.E.Corner	15.00	7.30	109.50	Layout - August 4
15	4356	N.E.Corner	15.00	7.30	109.50	Layout - August 5
16	4356	N.E.Corner	5.60	3.00	16.80	Layout - August 5
17	4356	N.E.Corner	4.00	4.00	16.00	Layout - August 5
18	4356	N.E.Corner	14.00	7.30	102.20	Layout - August 5
19	4356	North Slope	14.00	7.30	102.20	Layout - August 5
20	4356	North Slope	14.00	7.30	102.20	Layout - August 5
21	4356	N.W.Corner	14.00	7.30	102.20	Layout - August 5
22	4356	N.W.Corner	6.00	4.00	24.00	Layout - August 5
23	4356	N.W.Corner	6.00	3.00	18.00	Layout - August 5
24	4356	N.W.Corner	15.00	7.30	109.50	Layout - August 5

1978.00 **sq m**

Cassidy
Consulting Inc.

NON-DESTRUCTIVE TESTING
SEAM LOG

DATE: August 3 to August 5, 2021

PROJECT: **NORTHWIN ENVIRONMENTAL LANDFILL - EFFLUENT POND - 2021**

MATERIAL: 60mil HDPE DTEX - Secondary Liner

					AIR PRESSURE TESTING				PEELS				
SEAM NUMBER	SEAM LENGTH	WELD TIME	TECH INITIAL	WELDER NUMBER	TIME START	TIME FINISH	PSI START	PSI FINISH	PEEL INSIDE	PEEL OUTSIDE	VAC-TEST Pass/FAIL	QC INITIAL	COMMENTS:
Welded August 3rd													
1/2	29.0	9:17	JC	9	1:53	1:58	32	31	Pass	Pass	N/A	CC	
3/4	15.0	10:15	JC	9	12:10	12:15	30	30	Pass	Pass	N/A	CC	
West Butt	14.5	11:10	JC	9	2:25	2:30	30	29	Pass	Pass	N/A	CC	Panels 1,2 to 3,4.
Welded August 4th													
5/6	3.0	10:30	JC	9	12:18	12:23	30	30	Pass	Pass	N/A	CC	
7/8	4.0	11:07	JC	9	12:21	12:26	40	39	Pass	Pass	N/A	CC	
8/9	12.0	11:15	JC	9	12:29	12:34	32	32	Pass	Pass	N/A	CC	
9/10	12.0	11:45	JC	9	12:43	12:48	43	41	Pass	Pass	N/A	CC	
10/11	13.0	12:00	JC	9	12:48	12:53	41	40	Pass	Pass	N/A	CC	
11/12	3.0	12:10	JC	9	1:15	1:21	39	38	Pass	Pass	N/A	CC	
13/14	4.0	12:25	JC	9	1:32	1:37	41	40	Pass	Pass	N/A	CC	
S.W.Butt	16.0	12:40	JC	9	1:25	1:30	30	30	Pass	Pass	N/A	CC	Panels 5 - 8.
S.E.Butt	16.0	12:09	JC	9	1:35	1:40	31	31	Pass	Pass	N/A	CC	Panels 11 - 14.
South Butt	44.5	1:15	JC	9	1:41	1:46	42	41	Pass	Pass	N/A	CC	Panels 2, 4 to 5, 9, 10, 14.
Welded August 5th													
15/16	5.6	8:07	JC	9	1:59	2:04	36	36	Pass	Pass	N/A	CC	
17/18	4.0	8:15	JC	9	9:36	9:40	30	30	Pass	Pass	N/A	CC	
18/19	14.0	8:25	JC	9	9:37	9:42	30	30	Pass	Pass	N/A	CC	
19/20	14.0	8:47	JC	9	1:51	1:56	38	38	Pass	Pass	N/A	CC	
20/21	14.0	9:03	JC	9	2:10	2:15	30	29	Pass	Pass	N/A	CC	
21/22	6.0	9:15	JC	9	2:18	2:23	31	31	Pass	Pass	N/A	CC	
23/24	6	9:22	JC	9	9:44	9:49	30	30	Pass	Pass	N/A	CC	
N.E.Butt	16	9:57	JC	9	2:30	2:35	30	30	Pass	Pass	N/A	CC	Panels 15 - 18.
N.W..Butt	16	10:44	JC	9	2:45	2:50	30	30	Pass	Pass	N/A	CC	Panels 21 - 24.
North Butt	44.5	11:32	JC	9	2:57	3:02	31	29	Pass	Pass	N/A	CC	Panels 1, 3 to 15, 19, 20, 24.

Cassidy
Consulting Inc.

EXTRUSION WELD REPORT

DATE August 4th and 5th, 2021

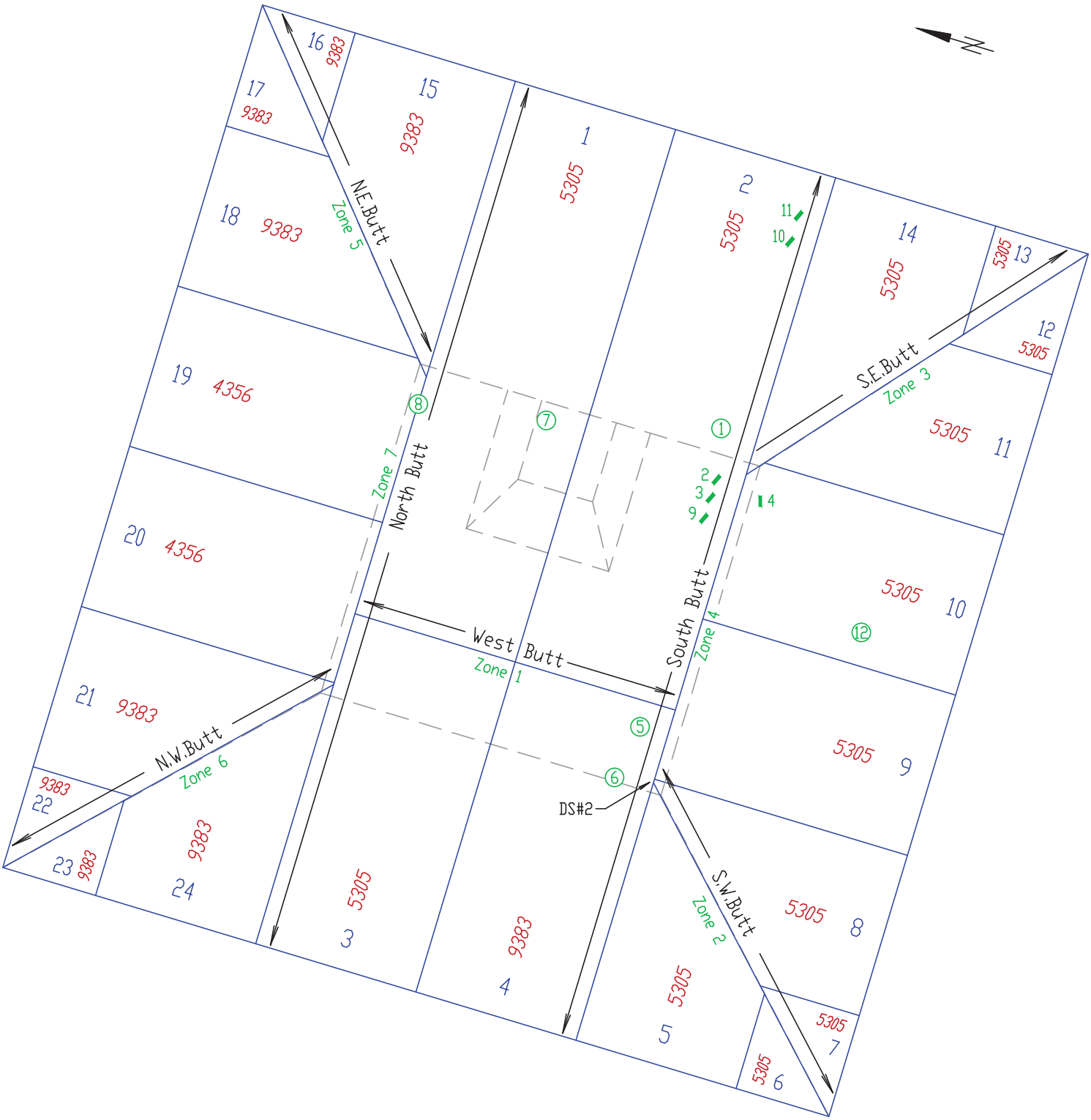
PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - EFFLUENT POND - 2021**

MATERIAL 60mil HDPE DTEX - Secondary Liner

EXTRUSION NUMBER	EXTRUSION TYPE	PANEL/SEAM NUMBER	TEST DATE	TECH INITIAL	MACHINE NUMBER	QC INITIAL	PASS/ FAIL	COMMENTS:
	Extruded August 4th							
1	Patch/Bead	4	Aug 4, 2021	JC	X2	CC	Pass	Near S.W.Toe.
2	Patch	South Butt	Aug 4, 2021	JC	X2	CC	Pass	On West Slope.
3	Patch	S.W.Butt	Aug 4, 2021	JC	X2	CC	Pass	Near top of Slope.
4	Patch	S.E.Butt	Aug 4, 2021	JC	X2	CC	Pass	On Corner Slope.
5	Bead	13	Aug 4, 2021	JC	X2	CC	Pass	Roll damage near top of slope.
6	Bead	S.W.Butt	Aug 4, 2021	JC	X2	CC	Pass	Near top of slope.
7	Patch/Bead	1	Aug 4, 2021	JC	X2	CC	Pass	Patch and Bead in Sump to remove Slack.
8	Patch/Bead	1	Aug 4, 2021	JC	X2	CC	Pass	Patch and Bead in Sump to remove Slack.
9	Patch/Bead	1	Aug 4, 2021	JC	X2	CC	Pass	Patch and Bead in Sump to remove Slack.
10	Patch/Bead	1	Aug 4, 2021	JC	X2	CC	Pass	Bead in Sump to remove Slack.
11	Patch/Bead	1	Aug 4, 2021	JC	X2	CC	Pass	Patch and Bead in Sump to remove Slack.
12	Patch/Bead	1	Aug 4, 2021	JC	X2	CC	Pass	Patch and Bead in Sump to remove Slack.
13	Patch/Bead	1	Aug 4, 2021	JC	X2	CC	Pass	Patch and Bead in Sump to remove Slack.
Zone 1	Beads	West Butt	Aug 4, 2021	JC	X2	CC	Pass	All "T" Intersections along West Butt Seam.
Zone 2	Beads	S.W.Butt	Aug 4, 2021	JC	X2	CC	Pass	All "T" Intersections along South West Butt Seam.
Zone 3	Beads	S.E.Butt	Aug 4, 2021	JC	X2	CC	Pass	All "T" Intersections along South East Butt Seam.
Zone 4	Beads	South Butt	Aug 4, 2021	JC	X2	CC	Pass	All "T" Intersections along South Butt Seam.
	Extruded August 5th							
14	Patch	North Butt	Aug 5, 2021	MC	X2	CC	Pass	Patch over Destruct #1.
15	Bead	North Butt	Aug 5, 2021	MC	X2	CC	Pass	At panel 19.
16	Patch	19/20	Aug 5, 2021	MC	X2	CC	Pass	At top of slope.
Zone 5	Beads	N.E.Butt	Aug 5, 2021	MC	X2	CC	Pass	All "T" Intersections along North East Butt Seam.
Zone 6	Beads	N.W.Butt	Aug 5, 2021	MC	X2	CC	Pass	All "T" Intersections along North West Butt Seam.
Zone 7	Beads	North Butt	Aug 5, 2021	MC	X2	CC	Pass	All "T" Intersections along North Butt Seam.

EFFLUENT STORAGE POND

PRIMARY LINER



DATE: August 30 2021	Cassidy Consulting Inc.	NORTHWIN LANDFILL CAMPBELL RIVER, B.C. - 2021
SCALE: NTS		EFFLUENT STORAGE POND
FILE NAME: EffluentStoragePond-Primary		Primary Liner Representative Drawing
DRAWN BY: SSC		
CHECKED BY: CJC		

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Thursday, August 05, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - EFFLUENT POND - 2021**

MATERIAL 60mil HDPE DTEX - Primary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
7:42	9	JC			860ºF		430ºF	1	128	1	150	1	189	CC	
7:42	9	JC			860ºF		430ºF	2	150	2	138	2	188	CC	
7:42	9	JC			860ºF		430ºF	3	128	3	136	3	193	CC	
7:42	9	JC			860ºF		430ºF	4	148	4	142	4	186	CC	
7:42	9	JC			860ºF		430ºF	5	136	5	152	5	181	CC	
1:37	X2	MC	500ºC	500ºC				1	109	1		1	162	CC	
1:37	X2	MC	500ºC	500ºC				2	137	2		2	164	CC	
1:37	X2	MC	500ºC	500ºC				3	129	3		3	161	CC	
1:37	X2	MC	500ºC	500ºC				4	124	4		4	162	CC	
1:37	X2	MC	500ºC	500ºC				5	133	5		5	162	CC	
8:18	9	JC			860ºF		430ºF	1	113	1	131	1	174	CC	
8:18	9	JC			860ºF		430ºF	2	120	2	132	2	168	CC	
8:18	9	JC			860ºF		430ºF	3	127	3	144	3	170	CC	
8:18	9	JC			860ºF		430ºF	4	133	4	134	4	171	CC	
8:18	9	JC			860ºF		430ºF	5	128	5	133	5	158	CC	

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Friday, August 06, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - EFFLUENT POND - 2021**

MATERIAL 60mil HDPE DTEX - Primary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
6:30	9	JC			860ºF		430	1	122	1	148	1	206	CC	
6:30	9	JC			860ºF		430	2	137	2	120	2	200	CC	
6:30	9	JC			860ºF		430	3	142	3	111	3	203	CC	
6:30	9	JC			860ºF		430	4	135	4	138	4	203	CC	
6:30	9	JC			860ºF		430	5	128	5	154	5	199	CC	
8:45	X2	MC	500ºC	500ºC				1	92	1		1	178	CC	
8:45	X2	MC	500ºC	500ºC				2	99	2		2	184	CC	
8:45	X2	MC	500ºC	500ºC				3	91	3		3	177	CC	
8:45	X2	MC	500ºC	500ºC				4	101	4		4	178	CC	
8:45	X2	MC	500ºC	500ºC				5	112	5		5	190	CC	

PANEL PLACEMENT LOG

Cassidy
Consulting Inc.

DATE August 5 to August 6, 2021

PROJECT NORTHWIN ENVIRONMENTAL LANDFILL - EFFLUENT POND - 2021

MATERIAL 60mil HDPE DTEX - **Primary Liner**

PANEL NUMBER	ROLL NUMBER	WORK AREA	PANEL LENGTH	PANEL WIDTH	PANEL AREA	COMMENTS:
1	5305	E.Slope & Floor	24.00	7.30	175.20	Layout - August 5
2	5305	E.Slope & Floor	24.00	7.30	175.20	Layout - August 5
3	5305	E.Slope & Floor	20.00	7.30	146.00	Layout - August 5
4	9383	E.Slope & Floor	20.00	7.30	146.00	Layout - August 5
5	5305	S.W.Corner	15.00	7.30	109.50	Layout - August 6
6	5305	S.W.Corner	5.00	3.00	15.00	Layout - August 6
7	5305	S.W.Corner	7.00	4.00	28.00	Layout - August 6
8	5305	S.W.Corner	12.00	7.30	87.60	Layout - August 6
9	5305	South Slope	12.00	7.30	87.60	Layout - August 6
10	5305	South Slope	12.00	7.30	87.60	Layout - August 6
11	5305	S.E.Corner	12.00	7.30	87.60	Layout - August 6
12	5305	S.E.Corner	4.00	4.00	16.00	Layout - August 6
13	5305	S.E.Corner	4.00	3.00	12.00	Layout - August 6
14	5305	S.E.Corner	15.00	7.30	109.50	Layout - August 6
15	9383	N.E.Corner	15.00	7.30	109.50	Layout - August 6
16	9383	N.E.Corner	4.00	4.00	16.00	Layout - August 6
17	9383	N.E.Corner	4.00	4.00	16.00	Layout - August 6
18	9383	N.E.Corner	15.00	7.30	109.50	Layout - August 6
19	4356	North Slope	15.00	7.30	109.50	Layout - August 6
20	4356	North Slope	15.00	7.30	109.50	Layout - August 6
21	9383	N.W.Corner	15.00	7.30	109.50	Layout - August 6
22	9383	N.W.Corner	4.00	4.00	16.00	Layout - August 6
23	9383	N.W.Corner	4.00	4.00	16.00	Layout - August 6
24	9383	N.W.Corner	12.00	7.30	87.60	Layout - August 6

1981.90 **sq m**

Cassidy
Consulting Inc.

NON-DESTRUCTIVE TESTING SEAM LOG

DATE: August 5 to August 6, 2021

PROJECT: **NORTHWIN ENVIRONMENTAL LANDFILL - EFFLUENT POND - 2021**

MATERIAL: 60mil HDPE DTEX - Primary Liner

					AIR PRESSURE TESTING				PEELS				
SEAM NUMBER	SEAM LENGTH	WELD TIME	TECH INITIAL	WELDER NUMBER	TIME START	TIME FINISH	PSI START	PSI FINISH	PEEL INSIDE	PEEL OUTSIDE	VAC-TEST Pass/FAIL	QC INITIAL	COMMENTS:
Welded August 5th													
1/2	24.0	8:55	JC	9	2:13	2:18	40	40	Pass	Pass	N/A	CC	
3/4	20.0	9:35	JC	9	2:46	2:51	30	30	Pass	Pass	N/A	CC	
West Butt	14.5	10:22	JC	9	2:19	2:26	30	29	Pass	Pass	N/A	CC	Panels 1,2 to 3,4.
Welded August 6th													
5/6	5.0	9:47	JC	9	10:09	10:14	30	30	Pass	Pass	N/A	CC	
7/8	7.0	9:02	JC	9	11:21	11:17	40	40	Pass	Pass	N/A	CC	
8/9	12.0	9:14	JC	9	11:41	11:46	40	39	Pass	Pass	N/A	CC	
9/10	12.0	9:33	JC	9	12:31	12:37	31	31	Pass	Pass	N/A	CC	
10/11	12.0	11:21	JC	9	6:50	6:55	40	40	Pass	Pass	N/A	CC	
11/12	4.0	11:30	JC	9	1:28	1:37	40	40	Pass	Pass	N/A	CC	
13/14	4.0	11:39	JC	9	1:41	1:46	30	30	Pass	Pass	N/A	CC	
S.E.Butt	17.0	11:49	JC	9	1:31	1:36	40	40	Pass	Pass	N/A	CC	Panels 11 - 14.
S.W.Butt	17.0	10:28	JC	9	10:00	10:15	30	29	Pass	Pass	N/A	CC	Panels 5 - 8.
South Butt	44.0	1:36	JC	9	2:05	2:10	38	37	Pass	Pass	N/A	CC	Panels 2, 4 to 5, 9, 10, 14.
16/15	4.0	11:58	JC	9	6:35	6:40	40	40	Pass	Pass	N/A	CC	
17/18	4.0	12:36	JC	9	6:30	6:35	40	40	Pass	Pass	N/A	CC	
18/19	15.0	1:05	JC	9	6:30	6:35	40	40	Pass	Pass	N/A	CC	
19/20	15.0	12:29	JC	9	13:05	13:10	35	35	Pass	Pass	N/A	CC	
20/21	15.0	11:05	JC	9	11:15	11:20	30	29	Pass	Pass	N/A	CC	
21/22	4.0	10:50	JC	9	2:39	2:44	31	31	Pass	Pass	N/A	CC	
24/23	4.0	10:36	JC	9	2:24	2:29	31	30	Pass	Pass	N/A	CC	
N.E.Butt	16.5	12:45	JC	9	6:35	6:40	40	40	Pass	Pass	N/A	CC	Panels 15 - 18.
N.W..Butt	17.0	10:47	JC	9	2:31	2:36	40	38	Pass	Pass	N/A	CC	Panels 21 - 24.
North Butt	44.0	1:55	JC	9	2:47	2:52	30	30	Pass	Pass	N/A	CC	Panels 1, 3 to 15, 19, 20, 24.

Cassidy
Consulting Inc.

EXTRUSION WELD REPORT

DATE Friday, August 06, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - EFFLUENT POND - 2021**

MATERIAL 60mil HDPE DTEX - Primary Liner

EXTRUSION NUMBER	EXTRUSION TYPE	PANEL/SEAM NUMBER	TEST DATE	TECH INITIAL	MACHINE NUMBER	QC INITIAL	PASS/ FAIL	COMMENTS:
1	Patch	2	Aug 6, 2021	MC	X2	CC	Pass	Near bottom of slope.
2	Bead	2	Aug 6, 2021	MC	X2	CC	Pass	On floor.
3	Bead	2	Aug 6, 2021	MC	X2	CC	Pass	On floor.
4	Bead	10	Aug 6, 2021	MC	X2	CC	Pass	At Toe.
5	Patch	4	Aug 6, 2021	MC	X2	CC	Pass	On floor.
6	Patch	4	Aug 6, 2021	MC	X2	CC	Pass	At Toe.
7	Patch	1	Aug 6, 2021	MC	X2	CC	Pass	In The Sump.
8	Patch	North Butt	Aug 6, 2021	MC	X2	CC	Pass	At panel 19.
9	Bead	2	Aug 6, 2021	MC	X2	CC	Pass	On floor.
10	Bead	2	Aug 6, 2021	MC	X2	CC	Pass	Upper slope.
11	Bead	2	Aug 6, 2021	MC	X2	CC	Pass	Upper slope.
12	Patch	10	Aug 6, 2021	MC	X2	CC	Pass	On Slope.
Zone 1	Beads	West Butt	Aug 6, 2021	MC	X2	CC	Pass	All "T" Intersections along West Butt Seam.
Zone 2	Beads	S.W.Butt	Aug 6, 2021	MC	X2	CC	Pass	All "T" Intersections along South West Butt Seam.
Zone 3	Beads	S.E.Butt	Aug 6, 2021	MC	X2	CC	Pass	All "T" Intersections along South East Butt Seam.
Zone 4	Beads	South Butt	Aug 6, 2021	MC	X2	CC	Pass	All "T" Intersections along South Butt Seam.
Zone 5	Beads	N.E. Butt	Aug 6, 2021	MC	X2	CC	Pass	All "T" Intersections along North East Butt Seam.
Zone 6	Beads	N.W.Butt	Aug 6, 2021	MC	X2	CC	Pass	All "T" Intersections along North West Butt Seam.
Zone 7	Beads	North Butt	Aug 6, 2021	MC	X2	CC	Pass	All "T" Intersections along North West Butt Seam.

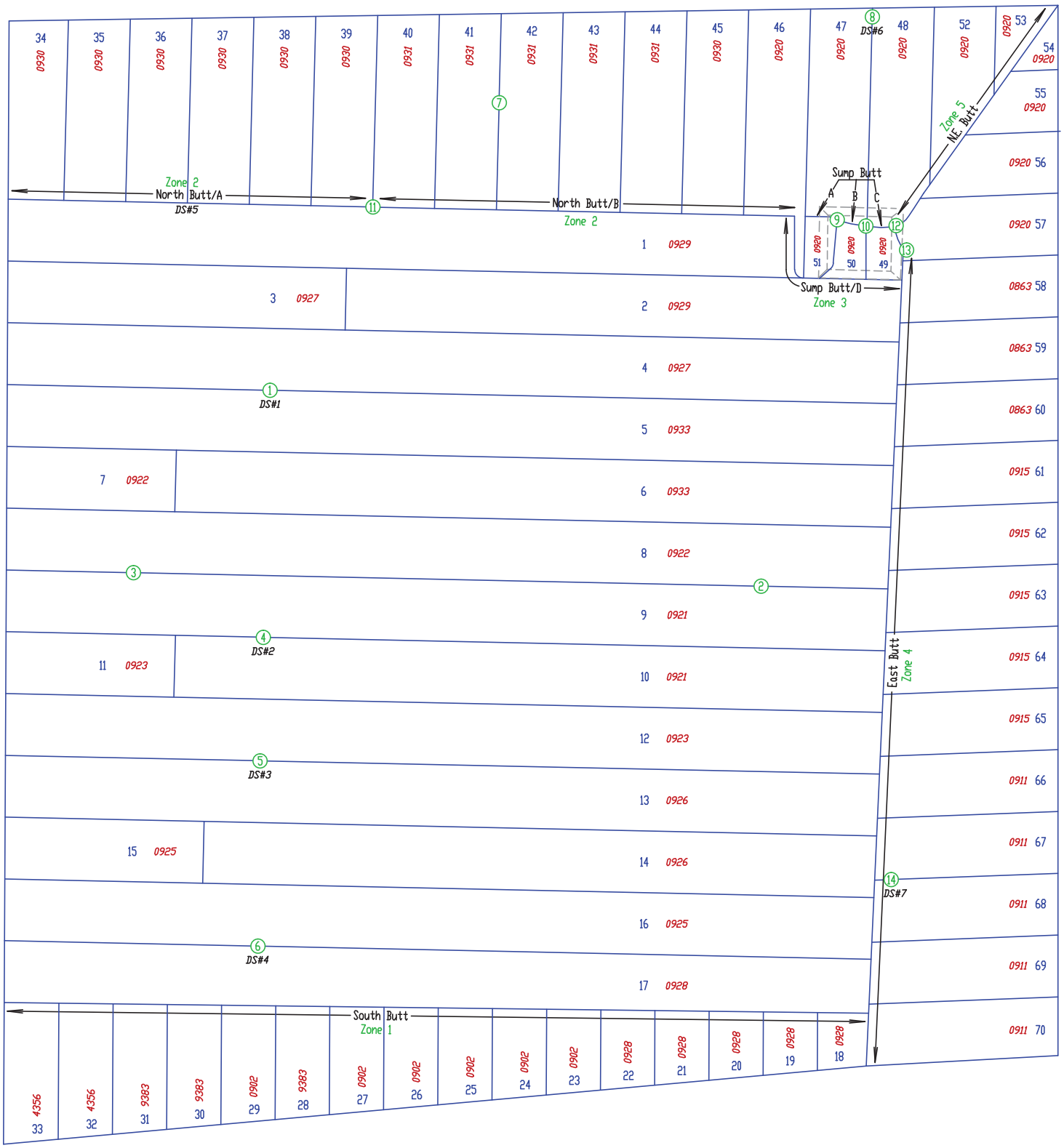
Cassidy
Consulting Inc.

DESTRUCTIVE TESTING REPORT

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - EFFLUENT POND - 2021** MATERIAL 60mil HDPE DTEX - Secondary & Primary Liners

WELD DATE	D.S. #	SEAM #	TECH INITIAL	WELDER NUMBER	PEEL 1		SHEAR	PEEL 2		SHEAR	PEEL 3		SHEAR	PEEL 4		SHEAR	PEEL 5		SHEAR	QC INITIAL	COMMENTS / LOCATION
					IN	OUT		IN	OUT		IN	OUT		IN	OUT		IN	OUT			
Aug 5/21	1	19/20	JC	9	129	135	186	136	114	183	132	115	187	121	124	180	121	111	185	CC	Seam 19/20 at Toe - Secondary.
Aug 6/21	2	8/9	JC	9	124	124	208	142	118	210	135	119	208	121	119	208	150	133	201	CC	Seam 8/9 at Toe - Primary.

NORTHWIN LANDFILL CELL 1
SECONDARY LINER



DATE: September 7, 2021	Cassidy Consulting Inc.	NORTHWIN LANDFILL - CELL 1 - 2021
SCALE: NTS		CAMPBELL RIVER, B.C.
FILE NAME: CampbellRiverCell-Secondary		60mil Dtex Secondary Liner Representative Drawing
DRAWN BY: SSC		
CHECKED BY: CJC		

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Monday, August 09, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL 60mil HDPE DTEX - Secondary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
8:54	9	RC			860ºF		600	1	137	1	140	1	175	CC	
8:54	9	RC			860ºF		600	2	131	2	134	2	182	CC	
8:54	9	RC			860ºF		600	3	104	3	140	3	172	CC	
8:54	9	RC			860ºF		600	4	127	4	141	4	165	CC	
8:54	9	RC			860ºF		600	5	130	5	143	5	170	CC	
11:28	9	RC			860ºF		430	1	124	1	125	1	173	CC	
11:28	9	RC			860ºF		430	2	128	2	133	2	168	CC	
11:28	9	RC			860ºF		430	3	130	3	135	3	168	CC	
11:28	9	RC			860ºF		430	4	130	4	129	4	173	CC	
11:28	9	RC			860ºF		430	5	131	5	137	5	169	CC	
12:19	X2	JC	520ºF	530ºF				1	96	1		1	158	CC	
12:19	X2	JC	520ºF	530ºF				2	99	2		2	158	CC	
12:19	X2	JC	520ºF	530ºF				3	92	3		3	152	CC	
12:19	X2	JC	520ºF	530ºF				4	103	4		4	154	CC	
12:19	X2	JC	520ºF	530ºF				5	108	5		5	154	CC	

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Tuesday, August 10, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL 60mil HDPE DTEX - Secondary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
7:13	9	RC			860ºF		600ºF	1	141	1	137	1	188	CC	
7:13	9	RC			860ºF		600ºF	2	148	2	147	2	186	CC	
7:13	9	RC			860ºF		600ºF	3	143	3	147	3	188	CC	
7:13	9	RC			860ºF		600ºF	4	142	4	143	4	188	CC	
7:13	9	RC			860ºF		600ºF	5	144	5	141	5	185	CC	
9:28	X2	JC	520ºF	530ºF				1	115	1		1	146	CC	
9:28	X2	JC	520ºF	530ºF				2	107	2		2	141	CC	
9:28	X2	JC	520ºF	530ºF				3	109	3		3	146	CC	
9:28	X2	JC	520ºF	530ºF				4	106	4		4	164	CC	
9:28	X2	JC	520ºF	530ºF				5	105	5		5	156	CC	
11:22	9	RC			860ºF		600ºF	1	134	1	129	1	178	CC	
11:22	9	RC			860ºF		600ºF	2	136	2	133	2	178	CC	
11:22	9	RC			860ºF		600ºF	3	141	3	146	3	181	CC	
11:22	9	RC			860ºF		600ºF	4	143	4	156	4	184	CC	
11:22	9	RC			860ºF		600ºF	5	149	5	159	5	177	CC	
12:21	9	RC			860ºF		750ºF	1	123	1	119	1	154	CC	
12:21	9	RC			860ºF		750ºF	2	135	2	121	2	155	CC	
12:21	9	RC			860ºF		750ºF	3	127	3	122	3	155	CC	
12:21	9	RC			860ºF		750ºF	4	140	4	134	4	160	CC	
12:21	9	RC			860ºF		750ºF	5	141	5	137	5	161	CC	

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Wednesday, August 11, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL 60mil HDPE DTEX - Secondary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
6:13	9	RC			860ºF		600ºF	1	143	1	144	1	186	CC	
6:13	9	RC			860ºF		600ºF	2	120	2	141	2	183	CC	
6:13	9	RC			860ºF		600ºF	3	140	3	144	3	183	CC	
6:13	9	RC			860ºF		600ºF	4	135	4	151	4	180	CC	
6:13	9	RC			860ºF		600ºF	5	135	5	137	5	183	CC	
8:48	X2	JC	520ºF	530ºF				1	91	1		1	153	CC	
8:48	X2	JC	520ºF	530ºF				2	92	2		2	156	CC	
8:48	X2	JC	520ºF	530ºF				3	97	3		3	150	CC	
8:48	X2	JC	520ºF	530ºF				4	98	4		4	153	CC	
8:48	X2	JC	520ºF	530ºF				5	94	5		5	150	CC	

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Saturday, August 14, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL 60mil HDPE DTEX - Secondary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
6:23	9	RC			860ºF		600ºF	1	137	1	1125	1	172	CC	
6:23	9	RC			860ºF		600ºF	2	129	2	123	2	168	CC	
6:23	9	RC			860ºF		600ºF	3	99	3	126	3	168	CC	
6:23	9	RC			860ºF		600ºF	4	94	4	126	4	167	CC	
6:23	9	RC			860ºF		600ºF	5	142	5	125	5	170	CC	
8:40	17	RC			860ºF		620ºF	1	142	1	138	1	173	CC	
8:40	17	RC			860ºF		620ºF	2	129	2	137	2	174	CC	
8:40	17	RC			860ºF		620ºF	3	123	3	125	3	169	CC	
8:40	17	RC			860ºF		620ºF	4	131	4	138	4	166	CC	
8:40	17	RC			860ºF		620ºF	5	136	5	131	5	164	CC	
11:19	X2	MC	520ºF	530ºF				1	109	1		1	147	CC	
11:19	X2	MC	520ºF	530ºF				2	106	2		2	146	CC	
11:19	X2	MC	520ºF	530ºF				3	112	3		3	145	CC	
11:19	X2	MC	520ºF	530ºF				4	113	4		4	146	CC	
11:19	X2	MC	520ºF	530ºF				5	121	5		5	148	CC	

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Monday, August 16, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL 60mil HDPE DTEX - Secondary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
7:31	9	RC			860ºF		600ºF	1	123	1	145	1	193	CC	
7:31	9	RC			860ºF		600ºF	2	116	2	141	2	194	CC	
7:31	9	RC			860ºF		600ºF	3	130	3	138	3	193	CC	
7:31	9	RC			860ºF		600ºF	4	122	4	130	4	190	CC	
7:31	9	RC			860ºF		600ºF	5	120	5	139	5	194	CC	
11:01	17	JC			860ºF		620ºF	1	116	1	122	1	166	CC	
11:01	17	JC			860ºF		620ºF	2	118	2	115	2	163	CC	
11:01	17	JC			860ºF		620ºF	3	117	3	121	3	169	CC	
11:01	17	JC			860ºF		620ºF	4	120	4	125	4	164	CC	
11:01	17	JC			860ºF		620ºF	5	139	5	121	5	165	CC	
11:06	X2	MC	520ºF	530ºF				1	124	1		1	182	CC	
11:06	X2	MC	520ºF	530ºF				2	128	2		2	181	CC	
11:06	X2	MC	520ºF	530ºF				3	112	3		3	179	CC	
11:06	X2	MC	520ºF	530ºF				4	109	4		4	176	CC	
11:06	X2	MC	520ºF	530ºF				5	130	5		5	178	CC	

PANEL PLACEMENT LOG

Cassidy
Consulting Inc.

DATE Monday, August 09, 2021

PROJECT NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021

MATERIAL 60mil HDPE DTEX - Secondary Liner

PANEL NUMBER	ROLL NUMBER	WORK AREA	PANEL LENGTH	PANEL WIDTH	PANEL AREA	COMMENTS:
1	0929	Floor	90.00	7.30	657.00	
2	0929	Floor	60.00	7.30	438.00	
3	0927	Floor	40.00	7.30	292.00	
4	0927	Floor	100.00	7.30	730.00	
5	0933	Floor	100.00	7.30	730.00	
6	0933	Floor	80.00	7.30	584.00	
7	0922	Floor	20.00	7.30	146.00	
8	0922	Floor	102.00	7.30	744.60	

4321.60 **sq m**

PANEL PLACEMENT LOG

Cassidy
Consulting Inc.

DATE Tuesday, August 10, 2021

PROJECT NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021

MATERIAL 60mil HDPE DTEX - Secondary Liner

PANEL NUMBER	ROLL NUMBER	WORK AREA	PANEL LENGTH	PANEL WIDTH	PANEL AREA	COMMENTS:
9	0921	Floor	100.00	7.30	730.00	
10	0921	Floor	80.00	7.30	584.00	
11	0923	Floor	20.00	7.30	146.00	
12	0923	Floor	99.00	7.30	722.70	
13	0926	Floor	97.00	7.30	708.10	
14	0926	Floor	80.00	7.30	584.00	
15	0925	Floor	20.00	7.30	146.00	
16	0925	Floor	94.00	7.30	686.20	
17	0928	Floor	92.00	7.30	671.60	

4978.60 **sq m**

PANEL PLACEMENT LOG

Cassidy
Consulting Inc.

DATE Wednesday, August 11, 2021

PROJECT NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021

MATERIAL 60mil HDPE DTEX - Secondary Liner

PANEL NUMBER	ROLL NUMBER	WORK AREA	PANEL LENGTH	PANEL WIDTH	PANEL AREA	COMMENTS:
18	0928	South Slope	5.00	7.30	36.50	
19	0928	South Slope	5.00	7.30	36.50	
20	0928	South Slope	6.00	7.30	43.80	
21	0928	South Slope	7.00	7.30	51.10	
22	0928	South Slope	7.00	7.30	51.10	
23	0902	South Slope	8.00	7.30	58.40	
24	0902	South Slope	9.00	7.30	65.70	
25	0902	South Slope	11.00	7.30	80.30	
26	0902	South Slope	12.00	7.30	87.60	
27	0902	South Slope	13.00	7.30	94.90	
28	9383	South Slope	13.00	7.30	94.90	
29	0902	South Slope	14.00	7.30	102.20	
30	9383	South Slope	16.00	7.30	116.80	
31	9383	South Slope	17.00	7.30	124.10	
32	4356	South Slope	18.00	7.30	131.40	
33	4356	South Slope	18.00	7.30	131.40	

1306.70 **sq m**

PANEL PLACEMENT LOG

Cassidy
Consulting Inc.

DATE Saturday, August 14, 2021

PROJECT NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021

MATERIAL 60mil HDPE DTEX - Secondary Liner

PANEL NUMBER	ROLL NUMBER	WORK AREA	PANEL LENGTH	PANEL WIDTH	PANEL AREA	COMMENTS:
34	0930	North Slope	17.00	7.30	124.10	
35	0930	North Slope	19.00	7.30	138.70	
36	0930	North Slope	20.00	7.30	146.00	
37	0930	North Slope	20.00	7.30	146.00	
38	0930	North Slope	21.00	7.30	153.30	
39	0930	North Slope	21.00	7.30	153.30	
40	0931	North Slope	23.00	7.30	167.90	
41	0931	North Slope	23.00	7.30	167.90	
42	0931	North Slope	23.00	7.30	167.90	
43	0931	North Slope	23.00	7.30	167.90	
44	0931	North Slope	24.00	7.30	175.20	
45	0930	North Slope	25.00	7.30	182.50	
46	0920	North Slope	34.00	7.30	248.20	
47	0920	North Slope	28.00	7.30	204.40	
48	0920	North Slope	26.00	7.30	189.80	
49	0920	North Slope	8.00	3.60	28.80	
50	0920	North Slope	8.00	3.60	28.80	
51	0920	North Slope	6.00	3.60	21.60	

2612.30 **sq m**

PANEL PLACEMENT LOG

Cassidy
Consulting Inc.

DATE Monday, August 16, 2021

PROJECT NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021

MATERIAL 60mil HDPE DTEX - Secondary Liner

PANEL NUMBER	ROLL NUMBER	WORK AREA	PANEL LENGTH	PANEL WIDTH	PANEL AREA	COMMENTS:
52	0920	NE Corner	18.00	7.30	131.40	
53	0920	NE Corner	12.00	7.30	87.60	
54	0920	NE Corner	4.00	7.30	29.20	
55	0920	NE Corner	8.00	7.30	58.40	
56	0920	East Slope	12.00	7.30	87.60	
57	0920	East Slope	18.00	7.30	131.40	
58	0863	East Slope	22.00	7.30	160.60	
59	0863	East Slope	23.00	7.30	167.90	
60	0863	East Slope	23.00	7.30	167.90	
61	0915	East Slope	23.00	7.30	167.90	
62	0915	East Slope	23.00	7.30	167.90	
63	0915	East Slope	24.00	7.30	175.20	
64	0915	East Slope	24.00	7.30	175.20	
65	0915	East Slope	24.00	7.30	175.20	
66	0911	East Slope	24.00	7.30	175.20	
67	0911	East Slope	24.00	7.30	175.20	
68	0911	East Slope	24.00	7.30	175.20	
69	0911	East Slope	24.00	7.30	175.20	
70	0911	East Slope	25.00	7.30	182.50	

2766.70 **sq m**

Cassidy
Consulting Inc.

NON-DESTRUCTIVE TESTING
SEAM LOG

DATE: Monday, August 09, 2021

PROJECT: **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL: 60mil HDPE DTEX - Secondary Liner

					AIR PRESSURE TESTING				PEELS				
SEAM NUMBER	SEAM LENGTH	WELD TIME	TECH INITIAL	WELDER NUMBER	TIME START	TIME FINISH	PSI START	PSI FINISH	PEEL INSIDE	PEEL OUTSIDE	VAC-TEST Pass/FAIL	QC INITIAL	COMMENTS:
2/3	7.3	9:03	RC	9	12:36	12:41	35	35	Pass	Pass	N/A	CC	Cross Seam
1/2/3	90.0	9:10	RC	9	10:09	10:14	30	30	Pass	Pass	N/A	CC	
2/3/4	100.0	10:30	RC	9	11:17	11:23	35	35	Pass	Pass	N/A	CC	
4/5	100.0	11:26	RC	9	1:18	1:23	30	29	Pass	Pass	N/A	CC	
6/7	7.3	12:32	RC	9	2:01	2:06	30	30	Pass	Pass	N/A	CC	Cross Seam
5/6/7	100.0	12:43	RC	9	1:33	1:38	40	39	Pass	Pass	N/A	CC	
6/7/8	100.0	1:37	RC	9	2:45	2:50	30	30	Pass	Pass	N/A	CC	

Cassidy
Consulting Inc.

NON-DESTRUCTIVE TESTING
SEAM LOG

DATE: Tuesday, August 10, 2021

PROJECT: **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL: 60mil HDPE DTEX - Secondary Liner

					AIR PRESSURE TESTING				PEELS				
SEAM NUMBER	SEAM LENGTH	WELD TIME	TECH INITIAL	WELDER NUMBER	TIME START	TIME FINISH	PSI START	PSI FINISH	PEEL INSIDE	PEEL OUTSIDE	VAC-TEST Pass/FAIL	QC INITIAL	COMMENTS:
8/9/A	15.0	7:36	RC	9	10:24	10:29	30	30	Pass	Pass	N/A	CC	
8/9/B	75.0	7;36	RC	9	10:25	10:30	30	30	Pass	Pass	N/A	CC	
8/9/C	15.0	7:36	RC	9	10:36	10:41	30	30	Pass	Pass	N/A	CC	
10/11	7.3	8:31	RC	9	10:27	10:32	30	29	Pass	Pass	N/A	CC	Cross Seam
9/10/11	100.0	9:23	RC	9	11:00	11:05	30	30	Pass	Pass	N/A	CC	
10/11/12	99.0	9:40	RC	9	11:12	11:17	30	28	Pass	Pass	N/A	CC	
12/13	97.0	10:22	RC	9	12:15	12:20	32	31	Pass	Pass	N/A	CC	
14/15	7.3	11:47	RC	9	12:23	12:28	40	39	Pass	Pass	N/A	CC	Cross Seam
13/14/15	97.0	11:55	RC	9	12:30	12:35	32	30	Pass	Pass	N/A	CC	
14/15/16	94.0	12:37	RC	9	1:58	2:03	30	29	Pass	Pass	N/A	CC	
16/17	92.0	2:28	RC	9	3:00	3:05	30	30	Pass	Pass	N/A	CC	

Cassidy
Consulting Inc.

NON-DESTRUCTIVE TESTING
SEAM LOG

DATE: Wednesday, August 11, 2021

PROJECT: **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL: 60mil HDPE DTEX - Secondary Liner

					AIR PRESSURE TESTING				PEELS				
SEAM NUMBER	SEAM LENGTH	WELD TIME	TECH INITIAL	WELDER NUMBER	TIME START	TIME FINISH	PSI START	PSI FINISH	PEEL INSIDE	PEEL OUTSIDE	VAC-TEST Pass/FAIL	QC INITIAL	COMMENTS:
18/19	5.0	8:06	RC	9	9:14	9:19	38	38	Pass	Pass	N/A	CC	
19/20	5.0	8:12	RC	9	9:18	9:23	30	30	Pass	Pass	N/A	CC	
20/21	5.0	8:17	RC	9	9:20	9:25	30	30	Pass	Pass	N/A	CC	
21/22	7.0	8:31	RC	9	9:26	9:31	40	40	Pass	Pass	N/A	CC	
22/23	7.0	8:37	RC	9	9:27	9:32	30	29	Pass	Pass	N/A	CC	
23/24	8.0	9:15	RC	9	10:50	10:55	32	31	Pass	Pass	N/A	CC	
24/25	9.0	9:22	RC	9	11:30	11:35	40	39	Pass	Pass	N/A	CC	
25/26	11.0	9:30	RC	9	11:35	11:40	32	30	Pass	Pass	N/A	CC	
26/27	12.0	9:38	RC	9	11:40	11:45	30	29	Pass	Pass	N/A	CC	
27/28	13.0	9:52	RC	9	11:45	11:50	30	30	Pass	Pass	N/A	CC	
28/29	13.0	9:57	RC	9	11:50	11:55	30	30	Pass	Pass	N/A	CC	
29/30	14.0	10:05	RC	9	11:55	12:00	30	30	Pass	Pass	N/A	CC	
30/31	16.0	10:15	RC	9	12:00	12:05	30	30	Pass	Pass	N/A	CC	
31/32	17.0	10:24	RC	9	12:04	12:09	30	30	Pass	Pass	N/A	CC	
32/33	18.0	10:32	RC	9	12:09	12:13	30	29	Pass	Pass	N/A	CC	
S.Butt	92.0	11:02	RC	9	12:15	12:20	36	35	Pass	Pass	N/A	CC	Panels 18 - 33.

Cassidy
Consulting Inc.

NON-DESTRUCTIVE TESTING
SEAM LOG

DATE: Saturday, August 14, 2021

PROJECT: **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL: 60mil HDPE DTEX - Secondary Liner

					AIR PRESSURE TESTING				PEELS				
SEAM NUMBER	SEAM LENGTH	WELD TIME	TECH INITIAL	WELDER NUMBER	TIME START	TIME FINISH	PSI START	PSI FINISH	PEEL INSIDE	PEEL OUTSIDE	VAC-TEST Pass/FAIL	QC INITIAL	COMMENTS:
34/35	17.0	6:49	RC	9	11:36	11:41	30	30	Pass	Pass	N/A	CC	
35/36	19.0	7:00	RC	9	12:34	12:39	40	40	Pass	Pass	N/A	CC	
36/37	20.0	7:11	RC	9	11:45	11:50	30	30	Pass	Pass	N/A	CC	
37/38	20.0	7:23	RC	9	11:37	11:42	30	30	Pass	Pass	N/A	CC	
38/39	21.0	7:36	RC	9	11:29	11:34	30	30	Pass	Pass	N/A	CC	
39/40	21.0	7:48	RC	9	11:20	11:25	30	30	Pass	Pass	N/A	CC	
40/41	23.0	8:03	RC	9	11:14	11:19	30	29	Pass	Pass	N/A	CC	
41/42A	13.0	8:15	RC	9	11:55	12:00	32	30	Pass	Pass	N/A	CC	
41/42B	10.0	8:22	RC	9	11:54	12:00	30	30	Pass	Pass	N/A	CC	
42/43	23.0	8:58	RC	9	12:55	1:00	30	30	Pass	Pass	N/A	CC	
43/44	23.0	9:10	RC	9	1:01	1:06	30	30	Pass	Pass	N/A	CC	
44/45	24.0	9:21	RC	9	10:12	10:17	30	30	Pass	Pass	N/A	CC	
45/46	25.0	10:07	RC	9	10:20	10:25	31	30	Pass	Pass	N/A	CC	
46/47	28.0	9;37	RC	9	10:45	10:50	30	30	Pass	Pass	N/A	CC	
47/48	26.0	10:21	RC	9	10:53	10:58	31	31	Pass	Pass	N/A	CC	
49/50	8.0	10:03	RC	9	11:00	11:05	30	29	Pass	Pass	N/A	CC	
50/51	8.0	10:33	RC	9	11:06	11:11	30	30	Pass	Pass	N/A	CC	
N.Butt/A	43.0	11:35	RC	9	12:20	12:25	31	28	Pass	Pass	N/A	CC	Panels 34 - 39.
N.Butt/B	50.0	11:35	RC	9	12:33	12:38	30	29	Pass	Pass	N/A	CC	Panels 40 - 46.
Sump/A	3.5	12:10	RC	9	1:13	1:18	30	30	Pass	Pass	N/A	CC	North side of Sump, Panels 47/51.
Sump/B	3.5	12:10	RC	9	1:20	1:25	30	30	Pass	Pass	N/A	CC	North side of Sump, Panels 47/50.
Sump/C	3.5	12:10	RC	9	1:29	1:34	30	30	Pass	Pass	N/A	CC	North side of Sump, Panels 48/49.
Sump/D	20.0	12:35	RC	9	1:45	1:50	30	28	Pass	Pass	N/A	CC	South side of Sump, Panels 49 - 51.

Cassidy
Consulting Inc.

NON-DESTRUCTIVE TESTING
SEAM LOG

DATE: Monday, August 16, 2021

PROJECT: **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL: 60mil HDPE DTEX - Secondary Liner

					AIR PRESSURE TESTING				PEELS				
SEAM NUMBER	SEAM LENGTH	WELD TIME	TECH INITIAL	WELDER NUMBER	TIME START	TIME FINISH	PSI START	PSI FINISH	PEEL INSIDE	PEEL OUTSIDE	VAC-TEST Pass/FAIL	QC INITIAL	COMMENTS:
48/52	18.0	8:17	RC	9	9:58	10:03	30	30	Pass	Pass	N/A	CC	
52/53	12.0	8:31	RC	9	9:50	9:55	32	32	Pass	Pass	N/A	CC	
54/55	4.0	9:27	RC	9	10:22	10:27	30	30	Pass	Pass	N/A	CC	
55/56	8.0	9:00	RC	9	10:35	10:40	30	30	Pass	Pass	N/A	CC	
56/57	12.0	9:12	RC	9	10:50	10:55	30	30	Pass	Pass	N/A	CC	
57/58	18.0	9:47	RC	9	11:11	11:16	33	33	Pass	Pass	N/A	CC	
58/59	22.0	10:03	RC	9	11:20	11:25	30	30	Pass	Pass	N/A	CC	
59/60	23.0	10:15	RC	9	11:29	11:34	30	30	Pass	Pass	N/A	CC	
60/61	23.0	10:45	RC	9	11:43	11:48	30	30	Pass	Pass	N/A	CC	
61/62	23.0	10:59	RC	9	11:55	12:00	30	30	Pass	Pass	N/A	CC	
62/63	23.0	11:43	RC	9	12:20	12:25	30	30	Pass	Pass	N/A	CC	
63/64	24.0	11:26	RC	9	12:33	12:38	31	30	Pass	Pass	N/A	CC	
64/65	24.0	11:34	RC	9	12:41	12:46	30	30	Pass	Pass	N/A	CC	
65/66	24.0	12:50	RC	9	1:47	1:51	30	30	Pass	Pass	N/A	CC	
66/67	24.0	1:02	RC	9	1:57	2:02	30	30	Pass	Pass	N/A	CC	
67/68	24.0	1:19	RC	9	2:06	2:11	30	30	Pass	Pass	N/A	CC	
68/69	24.0	1:41	RC	9	2:22	2:27	32	31	Pass	Pass	N/A	CC	
69/70	24.0	2:03	RC	9	2:26	2:31	40	38	Pass	Pass	N/A	CC	
East Butt	93.0	3:22	RC	9	7:06	7:11	34	33	Pass	Pass	N/A	CC	Panels 70 - 57.
N.E.Butt	35.0	12:11	JC	17	2:45	2:50	30	29	Pass	Pass	N/A	CC	Panels 57 - 52.

Cassidy
Consulting Inc.

EXTRUSION WELD REPORT

DATE August 9 to 16, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021** MATERIAL 60mil HDPE DTEX - Secondary Liner

EXTRUSION NUMBER	EXTRUSION TYPE	PANEL/SEAM NUMBER	TEST DATE	TECH INITIAL	MACHINE NUMBER	QC INITIAL	PASS/ FAIL	COMMENTS:
	Extruded August 9th							
1	Patch	4/5	Aug 9, 2021	JC	X2	RC	Pass	Destruct #1.
	Extruded August 10th							
2	Patch	8/9	Aug 10, 2021	JC	X2	RC	Pass	GCL caught in welder.
3	Patch	8/9	Aug 10, 2021	JC	X2	RC	Pass	GCL caught in welder.
4	Patch	9/10	Aug 10, 2021	JC	X2	RC	Pass	Destruct #2.
5	Patch	12/13	Aug 10, 2021	JC	X2	RC	Pass	Destruct #3.
6	Patch	16/17	Aug 10, 2021	JC	X2	RC	Pass	Destruct #4.
	Extruded August 11th							
Zone 1	Beads	S.Butt	Aug 11, 2021	JC	X2	MC	Pass	All "T" Intersections along South Butt.
	Extruded August 14th							
7	Patch	41/42	Aug 14, 2021	MC	X2	CC	Pass	Welder stalled midway up slope.
8	Patch	47/48	Aug 14, 2021	MC	X2	CC	Pass	Destruct #6.
9	Patch	50/51	Aug 14, 2021	MC	X2	CC	Pass	In Sump.
10	Patch	49/50	Aug 14, 2021	MC	X2	CC	Pass	In Sump.
11	Patch	N.Butt	Aug 14, 2021	MC	X2	CC	Pass	At Seam 39/40.
Zone 2	Beads	N.Butt	Aug 14, 2021	MC	X2	CC	Pass	All "T" Intersections along South Butt/A and B.
Zone 3	Beads	Sump Butt	Aug 14, 2021	MC	X2	CC	Pass	All "T" Intersections along Sump Butt/D.
	Extruded August 16th							
12	Patch	49/57	Aug 16, 2021	MC	X2	CC	Pass	At Sump.
13	Patch	E.Butt	Aug 16, 2021	MC	X2	CC	Pass	End of East Butt at Panel 57.
14	Patch	67/68	Aug 16, 2021	MC	X2	CC	Pass	Destruct #7.
Zone 4	Beads	E.Butt	Aug 16, 2021	MC	X2	CC	Pass	All "T" Intersections along East Butt.
Zone 5	Beads	N.E.Butt	Aug 16, 2021	MC	X2	CC	Pass	All "T" Intersections along North East Butt.

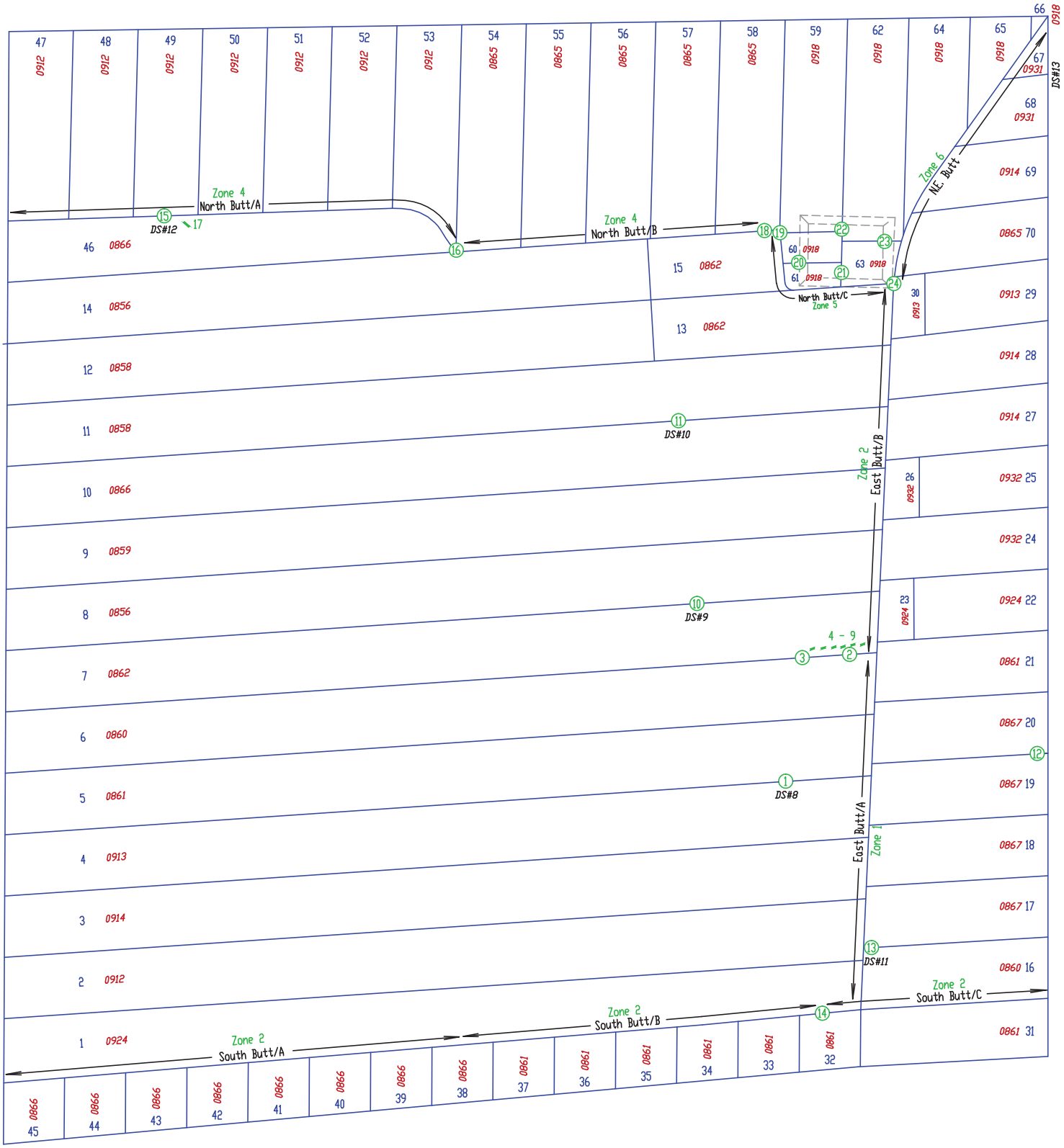
Cassidy
Consulting Inc.

DESTRUCTIVE TESTING REPORT

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021** MATERIAL 60mil HDPE DTEX - Secondary Liner

WELD DATE	D.S. #	SEAM #	TECH INITIAL	WELDER NUMBER	PEEL 1		SHEAR	PEEL 2		SHEAR	PEEL 3		SHEAR	PEEL 4		SHEAR	PEEL 5		SHEAR	QC INITIAL	COMMENTS / LOCATION
					IN	OUT		IN	OUT		IN	OUT		IN	OUT		IN	OUT			
8-09-21	1	4/5	RC	9	121	128	193	117	138	194	128	113	194	108	143	192	133	143	190	CC	On Floor.
8-10-21	2	9/10	RC	9	130	150	190	121	142	189	124	148	193	119	145	191	122	141	190	CC	On Floor.
8-10-21	3	12/13	RC	9	105	121	151	113	118	155	106	116	158	118	121	156	138	129	159	CC	On Floor.
8-10-21	4	16/17	RC	9	112	123	151	110	120	151	114	109	152	115	117	150	112	107	158	CC	On Floor.
8-14-21	5	36/37	RC	9	105	116	181	113	126	182	115	127	184	137	131	179	119	120	180	CC	Run out on floor.
8-14-21	6	47/48	RC	9	134	244	187	130	125	192	136	132	191	127	133	192	129	136	189	CC	Crest of slope.
8-16-21	7	67/68	RC	9	130	120	180	118	116	179	134	129	178	128	132	177	149	128	177	CC	Toe of slope.

NORTHWIN LANDFILL CELL 1
PRIMARY LINER



DATE: September 13, 2021	Cassidy Consulting Inc.	NORTHWIN LANDFILL - CELL 1 - 2021
SCALE: NTS		CAMPBELL RIVER, B.C.
FILE NAME: CampbellRiverCell-Primary		60mil Dtex Primary Liner Representative Drawing
DRAWN BY: SSC		
CHECKED BY: CJC		

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Wednesday, August 18, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL 60mil HDPE DTEX - Primary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
8:31	9	RC			860ºF		600	1	140	1	128	1	190	CC	
8:31	9	RC			860ºF		600	2	131	2	124	2	193	CC	
8:31	9	RC			860ºF		600	3	132	3	143	3	191	CC	
8:31	9	RC			860ºF		600	4	131	4	140	4	191	CC	
8:31	9	RC			860ºF		600	5	136	5	137	5	188	CC	
11:01	9	RC			860ºF		620	1	125	1	145	1	182	CC	
11:01	9	RC			860ºF		620	2	130	2	134	2	183	CC	
11:01	9	RC			860ºF		620	3	133	3	142	3	177	CC	
11:01	9	RC			860ºF		620	4	137	4	139	4	182	CC	
11:01	9	RC			860ºF		620	5	132		139	5	179	CC	
1:30	X2	MC	520ºF	530ºF				1	125	1		1	176	CC	
1:30	X2	MC	520ºF	530ºF				2	128	2		2	178	CC	
1:30	X2	MC	520ºF	530ºF				3	136	3		3	171	CC	
1:30	X2	MC	520ºF	530ºF				4	137	4		4	176	CC	
1:30	X2	MC	520ºF	530ºF				5	133	5		5	174	CC	

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Thursday, August 19, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL 60mil HDPE DTEX - Primary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
7:22	9	RC			860ºF		600	1	135	1	147	1	195	CC	
7:22	9	RC			860ºF		600	2	138	2	132	2	193	CC	
7:22	9	RC			860ºF		600	3	145	3	137	3	194	CC	
7:22	9	RC			860ºF		600	4	127	4	120	4	191	CC	
7:22	9	RC			860ºF		600	5	115	5	131	5	193	CC	

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Friday, August 20, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL 60mil HDPE DTEX - Primary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
6:44	9	RC			860ºF		600	1	113	1	112	1	176	CC	
6:44	9	RC			860ºF		600	2	109	2	116	2	177	CC	
6:44	9	RC			860ºF		600	3	114	3	113	3	174	CC	
6:44	9	RC			860ºF		600	4	116	4	119	4	174	CC	
6:44	9	RC			860ºF		600	5	127		123	5	176	CC	
9:35	X2	MC	520ºF	530ºF				1	139	1		1	170	CC	
9:35	X2	MC	520ºF	530ºF				2	126	2		2	172	CC	
9:35	X2	MC	520ºF	530ºF				3	133	3		3	169	CC	
9:35	X2	MC	520ºF	530ºF				4	130	4		4	164	CC	
9:35	X2	MC	520ºF	530ºF				5	135	5		5	167	CC	

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Saturday, August 21, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL 60mil HDPE DTEX - Primary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
6:24	9	RC			860ºF		600	1	132	1	126	1	200	CC	
6:24	9	RC			860ºF		600	2	134	2	132	2	199	CC	
6:24	9	RC			860ºF		600	3	137	3	129	3	199	CC	
6:24	9	RC			860ºF		600	4	136	4	134	4	197	CC	
6:24	9	RC			860ºF		600	5	135		138	5	195	CC	
2:15	X2	JC	520ºF	530ºF				1	131	1		1	178	CC	
2:15	X2	JC	520ºF	530ºF				2	141	2		2	174	CC	
2:15	X2	JC	520ºF	530ºF				3	143	3		3	171	CC	
2:15	X2	JC	520ºF	530ºF				4	132	4		4	174	CC	
2:15	X2	JC	520ºF	530ºF				5	117			5	178	CC	

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Monday, August 23, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL 60mil HDPE DTEX - Primary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
12:00	9	RC			860ºF		600	1	115	1	134	1	168	CC	
12:00	9	RC			860ºF		600	2	116	2	129	2	169	CC	
12:00	9	RC			860ºF		600	3	139	3	133	3	164	CC	
12:00	9	RC			860ºF		600	4	122	4	129	4	173	CC	
12:00	9	RC			860ºF		600	5	119		128	5	172	CC	
2:00	X2	JC	520ºF	530ºF				1	121	1		1	171	CC	
2:00	X2	JC	520ºF	530ºF				2	132	2		2	173	CC	
2:00	X2	JC	520ºF	530ºF				3	135	3		3	169	CC	
2:00	X2	JC	520ºF	530ºF				4	112	4		4	169	CC	
2:00	X2	JC	520ºF	530ºF				5	113			5	166	CC	

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Tuesday, August 24, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL 60mil HDPE DTEX - Primary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
12:00	9	RC			860ºF		600	1	134	1	133	1	168	CC	
12:00	9	RC			860ºF		600	2	123	2	146	2	167	CC	
12:00	9	RC			860ºF		600	3	124	3	145	3	169	CC	
12:00	9	RC			860ºF		600	4	111	4	145	4	168	CC	
12:00	9	RC			860ºF		600	5	124		136	5	170	CC	
2:00	X2	JC	520ºF	530ºF				1	111	1		1	155	CC	
2:00	X2	JC	520ºF	530ºF				2	109	2		2	156	CC	
2:00	X2	JC	520ºF	530ºF				3	108	3		3	164	CC	
2:00	X2	JC	520ºF	530ºF				4	121	4		4	164	CC	
2:00	X2	JC	520ºF	530ºF				5	107			5	159	CC	

Cassidy
Consulting Inc.

WELDER QUALIFICATIONS

DATE Wednesday, August 25, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL 60mil HDPE DTEX - Primary Liner

			EXTRUDER		FUSION WELDER			TENSIONMETER VALUES LBs/INCH								
QUALIFY TIME	WELDER NUMBER	TECH INITIALS	BARREL TEMP ºC/ºF	PREHEAT TEMP ºC/ºF	SET TEMP ºC/ºF	MEASURED SPEED	SPEED SETTINGS		PEEL INSIDE		PEEL OUTSIDE		SHEAR VALUE	QC INITIAL	WEATHER / COMMENTS:
7:08	9	RC			860ºF		600	1	135	1	112	1	169	CC	
7:08	9	RC			860ºF		600	2	114	2	117	2	172	CC	
7:08	9	RC			860ºF		600	3	133	3	107	3	168	CC	
7:08	9	RC			860ºF		600	4	142	4	106	4	169	CC	
7:08	9	RC			860ºF		600	5	133		115	5	160	CC	
11:00	9	RC			860ºF		680	1	107	1	112	1	167	CC	
11:00	9	RC			860ºF		680	2	113	2	112	2	165	CC	
11:00	9	RC			860ºF		680	3	109	3	112	3	166	CC	
11:00	9	RC			860ºF		680	4	110	4	111	4	170	CC	
11:00	9	RC			860ºF		680	5	118	5	113	5	178	CC	
11:54	X2	JC	520ºF	530ºF				1	111	1		1	155	CC	
11:54	X2	JC	520ºF	530ºF				2	109	2		2	156	CC	
11:54	X2	JC	520ºF	530ºF				3	109	3		3	160	CC	
11:54	X2	JC	520ºF	530ºF				4	105	4		4	161	CC	
11:54	X2	JC	520ºF	530ºF				5	106			5	160	CC	

PANEL PLACEMENT LOG

Cassidy
Consulting Inc.

DATE Wednesday, August 18, 2021

PROJECT NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021

MATERIAL 60mil HDPE DTEX - Primary Liner

PANEL NUMBER	ROLL NUMBER	WORK AREA	PANEL LENGTH	PANEL WIDTH	PANEL AREA	COMMENTS:
1	0924	Floor	84.00	7.30	613.20	South side laying North - West to East.
2	0912	Floor	84.00	7.30	613.20	
3	0914	Floor	87.00	7.30	635.10	
4	0913	Floor	90.00	7.30	657.00	
5	0861	Floor	90.00	7.30	657.00	
6	0860	Floor	90.00	7.30	657.00	
7	0862	Floor	90.00	7.30	657.00	
8	0856	Floor	90.00	7.30	657.00	

5146.50 **sq m**

PANEL PLACEMENT LOG

Cassidy
Consulting Inc.

DATE Thursday, August 19, 2021

PROJECT NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021

MATERIAL 60mil HDPE DTEX - Primary Liner

PANEL NUMBER	ROLL NUMBER	WORK AREA	PANEL LENGTH	PANEL WIDTH	PANEL AREA	COMMENTS:
9	0859	Floor	90.00	7.30	657.00	
10	0866	Floor	90.00	7.30	657.00	
11	0858	Floor	87.00	7.30	635.10	
12	0858	Floor	60.00	7.30	438.00	
13	0862	Floor	30.00	7.30	219.00	
14	0856	Floor	60.00	7.30	438.00	
15	0862	Floor	20.00	7.30	146.00	

3190.10 **sq m**

PANEL PLACEMENT LOG

Cassidy

Consulting Inc.

DATE Friday, August 20, 2021

PROJECT NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021

MATERIAL 60mil HDPE DTEX - **Primary Liner**

PANEL NUMBER	ROLL NUMBER	WORK AREA	PANEL LENGTH	PANEL WIDTH	PANEL AREA	COMMENTS:
16	0860	East Slope	34.00	7.30	248.20	
17	0867	East Slope	35.00	7.30	255.50	
18	0867	East Slope	35.00	7.30	255.50	
19	0867	East Slope	35.00	7.30	255.50	
20	0867	East Slope	34.00	7.30	248.20	
21	0861	East Slope	32.00	7.30	233.60	

1496.50 **sq m**

PANEL PLACEMENT LOG

Cassidy

Consulting Inc.

DATE Saturday, August 21, 2021

PROJECT NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021

MATERIAL 60mil HDPE DTEX - Primary Liner

PANEL NUMBER	ROLL NUMBER	WORK AREA	PANEL LENGTH	PANEL WIDTH	PANEL AREA	COMMENTS:
22	0924	East Slope	30.00	7.30	219.00	
23	0924	Floor	3.00	7.30	21.90	
24	0932	East Slope	34.00	7.30	248.20	
25	0932	East Slope	28.00	7.30	204.40	
26	0932	Floor	4.00	7.30	29.20	
27	0914	East Slope	32.00	7.30	233.60	
28	0914	East Slope	32.00	7.30	233.60	
29	0913	East Slope	29.00	7.30	211.70	
30	0913	Floor	3.00	7.30	21.90	

1423.50 **sq m**

PANEL PLACEMENT LOG

Cassidy

Consulting Inc.

DATE Monday, August 23, 2021

PROJECT NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021

MATERIAL 60mil HDPE DTEX - Primary Liner

PANEL NUMBER	ROLL NUMBER	WORK AREA	PANEL LENGTH	PANEL WIDTH	PANEL AREA	COMMENTS:
31	0861	S.E.Corner	33.00	7.30	240.90	
32	0861	South Slope	5.00	7.30	36.50	
33	0861	South Slope	5.00	7.30	36.50	
34	0861	South Slope	6.00	7.30	43.80	
35	0861	South Slope	7.00	7.30	51.10	
36	0861	South Slope	7.00	7.30	51.10	
37	0861	South Slope	7.00	7.30	51.10	
38	0866	South Slope	8.00	7.30	58.40	
39	0866	South Slope	8.00	7.30	58.40	
40	0866	South Slope	9.00	7.30	65.70	
41	0866	South Slope	9.00	7.30	65.70	
42	0866	South Slope	9.00	7.30	65.70	
43	0866	South Slope	8.00	7.30	58.40	
44	0866	South Slope	7.00	7.30	51.10	
45	0866	S.W.Corner	7.00	7.30	51.10	

985.50 **sq m**

PANEL PLACEMENT LOG

Cassidy
Consulting Inc.

DATE Tuesday, August 24, 2021

PROJECT NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021 MATERIAL 60mil HDPE DTEX - Primary Liner

PANEL NUMBER	ROLL NUMBER	WORK AREA	PANEL LENGTH	PANEL WIDTH	PANEL AREA	COMMENTS:
46	0866	Floor	50.00	7.30	365.00	
47	0912	N.W.Corner	23.00	7.30	167.90	
48	0912	North Slope	24.00	7.30	175.20	
49	0912	North Slope	24.00	7.30	175.20	
50	0912	North Slope	24.00	7.30	175.20	
51	0912	North Slope	24.00	7.30	175.20	
52	0912	North Slope	24.00	7.30	175.20	
53	0912	North Slope	31.00	7.30	226.30	
54	0865	North Slope	31.00	7.30	226.30	
55	0865	North Slope	31.00	7.30	226.30	
56	0865	North Slope	31.00	7.30	226.30	
57	0865	North Slope	31.00	7.30	226.30	
58	0865	North Slope	31.00	7.30	226.30	

2766.70 **sq m**

PANEL PLACEMENT LOG

Cassidy

Consulting Inc.

DATE Wednesday, August 25, 2021

PROJECT NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021

MATERIAL 60mil HDPE DTEX - Primary Liner

PANEL NUMBER	ROLL NUMBER	WORK AREA	PANEL LENGTH	PANEL WIDTH	PANEL AREA	COMMENTS:
59	0918	North Slope	32.00	7.30	233.60	
60	0918	Sump	4.00	7.30	29.20	
61	0918	Sump	3.00	7.30	21.90	
62	0918	North Slope	33.00	7.30	240.90	
63	0918	Sump	7.00	7.30	51.10	
64	0918	N.E.Corner	25.00	7.30	182.50	
65	0918	N.E.Corner	9.00	7.30	65.70	
66	0918	N.E.Corner	3.00	7.30	21.90	
67	0931	N.E.Corner	7.00	7.30	51.10	
68	0931	N.E.Corner	18.00	7.30	131.40	
69	0914	N.E.Corner	26.00	7.30	189.80	
70	0865	East Slope	29.00	7.30	211.70	

1430.80 **sq m**

Cassidy
Consulting Inc.

NON-DESTRUCTIVE TESTING
SEAM LOG

DATE: Wednesday, August 18, 2021

PROJECT: **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL: 60mil HDPE DTEX - Primary Liner

					AIR PRESSURE TESTING				PEELS				
SEAM NUMBER	SEAM LENGTH	WELD TIME	TECH INITIAL	WELDER NUMBER	TIME START	TIME FINISH	PSI START	PSI FINISH	PEEL INSIDE	PEEL OUTSIDE	VAC-TEST Pass/FAIL	QC INITIAL	COMMENTS:
1/2	84.0	9:06	RC	9	9:45	9:50	35	35	Pass	Pass	N/A	CC	
2/3	84.0	9:45	RC	9	10:30	10:35	30	30	Pass	Pass	N/A	CC	
3/4	87.0	10:57	RC	9	12:02	12:07	40	39	Pass	Pass	N/A	CC	
4/5	90.0	11:27	RC	9	12:11	12:16	30	30	Pass	Pass	N/A	CC	
5/6	90.0	12:58	RC	9	1:33	1:38	30	30	Pass	Pass	N/A	CC	
6/7/A	75.0	1:47	RC	9	3:06	3:11	30	30	Pass	Pass	N/A	CC	
6/7/B	15.0	1:47	RC	9	3:01	3:06	30	30	Pass	Pass	N/A	CC	
7/8	90.0	2:55	RC	9	3:40	3:45	30	30	Pass	Pass	N/A	CC	

Cassidy
Consulting Inc.

NON-DESTRUCTIVE TESTING
SEAM LOG

DATE: Thursday, August 19, 2021

PROJECT: **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL: 60mil HDPE DTEX - Primary Liner

					AIR PRESSURE TESTING				PEELS				
SEAM NUMBER	SEAM LENGTH	WELD TIME	TECH INITIAL	WELDER NUMBER	TIME START	TIME FINISH	PSI START	PSI FINISH	PEEL INSIDE	PEEL OUTSIDE	VAC-TEST Pass/FAIL	QC INITIAL	COMMENTS:
8/9	90.0	8:06	RC	9	8:46	8:51	30	30	Pass	Pass	N/A	CC	
9/10	90.0	8:45	RC	9	9:25	9:30	30	30	Pass	Pass	N/A	CC	
10/11	87.0	7:18	RC	9	8:06	8:11	40	39	Pass	Pass	N/A	CC	
12/13	7.3	8:08	RC	9	9:15	9:20	30	30	Pass	Pass	N/A	CC	Cross Seam
11/12/13	87.0	8:12	RC	9	9:30	9:35	30	30	Pass	Pass	N/A	CC	
14/15	7.3	8:45	RC	9	8:40	8:45	30	30	Pass	Pass	N/A	CC	Cross Seam
12/13/14/15	80.0	8:52	RC	9	9:36	9:41	30	30	Pass	Pass	N/A	CC	

Cassidy
Consulting Inc.

NON-DESTRUCTIVE TESTING
SEAM LOG

DATE: Friday, August 20, 2021

PROJECT: **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL: 60mil HDPE DTEX - Primary Liner

					AIR PRESSURE TESTING				PEELS				
SEAM NUMBER	SEAM LENGTH	WELD TIME	TECH INITIAL	WELDER NUMBER	TIME START	TIME FINISH	PSI START	PSI FINISH	PEEL INSIDE	PEEL OUTSIDE	VAC-TEST Pass/FAIL	QC INITIAL	COMMENTS:
16/17	34.0	12:06	RC	9	12:38	12:43	30	30	Pass	Pass	N/A	CC	
17/18	35.0	12:32	RC	9	12::42	12:47	30	30	Pass	Pass	N/A	CC	
18/19	35.0	12:37	RC	9	1:25	1:30	30	30	Pass	Pass	N/A	CC	
19/20	34.0	12:54	RC	9	1:20	1:25	30	30	Pass	Pass	N/A	CC	
20/21	32.0	1:08	RC	9	1:30	1:35	30	30	Pass	Pass	N/A	CC	
E.Butt/A	42.0	1:53	RC	9	3:11	3:16	30	30	Pass	Pass	N/A	CC	Panels 16 - 21.

Cassidy
Consulting Inc.

NON-DESTRUCTIVE TESTING
SEAM LOG

DATE: Saturday, August 21, 2021

PROJECT: **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL: 60mil HDPE DTEX - Primary Liner

					AIR PRESSURE TESTING				PEELS				
SEAM NUMBER	SEAM LENGTH	WELD TIME	TECH INITIAL	WELDER NUMBER	TIME START	TIME FINISH	PSI START	PSI FINISH	PEEL INSIDE	PEEL OUTSIDE	VAC-TEST Pass/FAIL	QC INITIAL	COMMENTS:
22/23	7.3	6:54	RC	9	9:06	9:11	30	30	Pass	Pass	N/A	CC	Cross Seam
21/22/23	32.0	8:54	RC	9	10:35	10:40	30	30	Pass	Pass	N/A	CC	
22/23/24	33.0	6:59	RC	9	10:18	10:23	40	39	Pass	Pass	N/A	CC	
25/26	7.3	7:29	RC	9	9:10	9:15	30	30	Pass	Pass	N/A	CC	Cross Seam
24/25/26	32.0	7:46	RC	9	10:13	10:18	30	30	Pass	Pass	N/A	CC	
25/26/27	32.0	8:05	RC	9	10:43	10:48	30	30	Pass	Pass	N/A	CC	
27/28	32.0	8:26	RC	9	10:52	10:57	33	31	Pass	Pass	N/A	CC	
29/30	7.3	9:09	RC	9	9:30	9:40	30	30	Pass	Pass	N/A	CC	Cross Seam
28/29/30	32.0	9:27	RC	9	9:22	9:27	30	30	Pass	Pass	N/A	CC	
E.Butt/B	42.0	9:46	RC	9	11:25	11:30	30	30	Pass	Pass	N/A	CC	Panels 21 - 30.

Cassidy
Consulting Inc.

NON-DESTRUCTIVE TESTING
SEAM LOG

DATE: Monday, August 23, 2021

PROJECT: **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL: 60mil HDPE DTEX - Primary Liner

					AIR PRESSURE TESTING				PEELS				
SEAM NUMBER	SEAM LENGTH	WELD TIME	TECH INITIAL	WELDER NUMBER	TIME START	TIME FINISH	PSI START	PSI FINISH	PEEL INSIDE	PEEL OUTSIDE	VAC-TEST Pass/FAIL	QC INITIAL	COMMENTS:
31/32	5.0	12:01	RC	9	12:10	12:15	30	30	Pass	Pass	N/A	CC	
32/33	5.0	12:10	RC	9	12:15	12:20	30	30	Pass	Pass	N/A	CC	
33/34	5.0	12:14	RC	9	12:20	12:25	40	39	Pass	Pass	N/A	CC	
34/35	6.0	12:18	RC	9	12:30	12:35	30	30	Pass	Pass	N/A	CC	
35/36	7.0	12:20	RC	9	12:37	12:42	30	30	Pass	Pass	N/A	CC	
36/37	7.0	12:25	RC	9	12:45	12:50	30	30	Pass	Pass	N/A	CC	
37/38	7.0	12:29	RC	9	12:50	12:55	30	30	Pass	Pass	N/A	CC	
38/39	8.0	12:34	RC	9	12:55	1:00	33	31	Pass	Pass	N/A	CC	
39/40	8.0	12:41	RC	9	1:01	1:06	30	30	Pass	Pass	N/A	CC	
40/41	9.0	12:45	RC	9	1:07	1:12	30	30	Pass	Pass	N/A	CC	
41/42	9.0	12:50	RC	9	1:15	1:20	30	30	Pass	Pass	N/A	CC	
42/43	8.0	1:01	RC	9	1:20	1:25	30	30	Pass	Pass	N/A	CC	
43/44	8.0	1:07	RC	9	1:30	1:35	30	30	Pass	Pass	N/A	CC	
44/45	7.0	1:11	RC	9	1:36	1:41	31	30	Pass	Pass	N/A	CC	
S.Butt/A	47.0	1:33	RC	9	2.57	3:02	35	33	Pass	Pass	N/A	CC	Panels 45 - 39.
S.Butt/B	47.0	1:33	RC	9	3:11	3:16	30	28	Pass	Pass	N/A	CC	Panels 39 - 32.
S.Butt/C	38.0	1:33	RC	9	3:25	3:30	30	29	Pass	Pass	N/A	CC	Panels 32 - 31.

Cassidy
Consulting Inc.

NON-DESTRUCTIVE TESTING
SEAM LOG

DATE: Tuesday, August 24, 2021

PROJECT: **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL: 60mil HDPE DTEX - Primary Liner

					AIR PRESSURE TESTING				PEELS				
SEAM NUMBER	SEAM LENGTH	WELD TIME	TECH INITIAL	WELDER NUMBER	TIME START	TIME FINISH	PSI START	PSI FINISH	PEEL INSIDE	PEEL OUTSIDE	VAC-TEST Pass/FAIL	QC INITIAL	COMMENTS:
47/48	23.0	9:04	RC	9	11:10	11:15	30	30	Pass	Pass	N/A	CC	
48/49	24.0	9:14	RC	9	11:15	11:20	30	30	Pass	Pass	N/A	CC	
49/50	24.0	9:43	RC	9	11:21	11:26	40	39	Pass	Pass	N/A	CC	
50/51	24.0	9:54	RC	9	11:27	11:32	30	30	Pass	Pass	N/A	CC	
51/52	24.0	10:03	RC	9	11:38	11:43	30	30	Pass	Pass	N/A	CC	
52/53	24.0	11:39	RC	9	12:06	12:11	30	30	Pass	Pass	N/A	CC	
53/54	31.0	11:51	RC	9	12:12	12:17	30	30	Pass	Pass	N/A	CC	
54/55	31.0	12:50	RC	9	1:05	1:10	33	31	Pass	Pass	N/A	CC	
55/56	31.0	12:07	RC	9	12:18	12:23	30	30	Pass	Pass	N/A	CC	
56/57	31.0	12:21	RC	9	12:24	12:29	30	30	Pass	Pass	N/A	CC	
57/58	31.0	12:32	RC	9	12:40	12:45	30	30	Pass	Pass	N/A	CC	
14/46	50.0	1:15	RC	9	2:46	2:51	30	30	Pass	Pass	N/A	CC	
N.Butt/A	50.0	10:28	RC	9	11:47	11:52	35	33	Pass	Pass	N/A	CC	Panels 46 - 53.
N.Butt/B	35.0	1:15	RC	9	2:46	2:51	32	30	Pass	Pass	N/A	CC	Panels 54 - 58

Cassidy
Consulting Inc.

NON-DESTRUCTIVE TESTING
SEAM LOG

DATE: Wednesday, August 25, 2021

PROJECT: **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021**

MATERIAL: 60mil HDPE DTEX - Primary Liner

					AIR PRESSURE TESTING				PEELS				
SEAM NUMBER	SEAM LENGTH	WELD TIME	TECH INITIAL	WELDER NUMBER	TIME START	TIME FINISH	PSI START	PSI FINISH	PEEL INSIDE	PEEL OUTSIDE	VAC-TEST Pass/FAIL	QC INITIAL	COMMENTS:
58/59	31.0	11:41	RC	9	12:26	12:31	30	30	Pass	Pass	N/A	CC	
59/60	7.3	10:25	RC	9	10:45	10:50	30	30	Pass	Pass	N/A	CC	Cross Seam
60/61	7.3	10:38	RC	9	11:10	11:15	40	39	Pass	Pass	N/A	CC	Cross Seam
62/63	7.3	10:34	RC	9	11:01	11:06	30	30	Pass	Pass	N/A	CC	Cross Seam
59-62/60-63	39.0	11:10	RC	9	11:56	12:01	30	30	Pass	Pass	N/A	CC	Slope to Sump Panels 59/60/61/62/63.
62/64	25.0	9:56	RC	9	10:44	10:49	30	30	Pass	Pass	N/A	CC	
64/65	9.0	9:46	RC	9	10:31	10:36	30	30	Pass	Pass	N/A	CC	
65/66	3.0	10:07	RC	9	10:36	10:41	33	31	Pass	Pass	N/A	CC	
67/68	7.0	11:27	RC	9	12:11	12:16	30	30	Pass	Pass	N/A	CC	
68/69	18.0	9:29	RC	9	9:40	9:45	30	30	Pass	Pass	N/A	CC	
69/70	26.0	9:20	RC	9	9:10	9:15	30	30	Pass	Pass	N/A	CC	
70/29	29.0	8:44	RC	9	8:50	8:55	32	31	Pass	Pass	N/A	CC	
N.Butt/C	20.0	12:09	RC	9	12:47	12:52	30	28	Pass	Pass	N/A	CC	Sump Panels 60 - 63.
N.E.Butt	51.0	1:27	RC	9	2:11	2:16	40	38	Pass	Pass	N/A	CC	Panels 63 - 70.

Cassidy
Consulting Inc.

EXTRUSION WELD REPORT

DATE August 18 to 23, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021** MATERIAL 60mil HDPE DTEX - Primary Liner

EXTRUSION NUMBER	EXTRUSION TYPE	PANEL/SEAM NUMBER	TEST DATE	TECH INITIAL	MACHINE NUMBER	QC INITIAL	PASS/ FAIL	COMMENTS:
	Extruded August 18th							
1	Patch	4/5	Aug 18, 2021	MC	X2	CC	Pass	Destruct #8.
2	Patch	6/7	Aug 18, 2021	MC	X2	CC	Pass	Burn Out.
3	Patch	6/7	Aug 18, 2021	MC	X2	CC	Pass	Burn Out.
4	Bead	7	Aug 18, 2021	MC	X2	CC	Pass	Roll Damage.
5	Bead	7	Aug 18, 2021	MC	X2	CC	Pass	Roll Damage.
6	Bead	7	Aug 18, 2021	MC	X2	CC	Pass	Roll Damage.
7	Bead	7	Aug 18, 2021	MC	X2	CC	Pass	Roll Damage.
8	Bead	7	Aug 18, 2021	MC	X2	CC	Pass	Roll Damage.
9	Bead	7	Aug 18, 2021	MC	X2	CC	Pass	Roll Damage.
	Extruded August 20th							
10	Patch	7/8	Aug 20, 2021	MC	X2	CC	Pass	Destruct #9.
11	Patch	10/11	Aug 20, 2021	MC	X2	CC	Pass	Destruct #10.
12	Patch	19/20	Aug 20, 2021	MC	X2	CC	Pass	Burn out Crest of slope.
Zone 1	Beads	E.Butt/A	Aug 20, 2021	MC	X2	CC	Pass	All "T" Intersections along E.Butt/A.
	Extruded August 21st							
13	Patch	16/17	Aug 21, 2021	JC	X2	RC	Pass	Destruct #11.
Zone 2	Beads	E.Butt/B	Aug 21, 2021	JC	X2	RC	Pass	All "T" Intersections along E.Butt/B.
	Extruded August 23rd							
14	Patch	32/1	Aug 23, 2021	JC	X2	RC	Pass	Start/Stop at Panel 32.

Cassidy
Consulting Inc.

EXTRUSION WELD REPORT

DATE August 24 to 25, 2021

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021** MATERIAL 60mil HDPE DTEX - Primary Liner

EXTRUSION NUMBER	EXTRUSION TYPE	PANEL/SEAM NUMBER	TEST DATE	TECH INITIAL	MACHINE NUMBER	QC INITIAL	PASS/ FAIL	COMMENTS:
	Extruded August 24th							
15	Patch	46/49	Aug 24, 2021	JC	X2	RC	Pass	Destruct #12.
16	Patch	N.Butt	Aug 24, 2021	JC	X2	RC	Pass	Start/Stop at Seam 53/54.
17	Bead	46	Aug 24, 2021	JC	X2	RC	Pass	Near Panel 49.
Zone 4	Beads	N.Butt/A&B	Aug 24, 2021	JC	X2	RC	Pass	All "T" Intersections along N.Butt/A and B.
	Extruded August 25th							
18	Patch	N.Butt/B	Aug 25, 2021	JC	X2	RC	Pass	Start/Stop at Panel 58.
19	Patch	58/59	Aug 25, 2021	JC	X2	RC	Pass	At N.W. Corner of Sump.
20	Patch	60/61	Aug 25, 2021	JC	X2	RC	Pass	Fit Liner in Sump area.
21	Patch	61/63	Aug 25, 2021	JC	X2	RC	Pass	Fit Liner in Sump area.
22	Patch	59/62	Aug 25, 2021	JC	X2	RC	Pass	Fit Liner in Sump area.
23	Patch	62/63	Aug 25, 2021	JC	X2	RC	Pass	Fit Liner in Sump area.
24	Patch	E.Butt/B	Aug 25, 2021	JC	X2	RC	Pass	Start/Stop between E.Butt/B and N.E.Butt.
Zone 5	Beads	N.Butt/C	Aug 25, 2021	JC	X2	RC	Pass	All "T" Intersections along N.Butt/C.
Zone 6	Beads	N.E.Butt	Aug 25, 2021	JC	X2	RC	Pass	All "T" Intersections along N.E.Butt.

Cassidy
Consulting Inc.

DESTRUCTIVE TESTING REPORT

PROJECT **NORTHWIN ENVIRONMENTAL LANDFILL - CELL1 - 2021** MATERIAL 60mil HDPE DTEX - Primary Liner

WELD DATE	D.S. #	SEAM #	TECH INITIAL	WELDER NUMBER	PEEL 1		SHEAR	PEEL 2		SHEAR	PEEL 3		SHEAR	PEEL 4		SHEAR	PEEL 5		SHEAR	QC INITIAL	COMMENTS / LOCATION
					IN	OUT		IN	OUT		IN	OUT		IN	OUT		IN	OUT			
8-18-21	8	4/5	RC	9	107	122	183	129	128	183	127	113	181	127	111	182	117	122	182	CC	First Destruct on Primary liner - Floor.
8-19-21	9	7/8	RC	9	119	117	156	102	104	158	119	106	159	120	116	160	113	115	169	CC	On Floor.
8-19-21	10	10/11	RC	9	124	120	170	122	108	168	123	111	164	127	112	167	129	140	165	CC	On Floor.
8-20-21	11	16/17	RC	9	132	119	172	119	107	173	121	106	171	118	122	170	120	120	165	CC	At Toe of Slope.
8-24-21	12	46/49	RC	9	135	145	151	131	135	153	112	134	152	113	135	150	131	122	150	CC	On Floor.
8-25-21	13	67/68	RC	9	143	130	175	117	120	174	118	128	174	119	134	180	136	121	175	CC	In Anchor Trench.

Appendix F

Field Inspections

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	3/19/2021 13:00	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Vanderweil, Brad Maxwell		
WEATHER CONDITIONS:	Raining 7 ^{o}C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Observe sub-base conditions of pit particularly where East Berm construction will begin next week

SITE NOTES / PROGRESS:
-Fill stakes have been placed by surveyor
-No excavation required before filling activities begin for East Berm
-Floor of pit generally compact and free of debris
-Small amounts of ponding scattered around pit floor due to recent rain
-Observed proof roll, soil compaction appeared adequate
-One large rock observed near toe of east slope (photo attached). Instructed Joe to remove before placing fill

Next Steps
-Begin fill activities on Monday, March 22
-Compaction testing tentatively set for 13:00 on March 22

OUTSTANDING INFORMATION / NEW ISSUES:
-Brad has question regarding centre line of East Berm on drawing. Email sent to Roxy.

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):
-See attached photolog

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	3/22/2021 13:00	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Vanderweil, Brad Maxwell Johnny Csondes (McElhanney)		
WEATHER CONDITIONS:	Mixed sun, cloud, rain 10 ^{o}C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Observe fill activites and compaction testing

SITE NOTES / PROGRESS:
-One lift had been placed on North and East Berm
-Trucks were hauling material being excavated from slope South of Landfill routing over East Berm to North Berm to increase compaction
-McElhanney tested compaction on several places on East Berm. It was unknown how many passes were made with the vibrator packer.
-No packing had yet taken place on the North Berm. Material had been placed in approximiately 0.3 m lift.
-Vibrator packer made 6 passes, compaction was tested, 4 more passes, compaction tested, 4 more passes, compaction tested on North Berm.
-Compaction test results averaged 93.5% based on Proctor on file. Did not improve noticable with subsequent passes of packer McElhanney grabbed a sample of material from where it was being excavated to send to lab
-Confirmed with Brad that Proctor results that were given to GHD did not represent the material that was being placed

Next Steps
-Lab results expected tomorrow (March 23) evening
-McElhanney to confirm compaction based on lab results
-GHD to determine appropriate inspection schedule for remainder of berm construction

OUTSTANDING INFORMATION / NEW ISSUES:
-Proctor test given to GHD from Upland not representative of material being placed

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):
-See attached photolog

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	3/23/2021 14:30	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Vanderweil		
WEATHER CONDITIONS:	Overcast 9 °C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Observe fill activites on North and East Berms

SITE NOTES / PROGRESS:
-Three lifts placed on North and East Berms, begining to work on 4th lift on south end of East Berm
-Trucks continuing one way haul, dumping and then driving the length of the two berms to increase compaction
-D8 pushing material and vibrator packer working continously
-Height of 3 compacted lifts approximately 1m
-Height of 4th lift approximately 0.3m
-Material being hauled from same location as yesterday from slope south of landfill footpring

OUTSTANDING INFORMATION / NEW ISSUES:
-Results Proctor test given to GHD from Upland not representative of material being placed
-Results of Proctor of material being placed expected by end of day today

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):
-See attached photolog

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	3/29/2021 12:10	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Doug Wynd		
WEATHER CONDITIONS:	Sunny 8 °C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Observe fill activites on North and East Berms

SITE NOTES / PROGRESS:
-North Berm and majority of East Berm filled to design grade.
-Small fill remaining on south end of East Berm
-crushing plant being removed from landfill footprint
-lock blocks placed at west end of North Berm
-trucks hauling material to remaining fill by driving over North Berm full and dumping on East Berm
-vibratory compactor working continously, when operator takes break different operator fills in
-location of infiltration pond berms marked out with paint, some aggregate currently in way of fill

Next Steps

-complete fill on East Berm
-cut back berms slopes to design
-complete moving crushing plant
-move pile of aggregate that is in base of infiltration pond
-cut base of landfill to grade

OUTSTANDING INFORMATION / NEW ISSUES:
-Results of Proctor still not available from lab - Brad followed up again today

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):
-See attached photolog

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	3/31/2021 9:10	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Brad Maxwell Tyler(surveyor)		
WEATHER CONDITIONS:	Mixed Sun and Cloud 8 °C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Observe fill activites and base of infiltration pond

SITE NOTES / PROGRESS:
-Fill on North and East Berm almost complete. Small fill required on south end of East Berm
-Shaping of inside slopes of North Berm beginig
-Base of lock-block wall on north-east corner of Infiltration Pond being prepped
-Crew moving stockpiled material out of way that is currently setting in of infiltration pond
-Observed loaded trucks travelling over base of berms. Sub-base is competent with no deflection observed..
-Varying depth of round-rock, from previous stockpiled material up to 30 mm depth sitting where in footprint of Infiltraion Pond including where berms will be constructed.
-Instructed Tyler and followed up with Brad, to make sure round-rock is removed before berms are placed

Next Steps

-Remove round-rock from base of infiltration pond berms before constructing berms
-Complete removing stock-pile of material that is in infiltration pond footprint
-Cut base of landfill to design contours (up to 2m cut close to North Berm) This will take most of next week.

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):
-See attached photolog

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	4/7/2021 14:30	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Vanderweil		
WEATHER CONDITIONS:	Mixed Sun and Cloud 7 °C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Observe / excavation activites

SITE NOTES / PROGRESS:
-Excavation of base of landfill underway
-Gravel removed from base of infiltration pond
-Infiltration pond berms nearly complete
-Grubbing activities have begun for leachate treatment pond

Next Steps

-Remove round-rock from base of infiltration pond berms before constructing berms
-Complete removing stock-pile of material that is in infiltration pond footprint
-Cut base of landfill to design contours (up to 2m cut close to North Berm) This will take most of next week.

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):
-See attached photolog

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	4/16/2021 14:30 AM	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Vanderweil		
WEATHER CONDITIONS:	Mixed Sun and Cloud 7 °C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Observe / excavation activites

SITE NOTES / PROGRESS:
-Excavation of base of landfill underway
-Gravel removed from base of infiltration pond
-Infiltration pond berms nearly complete
-Grubbing activities have begun for leachate treatment pond

Next Steps

-Remove round-rock from base of infiltration pond berms before constructing berms
-Complete removing stock-pile of material that is in infiltration pond footprint
-Cut base of landfill to design contours (up to 2m cut close to North Berm) This will take most of next week.

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):
-See attached photolog

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	4/30/2021 8:00	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Vanderweil, Brad Maxwell		
WEATHER CONDITIONS:	Mixed Sun and Cloud 7 °C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Observe sand to be used for GCL protection layers

SITE NOTES / PROGRESS:
-Excavation to new contours rearly complete
-Material in base of pit was sandy Joe Vandereil asked if it would be acceptable for GCL protection layer. Sand was observed to be clean free of fines but contained oversized up to approximately 25 mm. (see attached photolog)
-Disccussed with Brad and Joe if protection layer would be required on slopes given that rocks are on side slope.

Next Steps

-Complete excavation to new contours

OUTSTANDING INFORMATION / NEW ISSUES:
-sand present in landfill excavation not acceptable for placement as GCL protection Layer

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):
-See attached photolog

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	5/7/2021 11:00	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Vanderweil,		
WEATHER CONDITIONS:	Mixed Sun and Cloud 9 °C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Observe subbase excavation and potential sand to be placed for GCL protection layer

SITE NOTES / PROGRESS:
-Excavation to base contours complete. Floor of pit is clean and free of lumps and debris, slopes visually appear to match design.
-some triming of berms still required
-observed potential sand source to be used for GCL protection layer. Material was clean but conatined signifant rocks greater than max spec (4.75mm). Reviewed sand specification with Joe and conclued that that sand would have to be screened

Next Steps

-Complete shaping of berms where required
-Perform as-built survey of pit
-Screen and place sand

OUTSTANDING INFORMATION / NEW ISSUES:
-GHD to determine if GCL protection layer required on landfill slopes

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):
-See attached photolog

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	5/12/2021 10:00	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Vanderweil,		
WEATHER CONDITIONS:	Sunny 12 ^{o}C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Inspect sand and observe sand placement on floor of Landfill

SITE NOTES / PROGRESS:
-observed stockpiled sand being used for GCL protection layer. Sand washed, screened and acceptable for use as the GCL protection layer
-Sand was being place to depth of 150 mm starting on south end of landfill.
-Dozer placing sand is equipped with laser level to ensure correct depth of is placed
-Vibrator packer will be used to compact sand layer

Next Steps

-Complete placing sand
- minimal futher activities unitl lining

OUTSTANDING INFORMATION / NEW ISSUES:
-GHD to determine if GCL protection layer required on landfill slopes
-GHD to complete review of moisture sensor

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):
-See attached photolog

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/3/2021 7:00	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner crew		
WEATHER CONDITIONS:	Sunny, 16 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Witness test seams
- Obersrve panel placement and welds
- Observe Geosynthetic deployement

SITE NOTES / PROGRESS:
-Geomembrane placed on Leachate Pond except North Slope.
-1 roll of geomembrane used, second roll started
-Witnessed sheer and peel of test weld
-Oberved liner welds and panel placement
-Liner placement and welds appeared acceptable. No wrinkles observed in geomembrane
-Observed HDPE pipe for leachate leak detection being fused on site

Next Steps

- Continue placing geosythetics
- Place geotextile protection layer leak detection pipe
- Pressure test seams
- Vaccuum test repairs
- Backfill leack detection sump with sand

OUTSTANDING INFORMATION / NEW ISSUES:
-Vaccuum box is not working, New device is expected to arrive tomorrow. Cannot place sand in Leachate pond sump until repairs are tested

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):
-See attached photolog

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/4/2021 6:00	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner crew		
WEATHER CONDITIONS:	Sunny, 20 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Witness test seams
- Obersrve panel placement and welds
- Observe Geosynthetic deployement

SITE NOTES / PROGRESS:
-1st layer of geomembrane placement complete. Panels 17-24 placed yesterday
-Geocomposite installation began yesterday two panels placed on south and two placed on west slope
-Leak detection pipe placed with geotextile covering perforated section
-Witnessed test weld and destructive tests.
-Observed extrusiion test weld and destructive test
-Cut first destructive test sample
-Observed geocomposite connections
-Observed vaccum test of repairs

Next Steps

-Continue placing geosythetics
-Place sand in leak detection sump
-Pressure test seams
-Backfill leack detection sump with sand

OUTSTANDING INFORMATION / NEW ISSUES:
-Temperature got too high in the afternoon so geomembrane installation shut down early

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/5/2021 7:00	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner crew		
WEATHER CONDITIONS:	Scattered cloud 18 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Witness test seams
- Obersrve geo-synthetic installation

SITE NOTES / PROGRESS:
-Geocomposite installation complete
-Second GCL layer installation complete except corners
-Two panels of Geomembrane placed
-Witnessed test weld destructive tests, all results acceptable
-Observed GCL placement and checked overlap
-Observed geomembrane placement
-Leak detection sump backfilled with sand

Next Steps

- Complete placement of final layer of Geomembrane on Leachate pond
- Perform pressure tests on seams
- Backfill anchor trench

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):
-See attached photolog

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/6/2021 7:30	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Terry Stuart, Liner crew		
WEATHER CONDITIONS:	Scattered cloud 18 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Observe Leachate pond geomembrane installation

SITE NOTES / PROGRESS:
-All geomembrane installed fused and repairs / patches made
-Observed all welds and repairs, all repairs marked after vaccuum test
-Walked each panel with Joe Cassidy, and Terry Stuart inspecting for defects. No issues observed
-Observed field sheer and peel test on destructive test 2 (DT-2), sent sample to lab

Next Steps

- Complete sealing geomembrane to HDPE leak detection pipe.
- Backfill anchor trench
- Begin geosythetic installation on landfill cell

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):
-See attached photolog

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/9/2021 7:00	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner crew		
WEATHER CONDITIONS:	Sun and cloud, 14 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Witness lining activities in Landfill area
- Observe conditions after Saturday's rain

SITE NOTES / PROGRESS:
-First day of geosythetic installation in landfill area.
-Rolls of Geotextile placed around landfill perimeter
-Bedding sand placed and compacted where it was previously missing on sub-base on north-west corner
-All sub-base now acceptable, some trimming still required on toe of slopes
-Sump dimensions are acceptable but edges need to be trimmed before liner placed
-Observed deployement of geotextile and geomembrane
-No ponding of water after rainfall in area where GCL rolls placed. No GCL was deployed before rainfall on Saturday

Next Steps

- Continue placing first layer of GCL and geomembrane on base of landfill

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):
-See attached photolog

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/10/2021 7:00	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner crew		
WEATHER CONDITIONS:	Mostly sunny, 18 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Witness lining activities in Landfill area

SITE NOTES / PROGRESS:
- Eight Geomembrane panels laid yesterday
- Observed field peel and sheer test for first destructive test, DT - 1, Seam 4/5, Welder # 9, field results acceptable
- Obersvered peel and sheer on test seem, results acceptable
- Marked out location of DT-2, Seam 8/9, Welder # 9, observed field peel and sheer tests, field results acceptable
- Sent DT-1 and DT-2 to lab
- Observed GCL and Geomembrane placement and seam welding

Next Steps

- Continue placing first layer of GCL and geomembrane on base of landfill

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/11/2021 14:30	**SITE:**	Upland landfill
PERSONNEL ON SITE:			
WEATHER CONDITIONS:	Sunny, 30 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Witness lining activities in Landfill area

SITE NOTES / PROGRESS:
-Geosythetic placement had stopped for the day due to the heat and high winds
- Panels 9 - 17 placed and seamed yesterday completing floor of landfill to south toe
- Panels 18-33 placed and seamed today on south slope
- Sent DT-3, Panel 12/13 and and DT-4, panel 16/17 to lab
- Crew attempted to place geocomposite with skid steer, weather was too hot and windy so shut down for the day
- Inspected new panels placed, no deficiencies found

Next Steps

- Place geo-composite on geomembrane
- Place geotextile on slopes

OUTSTANDING INFORMATION / NEW ISSUES:
-Need to review procedure for operating equipment on liner to ensure damage is avoided

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/12/2021 8:45	**SITE:**	Upland landfill
PERSONNEL ON SITE:			
WEATHER CONDITIONS:	Sunny, 18 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:
- Witness lining activities in Landfill area

SITE NOTES / PROGRESS:

-Spoke to Terry Stuart and Joe Cassidy about leak detection pipe locations and requirements. Confirmed that PVC is not acceptable for pipe material.
-Observed placement of Geomembrane, no damage was be observed from skid-steer on liner
-Practices being followed were acceptable including: leaf blower used to remove sand and gravel before placing material, equipment entering liner at 90 degree angle to edge and not turning on geombrane, crew members observing geomembrane as liner is placed, placing in morning when there are fewer wrinkles in the liner.

Next Steps

- Continue placing geo-composite on geomembrane
- Place geotextile on slopes
- Shape area for leak detection ports.

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/13/2021 7:00	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Terry Stuart, Brian Fagan, Liner Crew		
WEATHER CONDITIONS:	Sunny, 17 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Witness geosythetic installation activities in Landfill area

SITE NOTES / PROGRESS:

-Anchor trench on North and East Slopes excavated, excavation dimensions acceptable
-Observed Geotextile installed on North Slope
-Observed location marking for Leak Detection Ports, locations acceptable
-Observed crew was continuing to place geomembrane on west side of base of landfill

Next Steps

- Continue placing geocomposite on base of landfill
- Place geotextile on East Slope
- Place first layer of GCL and Geomembrane on North and East Slopes
- Hand dig leak detection port depression

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/14/2021 7:20	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy,, Brian Fagan, Liner Crew, Terry Stuart		
WEATHER CONDITIONS:	Sunny, 18 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Witness geosythetic installation activities in Landfill area

SITE NOTES / PROGRESS:

-Geotextile placement on East Slope complete
-Observed Geomebrane being placed on North Slope, Panels 34-44 placed from West to edge of sump
-Marked location of destructive test (DT-5), witnessed field sheer and peel tests
-Witnessed sheer and peel tests on trail seem, welder # 17
-Spoke to Brian and Terry about need for depression below gemembrane for leak detection Ports
- Observed placement of GCL in sump

Next Steps

- Finish placing and seaming geomembrane on North Slope and sump
- Place GCL and Geomembrane on East Slope
- Establish depression for leak detection ports

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/16/2021 6:45	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner Crew, Terry Stuart		
WEATHER CONDITIONS:	Overcast, 15 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Witness geosythetic installation activities in Landfill area

SITE NOTES / PROGRESS:

-Geomembrane installed on North Slope, up to and including Sump.
-All GCL placed was covered with geomembrane before Sunday's rain.
-Water drained to sump after rain yesterday, no pooling observed on geomembrane on base of landfill.
-Observed crew placing GCL and Geomembrane in North-East corner.
-Observed test weld peel and sheer test.
-Marked location of destructive test DT-6, Panel 47/48, observed field peer and sheer test.
-Sent DT-5 and DT-6 to lab.

Next Steps

- Place GCL and Geomembrane on East Slope.

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/17/2021 5:55	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner Crew		
WEATHER CONDITIONS:	Clear sky, 14 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Witness geosythetic installation activities in Landfill area

SITE NOTES / PROGRESS:

- First layer geomembrane installation complete
- Checked yesterday's geomembrane installation for defects
- Collected destructive test DT-7 seam, 67/68 and sent to lab

Next Steps

-Install leak detetion ports
-Install leachate leak detection sump riser pipe
-Complete installing geocomposite on geomembrane

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/18/2021 7:15	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner Crew		
WEATHER CONDITIONS:	Overcast, 16 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Witness geosythetic installation activities in Landfill area

SITE NOTES / PROGRESS:

- Geocomposite installation complete except for North Slope and area around sump
- Checked yesterday's geocomposite installation for defects
- Observed crew placing GCL and Geomembrane working from South end to North
- 50 mm HDPE pipe for leak detection port on site and perforations drilled

Next Steps

- Continue placing GCL and Geomembrane
- Install leak detection ports
- Install leachate leak detection sump riser pipe

OUTSTANDING INFORMATION / NEW ISSUES:

-No depression established for leak detection ports. Installation will require a field fit.

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/19/2021 7:15	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner Crew		
WEATHER CONDITIONS:	Sunny, 17 C, strong wind from North-West		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Witness geosythetic installation activities in Landfill area

SITE NOTES / PROGRESS:

- 8 geomembrane panels installed and welded yesterday along with underlying GCL
- Observed crew placing GCL and geomembrane panels 9 & 10
- Inspected yesterday's geomembrane installation
- Collected destructive test DT-8, Panel 4/5 and sent to lab

Next Steps

- Continue placing GCL and Geomembrane to toe of North slope
- Install leak detection ports
- Install leachate leak detection sump riser pipe

OUTSTANDING INFORMATION / NEW ISSUES:

- HDPE pipe fusion machine under repair, leachate leak detection pipe installation delayed until tomorrow or Monday

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/20/2021 7:15	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner Crew		
WEATHER CONDITIONS:	mixed sun and cloud, 14 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Witness geosythetic installation activities in Landfill area

SITE NOTES / PROGRESS:

- Operation shut down early yesterday due to high winds
- 2 geomembrane panels (9&10) installed and welded yesterday along with underlying GCL
- Observed crew placinng geomembrane panels 11 - 14 up to close to toe of North slope
- Observed crew placing geomembrane on South end of East slope
- Inspected yesterday's geomembrane installation
- Marked location for destructive test DT-10, witnessed field sheer and peel test, sent DT-9 and DT-10 to lab

Next Steps

- Continue placing GCL and Geomembrane on East Slope
- Install leak detection ports
- Install leachate leak detection sump riser pipe

OUTSTANDING INFORMATION / NEW ISSUES:

- HDPE pipe fusion machine still under repair

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/21/2021 7:15	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner Crew		
WEATHER CONDITIONS:	Sunny, 14 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Witness geosythetic installation activities in Landfill area

SITE NOTES / PROGRESS:

- Geomembrane panels 12 -21 and underlying GCL installed on East slope yesterday
- Obersrved crew placing geomembrane panels 22 - 29, completeing East slope
- HDPE pipe fusion welder onsite welding 300 mm leachate leak detection pipe
-Two leak detection ports were installed on East slope yesterday and GCL placed on top.

Construction notes on leak detection ports

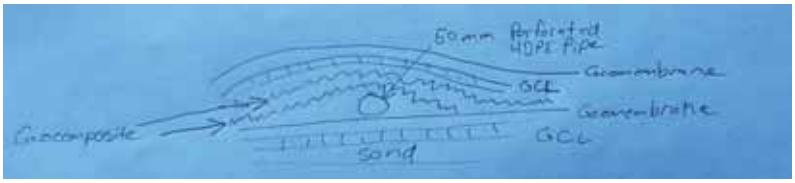
-Leak detection monitoring ports were field fit by the Contractor (without the presence of the Engineer)
-3 m section of perforated pipe was placed on top of geomembrane, two layers of geocomposite were placed on top of pipe, see sketch below
-The two layers of gemeombrane on top of perforated pipe will prevent the upper GCL from deforming around the perforated pipe and ensure hydraulic connectivity in the inter-membrane will be acceptable.
-Without depression below leak detection port, small volumes flowing past the detection port will be difficult to detect
-Port will function acceptably for detecting larger flow volumes and leachate pooled on the geomembrane in the area of the ports

Next Steps

-Place geocomposite on North slope
-Install two leak detection ports on North slope
- Install Leachate leak detection pipe
- Install GCL and geomembrane on South Transition Berm

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):



NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/23/2021 6:45	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner Crew		
WEATHER CONDITIONS:	Sunny, 12 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Witness geosythetic installation activities in Landfill area

SITE NOTES / PROGRESS:

-Observed crew placing geocomposite on North Slope and North-East Corner
-Witnessed destructive test, DT-11, field sheer and peel and sent sample to lab
-Observed Field fit of leak detection port on North Slope nearest to the sump

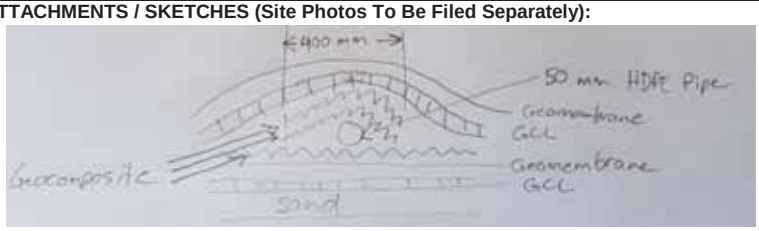
Construction notes on leak detection port:
-Leak detection port was field fit with Engineer present
-50 mm HDPE pipe was run along geomembrane, 3 m perforated section was placed on Geocomposite (see sketch below)
- Two 40 cm wide strips of geocomposite were placed on top of perforated section and heat seamed to layer below
- Installation achieves hydraulic connectivity with the inter-membrane space and will prevent the upper GCL from deforming around perforated pipe
- Lack of depression where perforated pipe sits will make it difficult to detect small volumes of leachate flowing past leak detection port
-Port will function acceptably for detecting large volumes or leachate pooled on the geomembrane in the area

Next Steps

-Complete installation of geocomposite on North slope
-Install second leak detection port on North Slope
-Insalll leachate leak detection pipe in sump
-Place GCL and Geomembrane on South Transition Berm
-Weld 600 mm leachate collection pipe, fusion machine expected to arrive today

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):



NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/24/2021 7:00	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner Crew		
WEATHER CONDITIONS:	Sunny, 12 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Witness geosythetic installation activities in Landfill area

SITE NOTES / PROGRESS:

-Geomembrane installation on South Transition Berm completed yesterday, panels 31 - 45
-Second leak detection port on North Berm installed yesterday, see Aug 23 Field Inspection notes for installation details
-Observed crew placing geotextile on west side of landfill
-Observed crew placing leak detection pipe in sump
-Observed crew placing geomembrane by toe of west slope
-Spoke to Briand and Joe about need for additional geocomposite at transition to sump
-Witnessed test seem field peel and sheer tests

Next Steps

-Complete installation of GCL and geomeombrane on North Slope
-Place sand in sump
-Place additional geocomposite where needed to ensure hydraulic connectivity between geocomposite layer and leak detection pipe in sump

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/25/2021 6:15	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner Crew		
WEATHER CONDITIONS:	Clear sky, 10 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Witness geosythetic installation activities in Landfill area

SITE NOTES / PROGRESS:

-Geomembrane panels 46 - 58 and underlying GCL installed on North Berm yesterday
-Observed crew installing geomembrane on North-East corner
-Witnessed test weld peel and sheer test
-Collected destructive test DT-12 and sent to lab
-Observed 600mm HDPE pipe welding
-Observed placement of 300 mm leak detection pipe
-Observed crew backfilling leak detection pipe

Leak detection pipe details:

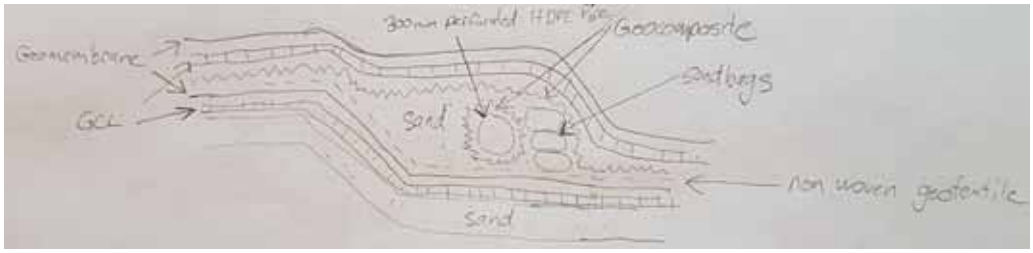
-The following modifications from design were observed and approved in the field by the Engineer:
-Sandbags were placed on east side of perforated pipe to secure pipe in place
-300mm perforated HDPE pipe was wrapped in geocomposite to maintain hydraulic connectivity between pipe and sandbags
-Non-woven geotextile was installed above lower geomembrane layer
-See sketch of installation below

Next Steps

-Complete installation of GCL and geomeombrane on North-East Corner
-Install Geocomposite on slopes
-Install non-woven geotextiile on remainder of landfill floor

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):



NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/26/2021 6:45	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner Crew		
WEATHER CONDITIONS:	Overcast, light rain 16 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Witness geosythetic installation activities in Landfill area

SITE NOTES / PROGRESS:

-Geomembrane panels 59 - 70 installed yesterday, geomembrane installation is now complete
-600 mm leachate collection pipe section welded yesterday and ready to be installed in sump
-Observed crew placing geocomposite on north slope
-Collected destructive test DT-13, panel 67/68, and sent to lab

Next Steps

- Complete installation of geocomposite on landfill slopes
- Install 600 mm HDPE leachate pipe in sump
- Install non-woven geotextile on remainder of landfill floor (East side)

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/27/2021 7:00	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Joe Cassidy, Brian Fagan, Liner Crew		
WEATHER CONDITIONS:	Sunny, 14 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Witness geosythetic installation activities in Landfill area

SITE NOTES / PROGRESS:

-Geocomposite installation complete on slopes
-Observed crew placing non-woven geotextile on floor of landfill

Next Steps

- Complete installation of geotextile on landfill floor
- Weld / place 200 mm HDPE leachate collection system
- Place stone drainage layer on landfill floor

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	8/28/2021 7:45	**SITE:**	Upland landfill
PERSONNEL ON SITE:			
WEATHER CONDITIONS:	Sunny, 12 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Inspect geotextile and geocomposite installation

SITE NOTES / PROGRESS:

-Geotextile installation on landfill complete
-Installation of geotextile and geocomposite is acceptable for placement of leachate collection pipe and stone drainage layer

Next Steps

- Seal geomembrane penetrations Landfill: 4 x 50 mm HDPE leak detection conduit, 1 x 300 mm HDPE leachate leak detection pipe
- Seal geomembrane penetration Leachate Treatment Pond: 1 x 300 mm leak detection pipe
- Weld / place 200 mm HDPE leachate collection pipe
- Place stone drainage layer on landfill floor

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	Dave Engstrom	**PROJECT NUMBER:**	11222680
DATE/TIME:	8/30/2021 9:00	**SITE:**	Upland Landfill
PERSONNEL ON SITE:	Brian Fagain; Liner Installation Contractor; Terry Stuart		
WEATHER CONDITIONS:	Sunny; 13-15 deg C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

Observe cell preparation for placement of drain rock and install of pipe boots for the cell and leachate pond underliners.

SITE NOTES / PROGRESS:

Discussed with Brian Fagan regarding schedule for producing drain rock. Tentative plan is to begin producing tomorrow when Brad Maxwell is on-site (8/31 follow-up - Brad provided an update that drain rock production would begin on Wednesday, 9/1).

Observed pipe boots with extrusion seams vacuum box tested at the leachate pond and the cell. Geocomposite was to be placed over the pipe boot at the cell.

Walked the cell for any new damage or concerns prior to drain rock install. No concerns or issues observed.

Next Steps

Coordinate with Brad Maxwell regarding schedule for production and placement of drain rock in the cell for next site visit.

OUTSTANDING INFORMATION / NEW ISSUES:

No issues observed during site visit.

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	Dave Engstrom	**PROJECT NUMBER:**	11222680
DATE/TIME:	9/1/2021 7:30	**SITE:**	Upland Landfill
PERSONNEL ON SITE:	Brad Maxwell; Kris Goodridge		
WEATHER CONDITIONS:	Sunny; 10-15 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

Observe cell preparation for placement of drain rock.

SITE NOTES / PROGRESS:

Met Brad Maxwell and Kris Goodridge on-site to discuss approach installing drain rock. Upland plans to mark locations of leachate pipes (to avoid placing drain rock until pipe is in place), construct a 1 m high road at the center of the cell for dumping with drain rock, placing the drain rock using a low-ground pressure excavator (CAT 315F) and placing the drain rock close to the surface (not dropping from high up). General approach will be to construct three roads from the west side future tie-in, place along the east toe and work back to the west tie in to push out any wrinkles.

Drain rock visually appeared to be in substantial conformance with the project specifications.

Leachate collection piping was inspected and found to be in conformance with the specifications. Confirmed with pipe fitter that thermal butt fusion of piping was in accordance with manufacturer's recommendations. Inspected fusion welds and found no issues.

Observed placement of drain rock at west end of cell by large mining rock truck (outside of cell). Excavator operator excavated from pile and placed in cell to start 1 m high road. Discussed with Kris and Upland plans to continue this approach until 1 m high road is started and CAT 370 rock truck will place on the road for placement by the excavator.

Next Steps

Coordinate with Upland for progress and visit site for progress check-in of the 1 m high drain rock road.

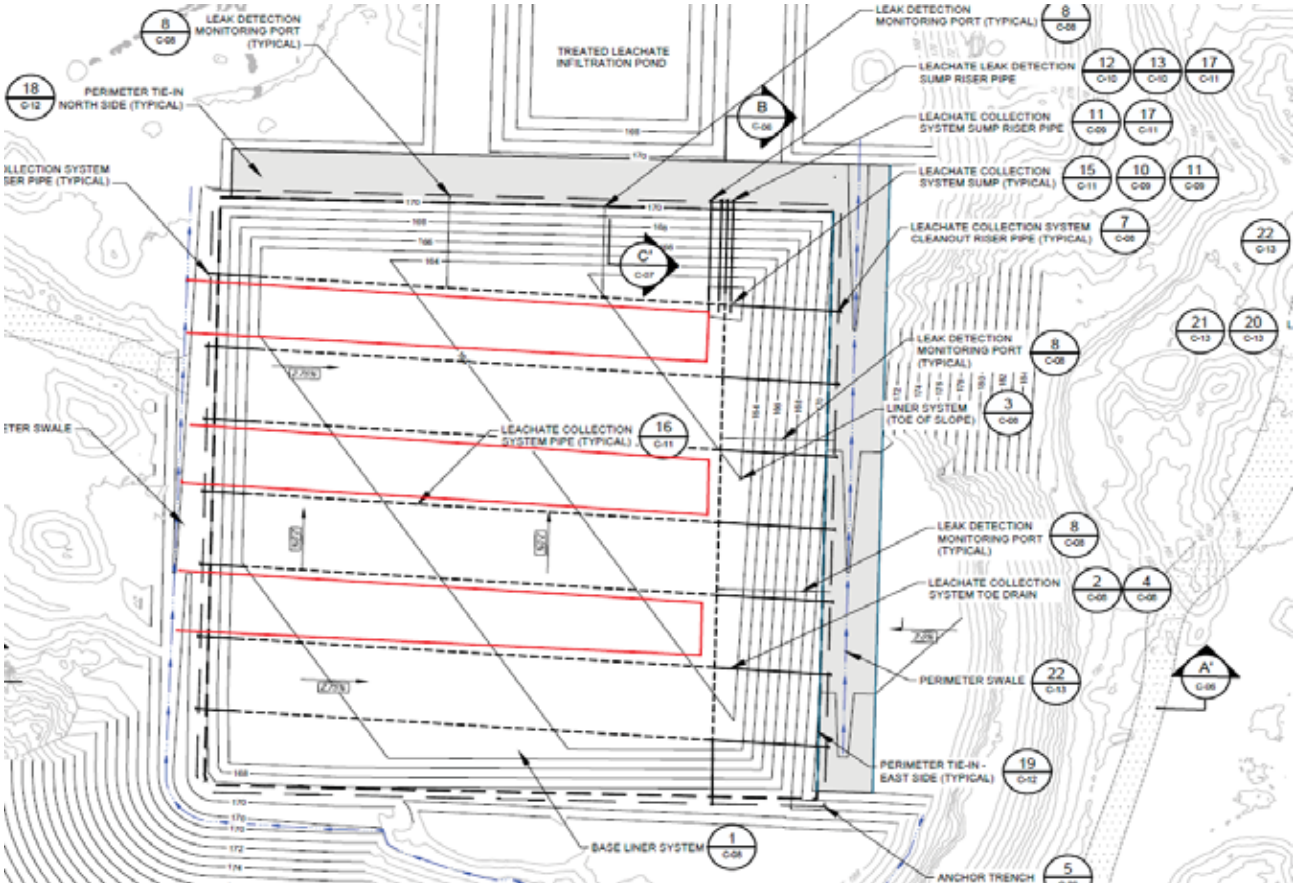
OUTSTANDING INFORMATION / NEW ISSUES:

No issues observed during site visit.

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

See attached sketch for haul road locations.

NOTE: All site photos to be filed in the Project Folder on the Project Portal.



Planned location of three 1 m high drain rock roads.

Field Notes

NAME:	Dave Engstrom	**PROJECT NUMBER:**	11222680
DATE/TIME:	9/2/2021 11:30	**SITE:**	Upland Landfill
PERSONNEL ON SITE:	Kris Goodridge		
WEATHER CONDITIONS:	Sunny; 15-17 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

Observe cell preparation for placement of drain rock.

SITE NOTES / PROGRESS:

Met Kris Goodridge on-site to discuss progress of drain rock and planned date for leachate collection piping installation (ETA Weds. 9/8).

Observed hauling, stockpiling and placement of drain rock on center minimum 1 m high drain rock road by the CAT 370 rock truck and CAT 315 low ground pressure dozer. Haul truck dumped drain rock on the 1 m high access road as a temporary stockpile. Excavator placed material in the cell by dropping from approximately less than 1 m from geosynthetics. Upland plans to continue this approach tomorrow and next Tuesday.

Collected a 5 gallon bucket sample of drain rock placed in the cell for quality assurance testing (sieve analysis).

Next Steps

Coordinate with Upland for progress and visit site for progress check-in of the 1 m high drain rock roads, placement of the leachate collection piping, and backfill over the leachate collection piping.

OUTSTANDING INFORMATION / NEW ISSUES:

No issues observed during site visit.

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	9/9/2021 14:30	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Kris Goodrich		
WEATHER CONDITIONS:	21 C		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Inspect drainage layer installation

SITE NOTES / PROGRESS:

-2 900 mm high roadway of drainrock installed from west to east toe
-3rd drainrock roadway being installed, rock trucks hauling and placing on top of lift and excavator being used to push material
-traffic cones being used to mark elevation of lift
-Two leachate riser pipes installed in sump,braced to temporary lock block
-4 perforated lengths of leachate collection pipe welded and ready to be placed in drainage layer.

Next Steps

- Finish placing 3rd 900 mm high drainrock road
- place perforated leachate collection pipes
- place 300 mm lift of drainrock on base of landfill

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	9/14/2021 7:30	**SITE:**	Upland landfill
PERSONNEL ON SITE:	Kris Goodrich, HDPE Welding Crew, Equipment Operators		
WEATHER CONDITIONS:	13 C raining		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Inspect drainage layer installation

SITE NOTES / PROGRESS:

-3 900 mm high roadway of drainrock installed from west to east toe complete. Traffic pilons with ribbons being used to indicate required heigh of lift
-Observed HDPE welding crew setting up to weld non- perforated leachate riser pipes. Party tent being used to shield welding area from rain
-Perforated leachate pipes placed on landfill floor ready for backfill

Next Steps

- Finish welding leachate riser pipes
- place 300 mm of drain rock on floor of landfill

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.

Field Notes

NAME:	David Barbour	**PROJECT NUMBER:**	88877
DATE/TIME:	9/22/2021 14:30	**SITE:**	Upland landfill
PERSONNEL ON SITE:	HDPE Welding Crew, Equipment Operators		
WEATHER CONDITIONS:	14 C Sunny		

HASP for this project can be found on project portal

SITE VISIT OBJECTIVE:

- Inspect drainage layer installation

SITE NOTES / PROGRESS:

-HDPE Leachate collection pipe installation complete on base of landfill
-Obseved crew placing placing 300 mm lift of drain rock with Caterpillar D5 dozer, using traffic pilons to indicate required depth. Dozer was pushing material from 900m lift onto geotextile to required depth

Next Steps

- Fuse solid HDPE leachate collection risers and install on east berm
- Continue placing drain rock on remainder of landfill footprint
- Install HDPE leachate risers

OUTSTANDING INFORMATION / NEW ISSUES:

ATTACHMENTS / SKETCHES (Site Photos To Be Filed Separately):

NOTE: All site photos to be filed in the Project Folder on the Project Portal.



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The Power of Commitment

Cell 1 West Construction Report

Cell 1 West Construction Report

Northwin Landfill

Upland Excavating Ltd.

19 March 2024



DRAFT

The Power of Commitment

DRAFT

GHD Limited 735
138 East 7th Avenue, Suite 100
Vancouver, BC V5T 1M6, Canada

Document status

Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S3	00	David Barbour	Roxy Hasior		Rose Marie Rocca		March 19, 2024
[Status code]							

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Appendix A Record Drawings
Appendix B Photograph Log
Appendix C Material Test Results
Appendix D Product Data
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1. Introduction

The Northwin Landfill (Landfill or Site) is owned by Upland Excavating Ltd. (Upland) and operated by Northwin Environmental (Northwin). The Site has an area of approximately 48 hectares (ha) and is located at civic address 7295 and 7311 Gold River Highway, Campbell River, BC, approximately 7 kilometres (km) southwest of Campbell River city centre. The Site operates as a sand, gravel and rock quarry and a waste management facility.

This Construction Report (Report) documents the construction of Cell 1 West carried out by Upland Contracting Ltd. (Contractor), Northwin and other contractors hired by Upland.

The Report has been prepared by GHD for Upland for submission to the Ministry of Environment and Climate Change Strategy (ENV) as required by Section 2.11 of the Landfill's OC and also satisfies the requirements of Section 10.2 of the Landfill Criteria for Municipal Solid Waste (Second Edition), BC Ministry of Environment, June 2016 (the Criteria).

Upland, as the OC holder retained GHD to act as the Qualified Professional (QP) for this project scope. In this capacity, GHD designed the civil work for Cell 1 West, carried out inspections during construction, and completed this construction report.

1.1 Project Scope

Cell 1 West is the second cell constructed in the Landfill. In accordance with the 2022 Design Operations and Closure Plan (DOCP) for the Landfill and the detailed design, the Cell 1 West base consists of a double liner system and includes a leak detection layer. Leachate generated from the Landfill will be collected within the cell and conveyed to the existing Cell 1 East sump, and then to the leachate treatment system. The leachate treatment system is a batch treatment system and includes the leachate collection system, aerated equalization pond, a treated leachate holding pond and an infiltration pond, which were initially designed and constructed in 2021.

The composite double liner system for Cell 1 West is comprised of a primary and secondary base liner. The primary base liner refers to the composite liner system that consists of an HDPE geomembrane liner and geosynthetic clay liner (GCL) which underlies the leachate collection system, and the secondary base liner refers to the composite liner system comprised from of an HDPE geomembrane liner and GCL which underlies the leak detection system.

The leachate collection system includes perforated leachate collection pipes within a stone drainage blanket sloped towards the leachate sump, with the following components:

- 300 mm thick, 50 mm diameter, clear, round stone drainage blanket, with minimal fines
- Perforated leachate collection pipes (LCP) with minimum diameter of 200 mm
- Maximum 15 m lateral spacing between leachate collection pipes (LCP) running south to north
- Maximum 50 m drainage path for leachate to travel before it is intercepted by the LCPs
- Clean-outs at each end of the LCPs
- Leachate collection header pipe at the east end of the Landfill running towards the leachate collection sump at a minimum slope of 2 percent
- Leachate sump at elevation 164 m AMSL with two leachate sump riser pipes with diameters of 450 mm
- Leak detection system with four 50 mm leak detection monitoring riser pipes

2. Construction Narrative

The following sections provide the construction narrative for Cell 1 West. Record drawings are provided in Appendix A.

Construction activities began on October 12, 2022, and were completed on September 22, 2023

In general, construction generally progressed as follows:

- Site preparation and excavation

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– Cell 1 West double liner installation
– Cell 1 West leachate collection and leak detection system installation

2.1 Site Preparation & Excavation

Site preparation activities including excavation of the Cell 1 West base, preparation of subgrade contours, and construction of berms around the Cell 1 West perimeter began in September 2022 and continued through October 12, 2022. Site preparation works were completed prior to GHD arriving on site.

2.2 Cell 1 West - Composite Double Liner

Joe Cassidy (Liner Installer) was hired as an independent contractor to oversee the geosynthetic installation. Mr. Cassidy is an experienced liner installer with over thirty years of experience in the industry. Several experienced liner technicians were also hired for the installation and worked alongside Upland (the Contractor) employees with Mr. Cassidy overseeing the work. The geosynthetic installation crew mobilized to site on October 12, 2022 and the installers met with GHD to confirm QA/QC requirements.

Installation of geosynthetics in the Cell 1 West began on October 14, 2022. The QA/QC program for the construction of the base liner systems included non-destructive testing of each seam. Details of the QA/QC program are described in Section 3.

The geosynthetic deployment began with the placement of a non-woven geotextile on the slopes and floor of the landfill cell, starting at the Cell 1 East tie in berm. Geosynthetic rolls were deployed using a telehandler forklift. An excavator was used to deploy geosynthetics for the rest of the Landfill cell.

GCL was placed over top of the non-woven geotextile. Rolls in the east section of the cell were installed in a north-south direction working from the east end of the landfill to the west. For the west section of the cell, rolls were installed in a west-east direction working from the north end of the landfill to the south. The seams of the GCL were overlapped, with the crew using factory provided indicating lines that marked the minimum overlap. The seams were heat seamed shortly after the GCL deployment. In general, the geomembrane was installed on top of the GCL as soon as the width of GCL panels would allow. This process continued until the primary GCL and geomembrane layer was installed across the landfill floor.

Geocomposite installation began after the primary geomembrane installation on the landfill floor. The geocomposite was installed with panels in the same direction starting near the north toe working south. A skid-steer with smooth rubber tracks was used to deploy the geocomposite on the liner while an excavator held the rolls. GHD observed the procedures being followed by the operators and determined they were acceptable to avoid damage to the liner. The deployment procedure involved using a leaf blower to remove any debris from the area being driven on, having a spotter observe the geomembrane between the skid-steer tracks and the geo-composite, and skid steer operator never turning the equipment on the exposed geomembrane. Nylon cable ties were applied at 1.5 m intervals at the edge netting and the overlapping geotextile was heat seamed.

As the geocomposite was being placed on the base of the landfill, the crew began deploying non-woven geotextile on the slopes of the landfill. The geotextile rolls were held with an excavator while the crew placed the material manually on the slopes. The geotextile was heat seamed shortly after deployment.

The GCL was placed on the slopes after the geotextile using the same method. GCL was heat seamed shortly after it was placed and covered with the second layer of Geomembrane. The primary layer of GCL and geomembrane was completed and tied into the geosynthetics on the floor of the landfill before the secondary containment layers were installed. The same procedures were followed to install the secondary geomembrane. The smooth tracked skid steer was used to pull the geosynthetics on the base of the landfill and while the excavator held the rolls and materials were pulled by hand down the slopes. Installation of geosynthetics was completed on November 20, 2022, with the final placement of non-woven geotextile on the floor of the landfill.

Some damage to the liner was observed and repaired on November 18, 2022. Photos of the repairs are provided in the Appendix B (photo log).

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2.3 Leachate Collection System

The Contractor began installing the leachate collection pipes and the stone drainage layer in November of 2022 after completion of the geosynthetics work, however construction was postponed for the winter and resumed on June 7, 2023.

The leachate collection system was installed per the drawings with one 300 mm HDPE leachate collection header pipe running south to north, and seven 300 mm HDPE leachate collection pipes running west to east. To facilitate installation of the leachate collection system over the liner, the Contractor initially placed the stone drainage layer in 3 rows of 900 mm high lifts to form roadways from the south to the north side of the landfill cell. The material was hauled with rock trucks and placed with an excavator. Traffic cones were used for visual aids to ensure the minimum 900 mm depth of material was placed. After the drain rock roads were built the Contractor fused and placed perforated leachate collection pipe on the base of the landfill. A Caterpillar mini excavator was then used to spread the drain rock in 300 mm lifts across the floor of the landfill. The Contractor placed woven geotextile on top of the drain rock, completing the leachate collection system installation.

2.4 Close-Out

GHD performed an inspection of the Cell 1 West Works on July 7, 2023, and created a deficiency list which was provided to the Contractor. All deficiencies were addressed to the satisfaction of GHD and Upland by September 22, 2023.

3. Construction Quality Assurance & Quality Control

GHD carried out regular inspections throughout the duration of the construction to assure construction quality and quality control (QA/QC). The QA/QC program included product data review and geosynthetics installation QA/QC according to the design specifications.

A photo log with select photographs from throughout the construction is provided in Appendix B. Appendix C provides the material test results. Product data sheets and reviewed submittals are provided in Appendix D. Appendix E provides geosynthetics QA/QC information including the results of destructive and non-destructive quality testing. GHD's inspection notes from select field inspections during liner installation are included in Appendix F.

3.1 Earthworks

Site preparation and excavation activities were completed by the contractor prior to GHD's first inspection. Based on GHD's earthworks inspection was conducted prior to geosynthetics placement, the materials installed were in conformance with design specifications and drawings (refer to Section 4.1).

3.2 Leachate Collection System & Leak Detection Piping

QA/QC activities carried out during leachate collection system installation include the following:

– Inspection to witness placement of materials
– Review of submittals for pipe materials
– Review of results of sieve analysis performed on a sample of drain rock material collected by Contractor. A total of 1 sample was collected and analysed (results are presented in Appendix C).

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3.3 Geosynthetics QA/QC

The Liner Installer performed QA/QC according to the design specifications on all geomembrane installed. QC included performing field sheer and peel on a test weld before welding began and whenever conditions changed, pressure testing each welded seam, recording roll number and location of each panel placed, location of each repair. After each repair was made the weld was tested with a vacuum box.

GHD collected samples of welds at intervals less than 300 m of seams. The samples were sent to TRI Environmental Inc. for peel and sheer testing and the results were reviewed by GHD. Laboratory results are presented in Appendix E.

Geotextile material met the specifications and was installed both on the side slopes per the design and the landfill base. The geotextile on the landfill based was installed in place of the bedding sand in the design and was approved by GHD.

Geocomposite material met the specifications and was installed both on the side slopes per the design, and on a portion of the west berm of the cell base, a design change that was approved by GHD. The affected area is shown on the record drawings and notes are provided in the June 13 inspection report.

4. Conformance with Design

In general, the construction of the Cell 1 West landfill cell was carried out according to the design and specifications prepared by GHD. The below documents conformance with the original design.

4.1 Earthworks

A berm was constructed on the north end of Cell 1 West, along the road from approximately the middle of Cell 1 West to the western edge. This berm was not included in the design or inspected by GHD.

Material was left on a portion of the cell base along the western edge of Cell 1 West to cover a bedrock outcrop. This was completed to protect the liner and achieve minimum depth to groundwater. The remainder of the earthworks were carried out in accordance with the design.

4.2 Leachate Collection System & Leak Detection Piping

The 300 mm HDPE leak detection system riser was constructed as shown on Detail 15 of Drawing CI-0104.The perforated portion of the pipe was wrapped in geo-composite and sandbags were placed on the east side of the pipe to secure the pipe in place. Wrapping the pipe in geo-composite ensured there was hydraulic connectivity around the pipe.

A sample of the drain rock was collected to carry out sieve analysis and confirm whether gradation met design specifications. The results of the sieve analysis showed gravel larger than 50 mm and fines content above the design specification. The fines content was less than or equal to 1% and the material was accepted by GHD.

The stone drainage layer was placed on the non-woven geotextile layer. The Contractor exposed the top of leachate pipe by hand to confirm pipe location prior to mounding drainage rock overtop to a depth of greater than 300 mm. The area was visually inspected and large rocks were identified and removed from the cell.

During an inspection, GHD noted that 20% of loads placed within a 20 x 30 m area on the southeast section of the cell had silty sand mixed into the drainage rock. Upland discussed with the loading operator to avoid material sitting directly on the pit floor, which resulted in the material meeting specifications and resolving the material issue.

The remaining components of the leachate collection system and leak detection piping were installed in conformance with the design drawings and specifications.

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4.3 Geosynthetics

Non-woven geotextile was placed on the subgrade in place of bedding sand, on the landfill base as well as the side slopes. The geotextile placed on the landfill base was a deviation from design, which was approved by GHD.

Geocomposite material was placed on an area of the west side of the cell where a grade break was present due to the bedrock outcropping mentioned in Section 4.1. =

All other geosynthetics were installed in conformance with the design.

5. Certification

This construction report dated MONTH X, 2024, demonstrates that the Cell 1 West has been constructed in accordance with OC and the most recent DOCP, with the changes noted below and approved by the undersigned during construction. Qualified Professionals completed inspections before and during construction of Cell 1 West.

This construction report includes the information described in Section 10.2 Construction Report(s) of the Landfill Criteria and Section 2.11 of the OC, specifically:

- Changes from the original design that were approved during construction
- As-built record drawings of Cell 1 West
- All inspection and testing reports
- Quality control and quality testing results
- Soil test data including field and laboratory testing

All of Which is Respectfully Certified and Submitted by:

GHD

Deacon Liddy

David Barbour

Roxy Hasior

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Cell 1 East, Cell 1 West & Ponds
Commissioning Report

Cell 1 East, Cell 1 West & Ponds Commissioning Report

Northwin Landfill

Northwin Environmental

22 March 2024



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Table 5.2 Summary of Treated Leachate Samples During Commissioning Period 4

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Figure 3.1 Leachate Treatment Process 2

Appendices

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Appendix B Photograph Log
Appendix C Laboratory Analytical Reports

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1. Introduction

1.1 Purpose of this Report

The Northwin Landfill (landfill) is owned by Upland Excavating Ltd. (Upland) and operated by Northwin Environmental (Northwin). The landfill is located on the Upland property at civic address 7295 and 7311 Gold River Highway, Campbell River, British Columbia (Site), approximately 7 kilometers (km) southwest of Campbell River city centre. The Site operates as a sand, gravel and rock quarry, and a waste management facility.

This Commissioning Report (Report) documents the initial leachate characterization and confirmation of treatment process capabilities during the commissioning period of Cell 1 East and Cell 1 West, carried out by Upland Contracting Ltd. (Contractor), Northwin, and other contractors hired by Upland. The Leachate Treatment Facility (LTF) Commissioning Plan is provided in Appendix F of the 2021 Design, Operation, and Closure Plan (DOCP).

The Report has been prepared by GHD for Upland for submission to the Ministry of Environment and Climate Change Strategy (ENV) fulfilling the requirements of Section 2.6(b) of the Landfill's Operational Certificate 107689 (OC).

Upland, as the OC holder retained GHD to act as the Qualified Professional (QP) for this project scope. In this capacity, GHD reviewed and summarized the sampling results taken during the commissioning period to determine the performance of LTF.

2. Leachate Treatment Concept

The leachate treatment system is designed to treat the landfill leachate to meet the BC Contaminated Sites Regulation (CSR) Schedule 3.2 Drinking Water Criteria (discharge criteria) prior to discharge to the infiltration pond.

A series of perforated pipes installed at the base of the landfill cell convey leachate to the existing Cell 1 East sump and the Cell 1 West sump. Pumps in perforated pipes within the Cell 1 East sump and Cell 1 West sump, pump leachate to the LTF. The pumps are controlled by level transducers.

The LTS is a batch treatment system, generating a batch of effluent for infiltration. To target operation of a weekly batch at the peak daily leachate generation rate, an average batch size is considered to be 625 m^3, with the maximum batch size to be 1,400 m^3. A batch size may vary, requiring operational adjustments to the treatment system.

The process begins with aerated equalization, where the aerated equalization pond is filled, and undergoes aeration during filling. The leachate is pumped through a shipping container where chemicals for oxidization, pH adjustment and/or coagulation/flocculation can be added inline through injection ports. After chemical addition, leachate can be recirculated to the equalization pond or a clarifier for settling/precipitation of solids. The water is then pumped through a series of sand filters before entering the effluent holding pond and/or pumped through Granular Activated Carbon (GAC) filters. The effluent batch will be held in the effluent holding pond and sampled and sent for laboratory analysis. Following receipt of sample results, the batch will then be pumped to the infiltration pond or recirculated through the treatment steps as required to meet discharge criteria. During operations the batches will be tested periodically to confirm discharge criteria are being met.

The leachate treatment system will reduce the concentration of leachate constituents by the processes described below:

– Aeration oxidizes dissolved metals such as iron and manganese to less soluble forms and produces flocs that will be filtered. Concentrations of other metals present in the leachate that are not readily oxidized in an aeration lagoon will also be reduced when the suspended (not dissolved) components of these metals are filtered in the sand filters. Oxidization can also be enhanced by adding oxidization chemicals.

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– Hydrocarbons and volatile organic compounds will be readily volatized in an aeration lagoon thereby reducing the concentration. If concentrations of organic compounds are required to be further reduced, the effluent will be filtered through a GAC filter.
– The dissolved metals will be removed, if required by chemical precipitation, by adding a volume of chemicals (i.e., mild acids or bases) that will cause an increase or decrease of pH of the leachate to facilitate the formation of an insoluble salt.

Should leachate quality change over time and additional leachate constituents require treatment, the process can include a polishing step to continue to meet the CSR Schedule 3.2 Drinking Water Criteria.

3. Summary of Construction

Construction of the LTF was completed with the liner installation on the effluent holding pond on October 19, 2021. The effluent pond was expanded in November with construction completed on November 12, 2021. All components of the LTF were tested by Northwin. GHD observed the functioning of pumps through each stage of the treatment process on December 2, 2021. A drawing of the leachate treatment works layout is provided in Appendix A.

The leachate treatment process is depicted in Figure 3.1 below.

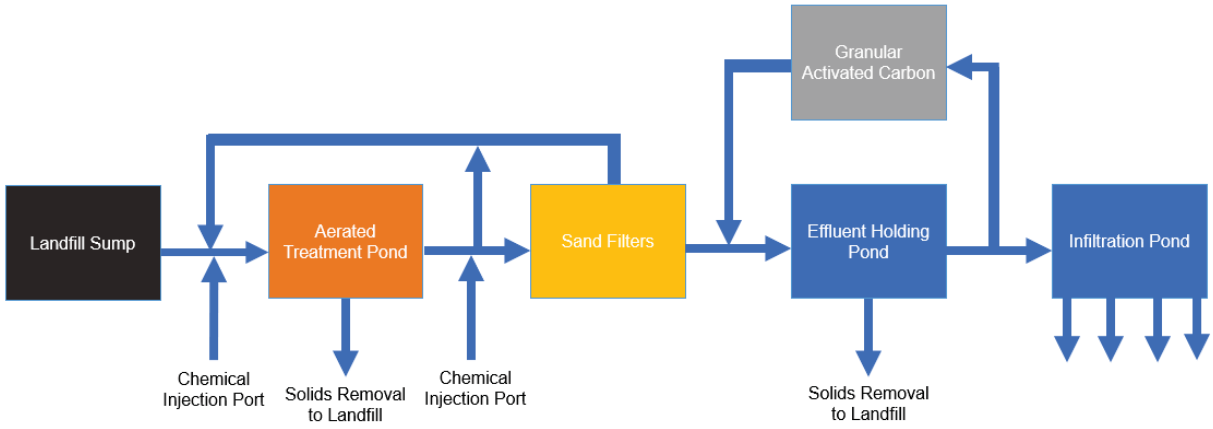


Figure 3.1 Leachate Treatment Process

3.1 Observed Deficiencies and Corrective Actions

The effluent holding pond constructed in October 2021 was undersized. A larger effluent holding pond of appropriate size was constructed in November 2021.

4. Commissioning Activities

The commissioning activities support initial leachate quality characterization and confirm treatment process capabilities. the commissioning activities summarized below.

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Clean Water Testing and Equipment Commissioning

Clean water testing was the initial step in the LTF commissioning in the fall of 2021. The hydraulic integrity of all major process ponds, tanks, pumps, piping, and appurtenance was verified via clean water testing prior to the commencement of start-up and commissioning activities. Process equipment (blowers, pumps, and aeration system) was also commissioned by manufacturer representatives prior to start-up activities. All necessary process chemicals were delivered to Site prior to commissioning and all control systems were tested to verify automatic control functions prior to initiation of start-up activities.

Sampling Activities

During the commissioning period, untreated leachate samples were collected from the effluent holding pond prior to discharge to the infiltration pond. This will aid in leachate characterization and establish a baseline for determining the effectiveness of the leachate treatment process.

Samples were analyzed for the comprehensive set of parameters presented in the attached Tables 1 through 4 to confirm the parameters of concern within the leachate.

5. Analytical Results

Influent and treated leachate samples were collected and submitted to ALS Environmental (ALS) in Burnaby, BC. Samples were analysed for one or more of the treatment parameters listed in the LTF Commissioning Plan (refer to Appendix F of the DOCP) which include dissolved metals, hardness, chemical oxygen demand (COD), alkalinity, sulphate, sulphide, sodium, pH, total dissolved solids (TDS), total suspended solids (TSS), and polycyclic aromatic hydrocarbons (PAH). Parameter concentrations were compared to the CSR Schedule 3.2 Drinking Water Criteria. If treated leachate concentrations met the discharge criteria, then the treated leachate was discharged to the infiltration pond. If the discharge criteria were not met, leachate continued treatment.

During the commissioning period between December 2021 to December 2023, 24 sampling events were completed. Influent samples were collected by GHD and are summarized in Table 5.1. Treated leachate samples were collected by Northwin and are summarized in Table 5.2. Laboratory reports are provided in Appendix C.

Table 5.1 Summary of Influent Leachate Samples During Commissioning Period

Sample Date	Lab Report No.
June 03, 2021	C138327
November 16, 2021	C188804
April 01, 2022	C221453
June 22, 2022	C244592
September 8, 2022	C268908
November 17, 2022	C268889

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Table 5.2 Summary of Treated Leachate Samples During Commissioning Period

Sample Date	Lab Report No.	Discharge Criteria Results	Treatment Continued or Discharged
December 8, 2021	VA21C7462	– 001: Quinoline	Treatment continued
December 15, 2021	VA21C7962	– 001: Quinoline	Treatment continued
January 7, 2022	VA22A0431	– 001: No exceedances	Treatment continued
January 12, 2022	VA22A0612	– 001: No exceedances	Discharged
February 23, 2022	VA22A3490	– 001: Sulphate, lithium, manganese, benzo(b)pyridine (Quinoline) – 002: Sulphate	Treatment continued
March 29, 2022	VA22A6872	– 001: Sulfate, manganese, quinoline	Treatment continued
April 11, 2022	VA22A7623	– 001: Sulfate, manganese, quinoline	Treatment continued
June 07, 2022	VA22B2754	– 001: Sulfate	Treatment continued
July 01, 2022	VA22B5020	– 001: Quinoline, cobalt	Treatment continued
July 29, 2022	VA22B7883	– 001: No exceedances	Discharged
July 29, 2022	VA22B7886	– 001: Boron, cobalt, sodium	Treatment continued
November 2, 2022	VA22C6839	– 001: Sulfate, boron, sodium	Treatment continued
February 2, 2023	VA23A2628	– 001: No exceedances	Discharged
February 13, 2023	VA23A3351	– 001: Boron, quinoline	Treatment continued
March 6, 2023	VA23A4848	– 001: Arsenic, boron, quinoline	Treatment continued
March 30, 2023	VA23A6860	– 001: No exceedances – 002: No exceedances	Discharged
April 14, 2023	VA23A8082	– 001: Boron, sodium	Treatment continued
October 23, 2023	VA23C5387	– 001: Sulfate, boron, benzo(a)pyrene, quinoline	Treatment continued
November 21, 2023	VA23C7975	– 001: No exceedances – 002: No exceedances	Discharged
December 11, 2023	VA23C0976	– 001: No exceedances	Discharged
December 18, 2023	VA23D0378	– 001: Benzo(a)pyrene, quinoline – 002: No exceedances	Treatment continued Discharged

6. Maintenance and Performance Monitoring Plan

To assist in the operation and maintenance of the LTF, a Maintenance and Performance Monitoring Plan has been developed to monitor the performance of the LTF and to identify modifications where necessary.

Influent and Chemical Jar Testing

To optimize chemical dosing to suit the influent leachate characteristics, on-site jar testing will be conducted at the same time as clean water testing. Influent samples will be collected to create an initial leachate profile. LTF operators will conduct jar tests with various chemicals and dosages to evaluate the effectiveness and appropriate dose conditions for removal of target parameters. The jar tests will be used to set initial batch volume chemical dosage rates.

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Future Sampling Activities

To meet discharge quality objectives, treated leachate will be sampled regularly to develop a relationship between the parameters of concern within the leachate and the batch treatment sampling program, as well as to monitor the performance of the LTF and chemical dosage.

Each batch of effluent will be sampled from the effluent holding pond and analyzed for a comprehensive set of parameters to determine if a batch can be discharged to the infiltration pond. The effluent will only be discharged to the infiltration pond if the effluent meets the CSR Schedule 3.2 DW criteria. Dependent on the analytical sampling results, leachate will either be recirculated back through the treatment process for additional treatment or, if the effluent meets CSR Schedule 3.2 Drinking Water Criteria, discharged into the infiltration pond.

The effluent sampling results will be used to establish the parameter list for compliance sampling throughout the operation of LTF. Based on leachate quality forecasting discussed in the DOCP, the key leachate parameters will be chemical constituents commonly found in construction and demolition waste, and contaminated soil leachate which may include:

- Chloride
- Sulphate
- Boron
- Iron
- Manganese
- Sulphide
- Arsenic
- Sodium
- PAHs

In addition to sampling to meet discharge quality objectives, leachate will also be sampled to monitor the performance of the treatment process and to observe changes to leachate quality over time as additional waste is added to the landfill. The following parameters may be used to develop an understanding of the system performance and to assist in the operation and maintenance of the LTF:

- Chemical Oxygen Demand (COD)
- Alkalinity
- CSR Metals including hardness
- pH
- TDS
- TSS

Northwin and GHD will continue to monitor parameters and observe changes to the leachate quality, if any.

7. Certification

This commissioning report demonstrates that Cell 1 East, Cell 1 West and Ponds have been commissioned in accordance with the OC and the 2021 DOCP. QPs completed inspections before and during commissioning of Cell 1 East, Cell 1 West and the Ponds.

This commissioning report includes the information described in Section 2.6(b) of the OC, and LTF Commissioning Plan presented in the 2021 DOCP, specifically:

- Summary of commission activities including sampling activities
- Summary of analytical results of influent leachate and effluent sampling
- Copy of all calibration reports and laboratory analytical reports
- Comments on any observed deficiencies in the LTF design or performance, and a plan for addressing any such deficiencies
- Maintenance and performance monitoring plan

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All of Which is Respectfully Certified and Submitted by:

GHD

Deacon Liddy

Rose Marie Rocca

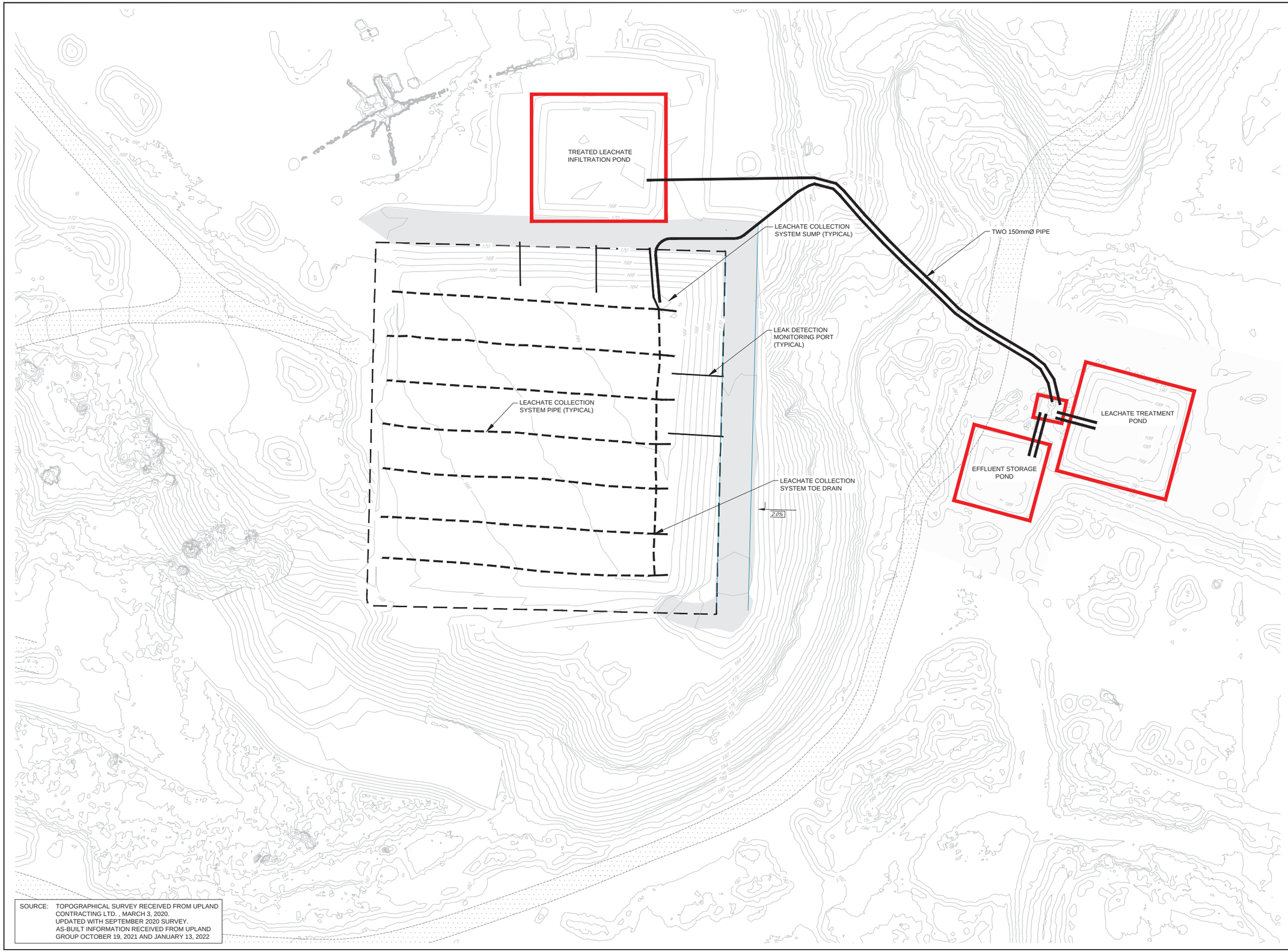
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Appendices

Appendix A

Leachate Treatment Works Layout



SOURCE: TOPOGRAPHICAL SURVEY RECEIVED FROM UPLAND CONTRACTING LTD. , MARCH 3, 2020.
UPDATED WITH SEPTEMBER 2020 SURVEY.
AS-BUILT INFORMATION RECEIVED FROM UPLAND GROUP OCTOBER 19, 2021 AND JANUARY 13, 2022

GHD Ltd.
138 EAST 7TH AVENUE, SUITE 100
VANCOUVER, BRITISH COLUMBIA V5T 1M6 CANADA
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0 6 12 18m

Client
UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

Project
LEACHATE TREATMENT WORKS

No.	Issue	Drawn	Approved	Date

Drawn T.WAGSTAFF	Designer
Drafting Check	Design Check
Project Manager	Date January 19, 2022
This document shall not be used for construction unless signed and sealed for construction.	Scale 1:600
Original Size ANSI D	Bar is 20mm on original size drawing 0 20mm

Project No. 11222680

Title
LEACHATE TREATMENT WORKS LAYOUT

Sheet No.
CI-0001

Sheet 1 of 1

Plot Date: 19 January 2022 - 12:56 PM Plotted By: Tyler Wagstaff CAD File: N:\CA\Vancouver\Projects\663\11222680\Digital_Design\ACAD\Figures\PRES\11222680-GHD-0000-PRE-CI-0001.dwg

Appendix B

Photo Log

Site Photographs



Photo 1 *Aerated Treatment Pond*



Photo 2 *Infiltration Pond*



Photo 3 *Submersible landfill leachate pump*



Photo 4 *Effluent pond after reconstruction*



Photo 5 *Leachate inlet / effluent out lines*



Photo 6 *Recirculation control valves*



Photo 7 *Leachate and effluent lines inside treatment container*



Photo 8 *Typical chemical injection port*



Photo 9 *Aeration Pond inlet / suction lines*



Photo 10 *Effluent Pond inlet lines*

Appendix C

Laboratory Analytical Reports

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **VA21C7462**	Page	: 1 of 7
Client	: **Northwin Environmental Ltd.**	Laboratory	: Vancouver - Environmental
Contact	: Mr Brian Fagan	Account Manager	: Sneha Sansare
Address	: 315 - 1434 Ironwood Street Campbell River BC Canada V9W 5T5	Address	: 8081 Lougheed Highway Burnaby BC Canada V5A 1W9
Telephone	: ----	Telephone	: +1 604 253 4188
Project	: ----	Date Samples Received	: 09-Dec-2021 13:15
PO	: ----	Date Analysis Commenced	: 09-Dec-2021
C-O-C number	: ----	Issue Date	: 11-Dec-2021 17:01
Sampler	: ----		
Site	: ----		
Quote number	: ----		
No. of samples received	: 1		
No. of samples analysed	: 1		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Angelo Salandanan	Lab Assistant	Metals, Burnaby, British Columbia
Dee Lee	Analyst	Metals, Burnaby, British Columbia
Harsha Attanayake	Laboratory Analyst	Organics, Burnaby, British Columbia
Kevin Duarte	Supervisor - Metals ICP Instrumentation	Metals, Burnaby, British Columbia
Ophelia Chiu	Department Manager - Organics	Organics, Burnaby, British Columbia
Owen Cheng		Metals, Burnaby, British Columbia
Tracy Harley	Supervisor - Water Quality Instrumentation	Inorganics, Burnaby, British Columbia

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	*Description*
-	No Unit
µg/L	micrograms per litre
mg/L	milligrams per litre

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Qualifiers

Qualifier	*Description*
DLCI	*Detection Limit Raised: Chromatographic interference due to co-elution.*
DLQ	*Detection Limit raised due to co-eluting interference. GCMS qualifier ion ratio did not meet acceptance criteria.*

Analytical Results

Sub-Matrix: **Water**
(Matrix: **Water**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID: New Landfill Holding Pond 08/12/21	----	----	----	----
					Client sampling date / time: 08-Dec-2021 04:30	----	----	----	----
					VA21C7462-001	--------	--------	--------	--------
					Result	----	----	----	----
Physical Tests									
hardness (as CaCO3), dissolved	----	EC100	0.60	mg/L	22.8	----	----	----	----
Anions and Nutrients									
sulfate (as SO4)	14808-79-8	E235.SO4	0.30	mg/L	2.84	----	----	----	----
Dissolved Metals									
aluminum, dissolved	7429-90-5	E421	0.0010	mg/L	0.0244	----	----	----	----
antimony, dissolved	7440-36-0	E421	0.00010	mg/L	<0.00010	----	----	----	----
arsenic, dissolved	7440-38-2	E421	0.00010	mg/L	0.00025	----	----	----	----
barium, dissolved	7440-39-3	E421	0.00010	mg/L	0.00537	----	----	----	----
beryllium, dissolved	7440-41-7	E421	0.000100	mg/L	<0.000100	----	----	----	----
bismuth, dissolved	7440-69-9	E421	0.000050	mg/L	<0.000050	----	----	----	----
boron, dissolved	7440-42-8	E421	0.010	mg/L	<0.010	----	----	----	----
cadmium, dissolved	7440-43-9	E421	0.0000050	mg/L	<0.0000050	----	----	----	----
calcium, dissolved	7440-70-2	E421	0.050	mg/L	6.93	----	----	----	----
cesium, dissolved	7440-46-2	E421	0.000010	mg/L	<0.000010	----	----	----	----
chromium, dissolved	7440-47-3	E421	0.00050	mg/L	<0.00050	----	----	----	----
cobalt, dissolved	7440-48-4	E421	0.00010	mg/L	0.00010	----	----	----	----
copper, dissolved	7440-50-8	E421	0.00020	mg/L	0.00409	----	----	----	----
iron, dissolved	7439-89-6	E421	0.010	mg/L	0.017	----	----	----	----
lead, dissolved	7439-92-1	E421	0.000050	mg/L	0.000061	----	----	----	----
lithium, dissolved	7439-93-2	E421	0.0010	mg/L	<0.0010	----	----	----	----
magnesium, dissolved	7439-95-4	E421	0.0050	mg/L	1.34	----	----	----	----
manganese, dissolved	7439-96-5	E421	0.00010	mg/L	0.0414	----	----	----	----
mercury, dissolved	7439-97-6	E509	0.0000050	mg/L	<0.0000050	----	----	----	----
molybdenum, dissolved	7439-98-7	E421	0.000050	mg/L	0.000220	----	----	----	----
nickel, dissolved	7440-02-0	E421	0.00050	mg/L	<0.00050	----	----	----	----
phosphorus, dissolved	7723-14-0	E421	0.050	mg/L	0.060	----	----	----	----
potassium, dissolved	7440-09-7	E421	0.050	mg/L	0.287	----	----	----	----
rubidium, dissolved	7440-17-7	E421	0.00020	mg/L	<0.00020	----	----	----	----
selenium, dissolved	7782-49-2	E421	0.000050	mg/L	0.000095	----	----	----	----

Analytical Results

Sub-Matrix: **Water**
(Matrix: **Water**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID: New Landfill Holding Pond 08/12/21	----	----	----	----
					Client sampling date / time: 08-Dec-2021 04:30	----	----	----	----
					VA21C7462-001	--------	--------	--------	--------
					Result	----	----	----	----
Dissolved Metals									
silicon, dissolved	7440-21-3	E421	0.050	mg/L	1.11	----	----	----	----
silver, dissolved	7440-22-4	E421	0.000010	mg/L	<0.000010	----	----	----	----
sodium, dissolved	17341-25-2	E421	0.050	mg/L	5.47	----	----	----	----
strontium, dissolved	7440-24-6	E421	0.00020	mg/L	0.0186	----	----	----	----
sulfur, dissolved	7704-34-9	E421	0.50	mg/L	0.89	----	----	----	----
tellurium, dissolved	13494-80-9	E421	0.00020	mg/L	<0.00020	----	----	----	----
thallium, dissolved	7440-28-0	E421	0.000010	mg/L	<0.000010	----	----	----	----
thorium, dissolved	7440-29-1	E421	0.00010	mg/L	<0.00010	----	----	----	----
tin, dissolved	7440-31-5	E421	0.00010	mg/L	0.00018	----	----	----	----
titanium, dissolved	7440-32-6	E421	0.00030	mg/L	0.00096	----	----	----	----
tungsten, dissolved	7440-33-7	E421	0.00010	mg/L	<0.00010	----	----	----	----
uranium, dissolved	7440-61-1	E421	0.000010	mg/L	0.000013	----	----	----	----
vanadium, dissolved	7440-62-2	E421	0.00050	mg/L	0.00055	----	----	----	----
zinc, dissolved	7440-66-6	E421	0.0010	mg/L	0.0018	----	----	----	----
zirconium, dissolved	7440-67-7	E421	0.00020	mg/L	<0.00020	----	----	----	----
dissolved mercury filtration location	----	EP509	-	-	Field	----	----	----	----
dissolved metals filtration location	----	EP421	-	-	Field	----	----	----	----
Volatile Organic Compounds									
chlorobenzene	108-90-7	E611C	0.50	µg/L	<0.50	----	----	----	----
chloromethane	74-87-3	E611C	5.0	µg/L	<5.0	----	----	----	----
dichlorobenzene, 1,2-	95-50-1	E611C	0.50	µg/L	<0.50	----	----	----	----
dichlorobenzene, 1,3-	541-73-1	E611C	0.50	µg/L	<0.50	----	----	----	----
dichlorobenzene, 1,4-	106-46-7	E611C	0.50	µg/L	<0.50	----	----	----	----
dichloropropane, 1,2-	78-87-5	E611C	0.50	µg/L	<0.50	----	----	----	----
dichloropropylene, cis+trans-1,3-	542-75-6	E611C	0.75	µg/L	<0.75	----	----	----	----
dichloropropylene, cis-1,3-	10061-01-5	E611C	0.50	µg/L	<0.50	----	----	----	----
tetrachloroethane, 1,1,1,2-	630-20-6	E611C	0.50	µg/L	<0.50	----	----	----	----
tetrachloroethane, 1,1,2,2-	79-34-5	E611C	0.20	µg/L	<0.20	----	----	----	----
trichloroethane, 1,1,2-	79-00-5	E611C	0.50	µg/L	<0.50	----	----	----	----
trichlorofluoromethane	75-69-4	E611C	0.50	µg/L	<0.50	----	----	----	----

Analytical Results

Sub-Matrix: **Water**
(Matrix: **Water**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID: New Landfill Holding Pond 08/12/21	----	----	----	----
					Client sampling date / time: 08-Dec-2021 04:30	----	----	----	----
					VA21C7462-001	--------	--------	--------	--------
					Result	----	----	----	----
Volatile Organic Compounds [Drycleaning]									
carbon tetrachloride	56-23-5	E611C	0.50	µg/L	<0.50	----	----	----	----
chloroethane	75-00-3	E611C	0.50	µg/L	<0.50	----	----	----	----
dichloroethane, 1,1-	75-34-3	E611C	0.50	µg/L	<0.50	----	----	----	----
dichloroethane, 1,2-	107-06-2	E611C	0.50	µg/L	<0.50	----	----	----	----
dichloroethylene, 1,1-	75-35-4	E611C	0.50	µg/L	<0.50	----	----	----	----
dichloroethylene, cis-1,2-	156-59-2	E611C	0.50	µg/L	<0.50	----	----	----	----
dichloroethylene, trans-1,2-	156-60-5	E611C	0.50	µg/L	<0.50	----	----	----	----
dichloromethane	75-09-2	E611C	1.0	µg/L	<1.0	----	----	----	----
dichloropropylene, trans-1,3-	10061-02-6	E611C	0.50	µg/L	<0.50	----	----	----	----
tetrachloroethylene	127-18-4	E611C	0.50	µg/L	<0.50	----	----	----	----
trichloroethane, 1,1,1-	71-55-6	E611C	0.50	µg/L	<0.50	----	----	----	----
trichloroethylene	79-01-6	E611C	0.50	µg/L	<0.50	----	----	----	----
vinyl chloride	75-01-4	E611C	0.40	µg/L	<0.40	----	----	----	----
Volatile Organic Compounds [Fuels]									
benzene	71-43-2	E611C	0.50	µg/L	<0.50	----	----	----	----
ethylbenzene	100-41-4	E611C	0.50	µg/L	<0.50	----	----	----	----
methyl-tert-butyl ether [MTBE]	1634-04-4	E611C	0.50	µg/L	<0.50	----	----	----	----
styrene	100-42-5	E611C	0.50	µg/L	<0.50	----	----	----	----
toluene	108-88-3	E611C	0.40	µg/L	<0.40	----	----	----	----
xylene, m+p-	179601-23-1	E611C	0.40	µg/L	<0.40	----	----	----	----
xylene, o-	95-47-6	E611C	0.30	µg/L	<0.30	----	----	----	----
xylenes, total	1330-20-7	E611C	0.50	µg/L	<0.50	----	----	----	----
Volatile Organic Compounds [THMs]									
bromodichloromethane	75-27-4	E611C	0.50	µg/L	<0.50	----	----	----	----
bromoform	75-25-2	E611C	0.50	µg/L	<0.50	----	----	----	----
chloroform	67-66-3	E611C	0.50	µg/L	<0.50	----	----	----	----
dibromochloromethane	124-48-1	E611C	0.50	µg/L	<0.50	----	----	----	----
Volatile Organic Compounds Surrogates									
bromofluorobenzene, 4-	460-00-4	E611C	1.0	%	84.2	----	----	----	----
difluorobenzene, 1,4-	540-36-3	E611C	1.0	%	101	----	----	----	----

Analytical Results

Sub-Matrix: **Water**
(Matrix: **Water**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID: New Landfill Holding Pond 08/12/21	----	----	----	----
					Client sampling date / time: 08-Dec-2021 04:30	----	----	----	----
					VA21C7462-001	--------	--------	--------	--------
					Result	----	----	----	----
Hydrocarbons									
EPH (C10-C19)	----	E601A	250	µg/L	<250	----	----	----	----
EPH (C19-C32)	----	E601A	250	µg/L	<250	----	----	----	----
HEPHw	----	EC600A	250	µg/L	<250	----	----	----	----
LEPHw	----	EC600A	250	µg/L	<250	----	----	----	----
Hydrocarbons Surrogates									
bromobenzotrifluoride, 2- (EPH surr)	392-83-6	E601A	1.0	%	90.7	----	----	----	----
Polycyclic Aromatic Hydrocarbons									
acenaphthene	83-32-9	E641A	0.010	µg/L	0.399	----	----	----	----
acenaphthylene	208-96-8	E641A	0.010	µg/L	0.012	----	----	----	----
acridine	260-94-6	E641A	0.010	µg/L	<0.021 DLQ	----	----	----	----
anthracene	120-12-7	E641A	0.010	µg/L	<0.022 DLCI	----	----	----	----
benz(a)anthracene	56-55-3	E641A	0.010	µg/L	<0.011 DLQ	----	----	----	----
benzo(a)pyrene	50-32-8	E641A	0.0050	µg/L	<0.0050	----	----	----	----
benzo(b+j)fluoranthene	----	E641A	0.010	µg/L	0.010	----	----	----	----
benzo(b+j+k)fluoranthene	----	E641A	0.015	µg/L	<0.015	----	----	----	----
benzo(g,h,i)perylene	191-24-2	E641A	0.010	µg/L	<0.010	----	----	----	----
benzo(k)fluoranthene	207-08-9	E641A	0.010	µg/L	<0.010	----	----	----	----
chrysene	218-01-9	E641A	0.010	µg/L	<0.010	----	----	----	----
dibenz(a,h)anthracene	53-70-3	E641A	0.0050	µg/L	<0.0050	----	----	----	----
fluoranthene	206-44-0	E641A	0.010	µg/L	0.112	----	----	----	----
fluorene	86-73-7	E641A	0.010	µg/L	0.176	----	----	----	----
indeno(1,2,3-c,d)pyrene	193-39-5	E641A	0.010	µg/L	<0.010	----	----	----	----
methylnaphthalene, 1-	90-12-0	E641A	0.010	µg/L	<0.064 DLQ	----	----	----	----
methylnaphthalene, 2-	91-57-6	E641A	0.010	µg/L	0.032	----	----	----	----
naphthalene	91-20-3	E641A	0.050	µg/L	0.098	----	----	----	----
phenanthrene	85-01-8	E641A	0.020	µg/L	0.104	----	----	----	----
pyrene	129-00-0	E641A	0.010	µg/L	0.055	----	----	----	----
quinoline	91-22-5	E641A	0.050	µg/L	0.554	----	----	----	----
Polycyclic Aromatic Hydrocarbons Surrogates									
chrysene-d12	1719-03-5	E641A	0.1	%	101	----	----	----	----

Analytical Results

Sub-Matrix: **Water** (Matrix: **Water**)					Client sample ID	**New Landfill Holding Pond 08/12/21**	**----**	**----**	**----**	**----**
					Client sampling date / time	08-Dec-2021 04:30	----	----	----	----
Analyte	*CAS Number*	*Method*	*LOR*	*Unit*		**VA21C7462-001**	**--------**	**--------**	**--------**	**--------**
						Result	----	----	----	----
Polycyclic Aromatic Hydrocarbons Surrogates										
naphthalene-d8	1146-65-2	E641A	0.1	%		97.1	----	----	----	----
phenanthrene-d10	1517-22-2	E641A	0.1	%		111	----	----	----	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **VA21C7462**	ePgs	: 1 of L
CirsVt	: **Northwin Environmental Ltd.**	bPr oaPtoay	: c PVuol vsa- EVvraoVmsVtPi
CoVtPut	: MaBarPV SPgPV	3uuol Vt MPVPgsa	: hVsAP h PVdPas
355asdd	: 417 - 1l 4l waoVp oo5 h tasst CPmRr sii 9 nvsaBC CPVP5P c WT 7F7	355asdd	: 8081 bol gAss5 HrgAp Py Bl aVPr y BC CPVP5P c73 1T W
FsisRAoVs	: ----	FsisRAoVs	: +1 60l 274 l 188
eaojsut	: ----	DPts h PmRisd 9 susnvs5	: 17-Dsu-2021 20:47
eO	: ----	DPts 3 VPiydnd CommsVus5	: 16-Dsu-2021
C-O-C Vl mr sa	: ----	wddl s DPts	: 1WDsu-2021 24:0L
h PmRisa	: ----		
h nts	: ----		
Ql ots Vl mr sa	: ----		
No. of dPmRisd asusnvs5	: 1		
No. of dPmRisd PVPiyds5	: 1		

FAnd asRoat dl Rsads5sd PVy Rasvnol d asRoat(d) p ntA tAnd asfsasVus. 9 sdl itd PRRiy to tAs dPmRis(d) Pd dl r mnts5. FAnd 5oul msVt dAPii Vot r s asRao5l us5, sxusRt nV fl ii.

FAnd CsatnnuPts of 3 VPiydnd uoVtPnVd tAs foiiop nVg nVfoamPtnoV:

- GsVsaPi CommsVtd
- 3 VPiytnuPi 9 sdl itd
- h l aaogPts CoVtaoi bnmntd

355ntnoVPi nVfoamPtnoV RsatnVsVt to tAnd asRoat p nii r s fol V5 nV tAs foiiop nVg dsRPaPts PttPuAmsVtd: Ql Pinty CoVtaoi 9 sRoat, QC wtsaRastnvs asRoat to Pddndt p ntA Ql Pinty 9 svnsp PV5 h PmRis 9 susnRt NotnnuPtnoV (h 9 N).

Signatories

FAnd 5oul msVt APd r ssV sisutaoVnuPiiy dngVs5 r y tAs Pl tAoazs5 dngVPtoansd r siop . EisutaoVnu dngVnVg nd uoV5l uts5 nV Puuoa5PVus p ntA Uh SD3 21 CS9 ePat 11.

Signatories	*Position*	*Laboratory Department*
CnV5y FPVg	FsPm bsP5sa- wVoagPVnud	wVoagPVnud, Bl aVPr y, BantndA Coil mr nP
Dss bss	3 VPiydt	MstPid, Bl aVPr y, BantndA Coil mr nP
wVPz BP5r szPVuAn	FsPm bsP5sa- MstPid RasRPaPtnoV	MstPid, Bl aVPr y, BantndA Coil mr nP
ORAsinP CAnl	DsRPatmsVt MPVPgsa- OagPVnud	OagPVnud, Bl aVPr y, BantndA Coil mr nP
9 or nV T sskd	FsPm bsP5sa- MstPid	MstPid, Bl aVPr y, BantndA Coil mr nP

General Comments

FAs PVPiytnuPi mstAo5d lds5 ry 3bh Pas 5svsioRs5 ldnVg nVtsaVPtnoVPiiy asuogVnzs5 asfsasVus mstAo5d (pAsas PvPniPris), dl uA Pd tAods Rl rindAs5 ry Uh Ee3, 3eH3 htPV5Pa5 MstAo5d, 3hFM, wnO, EVvnaoVmsVt CPVP5P, BC MOE, PV5 OVtPano MOE. 9sfsa to tAs 3bh Ql Pinty CoVtaoi wVtsaRastnvs asRoat (QCw foa PRRinuPris asfsasVusd PV5 mstAo5oiogy dl mmPansd. 9sfsasVus mstAo5d mPy nVuoaRoaPts mo5rinuPtnoVd to nmRaovs RsafoamPVus.

TAsas PasRoats5 isddtAPV(K) asdl it nd AngAsatAPV tAs bO9, tAnd mPy rs 5l s to RanmPay dPmRis sxtaPut<5ngsdtPts 5nil troV PV5<oanVdl ffnunsVt dPmRis foaPVPiydnd.

TAsas tAs bO9 of PasRoats5 asdl it 5nffsad faom dtPV5Pa5 bO9, tAnd mPy rs 5l s to AngA mondtl as uoVtsVt, nVdl ffnunsVt dPmRis (as5l us5 psngAt smRioys5) oamPtanx nVtsafsasVus.

eisPds asfsato Ql Pinty CoVtaoi wVtsaRastnvs asRoat (QCw foanVfoamPtnoV asgPa5nVg Hoi5nVg Fnnms uomRinPVus.

/sy : C3h Nl mr sa: CAsmnuPi 3rdtaPutd hsavnusd Vl mr sand P l Vnql s n5sVtnfnsaPddngVs5 to 5nduasts dl r dtPVusd
bO9 : bnnnnt of 9sRoatnVg (5stsutnoV innnnt).

Unit	Description
-	No UVnt
µg+b	mnuaogaPmd Rsaintas
mg+b	mniingaPmd Rsaintas

K: isddtAPV.

>: gasPtsatAPV.

hl aaogPts: 3V PVPiyts tAPt nd dnnniPanV r sAPvnoato tPagst PVPiyts(d), r l t tAPt 5osd Vot ouul aVPtl aPiiy nV sVvnaoVmsVtPi dPmRisd. SoaPRRinuPris tsdtd, dl aaogPtsd Pas P55s5 to dPmRisd Ranoato PVPiydnd Pd P uAsuk oV asuovsay.

Fsdt asdl itd asRoats5 asiPts oViy to tAs dPmRisd Pd asusnvs5 r y tAs iPr oaPtoay.

UNbEhh OFHE9T wnE hF3FED oVh9N oaQCw9sRoat, 3bb h3MebEh T E9E9ECEwcED wN 3CCEeF3BbE CONDwFvON.

Qualifiers

Qualifier	Description
DLCI	*Detection Limit Raised: Chromatographic interference due to co-elution.*
DLQ	*Detection Limit raised due to co-eluting interference. GCMS qualifier ion ratio did not meet acceptance criteria.*

Analytical Results

hl r-MPtax: Water
(MPtax: Water)

					Client sample ID	New Landfill Holding Pond 08/12/21	----	----	----	----
					Client sampling date / time	17-Dsu-2021 0l :40	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit		VA21C7462-001	--------	--------	--------	--------
						9sdl it	----	----	----	----
Physical Tests										
hardness (as CaCO3), dissolved	----	EC100	0.60	mg<b		2W6	----	----	----	----
Anions and Nutrients										
sulfate (as SOD)	1l 808-LW8	E247.hOI	0.40	mg<b		11.L	----	----	----	----
Missolved b etals										
aluminum, dissolved	Ll 2WW0-7	El 21	0.0010	mg<b		0.02Wl	----	----	----	----
antimony, dissolved	Ll l 0-46-0	El 21	0.00010	mg<b		K0.00010	----	----	----	----
arsenic, dissolved	Ll l 0-48-2	El 21	0.00010	mg<b		0.00047	----	----	----	----
parium, dissolved	Ll l 0-4W4	El 21	0.00010	mg<b		0.00l 78	----	----	----	----
peryllium, dissolved	Ll l 0-l 1-L	El 21	0.000100	mg<b		K0.000100	----	----	----	----
pismuth, dissolved	Ll l 0-6WW	El 21	0.000070	mg<b		K0.000070	----	----	----	----
poron, dissolved	Ll l 0-l 2-8	El 21	0.010	mg<b		0.021	----	----	----	----
cadmium, dissolved	Ll l 0-l 4-W	El 21	0.0000070	mg<b		0.000014l	----	----	----	----
calcium, dissolved	Ll l 0-L0-2	El 21	0.070	mg<b		W0l	----	----	----	----
cesium, dissolved	Ll l 0-l 6-2	El 21	0.000010	mg<b		K0.000010	----	----	----	----
chromium, dissolved	Ll l 0-l L-4	El 21	0.00070	mg<b		K0.00070	----	----	----	----
copalt, dissolved	Ll l 0-l 8-l	El 21	0.00010	mg<b		0.00016	----	----	----	----
cozzer, dissolved	Ll l 0-70-8	El 21	0.00020	mg<b		0.00LLW	----	----	----	----
iron, dissolved	Ll 4W8W6	El 21	0.010	mg<b		0.018	----	----	----	----
lead, dissolved	Ll 4WW2-1	El 21	0.000070	mg<b		0.000112	----	----	----	----
lithium, dissolved	Ll 4WW4-2	El 21	0.0010	mg<b		K0.0010	----	----	----	----
magnesium, dissolved	Ll 4WW7-l	El 21	0.0070	mg<b		1.L1	----	----	----	----
manganese, dissolved	Ll 4WW6-7	El 21	0.00010	mg<b		0.066l	----	----	----	----
mercury, dissolved	Ll 4WWL-6	E70W	0.0000070	mg<b		K0.0000070	----	----	----	----
molypdenum, dissolved	Ll 4WW8-L	El 21	0.000070	mg<b		0.0007l W	----	----	----	----
nickel, dissolved	Ll l 0-02-0	El 21	0.00070	mg<b		K0.00070	----	----	----	----
zhoszhorus, dissolved	LL24-1l -0	El 21	0.070	mg<b		0.106	----	----	----	----
zotassium, dissolved	Ll l 0-0WL	El 21	0.070	mg<b		0.484	----	----	----	----
rupidium, dissolved	Ll l 0-1L-L	El 21	0.00020	mg<b		0.00027	----	----	----	----
selenium, dissolved	LL82-l W2	El 21	0.000070	mg<b		0.0000WL	----	----	----	----

Analytical Results

hlr-MPtax: Water
(MPtax: Water)

					Client sample ID	New Landfill Holding Pond 08/12/21	----	----	----	----
					Client sampling date / time	17-Dsu-2021 0l :40	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit		VA21C7462-001	--------	--------	--------	--------
						9sdl it	----	----	----	----
Missolved b etals										
silicon, dissolved	Ll l 0-21-4	El 21	0.070	mg•b		1.06	----	----	----	----
silver, dissolved	Ll l 0-22-l	El 21	0.000010	mg•b		K0.000010	----	----	----	----
sodium, dissolved	Ll l 0-24-7	El 21	0.070	mg•b		8.6W	----	----	----	----
strontium, dissolved	Ll l 0-2l -6	El 21	0.00020	mg•b		0.0411	----	----	----	----
sulfur, dissolved	LL0l -4l -W	El 21	0.70	mg•b		4.L8	----	----	----	----
tellurium, dissolved	14l W-80-W	El 21	0.00020	mg•b		K0.00020	----	----	----	----
thallium, dissolved	Ll l 0-28-0	El 21	0.000010	mg•b		K0.000010	----	----	----	----
thorium, dissolved	Ll l 0-2W1	El 21	0.00010	mg•b		K0.00010	----	----	----	----
tin, dissolved	Ll l 0-41-7	El 21	0.00010	mg•b		K0.00010	----	----	----	----
titanium, dissolved	Ll l 0-42-6	El 21	0.00040	mg•b		0.00106	----	----	----	----
tungsten, dissolved	Ll l 0-44-L	El 21	0.00010	mg•b		K0.00010	----	----	----	----
uranium, dissolved	Ll l 0-61-1	El 21	0.000010	mg•b		0.000016	----	----	----	----
vanadium, dissolved	Ll l 0-62-2	El 21	0.00070	mg•b		0.00076	----	----	----	----
+inc, dissolved	Ll l 0-66-6	El 21	0.0010	mg•b		0.00l 4	----	----	----	----
+irconium, dissolved	Ll l 0-6L-L	El 21	0.00020	mg•b		K0.00020	----	----	----	----
dissolved mercury filtration location	----	Ee70W	-	-		Srsi5	----	----	----	----
dissolved metals filtration location	----	Eel 21	-	-		Srsi5	----	----	----	----
Volatile Organic Comzounds										
chloropen+ene	108-W0-L	E611C	0.70	µg•b		K0.70	----	----	----	----
chloromethane	Ll -8L-4	E611C	7.0	µg•b		K7.0	----	----	----	----
dichloropen+ene, 1,2-	W7-70-1	E611C	0.70	µg•b		K0.70	----	----	----	----
dichloropen+ene, 1,3-	7l 1-L4-1	E611C	0.70	µg•b		K0.70	----	----	----	----
dichloropen+ene, 1,D-	106-l 6-L	E611C	0.70	µg•b		K0.70	----	----	----	----
dichlorozrozane, 1,2-	L8-8L-7	E611C	0.70	µg•b		K0.70	----	----	----	----
dichlorozrozylene, cis[trans-1,3-	7l 2-L7-6	E611C	0.L7	µg•b		K0.L7	----	----	----	----
dichlorozrozylene, cis-1,3-	10061-01-7	E611C	0.70	µg•b		K0.70	----	----	----	----
tetrachloroethane, 1,1,1,2-	640-20-6	E611C	0.70	µg•b		K0.70	----	----	----	----
tetrachloroethane, 1,1,2,2-	LW4l -7	E611C	0.20	µg•b		K0.20	----	----	----	----
trichloroethane, 1,1,2-	LW00-7	E611C	0.70	µg•b		K0.70	----	----	----	----
trichlorofluoromethane	L7-6Wl	E611C	0.70	µg•b		K0.70	----	----	----	----

Analytical Results

hl r-MPtax: Water
(MPtax: Water)

					Client sample ID	New Landfill Holding Pond 08/12/21	----	----	----	----
					Client sampling date / time	17-Dsu-2021 0l :40	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit		VA21C7462-001	--------	--------	--------	--------
						9sdl it	----	----	----	----
Volatile Organic Comzounds]MrycleaningB										
carpon tetrachloride	76-24-7	E611C	0.70	µg•b		K0.70	----	----	----	----
chloroethane	L7-00-4	E611C	0.70	µg•b		K0.70	----	----	----	----
dichloroethane, 1,1-	L7-4l -4	E611C	0.70	µg•b		K0.70	----	----	----	----
dichloroethane, 1,2-	10L-06-2	E611C	0.70	µg•b		K0.70	----	----	----	----
dichloroethylene, 1,1-	L7-47-l	E611C	0.70	µg•b		K0.70	----	----	----	----
dichloroethylene, cis-1,2-	176-7W2	E611C	0.70	µg•b		K0.70	----	----	----	----
dichloroethylene, trans-1,2-	176-60-7	E611C	0.70	µg•b		K0.70	----	----	----	----
dichloromethane	L7-0W2	E611C	1.0	µg•b		K1.0	----	----	----	----
dichlorozrozylene, trans-1,3-	10061-02-6	E611C	0.70	µg•b		K0.70	----	----	----	----
tetrachloroethylene	12L-18-l	E611C	0.70	µg•b		K0.70	----	----	----	----
trichloroethane, 1,1,1-	L1-77-6	E611C	0.70	µg•b		K0.70	----	----	----	----
trichloroethylene	LW01-6	E611C	0.70	µg•b		K0.70	----	----	----	----
vinyl chloride	L7-01-l	E611C	0.l 0	µg•b		K0.l 0	----	----	----	----
Volatile Organic Comzounds]FuelsB										
pen+ene	L1-l 4-2	E611C	0.70	µg•b		K0.70	----	----	----	----
ethylpen+ene	100-l 1-l	E611C	0.70	µg•b		K0.70	----	----	----	----
methyl-tert-putyl ether]b Tx EB	164l -0l -l	E611C	0.70	µg•b		K0.70	----	----	----	----
styrene	100-l 2-7	E611C	0.70	µg•b		K0.70	----	----	----	----
toluene	108-88-4	E611C	0.l 0	µg•b		K0.l 0	----	----	----	----
9ylene, m[z-	1LW601-24-1	E611C	0.l 0	µg•b		K0.l 0	----	----	----	----
9ylene, o-	W7-l L-6	E611C	0.40	µg•b		K0.40	----	----	----	----
9ylenes, total	1440-20-L	E611C	0.70	µg•b		K0.70	----	----	----	----
Volatile Organic Comzounds]THb sB										
promodichloromethane	L7-2L-l	E611C	0.70	µg•b		K0.70	----	----	----	----
promoform	L7-27-2	E611C	0.70	µg•b		K0.70	----	----	----	----
chloroform	6L-66-4	E611C	0.70	µg•b		K0.70	----	----	----	----
dipromochloromethane	12l -l 8-1	E611C	0.70	µg•b		K0.70	----	----	----	----
Volatile Organic Comzounds Surrogates										
promofluoropen+ene, D-	l 60-00-l	E611C	1.0	%		102	----	----	----	----
difluoropen+ene, 1,D-	7l 0-46-4	E611C	1.0	%		WW8	----	----	----	----

Analytical Results

hl r-MPtax: **Water**
(MPtax: **Water**)

					Client sample ID	New Landfill Holding Pond 08/12/21	----	----	----	----
					Client sampling date / time	17-Dsu-2021 0l :40	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit		VA21C7462-001	--------	--------	--------	--------
						9sdl it	----	----	----	----
Hydrocarpons										
EPH (C10-C14)	----	E6013	270	µg<b		K270	----	----	----	----
EPH (C14-C32)	----	E6013	270	µg<b		K270	----	----	----	----
HEPHw	----	EC6003	270	µg<b		K270	----	----	----	----
LEPHw	----	EC6003	270	µg<b		K270	----	----	----	----
Hydrocarpons Surrogates										
promopen+otrifluoride, 2- (EPH surr)	4W2-84-6	E6013	1.0	%		8W2	----	----	----	----
Polycyclic Aromatic Hydrocarpons										
acenazhthene	84-42-W	E6l 13	0.010	µg<b		0.210	----	----	----	----
acenazhthylene	208-W6-8	E6l 13	0.010	µg<b		K0.010	----	----	----	----
acridine	260-WI-6	E6l 13	0.010	µg<b		0.021	----	----	----	----
anthracene	120-12-L	E6l 13	0.010	µg<b		K0.020 DbCw	----	----	----	----
pen+(a)anthracene	76-77-4	E6l 13	0.010	µg<b		K0.010	----	----	----	----
pen+o(a)zyrene	70-42-8	E6l 13	0.0070	µg<b		K0.0070	----	----	----	----
pen+o(p[j)fluoranthene	V<P	E6l 13	0.010	µg<b		K0.010	----	----	----	----
pen+o(p[j[k)fluoranthene	V<P	E6l 13	0.017	µg<b		K0.017	----	----	----	----
pen+o(g,h,i)zerylene	1WI-2I -2	E6l 13	0.010	µg<b		K0.010	----	----	----	----
pen+o(k)fluoranthene	20L-08-W	E6l 13	0.010	µg<b		K0.010	----	----	----	----
chrysene	218-01-W	E6l 13	0.010	µg<b		K0.010	----	----	----	----
dipen+(a,h)anthracene	74-L0-4	E6l 13	0.0070	µg<b		K0.0070	----	----	----	----
fluoranthene	206-I I -0	E6l 13	0.010	µg<b		0.0LI	----	----	----	----
fluorene	86-L4-L	E6l 13	0.010	µg<b		0.086	----	----	----	----
indeno(1,2,3-c,d)zyrene	1WI-4W7	E6l 13	0.010	µg<b		K0.010	----	----	----	----
methylnazhthalene, 1-	W0-12-0	E6l 13	0.010	µg<b		K0.070 DbQ	----	----	----	----
methylnazhthalene, 2-	WI-7L-6	E6l 13	0.010	µg<b		0.01I	----	----	----	----
nazhthalene	WI-20-4	E6l 13	0.070	µg<b		K0.070	----	----	----	----
zhenanthrene	87-01-8	E6l 13	0.020	µg<b		0.044	----	----	----	----
zyrene	12W00-0	E6l 13	0.010	µg<b		0.04W	----	----	----	----
quinoline	WI-22-7	E6l 13	0.070	µg<b		0.712	----	----	----	----
Polycyclic Aromatic Hydrocarpons Surrogates										
chrysene-d12	1L1W04-7	E6l 13	0.1	%		W8.2	----	----	----	----

ePgs	:	L of L
T oak Oa5sa	:	c321CLW62
CinsVt	:	NoatApnV EVvraoVmsVtPi bt5.
eaajsut	:	----

Analytical Results

hl r-MPtax: Water (MPtax: Water)	Client sample ID	New Landfill Holding Pond 08/12/21	----	----	----	----
	Client sampling date / time	17-Dsu-2021 0l :40	----	----	----	----

Analyte	CAS Number	Method	LOR	Unit	VA21C7462-001	--------	--------	--------	--------
					9sdl it	----	----	----	----
Polycyclic Aromatic Hydrocarpons Surrogates									
nazhthalene-d8	11l 6-67-2	E6l 13	0.1	%	87.6	----	----	----	----
zhenanthrene-d10	171L-22-2	E6l 13	0.1	%	107	----	----	----	----

eisPds asfsato tAs GsVsaPi CommsVtd dsutroV foaPV sxRiPVPtroV of PVy ql Pirfirsad 5stsuts5.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **VA22A0431**	Page	: 1 of 5
Amendment	: **(Partial Results)**		
Client	: **Northwin Environmental Ltd.**	Laboratory	: Vancouver - Environmental
Contact	: Mr Brian Fagan	Account Manager	: Sneha Sansare
Address	: 315 - 1434 Ironwood Street Campbell River BC Canada V9W 5T5	Address	: 8081 Lougheed Highway Burnaby BC Canada V5A 1W9
Telephone	: ----	Telephone	: +1 604 253 4188
Project	: ----	Date Samples Received	: 12-Jan-2022 07:30
PO	: ----	Date Analysis Commenced	: 12-Jan-2022
C-O-C number	: ----	Issue Date	: 12-Jan-2022 16:32
Sampler	: B F		
Site	: ----		
Quote number	: ----		
No. of samples received	: 1		
No. of samples analysed	: 1		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Christopher Li	Lab Assistant	Metals, Burnaby, British Columbia
Kevin Duarte	Supervisor - Metals ICP Instrumentation	Metals, Burnaby, British Columbia
Tracy Harley	Supervisor - Water Quality Instrumentation	Inorganics, Burnaby, British Columbia

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	*Description*
-	No Unit
µg/L	micrograms per litre
mg/L	milligrams per litre

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Sample Comments

Sample	Client Id	*Comment*
VA22A0431-001	Holding Pond	Sample(s) XXX: Water sample(s) for dissolved mercury analysis was not submitted in glass or PTFE container with HCl preservative. Results may be biased low.

Qualifiers

Qualifier	*Description*
DLM	*Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).*

Analytical Results

Sub-Matrix: **Water**
(Matrix: **Water**)

					Client sample ID	Holding Pond	----	----	----	----
					Client sampling date / time	07-Jan-2022	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit		VA22A0431-001	--------	--------	--------	--------
						Result	----	----	----	----
Physical Tests										
hardness (as CaCO3), dissolved	----	EC100	0.60	mg/L		165	----	----	----	----
Anions and Nutrients										
sulfate (as SO4)	14808-79-8	E235.SO4	0.30	mg/L		166	----	----	----	----
Dissolved Metals										
aluminum, dissolved	7429-90-5	E421	0.0010	mg/L		0.0112	----	----	----	----
antimony, dissolved	7440-36-0	E421	0.00010	mg/L		0.00202	----	----	----	----
arsenic, dissolved	7440-38-2	E421	0.00010	mg/L		0.00186	----	----	----	----
barium, dissolved	7440-39-3	E421	0.00010	mg/L		0.0228	----	----	----	----
beryllium, dissolved	7440-41-7	E421	0.000100	mg/L		<0.000100	----	----	----	----
bismuth, dissolved	7440-69-9	E421	0.000050	mg/L		<0.000050	----	----	----	----
boron, dissolved	7440-42-8	E421	0.010	mg/L		0.857	----	----	----	----
cadmium, dissolved	7440-43-9	E421	0.0000050	mg/L		0.000151	----	----	----	----
calcium, dissolved	7440-70-2	E421	0.050	mg/L		55.1	----	----	----	----
cesium, dissolved	7440-46-2	E421	0.000010	mg/L		0.000010	----	----	----	----
chromium, dissolved	7440-47-3	E421	0.00050	mg/L		0.00192	----	----	----	----
cobalt, dissolved	7440-48-4	E421	0.00010	mg/L		0.00188	----	----	----	----
copper, dissolved	7440-50-8	E421	0.00020	mg/L		0.0553	----	----	----	----
iron, dissolved	7439-89-6	E421	0.010	mg/L		0.020	----	----	----	----
lead, dissolved	7439-92-1	E421	0.000050	mg/L		0.000431	----	----	----	----
lithium, dissolved	7439-93-2	E421	0.0010	mg/L		0.0025	----	----	----	----
magnesium, dissolved	7439-95-4	E421	0.0050	mg/L		6.68	----	----	----	----
manganese, dissolved	7439-96-5	E421	0.00010	mg/L		0.344	----	----	----	----
molybdenum, dissolved	7439-98-7	E421	0.000050	mg/L		0.00186	----	----	----	----
nickel, dissolved	7440-02-0	E421	0.00050	mg/L		0.00364	----	----	----	----
phosphorus, dissolved	7723-14-0	E421	0.050	mg/L		0.074	----	----	----	----
potassium, dissolved	7440-09-7	E421	0.050	mg/L		6.65	----	----	----	----
rubidium, dissolved	7440-17-7	E421	0.00020	mg/L		0.00348	----	----	----	----
selenium, dissolved	7782-49-2	E421	0.000050	mg/L		0.000286	----	----	----	----
silicon, dissolved	7440-21-3	E421	0.050	mg/L		1.72	----	----	----	----
silver, dissolved	7440-22-4	E421	0.000010	mg/L		<0.000010	----	----	----	----
sodium, dissolved	7440-23-5	E421	0.050	mg/L		35.3	----	----	----	----

Analytical Results

Sub-Matrix: Water (Matrix: Water)					Client sample ID	Holding Pond	----	----	----	----
					Client sampling date / time	07-Jan-2022	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit		VA22A0431-001	--------	--------	--------	--------
						Result	----	----	----	----
Dissolved Metals										
strontium, dissolved	7440-24-6	E421	0.00020	mg/L		0.240	----	----	----	----
sulfur, dissolved	7704-34-9	E421	0.50	mg/L		54.3	----	----	----	----
tellurium, dissolved	13494-80-9	E421	0.00020	mg/L		<0.00020	----	----	----	----
thallium, dissolved	7440-28-0	E421	0.000010	mg/L		0.000014	----	----	----	----
thorium, dissolved	7440-29-1	E421	0.00010	mg/L		<0.00010	----	----	----	----
tin, dissolved	7440-31-5	E421	0.00010	mg/L		0.00020	----	----	----	----
titanium, dissolved	7440-32-6	E421	0.00030	mg/L		<0.00060 DLM	----	----	----	----
tungsten, dissolved	7440-33-7	E421	0.00010	mg/L		<0.00010	----	----	----	----
uranium, dissolved	7440-61-1	E421	0.000010	mg/L		0.000272	----	----	----	----
vanadium, dissolved	7440-62-2	E421	0.00050	mg/L		0.00065	----	----	----	----
zinc, dissolved	7440-66-6	E421	0.0010	mg/L		0.0207	----	----	----	----
zirconium, dissolved	7440-67-7	E421	0.00020	mg/L		<0.00020	----	----	----	----
dissolved metals filtration location	----	EP421	-	-		Field	----	----	----	----
Volatile Organic Compounds [Fuels]										
benzene	71-43-2	E611A	0.50	µg/L		Not Authorised	----	----	----	----
ethylbenzene	100-41-4	E611A	0.50	µg/L		Not Authorised	----	----	----	----
methyl-tert-butyl ether [MTBE]	1634-04-4	E611A	0.50	µg/L		Not Authorised	----	----	----	----
styrene	100-42-5	E611A	0.50	µg/L		Not Authorised	----	----	----	----
toluene	108-88-3	E611A	0.50	µg/L		Not Authorised	----	----	----	----
xylene, m+p-	179601-23-1	E611A	0.40	µg/L		Not Authorised	----	----	----	----
xylene, o-	95-47-6	E611A	0.30	µg/L		Not Authorised	----	----	----	----
xylenes, total	1330-20-7	E611A	0.50	µg/L		Not Authorised	----	----	----	----
Volatile Organic Compounds Surrogates										
bromofluorobenzene, 4-	460-00-4	E611A	1.0	%		Not Authorised	----	----	----	----
difluorobenzene, 1,4-	540-36-3	E611A	1.0	%		Not Authorised	----	----	----	----

Analytical Results

Sub-Matrix: Water (Matrix: Water)					Client sample ID	Holding Pond	----	----	----	----
					Client sampling date / time	07-Jan-2022	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit		VA22A0431-001	--------	--------	--------	--------
						Result	----	----	----	----
Hydrocarbons										
EPH (C10-C19)	----	E601A	250	µg/L		Not Authorised	----	----	----	----
EPH (C19-C32)	----	E601A	250	µg/L		Not Authorised	----	----	----	----
VHw (C6-C10)	----	E581.VH+F1	100	µg/L		Not Authorised	----	----	----	----
VPHw	----	EC580A	100	µg/L		Not Authorised	----	----	----	----
Hydrocarbons Surrogates										
bromobenzotrifluoride, 2- (EPH surr)	392-83-6	E601A	1.0	%		Not Authorised	----	----	----	----
dichlorotoluene, 3,4-	97-75-0	E581.VH+F1	1.0	%		Not Authorised	----	----	----	----

Please refer to the General Comments section for an explanation of any qualifiers detected.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **VA22A0612**	Page	: 1 of 6
Client	: **Northwin Environmental Ltd.**	Laboratory	: Vancouver - Environmental
Contact	: Mr Brian Fagan	Account Manager	: Sneha Sansare
Address	: 315 - 1434 Ironwood Street Campbell River BC Canada V9W 5T5	Address	: 8081 Lougheed Highway Burnaby BC Canada V5A 1W9
Telephone	: ----	Telephone	: +1 604 253 4188
Project	: ----	Date Samples Received	: 13-Jan-2022 17:50
PO	: ----	Date Analysis Commenced	: 13-Jan-2022
C-O-C number	: ----	Issue Date	: 14-Jan-2022 20:23
Sampler	: ----		
Site	: ----		
Quote number	: ----		
No. of samples received	: 1		
No. of samples analysed	: 1		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

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Signatories	*Position*	*Laboratory Department*
Kevin Duarte	Supervisor - Metals ICP Instrumentation	Metals, Burnaby, British Columbia
Lindsay Gung	Supervisor - Water Chemistry	Inorganics, Burnaby, British Columbia
Ophelia Chiu	Department Manager - Organics	Organics, Burnaby, British Columbia
Ruby Pham	Lab Assistant	Metals, Burnaby, British Columbia

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Qualifiers

Qualifier	*Description*
DLQ	*Detection Limit raised due to co-eluting interference. GCMS qualifier ion ratio did not meet acceptance criteria.*

Analytical Results

Sub-Matrix: **Water**
(Matrix: **Water**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID: New Landfill Recirc 13/01/22	----	----	----	----
					Client sampling date / time: 12-Jan-2022 04:30	----	----	----	----
					VA22A0612-001	--------	--------	--------	--------
					Result	----	----	----	----
Physical Tests									
hardness (as CaCO3), dissolved	----	EC100	0.50	mg/L	85.1	----	----	----	----
Anions and Nutrients									
sulfate (as SO4)	14808-79-8	E235.SO4	0.30	mg/L	87.3	----	----	----	----
Dissolved Metals									
aluminum, dissolved	7429-90-5	E421	0.0010	mg/L	0.0079	----	----	----	----
antimony, dissolved	7440-36-0	E421	0.00010	mg/L	0.00096	----	----	----	----
arsenic, dissolved	7440-38-2	E421	0.00010	mg/L	0.00090	----	----	----	----
barium, dissolved	7440-39-3	E421	0.00010	mg/L	0.00764	----	----	----	----
beryllium, dissolved	7440-41-7	E421	0.000020	mg/L	<0.000020	----	----	----	----
bismuth, dissolved	7440-69-9	E421	0.000050	mg/L	<0.000050	----	----	----	----
boron, dissolved	7440-42-8	E421	0.010	mg/L	0.317	----	----	----	----
cadmium, dissolved	7440-43-9	E421	0.0000050	mg/L	0.0000541	----	----	----	----
calcium, dissolved	7440-70-2	E421	0.050	mg/L	27.5	----	----	----	----
cesium, dissolved	7440-46-2	E421	0.000010	mg/L	0.000032	----	----	----	----
chromium, dissolved	7440-47-3	E421	0.00050	mg/L	0.00079	----	----	----	----
cobalt, dissolved	7440-48-4	E421	0.00010	mg/L	0.00069	----	----	----	----
copper, dissolved	7440-50-8	E421	0.00020	mg/L	0.0218	----	----	----	----
iron, dissolved	7439-89-6	E421	0.010	mg/L	0.024	----	----	----	----
lead, dissolved	7439-92-1	E421	0.000050	mg/L	0.000785	----	----	----	----
lithium, dissolved	7439-93-2	E421	0.0010	mg/L	0.0013	----	----	----	----
magnesium, dissolved	7439-95-4	E421	0.0050	mg/L	4.00	----	----	----	----
manganese, dissolved	7439-96-5	E421	0.00010	mg/L	0.140	----	----	----	----
molybdenum, dissolved	7439-98-7	E421	0.000050	mg/L	0.000956	----	----	----	----
nickel, dissolved	7440-02-0	E421	0.00050	mg/L	0.00167	----	----	----	----
phosphorus, dissolved	7723-14-0	E421	0.050	mg/L	0.113	----	----	----	----
potassium, dissolved	7440-09-7	E421	0.050	mg/L	3.76	----	----	----	----
rubidium, dissolved	7440-17-7	E421	0.00020	mg/L	0.00263	----	----	----	----
selenium, dissolved	7782-49-2	E421	0.000050	mg/L	0.000140	----	----	----	----
silicon, dissolved	7440-21-3	E421	0.050	mg/L	1.10	----	----	----	----
silver, dissolved	7440-22-4	E421	0.000010	mg/L	<0.000010	----	----	----	----

Analytical Results

Sub-Matrix: Water (Matrix: Water)					Client sample ID	New Landfill Recirc 13/01/22	----	----	----	----
					Client sampling date / time	12-Jan-2022 04:30	----	----	----	----
Analyte	CAS Number	Method	LOR	Unit		VA22A0612-001	--------	--------	--------	--------
						Result	----	----	----	----
Dissolved Metals										
sodium, dissolved	7440-23-5	E421	0.050	mg/L		20.6	----	----	----	----
strontium, dissolved	7440-24-6	E421	0.00020	mg/L		0.127	----	----	----	----
sulfur, dissolved	7704-34-9	E421	0.50	mg/L		30.8	----	----	----	----
tellurium, dissolved	13494-80-9	E421	0.00020	mg/L		<0.00020	----	----	----	----
thallium, dissolved	7440-28-0	E421	0.000010	mg/L		<0.000010	----	----	----	----
thorium, dissolved	7440-29-1	E421	0.00010	mg/L		<0.00010	----	----	----	----
tin, dissolved	7440-31-5	E421	0.00010	mg/L		0.00014	----	----	----	----
titanium, dissolved	7440-32-6	E421	0.00030	mg/L		<0.00030	----	----	----	----
tungsten, dissolved	7440-33-7	E421	0.00010	mg/L		<0.00010	----	----	----	----
uranium, dissolved	7440-61-1	E421	0.000010	mg/L		0.000092	----	----	----	----
vanadium, dissolved	7440-62-2	E421	0.00050	mg/L		<0.00050	----	----	----	----
zinc, dissolved	7440-66-6	E421	0.0010	mg/L		0.0157	----	----	----	----
zirconium, dissolved	7440-67-7	E421	0.00030	mg/L		<0.00030	----	----	----	----
dissolved metals filtration location	----	EP421	-	-		Field	----	----	----	----
Volatile Organic Compounds										
chlorobenzene	108-90-7	E611C	0.50	µg/L		<0.50	----	----	----	----
chloromethane	74-87-3	E611C	5.0	µg/L		<5.0	----	----	----	----
dichlorobenzene, 1,2-	95-50-1	E611C	0.50	µg/L		<0.50	----	----	----	----
dichlorobenzene, 1,3-	541-73-1	E611C	0.50	µg/L		<0.50	----	----	----	----
dichlorobenzene, 1,4-	106-46-7	E611C	0.50	µg/L		<0.50	----	----	----	----
dichloropropane, 1,2-	78-87-5	E611C	0.50	µg/L		<0.50	----	----	----	----
dichloropropylene, cis+trans-1,3-	542-75-6	E611C	0.75	µg/L		<0.75	----	----	----	----
dichloropropylene, cis-1,3-	10061-01-5	E611C	0.50	µg/L		<0.50	----	----	----	----
tetrachloroethane, 1,1,1,2-	630-20-6	E611C	0.50	µg/L		<0.50	----	----	----	----
tetrachloroethane, 1,1,2,2-	79-34-5	E611C	0.20	µg/L		<0.20	----	----	----	----
trichloroethane, 1,1,2-	79-00-5	E611C	0.50	µg/L		<0.50	----	----	----	----
trichlorofluoromethane	75-69-4	E611C	0.50	µg/L		<0.50	----	----	----	----
Volatile Organic Compounds [Drycleaning]										
carbon tetrachloride	56-23-5	E611C	0.50	µg/L		<0.50	----	----	----	----
chloroethane	75-00-3	E611C	0.50	µg/L		<0.50	----	----	----	----
dichloroethane, 1,1-	75-34-3	E611C	0.50	µg/L		<0.50	----	----	----	----

Analytical Results

Sub-Matrix: **Water**
(Matrix: **Water**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID: New Landfill Recirc 13/01/22	----	----	----	----
					Client sampling date / time: 12-Jan-2022 04:30	----	----	----	----
					VA22A0612-001	--------	--------	--------	--------
					Result	----	----	----	----
Volatile Organic Compounds [Drycleaning]									
dichloroethane, 1,2-	107-06-2	E611C	0.50	µg/L	<0.50	----	----	----	----
dichloroethylene, 1,1-	75-35-4	E611C	0.50	µg/L	<0.50	----	----	----	----
dichloroethylene, cis-1,2-	156-59-2	E611C	0.50	µg/L	<0.50	----	----	----	----
dichloroethylene, trans-1,2-	156-60-5	E611C	0.50	µg/L	<0.50	----	----	----	----
dichloromethane	75-09-2	E611C	1.0	µg/L	<1.0	----	----	----	----
dichloropropylene, trans-1,3-	10061-02-6	E611C	0.50	µg/L	<0.50	----	----	----	----
tetrachloroethylene	127-18-4	E611C	0.50	µg/L	<0.50	----	----	----	----
trichloroethane, 1,1,1-	71-55-6	E611C	0.50	µg/L	<0.50	----	----	----	----
trichloroethylene	79-01-6	E611C	0.50	µg/L	<0.50	----	----	----	----
vinyl chloride	75-01-4	E611C	0.40	µg/L	<0.40	----	----	----	----
Volatile Organic Compounds [Fuels]									
benzene	71-43-2	E611C	0.50	µg/L	<0.50	----	----	----	----
ethylbenzene	100-41-4	E611C	0.50	µg/L	<0.50	----	----	----	----
methyl-tert-butyl ether [MTBE]	1634-04-4	E611C	0.50	µg/L	<0.50	----	----	----	----
styrene	100-42-5	E611C	0.50	µg/L	<0.50	----	----	----	----
toluene	108-88-3	E611C	0.40	µg/L	0.69	----	----	----	----
xylene, m+p-	179601-23-1	E611C	0.40	µg/L	<0.40	----	----	----	----
xylene, o-	95-47-6	E611C	0.30	µg/L	<0.30	----	----	----	----
xylenes, total	1330-20-7	E611C	0.50	µg/L	<0.50	----	----	----	----
Volatile Organic Compounds [THMs]									
bromodichloromethane	75-27-4	E611C	0.50	µg/L	<0.50	----	----	----	----
bromoform	75-25-2	E611C	0.50	µg/L	<0.50	----	----	----	----
chloroform	67-66-3	E611C	0.50	µg/L	3.28	----	----	----	----
dibromochloromethane	124-48-1	E611C	0.50	µg/L	<0.50	----	----	----	----
Hydrocarbons									
EPH (C10-C19)	----	E601A	250	µg/L	<250	----	----	----	----
EPH (C19-C32)	----	E601A	250	µg/L	<250	----	----	----	----
HEPHw	----	EC600A	250	µg/L	<250	----	----	----	----
LEPHw	----	EC600A	250	µg/L	<250	----	----	----	----
Hydrocarbons Surrogates									
bromobenzotrifluoride, 2- (EPH surr)	392-83-6	E601A	1.0	%	64.2	----	----	----	----

Analytical Results

Sub-Matrix: **Water**
(Matrix: **Water**)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID: New Landfill Recirc 13/01/22	----	----	----	----
					Client sampling date / time: 12-Jan-2022 04:30	----	----	----	----
					VA22A0612-001	--------	--------	--------	--------
					Result	----	----	----	----
Polycyclic Aromatic Hydrocarbons									
acenaphthene	83-32-9	E641A	0.010	µg/L	<0.035 DLQ	----	----	----	----
acenaphthylene	208-96-8	E641A	0.010	µg/L	<0.010	----	----	----	----
acridine	260-94-6	E641A	0.010	µg/L	<0.010	----	----	----	----
anthracene	120-12-7	E641A	0.010	µg/L	<0.010	----	----	----	----
benz(a)anthracene	56-55-3	E641A	0.010	µg/L	<0.010	----	----	----	----
benzo(a)pyrene	50-32-8	E641A	0.0050	µg/L	<0.0050	----	----	----	----
benzo(b+j)fluoranthene	n/a	E641A	0.010	µg/L	<0.010	----	----	----	----
benzo(b+j+k)fluoranthene	n/a	E641A	0.015	µg/L	<0.015	----	----	----	----
benzo(g,h,i)perylene	191-24-2	E641A	0.010	µg/L	<0.010	----	----	----	----
benzo(k)fluoranthene	207-08-9	E641A	0.010	µg/L	<0.010	----	----	----	----
chrysene	218-01-9	E641A	0.010	µg/L	<0.010	----	----	----	----
dibenz(a,h)anthracene	53-70-3	E641A	0.0050	µg/L	<0.0050	----	----	----	----
fluoranthene	206-44-0	E641A	0.010	µg/L	<0.010	----	----	----	----
fluorene	86-73-7	E641A	0.010	µg/L	<0.010	----	----	----	----
indeno(1,2,3-c,d)pyrene	193-39-5	E641A	0.010	µg/L	<0.010	----	----	----	----
methylnaphthalene, 1-	90-12-0	E641A	0.010	µg/L	0.108	----	----	----	----
methylnaphthalene, 2-	91-57-6	E641A	0.010	µg/L	0.277	----	----	----	----
naphthalene	91-20-3	E641A	0.050	µg/L	0.233	----	----	----	----
phenanthrene	85-01-8	E641A	0.020	µg/L	<0.020	----	----	----	----
pyrene	129-00-0	E641A	0.010	µg/L	<0.010	----	----	----	----
quinoline	91-22-5	E641A	0.050	µg/L	<0.050	----	----	----	----
Polycyclic Aromatic Hydrocarbons Surrogates									
chrysene-d12	1719-03-5	E641A	0.1	%	108	----	----	----	----
naphthalene-d8	1146-65-2	E641A	0.1	%	98.9	----	----	----	----
phenanthrene-d10	1517-22-2	E641A	0.1	%	106	----	----	----	----

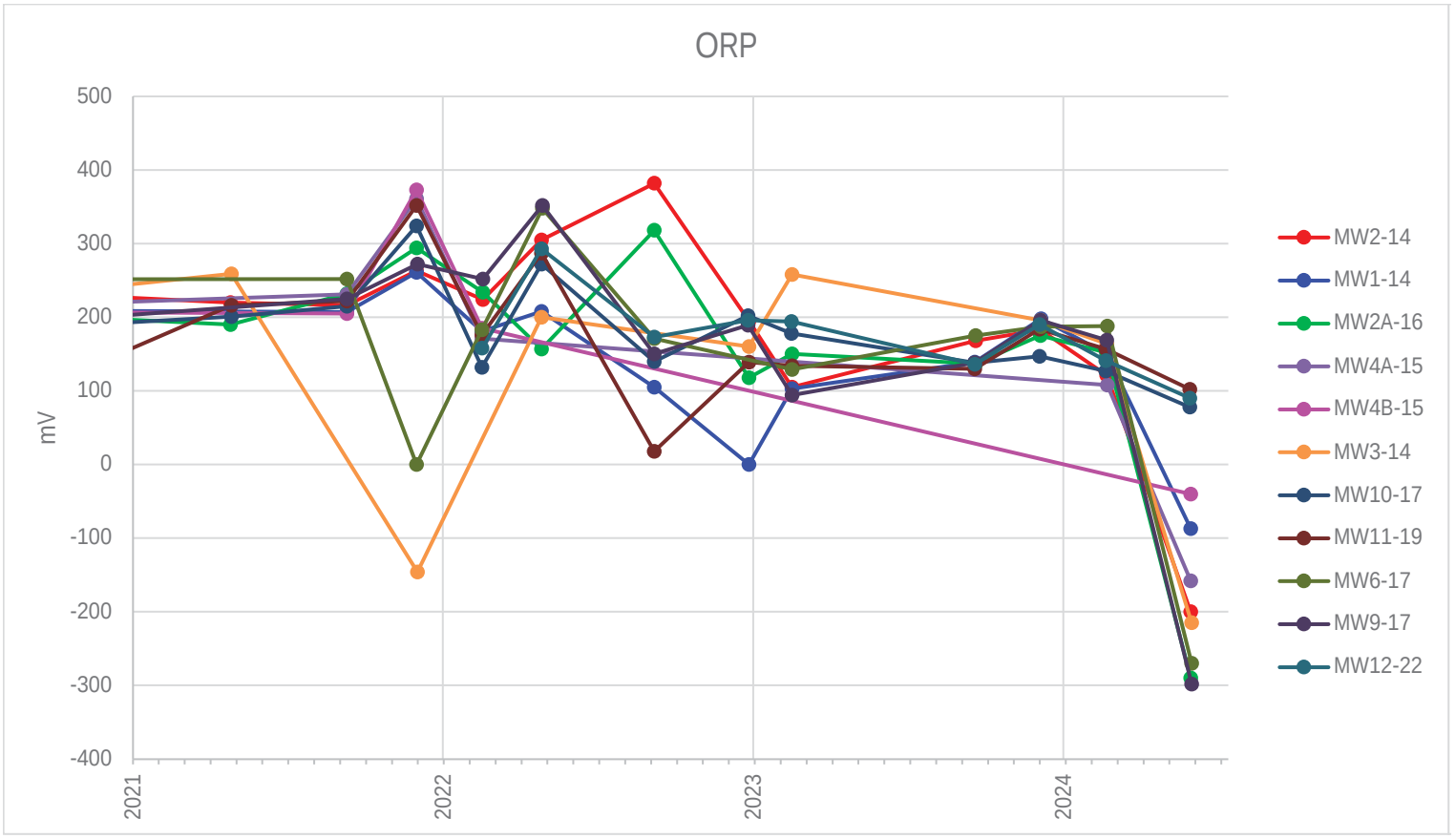
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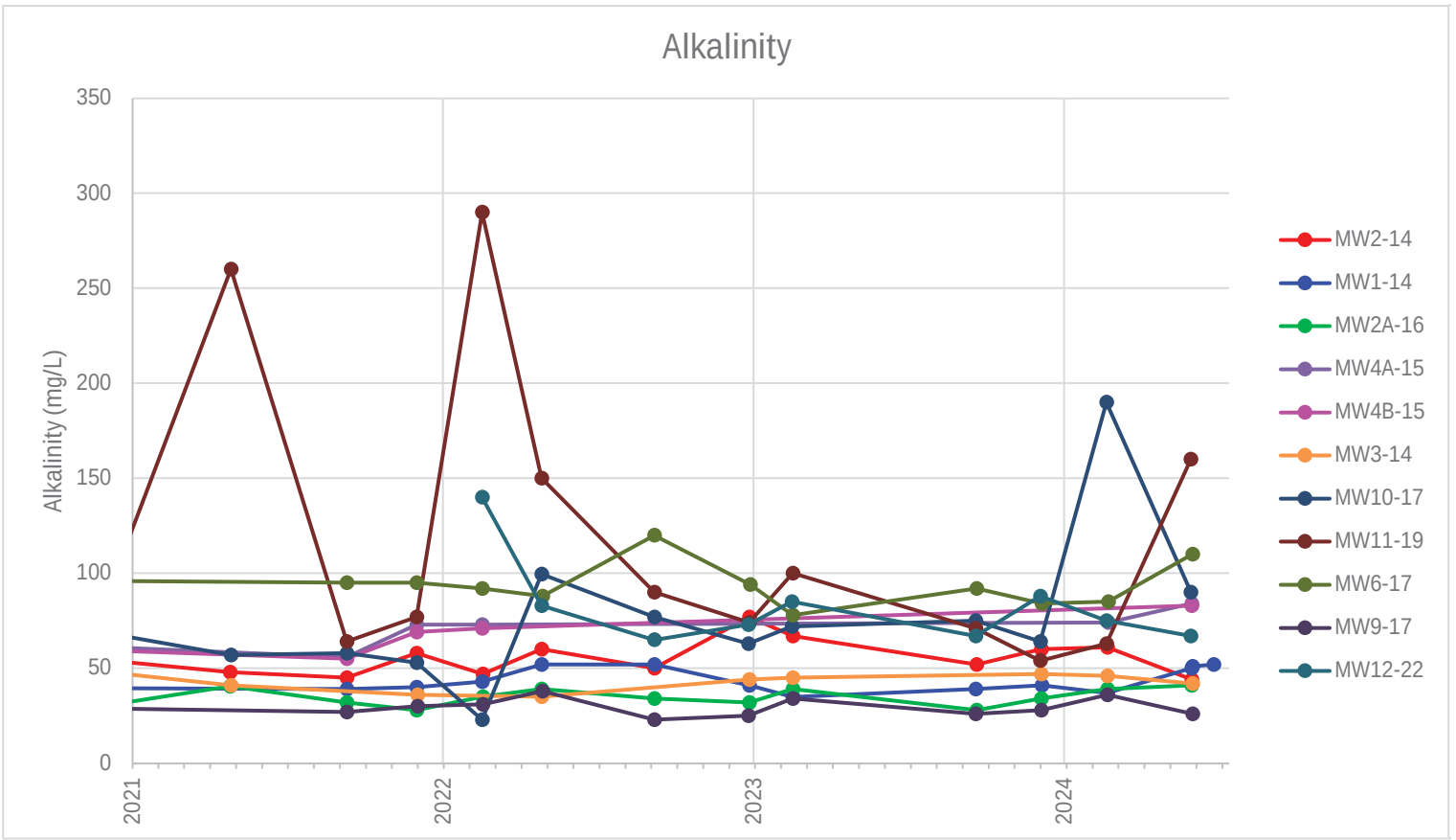

GHD

APPENDIX D

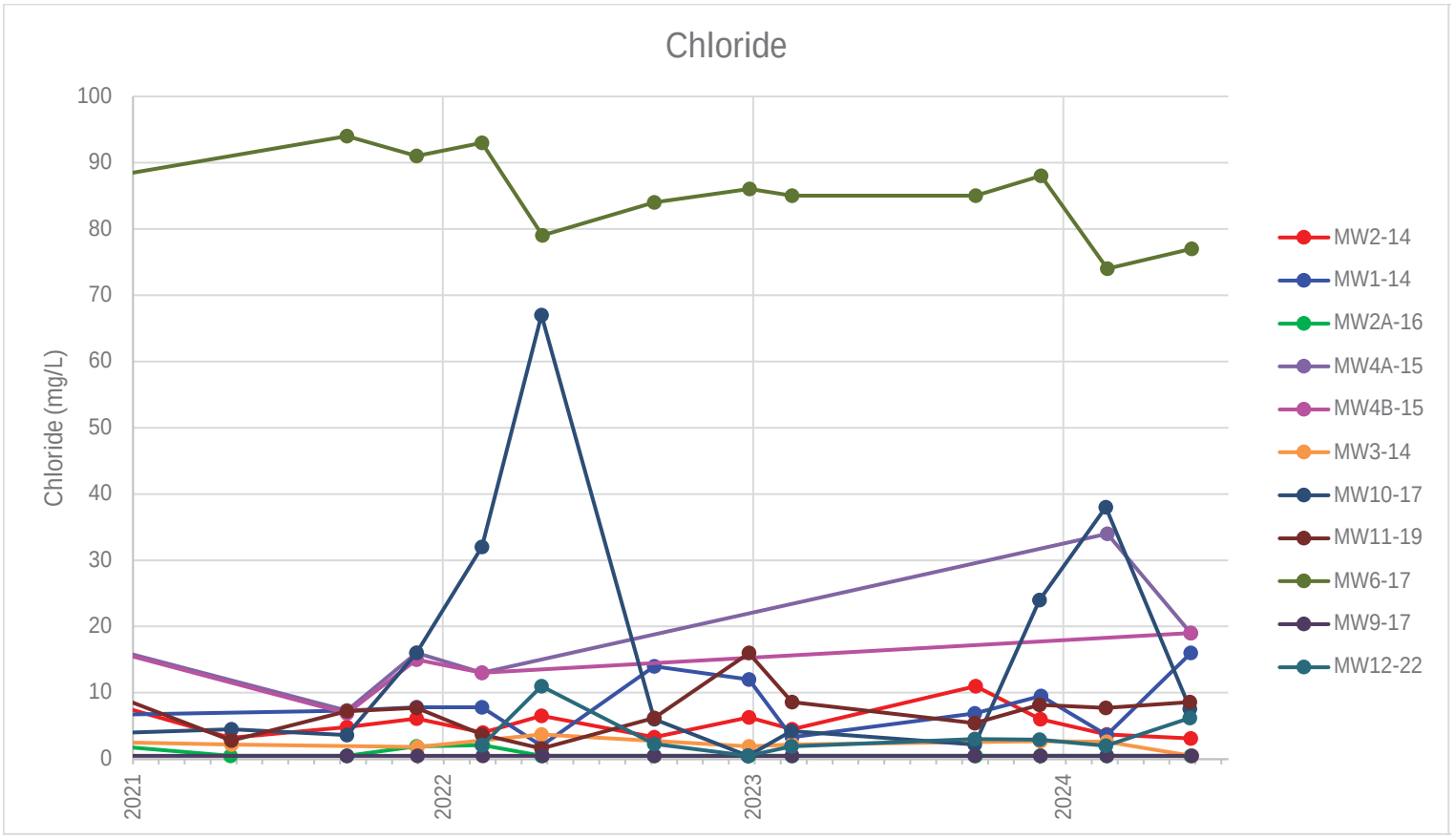
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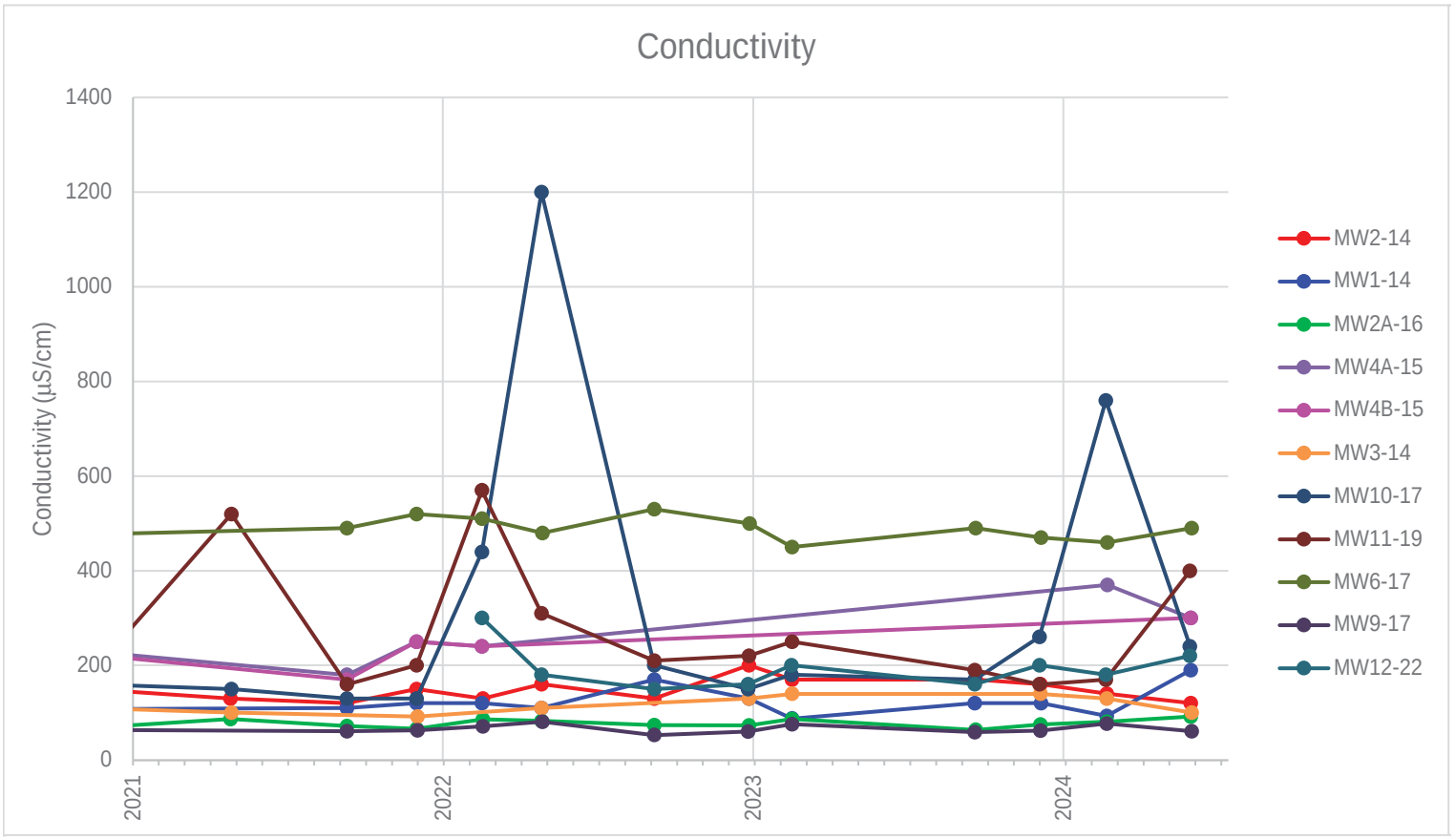
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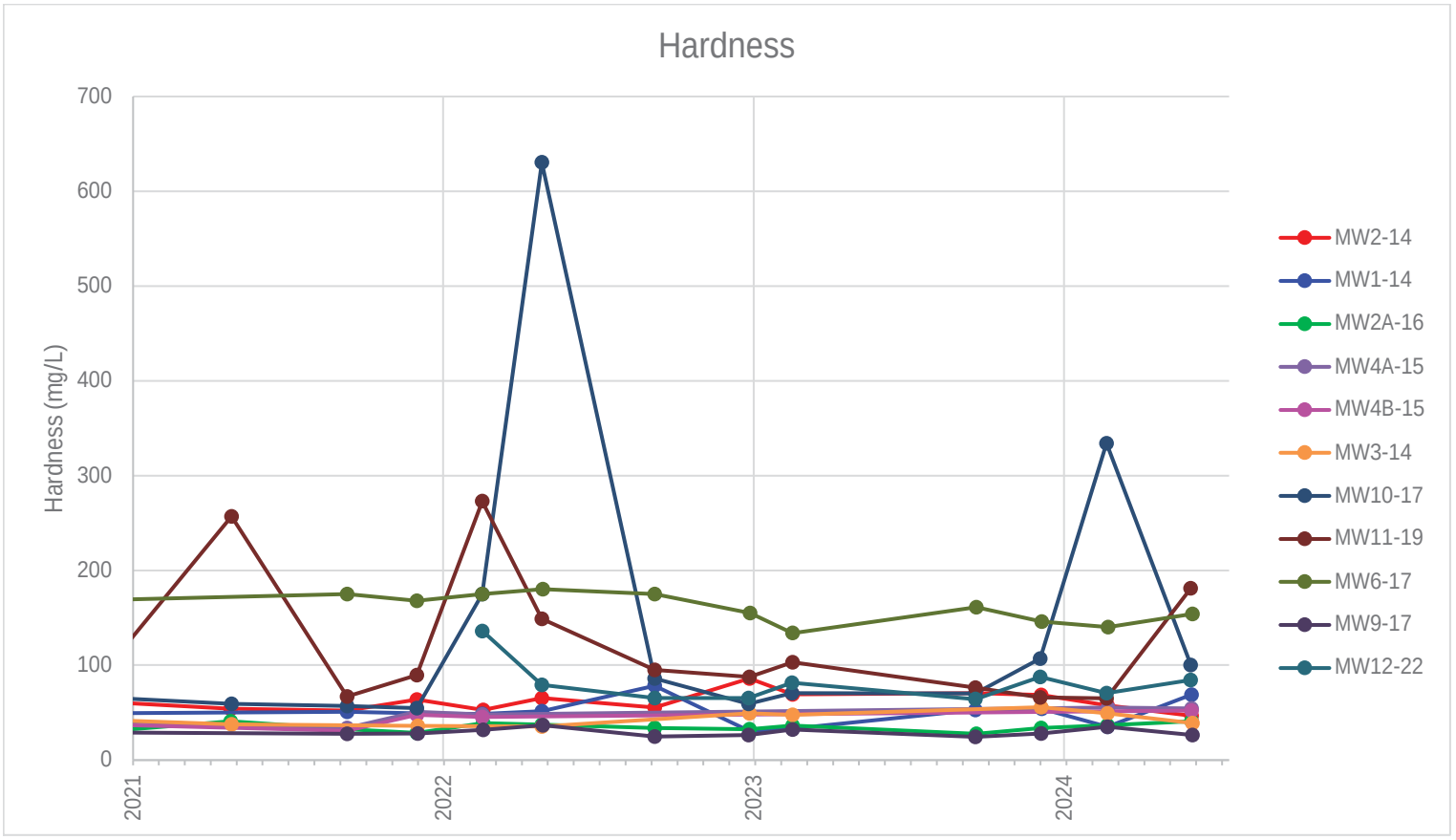


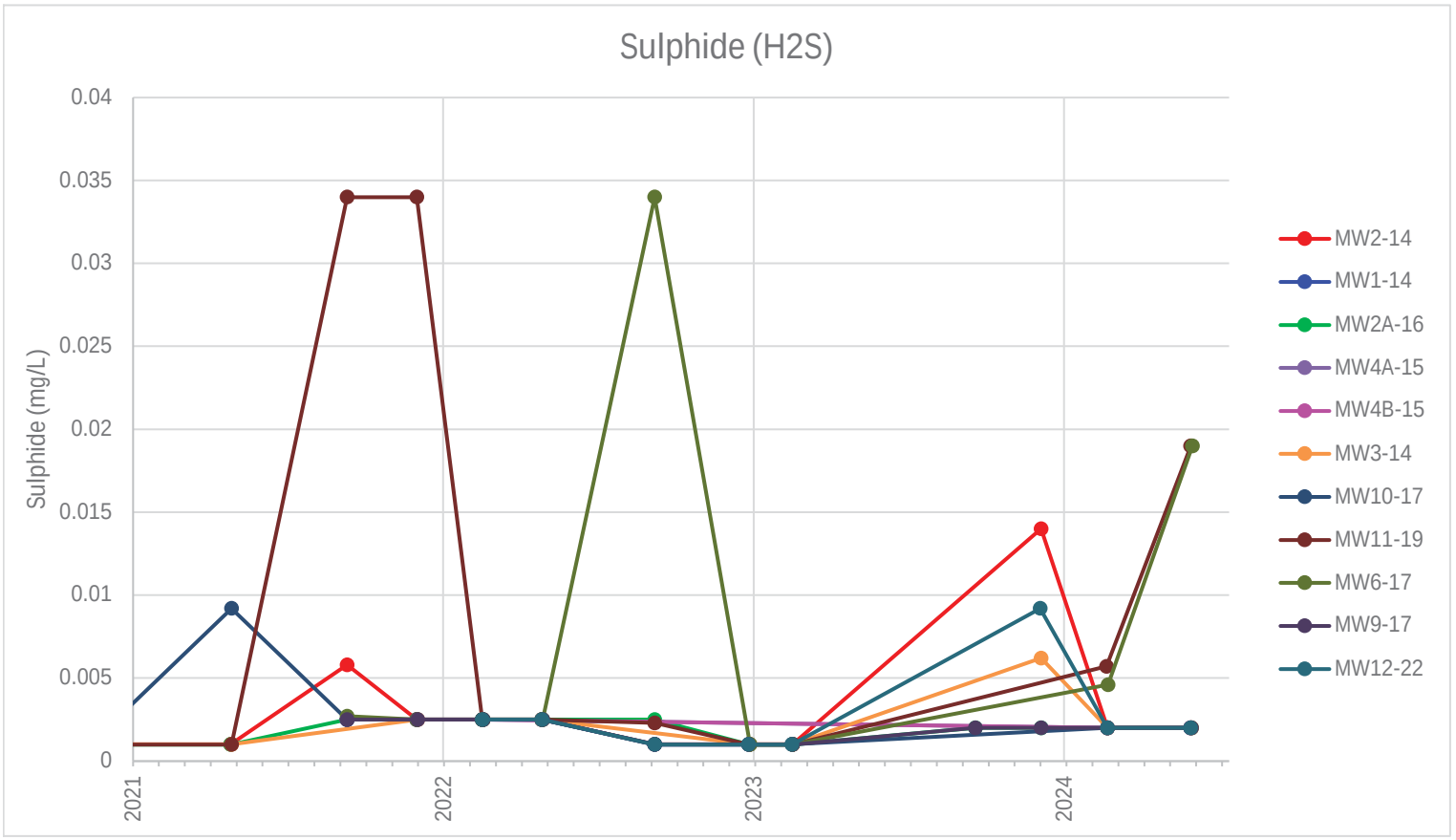
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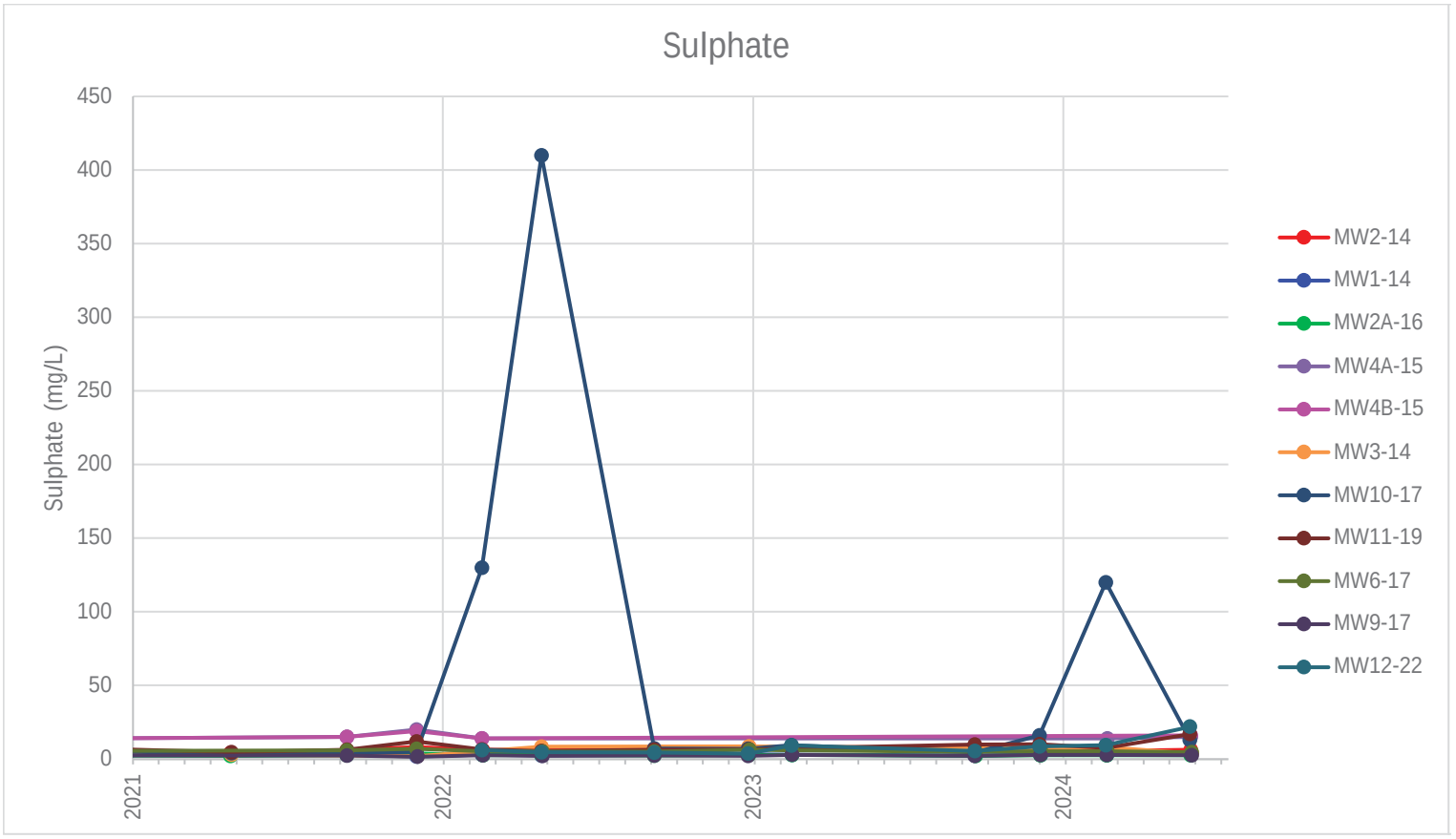


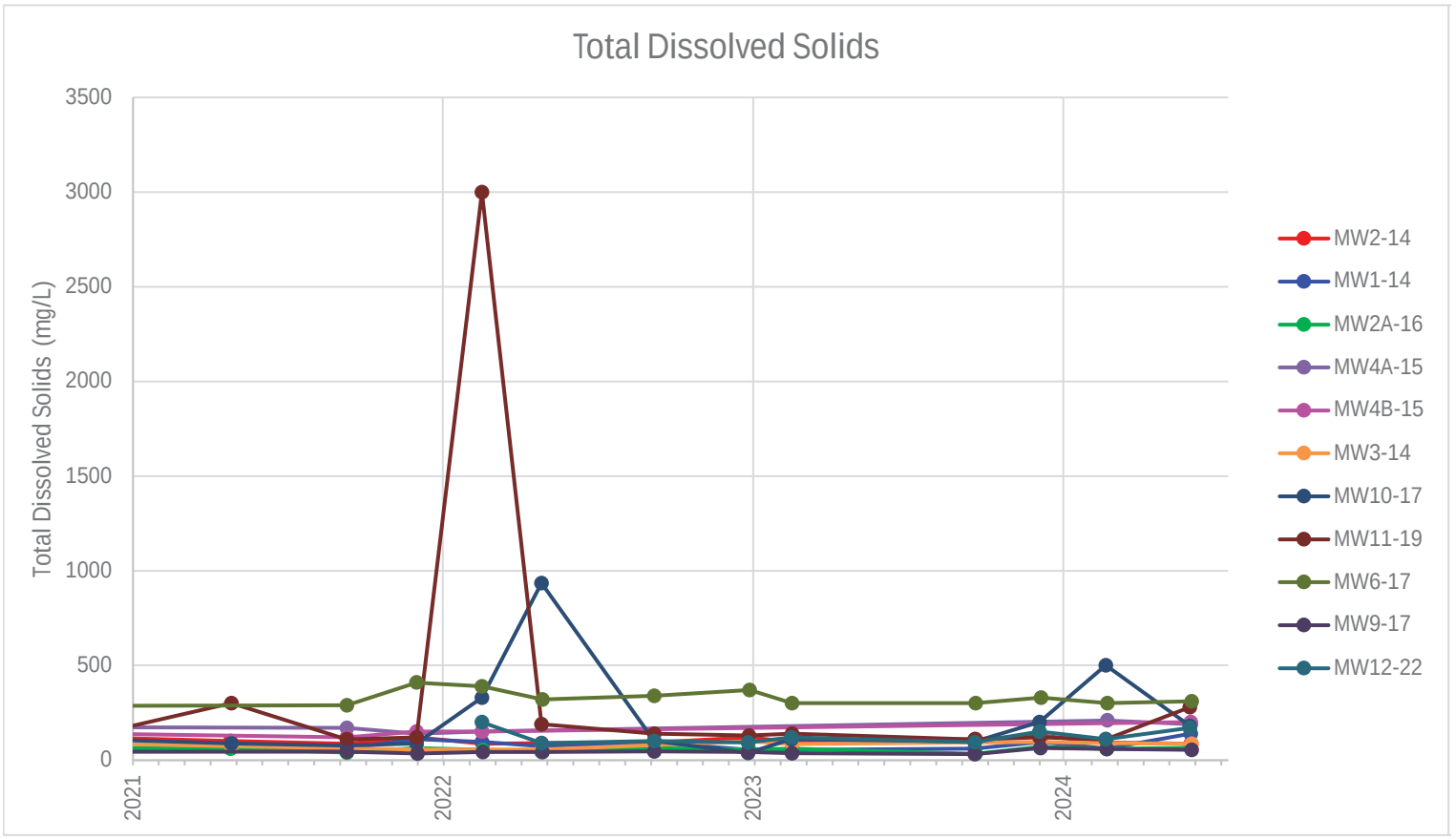
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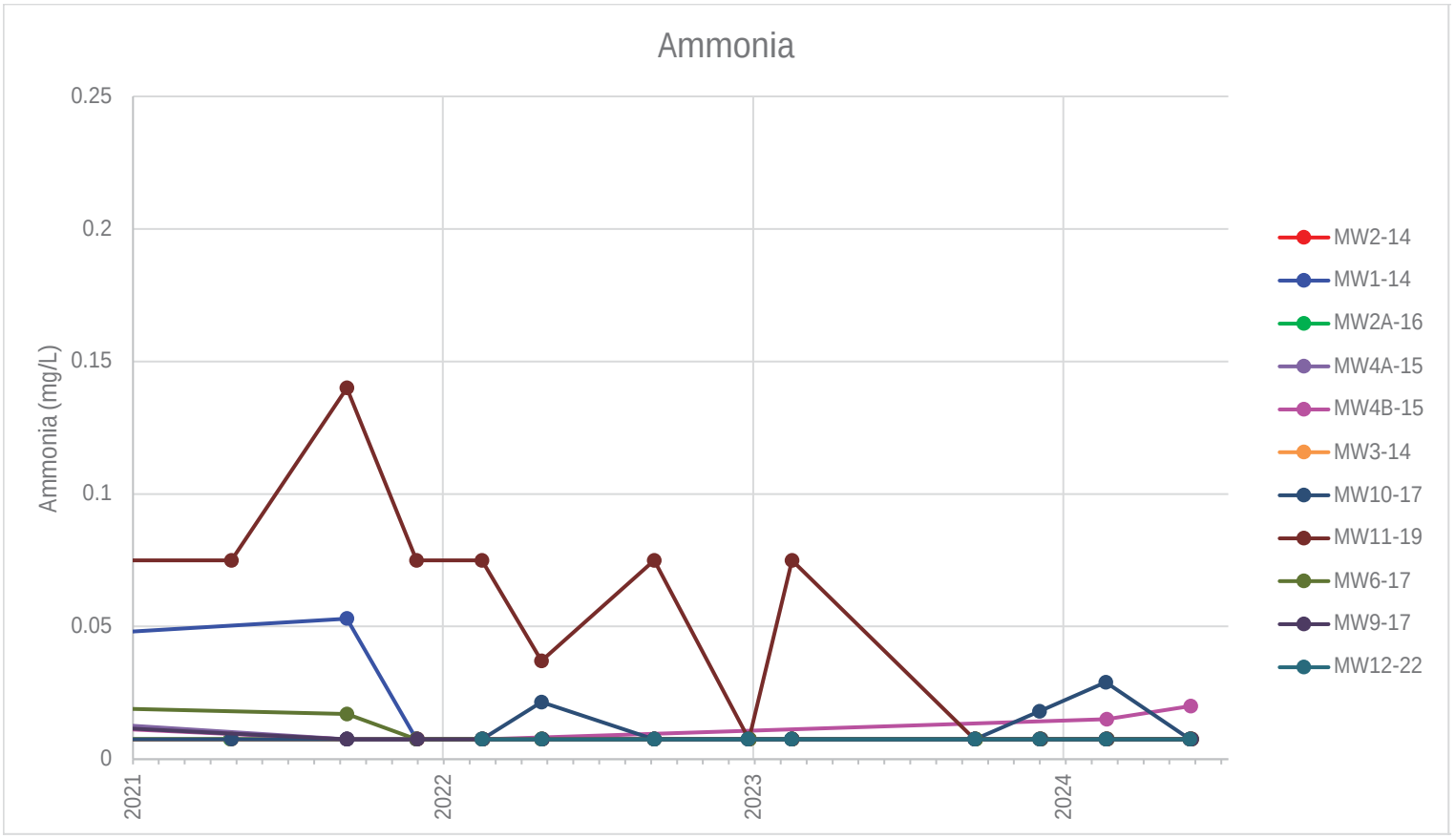


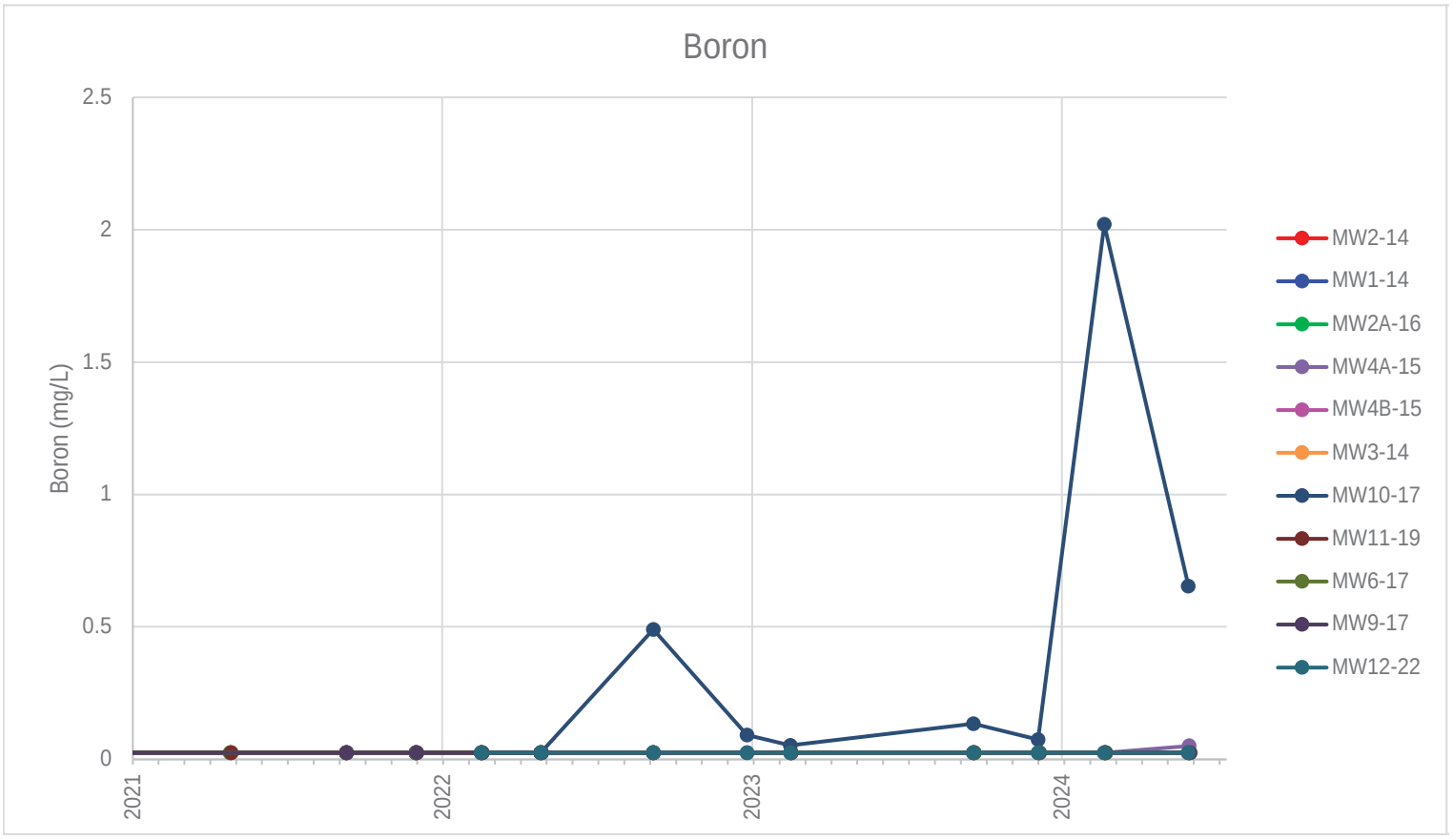
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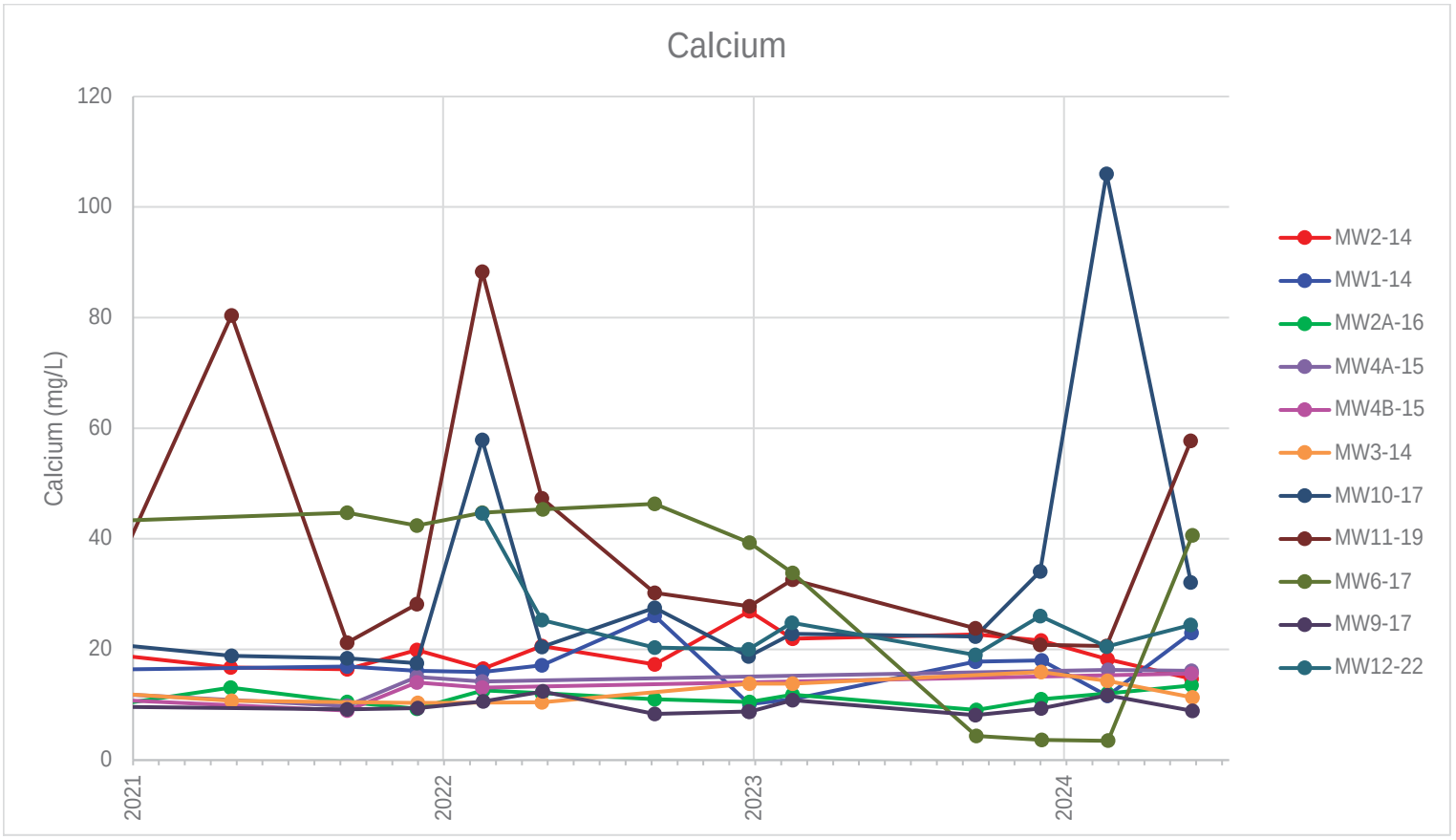


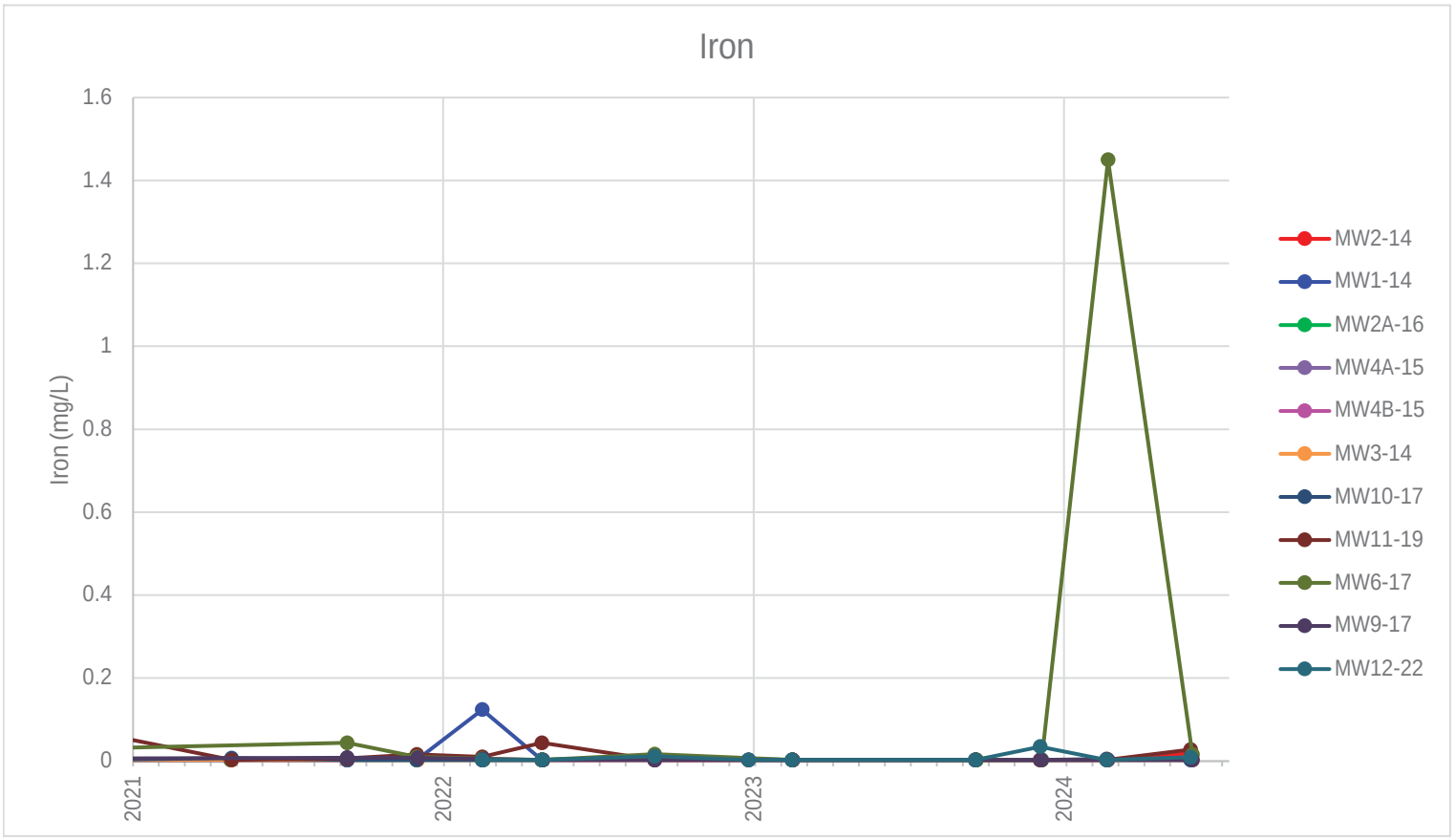
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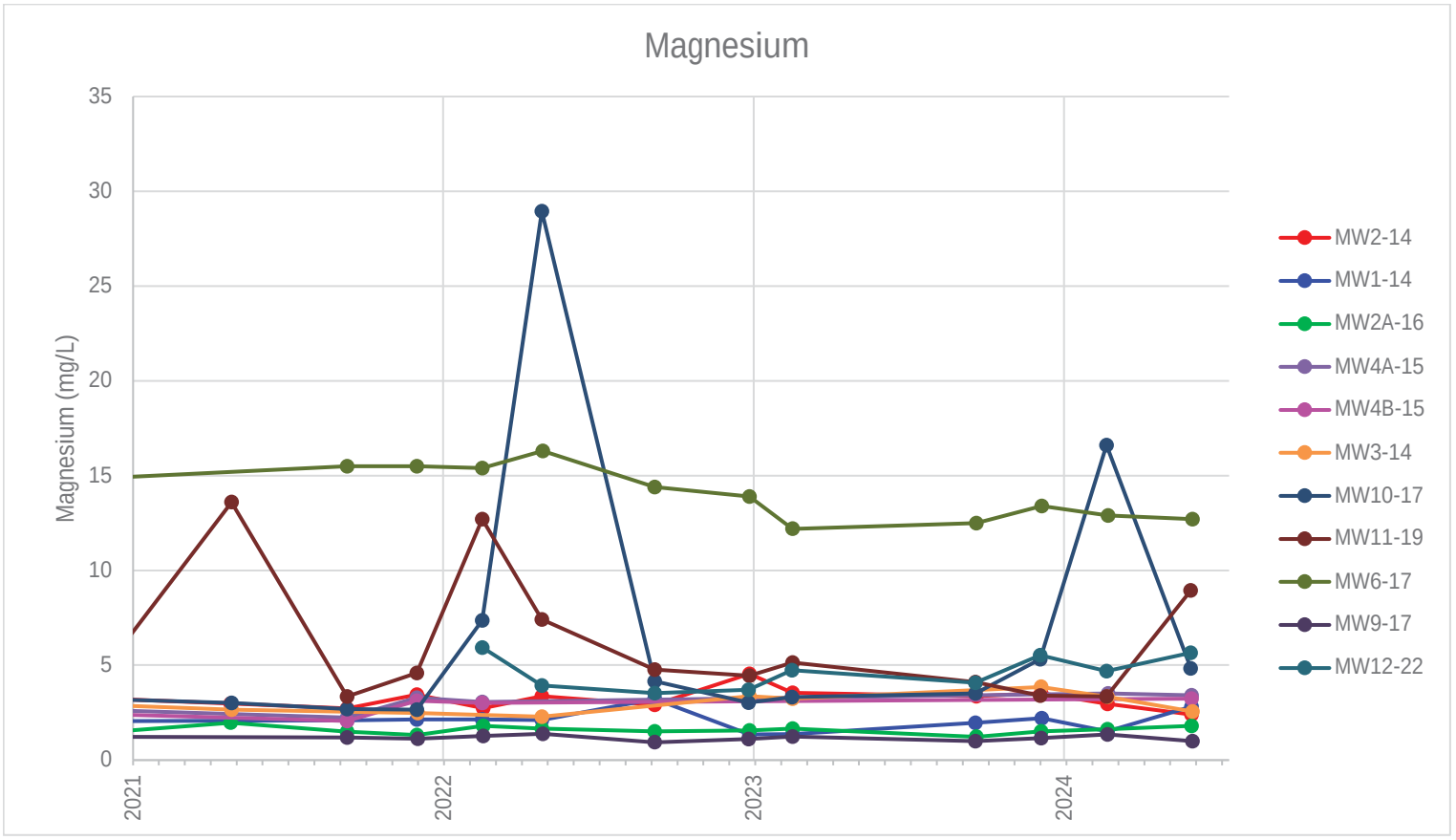


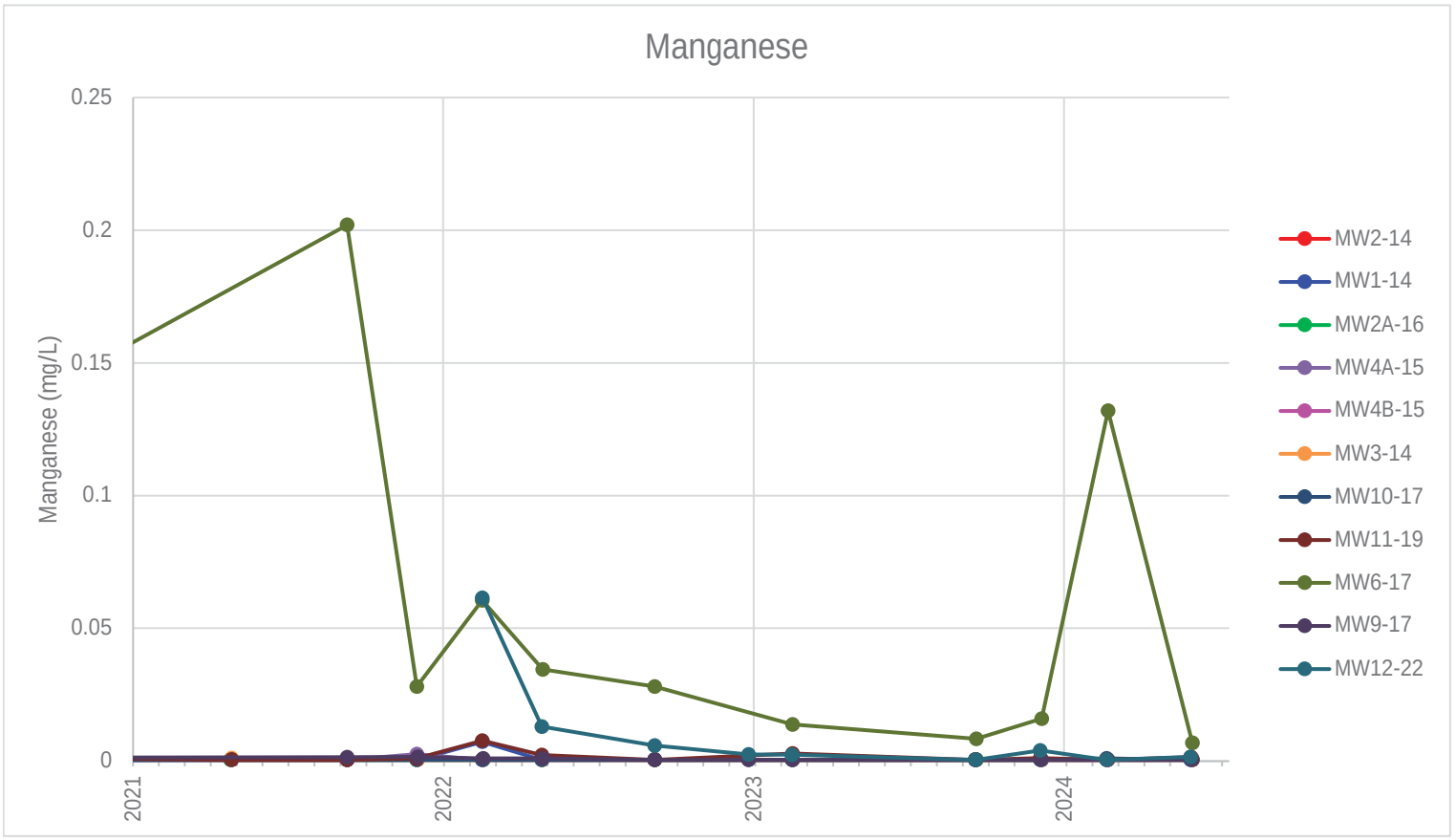
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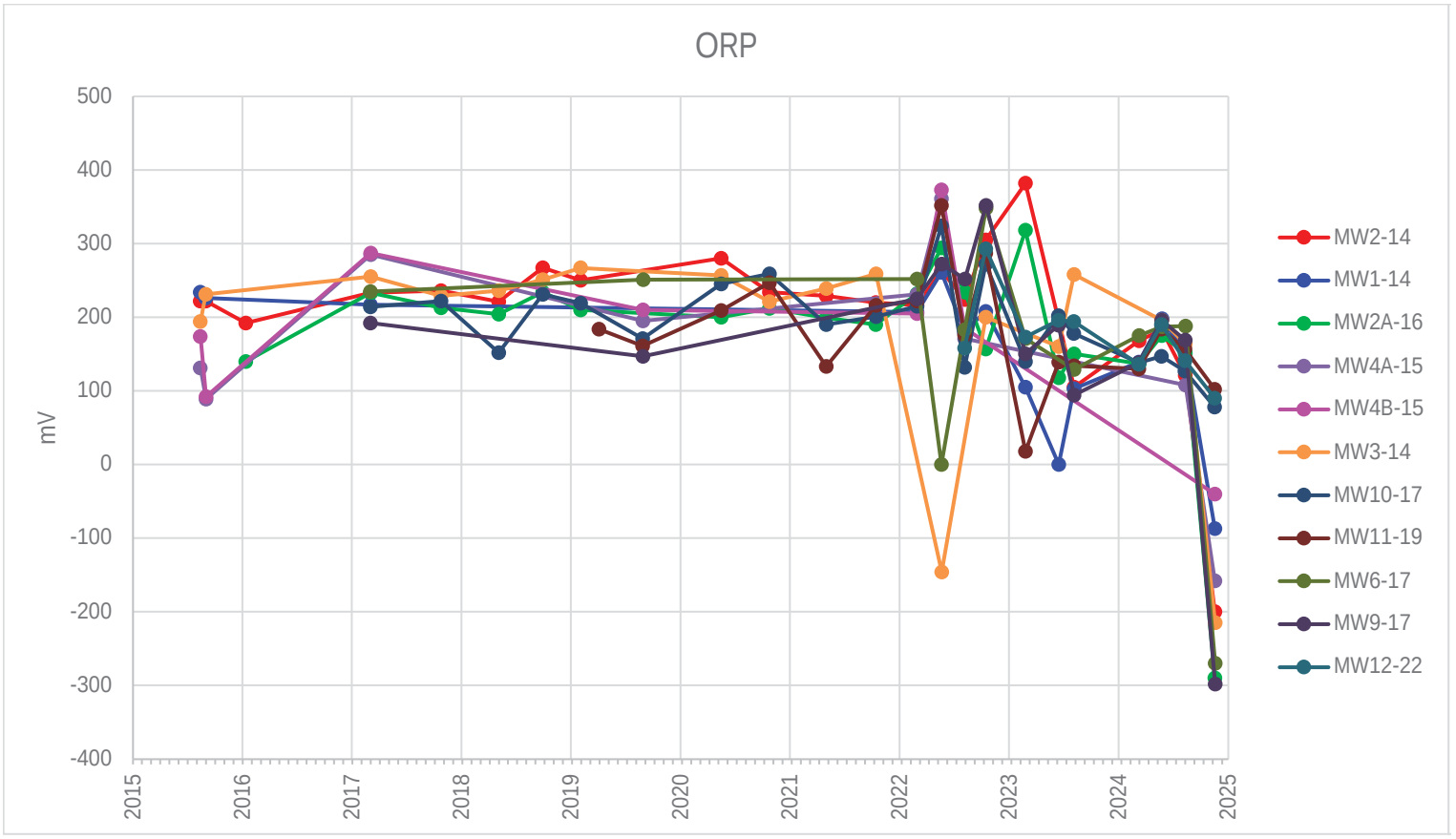


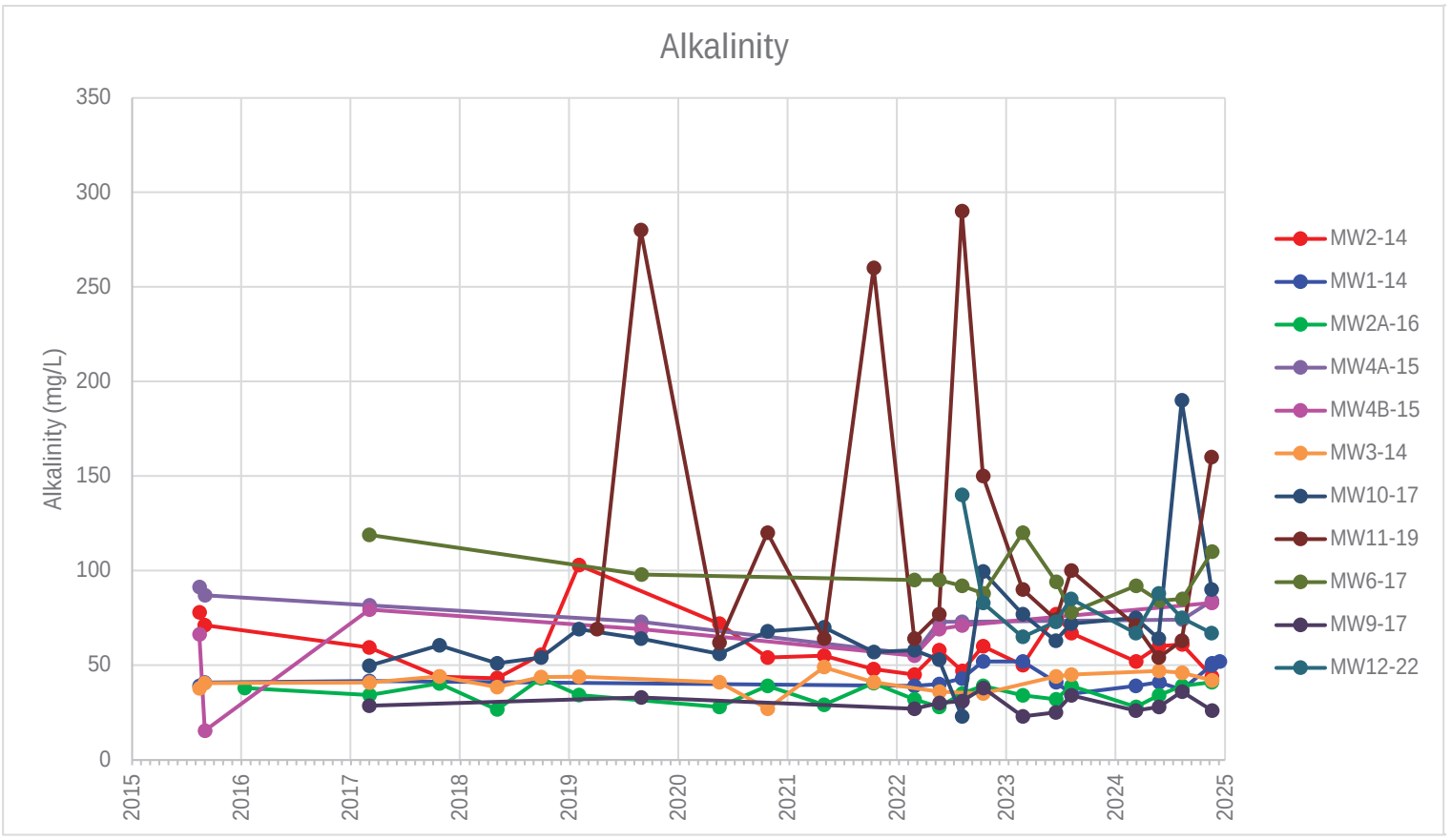
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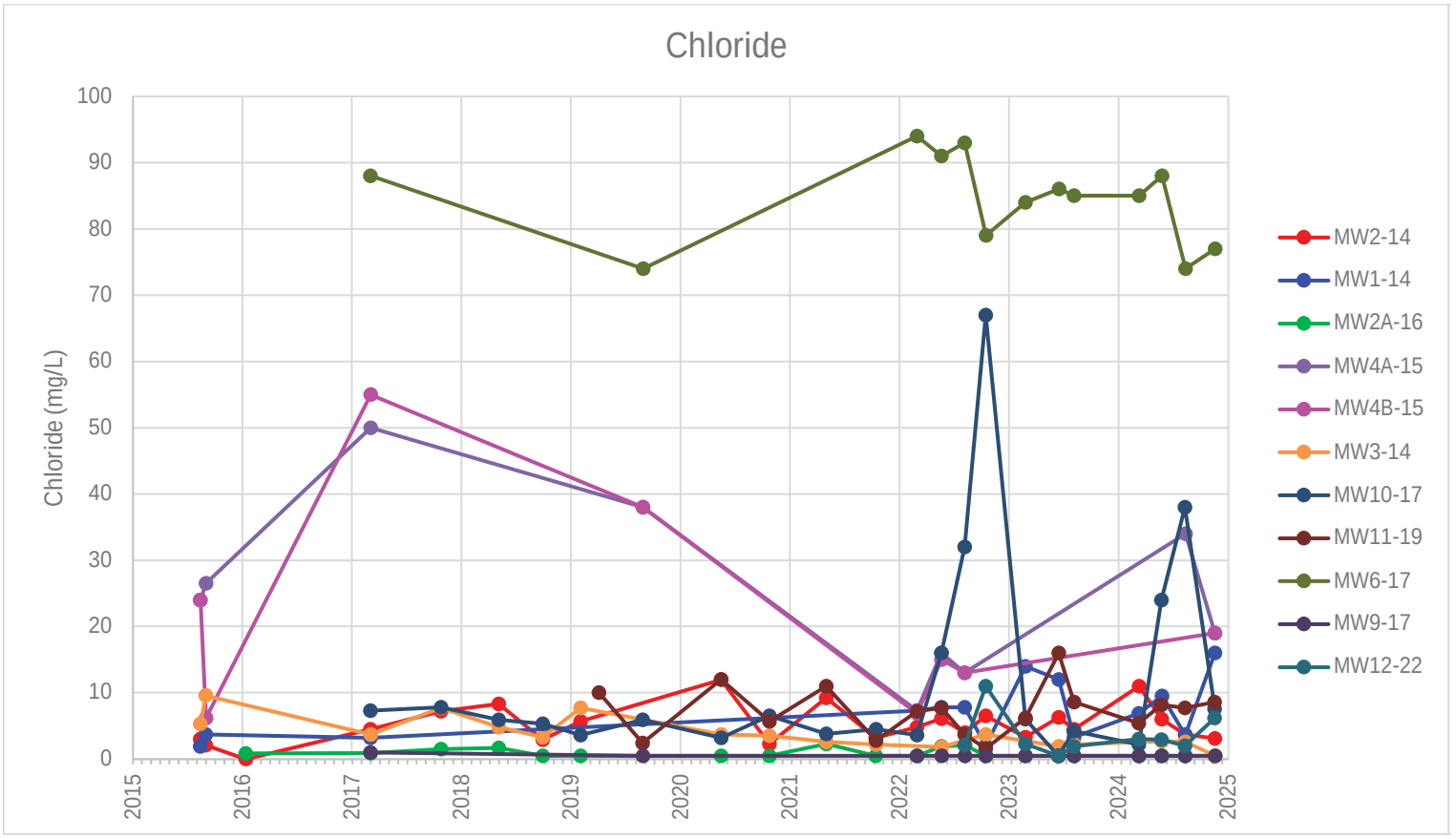


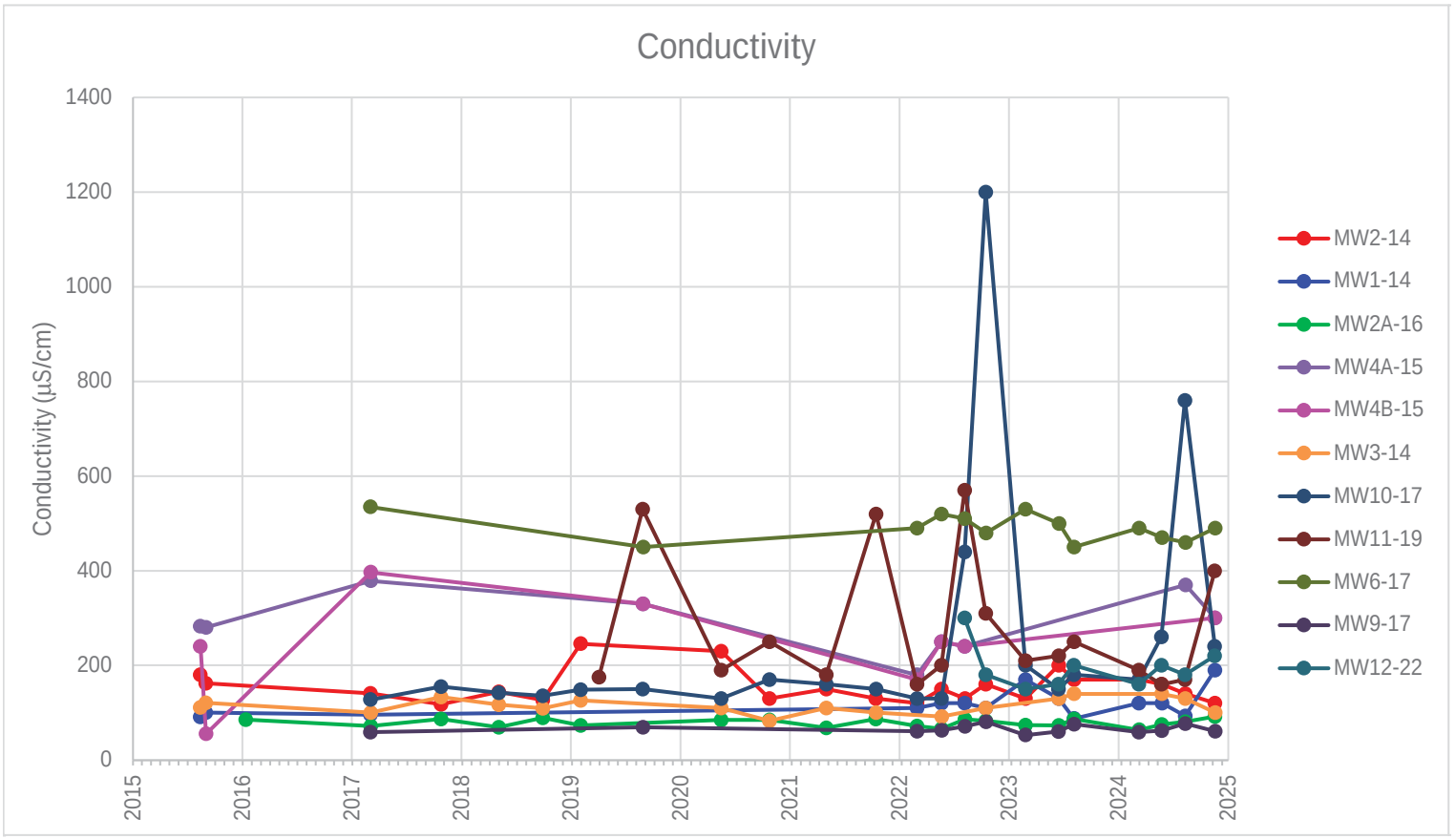
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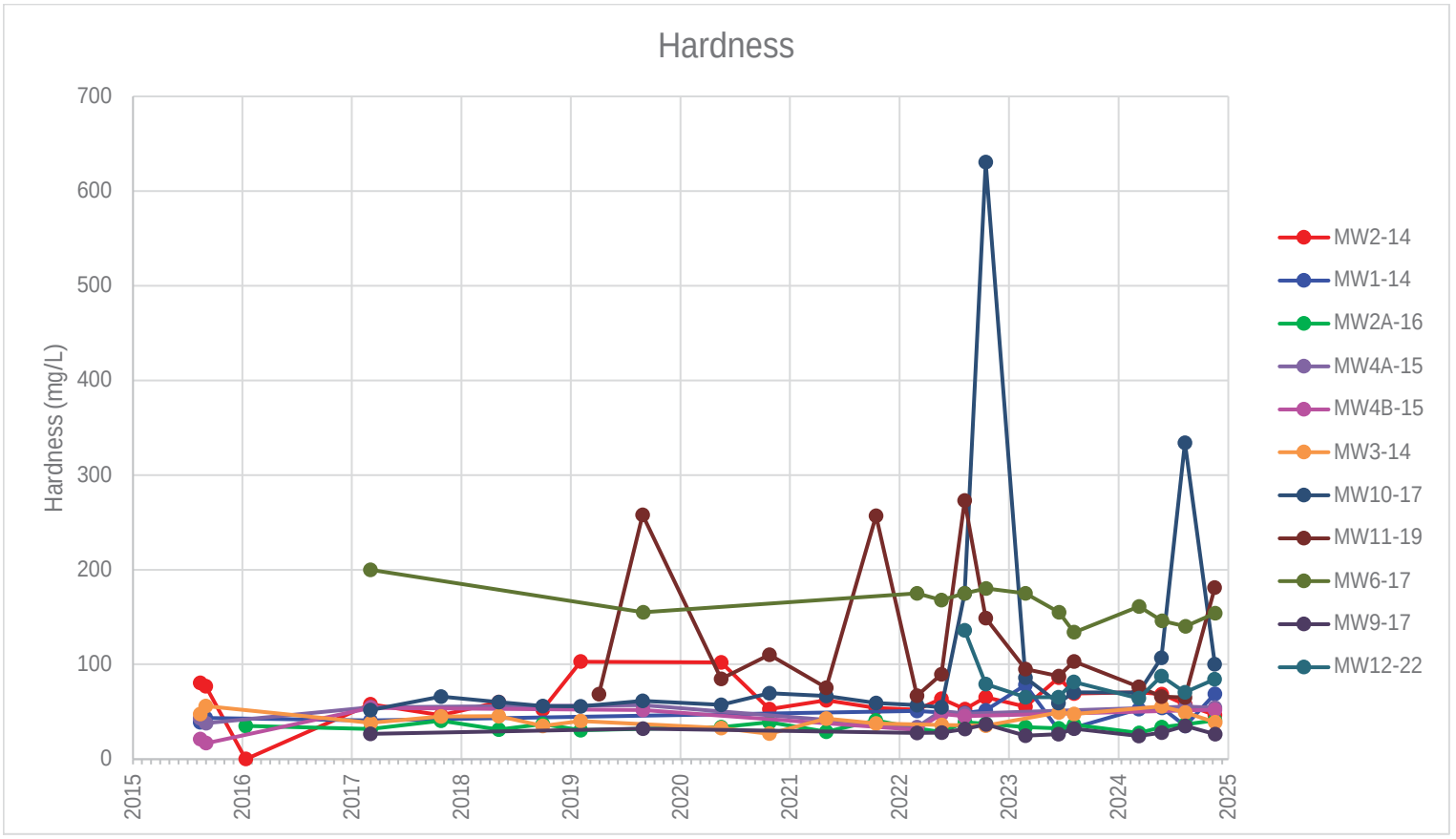


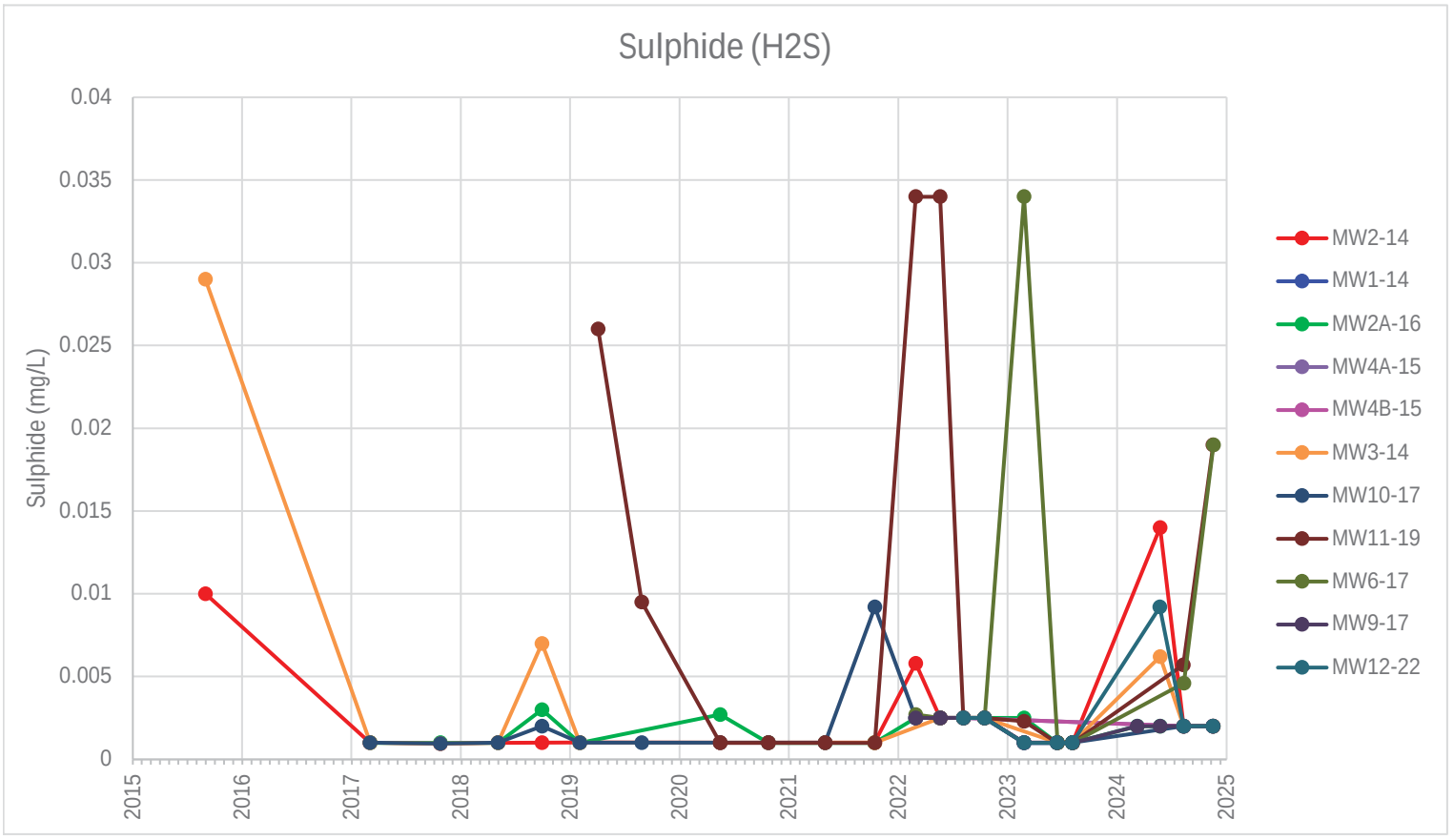
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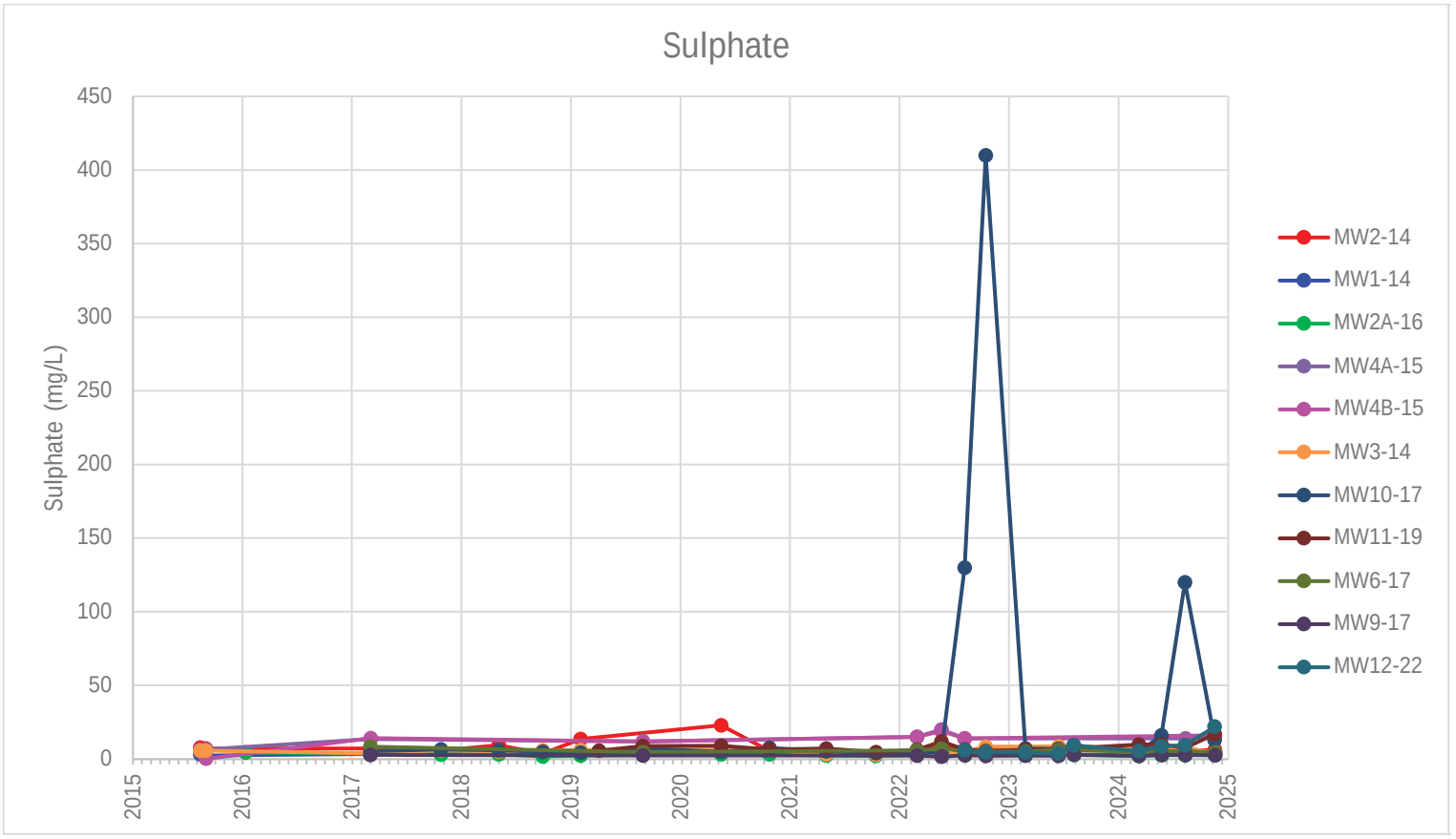


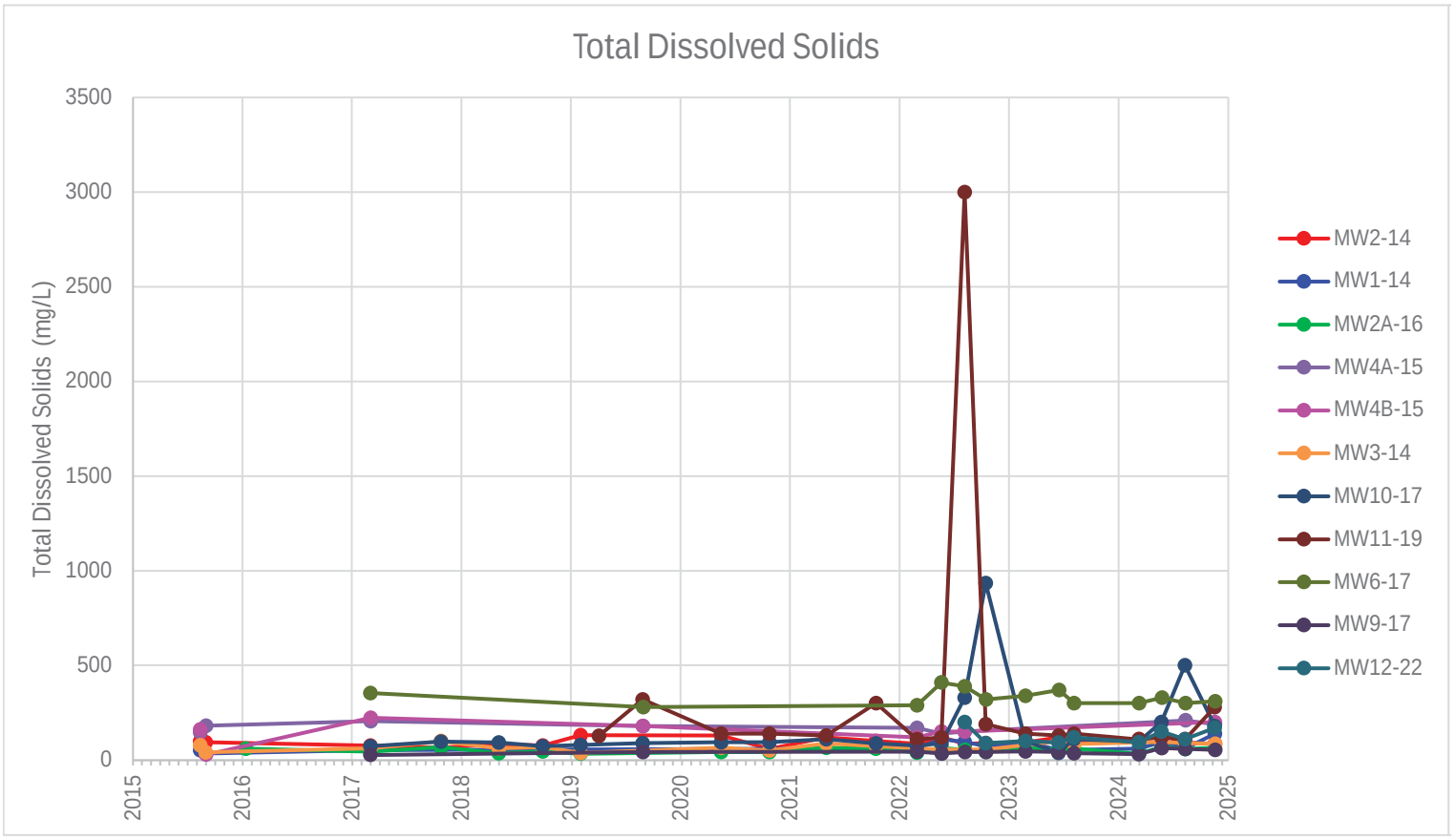
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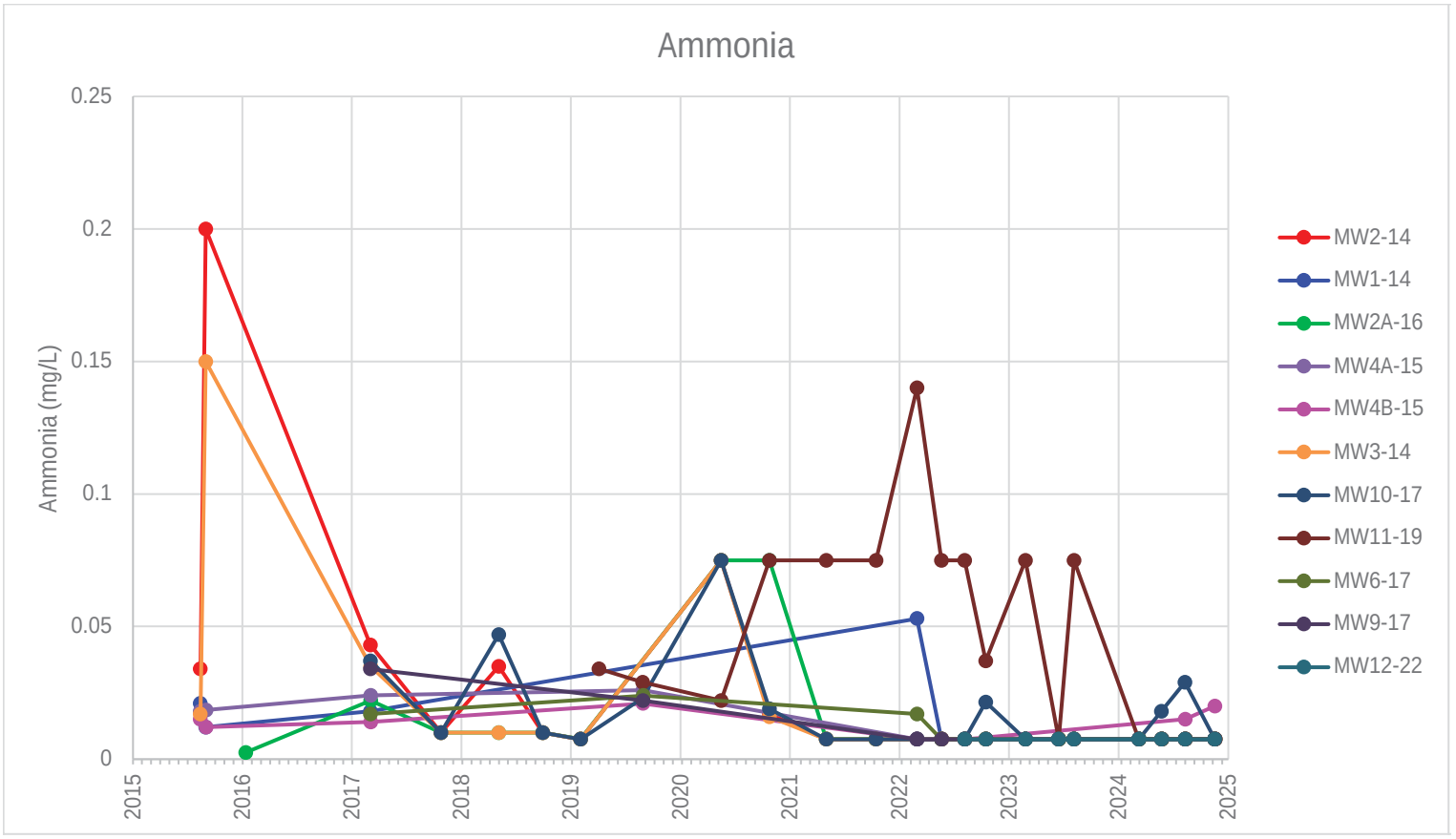


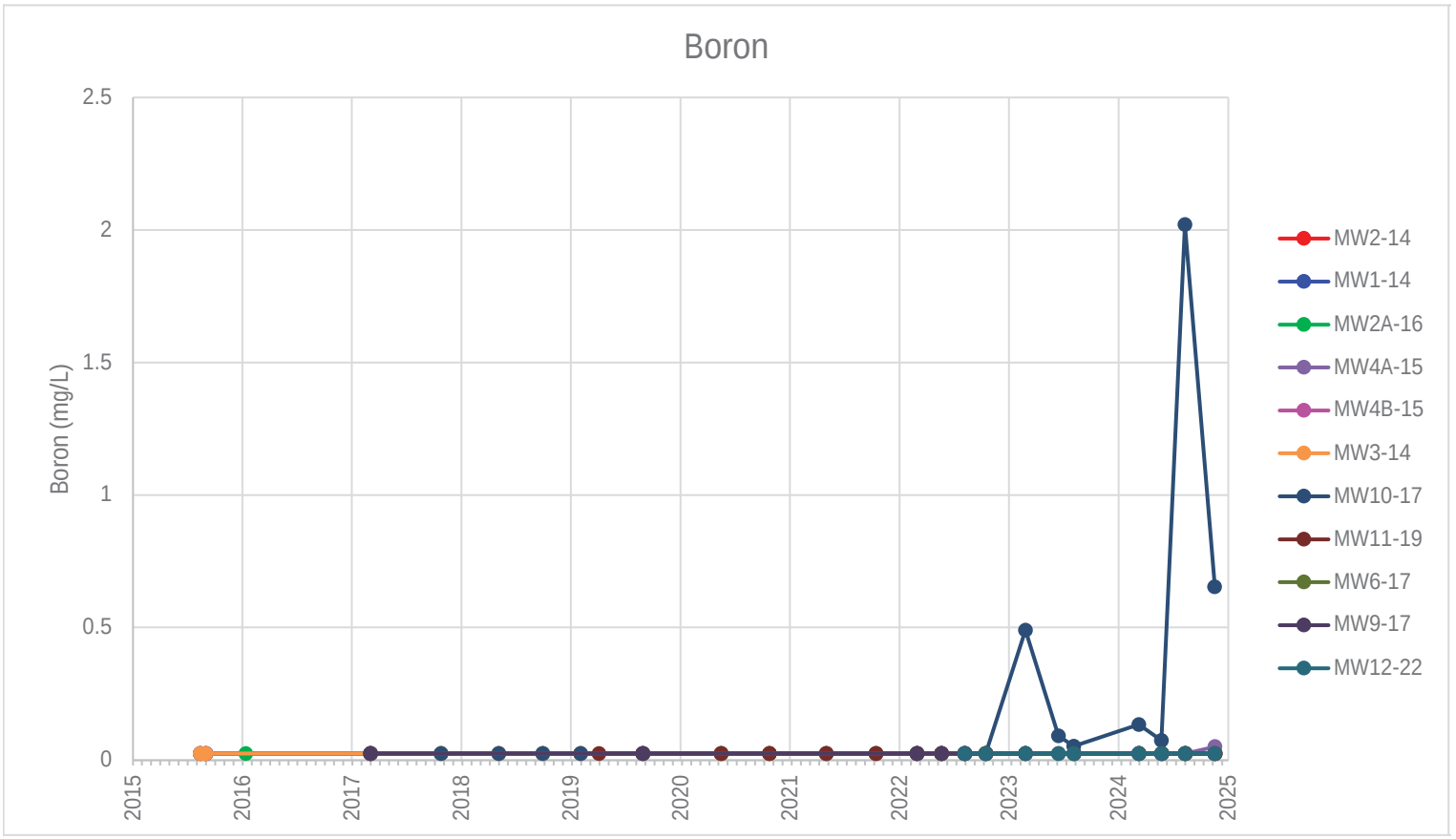
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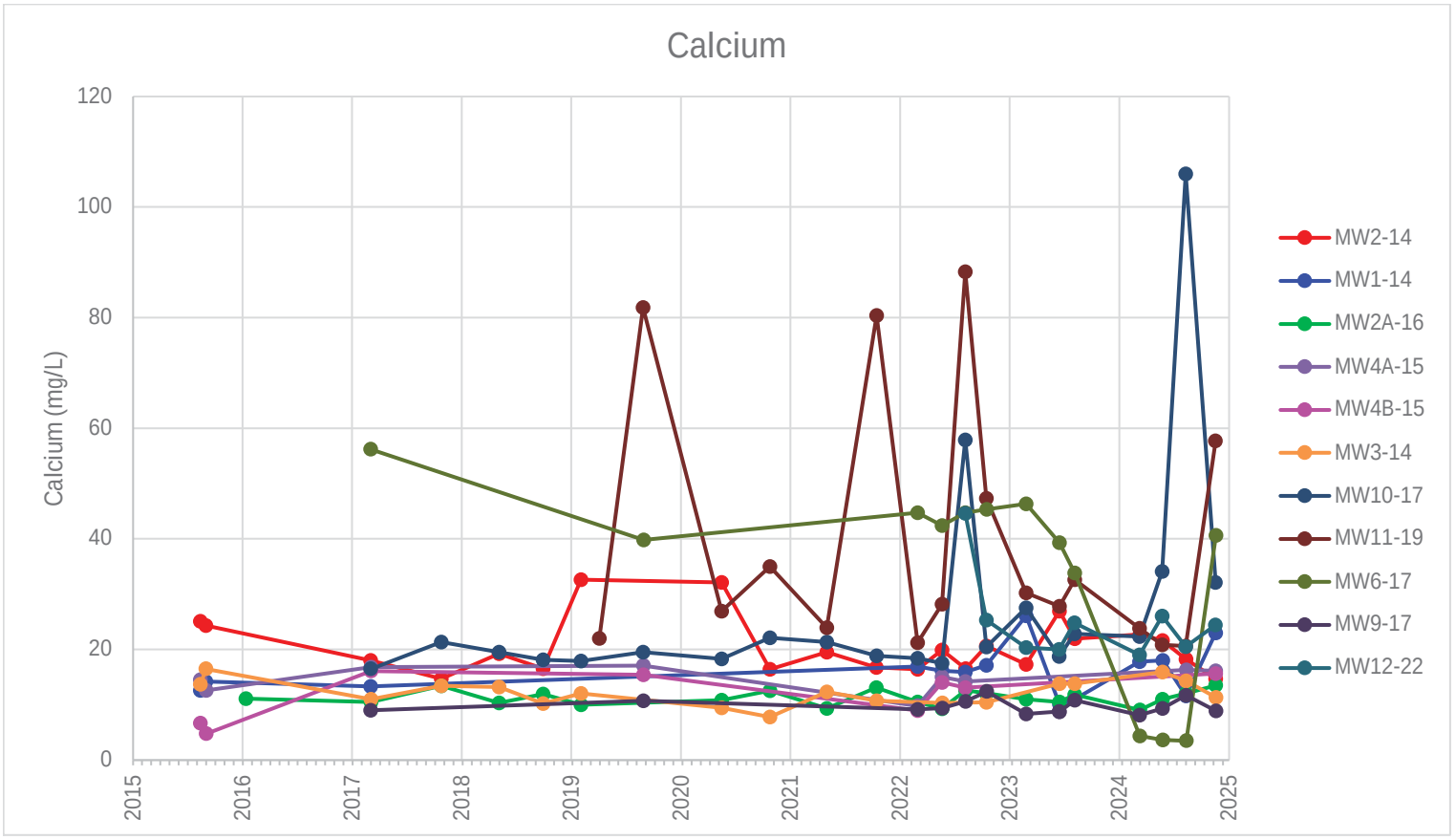


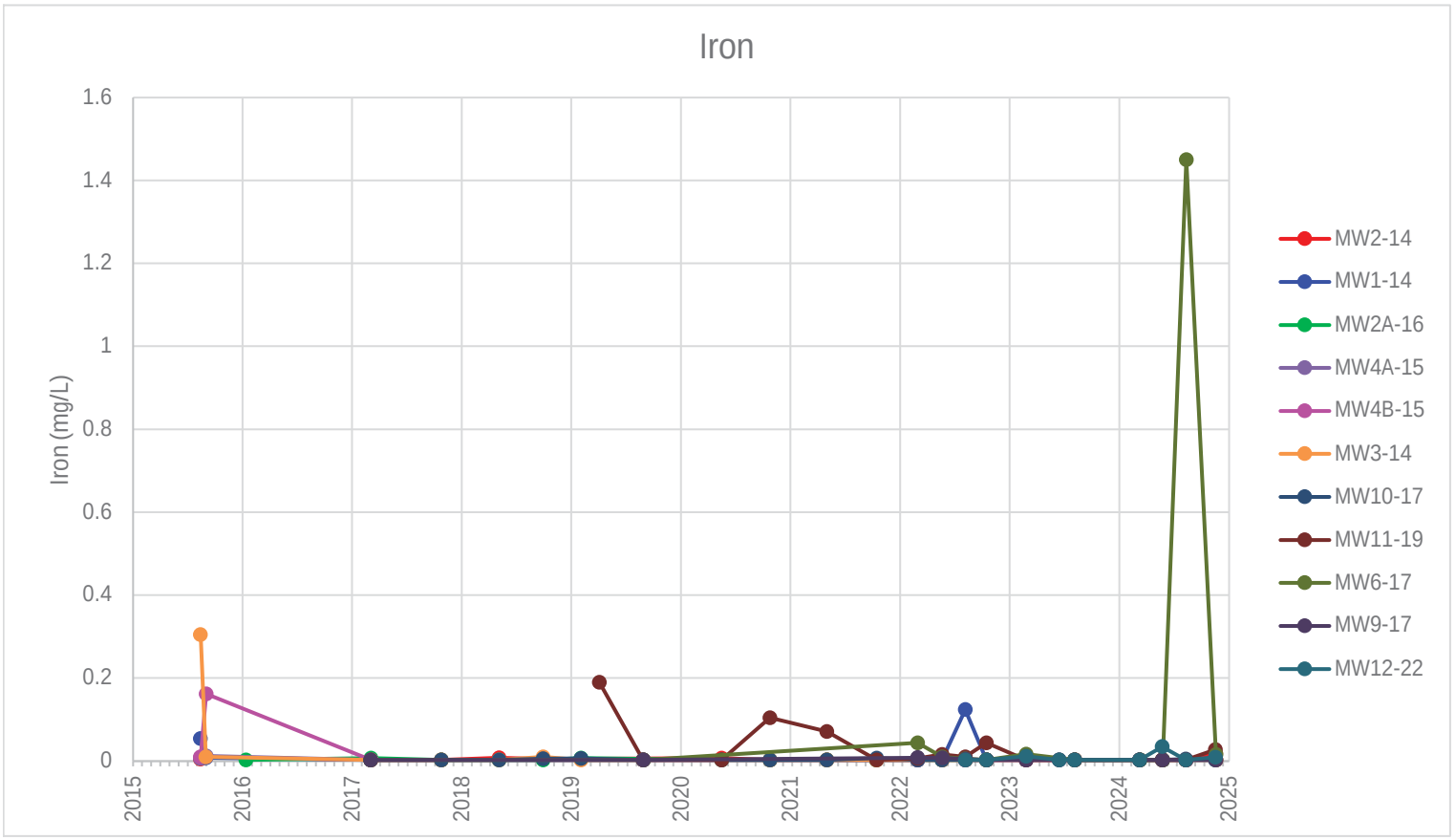
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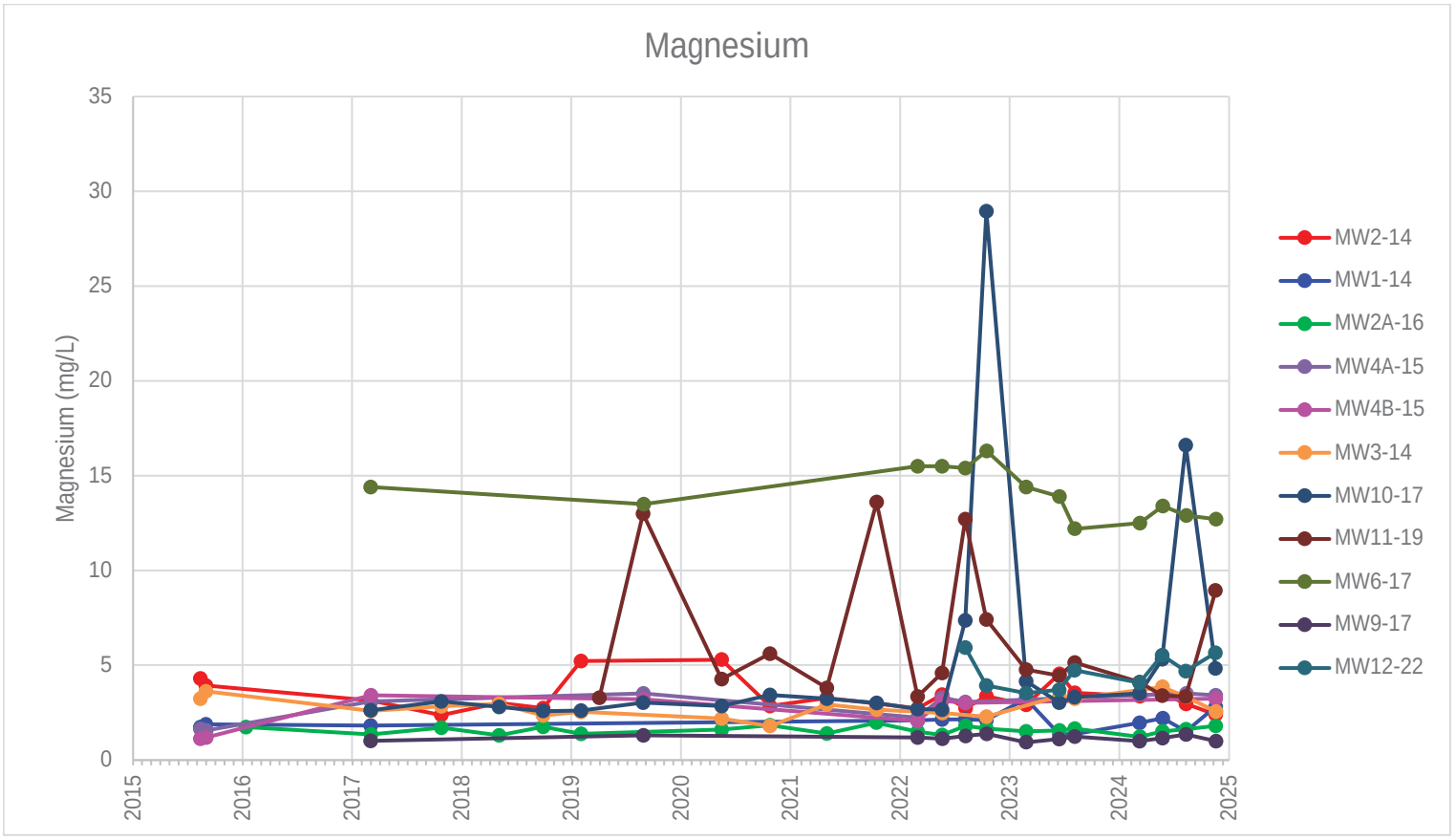


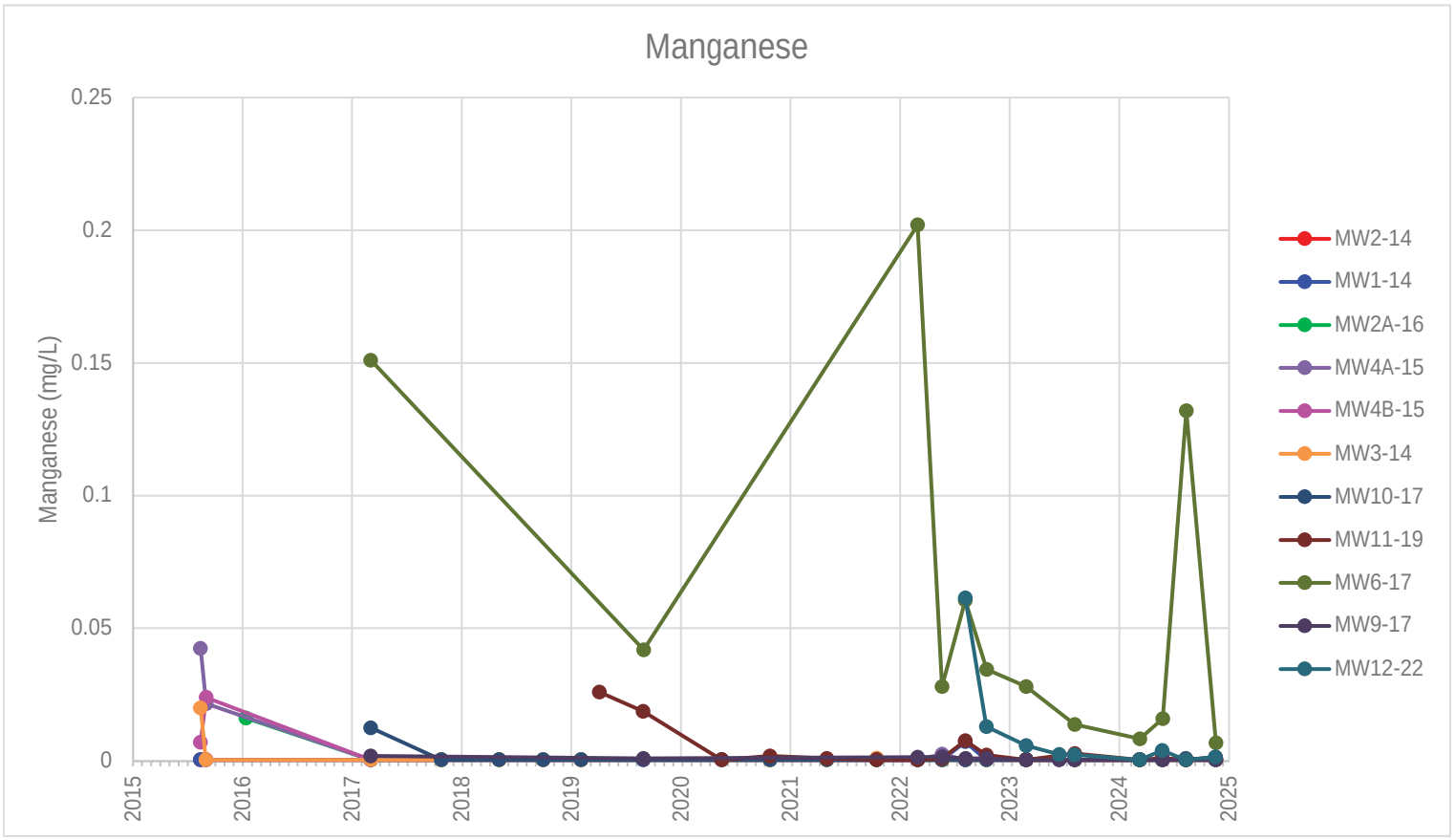
APPENDIX D2 (2015-2024)





APPENDIX D2 (2015-2024)





APPENDIX E:
EnviroChem 2024 Q4 Water Monitoring / Sampling Program Report

March 27, 2025
File No.: 24209
Revision: 1

Northwin Environmental Ltd.
7295 Gold River Highway
Campbell River, BC

Attn: Brian Fagan

Re: 2024 Q4 Water Monitoring / Sampling Program – New Landfill
7295 Gold River Highway, Campbell River, BC

1.0 INTRODUCTION

Northwin Environmental Ltd. (Northwin) retained Envirochem Services Inc. (Envirochem) to provide environmental consulting services related to annual groundwater, surface water, and leachate monitoring / sampling at an area designated as the New Landfill located at 7295 Gold River Highway, Campbell River, BC (the Site). A Site Location Map is presented on **Figure 1** in **Attachment 1**. A Site Plan is presented on **Figure 2**, with the New Landfill Site Plan as of January 29, 2025, shown on **Figure 3** in **Attachment 1**.

1.1 Project Understanding

Northwin operates a landfill consisting of two general areas at the Site: 1) an Original Landfill (closed) and 2) a New Landfill (operational – refer to **Figures 2 and 3** in **Attachment 1**). The New Landfill has been in operation since 2019 and is the subject of this report. At the New Landfill, Northwin is authorized to discharge wastes under the provincial Ministry of Environment and Parks (BC ENV) Operational Certificate 107689 (Permit) and 2021 Design, Operations and Closure Plan (DOCP).[1] The authorized characteristics of the waste discharges under the Permit include: construction and demolition (C&D) waste; land clearing waste; industrial (IL) waste quality soil (i.e., soil concentrations greater than provincial IL quality standards and less than hazardous waste standards) (amended on April 26, 2022); sludge from leachate management works or stormwater management works; and other wastes as may be authorized by BC ENV.

It is understood that Sperling Hansen Associates Inc. (SHA) has been retained by Northwin to oversee the overall annual operations and monitoring program (the Program) for the Site. Envirochem's role within the project team is to support SHA by monitoring various groundwater, surface water, and leachate sampling points (refer to **Figure 4** in **Attachment 1**) and collecting measurements and samples from those locations, where applicable, to satisfy the requirements of the Permit / DOCP. It is also understood that Envirochem's findings (i.e., this report) will be incorporated into the annual operations and monitoring report for the Site prepared by SHA.

[1] *2021 Design, Operations and Closure Plan, Northwin Landfill, Upland Pit Property, Campbell River, British Columbia* prepared by GHD, dated July 8, 2021.

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Fax: 604-986-8583
Email: response@envirochem.com
envirochem.com

In its 2024 Environmental Monitoring Program Specification (2024 Specification)[2], GHD outlined the monitoring / sampling program for each quarter in 2024. GHD completed the 2024 Q1, Q2, and Q3[3] monitoring / sampling activities in general conformance with the 2024 Specification. Envirochem was retained to fulfil the 2024 Q4 groundwater, surface water, and leachate monitoring / sampling program laid out in the 2024 Specification.

1.2 Objectives

Based on our understanding of the project requirements, Envirochem interprets its objectives for the 2024 Q4 portion of the Program to be as follows:

- To complete the specified 2024 Q4 water monitoring field activities as per the 2024 Specification.
- To provide a report of the field activities and associated monitoring / sampling results for incorporation into the 2024 operations and monitoring report for the Site, which is being prepared by SHA.

2.0 SCOPE OF WORK

To fulfil the project objectives, Envirochem completed the scope of work described below.

2.1 Monitoring Locations

The monitoring locations targeted during the 2024 Q4 monitoring / sampling program are summarized as follows:

Table 2-1: Monitoring Locations

Type	Monitoring Location Identifications				
Up-gradient Groundwater Monitoring Wells	MW1-14	MW4A-15	MW4B-15	MW6-17	MW9-17
Cross-gradient Groundwater Monitoring Wells	MW2-14	MW2A-16	-	-	-
Down-Gradient Groundwater Monitoring Wells	MW3-14	MW10-17	MW11-19	MW12-22	MW13 [1]
Additional Groundwater Monitoring Wells [2]	MW5A-15	MW5B-15	MW7-17	MW8-17	MW15A-18
	MW15B-18	PZ1-19	-	-	-

[2] Appendix J in GHD's *2023 Operations and Monitoring Report, New Landfill* report dated March 27, 2024.
[3] Quarterly monitoring events have typically occurred in March/April (Q1), June (Q2), August/September (Q3), and November (Q4).

Type	Monitoring Location Identifications				
Surface Water	Rico Gauge	McIvor Lake	SW15-01	SW15-02	-
Leachate	S06-21	S07-24	TLIP	-	-
Leak Detection	LDS	LDMP-1	LDMP-2	LDMP-3	LDMP-4

Table 2-1 Notes:

1. Monitoring well MW13 has yet to be installed.
2. Water level measurements only. No samples to be taken.

2.2 Monitoring Activities

The following monitoring activities were completed during the 2024 Q4 monitoring / sampling program:

- Water level measurements were collected at all monitoring locations listed in **Table 2-1**, above, with the exception of the locations identified as Additional Groundwater Monitoring Wells.
  - Water level measurements for monitoring well locations and select leak detection locations were taken using a Heron Instruments water level meter.
  - Water level measurements for surface water locations were taken as follows:
    - McIvor Lake (SW15-01) – water level for Ladore Dam obtained on day of monitoring using the following link:

      https://www.bchydro.com/energy-in-bc/operations/transmission-reservoir-data/previous-reservoir-elevations/vancouver_island/ladore_ldr.html
    - Rico Gauge (SW15-02) – existing gauge at monitoring location.
- Field parameter measurements were collected at all groundwater, surface water, leachate, and leak detection monitoring locations listed in **Table 2-1**, above, excluding the locations identified as Additional Groundwater Monitoring Wells.
  - Parameters measured in the field included:
    - conductivity (µS/cm)
    - dissolved oxygen (mg/L)
    - oxidation reduction potential (mV)
    - pH
    - temperature (°C)
    - total dissolved solids (TDS, mg/L)
    - turbidity (NTU)
- Samples were collected from those groundwater, surface water, leachate, and leak detection monitoring locations listed in **Table 2-1**, above, which contained sufficient water for sampling, excluding the locations identified as Additional Groundwater Monitoring Wells.
  - Chemical parameters analyzed in the laboratory:
    - General Chemistry (all monitoring locations):

- Alkalinity (speciated)
- Conductivity
- Chloride
- Sulphate
- Total sulphide (low level) + H_2S calculation
- Total sulphide, un-ionized (as H_2S) (calc)
- Nitrate (as N)
- Nitrite (as N)
- Nitrite/Nitrate (N+N)
- Orthophosphate
- TDS (excluding surface water monitoring locations)

- General Chemistry (surface water, leachate, and leak detection monitoring locations only):
  - Total suspended solids (TSS)
- General Chemistry (leachate and leak detection monitoring locations only):
  - Biochemical oxygen demand (BOD5)
  - Chemical oxygen demand (COD)
- Nutrients (all monitoring locations):
  - Ammonia nitrogen
- Metals (groundwater monitoring locations only):
  - Dissolved metals, including mercury (BC Contaminated Sites Regulation list)
  - Dissolved hardness (as $CaCO_3$)
- Metals (surface water, leachate, and leak detection monitoring locations only):
  - Total metals, including mercury (BC CSR list)
  - Dissolved hardness (as $CaCO_3$)
- Other
  - Groundwater, leachate, and leak detection monitoring locations only:
    - Light and heavy extractable petroleum hydrocarbons (LEPH, HEPH) (incl. EPH)
    - Polycyclic aromatic hydrocarbons (PAH)
  - Leachate and leak detection monitoring locations only:
    - Benzene, toluene, ethylbenzene, xylenes (BTEX)
    - Volatile petroleum hydrocarbons (VPH)
    - Chlorinate phenols
    - Non-chlorinated phenols
    - Nitrophenols

- Hydroxy phenols

Collected samples were submitted under chain of custody to Bureau Veritas (BV) on a standard 5-7 business day turnaround time (TAT).

Quality assurance / quality control (QA/QC) samples, including field blank(s), trip blank(s) (volatile substances only), and field duplicates were submitted to supplement Q1-Q3 QA/QC samples such that an overall annual frequency of approximately 20% was achieved.

Analytical results for all water / leachate samples were tabulated and compared to the BC Contaminated Sites Regulation (BC CSR) drinking water (DW) quality standards.

Landfill gas in soil monitoring at monitoring locations LFG1-22 and LFG2-22 was not included in the scope of work for 2024 Q4. Based on conversations with Northwin, this work will be completed by others.

3.0 METHODOLOGY

3.1 Sample Collection

Envirochem conducted field activities for the Q4 program on December 20, 2024, and January 17 and 24, 2025. Due to various factors, supplemental site visits targeting sampling locations S06-21, SW15-01, and/or SW15-02 were conducted in January 2025 to ensure the full complement of 2024 Q4 analyses were performed.

Monitoring / sampling activities were completed in general conformance with the BC Field Sampling Manual.[4]

- Groundwater samples were collected from the targeted monitoring wells using a low flow (i.e., minimal drawdown) groundwater sampling procedure. Implementation of this groundwater sample collection technique was intended to increase the representativeness of the data generated during the investigation.

  Due to the depth of the wells, HDPE tubing with inertial foot valves coupled with a Waterra Hydrolift actuator were used to extract groundwater from the monitoring wells. A YSI multiparameter water quality instrument with flow-through cell was used to monitor groundwater characteristics.

  The tubing was inserted at approximately the mid-point of the saturated screened interval. Groundwater was purged at a rate that minimized drawdown (i.e., pump typically set to lowest setting) until such time that the groundwater characteristics stabilized (i.e., pH within +/-0.1, conductivity within +/- 3%, and temperature within +/- 0.2°C).

  Following stabilization, individual laboratory-supplied sample containers containing appropriate preservatives, as applicable, were filled directly from the tubing.

- Surface water samples were collected by slowly submerging a 1 L, laboratory-supplied container approximately 30 cm below the surface of the water. Individual laboratory-supplied

[4] BC Ministry of Environment and Climate Change Strategy (2020). *British Columbia Field Sampling Manual for Continuous Monitoring Plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples*. https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/bc-field-sampling-manual

sample containers containing appropriate preservatives, as applicable, were filled by decanting water from the recently submerged / filled 1 L container.

- Leachate samples (i.e., S06-21) were collected directly from the leachate sump (i.e., via pump / tap) into individual laboratory-supplied sample containers containing appropriate preservatives, as applicable.
- An in-line 0.45 µm filter was used during the collection of samples for dissolved metals analysis.
- All equipment and tubing placed into the monitoring well was single-use and dedicated to the well. Equipment and water / leachate samples were handled with dedicated nitrile gloves.
- Collected water / leachate samples were placed in a cooler containing ice packs and delivered under chain of custody documentation to the project laboratory.

3.2 QA/QC Samples

A quality assurance / quality control (QA/QC) program was implemented as part of the 2024 Q4 in an effort to ensure that the groundwater samples collected from the Site were representative of actual site conditions. The QA/QC program, consisting of well-documented sample collection, storage, and transportation procedures, provides a record of any deviation from the methodologies described above. This provides a measure of confidence in the data being collected and used to draw conclusions regarding potential environmental impacts at a site. For this investigation, the field QA/QC program consisted of the following:

- Protocols designed to reduce the incidents of cross-contamination of samples during the field work including replacing chemical resistant nitrile gloves after collecting each sample and utilizing dedicated and disposable single-use sampling equipment.
- Detailed records of all aspects of the sampling program (e.g., field notes and chain-of-custody forms) and noting any deviations that could potentially cause sampling bias.
- Collection of samples in clean laboratory supplied jars and bottles. Proper labelling of samples for identification and storage of sample containers in coolers during field work and transportation.
- Submission of samples under chain-of-custody to a laboratory accredited by the Canadian Association for Laboratory Accreditation (CALA), that is qualified to analyze the samples using BC ENV approved procedures.
- Adherence to laboratory sampling and analysis protocols (e.g., hold times, detection limits, approved methodology).
- Quality assurance / quality control (QA/QC) samples, including field blank(s), trip blank(s) (volatile substances only), and/or field duplicates were submitted to supplement Q1-Q3 QA/QC samples such that an overall annual frequency of approximately 20% was achieved.
    - Field duplicates:
        - MW2A-16 / MW2A-16 DUP (December 19, 2024).
        - MW9-17 / MW9-17 DUP (December 19, 2024).
        - S06-21 / S06-21 DUP (January 14, 2025).

- S06-21 / S06-21 DUP (January 27, 2025).

- Trip blanks:
  - TRIP BLANK (January 14, 2025).

In addition, the project laboratory followed its independent internal QA/QC program in which samples were replicated and analyzed and the results compared. The laboratories provide details of their QA/QC procedures and findings in the Laboratory Certificates of Analysis, which are presented in **Attachment C**.

4.0 WATER QUALITY CRITERIA

4.1 Groundwater Quality Criteria

In British Columbia, environmental standards are governed by the *Contaminated Sites Regulation* (CSR), which makes up a component of the *Environmental Management Act* (EMA). The standards prescribed in the CSR are dependent on the land use of the Site and the uses of groundwater beneath the Site. Based on information provided in prior reports by GHD, the following standards were applied at the Site:

- Schedule 3.2 – Generic Numerical Water Standards, Column 6: Drinking Water (DW).

Envirochem notes that groundwater at the Site is not currently being used for drinking water. However, as outlined in BC ENV Protocol 21, drinking water use standards (based on potential future requirements) must be considered applicable by default unless site conditions warrant their exclusion. To prove that drinking water standards do not apply according to BC ENV requirements, additional work would be required at the Site (e.g., hydraulic response testing).

Aquatic life, irrigation, and livestock standards in the CSR were excluded previously by GHD based on the following rationales:

- GHD completed an aquatic life assessment (as described in its 2023 Operations and Monitoring Report for the Site, which cites a Hydrogeology and Hydrology Characterization Report (HHCR), dated May 27, 2016, and last amended May 4, 2021) that established groundwater from the Site does not discharge into a surface water body located within 500 m of the Site. Aquatic life standards were excluded on this basis.
- There are no known agricultural activities (i.e., no groundwater extraction points for irrigation / livestock watering) occurring within 500 m of the Site.

Iron and manganese were analyzed in all groundwater samples (including background locations), with the data presented herein, and evaluated against CSR Schedule 3.2 criteria for screening purposes only. Footnotes listed below the standards tables in CSR Schedule 3.2 indicate iron and manganese standards only apply at select properties where specified industrial / commercial uses listed in CSR Schedule 2 are occurring or have occurred. Based on available information, the Site's activities do not trigger the applicability of these standards.

In accordance with BC ENV Protocol 9, a local background concentration can be established by directly applying regional background concentration estimates provided by BC ENV for specified inorganic substances. The Site does not fall within any of the listed regional boundaries, so regional background

concentration estimates were not applied at the Site. Notwithstanding, the interim cobalt value of 20 μg/L remains in effect for the remaining regions of the province; this standard was applied at the Site rather than the default standard listed in CSR Schedule 3.2.

Based on the above rationale, the BC CSR DW standards were applied to the analytical groundwater quality results for the Site.

4.2 Surface Water and Leachate Quality Criteria

Although not directly applicable, CSR DW standards were also used to evaluate the analytical surface water and raw leachate quality results as preliminary screening criteria based on a continuation of the past monitoring program conducted by GHD. It is understood that this comparison would yield an indication whether surface water and/or leachate quality could potentially have an impact on the groundwater quality at the Site and whether additional actions or evaluation would be necessary. Again, for surface water, past hydrogeological studies by others indicate the landfill would not flow to the nearby surface water bodies being sampled as part of the monitoring program.

5.0 RESULTS & DISCUSSION

5.1 Water Level Monitoring

Monitoring wells were inspected for depth to groundwater on December 18-20, 2024. Surface water elevations were recorded on January 27, 2025. **Table 1** in **Attachment B** lists the water level measurements and corresponding elevations.

Hydraulic monitoring records for 2024 Q1-Q3 monitoring periods conducted by GHD were not available to Envirochem prior to preparation of this report. Therefore, this information is not included in **Table 1** in **Attachment B**. Additionally, all leak detection monitoring points (i.e., LDS, LDMP-1 to LDMP-4) were dry in 2024 Q4.

Based on the information collected, and communications with SHA, the inferred direction of groundwater flow, as interpreted by SHA, is towards the southeast (i.e., from McIvor Lake towards the southeast corner of the Site). This groundwater flow direction is consistent with historical results. Refer to **Figure 5** in **Attachment A** for a depiction of the inferred groundwater elevation contours and groundwater flow direction, and refer to the 2024 operations and monitoring report for further interpretation and details.

5.2 Leachate Quality

Envirochem collected samples from the raw leachate sump (i.e., sampling point S06-21) on December 20, 2024, and January 14 and 27, 2025. Multiple sampling events were needed to ensure all parameters were accounted for as there were logistical and laboratory communication challenges during the 2024 Q4 program. GHD also collected leachate samples from S06-21 during the 2024 Q1-Q3 monitoring periods. Treated leachate (i.e., sampling point TLIP) was not sampled during the 2024 Q1-Q4 field program.

Analytical results for the leachate samples collected from S06-21 for all 2024 monitoring periods are presented on **Table 2** in **Attachment B**. Although not applicable to leachate, the analytical results were compared to BC CSR DW groundwater standards. Leachate quality concentrations that were measured at levels greater than the BC CSR DW standards are highlighted red. For instances where the laboratory

detection limits were greater than the BC CSR DW standards, those concentrations are highlighted blue. As would be expected for raw leachate, several substance concentrations were measured at levels greater than the BC CSR DW standards.

A summary of the key leachate indicator parameter concentrations measured in leachate at S06-21 in 2024 are presented in **Table 5-1**, below. A summary of the 2023 concentrations as previously reported by GHD are also included for reference.

Table 5-1: 2024 Summary of Leachate Indicator Parameters in Leachate at S06-21

Leachate Indicator Parameter	Units	2023 Leachate Concentration Range (GHD, 2023)	2024 Leachate Concentration Range
ORP (field)	mV	(-376) – 60	(-317.2) – 174
TDS (lab)	mg/L	2,300 – 3,700	1,400 – 2,700
Hardness (dissolved)	mg/L	1,010 – 1,560	946 – 1,120
Conductivity (lab)	mg/L	3,200 – 4,400	2,300 – 3,800
Bicarbonate (total)	mg/L	31 – 1000	800 – 1,000
Alkalinity (total)	mg/L	26 – 840	650 – 820
Chloride (dissolved)	mg/L	190 – 310	120 – 290
Sulphate (dissolved)	mg/L	720 – 2,000	220 – 1,100
Sulphide as H_2S (total)	mg/L	0.020 – 13	0.010 – 14
Boron (total)	µg/L	1,240 – 12,200	6,850 – 15,900
Iron (total)	µg/L	1,970 – 26,500	249 – 3,280
Manganese (total)	µg/L	923 – 4,790	1,350 – 2,090
Sulphur (total)	µg/L	235,000 – 648,000	49,000 – 333,000
Total PAH	µg/L	4.0 – 4.2	1.1 – 29

The 2024 concentration ranges are generally consistent with those reported in 2023 GHD.

5.3 Leak Detection System Water Quality

All inspected leak detection monitoring points (i.e., LDS, LDMP-1 to LDMP-4) (between the primary base liner and secondary base liner) were dry in 2024 Q4. No analytical data was provided for these sampling points in the 2024 Q1-Q3 data provided by GHD.

Although there is no water data from the leak detection monitoring points from 2024 Q1-Q3, an inference could be made that the leak detection monitoring points were also dry for those monitoring periods based on the 2024 Q4 data obtained in the ‘wet’ season.

5.4 Groundwater Quality

Envirochem collected samples from the up-gradient (i.e., MW1-14, MW4A-15, MW4B-15, MW6-17, MW9-17), cross-gradient (i.e., MW2-14, MW2A-16), and down-gradient (i.e., MW3-14, MW10-17, MW11-19, MW12-22) on December 18-20, 2024. GHD also collected groundwater samples from the monitoring wells during the 2024 Q1-Q3 monitoring periods.

Analytical results for the groundwater samples collected during all 2024 monitoring periods are presented on **Table 3** in **Attachment B**. The analytical results were compared to BC CSR DW groundwater standards. Groundwater concentrations that were measured at levels greater than the BC CSR DW standards are highlighted red. There were no reported instances where the laboratory detection limits were greater than the BC CSR DW standards. A comparison of the analytical results with the applied reference criteria indicates all measured substance concentrations were reported at levels below the BC CSR DW standards, with the exception of the following exceedance:

- **Benzo(a)pyrene** - the concentration of benzo(a)pyrene (0.018 μg/L) measured in GHD groundwater sample WG-11222680-100424-KH-11 collected from MW6-17 in 2024 Q1 exceeded the BC CSR DW standard (0.01 μg/L).

This exceedance appears to be a false positive. The benzo(a)pyrene concentrations measured in the groundwater samples collected from MW6-17 during the Q2, Q3, and Q4 monitoring periods were all below the laboratory detection limit of 0.0050 μg/L and, therefore, below the BC CSR DW standard.

Additionally, the turbidity measured in the field for sample WG-11222680-100424-KH-11 collected at MW16-17, as reported by GHD, was somewhat elevated (i.e., highest turbidity level measured in 2024). Elevated turbidity can lead to “false positive” PAH concentrations in groundwater. As the benzo(a)pyrene concentrations in MW6-17 were below laboratory detection limits for all other 2024 monitoring periods, Envirochem infers this temporary increase in PAH concentration is unlikely indicative of contamination but, rather, an indication of elevated turbidity. Irrespective of this interpretation, MW6-17 is up-gradient of site operations and, therefore, not susceptible to contamination from those operations.

A summary of the key leachate indicator parameter concentrations measured in groundwater in 2024 are presented in **Table 5-2**, below.

Table 5-2: 2024 Summary of Leachate Indicator Parameters in Groundwater

Leachate Indicator Parameter	Units	Up-gradient Wells Concentration Range	Cross-gradient Wells Concentration Range	Down-gradient Wells Concentration Range
ORP (field)	mV	(-298) – 198	(-290) – 183	(-215) – 196
TDS (lab)	mg/L	32 – 330	34 – 130	86 – 500
Hardness (dissolved)	mg/L	24.2 – 161	27.6 – 70.5	38.7 - 334
Conductivity (lab)	mg/L	59 – 490	64 – 170	100 – 760
Bicarbonate (total)	mg/L	31 – 130	34 – 74	51 – 230
Alkalinity (total)	mg/L	26 – 110	28 – 61	42 – 190
Chloride (dissolved)	mg/L	<1.0 – 88	<1.0 – 11	<1.0 – 38

Leachate Indicator Parameter	Units	Up-gradient Wells Concentration Range	Cross-gradient Wells Concentration Range	Down-gradient Wells Concentration Range
Sulphate (dissolved)	mg/L	2.2 – 16	2.2 – 7.6	3.9 – 120
Sulphide as H_2S (total)	mg/L	<0.0020 – 0.019	<0.0020 – 0.014	<0.0020 – 0.019
Boron (dissolved)	µg/L	<50 – 51	<50	<50 – 2020
Iron (dissolved)	µg/L	<5.0 – 1450	<5.0 – 18.8	<5.0 – 34.9
Manganese (dissolved)	µg/L	<1.0 – 132	<1.0 – 1.3	<1.0 – 4.0
Sulphur (dissolved)	µg/L	<3,000 – 5,100	<3,000	<3,000 – 40,200
Total PAH	µg/L	<0.1 – 0.18	<0.1	<0.1

The 2024 concentration ranges are generally consistent with those reported in 2023 by GHD. However, Envirochem offers the following comments with respect to select parameters:

- **Negative ORP measurements in Q4** – measurement of negative ORP values in the monitoring wells during the Q4 monitoring period is inconsistent with past results and expected values. Envirochem suspects this inconsistency is due to an issue with equipment calibration by the supplier rather than an indicator of a potential problem at the Site.
- **Elevated iron and manganese concentrations at MW6-17 in Q3** – when the Q3 concentrations of iron and manganese at MW6-17 (1,450 µg/L and 132 µg/L, respectively) are excluded, the concentration ranges for up-gradient wells (<5.0 µg/L for iron at all sampling points and <1.0 – 15.9 µg/L for manganese) are more consistent with the reported 2023 ranges (<5.0 – 7.3 µg/L for iron and <1.0 – 28.1 µg/L for manganese). As the iron and manganese concentrations at MW6-17 returned to historically typical levels in Q4, there does not appear to be cause for action at present.
- **Elevated boron and sulphur concentrations at MW10-17 in Q3** – when the Q3 concentrations of boron and sulphur at MW10-17 (2,020 µg/L and 40,200 µg/L, respectively) are excluded, the concentration ranges for down-gradient wells (<50 – 654 µg/L for boron and <3,000 – 6,800 µg/L for sulphur) are more consistent with the reported 2023 ranges (<50 – 171 µg/L for boron and <3,000 – 16,400 µg/L for sulphur). As the boron and sulphur concentrations at MW10-17 returned to historically typical levels in Q4, there does not appear to be cause for action at present.

5.5 Surface Water Quality

GHD's 2023 Operations and Monitoring Report for the Site references a Hydrogeology and Hydrology Characterization Report (HHCR) previously conducted by GHD in 2016 (amended 2021), which interpreted that both McIvor Lake and Rico Lake are not receptors of groundwater discharge from the Site. However, as Rico Lake discharges to McIvor Lake and McIvor Lake recharges the sand and gravel aquifer beneath the Site, the surface water quality in these up-gradient water bodies assists with understanding overall water conditions at the Site.

Envirochem collected samples from the surface water sampling station (i.e., SW15-01 (McIvor Lake) and SW15-02 (Rico Lake)) on December 20, 2024, and January 27, 2025. Multiple sampling events were needed to ensure all parameters were accounted for as there were logistical and laboratory communication challenges during the 2024 Q4 program. GHD also collected a surface water sample from SW16-03 during the 2024 Q1 monitoring period. The location of SW16-03 is described as the bottom of the south road just outside the landfill footprint; however, the exact location of this sampling point is presently unknown as it does not appear on the site plans provided in prior GHD reports for the Site.

Analytical results for the surface water samples collected during all 2024 monitoring periods are presented on **Table 4** in **Attachment B**. Although not applicable to surface water, the analytical results were compared to BC CSR DW groundwater standards. A comparison of the analytical results with the applied reference criteria indicates all measured substance concentrations were reported at levels below the BC CSR DW standards. There were no reported instances where the laboratory detection limits were greater than the BC CSR DW standards.

A summary of the key leachate indicator parameter concentrations measured in surface water at SW15-01 and SW15-02 in 2024 are presented in **Table 5-3**, below.

Table 5-3: 2024 Summary of Leachate Indicator Parameters in Surface Water (SW15-01 / SW15-02)

Leachate Indicator Parameter	Units	Up-gradient GW Concentration Range	SW15-01 (McIvor Lake) Concentration Range	SW15-02 (Rico Lake) Concentration Range
ORP (field)	mV	(-298) – 198	119	86.7
TDS (lab)	mg/L	32 – 330	-	-
Hardness (dissolved)	mg/L	24.2 – 161	21.8	18.7
Conductivity (lab)	mg/L	59 – 490	37	63
Bicarbonate (total)	mg/L	31 – 130	13	22
Alkalinity (total)	mg/L	26 – 110	10	18
Chloride (dissolved)	mg/L	<1.0 – 88	2.2	4.6
Sulphate (dissolved)	mg/L	2.2 – 16	<1.0	1.1
Sulphide as H_2S (total)	mg/L	<0.0020 – 0.019	<0.0020	<0.0020
Boron (total)	µg/L	<50 – 51	<50	<50
Iron (total)	µg/L	<5.0 – 1450	21	182
Manganese (total)	µg/L	<1.0 – 132	2.5	8.8
Sulphur (total)	µg/L	<3,000 – 5,100	<3,000	<3,000
Total PAH	µg/L	<0.1 – 0.18	-	-

The 2024 concentrations are generally consistent with those reported in 2023 by GHD.

5.6 Quality Assurance / Quality Control Samples

Overall, for the 2024 monitoring period, QA/QC samples were collected at a rate of approximately 20%. A total of 10 field duplicates and 1 trip blank were collected during the 2024 monitoring period. A field blank was listed in the 2024 Specification for collection in Q3; however, it is unclear from the information provided by GHD whether this sample was collected / analyzed. Notwithstanding, there appears to be sufficient QA/QC data to conclude that the analytical data collected is reliable:

- The trip blank (i.e. TRIP BLANK) was collected by Envirochem on January 14, 2025, and analyzed for volatile substances (i.e., BTEX, MTBE, styrene, VPH). All substance concentrations were reported below the laboratory detection limit. The analytical results are shown on the Laboratory Certificates of Analysis, which are presented in **Attachment C**.

- The analytical results for the field duplicate samples are presented on **Tables 2 and 3** in **Attachment B**, shaded grey. The Laboratory Certificates of Analysis for field duplicates collected by Envirochem are presented in **Attachment C**. In accordance with the BC Field Sampling Manual, Envirochem applied a data quality objective (DQO) of 50% (i.e., indicative of “a definite problem”) to the variance between original / duplicate sample pairs, as measured using relative percent difference (RPD). All calculated RPDs were less than 50%, with the exception of the following:

    - An RPD of 81% was calculated for the orthophosphate concentrations in leachate sample pair WL-11222680-120924-DT-01 / WL-11222680-120924-DT-02 collected by GHD from sampling point S06-21 in 2024 Q3. Potential reasons for the variance are unclear as Envirochem was not able to review field notes for the GHD Q3 sampling event and RPDs for all other parameters are well below the applied DQO.
    - An RPD of 103% was calculated for the dissolved aluminum concentrations in groundwater sample pair WG-11222680-110924-DT-06 / WG-11222680-110924-DT-07 collected by GHD from monitoring well MW2A-16 in 2024 Q3. As both the original and duplicate dissolved aluminum concentrations (3.6 μg/L and 11.3 μg/L, respectively) are less than five times the detection limit of 3.0 μg/L, larger variance can be expected. Additionally, as the measured concentrations are two orders of magnitude less than the BC CSR DW standard (9,500 μg/L), the variance does not alter the conclusions of this report with respect to groundwater quality.

6.0 CONCLUSIONS

Following completion of the 2024 Q4 monitoring / sampling program, Envirochem offers the following conclusions based on a review of the analytical data:

- **Water Levels and Groundwater Flow**: Water levels as measured in 2024 appear consistent with historical measurements. See **Table 1** in **Attachment B**.
- **Leachate Quality**: Select parameters were measured in leachate samples at concentrations greater than BC CSR DW standards (screening level criteria), which is to be expected in raw leachate derived from a landfill system. The substance concentration ranges appear to be consistent with historical levels as reported by GHD in 2023. See **Table 2** in **Attachment B**.
- **Leak Detection System Water Quality**: The leachate detection system inspection points were all dry during the 2024 monitoring period. The absence of water within the leak detection system inspection points suggests the landfill liners are functioning as intended.
- **Groundwater Quality**: With the exception of a single benzo(a)pyrene concentration measured in GHD groundwater sample WG-11222680-100424-KH-11 collected from MW6-17 in 2024 Q1, which was likely attributable to elevated turbidity in the sample, all reported substance concentrations in groundwater were below the BS CSR DW standards and generally consistent with 2023 levels. See **Table 3** in **Attachment B**.
- **Surface Water Quality:** A comparison of the surface water analytical results with the applied reference criteria indicates all measured substance concentrations were reported at levels below the BC CSR DW standards and at levels consistent with reported 2023 data. See **Table 4** in **Attachment B**.

This report is intended to support the 2024 operations and monitoring report being prepared by SHA. Limited interpretation and evaluation of data is presented herein.

7.0 CLOSURE

We trust this report meets your current requirements. If you have any questions or comments regarding this report, please contact the undersigned. The limitations of this report are presented in **Attachment D**.

Yours truly,

Envirochem Services Inc.
EGBC Permit to Practice No. 1002708





Paul Dawson, P.Eng.
Senior Environmental Engineer

Eric Choi, P.Eng.
Senior Environmental Engineer

Contributions by: Darryl Stowe, P.Chem.

Attachments:

Attachment A – Figures
Attachment B – Analytical Tables
Attachment C – Laboratory Certificates of Analysis
Attachment D – Limitations

ATTACHMENT A

Figures



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SPERLING HANSEN ASSOCIATES

Landfill Services Group

- Landfill Siting
- Design & Operations Plans
- Landfill Closure
- Environmental Monitoring

#8 - 1225 Keith Road East
North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723

LEGEND:

- UTM GRIDLINE
- PROPERTY BOUNDARY
- ROAD

CLIENT: NORTHWIN ENVIRONMENTAL LTD

PROJECT: NORTHWIN LANDFILLL 2024 ENGINEERING

TITLE: SITE LOCATION MAP

SCALE:	DATE:	PROJECT NO:
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LEGEND:

- UTM GRID LINE
- CONTOUR - EXISTING (5m)
- PROPERTY BOUNDARY
- LEACHATE TREATMENT SYSTEM
- LANDFILL BASE LINER EXTENTS
- SURVEY CONTROL POINT

TOPO SURFACE SURVEYED JANUARY 29, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

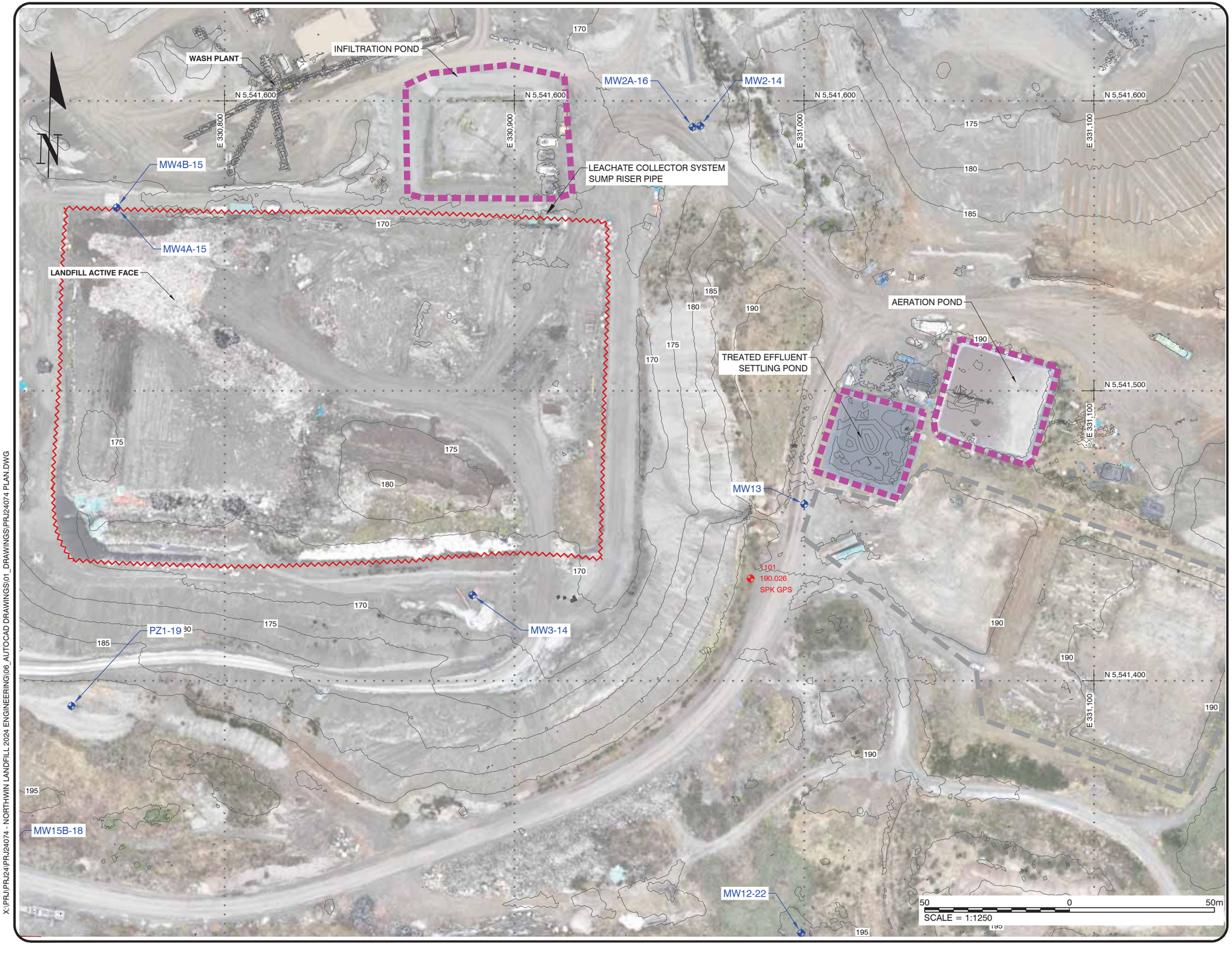
SITE ORTHO IMAGE BY NORTHWIN - JAN 29, 2025
OTHER IMAGE BY BING MAPS

CLIENT: NORTHWIN ENVIRONMENTAL LTD

PROJECT: NORTHWIN LANDFILLL 2024 ENGINEERING

TITLE: SITE PLAN

SCALE:	DATE:	PROJECT NO:
1:3000	2025/03/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO:
DRAWN	NL	**FIGURE 2**
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Landfill Services Group
- Landfill Siting
- Design & Operations Plans
- Landfill Closure
- Environmental Monitoring

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LEGEND:

- UTM GRID LINE
- CONTOUR - EXISTING (5m)
- PROPERTY BOUNDARY
- LEACHATE TREATMENT SYSTEM
- ORIGINAL LANDFILL (DECOMMISSIONED)
- LANDFILL BASE LINER EXTENTS
- MONITORING WELL
- SURVEY CONTROL POINT

TOPO SURFACE SURVEYED JANUARY 29, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

SITE ORTHO IMAGE BY NORTHWIN - JAN 29, 2025

CLIENT: NORTHWIN ENVIRONMENTAL LTD

PROJECT: NORTHWIN LANDFILLL 2024 ENGINEERING

TITLE: NEW LANDFILL SITE PLAN - EXISTING TOPO JAN. 29, 2025

SCALE:	DATE:	PROJECT NO:
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DESIGNED	-	DRAWING NO:
DRAWN	NL	**FIGURE 3**
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LEGEND:

- UTM GRID LINE
- CONTOUR - EXISTING (5m)
- PROPERTY BOUNDARY
- LEACHATE TREATMENT SYSTEM
- LANDFILL BASE LINER EXTENTS
- EXISTING MONITORING WELL
- PROPOSED MONITORING WELL
- EXISTING SURFACE WATER MONITORING LOCATION
- EXISTING BOREHOLE
- SOIL VAPOUR PROBE

TOPO SURFACE SURVEYED JANUARY 29, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

SITE ORTHO IMAGE BY NORTHWIN - JAN 29, 2025
OTHER IMAGE BY BING MAPS

CLIENT: NORTHWIN ENVIRONMENTAL LTD

PROJECT:

NORTHWIN LANDFILLL 2024 ENGINEERING

TITLE:

MONITORING LOCATIONS

SCALE:	DATE:	PROJECT NO:
1:5000	2025/03/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO:
DRAWN	NL	**FIGURE 4**
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SPERLING HANSEN ASSOCIATES

Landfill Services Group

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- Design & Operations Plans
- Landfill Closure
- Environmental Monitoring

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North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723

LEGEND:

- UTM GRID LINE
- CONTOUR - EXISTING (5m)
- PROPERTY BOUNDARY
- LEACHATE TREATMENT SYSTEM
- LANDFILL BASE LINER EXTENTS
- MONITORING WELL
- GROUNDWATER LEVEL CONTOURS (5m)

TOPO SURFACE SURVEYED JANUARY 29, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

SITE ORTHO IMAGE BY NORTHWIN - JAN 29, 2025
OTHER IMAGE BY BING MAPS

CLIENT: NORTHWIN ENVIRONMENTAL LTD

PROJECT:

NORTHWIN LANDFILLL 2024 ENGINEERING

TITLE:

GROUNDWATER ELEVATION CONTOURS DECEMBER 2024

SCALE:	DATE: yyyy/mm/dd	PROJECT NO:
1:3000	2025/03/11	PRJ 24074
DESIGNED	-	DRAWING NO:
DRAWN	NL	**FIGURE 5**
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ATTACHMENT B

Analytical Tables

Table 1

Hydraulic Monitoring Results
2024 Operations and Monitoring Report
New Landfill
Campbell River, British Columbia

Monitoring Location	Depth to Bottom (m BGS)	Reference Elevation TOR (m AMSL)	Depth to Water (m BTOR)				Water Elevation (m AMSL)				Screened Unit (Aquifer)
	Monitoring Date:		April 9-10, 2024	June 25-26, 2024	September 11-12, 2024	December 18-20, 2024 and January 27, 2025	April 9-10, 2024	June 25-26, 2024	September 11-12, 2024	December 18-20, 2024 January 27, 2025	Primary Constituent
MW1-14	11.0	172.9	-	-	-	7.651	-	-	-	165.2	Sand/gravel (S&G Aquifer)
MW2-14	21.6	173.8	-	-	-	16.810	-	-	-	157.0	Sand/gravel (S&G Aquifer)
MW2A-16	45.4	173.9	-	-	-	16.725	-	-	-	157.2	Sand (S&G Aquifer)
MW3-14	18.6	168.6	-	-	-	14.657	-	-	-	153.9	Sand/gravel (S&G Aquifer)
MW4A-15	21.3	169.3	-	-	-	6.995	-	-	-	162.3	Bedrock (Bedrock)
MW4B-15	18.3	169.3	-	-	-	7.153	-	-	-	162.1	Sand (S&G Aquifer)
MW5A-15	10.7	191.9	-	-	-	-	-	-	-	-	Bedrock (Bedrock)
MW5B-15	8.2	192.0	-	-	-	-	-	-	-	-	Sand/Silt with clay (Shallow Aquifer)
MW6-17	11.3	*185.4*	-	-	-	7.500	-	-	-	177.9	Sand (S&G Aquifer)
MW7-17	4.3	*187.5*	-	-	-	-	-	-	-	-	Gravel (Shallow Aquifer)
MW8-17	18.8	*192.5*	-	-	-	-	-	-	-	-	Gravel (S&G Aquifer)
MW9-17	33.5	*191.7*	-	-	-	24.406	-	-	-	167.3	Sand/gravel (S&G Aquifer)
MW10-17	46.3	*189.1*	-	-	-	42.343	-	-	-	146.8	Sand (S&G Aquifer)
MW11-19	54.9	194.8	-	-	-	48.535	-	-	-	146.3	Sand (S&G Aquifer)
MW12-22	45.1	-	-	-	-	40.980	-	-	-	-	Sand (S&G Aquifer)
MW15A-18	15.2	183.1	-	-	-	-	-	-	-	-	Bedrock (Bedrock)
MW15B-18	9.0	183.2	-	-	-	-	-	-	-	-	Silty/Clayey Sand (S&G Aquifer)
PZ1-19	20.4	192.1	-	-	-	-	-	-	-	-	Sand/Silty Gravel (Shallow Aquifer)
SW15-01 [McIvor Lake]*	N/A	N/A	-	-	-	-	-	-	-	177.3	N/A
SW15-02 [Rico Lake]**	N/A	180.3	-	-	-	0.4	-	-	-	180.7	N/A
East Surface Water Ditch[1]	N/A	N/A	-	-	-	-	-	-	-	-	N/A
West Surface Water Ditch[1]	N/A	N/A	-	-	-	-	-	-	-	-	N/A
S06-21	N/A	N/A	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A
LDS3	N/A	N/A	-	-	-	Dry	-	-	-	Dry	N/A
LDMP-1	N/A	N/A	-	-	-	Dry	-	-	-	Dry	N/A
LDMP-2	N/A	N/A	-	-	-	Dry	-	-	-	Dry	N/A
LDMP-3	N/A	N/A	-	-	-	Dry	-	-	-	Dry	N/A
LDMP-4	N/A	N/A	-	-	-	Dry	-	-	-	Dry	N/A

Notes:

191.88	Surveys completed by McElhanney on April 6, 2016 and March 16 and 31, 2017.
185.4	Survey completed by Upland Excavating Ltd. on January 29th, 2015, March 8, 2016 and April 6th, 2016. Elevations measured with respect to AMSL.
*	McIvor Lake elevations are based on BC Hydro record of water elevations at Ladore Dam recorded every three hours.
**	Surface water gauge reference elevation refers to the bottom of the gauge (0 m on gauge = 180.33 m amsl).
m BGS	metres below ground surface.
m AMSL	metres above mean sea level (WGS1984).
TOR	top of riser.
BTOR	below top of riser.
S&G	sand and gravel.
N/A	not applicable.
MW	monitoring well.
LDS	leak detection sump.
LDMP	leak detection monitoring pipe.
-	Q1-Q3 data not available, not included in the Q4 monitoring event.
1	East and West Ditch removed from EMP in July 2023 until final cover is placed.
2	Leachate is pumped and depth to water mesurement is not possible, sample collection is completed via tap from riser pipe.

Table 2

Analytical Results Summary
Raw Leachate Sampling
2024 Operations and Monitoring Report
New Landfill
Campbell River, British Columbia

			Sample Location:	S06-21															
			Sample ID:	LW-11222680-090424-KH-01	LW-11222680-090424-KH-02	RPD	WL-11222680-260624-DT-01	WL-11222680-260624-DT-02	RPD	WL-11222680-120924-DT-01	WL-11222680-120924-DT-02	RPD	S06-21	S06-21	S06-21 DUP	RPD	S06-21	S06-21 DUP	RPD
			Sample Date:	4/9/2024	4/9/2024 Duplicate	(%)	6/26/2024	6/26/2024 Duplicate	(%)	9/12/2024	9/12/2024 Duplicate	(%)	12/20/2024	01/14/2025	01/14/2025 Duplicate	(%)	01/27/2025	01/27/2025 Duplicate	(%)
Parameters	**Units**	**BC CSR[1] DW**																	
Field Parameters																			
Conductivity, field	µS/cm	--		2620	2620	-	3260	3260	-	3770	3770	-	-	-	-	-	3580	3580	-
Dissolved oxygen (DO), field	mg/L	--		13.06	13.06	-	0.84	0.84	-	1.29	1.29	-	-	-	-	-	0.31	0.31	-
Oxidation reduction potential (ORP), field	millivolts	--		174	174	-	158	158	-	-82	-82	-	-	-	-	-	-317.2	-317.2	-
pH, field	s.u.	--		7.23	7.23	-	6.87	6.87	-	7.29	7.29	-	-	-	-	-	6.81	6.81	-
Temperature, field	Deg C	--		10.11	10.11	-	21.07	21.07	-	31.01	31.01	-	-	-	-	-	21.2	21.2	-
Total dissolved solids, field (TDS)	mg/L	--		1680	1680	-	2090	2090	-	2410	2410	-	-	-	-	-	2290	2290	-
Turbidity, field	NTU	--		21.8	21.8	-	4.7	4.7	-	96.1	96.1	-	-	-	-	-	9.75	9.75	-
General Chemistry																			
Alkalinity (as CaCO3 pH=8.3)	mg/L	--		ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	0	<1.0	-	-	-	-	-	-
Alkalinity, total (as CaCO3)	mg/L	--		670	670	0	750	750	0	660	650	2	820	-	-	-	-	-	-
Biochemical oxygen demand (BOD)	mg/L	--		9.3	8.2	13	ND (2.0)	ND (2.0)	0	36	34	6	31	-	-	-	-	-	-
Chemical oxygen demand (COD)	mg/L	--		221	222	0	189	188	1	406	404	0	284	-	-	-	-	-	-
Chloride (dissolved)	mg/L	250		190	190	0	270	270	0	290	290	0	120	-	-	-	-	-	-
Conductivity	µS/cm	--		2900	2900	0	3200	3300	3	3800	3800	0	2300	-	-	-	-	-	-
Hardness	mg/L	--		957	851	12	824	828	0	1020	1080	6	608	-	-	-	-	-	-
Hardness (dissolved)	mg/L	--		946	991	5	957	959	0	1120	1120	0	-	-	-	-	1080	1080	0
Hydroxide (as CaCO3)	mg/L	--		ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	0	<1.0	-	-	-	-	-	-
Orthophosphate	mg/L	--		0.02	0.017	16	0.051	0.042	19	0.40	0.17	81	0.017	-	-	-	-	-	-
pH	s.u.	--		7.61	7.56	1	-	-	0	-	-	0	7.47	-	-	-	-	-	-
Sulphate (Dissolved)	mg/L	500		550	540	2	590	600	2	1000	1100	10	220	-	-	-	-	-	-
Total Un-ionized Hydrogen Sulfide as S	mg/L	--		-	-	0	-	-	0	0.40	0.43	7	-	-	-	-	8.2	6.5	23
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	0.05		-	-	0	-	-	0	0.43	0.46	7	-	-	-	-	8.7	6.9	23
Total Sulfide as H2S	mg/L	--		0.026	0.032	21	0.0087	0.010	14	1.7	1.9	11	14	-	-	-	-	-	-
Total Sulfide as S	mg/L	--		0.024	0.03	22	0.0082	0.0096	16	1.6	1.7	6	13	-	-	-	-	-	-
Total dissolved solids (TDS)	mg/L	--		2000	2000	0	2400	2300	4	2700	2700	0	1400	-	-	-	-	-	-
Total suspended solids (TSS)	mg/L	--		8.4	12	35	5.6	3.6	43	81	73	10	11	-	-	-	-	-	-
Nutrients																			
Ammonia-N	mg/L	--		17	17	0	4.0	3.7	8	41	42	2	40	-	-	-	-	-	-
Bicarbonate (as CaCO3)	mg/L	--		810	820	1	910	910	0	800	800	0	1000	-	-	-	-	-	-
Carbonate (as CaCO3)	mg/L	--		ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	0	<1.0	-	-	-	-	-	-
Nitrate (as N)	mg/L	10		15.6	15.6	0	15.7	15.3	3	ND (0.020)	ND (0.020)	0	<0.020	-	-	-	-	-	-
Nitrite (as N)	mg/L	1		0.11	0.108	2	0.0671	0.0662	1	0.0059	0.0073	21	<0.0050	-	-	-	-	-	-
Nitrate and Nitrite (as N)	mg/L	10		15.7	15.7	0	15.7	15.4	2	ND (0.020)	ND (0.020)	0	<0.020	-	-	-	-	-	-
Dissolved Metals																			
Calcium (dissolved)	µg/L	--		299000	313000	5	291000	290000	0	356000	353000	1	-	-	-	-	-	-	-
Magnesium (dissolved)	µg/L	--		48500	50500	4	56200	56900	1	57200	58200	2	-	-	-	-	-	-	-
Total Metals																			
Aluminum	µg/L	9500		217	191	13	161	170	5	138	103	29	311	-	-	-	-	-	-
Antimony	µg/L	6		ND (5.0)	ND (5.0)	0	ND (5.0)	ND (5.0)	0	ND (5.0)	ND (5.0)	0	<2.5	-	-	-	-	-	-
Arsenic	µg/L	10		5.7	5.2	9	2.1	2.0	5	15.8	16.5	4	11.1	-	-	-	-	-	-
Barium	µg/L	1000		103	98	5	111	110	1	123	131	6	120	-	-	-	-	-	-
Beryllium	µg/L	8		ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	0	<0.50	-	-	-	-	-	-
Bismuth	µg/L	--		ND (10)	ND (10)	0	ND (10)	ND (10)	0	ND (10)	ND (10)	0	<5.0	-	-	-	-	-	-
Boron	µg/L	5000		12100	12200	1	13200	13800	4	15200	15900	5	6850	-	-	-	-	-	-
Cadmium	µg/L	5		0.15	0.14	7	0.27	0.27	0	0.11	0.11	0	0.068	-	-	-	-	-	-
Calcium	µg/L	--		305000	266000	14	246000	248000	1	314000	332000	6	196000	-	-	-	-	-	-
Chromium	µg/L	50		ND (10)	ND (10)	0	ND (10)	ND (10)	0	ND (10)	ND (10)	0	8.4	-	-	-	-	-	-
Cobalt	µg/L	20		3.4	3.2	6	5.9	5.8	2	4.3	4.5	5	1.5	-	-	-	-	-	-
Copper	µg/L	1500		51	48.2	6	71.8	66.8	7	23.5	24.1	3	40.6	-	-	-	-	-	-
Iron	µg/L	6500[6]		1360	1120	19	260	249	4	3140	3280	4	2980	-	-	-	-	-	-
Lead	µg/L	10		ND (2.0)	ND (2.0)	0	ND (2.0)	ND (2.0)	0	ND (2.0)	ND (2.0)	0	1.7	-	-	-	-	-	-
Lithium	µg/L	8		ND (20)	ND (20)	0	ND (20)	ND (20)	0	ND (20)	ND (20)	0	<10	-	-	-	-	-	-
Magnesium	µg/L	--		47700	45300	5	50800	50700	0	58100	60600	4	28900	-	-	-	-	-	-
Manganese	µg/L	1500[6]		1450	1350	7	1930	1890	2	2010	2090	4	1370	-	-	-	-	-	-
Mercury	µg/L	1		0.011	0.0109	1	0.0033	0.0056	52	0.0218	0.0195	11	-	-	-	-	-	-	-
Molybdenum	µg/L	250		ND (10)	ND (10)	0	10	ND (10)	0	ND (10)	ND (10)	0	<5.0	-	-	-	-	-	-
Nickel	µg/L	80		10	ND (10)	0	15	15	0	11	11	0	<5.0	-	-	-	-	-	-
Phosphorus	µg/L	--		218	208	5	ND (100)	ND (100)	0	775	795	3	-	-	-	-	-	-	-
Potassium	µg/L	--		36000	34300	5	32800	32200	2	42300	44700	6	24800	-	-	-	-	-	-
Selenium	µg/L	10		ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	0	<0.50	-	-	-	-	-	-
Silicon	µg/L	--		14300	12800	11	13800	13600	1	15500	16500	6	12300	-	-	-	-	-	-
Silver	µg/L	20		ND (0.20)	ND (0.20)	0	ND (0.20)	ND (0.20)	0	ND (0.20)	ND (0.20)	0	<0.10	-	-	-	-	-	-
Sodium	µg/L	200000		234000	223000	5	305000	301000	1	308000	318000	3	145000	-	-	-	-	-	-
Strontium	µg/L	2500		1750	1690	3	1680	1700	1	2300	2390	4	1190	-	-	-	-	-	-
Sulphur	µg/L	--		195000	184000	6	190000	181000	5	321000	333000	4	49000	-	-	-	-	-	-
Thallium	µg/L	--		ND (0.10)	ND (0.10)	0	ND (0.10)	ND (0.10)	0	ND (0.10)	ND (0.10)	0	<0.050	-	-	-	-	-	-
Tin	µg/L	2500		ND (50)	ND (50)	0	ND (50)	ND (50)	0	ND (50)	ND (50)	0	<25	-	-	-	-	-	-
Titanium	µg/L	--		ND (50)	ND (50)	0	ND (50)	ND (50)	0	ND (50)	ND (50)	0	38	-	-	-	-	-	-
Uranium	µg/L	20		1.4	1.4	0	4.0	3.8	5	1.2	1.3	8	<0.50	-	-	-	-	-	-
Vanadium	µg/L	20		ND (50)	ND (50)	0	ND (50)	ND (50)	0	ND (50)	ND (50)	0	<25	-	-	-	-	-	-
Zinc	µg/L	3000		57	52	9	80	77	4	786	796	1	65	-	-	-	-	-	-
Zirconium	µg/L	--		1.2	1.2	0	ND (1.0)	ND (1.0)	0	1.2	1.3	8	1.77	-	-	-	-	-	-

Table 2

Analytical Results Summary
Raw Leachate Sampling
2024 Operations and Monitoring Report
New Landfill
Campbell River, British Columbia

			Sample Location:	S06-21															
			Sample ID:	LW-11222680-090424-KH-01	LW-11222680-090424-KH-02	RPD	WL-11222680-260624-DT-01	WL-11222680-260624-DT-02	RPD	WL-11222680-120924-DT-01	WL-11222680-120924-DT-02	RPD	S06-21	S06-21	S06-21 DUP	RPD	S06-21	S06-21 DUP	RPD
			Sample Date:	4/9/2024	4/9/2024 Duplicate	(%)	6/26/2024	6/26/2024 Duplicate	(%)	9/12/2024	9/12/2024 Duplicate	(%)	12/20/2024	01/14/2025	01/14/2025 Duplicate	(%)	01/27/2025	01/27/2025 Duplicate	(%)
Parameters	**Units**	**BC CSR[1] DW**																	
PHCs																			
EPHw (C10-C19)	µg/L	5000		ND (200)	ND (200)	0	ND (200)	ND (200)	0	250	240	4	290	-	-	-	-	-	-
LEPH (EPHw C10-C19 less PAH)	µg/L	--		ND (200)	ND (200)	0	ND (200)	ND (200)	0	250	240	4	270	-	-	-	-	-	-
EPHw (C19-C32)	µg/L	--		ND (200)	ND (200)	0	ND (200)	ND (200)	0	230	ND (200)	0	<200	-	-	-	-	-	-
HEPHw (EPHw C19-C32 less PAH)	µg/L	--		ND (200)	ND (200)	0	ND (200)	ND (200)	0	220	ND (200)	0	<200	-	-	-	-	-	-
VHw (C6-C10)	µg/L	15000		-	-	-	-	-	-	-	-	-	<300	<300	<300	0	-	-	-
VPHw (VHw C6-C10 less BTEX)	µg/L	--		-	-	-	-	-	-	-	-	-	<300	<300	<300	0	-	-	-
VOCs																			
Benzene	µg/L	5		-	-	-	-	-	-	-	-	-	<0.40	1.2	1.1	9	-	-	-
Toluene	µg/L	60		-	-	-	-	-	-	-	-	-	3.8	9.4	9.1	3	-	-	-
Ethylbenzene	µg/L	140		-	-	-	-	-	-	-	-	-	2.0	6.8	6.7	1	-	-	-
m & p-Xylene	µg/L	--		-	-	-	-	-	-	-	-	-	4.6	16	17	6	-	-	-
o-Xylene	µg/L	--		-	-	-	-	-	-	-	-	-	2.4	8.6	8.5	1	-	-	-
Xylenes (Total)	µg/L	90		-	-	-	-	-	-	-	-	-	7.1	25	25	0	-	-	-
Methyl-tert-butylether (MTBE)	µg/L	95		-	-	-	-	-	-	-	-	-	<4.0	<4.0	<4.0	0	-	-	-
Styrene	µg/L	800		-	-	-	-	-	-	-	-	-	<0.40	<0.40	<0.40	0	-	-	-
PAHs																			
1-Methylnaphthalene	µg/L	5.5		ND (0.050)	ND (0.050)	0	0.10	0.10	0	0.18	0.19	5	1.2	-	-	-	-	-	-
2-Methylnaphthalene	µg/L	15		ND (0.10)	ND (0.10)	0	0.12	0.12	0	0.19	0.19	0	1.5	-	-	-	-	-	-
Acenaphthene	µg/L	250		0.12	0.12	0	0.4	0.38	5	0.46	0.47	2	1.8	-	-	-	-	-	-
Acenaphthylene	µg/L	--		ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	0	<0.050	-	-	-	-	-	-
Acridine	µg/L	--		0.069	0.072	4	ND (0.050)	ND (0.050)	0	0.54	0.56	4	0.15	-	-	-	-	-	-
Anthracene	µg/L	1000		0.033	0.035	6	0.10	0.11	10	0.16	0.17	6	0.096	-	-	-	-	-	-
Benzo(a)anthracene	µg/L	0.07		0.018	0.019	5	0.014	0.010	33	0.21	0.21	0	0.053	-	-	-	-	-	-
Benzo(a)pyrene	µg/L	0.01		0.007	0.0077	10	ND (0.0050)	ND (0.0050)	0	0.049	0.050	2	0.025	-	-	-	-	-	-
Benzo(b+j)fluoranthenes	µg/L	0.07		ND (0.030)	ND (0.030)	0	ND (0.030)	ND (0.030)	0	0.12	0.12	0	0.035	-	-	-	-	-	-
Benzo(b)pyridine (Quinoline)	µg/L	0.05		0.076	0.075	1	ND (0.020)	ND (0.020)	0	0.045	0.046	2	<0.020	-	-	-	-	-	-
Benzo(g,h,i)perylene	µg/L	--		ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	0	<0.050	-	-	-	-	-	-
Benzo(k)fluoranthene	µg/L	--		ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	0	<0.050	-	-	-	-	-	-
Chrysene	µg/L	7		0.032	0.031	3	0.024	ND (0.020)	0	0.27	0.27	0	0.066	-	-	-	-	-	-
Dibenz(a,h)anthracene	µg/L	0.01		ND (0.0030)	ND (0.0030)	0	ND (0.0030)	ND (0.0030)	0	ND (0.0030)	ND (0.0030)	0	<0.0030	-	-	-	-	-	-
Fluoranthene	µg/L	150		0.13	0.13	0	0.13	0.12	8	4.0	4.2	5	0.34	-	-	-	-	-	-
Fluorene	µg/L	150		0.097	0.098	1	0.26	0.25	4	0.23	0.26	12	0.82	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	µg/L	--		ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	0	<0.050	-	-	-	-	-	-
Naphthalene	µg/L	80		0.25	0.26	4	0.75	0.77	3	2.4	2.4	0	22	-	-	-	-	-	-
PAH high molecular weight	µg/L	--		0.31	0.31	0	0.3	0.24	22	8.0	8.4	5	0.77	-	-	-	-	-	-
PAH low molecular weight	µg/L	--		0.78	0.8	3	2	2	0	5.4	5.7	5	28	-	-	-	-	-	-
Phenanthrene	µg/L	--		0.14	0.14	0	0.29	0.28	4	1.2	1.3	8	0.56	-	-	-	-	-	-
Pyrene	µg/L	100		0.13	0.13	0	0.13	0.11	17	3.4	3.5	3	0.24	-	-	-	-	-	-
Total PAH	µg/L	--		1.1	1.1	0	2.3	2.3	0	13	14	7	29	-	-	-	-	-	-
Phenols																			
2-Hydroxyphenol (Catechol)	µg/L	--		-	-	-	-	-	-	-	-	-	<20	<50	<50	0	-	-	-
3-Hydroxyphenol (Resorcinol)	µg/L	4500		-	-	-	-	-	-	-	-	-	<10	<50	<50	0	-	-	-
4-Hydroxyphenol (Hydroquinone)	µg/L	2.5		-	-	-	-	-	-	-	-	-	2.4	<5.0	<5.0	0	-	-	-
Cresols	µg/L	--		-	-	-	-	-	-	-	-	-	0.045	-	-	-	-	-	-
Total Dichlorophenols	µg/L	--		-	-	-	-	-	-	-	-	-	0.61	-	-	-	-	-	-
Total Chlorophenols	µg/L	--		-	-	-	-	-	-	-	-	-	1.3	-	-	-	-	-	-
Total Monochlorophenols	µg/L	--		-	-	-	-	-	-	-	-	-	<0.090	-	-	-	-	-	-
Total Nonchlorinated Phenols	µg/L	--		-	-	-	-	-	-	-	-	-	54	-	-	-	-	-	-
Total Tetrachlorophenols	µg/L	--		-	-	-	-	-	-	-	-	-	<0.17	-	-	-	-	-	-
Total Trichlorophenols	µg/L	--		-	-	-	-	-	-	-	-	-	<0.24	-	-	-	-	-	-
Phenol	µg/L	1000		-	-	-	-	-	-	-	-	-	6.0	150	160	6	-	-	-
2-chlorophenol	µg/L	45		-	-	-	-	-	-	-	-	-	<0.050	-	-	-	-	-	-
3 & 4-chlorophenol	µg/L	--		-	-	-	-	-	-	-	-	-	<0.075	-	-	-	-	-	-
2-methylphenol	µg/L	200		-	-	-	-	-	-	-	-	-	0.97	4.4	3.5	23	-	-	-
3 & 4-methylphenol	µg/L	400[2]		-	-	-	-	-	-	-	-	-	44	170	130	27	-	-	-
2-nitrophenol	µg/L	--		-	-	-	-	-	-	-	-	-	<0.50	<2.5	<2.5	0	-	-	-
2,4-dimethylphenol	µg/L	80		-	-	-	-	-	-	-	-	-	0.91	6.6	7.5	13	-	-	-
2,4 + 2,5-Dichlorophenol	µg/L	900[3]		-	-	-	-	-	-	-	-	-	0.61	-	-	-	-	-	-
2,3-Dichlorophenol	µg/L	--		-	-	-	-	-	-	-	-	-	<0.10	-	-	-	-	-	-
2,6-dichlorophenol	µg/L	--		-	-	-	-	-	-	-	-	-	<0.10	-	-	-	-	-	-
3,5-Dichlorophenol	µg/L	--		-	-	-	-	-	-	-	-	-	<0.10	-	-	-	-	-	-
3,4-Dichlorophenol	µg/L	--		-	-	-	-	-	-	-	-	-	<0.10	-	-	-	-	-	-
2,4,5-trichlorophenol	µg/L	400		-	-	-	-	-	-	-	-	-	<0.10	-	-	-	-	-	-
2,4,6-trichlorophenol	µg/L	5		-	-	-	-	-	-	-	-	-	0.22	-	-	-	-	-	-
2,3,5-trichlorophenol	µg/L	--		-	-	-	-	-	-	-	-	-	<0.10	-	-	-	-	-	-
2,3,6-Trichlorophenol	µg/L	--		-	-	-	-	-	-	-	-	-	<0.10	-	-	-	-	-	-
2,3,4-trichlorophenol	µg/L	--		-	-	-	-	-	-	-	-	-	<0.10	-	-	-	-	-	-
3,4,5-Trichlorophenol	µg/L	--		-	-	-	-	-	-	-	-	-	<0.10	-	-	-	-	-	-
2,4-dinitrophenol	µg/L	8		-	-	-	-	-	-	-	-	-	<0.50	<2.5	<2.5	0	-	-	-
4,6-dinitro-2-methylphenol	µg/L	--		-	-	-	-	-	-	-	-	-	<0.50	<2.5	<2.5	0	-	-	-
2,3,4,6-tetrachlorophenol	µg/L	100		-	-	-	-	-	-	-	-	-	<0.10	-	-	-	-	-	-
2,3,4,5-tetrachlorophenol	µg/L	--		-	-	-	-	-	-	-	-	-	<0.10	-	-	-	-	-	-
2,3,5,6-tetrachlorophenol	µg/L	--		-	-	-	-	-	-	-	-	-	0.15	-	-	-	-	-	-
4-nitrophenol	µg/L	--		-	-	-	-	-	-	-	-	-	<0.50	<2.5	<2.5	0	-	-	-
2,6-Dimethylphenol	µg/L	2.5		-	-	-	-	-	-	-	-	-	1.7	<2.5	<2.5	0	-	-	-
3,4-Dimethylphenol	µg/L	4		-	-	-	-	-	-	-	-	-	<0.50	<2.5	<2.5	0	-	-	-
4-chloro-3-methylphenol	µg/L	400		-	-	-	-	-	-	-	-	-	<0.10	-	-	-	-	-	-
Pentachlorophenol	µg/L	60		-	-	-	-	-	-	-	-	-	0.30	-	-	-	-	-	-

Table 3

Analytical Results Summary
Groundwater Sampling
2024 Operations and Monitoring Report
New Landfill
Campbell River, British Columbia

			Sample Location:	MW1-14		
			Sample ID:	WG-11222680-090424-KH-07	WG-11222680-260624-DT-10	WG-11222680-110924-DT-10	MW1-14
			Sample Date:	4/9/2024	6/26/2024	9/11/2024	12/19/2024
Parameters	**Units**	**BC CSR[1] DW**					
Field Parameters							
Conductivity, field	µS/cm	--		126	129	83	143
Dissolved oxygen (DO), field	mg/L	--		10.85	-	5.52	10.7
Oxidation reduction potential (ORP), field	millivolts	--		139	198	150	-87
pH, field	s.u.	--		8.09	7.12	6.85	6.91
Temperature, field	Deg C	--		14.11	11.54	11.23	13.5
Total dissolved solids, field (TDS)	mg/L	--		-	84	54	118
Turbidity, field	NTU	--		0.0	5.2	3.5	-[4]
General Chemistry							
Alkalinity (as CaCO3 pH=8.3)	mg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Alkalinity, total (as CaCO3)	mg/L	--		39	41	37	50
Chloride (dissolved)	mg/L	250		6.9	9.5	3.6	16
Conductivity	µS/cm	--		120	120	93	190
Hardness (dissolved)	mg/L	--		52.6	54.0	35.1	68.9
Hydroxide (as CaCO3)	mg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Orthophosphate	mg/L	--		0.0062	0.0069	0.0045	<0.0030
pH	s.u.	--		7.04	-	-	6.48
Sulfate (dissolved)	mg/L	500		2.4	3.0	2.8	3.5
Total Un-ionized Hydrogen Sulfide as S	mg/L	--		-	-	ND (0.0050)	<0.0050
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	0.05		-	-	ND (0.0050)	<0.0050
Total Sulfide as H2S	mg/L	--		ND (0.0020)	ND (0.0020)	ND (0.0020)	<0.0020
Total Sulfide as S	mg/L	--		ND (0.0018)	ND (0.0018)	ND (0.0018)	<0.0018
Total dissolved solids (TDS)	mg/L	--		60	96	60	140
Nutrients							
Ammonia-N	mg/L	--		ND (0.015)	ND (0.015)	ND (0.015)	<0.015
Bicarbonate (as CaCO3)	mg/L	--		47	50	45	61
Carbonate (as CaCO3)	mg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Nitrate (as N)	mg/L	10		1.04	0.347	0.130	3.25
Nitrite (as N)	mg/L	1		ND (0.0050)	ND (0.0050)	ND (0.0050)	<0.0050
Nitrate and Nitrite (as N)	mg/L	10		1.04	0.347	0.130	3.25
Dissolved Metals							
Aluminum (dissolved)	µg/L	9500		ND (3.0)	ND (3.0)	3.4	<3.0
Antimony (dissolved)	µg/L	6		ND (0.50)	ND (0.50)	ND (0.50)	<0.50
Arsenic (dissolved)	µg/L	10		0.10	ND (0.10)	ND (0.10)	<0.10
Barium (dissolved)	µg/L	1000		ND (1.0)	ND (1.0)	ND (1.0)	1.5
Beryllium (dissolved)	µg/L	8		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Bismuth (dissolved)	µg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Boron (dissolved)	µg/L	5000		ND (50)	ND (50)	ND (50)	<50
Cadmium (dissolved)	µg/L	5		ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Calcium (dissolved)	µg/L	--		17800	18000	11600	23000
Chromium (dissolved)	µg/L	50		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Cobalt (dissolved)	µg/L	20		ND (0.20)	ND (0.20)	ND (0.20)	<0.20
Copper (dissolved)	µg/L	1500		ND (0.20)	ND (0.58)	ND (0.20)	<0.20
Iron (dissolved)	µg/L	6500[6]		ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Lead (dissolved)	µg/L	10		ND (0.20)	ND (0.20)	ND (0.20)	<0.20
Lithium (dissolved)	µg/L	8		ND (2.0)	ND (2.0)	ND (2.0)	<2.0
Magnesium (dissolved)	µg/L	--		1960	2200	1500	2810
Manganese (dissolved)	µg/L	1500[6]		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Mercury (dissolved)	µg/L	1		ND (0.0019)	ND (0.0019)	ND (0.0019)	-
Molybdenum (dissolved)	µg/L	250		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Nickel (dissolved)	µg/L	80		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Phosphorus (dissolved)	µg/L	--		ND (10)	ND (10)	ND (10)	-
Potassium (dissolved)	µg/L	--		187	171	122	285
Selenium (dissolved)	µg/L	10		ND (0.10)	ND (0.10)	ND (0.10)	0.12
Silicon (dissolved)	µg/L	--		4610	4740	3520	6170
Silver (dissolved)	µg/L	20		ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Sodium (dissolved)	µg/L	200000		1930	2360	948	6120
Strontium (dissolved)	µg/L	2500		27.2	27.3	17.0	39.2
Sulfur (dissolved)	µg/L	--		ND (3000)	ND (3000)	ND (3000)	<3000
Thallium (dissolved)	µg/L	--		ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Tin (dissolved)	µg/L	2500		ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Titanium (dissolved)	µg/L	--		ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Uranium (dissolved)	µg/L	20		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Vanadium (dissolved)	µg/L	20		ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Zinc (dissolved)	µg/L	3000		ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Zirconium (dissolved)	µg/L	--		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
PHCs							
EPHw (C10-C19)	µg/L	5000		ND (200)	ND (200)	ND (200)	<200
LEPH (EPHw C10-C19 less PAH)	µg/L	--		ND (200)	ND (200)	ND (200)	<200
EPHw (C19-C32)	µg/L	--		ND (200)	ND (200)	ND (200)	<200
HEPHw (EPHw C19-C32 less PAH)	µg/L	--		ND (200)	ND (200)	ND (200)	<200
PAHs							
1-Methylnaphthalene	µg/L	5.5		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
2-Methylnaphthalene	µg/L	15		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Acenaphthene	µg/L	250		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Acenaphthylene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Acridine	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Anthracene	µg/L	1000		ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Benzo(a)anthracene	µg/L	0.07		ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Benzo(a)pyrene	µg/L	0.01		ND (0.0050)	ND (0.0050)	ND (0.0050)	<0.0050
Benzo(b+j)fluoranthenes	µg/L	0.07		ND (0.030)	ND (0.030)	ND (0.030)	<0.030
Benzo(b)pyridine (Quinoline)	µg/L	0.05		ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Benzo(g,h,i)perylene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Benzo(k)fluoranthene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Chrysene	µg/L	7		ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Dibenz(a,h)anthracene	µg/L	0.01		ND (0.0030)	ND (0.0030)	ND (0.0030)	<0.0030
Fluoranthene	µg/L	150		ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Fluorene	µg/L	150		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Indeno(1,2,3-cd)pyrene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Naphthalene	µg/L	80		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
PAH high molecular weight	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
PAH low molecular weight	µg/L	--		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Phenanthrene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Pyrene	µg/L	100		ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Total PAH	µg/L	--		ND (0.10)	ND (0.10)	ND (0.10)	<0.10

Table 3

Analytical Results Summary
Groundwater Sampling
2024 Operations and Monitoring Report
New Landfill
Campbell River, British Columbia

			Sample Location:	MW2-14		
			Sample ID:	WG-11222680-100424-KH-09	WG-11222680-250624-DT-07	WG-11222680-110924-DT-05	MW2-14
			Sample Date:	4/10/2024	6/25/2024	9/11/2024	12/19/2024
Parameters	**Units**	**BC CSR[1] DW**					
Field Parameters							
Conductivity, field	µS/cm	--		129	163	129	83.4
Dissolved oxygen (DO), field	mg/L	--		11.00	-	5.46	12.1
Oxidation reduction potential (ORP), field	millivolts	--		168	183	121	-200
pH, field	s.u.	--		7.43	7.09	6.95	7.26
Temperature, field	Deg C	--		10.65	16.31	11.10	10.9
Total dissolved solids, field (TDS)	mg/L	--		84	106	84	74.2
Turbidity, field	NTU	--		20	42.3	1.4	10.1
General Chemistry							
Alkalinity (as CaCO3 pH=8.3)	mg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Alkalinity, total (as CaCO3)	mg/L	--		52	60	61	44
Chloride (dissolved)	mg/L	250		11	6.0	3.7	3.1
Conductivity	µS/cm	--		170	160	140	120
Hardness (dissolved)	mg/L	--		70.5	68.5	57.5	46.5
Hydroxide (as CaCO3)	mg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Orthophosphate	mg/L	--		0.0065	0.0050	0.0053	<0.0030
pH	s.u.	--		7.16	-	-	6.53
Sulfate (dissolved)	mg/L	500		7.2	7.6	5.4	6.4
Total Un-ionized Hydrogen Sulfide as S	mg/L	--		-	-	ND (0.0050)	<0.0050
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	0.05		-	-	ND (0.0050)	<0.0050
Total Sulfide as H2S	mg/L	--		ND (0.0020)	0.014	ND (0.0020)	<0.0020
Total Sulfide as S	mg/L	--		ND (0.0018)	0.013	ND (0.0018)	<0.0018
Total dissolved solids (TDS)	mg/L	--		110	130	92	86
Nutrients							
Ammonia-N	mg/L	--		ND (0.015)	ND (0.015)	ND (0.015)	<0.015
Bicarbonate (as CaCO3)	mg/L	--		63	74	74	53
Carbonate (as CaCO3)	mg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Nitrate (as N)	mg/L	10		0.425	0.287	0.214	0.233
Nitrite (as N)	mg/L	1		ND (0.0050)	ND (0.0050)	ND (0.0050)	<0.0050
Nitrate and Nitrite (as N)	mg/L	10		0.425	0.287	0.214	0.233
Dissolved Metals							
Aluminum (dissolved)	µg/L	9500		ND (3.0)	ND (3.0)	ND (3.0)	11.7
Antimony (dissolved)	µg/L	6		ND (0.50)	ND (0.50)	ND (0.50)	<0.50
Arsenic (dissolved)	µg/L	10		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Barium (dissolved)	µg/L	1000		2.1	2.1	1.7	1.3
Beryllium (dissolved)	µg/L	8		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Bismuth (dissolved)	µg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Boron (dissolved)	µg/L	5000		ND (50)	ND (50)	ND (50)	<50
Cadmium (dissolved)	µg/L	5		ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Calcium (dissolved)	µg/L	--		22700	21600	18200	14700
Chromium (dissolved)	µg/L	50		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Cobalt (dissolved)	µg/L	20		ND (0.20)	ND (0.20)	ND (0.20)	<0.20
Copper (dissolved)	µg/L	1500		0.21	ND (0.20)	ND (0.20)	0.35
Iron (dissolved)	µg/L	6500[6]		ND (5.0)	ND (5.0)	ND (5.0)	18.8
Lead (dissolved)	µg/L	10		ND (0.20)	ND (0.20)	ND (0.20)	<0.20
Lithium (dissolved)	µg/L	8		ND (2.0)	ND (2.0)	ND (2.0)	<2.0
Magnesium (dissolved)	µg/L	--		3360	3520	2960	2390
Manganese (dissolved)	µg/L	1500[6]		ND (1.0)	ND (1.0)	ND (1.0)	1.3
Mercury (dissolved)	µg/L	1		ND (0.0019)	ND (0.0019)	ND (0.0019)	-
Molybdenum (dissolved)	µg/L	250		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Nickel (dissolved)	µg/L	80		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Phosphorus (dissolved)	µg/L	--		ND (10)	ND (10)	ND (10)	-
Potassium (dissolved)	µg/L	--		246	257	222	194
Selenium (dissolved)	µg/L	10		0.15	0.11	0.12	0.10
Silicon (dissolved)	µg/L	--		6580	5980	5700	5560
Silver (dissolved)	µg/L	20		ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Sodium (dissolved)	µg/L	200000		3670	4650	3690	3040
Strontium (dissolved)	µg/L	2500		36.9	36.1	32.1	22.6
Sulfur (dissolved)	µg/L	--		ND (3000)	ND (3000)	ND (3000)	<3000
Thallium (dissolved)	µg/L	--		ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Tin (dissolved)	µg/L	2500		ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Titanium (dissolved)	µg/L	--		ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Uranium (dissolved)	µg/L	20		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Vanadium (dissolved)	µg/L	20		ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Zinc (dissolved)	µg/L	3000		ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Zirconium (dissolved)	µg/L	--		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
PHCs							
EPHw (C10-C19)	µg/L	5000		ND (200)	ND (200)	ND (200)	<200
LEPH (EPHw C10-C19 less PAH)	µg/L	--		ND (200)	ND (200)	ND (200)	<200
EPHw (C19-C32)	µg/L	--		ND (200)	ND (200)	ND (200)	<200
HEPHw (EPHw C19-C32 less PAH)	µg/L	--		ND (200)	ND (200)	ND (200)	<200
PAHs							
1-Methylnaphthalene	µg/L	5.5		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
2-Methylnaphthalene	µg/L	15		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Acenaphthene	µg/L	250		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Acenaphthylene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Acridine	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Anthracene	µg/L	1000		ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Benzo(a)anthracene	µg/L	0.07		ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Benzo(a)pyrene	µg/L	0.01		ND (0.0050)	ND (0.0050)	ND (0.0050)	<0.0050
Benzo(b+j)fluoranthenes	µg/L	0.07		ND (0.030)	ND (0.030)	ND (0.030)	<0.030
Benzo(b)pyridine (Quinoline)	µg/L	0.05		ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Benzo(g,h,i)perylene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Benzo(k)fluoranthene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Chrysene	µg/L	7		ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Dibenz(a,h)anthracene	µg/L	0.01		ND (0.0030)	ND (0.0030)	ND (0.0030)	<0.0030
Fluoranthene	µg/L	150		ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Fluorene	µg/L	150		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Indeno(1,2,3-cd)pyrene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Naphthalene	µg/L	80		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
PAH high molecular weight	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
PAH low molecular weight	µg/L	--		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Phenanthrene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Pyrene	µg/L	100		ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Total PAH	µg/L	--		ND (0.10)	ND (0.10)	ND (0.10)	<0.10

Table 3

Analytical Results Summary
Groundwater Sampling
2024 Operations and Monitoring Report
New Landfill
Campbell River, British Columbia

			Sample Location:	MW2A-16						
			Sample ID:	WG-11222680-100424-KH-08	WG-11222680-250624-DT-06	WG-11222680-110924-DT-06	WG-11222680-110924-DT-07	RPD	MW2A-16	MW2A-16 DUP	RPD
			Sample Date:	4/10/2024	6/25/2024	9/11/2024	9/11/2024 Duplicate	(%)	12/19/2024	12/19/2024 Duplicate	(%)
Parameters	**Units**	**BC CSR[1] DW**									
Field Parameters											
Conductivity, field	µS/cm	--		51	76	76	76	-	65.7	65.7	-
Dissolved oxygen (DO), field	mg/L	--		11.16	-	2.31	2.31	-	10.4	10.4	-
Oxidation reduction potential (ORP), field	millivolts	--		137	175	152	152	-	-290	-290	-
pH, field	s.u.	--		8.31	7.53	6.96	6.96	-	8.21	8.21	-
Temperature, field	Deg C	--		11.38	14.32	11.09	11.09	-	10.7	10.7	-
Total dissolved solids, field (TDS)	mg/L	--		33	50	49	49	-	58.6	58.6	-
Turbidity, field	NTU	--		0.7	5.6	1.2	1.2	-	3.2	3.2	-
General Chemistry											
Alkalinity (as CaCO3 pH=8.3)	mg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	0	<1.0	<1.0	0
Alkalinity, total (as CaCO3)	mg/L	--		28	34	39	37	5	41	43	5
Chloride (dissolved)	mg/L	250		ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	0	<1.0	3.7	0
Conductivity	µS/cm	--		64	75	81	80	1	92	92	0
Hardness (dissolved)	mg/L	--		27.6	33.6	36.7	36	2	41.0	38.5	6
Hydroxide (as CaCO3)	mg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	0	<1.0	<1.0	0
Orthophosphate	mg/L	--		0.031	0.025	0.027	0.027	0	0.027	0.028	4
pH	s.u.	--		6.98	-	-	-	0	6.63	6.68	1
Sulfate (dissolved)	mg/L	500		2.2	2.6	2.5	2.5	0	2.5	2.7	8
Total Un-ionized Hydrogen Sulfide as S	mg/L	--		-	-	ND (0.0050)	ND (0.0050)	0	<0.0050	<0.0050	0
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	0.05		-	-	ND (0.0050)	ND (0.0050)	0	<0.0050	<0.0050	0
Total Sulfide as H2S	mg/L	--		ND (0.0020)	ND (0.0020)	ND (0.0020)	ND (0.0020)	0	<0.0020	<0.0020	0
Total Sulfide as S	mg/L	--		ND (0.0018)	ND (0.0018)	ND (0.0018)	ND (0.0018)	0	<0.0018	<0.0018	0
Total dissolved solids (TDS)	mg/L	--		34	70	58	56	4	66	-	-
Nutrients											
Ammonia-N	mg/L	--		ND (0.015)	ND (0.015)	ND (0.015)	ND (0.015)	0	<0.015	<0.015	0
Bicarbonate (as CaCO3)	mg/L	--		34	42	47	45	4	50	53	6
Carbonate (as CaCO3)	mg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	0	<1.0	<1.0	0
Nitrate (as N)	mg/L	10		0.060	0.064	0.085	0.089	5	<0.020	0.052	0
Nitrite (as N)	mg/L	1		ND (0.0050)	ND (0.0050)	ND (0.0050)	ND (0.0050)	0	<0.0050	<0.0050	0
Nitrate and Nitrite (as N)	mg/L	10		0.060	0.064	0.085	0.089	5	<0.020	0.052	0
Dissolved Metals											
Aluminum (dissolved)	µg/L	9500		5.4	3.9	3.6	11.3	103	4.1	3.7	10
Antimony (dissolved)	µg/L	6		ND (0.50)	ND (0.50)	ND (0.50)	ND (0.50)	0	<0.50	<0.50	0
Arsenic (dissolved)	µg/L	10		1.12	0.87	0.79	0.8	1	0.79	0.78	1
Barium (dissolved)	µg/L	1000		1.7	1.7	1.8	1.8	0	2.0	2.1	5
Beryllium (dissolved)	µg/L	8		ND (0.10)	ND (0.10)	ND (0.10)	ND (0.10)	0	<0.10	<0.10	0
Bismuth (dissolved)	µg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	0	<1.0	<1.0	0
Boron (dissolved)	µg/L	5000		ND (50)	ND (50)	ND (50)	ND (50)	0	<50	<50	0
Cadmium (dissolved)	µg/L	5		ND (0.010)	ND (0.010)	ND (0.010)	ND (0.010)	0	<0.010	<0.010	0
Calcium (dissolved)	µg/L	--		9050	11000	12000	11800	2	13500	12700	6
Chromium (dissolved)	µg/L	50		ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	0	<1.0	<1.0	0
Cobalt (dissolved)	µg/L	20		ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	0	<0.20	<0.20	0
Copper (dissolved)	µg/L	1500		ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	0	<0.20	<0.20	0
Iron (dissolved)	µg/L	6500[6]		ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	0	<5.0	<5.0	0
Lead (dissolved)	µg/L	10		ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	0	<0.20	<0.20	0
Lithium (dissolved)	µg/L	8		ND (2.0)	ND (2.0)	ND (2.0)	ND (2.0)	0	<2.0	<2.0	0
Magnesium (dissolved)	µg/L	--		1230	1500	1620	1620	0	1790	1660	8
Manganese (dissolved)	µg/L	1500[6]		ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	0	<1.0	<1.0	0
Mercury (dissolved)	µg/L	1		ND (0.0019)	ND (0.0019)	ND (0.0019)	ND (0.0019)	0	-	-	0
Molybdenum (dissolved)	µg/L	250		ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	0	<1.0	<1.0	0
Nickel (dissolved)	µg/L	80		ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	0	<1.0	<1.0	0
Phosphorus (dissolved)	µg/L	--		33	27	28	28	0	-	-	0
Potassium (dissolved)	µg/L	--		175	185	160	157	2	176	184	4
Selenium (dissolved)	µg/L	10		0.10	ND (0.10)	0.13	0.12	8	<0.10	<0.10	0
Silicon (dissolved)	µg/L	--		3680	3380	3500	3410	3	3560	3850	8
Silver (dissolved)	µg/L	20		ND (0.020)	ND (0.020)	ND (0.020)	ND (0.020)	0	<0.020	<0.020	0
Sodium (dissolved)	µg/L	200000		893	948	912	913	0	1030	989	4
Strontium (dissolved)	µg/L	2500		12.7	14.4	15.4	15.2	1	15.8	16.6	5
Sulfur (dissolved)	µg/L	--		ND (3000)	ND (3000)	ND (3000)	ND (3000)	0	<3000	<3000	0
Thallium (dissolved)	µg/L	--		ND (0.010)	ND (0.010)	ND (0.010)	ND (0.010)	0	<0.010	<0.010	0
Tin (dissolved)	µg/L	2500		ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	0	<5.0	<5.0	0
Titanium (dissolved)	µg/L	--		ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	0	<5.0	<5.0	0
Uranium (dissolved)	µg/L	20		ND (0.10)	ND (0.10)	ND (0.10)	ND (0.10)	0	<0.10	<0.10	0
Vanadium (dissolved)	µg/L	20		8.8	6.6	6.1	6.1	0	6.4	6.7	5
Zinc (dissolved)	µg/L	3000		ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	0	<5.0	<5.0	0
Zirconium (dissolved)	µg/L	--		ND (0.10)	ND (0.10)	ND (0.10)	ND (0.10)	0	<0.10	<0.10	0
PHCs											
EPHw (C10-C19)	µg/L	5000		ND (200)	ND (200)	ND (200)	ND (200)	0	<200	<200	0
LEPH (EPHw C10-C19 less PAH)	µg/L	--		ND (200)	ND (200)	ND (200)	ND (200)	0	<200	<200	0
EPHw (C19-C32)	µg/L	--		ND (200)	ND (200)	ND (200)	ND (200)	0	<200	<200	0
HEPHw (EPHw C19-C32 less PAH)	µg/L	--		ND (200)	ND (200)	ND (200)	ND (200)	0	<200	<200	0
PAHs											
1-Methylnaphthalene	µg/L	5.5		ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)	0	<0.050	<0.050	0
2-Methylnaphthalene	µg/L	15		ND (0.10)	ND (0.10)	ND (0.10)	ND (0.10)	0	<0.10	<0.10	0
Acenaphthene	µg/L	250		ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)	0	<0.050	<0.050	0
Acenaphthylene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)	0	<0.050	<0.050	0
Acridine	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)	0	<0.050	<0.050	0
Anthracene	µg/L	1000		ND (0.010)	ND (0.010)	ND (0.010)	ND (0.010)	0	<0.010	<0.010	0
Benzo(a)anthracene	µg/L	0.07		ND (0.010)	ND (0.010)	ND (0.010)	ND (0.010)	0	<0.010	<0.010	0
Benzo(a)pyrene	µg/L	0.01		ND (0.0050)	ND (0.0050)	ND (0.0050)	ND (0.0050)	0	<0.0050	<0.0050	0
Benzo(b+j)fluoranthenes	µg/L	0.07		ND (0.030)	ND (0.030)	ND (0.030)	ND (0.030)	0	<0.030	<0.030	0
Benzo(b)pyridine (Quinoline)	µg/L	0.05		ND (0.020)	ND (0.020)	ND (0.020)	ND (0.020)	0	<0.020	<0.020	0
Benzo(g,h,i)perylene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)	0	<0.050	<0.050	0
Benzo(k)fluoranthene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)	0	<0.050	<0.050	0
Chrysene	µg/L	7		ND (0.020)	ND (0.020)	ND (0.020)	ND (0.020)	0	<0.020	<0.020	0
Dibenz(a,h)anthracene	µg/L	0.01		ND (0.0030)	ND (0.0030)	ND (0.0030)	ND (0.0030)	0	<0.0030	<0.0030	0
Fluoranthene	µg/L	150		ND (0.020)	ND (0.020)	ND (0.020)	ND (0.020)	0	<0.020	<0.020	0
Fluorene	µg/L	150		ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)	0	<0.050	<0.050	0
Indeno(1,2,3-cd)pyrene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)	0	<0.050	<0.050	0
Naphthalene	µg/L	80		ND (0.10)	ND (0.10)	ND (0.10)	ND (0.10)	0	<0.10	<0.10	0
PAH high molecular weight	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)	0	<0.050	<0.050	0
PAH low molecular weight	µg/L	--		ND (0.10)	ND (0.10)	ND (0.10)	ND (0.10)	0	<0.10	<0.10	0
Phenanthrene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)	0	<0.050	<0.050	0
Pyrene	µg/L	100		ND (0.020)	ND (0.020)	ND (0.020)	ND (0.020)	0	<0.020	<0.020	0
Total PAH	µg/L	--		ND (0.10)	ND (0.10)	ND (0.10)	ND (0.10)	0	<0.10	<0.10	0

Table 3

Analytical Results Summary
Groundwater Sampling
2024 Operations and Monitoring Report
New Landfill
Campbell River, British Columbia

			Sample Location:	MW3-14	
			Sample ID:	WG-11222680-250624-DT-05	WG-11222680-110924-DT-08	MW3-14
			Sample Date:	6/25/2024	9/11/2024	12/20/2024
Parameters	**Units**	**BC CSR[1] DW**			
Field Parameters					
Conductivity, field	µS/cm	--	130	122	63
Dissolved oxygen (DO), field	mg/L	--	7.57	6.66	13.2
Oxidation reduction potential (ORP), field	millivolts	--	196	164	-215
pH, field	s.u.	--	6.51	6.23	7.18
Temperature, field	Deg C	--	13.40	12.04	10.1
Total dissolved solids, field (TDS)	mg/L	--	90	79	58
Turbidity, field	NTU	--	115	1.9	2.1
General Chemistry					
Alkalinity (as CaCO3 pH=8.3)	mg/L	--	ND (1.0)	ND (1.0)	<1.0
Alkalinity, total (as CaCO3)	mg/L	--	47	46	42
Chloride (dissolved)	mg/L	250	2.7	2.6	<1.0
Conductivity	µS/cm	--	140	130	100
Hardness (dissolved)	mg/L	--	55.7	49.3	38.7
Hydroxide (as CaCO3)	mg/L	--	ND (1.0)	ND (1.0)	<1.0
Orthophosphate	mg/L	--	0.0068	0.0039	0.0049
pH	s.u.	--	-	-	6.41
Sulfate (dissolved)	mg/L	500	7.4	8.0	3.9
Total Un-ionized Hydrogen Sulfide as S	mg/L	--	-	ND (0.0050)	<0.0050
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	0.05	-	ND (0.0050)	<0.0050
Total Sulfide as H2S	mg/L	--	0.0062	ND (0.0020)	<0.0020
Total Sulfide as S	mg/L	--	0.0058	ND (0.0018)	<0.0018
Total dissolved solids (TDS)	mg/L	--	96	90	86
Nutrients					
Ammonia-N	mg/L	--	ND (0.015)	ND (0.015)	<0.015
Bicarbonate (as CaCO3)	mg/L	--	57	57	51
Carbonate (as CaCO3)	mg/L	--	ND (1.0)	ND (1.0)	<1.0
Nitrate (as N)	mg/L	10	2.33	1.74	0.394
Nitrite (as N)	mg/L	1	ND (0.0050)	ND (0.0050)	<0.0050
Nitrate and Nitrite (as N)	mg/L	10	2.33	1.74	0.394
Dissolved Metals					
Aluminum (dissolved)	µg/L	9500	4.0	ND (3.0)	<3.0
Antimony (dissolved)	µg/L	6	ND (0.50)	ND (0.50)	<0.50
Arsenic (dissolved)	µg/L	10	ND (0.10)	ND (0.10)	<0.10
Barium (dissolved)	µg/L	1000	1.2	ND (1.0)	<1.0
Beryllium (dissolved)	µg/L	8	ND (0.10)	ND (0.10)	<0.10
Bismuth (dissolved)	µg/L	--	ND (1.0)	ND (1.0)	<1.0
Boron (dissolved)	µg/L	5000	ND (50)	ND (50)	<50
Cadmium (dissolved)	µg/L	5	ND (0.010)	ND (0.010)	<0.010
Calcium (dissolved)	µg/L	--	15900	14300	11300
Chromium (dissolved)	µg/L	50	ND (1.0)	ND (1.0)	<1.0
Cobalt (dissolved)	µg/L	20	ND (0.20)	ND (0.20)	<0.20
Copper (dissolved)	µg/L	1500	ND (0.20)	0.24	<0.20
Iron (dissolved)	µg/L	6500[6]	ND (5.0)	ND (5.0)	<5.0
Lead (dissolved)	µg/L	10	ND (0.20)	ND (0.20)	<0.20
Lithium (dissolved)	µg/L	8	ND (2.0)	ND (2.0)	<2.0
Magnesium (dissolved)	µg/L	--	3860	3330	2550
Manganese (dissolved)	µg/L	1500[6]	ND (1.0)	ND (1.0)	<1.0
Mercury (dissolved)	µg/L	1	ND (0.0019)	ND (0.0019)	-
Molybdenum (dissolved)	µg/L	250	ND (1.0)	ND (1.0)	<1.0
Nickel (dissolved)	µg/L	80	ND (1.0)	ND (1.0)	<1.0
Phosphorus (dissolved)	µg/L	--	ND (10)	ND (10)	-
Potassium (dissolved)	µg/L	--	203	172	162
Selenium (dissolved)	µg/L	10	0.22	0.27	<0.10
Silicon (dissolved)	µg/L	--	8070	6860	6700
Silver (dissolved)	µg/L	20	ND (0.020)	ND (0.020)	<0.020
Sodium (dissolved)	µg/L	200000	4510	4890	4170
Strontium (dissolved)	µg/L	2500	31.1	26.4	20.2
Sulfur (dissolved)	µg/L	--	ND (3000)	ND (3000)	<3000
Thallium (dissolved)	µg/L	--	ND (0.010)	ND (0.010)	<0.010
Tin (dissolved)	µg/L	2500	ND (5.0)	ND (5.0)	<5.0
Titanium (dissolved)	µg/L	--	ND (5.0)	ND (5.0)	<5.0
Uranium (dissolved)	µg/L	20	ND (0.10)	ND (0.10)	<0.10
Vanadium (dissolved)	µg/L	20	ND (5.0)	ND (5.0)	<5.0
Zinc (dissolved)	µg/L	3000	ND (5.0)	ND (5.0)	<5.0
Zirconium (dissolved)	µg/L	--	ND (0.10)	ND (0.10)	<0.10
PHCs					
EPHw (C10-C19)	µg/L	5000	ND (200)	ND (200)	<200
LEPH (EPHw C10-C19 less PAH)	µg/L	--	ND (200)	ND (200)	<200
EPHw (C19-C32)	µg/L	--	ND (200)	ND (200)	<200
HEPHw (EPHw C19-C32 less PAH)	µg/L	--	ND (200)	ND (200)	<200
PAHs					
1-Methylnaphthalene	µg/L	5.5	ND (0.050)	ND (0.050)	<0.050
2-Methylnaphthalene	µg/L	15	ND (0.10)	ND (0.10)	<0.10
Acenaphthene	µg/L	250	ND (0.050)	ND (0.050)	<0.050
Acenaphthylene	µg/L	--	ND (0.050)	ND (0.050)	<0.050
Acridine	µg/L	--	ND (0.050)	ND (0.050)	<0.050
Anthracene	µg/L	1000	ND (0.010)	ND (0.010)	<0.010
Benzo(a)anthracene	µg/L	0.07	ND (0.010)	ND (0.010)	<0.010
Benzo(a)pyrene	µg/L	0.01	ND (0.0050)	ND (0.0050)	<0.0050
Benzo(b+j)fluoranthenes	µg/L	0.07	ND (0.030)	ND (0.030)	<0.030
Benzo(b)pyridine (Quinoline)	µg/L	0.05	ND (0.020)	ND (0.020)	<0.020
Benzo(g,h,i)perylene	µg/L	--	ND (0.050)	ND (0.050)	<0.050
Benzo(k)fluoranthene	µg/L	--	ND (0.050)	ND (0.050)	<0.050
Chrysene	µg/L	7	ND (0.020)	ND (0.020)	<0.020
Dibenz(a,h)anthracene	µg/L	0.01	ND (0.0030)	ND (0.0030)	<0.0030
Fluoranthene	µg/L	150	ND (0.020)	ND (0.020)	<0.020
Fluorene	µg/L	150	ND (0.050)	ND (0.050)	<0.050
Indeno(1,2,3-cd)pyrene	µg/L	--	ND (0.050)	ND (0.050)	<0.050
Naphthalene	µg/L	80	ND (0.10)	ND (0.10)	<0.10
PAH high molecular weight	µg/L	--	ND (0.050)	ND (0.050)	<0.050
PAH low molecular weight	µg/L	--	ND (0.10)	ND (0.10)	<0.10
Phenanthrene	µg/L	--	ND (0.050)	ND (0.050)	<0.050
Pyrene	µg/L	100	ND (0.020)	ND (0.020)	<0.020
Total PAH	µg/L	--	ND (0.10)	ND (0.10)	<0.10

Table 3

Analytical Results Summary
Groundwater Sampling
2024 Operations and Monitoring Report
New Landfill
Campbell River, British Columbia

			Sample Location:	MW4A-15		MW4B-15	
			Sample ID:	WG-11222680-120924-DT-13	MW4A-15	WG-11222680-120924-DT-12	MW4B-15
			Sample Date:	9/12/2024	12/19/2024	9/12/2024	12/19/2024
Parameters	**Units**	**BC CSR[1] DW**					
Field Parameters							
Conductivity, field	µS/cm	--		310	205	307	198
Dissolved oxygen (DO), field	mg/L	--		5.83	8.5	4.82	8.9
Oxidation reduction potential (ORP), field	millivolts	--		108	-158	110	-40
pH, field	s.u.	--		6.94	6.92	6.87	7.02
Temperature, field	Deg C	--		13.78	9.3	12.29	9.1
Total dissolved solids, field (TDS)	mg/L	--		201	189	200	187
Turbidity, field	NTU	--		3.0	3.5	0.0	2.5
General Chemistry							
Alkalinity (as CaCO3 pH=8.3)	mg/L	--		ND (1.0)	<1.0	ND (1.0)	<1.0
Alkalinity, total (as CaCO3)	mg/L	--		74	84	73	83
Chloride (dissolved)	mg/L	250		34	19	36	19
Conductivity	µS/cm	--		370	300	370	300
Hardness (dissolved)	mg/L	--		55.2	54.3	53.3	52.2
Hydroxide (as CaCO3)	mg/L	--		ND (1.0)	<1.0	ND (1.0)	<1.0
Orthophosphate	mg/L	--		0.0063	0.0082	0.0071	0.0073
pH	s.u.	--		-	6.62	-	6.64
Sulfate (dissolved)	mg/L	500		14	15	13	16
Total Un-ionized Hydrogen Sulfide as S	mg/L	--		ND (0.0050)	<0.0050	ND (0.0050)	<0.0050
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	0.05		ND (0.0050)	<0.0050	ND (0.0050)	<0.0050
Total Sulfide as H2S	mg/L	--		ND (0.0020)	<0.0020	ND (0.0020)	<0.0020
Total Sulfide as S	mg/L	--		ND (0.0018)	<0.0018	ND (0.0018)	<0.0018
Total dissolved solids (TDS)	mg/L	--		210	190	220	200
Nutrients							
Ammonia-N	mg/L	--		ND (0.015)	<0.015	ND (0.015)	0.020
Bicarbonate (as CaCO3)	mg/L	--		90	100	89	100
Carbonate (as CaCO3)	mg/L	--		ND (1.0)	<1.0	ND (1.0)	<1.0
Nitrate (as N)	mg/L	10		7.21	3.84	7.33	3.95
Nitrite (as N)	mg/L	1		ND (0.0050)	<0.0050	ND (0.0050)	0.0082
Nitrate and Nitrite (as N)	mg/L	10		7.21	3.84	7.33	3.96
Dissolved Metals							
Aluminum (dissolved)	µg/L	9500		3.6	<3.0	ND (3.0)	<3.0
Antimony (dissolved)	µg/L	6		ND (0.50)	<0.50	ND (0.50)	<0.50
Arsenic (dissolved)	µg/L	10		0.10	0.11	ND (0.10)	<0.10
Barium (dissolved)	µg/L	1000		5.8	5.4	2.9	2.3
Beryllium (dissolved)	µg/L	8		ND (0.10)	<0.10	ND (0.10)	<0.10
Bismuth (dissolved)	µg/L	--		ND (1.0)	<1.0	ND (1.0)	<1.0
Boron (dissolved)	µg/L	5000		ND (50)	51	ND (50)	<50
Cadmium (dissolved)	µg/L	5		ND (0.010)	<0.010	ND (0.010)	0.011
Calcium (dissolved)	µg/L	--		16300	16100	15700	15600
Chromium (dissolved)	µg/L	50		ND (1.0)	<1.0	ND (1.0)	<1.0
Cobalt (dissolved)	µg/L	20		ND (0.20)	<0.20	ND (0.20)	<0.20
Copper (dissolved)	µg/L	1500		0.32	0.21	0.25	0.24
Iron (dissolved)	µg/L	6500[6]		ND (5.0)	<5.0	ND (5.0)	<5.0
Lead (dissolved)	µg/L	10		ND (0.20)	<0.20	ND (0.20)	<0.20
Lithium (dissolved)	µg/L	8		ND (2.0)	<2.0	ND (2.0)	<2.0
Magnesium (dissolved)	µg/L	--		3510	3410	3400	3230
Manganese (dissolved)	µg/L	1500[6]		ND (1.0)	<1.0	ND (1.0)	<1.0
Mercury (dissolved)	µg/L	1		ND (0.0019)	-	ND (0.0019)	-
Molybdenum (dissolved)	µg/L	250		ND (1.0)	<1.0	ND (1.0)	<1.0
Nickel (dissolved)	µg/L	80		ND (1.0)	<1.0	ND (1.0)	<1.0
Phosphorus (dissolved)	µg/L	--		11	-	11	-
Potassium (dissolved)	µg/L	--		368	334	348	317
Selenium (dissolved)	µg/L	10		0.66	0.58	0.63	0.60
Silicon (dissolved)	µg/L	--		7140	7130	7290	7110
Silver (dissolved)	µg/L	20		ND (0.020)	<0.020	ND (0.020)	<0.020
Sodium (dissolved)	µg/L	200000		46700	37300	46600	37700
Strontium (dissolved)	µg/L	2500		107	94.4	110	98.2
Sulfur (dissolved)	µg/L	--		4500	4600	4600	5100
Thallium (dissolved)	µg/L	--		ND (0.010)	<0.010	ND (0.010)	<0.010
Tin (dissolved)	µg/L	2500		ND (5.0)	<5.0	ND (5.0)	<5.0
Titanium (dissolved)	µg/L	--		ND (5.0)	<5.0	ND (5.0)	<5.0
Uranium (dissolved)	µg/L	20		ND (0.10)	<0.10	ND (0.10)	<0.10
Vanadium (dissolved)	µg/L	20		ND (5.0)	<5.0	ND (5.0)	<5.0
Zinc (dissolved)	µg/L	3000		ND (5.0)	<5.0	ND (5.0)	<5.0
Zirconium (dissolved)	µg/L	--		ND (0.10)	<0.10	ND (0.10)	<0.10
PHCs							
EPHw (C10-C19)	µg/L	5000		ND (200)	<200	ND (200)	<200
LEPH (EPHw C10-C19 less PAH)	µg/L	--		ND (200)	<200	ND (200)	<200
EPHw (C19-C32)	µg/L	--		ND (200)	<200	ND (200)	<200
HEPHw (EPHw C19-C32 less PAH)	µg/L	--		ND (200)	<200	ND (200)	<200
PAHs							
1-Methylnaphthalene	µg/L	5.5		ND (0.050)	<0.050	ND (0.050)	<0.050
2-Methylnaphthalene	µg/L	15		ND (0.10)	<0.10	ND (0.10)	<0.10
Acenaphthene	µg/L	250		ND (0.050)	<0.050	ND (0.050)	<0.050
Acenaphthylene	µg/L	--		ND (0.050)	<0.050	ND (0.050)	<0.050
Acridine	µg/L	--		ND (0.050)	<0.050	ND (0.050)	<0.050
Anthracene	µg/L	1000		ND (0.010)	<0.010	ND (0.010)	<0.010
Benzo(a)anthracene	µg/L	0.07		ND (0.010)	<0.010	ND (0.010)	<0.010
Benzo(a)pyrene	µg/L	0.01		ND (0.0050)	<0.0050	ND (0.0050)	<0.0050
Benzo(b+j)fluoranthenes	µg/L	0.07		ND (0.030)	<0.030	ND (0.030)	<0.030
Benzo(b)pyridine (Quinoline)	µg/L	0.05		ND (0.020)	<0.020	ND (0.020)	<0.020
Benzo(g,h,i)perylene	µg/L	--		ND (0.050)	<0.050	ND (0.050)	<0.050
Benzo(k)fluoranthene	µg/L	--		ND (0.050)	<0.050	ND (0.050)	<0.050
Chrysene	µg/L	7		ND (0.020)	<0.020	ND (0.020)	<0.020
Dibenz(a,h)anthracene	µg/L	0.01		ND (0.0030)	<0.0030	ND (0.0030)	<0.0030
Fluoranthene	µg/L	150		ND (0.020)	<0.020	ND (0.020)	<0.020
Fluorene	µg/L	150		ND (0.050)	<0.050	ND (0.050)	<0.050
Indeno(1,2,3-cd)pyrene	µg/L	--		ND (0.050)	<0.050	ND (0.050)	<0.050
Naphthalene	µg/L	80		ND (0.10)	<0.10	ND (0.10)	<0.10
PAH high molecular weight	µg/L	--		ND (0.050)	<0.050	ND (0.050)	<0.050
PAH low molecular weight	µg/L	--		ND (0.10)	<0.10	ND (0.10)	<0.10
Phenanthrene	µg/L	--		ND (0.050)	<0.050	ND (0.050)	<0.050
Pyrene	µg/L	100		ND (0.020)	<0.020	ND (0.020)	<0.020
Total PAH	µg/L	--		ND (0.10)	<0.10	ND (0.10)	<0.10

Table 3

Analytical Results Summary
Groundwater Sampling
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Campbell River, British Columbia

			Sample Location:	MW6-17		
			Sample ID:	WG-11222680-100424-KH-11	WG-11222680-260624-DT-09	WG-11222680-120924-DT-11	MW6-17
			Sample Date:	4/10/2024	6/26/2024	9/12/2024	12/20/2024
Parameters	**Units**	**BC CSR[1] DW**					
Field Parameters							
Conductivity, field	µS/cm	--		3.85	500	387	340
Dissolved oxygen (DO), field	mg/L	--		10.68	6.15	1.04	3.3
Oxidation reduction potential (ORP), field	millivolts	--		175	187	188	-270
pH, field	s.u.	--		7.02	6.34	6.30	7.28
Temperature, field	Deg C	--		10.43	16.68	13.10	9.8
Total dissolved solids, field (TDS)	mg/L	--		250	320	252	310
Turbidity, field	NTU	--		290	53.4	148	69
General Chemistry							
Alkalinity (as CaCO3 pH=8.3)	mg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Alkalinity, total (as CaCO3)	mg/L	--		92	84	85	110
Chloride (dissolved)	mg/L	250		85	88	74	77
Conductivity	µS/cm	--		490	470	460	490
Hardness (dissolved)	mg/L	--		161	146	140	154
Hydroxide (as CaCO3)	mg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Orthophosphate	mg/L	--		0.013	0.013	0.0061	0.0039
pH	s.u.	--		7.33	-	-	6.87
Sulfate (dissolved)	mg/L	500		4.9	5.3	5.2	4.7
Total Un-ionized Hydrogen Sulfide as S	mg/L	--		-	-	ND (0.0050)	0.0073
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	0.05		-	-	ND (0.0050)	0.0078
Total Sulfide as H2S	mg/L	--		ND (0.0020)	ND (0.0020)	0.0046	0.019
Total Sulfide as S	mg/L	--		ND (0.0018)	ND (0.0018)	0.0043	0.018
Total dissolved solids (TDS)	mg/L	--		300	330	300	310
Nutrients							
Ammonia-N	mg/L	--		ND (0.015)	ND (0.015)	ND (0.015)	<0.015
Bicarbonate (as CaCO3)	mg/L	--		110	100	100	130
Carbonate (as CaCO3)	mg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Nitrate (as N)	mg/L	10		0.793	0.759	0.566	0.415
Nitrite (as N)	mg/L	1		ND (0.0050)	ND (0.0050)	ND (0.0050)	<0.0050
Nitrate and Nitrite (as N)	mg/L	10		0.793	0.759	0.566	0.415
Dissolved Metals							
Aluminum (dissolved)	µg/L	9500		ND (3.0)	ND (3.0)	899	19.5
Antimony (dissolved)	µg/L	6		ND (0.50)	ND (0.50)	ND (0.50)	<0.50
Arsenic (dissolved)	µg/L	10		0.18	0.13	0.53	0.17
Barium (dissolved)	µg/L	1000		28.9	14.3	20.9	21.6
Beryllium (dissolved)	µg/L	8		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Bismuth (dissolved)	µg/L	--		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Boron (dissolved)	µg/L	5000		ND (50)	ND (50)	ND (50)	<50
Cadmium (dissolved)	µg/L	5		0.016	0.011	0.037	0.010
Calcium (dissolved)	µg/L	--		43600	36200	34800	40600
Chromium (dissolved)	µg/L	50		ND (1.0)	ND (1.0)	1.5	<1.0
Cobalt (dissolved)	µg/L	20		ND (0.20)	ND (0.20)	1.07	<0.20
Copper (dissolved)	µg/L	1500		0.66	ND (1.06)	4.02	0.40
Iron (dissolved)	µg/L	6500[6]		ND (5.0)	ND (5.0)	1450	16.0
Lead (dissolved)	µg/L	10		ND (0.20)	ND (0.20)	0.61	<0.20
Lithium (dissolved)	µg/L	8		ND (2.0)	ND (2.0)	ND (2.0)	<2.0
Magnesium (dissolved)	µg/L	--		12500	13400	12900	12700
Manganese (dissolved)	µg/L	1500[6]		8.3	15.9	132	6.8
Mercury (dissolved)	µg/L	1		ND (0.0019)	ND (0.0019)	0.0022	-
Molybdenum (dissolved)	µg/L	250		ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Nickel (dissolved)	µg/L	80		ND (1.0)	ND (1.0)	1.5	<1.0
Phosphorus (dissolved)	µg/L	--		ND (10)	10	70	-
Potassium (dissolved)	µg/L	--		1040	1080	1050	1100
Selenium (dissolved)	µg/L	10		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Silicon (dissolved)	µg/L	--		15000	14000	14400	10800
Silver (dissolved)	µg/L	20		ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Sodium (dissolved)	µg/L	200000		28300	28300	26000	28300
Strontium (dissolved)	µg/L	2500		110	99.2	102	99.2
Sulfur (dissolved)	µg/L	--		ND (3000)	ND (3000)	ND (3000)	<3000
Thallium (dissolved)	µg/L	--		ND (0.010)	ND (0.010)	0.014	<0.010
Tin (dissolved)	µg/L	2500		ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Titanium (dissolved)	µg/L	--		ND (5.0)	ND (5.0)	72.0	<5.0
Uranium (dissolved)	µg/L	20		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Vanadium (dissolved)	µg/L	20		ND (5.0)	ND (5.0)	5.8	<5.0
Zinc (dissolved)	µg/L	3000		8.2	ND (5.0)	6.1	<5.0
Zirconium (dissolved)	µg/L	--		ND (0.10)	ND (0.10)	0.35	<0.10
PHCs							
EPHw (C10-C19)	µg/L	5000		ND (200)	ND (200)	ND (200)	<200
LEPH (EPHw C10-C19 less PAH)	µg/L	--		ND (200)	ND (200)	ND (200)	<200
EPHw (C19-C32)	µg/L	--		ND (200)	ND (200)	ND (200)	290
HEPHw (EPHw C19-C32 less PAH)	µg/L	--		ND (200)	ND (200)	ND (200)	290
PAHs							
1-Methylnaphthalene	µg/L	5.5		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
2-Methylnaphthalene	µg/L	15		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Acenaphthene	µg/L	250		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Acenaphthylene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Acridine	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Anthracene	µg/L	1000		0.018	ND (0.010)	ND (0.010)	<0.010
Benzo(a)anthracene	µg/L	0.07		0.017	ND (0.010)	ND (0.010)	<0.010
Benzo(a)pyrene	µg/L	0.01		**0.018**	ND (0.0050)	ND (0.0050)	<0.0050
Benzo(b+j)fluoranthenes	µg/L	0.07		ND (0.030)	ND (0.030)	ND (0.030)	<0.030
Benzo(b)pyridine (Quinoline)	µg/L	0.05		0.032	ND (0.020)	ND (0.020)	<0.020
Benzo(g,h,i)perylene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Benzo(k)fluoranthene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Chrysene	µg/L	7		0.028	ND (0.020)	ND (0.020)	<0.020
Dibenz(a,h)anthracene	µg/L	0.01		ND (0.0030)	ND (0.0030)	ND (0.0030)	<0.0030
Fluoranthene	µg/L	150		0.030	ND (0.020)	ND (0.020)	<0.020
Fluorene	µg/L	150		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Indeno(1,2,3-cd)pyrene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Naphthalene	µg/L	80		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
PAH high molecular weight	µg/L	--		0.13	ND (0.050)	ND (0.050)	<0.050
PAH low molecular weight	µg/L	--		ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Phenanthrene	µg/L	--		ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Pyrene	µg/L	100		0.036	ND (0.020)	ND (0.020)	<0.020
Total PAH	µg/L	--		0.18	ND (0.10)	ND (0.10)	<0.10

Table 3

Analytical Results Summary
Groundwater Sampling
2024 Operations and Monitoring Report
New Landfill
Campbell River, British Columbia

		Sample Location:	MW9-17								
		Sample ID:	WG-11222680-090424-KH-03	WG-11222680-090424-KH-04	RPD	WG-11222680-250624-DT-08	WG-11222680-110924-DT-04	MW9-17	MW9-17 DUP	RPD
		Sample Date:	4/9/2024	4/9/2024 Duplicate	(%)	6/25/2024	9/11/2024	12/20/2024	12/20/2024 Duplicate	(%)
Parameters	**Units**	**BC CSR[1] DW**								
Field Parameters										
Conductivity, field	µS/cm	--	59	59	-	64	74	52.5	52.5	-
Dissolved oxygen (DO), field	mg/L	--	11.79	11.79	-	6.61	3.74	8.6	8.6	-
Oxidation reduction potential (ORP), field	millivolts	--	138	138	-	196	169	-298	-298	-
pH, field	s.u.	--	815	815	-	7.15	6.50	7.4	7.4	-
Temperature, field	Deg C	--	8.99	8.99	-	9.67	13.42	17.7	17.7	-
Total dissolved solids, field (TDS)	mg/L	--	39	39	-	42	48	39.5	39.5	-
Turbidity, field	NTU	--	0.0	0.0	-	7.1	3.4	3.7	3.7	-
General Chemistry										
Alkalinity (as CaCO3 pH=8.3)	mg/L	--	ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	<1.0	<1.0	0
Alkalinity, total (as CaCO3)	mg/L	--	26	26	0	28	36	26	27	4
Chloride (dissolved)	mg/L	250	ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	<1.0	<1.0	0
Conductivity	µS/cm	--	59	59	0	62	77	61	61	0
Hardness (dissolved)	mg/L	--	24.4	28.8	17	28.0	34.9	26.2	24.2	8
Hydroxide (as CaCO3)	mg/L	--	ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	<1.0	<1.0	0
Orthophosphate	mg/L	--	0.0039	0.0043	10	0.0037	ND (0.0030)	0.0036	0.0042	15
pH	s.u.	--	6.73	6.78	1	-	-	6.37	6.45	1
Sulfate (dissolved)	mg/L	500	2.2	2.2	0	2.7	2.8	2.6	2.6	0
Total Un-ionized Hydrogen Sulfide as S	mg/L	--	-	-	0	-	ND (0.0050)	<0.0050	<0.0050	0
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	0.05	-	-	0	-	ND (0.0050)	<0.0050	<0.0050	0
Total Sulfide as H2S	mg/L	--	ND (0.0020)	0.0032	0	ND (0.0020)	ND (0.0020)	<0.0020	<0.0020	0
Total Sulfide as S	mg/L	--	ND (0.0018)	0.003	0	ND (0.0018)	ND (0.0018)	<0.0018	<0.0018	0
Total dissolved solids (TDS)	mg/L	--	32	34	6	64	58	54	-	-
Nutrients										
Ammonia-N	mg/L	--	ND (0.015)	ND (0.015)	0	ND (0.015)	ND (0.015)	<0.015	<0.015	0
Bicarbonate (as CaCO3)	mg/L	--	31	31	0	34	44	31	33	6
Carbonate (as CaCO3)	mg/L	--	ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	<1.0	<1.0	0
Nitrate (as N)	mg/L	10	0.021	ND (0.020)	0	0.048	0.094	<0.020	0.023	0
Nitrite (as N)	mg/L	1	ND (0.0050)	ND (0.0050)	0	ND (0.0050)	ND (0.0050)	<0.0050	<0.0050	0
Nitrate and Nitrite (as N)	mg/L	10	0.021	ND (0.020)	0	0.048	0.094	<0.020	0.023	0
Dissolved Metals										
Aluminum (dissolved)	µg/L	9500	ND (3.0)	ND (3.0)	0	ND (3.0)	3.2	<3.0	<3.0	0
Antimony (dissolved)	µg/L	6	ND (0.50)	ND (0.50)	0	ND (0.50)	ND (0.50)	<0.50	<0.50	0
Arsenic (dissolved)	µg/L	10	ND (0.10)	ND (0.10)	0	ND (0.10)	ND (0.10)	<0.10	<0.10	0
Barium (dissolved)	µg/L	1000	ND (1.0)	ND (1.0)	0	ND (1.0)	1.2	<1.0	<1.0	0
Beryllium (dissolved)	µg/L	8	ND (0.10)	ND (0.10)	0	ND (0.10)	ND (0.10)	<0.10	<0.10	0
Bismuth (dissolved)	µg/L	--	ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	<1.0	<1.0	0
Boron (dissolved)	µg/L	5000	ND (50)	ND (50)	0	ND (50)	ND (50)	<50	<50	0
Cadmium (dissolved)	µg/L	5	ND (0.010)	ND (0.010)	0	ND (0.010)	ND (0.010)	<0.010	<0.010	0
Calcium (dissolved)	µg/L	--	8120	9940	20	9310	11700	8850	8260	7
Chromium (dissolved)	µg/L	50	ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	<1.0	<1.0	0
Cobalt (dissolved)	µg/L	20	ND (0.20)	ND (0.20)	0	ND (0.20)	ND (0.20)	<0.20	<0.20	0
Copper (dissolved)	µg/L	1500	ND (0.20)	ND (0.20)	0	ND (0.20)	ND (0.20)	<0.20	0.21	0
Iron (dissolved)	µg/L	6500[6]	ND (5.0)	ND (5.0)	0	ND (5.0)	ND (5.0)	<5.0	<5.0	0
Lead (dissolved)	µg/L	10	ND (0.20)	ND (0.20)	0	ND (0.20)	ND (0.20)	<0.20	<0.20	0
Lithium (dissolved)	µg/L	8	ND (2.0)	ND (2.0)	0	ND (2.0)	ND (2.0)	<2.0	<2.0	0
Magnesium (dissolved)	µg/L	--	994	964	3	1150	1340	997	867	14
Manganese (dissolved)	µg/L	1500[6]	ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	<1.0	<1.0	0
Mercury (dissolved)	µg/L	1	ND (0.0019)	ND (0.0019)	0	ND (0.0019)	ND (0.0019)	-	-	0
Molybdenum (dissolved)	µg/L	250	ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	<1.0	<1.0	0
Nickel (dissolved)	µg/L	80	ND (1.0)	ND (1.0)	0	ND (1.0)	ND (1.0)	<1.0	<1.0	0
Phosphorus (dissolved)	µg/L	--	ND (10)	ND (10)	0	ND (10)	ND (10)	-	-	0
Potassium (dissolved)	µg/L	--	133	123	8	113	162	187	186	1
Selenium (dissolved)	µg/L	10	ND (0.10)	ND (0.10)	0	ND (0.10)	0.13	<0.10	<0.10	0
Silicon (dissolved)	µg/L	--	2740	3350	20	2470	3370	3990	4240	6
Silver (dissolved)	µg/L	20	ND (0.020)	ND (0.020)	0	ND (0.020)	ND (0.020)	<0.020	<0.020	0
Sodium (dissolved)	µg/L	200000	734	694	6	736	894	1020	958	6
Strontium (dissolved)	µg/L	2500	12.4	11.7	6	12.5	16.0	11.8	12.5	6
Sulfur (dissolved)	µg/L	--	ND (3000)	ND (3000)	0	ND (3000)	ND (3000)	<3000	<3000	0
Thallium (dissolved)	µg/L	--	ND (0.010)	ND (0.010)	0	ND (0.010)	ND (0.010)	<0.010	<0.010	0
Tin (dissolved)	µg/L	2500	ND (5.0)	ND (5.0)	0	ND (5.0)	ND (5.0)	<5.0	<5.0	0
Titanium (dissolved)	µg/L	--	ND (5.0)	ND (5.0)	0	ND (5.0)	ND (5.0)	<5.0	<5.0	0
Uranium (dissolved)	µg/L	20	ND (0.10)	ND (0.10)	0	ND (0.10)	ND (0.10)	<0.10	<0.10	0
Vanadium (dissolved)	µg/L	20	ND (5.0)	ND (5.0)	0	ND (5.0)	ND (5.0)	<5.0	<5.0	0
Zinc (dissolved)	µg/L	3000	ND (5.0)	ND (5.0)	0	ND (5.0)	ND (5.0)	<5.0	<5.0	0
Zirconium (dissolved)	µg/L	--	ND (0.10)	ND (0.10)	0	ND (0.10)	ND (0.10)	<0.10	<0.10	0
PHCs										
EPHw (C10-C19)	µg/L	5000	ND (200)	ND (200)	0	ND (200)	ND (200)	<200	<200	0
LEPH (EPHw C10-C19 less PAH)	µg/L	--	ND (200)	ND (200)	0	ND (200)	ND (200)	<200	<200	0
EPHw (C19-C32)	µg/L	--	ND (200)	ND (200)	0	ND (200)	ND (200)	<200	<200	0
HEPHw (EPHw C19-C32 less PAH)	µg/L	--	ND (200)	ND (200)	0	ND (200)	ND (200)	<200	<200	0
PAHs										
1-Methylnaphthalene	µg/L	5.5	ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	<0.050	<0.050	0
2-Methylnaphthalene	µg/L	15	ND (0.10)	ND (0.10)	0	ND (0.10)	ND (0.10)	<0.10	<0.10	0
Acenaphthene	µg/L	250	ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	<0.050	<0.050	0
Acenaphthylene	µg/L	--	ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	<0.050	<0.050	0
Acridine	µg/L	--	ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	<0.050	<0.050	0
Anthracene	µg/L	1000	ND (0.010)	ND (0.010)	0	ND (0.010)	ND (0.010)	<0.010	<0.010	0
Benzo(a)anthracene	µg/L	0.07	ND (0.010)	ND (0.010)	0	ND (0.010)	ND (0.010)	<0.010	<0.010	0
Benzo(a)pyrene	µg/L	0.01	ND (0.0050)	ND (0.0050)	0	ND (0.0050)	ND (0.0050)	<0.0050	<0.0050	0
Benzo(b+j)fluoranthenes	µg/L	0.07	ND (0.030)	ND (0.030)	0	ND (0.030)	ND (0.030)	<0.030	<0.030	0
Benzo(b)pyridine (Quinoline)	µg/L	0.05	ND (0.020)	ND (0.020)	0	ND (0.020)	ND (0.020)	<0.020	<0.020	0
Benzo(g,h,i)perylene	µg/L	--	ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	<0.050	<0.050	0
Benzo(k)fluoranthene	µg/L	--	ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	<0.050	<0.050	0
Chrysene	µg/L	7	ND (0.020)	ND (0.020)	0	ND (0.020)	ND (0.020)	<0.020	<0.020	0
Dibenz(a,h)anthracene	µg/L	0.01	ND (0.0030)	ND (0.0030)	0	ND (0.0030)	ND (0.0030)	<0.0030	<0.0030	0
Fluoranthene	µg/L	150	ND (0.020)	ND (0.020)	0	ND (0.020)	ND (0.020)	<0.020	<0.020	0
Fluorene	µg/L	150	ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	<0.050	<0.050	0
Indeno(1,2,3-cd)pyrene	µg/L	--	ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	<0.050	<0.050	0
Naphthalene	µg/L	80	ND (0.10)	ND (0.10)	0	ND (0.10)	ND (0.10)	<0.10	<0.10	0
PAH high molecular weight	µg/L	--	ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	<0.050	<0.050	0
PAH low molecular weight	µg/L	--	ND (0.10)	ND (0.10)	0	ND (0.10)	ND (0.10)	<0.10	<0.10	0
Phenanthrene	µg/L	--	ND (0.050)	ND (0.050)	0	ND (0.050)	ND (0.050)	<0.050	<0.050	0
Pyrene	µg/L	100	ND (0.020)	ND (0.020)	0	ND (0.020)	ND (0.020)	<0.020	<0.020	0
Total PAH	µg/L	--	ND (0.10)	ND (0.10)	0	ND (0.10)	ND (0.10)	<0.10	<0.10	0

Table 3

Analytical Results Summary
Groundwater Sampling
2024 Operations and Monitoring Report
New Landfill
Campbell River, British Columbia

		Sample Location:	MW10-17					
		Sample ID:	WG-11222680-090424-KH-05	WG-11222680-240624-DT-02	WG-11222680-240624-DT-03	RPD	WG-11222680-100924-DT-01	MW10-17
		Sample Date:	4/9/2024	6/24/2024	6/24/2024 Duplicate	(%)	9/10/2024	12/18/2024
Parameters	**Units**	**BC CSR[1] DW**						
Field Parameters								
Conductivity, field	µS/cm	--	180	255	255	-	727	170
Dissolved oxygen (DO), field	mg/L	--	11.24	4.33	4.33	-	2.12	7.81
Oxidation reduction potential (ORP), field	millivolts	--	138	147	147	-	127	78
pH, field	s.u.	--	8.33	7.62	7.62	-	7.41	7.4
Temperature, field	Deg C	--	12.00	16.94	16.94	-	14.92	10.6
Total dissolved solids, field (TDS)	mg/L	--	117	166	166	-	465	152
Turbidity, field	NTU	--	0.0	1.3	1.3	-	0.0	6.6
General Chemistry								
Alkalinity (as CaCO3 pH=8.3)	mg/L	--	ND (1.0)	ND (1.0)	ND (1.0)	0	ND (1.0)	<1.0
Alkalinity, total (as CaCO3)	mg/L	--	75	64	64	0	190	90
Chloride (dissolved)	mg/L	250	2.2	24	24	0	38	7.6
Conductivity	µS/cm	--	170	260	260	0	760	240
Hardness (dissolved)	mg/L	--	70.1	107	109	2	334	100
Hydroxide (as CaCO3)	mg/L	--	ND (1.0)	ND (1.0)	ND (1.0)	0	ND (1.0)	<1.0
Orthophosphate	mg/L	--	0.017	0.011	0.01	10	0.0093	0.0087
pH	s.u.	--	7.68	-	-	0	-	7.48
Sulfate (dissolved)	mg/L	500	4.4	16	16	0	120	13
Total Un-ionized Hydrogen Sulfide as S	mg/L	--	-	-	-	0	ND (0.0050)	<0.0050
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	0.05	-	-	-	0	ND (0.0050)	<0.0050
Total Sulfide as H2S	mg/L	--	ND (0.0020)	ND (0.0020)	ND (0.0020)	0	ND (0.0020)	<0.0020
Total Sulfide as S	mg/L	--	ND (0.0018)	ND (0.0018)	ND (0.0018)	0	ND (0.0018)	<0.0018
Total dissolved solids (TDS)	mg/L	--	98	200	210	5	500	180
Nutrients								
Ammonia-N	mg/L	--	ND (0.015)	0.018	ND (0.015)	0	0.029	<0.015
Bicarbonate (as CaCO3)	mg/L	--	91	78	78	0	230	110
Carbonate (as CaCO3)	mg/L	--	ND (1.0)	ND (1.0)	ND (1.0)	0	ND (1.0)	<1.0
Nitrate (as N)	mg/L	10	0.153	2.84	2.86	1	3.29	1.01
Nitrite (as N)	mg/L	1	ND (0.0050)	ND (0.0050)	ND (0.0050)	0	ND (0.0050)	<0.0050
Nitrate and Nitrite (as N)	mg/L	10	0.153	2.84	2.86	1	3.29	1.01
Dissolved Metals								
Aluminum (dissolved)	µg/L	9500	ND (3.0)	ND (3.0)	4.4	0	ND (6.0)	4.6
Antimony (dissolved)	µg/L	6	ND (0.50)	ND (0.50)	ND (0.50)	0	ND (1.0)	<0.50
Arsenic (dissolved)	µg/L	10	0.38	0.32	0.32	0	0.43	0.32
Barium (dissolved)	µg/L	1000	3.4	4.7	4.9	4	16.3	4.4
Beryllium (dissolved)	µg/L	8	ND (0.10)	ND (0.10)	ND (0.10)	0	ND (0.20)	<0.10
Bismuth (dissolved)	µg/L	--	ND (1.0)	ND (1.0)	ND (1.0)	0	ND (2.0)	<1.0
Boron (dissolved)	µg/L	5000	134	74	76	3	2020	654
Cadmium (dissolved)	µg/L	5	ND (0.010)	ND (0.010)	ND (0.010)	0	ND (0.020)	<0.010
Calcium (dissolved)	µg/L	--	22300	34100	34800	2	106000	32100
Chromium (dissolved)	µg/L	50	ND (1.0)	ND (1.0)	ND (1.0)	0	ND (2.0)	<1.0
Cobalt (dissolved)	µg/L	20	ND (0.20)	ND (0.20)	ND (0.20)	0	ND (0.40)	<0.20
Copper (dissolved)	µg/L	1500	0.31	0.4	0.42	5	6.00	1.83
Iron (dissolved)	µg/L	6500[6]	ND (5.0)	ND (5.0)	ND (5.0)	0	ND (10)	<5.0
Lead (dissolved)	µg/L	10	ND (0.20)	ND (0.20)	ND (0.20)	0	ND (0.40)	<0.20
Lithium (dissolved)	µg/L	8	ND (2.0)	ND (2.0)	ND (2.0)	0	ND (4.0)	<2.0
Magnesium (dissolved)	µg/L	--	3500	5310	5390	1	16600	4830
Manganese (dissolved)	µg/L	1500[6]	ND (1.0)	ND (1.0)	ND (1.0)	0	ND (2.0)	<1.0
Mercury (dissolved)	µg/L	1	ND (0.0019)	0.0035	0.0035	0	0.0093	-
Molybdenum (dissolved)	µg/L	250	ND (1.0)	ND (1.0)	ND (1.0)	0	ND (2.0)	<1.0
Nickel (dissolved)	µg/L	80	ND (1.0)	ND (1.0)	ND (1.0)	0	ND (2.0)	<1.0
Phosphorus (dissolved)	µg/L	--	15	14	14	0	ND (20)	-
Potassium (dissolved)	µg/L	--	367	423	424	0	810	436
Selenium (dissolved)	µg/L	10	ND (0.10)	ND (0.10)	ND (0.10)	0	ND (0.20)	0.11
Silicon (dissolved)	µg/L	--	7160	6600	6590	0	7480	7020
Silver (dissolved)	µg/L	20	ND (0.020)	ND (0.020)	ND (0.020)	0	ND (0.040)	<0.020
Sodium (dissolved)	µg/L	200000	5730	7030	7150	2	20300	8700
Strontium (dissolved)	µg/L	2500	34.4	49.5	49.7	0	165	44.6
Sulfur (dissolved)	µg/L	--	ND (3000)	6400	5200	21	40200	3600
Thallium (dissolved)	µg/L	--	ND (0.010)	ND (0.010)	ND (0.010)	0	ND (0.020)	0.017
Tin (dissolved)	µg/L	2500	ND (5.0)	ND (5.0)	ND (5.0)	0	ND (10)	<5.0
Titanium (dissolved)	µg/L	--	ND (5.0)	ND (5.0)	ND (5.0)	0	ND (10)	<5.0
Uranium (dissolved)	µg/L	20	ND (0.10)	ND (0.10)	ND (0.10)	0	0.43	<0.10
Vanadium (dissolved)	µg/L	20	ND (5.0)	ND (5.0)	ND (5.0)	0	ND (10)	<5.0
Zinc (dissolved)	µg/L	3000	ND (5.0)	ND (5.0)	ND (5.0)	0	ND (10)	<5.0
Zirconium (dissolved)	µg/L	--	ND (0.10)	ND (0.10)	ND (0.10)	0	ND (0.20)	<0.10
PHCs								
EPHw (C10-C19)	µg/L	5000	ND (200)	ND (200)	ND (200)	0	ND (200)	<200
LEPH (EPHw C10-C19 less PAH)	µg/L	--	ND (200)	ND (200)	ND (200)	0	ND (200)	<200
EPHw (C19-C32)	µg/L	--	ND (200)	ND (200)	ND (200)	0	ND (200)	210
HEPHw (EPHw C19-C32 less PAH)	µg/L	--	ND (200)	ND (200)	ND (200)	0	ND (200)	210
PAHs								
1-Methylnaphthalene	µg/L	5.5	ND (0.050)	ND (0.050)	ND (0.050)	0	ND (0.050)	<0.050
2-Methylnaphthalene	µg/L	15	ND (0.10)	ND (0.10)	ND (0.10)	0	ND (0.10)	<0.10
Acenaphthene	µg/L	250	ND (0.050)	ND (0.050)	ND (0.050)	0	ND (0.050)	<0.050
Acenaphthylene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	0	ND (0.050)	<0.050
Acridine	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	0	ND (0.050)	<0.050
Anthracene	µg/L	1000	ND (0.010)	ND (0.010)	ND (0.010)	0	ND (0.010)	<0.010
Benzo(a)anthracene	µg/L	0.07	ND (0.010)	ND (0.010)	ND (0.010)	0	ND (0.010)	<0.010
Benzo(a)pyrene	µg/L	0.01	ND (0.0050)	ND (0.0050)	ND (0.0050)	0	ND (0.0050)	<0.0050
Benzo(b+j)fluoranthenes	µg/L	0.07	ND (0.030)	ND (0.030)	ND (0.030)	0	ND (0.030)	<0.030
Benzo(b)pyridine (Quinoline)	µg/L	0.05	0.032	ND (0.020)	ND (0.020)	0	ND (0.020)	<0.020
Benzo(g,h,i)perylene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	0	ND (0.050)	<0.050
Benzo(k)fluoranthene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	0	ND (0.050)	<0.050
Chrysene	µg/L	7	ND (0.020)	ND (0.020)	ND (0.020)	0	ND (0.020)	<0.020
Dibenz(a,h)anthracene	µg/L	0.01	ND (0.0030)	ND (0.0030)	ND (0.0030)	0	ND (0.0030)	<0.0030
Fluoranthene	µg/L	150	ND (0.020)	ND (0.020)	ND (0.020)	0	ND (0.020)	<0.020
Fluorene	µg/L	150	ND (0.050)	ND (0.050)	ND (0.050)	0	ND (0.050)	<0.050
Indeno(1,2,3-cd)pyrene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	0	ND (0.050)	<0.050
Naphthalene	µg/L	80	ND (0.10)	ND (0.10)	ND (0.10)	0	ND (0.10)	<0.10
PAH high molecular weight	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	0	ND (0.050)	<0.050
PAH low molecular weight	µg/L	--	ND (0.10)	ND (0.10)	ND (0.10)	0	ND (0.10)	<0.10
Phenanthrene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	0	ND (0.050)	<0.050
Pyrene	µg/L	100	ND (0.020)	ND (0.020)	ND (0.020)	0	ND (0.020)	<0.020
Total PAH	µg/L	--	ND (0.10)	ND (0.10)	ND (0.10)	0	ND (0.10)	<0.10

Table 3

Analytical Results Summary
Groundwater Sampling
2024 Operations and Monitoring Report
New Landfill
Campbell River, British Columbia

			Sample Location:	MW11-19		
			Sample ID:	WG-11222680-090424-KH-01	WG-11222680-240624-DT-01	WG-11222680-100924-DT-03	MW11-19
			Sample Date:	4/9/2024	6/24/2024	9/10/2024	12/18/2024
Parameters	**Units**	**BC CSR[1] DW**				
Field Parameters						
Conductivity, field	µS/cm	--	204	164	165	260
Dissolved oxygen (DO), field	mg/L	--	11.89	6.45	7.44	10.3
Oxidation reduction potential (ORP), field	millivolts	--	130	184	157	102
pH, field	s.u.	--	7.56	6.99	7.40	6.54
Temperature, field	Deg C	--	11.98	13.54	12.67	11.6
Total dissolved solids, field (TDS)	mg/L	--	-	106	107	240
Turbidity, field	NTU	--	10.6	19.6	13.2	70
General Chemistry						
Alkalinity (as CaCO3 pH=8.3)	mg/L	--	ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Alkalinity, total (as CaCO3)	mg/L	--	71	54	63	160
Chloride (dissolved)	mg/L	250	5.4	8.2	7.7	8.6
Conductivity	µS/cm	--	190	160	170	400
Hardness (dissolved)	mg/L	--	76.3	65.9	65.1	181
Hydroxide (as CaCO3)	mg/L	--	ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Orthophosphate	mg/L	--	0.017	0.014	0.013	0.0090
pH	s.u.	--	7.29	-	-	7.08
Sulfate (dissolved)	mg/L	500	9.9	10	7.6	17
Total Un-ionized Hydrogen Sulfide as S	mg/L	--	-	-	ND (0.0050)	0.014
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	0.05	-	-	ND (0.0050)	0.015
Total Sulfide as H2S	mg/L	--	ND (0.0020)	ND (0.0020)	0.0057	0.019
Total Sulfide as S	mg/L	--	ND (0.0018)	ND (0.0018)	0.0053	0.018
Total dissolved solids (TDS)	mg/L	--	110	120	110	280
Nutrients						
Ammonia-N	mg/L	--	ND (0.015)	ND (0.015)	ND (0.015)	<0.015
Bicarbonate (as CaCO3)	mg/L	--	86	66	77	200
Carbonate (as CaCO3)	mg/L	--	ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Nitrate (as N)	mg/L	10	0.995	0.397	0.349	1.57
Nitrite (as N)	mg/L	1	ND (0.0050)	ND (0.0050)	ND (0.0050)	<0.0050
Nitrate and Nitrite (as N)	mg/L	10	0.995	0.397	0.349	1.57
Dissolved Metals						
Aluminum (dissolved)	µg/L	9500	ND (3.0)	ND (3.0)	3.8	23.3
Antimony (dissolved)	µg/L	6	ND (0.50)	ND (0.50)	ND (0.50)	<0.50
Arsenic (dissolved)	µg/L	10	0.25	0.27	0.24	0.20
Barium (dissolved)	µg/L	1000	5.6	4.3	4.5	12.0
Beryllium (dissolved)	µg/L	8	ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Bismuth (dissolved)	µg/L	--	ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Boron (dissolved)	µg/L	5000	ND (50)	ND (50)	ND (50)	<50
Cadmium (dissolved)	µg/L	5	ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Calcium (dissolved)	µg/L	--	23800	20800	20600	57700
Chromium (dissolved)	µg/L	50	1.1	2.3	1.8	<1.0
Cobalt (dissolved)	µg/L	20	ND (0.20)	ND (0.20)	ND (0.20)	<0.20
Copper (dissolved)	µg/L	1500	0.27	0.22	0.22	0.24
Iron (dissolved)	µg/L	6500[6]	ND (5.0)	ND (5.0)	ND (5.0)	27.3
Lead (dissolved)	µg/L	10	ND (0.20)	ND (0.20)	ND (0.20)	<0.20
Lithium (dissolved)	µg/L	8	ND (2.0)	ND (2.0)	ND (2.0)	<2.0
Magnesium (dissolved)	µg/L	--	4100	3400	3340	8940
Manganese (dissolved)	µg/L	1500[6]	ND (1.0)	1.1	ND (1.0)	1.4
Mercury (dissolved)	µg/L	1	ND (0.0019)	ND (0.0019)	0.0135	-
Molybdenum (dissolved)	µg/L	250	ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Nickel (dissolved)	µg/L	80	ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Phosphorus (dissolved)	µg/L	--	14	13	11	-
Potassium (dissolved)	µg/L	--	386	484	362	542
Selenium (dissolved)	µg/L	10	0.21	0.19	0.18	0.14
Silicon (dissolved)	µg/L	--	9470	9020	9070	10800
Silver (dissolved)	µg/L	20	ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Sodium (dissolved)	µg/L	200000	5410	5080	5740	7090
Strontium (dissolved)	µg/L	2500	45.4	33.1	32.1	96.2
Sulfur (dissolved)	µg/L	--	4000	3300	ND (3000)	5500
Thallium (dissolved)	µg/L	--	ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Tin (dissolved)	µg/L	2500	ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Titanium (dissolved)	µg/L	--	ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Uranium (dissolved)	µg/L	20	ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Vanadium (dissolved)	µg/L	20	5.1	ND (5.0)	ND (5.0)	<5.0
Zinc (dissolved)	µg/L	3000	ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Zirconium (dissolved)	µg/L	--	ND (0.10)	ND (0.10)	ND (0.10)	<0.10
PHCs						
EPHw (C10-C19)	µg/L	5000	ND (200)	ND (200)	ND (200)	<200
LEPH (EPHw C10-C19 less PAH)	µg/L	--	ND (200)	ND (200)	ND (200)	<200
EPHw (C19-C32)	µg/L	--	ND (200)	ND (200)	ND (200)	<200
HEPHw (EPHw C19-C32 less PAH)	µg/L	--	ND (200)	ND (200)	ND (200)	<200
PAHs						
1-Methylnaphthalene	µg/L	5.5	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
2-Methylnaphthalene	µg/L	15	ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Acenaphthene	µg/L	250	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Acenaphthylene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Acridine	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Anthracene	µg/L	1000	ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Benzo(a)anthracene	µg/L	0.07	ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Benzo(a)pyrene	µg/L	0.01	ND (0.0050)	ND (0.0050)	ND (0.0050)	<0.0050
Benzo(b+j)fluoranthenes	µg/L	0.07	ND (0.030)	ND (0.030)	ND (0.030)	<0.030
Benzo(b)pyridine (Quinoline)	µg/L	0.05	0.034	ND (0.020)	ND (0.020)	<0.020
Benzo(g,h,i)perylene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Benzo(k)fluoranthene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Chrysene	µg/L	7	ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Dibenz(a,h)anthracene	µg/L	0.01	ND (0.0030)	ND (0.0030)	ND (0.0030)	<0.0030
Fluoranthene	µg/L	150	ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Fluorene	µg/L	150	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Indeno(1,2,3-cd)pyrene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Naphthalene	µg/L	80	ND (0.10)	ND (0.10)	ND (0.10)	<0.10
PAH high molecular weight	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
PAH low molecular weight	µg/L	--	ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Phenanthrene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Pyrene	µg/L	100	ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Total PAH	µg/L	--	ND (0.10)	ND (0.10)	ND (0.10)	<0.10

Table 3

Analytical Results Summary
Groundwater Sampling
2024 Operations and Monitoring Report
New Landfill
Campbell River, British Columbia

			Sample Location:	MW12-22		
			Sample ID:	WG-11222680-090424-KH-02	WG-11222680-240624-DT-04	WG-11222680-100924-DT-02	MW12-22
			Sample Date:	4/9/2024	6/24/2024	9/10/2024	12/18/2024
Parameters	**Units**	**BC CSR[1] DW**				
Field Parameters						
Conductivity, field	µS/cm	--	173	202	174	151
Dissolved oxygen (DO), field	mg/L	--	9.57	-	7.92	9.81
Oxidation reduction potential (ORP), field	millivolts	--	136	190	141	90.1
pH, field	s.u.	--	7.97	7.06	7.28	7.05
Temperature, field	Deg C	--	10.61	12.05	12.28	9.8
Total dissolved solids, field (TDS)	mg/L	--	-	131	113	138
Turbidity, field	NTU	--	0.0	18.2	8.2	14.3
General Chemistry						
Alkalinity (as CaCO3 pH=8.3)	mg/L	--	ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Alkalinity, total (as CaCO3)	mg/L	--	67	88	75	67
Chloride (dissolved)	mg/L	250	3.0	2.9	2.0	6.2
Conductivity	µS/cm	--	160	200	180	220
Hardness (dissolved)	mg/L	--	64.3	87.6	70.5	84.2
Hydroxide (as CaCO3)	mg/L	--	ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Orthophosphate	mg/L	--	0.0071	0.0080	0.0061	<0.0030
pH	s.u.	--	7.38	-	-	7.1
Sulfate (dissolved)	mg/L	500	5.5	8.5	9.5	22
Total Un-ionized Hydrogen Sulfide as S	mg/L	--	-	-	ND (0.0050)	<0.0050
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	0.05	-	-	ND (0.0050)	<0.0050
Total Sulfide as H2S	mg/L	--	ND (0.0020)	0.0092	ND (0.0020)	<0.0020
Total Sulfide as S	mg/L	--	ND (0.0018)	0.0087	ND (0.0018)	0.0018
Total dissolved solids (TDS)	mg/L	--	94	150	110	170
Nutrients						
Ammonia-N	mg/L	--	ND (0.015)	ND (0.015)	ND (0.015)	<0.015
Bicarbonate (as CaCO3)	mg/L	--	82	110	92	82
Carbonate (as CaCO3)	mg/L	--	ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Nitrate (as N)	mg/L	10	0.542	0.656	0.562	1.82
Nitrite (as N)	mg/L	1	ND (0.0050)	ND (0.0050)	ND (0.0050)	<0.0050
Nitrate and Nitrite (as N)	mg/L	10	0.542	0.656	0.562	1.82
Dissolved Metals						
Aluminum (dissolved)	µg/L	9500	ND (3.0)	14.0	ND (3.0)	4.5
Antimony (dissolved)	µg/L	6	ND (0.50)	ND (0.50)	ND (0.50)	<0.50
Arsenic (dissolved)	µg/L	10	ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Barium (dissolved)	µg/L	1000	2.1	2.5	2.0	2.4
Beryllium (dissolved)	µg/L	8	ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Bismuth (dissolved)	µg/L	--	ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Boron (dissolved)	µg/L	5000	ND (50)	ND (50)	ND (50)	<50
Cadmium (dissolved)	µg/L	5	ND (0.010)	0.011	ND (0.010)	<0.010
Calcium (dissolved)	µg/L	--	19000	26000	20500	24400
Chromium (dissolved)	µg/L	50	ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Cobalt (dissolved)	µg/L	20	ND (0.20)	ND (0.20)	ND (0.20)	<0.20
Copper (dissolved)	µg/L	1500	ND (0.20)	0.21	ND (0.20)	0.26
Iron (dissolved)	µg/L	6500[6]	ND (5.0)	34.9	ND (5.0)	9.3
Lead (dissolved)	µg/L	10	ND (0.20)	ND (0.20)	ND (0.20)	<0.20
Lithium (dissolved)	µg/L	8	ND (2.0)	ND (2.0)	ND (2.0)	<2.0
Magnesium (dissolved)	µg/L	--	4070	5520	4690	5650
Manganese (dissolved)	µg/L	1500[6]	ND (1.0)	4.0	ND (1.0)	1.6
Mercury (dissolved)	µg/L	1	ND (0.0019)	ND (0.0019)	ND (0.0019)	-
Molybdenum (dissolved)	µg/L	250	ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Nickel (dissolved)	µg/L	80	ND (1.0)	ND (1.0)	ND (1.0)	<1.0
Phosphorus (dissolved)	µg/L	--	ND (10)	ND (10)	ND (10)	-
Potassium (dissolved)	µg/L	--	282	338	283	331
Selenium (dissolved)	µg/L	10	0.14	0.23	0.11	0.21
Silicon (dissolved)	µg/L	--	7600	7290	7150	6430
Silver (dissolved)	µg/L	20	ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Sodium (dissolved)	µg/L	200000	6020	6740	6120	7580
Strontium (dissolved)	µg/L	2500	31.8	40.1	32.2	40.7
Sulfur (dissolved)	µg/L	--	ND (3000)	ND (3000)	ND (3000)	6800
Thallium (dissolved)	µg/L	--	ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Tin (dissolved)	µg/L	2500	ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Titanium (dissolved)	µg/L	--	ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Uranium (dissolved)	µg/L	20	ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Vanadium (dissolved)	µg/L	20	ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Zinc (dissolved)	µg/L	3000	ND (5.0)	ND (5.0)	ND (5.0)	<5.0
Zirconium (dissolved)	µg/L	--	ND (0.10)	ND (0.10)	ND (0.10)	<0.10
PHCs						
EPHw (C10-C19)	µg/L	5000	ND (200)	ND (200)	ND (200)	<200
LEPH (EPHw C10-C19 less PAH)	µg/L	--	ND (200)	ND (200)	ND (200)	<200
EPHw (C19-C32)	µg/L	--	ND (200)	ND (200)	ND (200)	<200
HEPHw (EPHw C19-C32 less PAH)	µg/L	--	ND (200)	ND (200)	ND (200)	<200
PAHs						
1-Methylnaphthalene	µg/L	5.5	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
2-Methylnaphthalene	µg/L	15	ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Acenaphthene	µg/L	250	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Acenaphthylene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Acridine	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Anthracene	µg/L	1000	ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Benzo(a)anthracene	µg/L	0.07	ND (0.010)	ND (0.010)	ND (0.010)	<0.010
Benzo(a)pyrene	µg/L	0.01	ND (0.0050)	ND (0.0050)	ND (0.0050)	<0.0050
Benzo(b+j)fluoranthenes	µg/L	0.07	ND (0.030)	ND (0.030)	ND (0.030)	<0.030
Benzo(b)pyridine (Quinoline)	µg/L	0.05	ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Benzo(g,h,i)perylene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Benzo(k)fluoranthene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Chrysene	µg/L	7	ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Dibenz(a,h)anthracene	µg/L	0.01	ND (0.0030)	ND (0.0030)	ND (0.0030)	<0.0030
Fluoranthene	µg/L	150	ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Fluorene	µg/L	150	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Indeno(1,2,3-cd)pyrene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Naphthalene	µg/L	80	ND (0.10)	ND (0.10)	ND (0.10)	<0.10
PAH high molecular weight	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
PAH low molecular weight	µg/L	--	ND (0.10)	ND (0.10)	ND (0.10)	<0.10
Phenanthrene	µg/L	--	ND (0.050)	ND (0.050)	ND (0.050)	<0.050
Pyrene	µg/L	100	ND (0.020)	ND (0.020)	ND (0.020)	<0.020
Total PAH	µg/L	--	ND (0.10)	ND (0.10)	ND (0.10)	<0.10

Table 4

Analytical Results Summary
Surface Water Sampling
2024 Operations and Monitoring Report
New Landfill
Campbell River, British Columbia

		Sample Location:	SW16-03[5]	SW15-01		SW15-02	
		Sample ID:	W-11222680-100424-KH-01	SW15-01	SW15-01	SW15-02	SW15-02
		Sample Date:	4/10/2024	12/20/2024	01/27/2025	12/20/2024	01/27/2025
Parameters	**Units**	**BC CSR[1] DW**					
Field Parameters							
Conductivity, field	µS/cm	--	63	-	32.2	-	34.8
Dissolved oxygen (DO), field	mg/L	--	7.92	-	10.89	-	10.19
Oxidation reduction potential (ORP), field	millivolts	--	152	-	119	-	86.7
pH, field	s.u.	--	7.74	-	6.52	-	6.27
Temperature, field	Deg C	--	10.14	-	5.0	-	2.1
Total dissolved solids, field (TDS)	mg/L	--	41	-	20.6	-	22.3
Turbidity, field	NTU	--	618	-	-0.96	-	-0.09
General Chemistry							
Alkalinity (as CaCO3 pH=8.3)	mg/L	--	ND (1.0)	<1.0	-	<1.0	-
Alkalinity, total (as CaCO3)	mg/L	--	16	10	-	18	-
Chloride (dissolved)	mg/L	250	5.1	2.2	-	4.6	-
Conductivity	µS/cm	--	79	37	-	63	-
Hardness	mg/L	--	-	11.3	-	17.5	-
Hardness (dissolved)	mg/L	--	27.4	-	21.8	-	18.7
Hydroxide (as CaCO3)	mg/L	--	ND (1.0)	<1.0	-	<1.0	-
Orthophosphate	mg/L	--	0.0039	<0.0030	-	<0.0030	-
pH	s.u.	--	6.68	6.16	-	6.22	-
Sulfate (dissolved)	mg/L	500	7.6	<1.0	-	1.1	-
Total Un-ionized Hydrogen Sulfide as S	mg/L	--	-	-	<0.0050	-	<0.0050
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	0.05	-	-	<0.0050	-	<0.0050
Total Sulfide as H2S	mg/L	--	ND (0.0040)	<0.0020	-	<0.0020	-
Total Sulfide as S	mg/L	--	ND (0.0036)	<0.0018	-	<0.0018	-
Total dissolved solids (TDS)	mg/L	--	40	-	-	-	-
Total suspended solids (TSS)	mg/L	--	-	<1.0	-	<1.0	-
Nutrients							
Ammonia-N	mg/L	--	ND (0.015)	<0.015	-	0.081	-
Bicarbonate (as CaCO3)	mg/L	--	20	13	-	22	-
Carbonate (as CaCO3)	mg/L	--	ND (1.0)	<1.0	-	<1.0	-
Nitrate (as N)	mg/L	10	0.263	<0.020	-	0.375	-
Nitrite (as N)	mg/L	1	ND (0.0050)	<0.0050	-	<0.0050	-
Nitrate and Nitrite (as N)	mg/L	10	0.263	<0.020	-	0.375	-
Total Metals							
Aluminum	µg/L	9500	9.0	41.1	-	38.5	-
Antimony	µg/L	6	ND (0.50)	<0.50	-	<0.50	-
Arsenic	µg/L	10	0.11	<0.10	-	<0.10	-
Barium	µg/L	1000	ND (1.0)	2.2	-	2.2	-
Beryllium	µg/L	8	ND (0.10)	<0.10	-	<0.10	-
Bismuth	µg/L	--	ND (1.0)	<1.0	-	<1.0	-
Boron	µg/L	5000	ND (50)	<50	-	<50	-
Cadmium	µg/L	5	ND (0.010)	<0.010	-	<0.010	-
Calcium	µg/L	--	8210	3330	-	5070	-
Chromium	µg/L	50	ND (1.0)	<1.0	-	<1.0	-
Cobalt	µg/L	20	ND (0.20)	<0.20	-	<0.20	-
Copper	µg/L	1500	0.49	0.56	-	0.79	-
Iron	µg/L	6500[6]	6.0	21	-	182	-
Lead	µg/L	10	ND (0.20)	<0.20	-	<0.20	-
Lithium	µg/L	8	ND (2.0)	<2.0	-	<2.0	-
Magnesium	µg/L	--	1670	736	-	1170	-
Manganese	µg/L	1500[6]	2.8	2.5	-	8.8	-
Mercury	µg/L	1	ND (0.0019)	-	-	-	-
Molybdenum	µg/L	250	ND (1.0)	<1.0	-	<1.0	-
Nickel	µg/L	80	ND (1.0)	<1.0	-	<1.0	-
Phosphorus	µg/L	--	ND (10)	-	-	-	-
Potassium	µg/L	--	163	90	-	130	-
Selenium	µg/L	10	ND (0.10)	<0.10	-	<0.10	-
Silicon	µg/L	--	2670	2450	-	1230	-
Silver	µg/L	20	ND (0.020)	<0.020	-	<0.020	-
Sodium	µg/L	200000	3110	1740	-	3460	-
Strontium	µg/L	2500	17.7	8.1	-	15.5	-
Sulphur	µg/L	--	ND (3000)	<3000	-	<3000	-
Thallium	µg/L	--	ND (0.010)	<0.010	-	<0.010	-
Tin	µg/L	2500	ND (5.0)	<5.0	-	<5.0	-
Titanium	µg/L	--	ND (5.0)	<5.0	-	<5.0	-
Uranium	µg/L	20	ND (0.10)	<0.10	-	<0.10	-
Vanadium	µg/L	20	ND (5.0)	<5.0	-	<5.0	-
Zinc	µg/L	3000	ND (5.0)	<5.0	-	<5.0	-
Zirconium	µg/L	--	ND (0.10)	<0.10	-	<0.10	-

Table 5

Analytical Tables Notes
2024 Operations and Monitoring Report
New Landfill
Campbell River, British Columbia

1	- British Columbia Contaminated Sites Regulation Generic Numerical Water Standards, Drinking Water (DW)
2	- BC CSR DW standard for 3-methylphenol is 200 µg/L, BC CSR DW standard for 4-methylphenol is 400 µg/L
3	- BC CSR DW standard 2,4-dichlorophenol is 900 µg/L, currently no BC CSR DW standard for 2,5-dichlorophenol
4	- Field turbidity could not be measured to to equipment malfunction
5	- Metals concentrations listed for this sample are dissolved metals
6	- Iron and manganese standards not applicable at the Site based on absence of applicable CSR Schedule 2 activities.
ND (50), <50	- Substance not detected at the associated laboratory detection limit
ND (50), <50	- Laboratory detection limit exceeds applied reference criteria
2890	- Reported concentration exceeds applied reference criteria
103	- RPD exceeds DQO
--	- Currently no standard listed in BC CSR
-	- Not analyzed
RPD	- Relative Percent Difference
DQO	- Data Quality Objective
µS/cm	- Microsiemens per centimetre
mg/L	- Milligrams per litre
µg/L	- Micrograms per litre
s.u.	- Standard units
Deg C	- Degrees Celcius
NTU	- Nephelometric turbidity units
ppm	- parts per million
%v/v	- Percent volume.

ATTACHMENT C

Laboratory Certificates of Analysis

Attention: Paul Dawson

Envirochem Services Inc.
#206 - 267 Esplanade West
North Vancouver, BC
Canada V7M 1A5

Your C.O.C. #: C#744122-01-01, C#744122-01-02, C#744122-02-01

Report Date: 2025/01/15
Report #: R3611590
Version: 5 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C4A4063
Received: 2024/12/20, 16:40

Sample Matrix: Water
Samples Received: 16

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity @25C (pp, total), CO3,HCO3,OH	2	N/A	2025/01/06	BBY6SOP-00026	SM 24 2320 B m
Alkalinity @25C (pp, total), CO3,HCO3,OH	14	N/A	2024/12/30	BBY6SOP-00026	SM 24 2320 B m
Biochemical Oxygen Demand	1	2024/12/28	2025/01/02	BBY6SOP-00045	SM 24 5210 B m
BTEX/MTBE LH, VH, F1 SIM/MS	1	N/A	2024/12/30	BBY8SOP-00010 / BBY8SOP-00011 / BBY8SOP-00012	BCMOE BCLM Jul 2017
Chloride/Sulphate by Auto Colourimetry	2	N/A	2025/01/03	BBY6SOP-00011 / BBY6SOP-00017	SM24-4500-Cl/SO4-E m
Chloride/Sulphate by Auto Colourimetry	14	N/A	2024/12/30	BBY6SOP-00011 / BBY6SOP-00017	SM24-4500-Cl/SO4-E m
COD by Colorimeter	1	N/A	2024/12/30	BBY6SOP-00024	SM 24 5220 D m
Total Phenols Calculation (1)	1	N/A	2025/01/04		Auto Calc
Total Cresols Calculation (1)	1	N/A	2025/01/04		Auto Calc
Conductivity @25C	2	N/A	2025/01/06	BBY6SOP-00026	SM 24 2510 B m
Conductivity @25C	14	N/A	2024/12/30	BBY6SOP-00026	SM 24 2510 B m
Sulphide (as H2S) (1)	2	N/A	2025/01/04		Auto Calc
Sulphide (as H2S) (1)	14	N/A	2024/12/31		Auto Calc
Un-ionized Hydrogen Sulphide as S Calc	2	N/A	2025/01/15	BBY WI-00033	Auto Calc
Un-ionized Hydrogen Sulphide as S Calc	11	N/A	2025/01/02	BBY WI-00033	Auto Calc
Hardness Total (calculated as CaCO3) (2)	2	N/A	2025/01/06	BBY WI-00033	Auto Calc
Hardness Total (calculated as CaCO3) (2)	1	N/A	2024/12/30	BBY WI-00033	Auto Calc
Hardness Total (calculated as CaCO3) (2)	13	N/A	2024/12/31	BBY WI-00033	Auto Calc
Hardness (calculated as CaCO3)	2	N/A	2025/01/06	BBY WI-00033	Auto Calc
Hardness (calculated as CaCO3)	11	N/A	2024/12/31	BBY WI-00033	Auto Calc
Hydroxyphenols (Water) (1)	1	2025/01/03	2025/01/06	CAL SOP-00275	EPA 8270e m
EPH in Water when PAH required	2	2025/01/03	2025/01/03	BBY8SOP-00029	BCMOE BCLM Sep2017 m
EPH in Water when PAH required	12	2024/12/30	2024/12/30	BBY8SOP-00029	BCMOE BCLM Sep2017 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	2	N/A	2025/01/06	BBY WI-00033	Auto Calc
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	11	N/A	2024/12/31	BBY WI-00033	Auto Calc
Elements by CRC ICPMS (dissolved) (3)	2	N/A	2025/01/03	BBY7SOP-00002	EPA 6020b R2 m

Attention: Paul Dawson

Envirochem Services Inc.
#206 - 267 Esplanade West
North Vancouver, BC
Canada V7M 1A5

Your C.O.C. #: C#744122-01-01, C#744122-01-02, C#744122-02-01

Report Date: 2025/01/15
Report #: R3611590
Version: 5 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C4A4063
Received: 2024/12/20, 16:40

Sample Matrix: Water
Samples Received: 16

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Elements by CRC ICPMS (dissolved) (3)	10	N/A	2024/12/30	BBY7SOP-00002	EPA 6020b R2 m
Elements by CRC ICPMS (dissolved) (3)	1	N/A	2024/12/31	BBY7SOP-00002	EPA 6020b R2 m
Na, K, Ca, Mg, S by CRC ICPMS (total)	3	2024/12/27	2024/12/31	BBY WI-00033	Auto Calc
Elements by CRC ICPMS (total)	3	2024/12/30	2024/12/30	BBY7SOP-00003 / BBY7SOP-00002	EPA 6020b R2 m
Ammonia-N (Total)	1	N/A	2025/01/06	AB SOP-00007	SM 24 4500 NH3 A G m
Ammonia-N (Total)	14	N/A	2024/12/30	AB SOP-00007	SM 24 4500 NH3 A G m
Nitrate + Nitrite (N)	2	N/A	2025/01/03	BBY6SOP-00010	SM 24 4500-NO3- H m
Nitrate + Nitrite (N)	14	N/A	2024/12/28	BBY6SOP-00010	SM 24 4500-NO3- H m
Nitrite (N) Regular Level Water	2	N/A	2025/01/03	BBY6SOP-00010	SM 24 4500-NO2- m
Nitrite (N) Regular Level Water	14	N/A	2024/12/28	BBY6SOP-00010	SM 24 4500-NO2- m
Nitrogen - Nitrate (as N)	2	N/A	2025/01/03	BBY WI-00033	Auto Calc
Nitrogen - Nitrate (as N)	14	N/A	2024/12/28	BBY WI-00033	Auto Calc
PAH in Water by GC/MS (SIM)	2	2025/01/03	2025/01/03	BBY8SOP-00021	BCMOE BCLM Jul2017m
PAH in Water by GC/MS (SIM)	12	2024/12/30	2024/12/30	BBY8SOP-00021	BCMOE BCLM Jul2017m
Total LMW, HMW, Total PAH Calc (4)	2	N/A	2025/01/06	BBY WI-00033	Auto Calc
Total LMW, HMW, Total PAH Calc (4)	12	N/A	2024/12/31	BBY WI-00033	Auto Calc
pH @25°C (5)	2	N/A	2025/01/06	BBY6SOP-00026	SM 24 4500-H+ B m
pH @25°C (5)	14	N/A	2024/12/30	BBY6SOP-00026	SM 24 4500-H+ B m
Orthophosphate by Automated Analyzer (6)	2	N/A	2025/01/03	BBY6SOP-00013	SM 24 4500-P E m
Orthophosphate by Automated Analyzer (6)	14	N/A	2024/12/28	BBY6SOP-00013	SM 24 4500-P E m
Total Sulphide (1)	2	2025/01/04	2025/01/04	AB SOP-00080	SM 24 4500 S2-A D Fm
Total Sulphide (1)	14	2024/12/31	2024/12/31	AB SOP-00080	SM 24 4500 S2-A D Fm
Phenols in Water by GCMS (BC) (1)	1	2025/01/02	2025/01/04	CAL SOP-00164	EPA 8270E m
Total Dissolved Solids (Filt. Residue)	12	2024/12/27	2024/12/30	BBY6SOP-00033	SM 24 2540 C m
EPH less PAH in Water by GC/FID (7)	2	N/A	2025/01/06	BBY WI-00033	Auto Calc
EPH less PAH in Water by GC/FID (7)	12	N/A	2024/12/31	BBY WI-00033	Auto Calc
Total Suspended Solids (NFR)	3	2024/12/27	2024/12/30	BBY6SOP-00034	SM 24 2540 D m
Field pH	2	N/A	2025/01/14		

Attention: Paul Dawson

Envirochem Services Inc.
#206 - 267 Esplanade West
North Vancouver, BC
Canada V7M 1A5

Your C.O.C. #: C#744122-01-01, C#744122-01-02, C#744122-02-01

Report Date: 2025/01/15
Report #: R3611590
Version: 5 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C4A4063
Received: 2024/12/20, 16:40

Sample Matrix: Water
Samples Received: 16

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Field pH	11	N/A	2025/01/02		
Field Temperature	2	N/A	2025/01/14		
Field Temperature	11	N/A	2025/01/02		
Volatile HC-BTEX (8)	1	N/A	2024/12/31	BBY WI-00033	Auto Calc

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, EPA, APHA or the Quebec Ministry of Environment.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by Bureau Veritas Calgary, 4000 - 19 St. , Calgary, AB, T2E 6P8
(2) "Total Hardness" was calculated from Total Ca and Mg concentrations and may be biased high (Hardness, or Dissolved Hardness, calculated from Dissolved Ca and Mg, should be used for compliance if available).
(3) Dissolved > Total Imbalance: When applicable, Dissolved and Total results were reviewed and data quality meets acceptable levels unless otherwise noted.
(4) Total PAHs in Water include: Quinoline, Naphthalene, 1-Methylnaphthalene, 2-Methylnaphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Acridine, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b&j)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene,

Attention: Paul Dawson

Envirochem Services Inc.
#206 - 267 Esplanade West
North Vancouver, BC
Canada V7M 1A5

Your C.O.C. #: C#744122-01-01, C#744122-01-02, C#744122-02-01

Report Date: 2025/01/15
Report #: R3611590
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CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C4A4063
Received: 2024/12/20, 16:40

and Benzo(g,h,i)perylene.
(5) The CCME method requires pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the CCME holding time. Bureau Veritas endeavours to analyze samples as soon as possible after receipt.
(6) Orthophosphate > Total Phosphorus Imbalance: When applicable, Orthophosphate, Total Phosphorus and dissolved Phosphorus results were reviewed and data quality meets acceptable levels unless otherwise noted.
(7) LEPH = EPH (C10 to C19) - (Acenaphthene + Acridine + Anthracene + Fluorene + Naphthalene + Phenanthrene)
HEPH = EPH (C19 to C32) - (Benzo(a)anthracene + Benzo(a)pyrene + Fluoranthene + Pyrene)
(8) VPH = VH - (Benzene + Toluene + Ethylbenzene + m & p-Xylene + o-Xylene + Styrene)

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:
Augustina Isesele, Customer Solutions Representative
Email: Augustina.isesele@bureauveritas.com
Phone# (604) 734 7276

==========

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation, please refer to the Validation Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Raphael Kwan, General Manager, BC and Yukon Regions responsible for British Columbia Environmental laboratory operations.

RESULTS OF CHEMICAL ANALYSES OF WATER

Bureau Veritas ID		DCN548		DCN549			DCN550		
Sampling Date		2024/12/19 04:15		2024/12/19 12:20			2024/12/19 11:45		
COC Number		C#744122-01-01		C#744122-01-01			C#744122-01-01		
	UNITS	MW1-14	RDL	MW2-14	RDL	QC Batch	MW2A-16 DUP	RDL	QC Batch
ANIONS									
Nitrite (N)	mg/L	<0.0050	0.0050	<0.0050	0.0050	B649329	<0.0050	0.0050	B652200
Calculated Parameters									
Nitrate (N)	mg/L	3.25	0.10	0.233	0.020	B648883	0.052	0.020	B651785
Sulphide (as H2S)	mg/L	<0.0020	0.0020	<0.0020	0.0020	B648677	<0.0020	0.0020	B651724
Field Parameters									
Field pH	pH	6.92	N/A	7.28	N/A	ONSITE	8.38	N/A	ONSITE
Field Temperature	°C	13.4	N/A	10.9	N/A	ONSITE	10.9	N/A	ONSITE
Misc. Inorganics									
Conductivity	uS/cm	190	2.0	120	2.0	B650039	92	2.0	B652958
pH	pH	6.48	N/A	6.53	N/A	B650036	6.68	N/A	B652957
Total Dissolved Solids	mg/L	140	10	86	10	B649241			
Anions									
Alkalinity (PP as CaCO3)	mg/L	<1.0	1.0	<1.0	1.0	B650037	<1.0	1.0	B652954
Alkalinity (Total as CaCO3)	mg/L	50	1.0	44	1.0	B650037	43	1.0	B652954
Bicarbonate (HCO3)	mg/L	61	1.0	53	1.0	B650037	53	1.0	B652954
Carbonate (CO3)	mg/L	<1.0	1.0	<1.0	1.0	B650037	<1.0	1.0	B652954
Hydroxide (OH)	mg/L	<1.0	1.0	<1.0	1.0	B650037	<1.0	1.0	B652954
Total Sulphide	mg/L	<0.0018	0.0018	<0.0018 (1)	0.0018	B650481	<0.0018 (2)	0.0018	B652508
Chloride (Cl)	mg/L	16	1.0	3.1	1.0	B649843	3.9	1.0	B652283
Sulphate (SO4)	mg/L	3.5	1.0	6.4	1.0	B649843	2.7	1.0	B652283
Nutrients									
Total Ammonia (N)	mg/L	<0.015	0.015	<0.015	0.015	B650147			
Orthophosphate (P)	mg/L	<0.0030 (1)	0.0030	<0.0030	0.0030	B649326	0.028	0.0030	B652271
Nitrate plus Nitrite (N)	mg/L	3.25 (3)	0.10	0.233	0.020	B649328	0.052	0.020	B652197

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Matrix spike exceeds acceptance limits due to matrix interference.
(2) Sample pH <9, preservation incomplete. Due to volatility of analyte, a low bias in the results is likely.
(3) Detection limit raised due to interferent.

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

RESULTS OF CHEMICAL ANALYSES OF WATER

Bureau Veritas ID		DCN551	DCN552		DCN553	DCN554		
Sampling Date		2024/12/19 11:45	2024/12/20 02:30		2024/12/19 01:30	2024/12/19 02:35		
COC Number		C#744122-01-02	C#744122-01-01		C#744122-01-01	C#744122-01-01		
	UNITS	MW2A-16	MW3-14	RDL	MW4A-15	MW4B-15	RDL	QC Batch
ANIONS								
Nitrite (N)	mg/L	<0.0050	<0.0050	0.0050	<0.0050	0.0082	0.0050	B649329
Calculated Parameters								
Nitrate (N)	mg/L	<0.020	0.394	0.020	3.84	3.95	0.10	B648883
Sulphide (as H2S)	mg/L	<0.0020	<0.0020	0.0020	<0.0020	<0.0020	0.0020	B648677
Field Parameters								
Field pH	pH	8.38	7.23	N/A	6.96	7.01	N/A	ONSITE
Field Temperature	°C	10.9	10.1	N/A	9.2	9.2	N/A	ONSITE
Misc. Inorganics								
Conductivity	uS/cm	92	100	2.0	300	300	2.0	B650039
pH	pH	6.63	6.41	N/A	6.62	6.64	N/A	B650036
Total Dissolved Solids	mg/L	66	86	10	190	200	10	B649241
Anions								
Alkalinity (PP as CaCO3)	mg/L	<1.0	<1.0	1.0	<1.0	<1.0	1.0	B650037
Alkalinity (Total as CaCO3)	mg/L	41	42	1.0	84	83	1.0	B650037
Bicarbonate (HCO3)	mg/L	50	51	1.0	100	100	1.0	B650037
Carbonate (CO3)	mg/L	<1.0	<1.0	1.0	<1.0	<1.0	1.0	B650037
Hydroxide (OH)	mg/L	<1.0	<1.0	1.0	<1.0	<1.0	1.0	B650037
Total Sulphide	mg/L	<0.0018	<0.0018	0.0018	<0.0018	<0.0018	0.0018	B650481
Chloride (Cl)	mg/L	<1.0	<1.0	1.0	19	19	1.0	B649843
Sulphate (SO4)	mg/L	2.5	3.9	1.0	15	16	1.0	B649843
Nutrients								
Total Ammonia (N)	mg/L	<0.015	<0.015	0.015	<0.015	0.020	0.015	B650231
Orthophosphate (P)	mg/L	0.027	0.0049	0.0030	0.0082	0.0073	0.0030	B649326
Nitrate plus Nitrite (N)	mg/L	<0.020	0.394	0.020	3.84 (1)	3.96 (1)	0.10	B649328

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Detection limit raised due to interferent.

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

RESULTS OF CHEMICAL ANALYSES OF WATER

Bureau Veritas ID		DCN555			DCN556			DCN557		
Sampling Date		2024/12/20 12:45			2024/12/20 11:10			2024/12/20 11:10		
COC Number		C#744122-01-01			C#744122-01-01			C#744122-01-02		
	UNITS	MW6-17	RDL	QC Batch	MW9-17 DUP	RDL	QC Batch	MW9-17	RDL	QC Batch
ANIONS										
Nitrite (N)	mg/L	<0.0050	0.0050	B649329	<0.0050	0.0050	B652200	<0.0050 (1)	0.0050	B649329
Calculated Parameters										
Nitrate (N)	mg/L	0.415	0.020	B648883	0.023	0.020	B651785	<0.020	0.020	B648883
Sulphide (as H2S)	mg/L	0.019	0.0020	B648677	<0.0020	0.0020	B651724	<0.0020	0.0020	B648677
Field Parameters										
Field pH	pH	7.33	N/A	ONSITE	7.38	N/A	ONSITE	7.38	N/A	ONSITE
Field Temperature	°C	9.8	N/A	ONSITE	17.4	N/A	ONSITE	17.4	N/A	ONSITE
Misc. Inorganics										
Conductivity	uS/cm	490	2.0	B650039	61	2.0	B652958	61	2.0	B650039
pH	pH	6.87	N/A	B650036	6.45	N/A	B652957	6.37	N/A	B650036
Total Dissolved Solids	mg/L	310	10	B649241				54	10	B649241
Anions										
Alkalinity (PP as CaCO3)	mg/L	<1.0	1.0	B650037	<1.0	1.0	B652954	<1.0	1.0	B650037
Alkalinity (Total as CaCO3)	mg/L	110	1.0	B650037	27	1.0	B652954	26	1.0	B650037
Bicarbonate (HCO3)	mg/L	130	1.0	B650037	33	1.0	B652954	31	1.0	B650037
Carbonate (CO3)	mg/L	<1.0	1.0	B650037	<1.0	1.0	B652954	<1.0	1.0	B650037
Hydroxide (OH)	mg/L	<1.0	1.0	B650037	<1.0	1.0	B652954	<1.0	1.0	B650037
Total Sulphide	mg/L	0.018	0.0018	B650481	<0.0018	0.0018	B652508	<0.0018	0.0018	B650481
Chloride (Cl)	mg/L	77	1.0	B649843	<1.0	1.0	B652283	<1.0	1.0	B649843
Sulphate (SO4)	mg/L	4.7	1.0	B649843	2.6	1.0	B652283	2.6	1.0	B649843
Nutrients										
Total Ammonia (N)	mg/L	<0.015	0.015	B650231	<0.015	0.015	B653426	<0.015	0.015	B650231
Orthophosphate (P)	mg/L	0.0039	0.0030	B649326	0.0042	0.0030	B652271	0.0036	0.0030	B649326
Nitrate plus Nitrite (N)	mg/L	0.415	0.020	B649328	0.023	0.020	B652197	<0.020 (1)	0.020	B649328

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Matrix spike exceeds acceptance limits due to probable matrix interference.

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

RESULTS OF CHEMICAL ANALYSES OF WATER

Bureau Veritas ID		DCN558		DCN559	DCN560		
Sampling Date		2024/12/18 12:40		2024/12/18 02:20	2024/12/18 04:20		
COC Number		C#744122-01-01		C#744122-01-01	C#744122-02-01		
	UNITS	**MW10-17**	**QC Batch**	**MW11-19**	**MW12-22**	**RDL**	**QC Batch**
ANIONS							
Nitrite (N)	mg/L	<0.0050	B649329	<0.0050	<0.0050	0.0050	B649329
Calculated Parameters							
Nitrate (N)	mg/L	1.01	B648883	1.57	1.82	0.020	B648883
Sulphide (as H2S)	mg/L	<0.0020	B648677	0.019	<0.0020	0.0020	B648677
Field Parameters							
Field pH	pH	7.47	ONSITE	6.55	7.06	N/A	ONSITE
Field Temperature	°C	10.6	ONSITE	11.8	9.8	N/A	ONSITE
Misc. Inorganics							
Conductivity	uS/cm	240	B650039	400	220	2.0	B650039
pH	pH	7.48	B650036	7.08	7.10	N/A	B650036
Total Dissolved Solids	mg/L	180	B649241	280	170	10	B649241
Anions							
Alkalinity (PP as CaCO3)	mg/L	<1.0	B650037	<1.0	<1.0	1.0	B650037
Alkalinity (Total as CaCO3)	mg/L	90	B650037	160	67	1.0	B650037
Bicarbonate (HCO3)	mg/L	110	B650037	200	82	1.0	B650037
Carbonate (CO3)	mg/L	<1.0	B650037	<1.0	<1.0	1.0	B650037
Hydroxide (OH)	mg/L	<1.0	B650037	<1.0	<1.0	1.0	B650037
Total Sulphide	mg/L	<0.0018	B650481	0.018	0.0018	0.0018	B650481
Chloride (Cl)	mg/L	7.6	B649843	8.6	6.2	1.0	B649845
Sulphate (SO4)	mg/L	13	B649843	17	22	1.0	B649845
Nutrients							
Total Ammonia (N)	mg/L	<0.015	B650231	<0.015	<0.015	0.015	B650231
Orthophosphate (P)	mg/L	0.0087	B649326	0.0090	<0.0030	0.0030	B649326
Nitrate plus Nitrite (N)	mg/L	1.01	B649328	1.57	1.82	0.020	B649328

RDL = Reportable Detection Limit
N/A = Not Applicable

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

RESULTS OF CHEMICAL ANALYSES OF WATER

Bureau Veritas ID		DCN561	DCN562			DCN563		
Sampling Date		2024/12/20 03:45	2024/12/20 04:10			2024/12/20 03:15		
COC Number		C#744122-02-01	C#744122-02-01			C#744122-02-01		
	UNITS	SW15-01	SW15-02	RDL	QC Batch	S06-21	RDL	QC Batch
ANIONS								
Nitrite (N)	mg/L	<0.0050	<0.0050	0.0050	B649329	<0.0050	0.0050	B649329
Calculated Parameters								
Nitrate (N)	mg/L	<0.020	0.375	0.020	B648883	<0.020	0.020	B648883
Sulphide (as H2S)	mg/L	<0.0020	<0.0020	0.0020	B648677	14	0.19	B648677
Demand Parameters								
Biochemical Oxygen Demand	mg/L					31	3.0	B648685
Chemical Oxygen Demand	mg/L					284	10	B650116
Misc. Inorganics								
Conductivity	uS/cm	37	63	2.0	B650039	2300	2.0	B650039
pH	pH	6.16	6.22	N/A	B650036	7.47	N/A	B650036
Total Dissolved Solids	mg/L					1400	10	B649241
Total Suspended Solids	mg/L	<1.0	<1.0	1.0	B649209	11	1.0	B649253
Anions								
Alkalinity (PP as CaCO3)	mg/L	<1.0	<1.0	1.0	B650037	<1.0	1.0	B650037
Alkalinity (Total as CaCO3)	mg/L	10	18	1.0	B650037	820	1.0	B650037
Bicarbonate (HCO3)	mg/L	13	22	1.0	B650037	1000	1.0	B650037
Carbonate (CO3)	mg/L	<1.0	<1.0	1.0	B650037	<1.0	1.0	B650037
Hydroxide (OH)	mg/L	<1.0	<1.0	1.0	B650037	<1.0	1.0	B650037
Total Sulphide	mg/L	<0.0018	<0.0018	0.0018	B650481	13 (1)	0.18	B650481
Chloride (Cl)	mg/L	2.2	4.6	1.0	B649845	120	5.0	B649845
Sulphate (SO4)	mg/L	<1.0	1.1	1.0	B649845	220	5.0	B649845
Nutrients								
Total Ammonia (N)	mg/L	<0.015	0.081	0.015	B650231	40	0.38	B650231
Orthophosphate (P)	mg/L	<0.0030	<0.0030	0.0030	B649326	0.017	0.0030	B649326
Nitrate plus Nitrite (N)	mg/L	<0.020	0.375	0.020	B649328	<0.020	0.020	B649328

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Sample pH <9, preservation incomplete. Due to volatility of analyte, a low bias in the results is likely.

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

SEMIVOLATILE ORGANICS BY GC-MS (WATER)

Bureau Veritas ID		DCN563		
Sampling Date		2024/12/20 03:15		
COC Number		C#744122-02-01		
	UNITS	S06-21	RDL	QC Batch
Phenols				
2-Hydroxyphenol (Catechol)	ug/L	<20	20	B652007
3-Hydroxyphenol (Resorcinol)	ug/L	<10	10	B652007
4-Hydroxyphenol (Hydroquinone)	ug/L	2.4 (1)	1.0	B652007
Cresols	mg/L	0.045	0.00071	B649068
Total Dichlorophenols	ug/L	0.61	0.22	B649054
Total Chlorophenols	ug/L	1.3	0.41	B649054
Total Monochlorophenols	ug/L	<0.090	0.090	B649054
Total Nonchlorinated Phenols	ug/L	54	1.6	B649054
Total Tetrachlorophenols	ug/L	<0.17	0.17	B649054
Total Trichlorophenols	ug/L	<0.24	0.24	B649054
SEMI-VOLATILE ORGANICS				
Phenol	ug/L	6.0	0.50	B650852
2-chlorophenol	ug/L	<0.050	0.050	B650852
3 & 4-chlorophenol	ug/L	<0.075	0.075	B650852
2-methylphenol	ug/L	0.97	0.50	B650852
3 & 4-methylphenol	ug/L	44	0.50	B650852
2-nitrophenol	ug/L	<0.50	0.50	B650852
2,4-dimethylphenol	ug/L	0.91	0.50	B650852
2,4 + 2,5-Dichlorophenol	ug/L	0.61	0.10	B650852
2,3-Dichlorophenol	ug/L	<0.10	0.10	B650852
2,6-dichlorophenol	ug/L	<0.10	0.10	B650852
3,5-Dichlorophenol	ug/L	<0.10	0.10	B650852
3,4-Dichlorophenol	ug/L	<0.10	0.10	B650852
2,4,5-trichlorophenol	ug/L	<0.10	0.10	B650852
2,4,6-trichlorophenol	ug/L	0.22	0.10	B650852
2,3,5-trichlorophenol	ug/L	<0.10	0.10	B650852
2,3,6-Trichlorophenol	ug/L	<0.10	0.10	B650852
2,3,4-trichlorophenol	ug/L	<0.10	0.10	B650852
3,4,5-Trichlorophenol	ug/L	<0.10	0.10	B650852
2,4-dinitrophenol	ug/L	<0.50	0.50	B650852
4,6-dinitro-2-methylphenol	ug/L	<0.50	0.50	B650852
2,3,4,6-tetrachlorophenol	ug/L	<0.10	0.10	B650852

RDL = Reportable Detection Limit

(1) Qualifying ion outside of acceptance criteria. Results are tentatively identified and potentially biased high.

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

SEMIVOLATILE ORGANICS BY GC-MS (WATER)

Bureau Veritas ID		DCN563		
Sampling Date		2024/12/20 03:15		
COC Number		C#744122-02-01		
	UNITS	S06-21	RDL	QC Batch
2,3,4,5-tetrachlorophenol	ug/L	<0.10	0.10	B650852
2,3,5,6-tetrachlorophenol	ug/L	0.15	0.10	B650852
4-nitrophenol	ug/L	<0.50	0.50	B650852
2,6-Dimethylphenol	ug/L	1.7	0.50	B650852
3,4-Dimethylphenol	ug/L	<0.50	0.50	B650852
4-chloro-3-methylphenol	ug/L	<0.10	0.10	B650852
Pentachlorophenol	ug/L	0.30	0.10	B650852
Surrogate Recovery (%)				
2,4,6-TRIBROMOPHENOL (sur.)	%	91		B652007
2,4-DIBROMOPHENOL (sur.)	%	93		B652007
2,4,6-TRIBROMOPHENOL (sur.)	%	123		B650852
2,4-DIBROMOPHENOL (sur.)	%	114		B650852
RDL = Reportable Detection Limit				

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

MISCELLANEOUS (WATER)

Bureau Veritas ID		DCN548	DCN549		DCN550		
Sampling Date		2024/12/19 04:15	2024/12/19 12:20		2024/12/19 11:45		
COC Number		C#744122-01-01	C#744122-01-01		C#744122-01-01		
	UNITS	MW1-14	MW2-14	QC Batch	MW2A-16 DUP	RDL	QC Batch
Calculated Parameters							
Total Un-ionized Hydrogen Sulfide as S	mg/L	<0.0050	<0.0050	B649076	<0.0050	0.0050	B659423
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	<0.0050	<0.0050	B649076	<0.0050	0.0050	B659423
RDL = Reportable Detection Limit							

Bureau Veritas ID		DCN551	DCN552	DCN553	DCN554		
Sampling Date		2024/12/19 11:45	2024/12/20 02:30	2024/12/19 01:30	2024/12/19 02:35		
COC Number		C#744122-01-02	C#744122-01-01	C#744122-01-01	C#744122-01-01		
	UNITS	MW2A-16	MW3-14	MW4A-15	MW4B-15	RDL	QC Batch
Calculated Parameters							
Total Un-ionized Hydrogen Sulfide as S	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	B649076
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	B649076
RDL = Reportable Detection Limit							

Bureau Veritas ID		DCN555		DCN556		DCN557		
Sampling Date		2024/12/20 12:45		2024/12/20 11:10		2024/12/20 11:10		
COC Number		C#744122-01-01		C#744122-01-01		C#744122-01-02		
	UNITS	MW6-17	QC Batch	MW9-17 DUP	QC Batch	MW9-17	RDL	QC Batch
Calculated Parameters								
Total Un-ionized Hydrogen Sulfide as S	mg/L	0.0073	B649076	<0.0050	B659423	<0.0050	0.0050	B649076
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	0.0078	B649076	<0.0050	B659423	<0.0050	0.0050	B649076
RDL = Reportable Detection Limit								

Bureau Veritas ID		DCN558	DCN559	DCN560		
Sampling Date		2024/12/18 12:40	2024/12/18 02:20	2024/12/18 04:20		
COC Number		C#744122-01-01	C#744122-01-01	C#744122-02-01		
	UNITS	MW10-17	MW11-19	MW12-22	RDL	QC Batch
Calculated Parameters						
Total Un-ionized Hydrogen Sulfide as S	mg/L	<0.0050	0.014	<0.0050	0.0050	B649076
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	<0.0050	0.015	<0.0050	0.0050	B649076
RDL = Reportable Detection Limit						

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

CSR BTEX/VPH IN WATER (WATER)

Bureau Veritas ID		DCN563		
Sampling Date		2024/12/20 03:15		
COC Number		C#744122-02-01		
	UNITS	S06-21	RDL	QC Batch
Calculated Parameters				
VPH (VH6 to 10 - BTEX)	ug/L	<300	300	B649082
Volatiles				
Methyl-tert-butylether (MTBE)	ug/L	<4.0	4.0	B649910
Benzene	ug/L	<0.40	0.40	B649910
Toluene	ug/L	3.8	0.40	B649910
Ethylbenzene	ug/L	2.0	0.40	B649910
m & p-Xylene	ug/L	4.6	0.40	B649910
o-Xylene	ug/L	2.4	0.40	B649910
Styrene	ug/L	<0.40	0.40	B649910
Xylenes (Total)	ug/L	7.1	0.40	B649910
VH C6-C10	ug/L	<300	300	B649910
Surrogate Recovery (%)				
1,4-Difluorobenzene (sur.)	%	99		B649910
4-Bromofluorobenzene (sur.)	%	101		B649910
D4-1,2-Dichloroethane (sur.)	%	90		B649910
RDL = Reportable Detection Limit				

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

LEPH & HEPH WITH CSR/CCME PAH IN WATER (WATER)

Bureau Veritas ID		DCN548	DCN549		DCN550		DCN551		
Sampling Date		2024/12/19 04:15	2024/12/19 12:20		2024/12/19 11:45		2024/12/19 11:45		
COC Number		C#744122-01-01	C#744122-01-01		C#744122-01-01		C#744122-01-02		
	UNITS	MW1-14	MW2-14	QC Batch	MW2A-16 DUP	QC Batch	MW2A-16	RDL	QC Batch
Calculated Parameters									
Low Molecular Weight PAH`s	ug/L	<0.10	<0.10	B648850	<0.10	B651788	<0.10	0.10	B648850
High Molecular Weight PAH`s	ug/L	<0.050	<0.050	B648850	<0.050	B651788	<0.050	0.050	B648850
Total PAH	ug/L	<0.10	<0.10	B648850	<0.10	B651788	<0.10	0.10	B648850
Polycyclic Aromatics									
Quinoline	ug/L	<0.020	<0.020	B649471	<0.020	B652071	<0.020	0.020	B649471
Naphthalene	ug/L	<0.10	<0.10	B649471	<0.10	B652071	<0.10	0.10	B649471
1-Methylnaphthalene	ug/L	<0.050	<0.050	B649471	<0.050	B652071	<0.050	0.050	B649471
2-Methylnaphthalene	ug/L	<0.10	<0.10	B649471	<0.10	B652071	<0.10	0.10	B649471
Acenaphthylene	ug/L	<0.050	<0.050	B649471	<0.050	B652071	<0.050	0.050	B649471
Acenaphthene	ug/L	<0.050	<0.050	B649471	<0.050	B652071	<0.050	0.050	B649471
Fluorene	ug/L	<0.050	<0.050	B649471	<0.050	B652071	<0.050	0.050	B649471
Phenanthrene	ug/L	<0.050	<0.050	B649471	<0.050	B652071	<0.050	0.050	B649471
Anthracene	ug/L	<0.010	<0.010	B649471	<0.010	B652071	<0.010	0.010	B649471
Acridine	ug/L	<0.050	<0.050	B649471	<0.050	B652071	<0.050	0.050	B649471
Fluoranthene	ug/L	<0.020	<0.020	B649471	<0.020	B652071	<0.020	0.020	B649471
Pyrene	ug/L	<0.020	<0.020	B649471	<0.020	B652071	<0.020	0.020	B649471
Benzo(a)anthracene	ug/L	<0.010	<0.010	B649471	<0.010	B652071	<0.010	0.010	B649471
Chrysene	ug/L	<0.020	<0.020	B649471	<0.020	B652071	<0.020	0.020	B649471
Benzo(b&j)fluoranthene	ug/L	<0.030	<0.030	B649471	<0.030	B652071	<0.030	0.030	B649471
Benzo(k)fluoranthene	ug/L	<0.050	<0.050	B649471	<0.050	B652071	<0.050	0.050	B649471
Benzo(a)pyrene	ug/L	<0.0050	<0.0050	B649471	<0.0050	B652071	<0.0050	0.0050	B649471
Indeno(1,2,3-cd)pyrene	ug/L	<0.050	<0.050	B649471	<0.050	B652071	<0.050	0.050	B649471
Dibenz(a,h)anthracene	ug/L	<0.0030	<0.0030	B649471	<0.0030	B652071	<0.0030	0.0030	B649471
Benzo(g,h,i)perylene	ug/L	<0.050	<0.050	B649471	<0.050	B652071	<0.050	0.050	B649471
Calculated Parameters									
LEPH (C10-C19 less PAH)	mg/L	<0.20	<0.20	B649080	<0.20	B651775	<0.20	0.20	B649080
HEPH (C19-C32 less PAH)	mg/L	<0.20	<0.20	B649080	<0.20	B651775	<0.20	0.20	B649080
Ext. Pet. Hydrocarbon									
EPH (C10-C19)	mg/L	<0.20	<0.20	B649473	<0.20	B652075	<0.20	0.20	B649473
EPH (C19-C32)	mg/L	<0.20	<0.20	B649473	<0.20	B652075	<0.20	0.20	B649473
Surrogate Recovery (%)									
O-TERPHENYL (sur.)	%	99	95	B649473	97	B652075	98		B649473
D10-ANTHRACENE (sur.)	%	93	92	B649471	95	B652071	89		B649471
D8-ACENAPHTHYLENE (sur.)	%	94	93	B649471	89	B652071	90		B649471

RDL = Reportable Detection Limit

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

LEPH & HEPH WITH CSR/CCME PAH IN WATER (WATER)

Bureau Veritas ID		DCN548	DCN549		DCN550		DCN551		
Sampling Date		2024/12/19 04:15	2024/12/19 12:20		2024/12/19 11:45		2024/12/19 11:45		
COC Number		C#744122-01-01	C#744122-01-01		C#744122-01-01		C#744122-01-02		
	UNITS	MW1-14	MW2-14	QC Batch	MW2A-16 DUP	QC Batch	MW2A-16	RDL	QC Batch
D8-NAPHTHALENE (sur.)	%	94	94	B649471	94	B652071	91		B649471
TERPHENYL-D14 (sur.)	%	92	92	B649471	69	B652071	89		B649471
RDL = Reportable Detection Limit									

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LEPH & HEPH WITH CSR/CCME PAH IN WATER (WATER)

Bureau Veritas ID		DCN552	DCN553	DCN554	DCN555		
Sampling Date		2024/12/20 02:30	2024/12/19 01:30	2024/12/19 02:35	2024/12/20 12:45		
COC Number		C#744122-01-01	C#744122-01-01	C#744122-01-01	C#744122-01-01		
	UNITS	MW3-14	MW4A-15	MW4B-15	MW6-17	RDL	QC Batch
Calculated Parameters							
Low Molecular Weight PAH`s	ug/L	<0.10	<0.10	<0.10	<0.10	0.10	B648850
High Molecular Weight PAH`s	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	B648850
Total PAH	ug/L	<0.10	<0.10	<0.10	<0.10	0.10	B648850
Polycyclic Aromatics							
Quinoline	ug/L	<0.020	<0.020	<0.020	<0.020	0.020	B649471
Naphthalene	ug/L	<0.10	<0.10	<0.10	<0.10	0.10	B649471
1-Methylnaphthalene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	B649471
2-Methylnaphthalene	ug/L	<0.10	<0.10	<0.10	<0.10	0.10	B649471
Acenaphthylene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	B649471
Acenaphthene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	B649471
Fluorene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	B649471
Phenanthrene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	B649471
Anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	B649471
Acridine	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	B649471
Fluoranthene	ug/L	<0.020	<0.020	<0.020	<0.020	0.020	B649471
Pyrene	ug/L	<0.020	<0.020	<0.020	<0.020	0.020	B649471
Benzo(a)anthracene	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	B649471
Chrysene	ug/L	<0.020	<0.020	<0.020	<0.020	0.020	B649471
Benzo(b&j)fluoranthene	ug/L	<0.030	<0.030	<0.030	<0.030	0.030	B649471
Benzo(k)fluoranthene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	B649471
Benzo(a)pyrene	ug/L	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	B649471
Indeno(1,2,3-cd)pyrene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	B649471
Dibenz(a,h)anthracene	ug/L	<0.0030	<0.0030	<0.0030	<0.0030	0.0030	B649471
Benzo(g,h,i)perylene	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	B649471
Calculated Parameters							
LEPH (C10-C19 less PAH)	mg/L	<0.20	<0.20	<0.20	<0.20	0.20	B649080
HEPH (C19-C32 less PAH)	mg/L	<0.20	<0.20	<0.20	0.29	0.20	B649080
Ext. Pet. Hydrocarbon							
EPH (C10-C19)	mg/L	<0.20	<0.20	<0.20	<0.20	0.20	B649473
EPH (C19-C32)	mg/L	<0.20	<0.20	<0.20	0.29	0.20	B649473
Surrogate Recovery (%)							
O-TERPHENYL (sur.)	%	96	94	95	90		B649473
D10-ANTHRACENE (sur.)	%	91	92	88	88		B649471
D8-ACENAPHTHYLENE (sur.)	%	91	91	88	90		B649471
RDL = Reportable Detection Limit							

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LEPH & HEPH WITH CSR/CCME PAH IN WATER (WATER)

Bureau Veritas ID		DCN552	DCN553	DCN554	DCN555		
Sampling Date		2024/12/20 02:30	2024/12/19 01:30	2024/12/19 02:35	2024/12/20 12:45		
COC Number		C#744122-01-01	C#744122-01-01	C#744122-01-01	C#744122-01-01		
	UNITS	MW3-14	MW4A-15	MW4B-15	MW6-17	RDL	QC Batch
D8-NAPHTHALENE (sur.)	%	92	93	88	92		B649471
TERPHENYL-D14 (sur.)	%	90	91	87	88		B649471
RDL = Reportable Detection Limit							

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LEPH & HEPH WITH CSR/CCME PAH IN WATER (WATER)

Bureau Veritas ID		DCN556		DCN557	DCN558	DCN559		
Sampling Date		2024/12/20 11:10		2024/12/20 11:10	2024/12/18 12:40	2024/12/18 02:20		
COC Number		C#744122-01-01		C#744122-01-02	C#744122-01-01	C#744122-01-01		
	UNITS	MW9-17 DUP	QC Batch	MW9-17	MW10-17	MW11-19	RDL	QC Batch
Calculated Parameters								
Low Molecular Weight PAH`s	ug/L	<0.10	B651788	<0.10	<0.10	<0.10	0.10	B648850
High Molecular Weight PAH`s	ug/L	<0.050	B651788	<0.050	<0.050	<0.050	0.050	B648850
Total PAH	ug/L	<0.10	B651788	<0.10	<0.10	<0.10	0.10	B648850
Polycyclic Aromatics								
Quinoline	ug/L	<0.020	B652071	<0.020	<0.020	<0.020	0.020	B649471
Naphthalene	ug/L	<0.10	B652071	<0.10	<0.10	<0.10	0.10	B649471
1-Methylnaphthalene	ug/L	<0.050	B652071	<0.050	<0.050	<0.050	0.050	B649471
2-Methylnaphthalene	ug/L	<0.10	B652071	<0.10	<0.10	<0.10	0.10	B649471
Acenaphthylene	ug/L	<0.050	B652071	<0.050	<0.050	<0.050	0.050	B649471
Acenaphthene	ug/L	<0.050	B652071	<0.050	<0.050	<0.050	0.050	B649471
Fluorene	ug/L	<0.050	B652071	<0.050	<0.050	<0.050	0.050	B649471
Phenanthrene	ug/L	<0.050	B652071	<0.050	<0.050	<0.050	0.050	B649471
Anthracene	ug/L	<0.010	B652071	<0.010	<0.010	<0.010	0.010	B649471
Acridine	ug/L	<0.050	B652071	<0.050	<0.050	<0.050	0.050	B649471
Fluoranthene	ug/L	<0.020	B652071	<0.020	<0.020	<0.020	0.020	B649471
Pyrene	ug/L	<0.020	B652071	<0.020	<0.020	<0.020	0.020	B649471
Benzo(a)anthracene	ug/L	<0.010	B652071	<0.010	<0.010	<0.010	0.010	B649471
Chrysene	ug/L	<0.020	B652071	<0.020	<0.020	<0.020	0.020	B649471
Benzo(b&j)fluoranthene	ug/L	<0.030	B652071	<0.030	<0.030	<0.030	0.030	B649471
Benzo(k)fluoranthene	ug/L	<0.050	B652071	<0.050	<0.050	<0.050	0.050	B649471
Benzo(a)pyrene	ug/L	<0.0050	B652071	<0.0050	<0.0050	<0.0050	0.0050	B649471
Indeno(1,2,3-cd)pyrene	ug/L	<0.050	B652071	<0.050	<0.050	<0.050	0.050	B649471
Dibenz(a,h)anthracene	ug/L	<0.0030	B652071	<0.0030	<0.0030	<0.0030	0.0030	B649471
Benzo(g,h,i)perylene	ug/L	<0.050	B652071	<0.050	<0.050	<0.050	0.050	B649471
Calculated Parameters								
LEPH (C10-C19 less PAH)	mg/L	<0.20	B651775	<0.20	<0.20	<0.20	0.20	B649080
HEPH (C19-C32 less PAH)	mg/L	<0.20	B651775	<0.20	0.21	<0.20	0.20	B649080
Ext. Pet. Hydrocarbon								
EPH (C10-C19)	mg/L	<0.20	B652075	<0.20	<0.20	<0.20	0.20	B649473
EPH (C19-C32)	mg/L	<0.20	B652075	<0.20	0.21	<0.20	0.20	B649473
Surrogate Recovery (%)								
O-TERPHENYL (sur.)	%	100	B652075	96	98	80		B649473
D10-ANTHRACENE (sur.)	%	97	B652071	98	94	87		B649471
D8-ACENAPHTHYLENE (sur.)	%	91	B652071	97	93	92		B649471
RDL = Reportable Detection Limit								

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LEPH & HEPH WITH CSR/CCME PAH IN WATER (WATER)

Bureau Veritas ID		DCN556		DCN557	DCN558	DCN559		
Sampling Date		2024/12/20 11:10		2024/12/20 11:10	2024/12/18 12:40	2024/12/18 02:20		
COC Number		C#744122-01-01		C#744122-01-02	C#744122-01-01	C#744122-01-01		
	UNITS	MW9-17 DUP	QC Batch	MW9-17	MW10-17	MW11-19	RDL	QC Batch
D8-NAPHTHALENE (sur.)	%	97	B652071	100	95	95		B649471
TERPHENYL-D14 (sur.)	%	71	B652071	102	95	76		B649471
RDL = Reportable Detection Limit								

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LEPH & HEPH WITH CSR/CCME PAH IN WATER (WATER)

Bureau Veritas ID		DCN560	DCN563		
Sampling Date		2024/12/18 04:20	2024/12/20 03:15		
COC Number		C#744122-02-01	C#744122-02-01		
	UNITS	MW12-22	S06-21	RDL	QC Batch
Calculated Parameters					
Low Molecular Weight PAH`s	ug/L	<0.10	28	0.10	B648850
High Molecular Weight PAH`s	ug/L	<0.050	0.77	0.050	B648850
Total PAH	ug/L	<0.10	29	0.10	B648850
Polycyclic Aromatics					
Quinoline	ug/L	<0.020	<0.020	0.020	B649471
Naphthalene	ug/L	<0.10	22	0.10	B649471
1-Methylnaphthalene	ug/L	<0.050	1.2	0.050	B649471
2-Methylnaphthalene	ug/L	<0.10	1.5	0.10	B649471
Acenaphthylene	ug/L	<0.050	<0.050	0.050	B649471
Acenaphthene	ug/L	<0.050	1.8	0.050	B649471
Fluorene	ug/L	<0.050	0.82	0.050	B649471
Phenanthrene	ug/L	<0.050	0.56	0.050	B649471
Anthracene	ug/L	<0.010	0.096	0.010	B649471
Acridine	ug/L	<0.050	0.15	0.050	B649471
Fluoranthene	ug/L	<0.020	0.34	0.020	B649471
Pyrene	ug/L	<0.020	0.24	0.020	B649471
Benzo(a)anthracene	ug/L	<0.010	0.053	0.010	B649471
Chrysene	ug/L	<0.020	0.066	0.020	B649471
Benzo(b&j)fluoranthene	ug/L	<0.030	0.035	0.030	B649471
Benzo(k)fluoranthene	ug/L	<0.050	<0.050	0.050	B649471
Benzo(a)pyrene	ug/L	<0.0050	0.025	0.0050	B649471
Indeno(1,2,3-cd)pyrene	ug/L	<0.050	<0.050	0.050	B649471
Dibenz(a,h)anthracene	ug/L	<0.0030	<0.0030	0.0030	B649471
Benzo(g,h,i)perylene	ug/L	<0.050	<0.050	0.050	B649471
Calculated Parameters					
LEPH (C10-C19 less PAH)	mg/L	<0.20	0.27	0.20	B649080
HEPH (C19-C32 less PAH)	mg/L	<0.20	<0.20	0.20	B649080
Ext. Pet. Hydrocarbon					
EPH (C10-C19)	mg/L	<0.20	0.29	0.20	B649473
EPH (C19-C32)	mg/L	<0.20	<0.20	0.20	B649473
Surrogate Recovery (%)					
O-TERPHENYL (sur.)	%	94	68		B649473
D10-ANTHRACENE (sur.)	%	91	89		B649471
D8-ACENAPHTHYLENE (sur.)	%	92	95		B649471
RDL = Reportable Detection Limit					

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LEPH & HEPH WITH CSR/CCME PAH IN WATER (WATER)

Bureau Veritas ID		DCN560	DCN563		
Sampling Date		2024/12/18 04:20	2024/12/20 03:15		
COC Number		C#744122-02-01	C#744122-02-01		
	UNITS	MW12-22	S06-21	RDL	QC Batch
D8-NAPHTHALENE (sur.)	%	94	96		B649471
TERPHENYL-D14 (sur.)	%	89	61		B649471
RDL = Reportable Detection Limit					

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

CSR TOTAL METALS (NO CV-HG) IN WATER

Bureau Veritas ID		DCN548	DCN549		DCN550		DCN551		
Sampling Date		2024/12/19 04:15	2024/12/19 12:20		2024/12/19 11:45		2024/12/19 11:45		
COC Number		C#744122-01-01	C#744122-01-01		C#744122-01-01		C#744122-01-02		
	UNITS	MW1-14	MW2-14	QC Batch	MW2A-16 DUP	QC Batch	MW2A-16	RDL	QC Batch
Calculated Parameters									
Total Hardness (CaCO3)	mg/L	60.3	41.9	B648843	39.0	B651780	38.0	0.50	B648843
RDL = Reportable Detection Limit									

Bureau Veritas ID		DCN552	DCN553	DCN554	DCN555		
Sampling Date		2024/12/20 02:30	2024/12/19 01:30	2024/12/19 02:35	2024/12/20 12:45		
COC Number		C#744122-01-01	C#744122-01-01	C#744122-01-01	C#744122-01-01		
	UNITS	MW3-14	MW4A-15	MW4B-15	MW6-17	RDL	QC Batch
Calculated Parameters							
Total Hardness (CaCO3)	mg/L	34.7	50.6	47.0	158	0.50	B648843
RDL = Reportable Detection Limit							

Bureau Veritas ID		DCN556		DCN557	DCN558	DCN559		
Sampling Date		2024/12/20 11:10		2024/12/20 11:10	2024/12/18 12:40	2024/12/18 02:20		
COC Number		C#744122-01-01		C#744122-01-02	C#744122-01-01	C#744122-01-01		
	UNITS	MW9-17 DUP	QC Batch	MW9-17	MW10-17	MW11-19	RDL	QC Batch
Calculated Parameters								
Total Hardness (CaCO3)	mg/L	24.1	B651780	23.3	96.6	197	0.50	B648843
RDL = Reportable Detection Limit								

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CSR TOTAL METALS (NO CV-HG) IN WATER

Bureau Veritas ID		DCN560			DCN561	DCN562		DCN563		
Sampling Date		2024/12/18 04:20			2024/12/20 03:45	2024/12/20 04:10		2024/12/20 03:15		
COC Number		C#744122-02-01			C#744122-02-01	C#744122-02-01		C#744122-02-01		
	UNITS	MW12-22	RDL	QC Batch	SW15-01	SW15-02	RDL	S06-21	RDL	QC Batch
Calculated Parameters										
Total Hardness (CaCO3)	mg/L	83.2	0.50	B648843	11.3	17.5	0.50	608	0.50	B648843
Total Metals by ICPMS										
Total Aluminum (Al)	ug/L				41.1	38.5	3.0	311	15	B649829
Total Antimony (Sb)	ug/L				<0.50	<0.50	0.50	<2.5	2.5	B649829
Total Arsenic (As)	ug/L				<0.10	<0.10	0.10	11.1	0.50	B649829
Total Barium (Ba)	ug/L				2.2	2.2	1.0	120	5.0	B649829
Total Beryllium (Be)	ug/L				<0.10	<0.10	0.10	<0.50	0.50	B649829
Total Bismuth (Bi)	ug/L				<1.0	<1.0	1.0	<5.0	5.0	B649829
Total Boron (B)	ug/L				<50	<50	50	6850	250	B649829
Total Cadmium (Cd)	ug/L				<0.010	<0.010	0.010	0.068	0.050	B649829
Total Chromium (Cr)	ug/L				<1.0	<1.0	1.0	8.4	5.0	B649829
Total Cobalt (Co)	ug/L				<0.20	<0.20	0.20	1.5	1.0	B649829
Total Copper (Cu)	ug/L				0.56	0.79	0.50	40.6	2.5	B649829
Total Iron (Fe)	ug/L				21	182	10	2980	50	B649829
Total Lead (Pb)	ug/L				<0.20	<0.20	0.20	1.7	1.0	B649829
Total Lithium (Li)	ug/L				<2.0	<2.0	2.0	<10	10	B649829
Total Manganese (Mn)	ug/L				2.5	8.8	1.0	1370	5.0	B649829
Total Molybdenum (Mo)	ug/L				<1.0	<1.0	1.0	<5.0	5.0	B649829
Total Nickel (Ni)	ug/L				<1.0	<1.0	1.0	<5.0	5.0	B649829
Total Selenium (Se)	ug/L				<0.10	<0.10	0.10	<0.50	0.50	B649829
Total Silicon (Si)	ug/L				2450	1230	100	12300	500	B649829
Total Silver (Ag)	ug/L				<0.020	<0.020	0.020	<0.10	0.10	B649829
Total Strontium (Sr)	ug/L				8.1	15.5	1.0	1190	5.0	B649829
Total Thallium (Tl)	ug/L				<0.010	<0.010	0.010	<0.050	0.050	B649829
Total Tin (Sn)	ug/L				<5.0	<5.0	5.0	<25	25	B649829
Total Titanium (Ti)	ug/L				<5.0	<5.0	5.0	38	25	B649829
Total Uranium (U)	ug/L				<0.10	<0.10	0.10	<0.50	0.50	B649829
Total Vanadium (V)	ug/L				<5.0	<5.0	5.0	<25	25	B649829
Total Zinc (Zn)	ug/L				<5.0	<5.0	5.0	65	25	B649829
Total Zirconium (Zr)	ug/L				<0.10	<0.10	0.10	1.77	0.50	B649829
Total Calcium (Ca)	mg/L				3.33	5.07	0.050	196	0.25	B649077
Total Magnesium (Mg)	mg/L				0.736	1.17	0.050	28.9	0.25	B649077
Total Potassium (K)	mg/L				0.090	0.130	0.050	24.8	0.25	B649077
Total Sodium (Na)	mg/L				1.74	3.46	0.050	145	0.25	B649077

RDL = Reportable Detection Limit

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

CSR TOTAL METALS (NO CV-HG) IN WATER

Bureau Veritas ID		DCN560			DCN561	DCN562		DCN563		
Sampling Date		2024/12/18 04:20			2024/12/20 03:45	2024/12/20 04:10		2024/12/20 03:15		
COC Number		C#744122-02-01			C#744122-02-01	C#744122-02-01		C#744122-02-01		
	UNITS	**MW12-22**	**RDL**	**QC Batch**	**SW15-01**	**SW15-02**	**RDL**	**S06-21**	**RDL**	**QC Batch**
Total Sulphur (S)	mg/L				<3.0	<3.0	3.0	49	15	B649077
RDL = Reportable Detection Limit										

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

CSR D. METALS (NO CV-HG)-DISS

Bureau Veritas ID		DCN548	DCN549		DCN550		DCN551		
Sampling Date		2024/12/19 04:15	2024/12/19 12:20		2024/12/19 11:45		2024/12/19 11:45		
COC Number		C#744122-01-01	C#744122-01-01		C#744122-01-01		C#744122-01-02		
	UNITS	**MW1-14**	**MW2-14**	**QC Batch**	**MW2A-16 DUP**	**QC Batch**	**MW2A-16**	**RDL**	**QC Batch**
Calculated Parameters									
Dissolved Hardness (CaCO3)	mg/L	68.9	46.5	B648844	38.5	B651781	41.0	0.50	B648844
Dissolved Metals by ICPMS									
Dissolved Aluminum (Al)	ug/L	<3.0	11.7	B649993	3.7	B652149	4.1	3.0	B649993
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	B649993	<0.50	B652149	<0.50	0.50	B649993
Dissolved Arsenic (As)	ug/L	<0.10	<0.10	B649993	0.78	B652149	0.79	0.10	B649993
Dissolved Barium (Ba)	ug/L	1.5	1.3	B649993	2.1	B652149	2.0	1.0	B649993
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	B649993	<0.10	B652149	<0.10	0.10	B649993
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	B649993	<1.0	B652149	<1.0	1.0	B649993
Dissolved Boron (B)	ug/L	<50	<50	B649993	<50	B652149	<50	50	B649993
Dissolved Cadmium (Cd)	ug/L	<0.010	<0.010	B649993	<0.010	B652149	<0.010	0.010	B649993
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	B649993	<1.0	B652149	<1.0	1.0	B649993
Dissolved Cobalt (Co)	ug/L	<0.20	<0.20	B649993	<0.20	B652149	<0.20	0.20	B649993
Dissolved Copper (Cu)	ug/L	<0.20	0.35	B649993	<0.20	B652149	<0.20	0.20	B649993
Dissolved Iron (Fe)	ug/L	<5.0	18.8	B649993	<5.0	B652149	<5.0	5.0	B649993
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	B649993	<0.20	B652149	<0.20	0.20	B649993
Dissolved Lithium (Li)	ug/L	<2.0	<2.0	B649993	<2.0	B652149	<2.0	2.0	B649993
Dissolved Manganese (Mn)	ug/L	<1.0	1.3	B649993	<1.0	B652149	<1.0	1.0	B649993
Dissolved Molybdenum (Mo)	ug/L	<1.0	<1.0	B649993	<1.0	B652149	<1.0	1.0	B649993
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	B649993	<1.0	B652149	<1.0	1.0	B649993
Dissolved Selenium (Se)	ug/L	0.12	0.10	B649993	<0.10	B652149	<0.10	0.10	B649993
Dissolved Silicon (Si)	ug/L	6170	5560	B649993	3850	B652149	3560	100	B649993
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	B649993	<0.020	B652149	<0.020	0.020	B649993
Dissolved Strontium (Sr)	ug/L	39.2	22.6	B649993	16.6	B652149	15.8	1.0	B649993
Dissolved Thallium (Tl)	ug/L	<0.010	<0.010	B649993	<0.010	B652149	<0.010	0.010	B649993
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	B649993	<5.0	B652149	<5.0	5.0	B649993
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	B649993	<5.0	B652149	<5.0	5.0	B649993
Dissolved Uranium (U)	ug/L	<0.10	<0.10	B649993	<0.10	B652149	<0.10	0.10	B649993
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	B649993	6.7	B652149	6.4	5.0	B649993
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	B649993	<5.0	B652149	<5.0	5.0	B649993
Dissolved Zirconium (Zr)	ug/L	<0.10	<0.10	B649993	<0.10	B652149	<0.10	0.10	B649993
Dissolved Calcium (Ca)	mg/L	23.0	14.7	B648777	12.7	B651783	13.5	0.050	B648777
Dissolved Magnesium (Mg)	mg/L	2.81	2.39	B648777	1.66	B651783	1.79	0.050	B648777
Dissolved Potassium (K)	mg/L	0.285	0.194	B648777	0.184	B651783	0.176	0.050	B648777
Dissolved Sodium (Na)	mg/L	6.12	3.04	B648777	0.989	B651783	1.03	0.050	B648777

RDL = Reportable Detection Limit

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CSR D. METALS (NO CV-HG)-DISS

Bureau Veritas ID		DCN548	DCN549		DCN550		DCN551		
Sampling Date		2024/12/19 04:15	2024/12/19 12:20		2024/12/19 11:45		2024/12/19 11:45		
COC Number		C#744122-01-01	C#744122-01-01		C#744122-01-01		C#744122-01-02		
	UNITS	**MW1-14**	**MW2-14**	**QC Batch**	**MW2A-16 DUP**	**QC Batch**	**MW2A-16**	**RDL**	**QC Batch**
Dissolved Sulphur (S)	mg/L	<3.0	<3.0	B648777	<3.0	B651783	<3.0	3.0	B648777
RDL = Reportable Detection Limit									

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CSR D. METALS (NO CV-HG)-DISS

Bureau Veritas ID		DCN552	DCN553	DCN554	DCN555		
Sampling Date		2024/12/20 02:30	2024/12/19 01:30	2024/12/19 02:35	2024/12/20 12:45		
COC Number		C#744122-01-01	C#744122-01-01	C#744122-01-01	C#744122-01-01		
	UNITS	MW3-14	MW4A-15	MW4B-15	MW6-17	RDL	QC Batch
Calculated Parameters							
Dissolved Hardness (CaCO3)	mg/L	38.7	54.3	52.2	154	0.50	B648844
Dissolved Metals by ICPMS							
Dissolved Aluminum (Al)	ug/L	<3.0	<3.0	<3.0	19.5	3.0	B649993
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	0.50	B649993
Dissolved Arsenic (As)	ug/L	<0.10	0.11	<0.10	0.17	0.10	B649993
Dissolved Barium (Ba)	ug/L	<1.0	5.4	2.3	21.6	1.0	B649993
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	<0.10	0.10	B649993
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	B649993
Dissolved Boron (B)	ug/L	<50	51	<50	<50	50	B649993
Dissolved Cadmium (Cd)	ug/L	<0.010	<0.010	0.011	0.010	0.010	B649993
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	B649993
Dissolved Cobalt (Co)	ug/L	<0.20	<0.20	<0.20	<0.20	0.20	B649993
Dissolved Copper (Cu)	ug/L	<0.20	0.21	0.24	0.40	0.20	B649993
Dissolved Iron (Fe)	ug/L	<5.0	<5.0	<5.0	16.0	5.0	B649993
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	<0.20	<0.20	0.20	B649993
Dissolved Lithium (Li)	ug/L	<2.0	<2.0	<2.0	<2.0	2.0	B649993
Dissolved Manganese (Mn)	ug/L	<1.0	<1.0	<1.0	6.8	1.0	B649993
Dissolved Molybdenum (Mo)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	B649993
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	B649993
Dissolved Selenium (Se)	ug/L	<0.10	0.58	0.60	<0.10	0.10	B649993
Dissolved Silicon (Si)	ug/L	6700	7130	7110	10800	100	B649993
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	<0.020	<0.020	0.020	B649993
Dissolved Strontium (Sr)	ug/L	20.2	94.4	98.2	99.2	1.0	B649993
Dissolved Thallium (Tl)	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	B649993
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	B649993
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	B649993
Dissolved Uranium (U)	ug/L	<0.10	<0.10	<0.10	<0.10	0.10	B649993
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	B649993
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	B649993
Dissolved Zirconium (Zr)	ug/L	<0.10	<0.10	<0.10	<0.10	0.10	B649993
Dissolved Calcium (Ca)	mg/L	11.3	16.1	15.6	40.6	0.050	B648777
Dissolved Magnesium (Mg)	mg/L	2.55	3.41	3.23	12.7	0.050	B648777
Dissolved Potassium (K)	mg/L	0.162	0.334	0.317	1.10	0.050	B648777
Dissolved Sodium (Na)	mg/L	4.17	37.3	37.7	28.3	0.050	B648777

RDL = Reportable Detection Limit

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CSR D. METALS (NO CV-HG)-DISS

Bureau Veritas ID		DCN552	DCN553	DCN554	DCN555		
Sampling Date		2024/12/20 02:30	2024/12/19 01:30	2024/12/19 02:35	2024/12/20 12:45		
COC Number		C#744122-01-01	C#744122-01-01	C#744122-01-01	C#744122-01-01		
	UNITS	MW3-14	MW4A-15	MW4B-15	MW6-17	RDL	QC Batch
Dissolved Sulphur (S)	mg/L	<3.0	4.6	5.1	<3.0	3.0	B648777
RDL = Reportable Detection Limit							

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CSR D. METALS (NO CV-HG)-DISS

Bureau Veritas ID		DCN556		DCN557		DCN558		
Sampling Date		2024/12/20 11:10		2024/12/20 11:10		2024/12/18 12:40		
COC Number		C#744122-01-01		C#744122-01-02		C#744122-01-01		
	UNITS	MW9-17 DUP	QC Batch	MW9-17	QC Batch	MW10-17	RDL	QC Batch
Calculated Parameters								
Dissolved Hardness (CaCO3)	mg/L	24.2	B651781	26.2	B648844	100	0.50	B648844
Dissolved Metals by ICPMS								
Dissolved Aluminum (Al)	ug/L	<3.0	B652149	<3.0	B649993	4.6	3.0	B650634
Dissolved Antimony (Sb)	ug/L	<0.50	B652149	<0.50	B649993	<0.50	0.50	B650634
Dissolved Arsenic (As)	ug/L	<0.10	B652149	<0.10	B649993	0.32	0.10	B650634
Dissolved Barium (Ba)	ug/L	<1.0	B652149	<1.0	B649993	4.4	1.0	B650634
Dissolved Beryllium (Be)	ug/L	<0.10	B652149	<0.10	B649993	<0.10	0.10	B650634
Dissolved Bismuth (Bi)	ug/L	<1.0	B652149	<1.0	B649993	<1.0	1.0	B650634
Dissolved Boron (B)	ug/L	<50	B652149	<50	B649993	654	50	B650634
Dissolved Cadmium (Cd)	ug/L	<0.010	B652149	<0.010	B649993	<0.010	0.010	B650634
Dissolved Chromium (Cr)	ug/L	<1.0	B652149	<1.0	B649993	<1.0	1.0	B650634
Dissolved Cobalt (Co)	ug/L	<0.20	B652149	<0.20	B649993	<0.20	0.20	B650634
Dissolved Copper (Cu)	ug/L	0.21	B652149	<0.20	B649993	1.83	0.20	B650634
Dissolved Iron (Fe)	ug/L	<5.0	B652149	<5.0	B649993	<5.0	5.0	B650634
Dissolved Lead (Pb)	ug/L	<0.20	B652149	<0.20	B649993	<0.20	0.20	B650634
Dissolved Lithium (Li)	ug/L	<2.0	B652149	<2.0	B649993	<2.0	2.0	B650634
Dissolved Manganese (Mn)	ug/L	<1.0	B652149	<1.0	B649993	<1.0	1.0	B650634
Dissolved Molybdenum (Mo)	ug/L	<1.0	B652149	<1.0	B649993	<1.0	1.0	B650634
Dissolved Nickel (Ni)	ug/L	<1.0	B652149	<1.0	B649993	<1.0	1.0	B650634
Dissolved Selenium (Se)	ug/L	<0.10	B652149	<0.10	B649993	0.11	0.10	B650634
Dissolved Silicon (Si)	ug/L	4240	B652149	3990	B649993	7020	100	B650634
Dissolved Silver (Ag)	ug/L	<0.020	B652149	<0.020	B649993	<0.020	0.020	B650634
Dissolved Strontium (Sr)	ug/L	12.5	B652149	11.8	B649993	44.6	1.0	B650634
Dissolved Thallium (Tl)	ug/L	<0.010	B652149	<0.010	B649993	0.017	0.010	B650634
Dissolved Tin (Sn)	ug/L	<5.0	B652149	<5.0	B649993	<5.0	5.0	B650634
Dissolved Titanium (Ti)	ug/L	<5.0	B652149	<5.0	B649993	<5.0	5.0	B650634
Dissolved Uranium (U)	ug/L	<0.10	B652149	<0.10	B649993	<0.10	0.10	B650634
Dissolved Vanadium (V)	ug/L	<5.0	B652149	<5.0	B649993	<5.0	5.0	B650634
Dissolved Zinc (Zn)	ug/L	<5.0	B652149	<5.0	B649993	<5.0	5.0	B650634
Dissolved Zirconium (Zr)	ug/L	<0.10	B652149	<0.10	B649993	<0.10	0.10	B650634
Dissolved Calcium (Ca)	mg/L	8.26	B651783	8.85	B648777	32.1	0.050	B648777
Dissolved Magnesium (Mg)	mg/L	0.867	B651783	0.997	B648777	4.83	0.050	B648777
Dissolved Potassium (K)	mg/L	0.186	B651783	0.187	B648777	0.436	0.050	B648777
Dissolved Sodium (Na)	mg/L	0.958	B651783	1.02	B648777	8.70	0.050	B648777
RDL = Reportable Detection Limit								

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CSR D. METALS (NO CV-HG)-DISS

Bureau Veritas ID		DCN556		DCN557		DCN558		
Sampling Date		2024/12/20 11:10		2024/12/20 11:10		2024/12/18 12:40		
COC Number		C#744122-01-01		C#744122-01-02		C#744122-01-01		
	UNITS	MW9-17 DUP	QC Batch	MW9-17	QC Batch	MW10-17	RDL	QC Batch
Dissolved Sulphur (S)	mg/L	<3.0	B651783	<3.0	B648777	3.6	3.0	B648777
RDL = Reportable Detection Limit								

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CSR D. METALS (NO CV-HG)-DISS

Bureau Veritas ID		DCN559	DCN560		
Sampling Date		2024/12/18 02:20	2024/12/18 04:20		
COC Number		C#744122-01-01	C#744122-02-01		
	UNITS	MW11-19	MW12-22	RDL	QC Batch
Calculated Parameters					
Dissolved Hardness (CaCO3)	mg/L	181	84.2	0.50	B648844
Dissolved Metals by ICPMS					
Dissolved Aluminum (Al)	ug/L	23.3	4.5	3.0	B649993
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	0.50	B649993
Dissolved Arsenic (As)	ug/L	0.20	<0.10	0.10	B649993
Dissolved Barium (Ba)	ug/L	12.0	2.4	1.0	B649993
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	0.10	B649993
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	1.0	B649993
Dissolved Boron (B)	ug/L	<50	<50	50	B649993
Dissolved Cadmium (Cd)	ug/L	<0.010	<0.010	0.010	B649993
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	1.0	B649993
Dissolved Cobalt (Co)	ug/L	<0.20	<0.20	0.20	B649993
Dissolved Copper (Cu)	ug/L	0.24	0.26	0.20	B649993
Dissolved Iron (Fe)	ug/L	27.3	9.3	5.0	B649993
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	0.20	B649993
Dissolved Lithium (Li)	ug/L	<2.0	<2.0	2.0	B649993
Dissolved Manganese (Mn)	ug/L	1.4	1.6	1.0	B649993
Dissolved Molybdenum (Mo)	ug/L	<1.0	<1.0	1.0	B649993
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	1.0	B649993
Dissolved Selenium (Se)	ug/L	0.14	0.21	0.10	B649993
Dissolved Silicon (Si)	ug/L	10800	6430	100	B649993
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	0.020	B649993
Dissolved Strontium (Sr)	ug/L	96.2	40.7	1.0	B649993
Dissolved Thallium (Tl)	ug/L	<0.010	<0.010	0.010	B649993
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	5.0	B649993
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	5.0	B649993
Dissolved Uranium (U)	ug/L	<0.10	<0.10	0.10	B649993
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	5.0	B649993
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	5.0	B649993
Dissolved Zirconium (Zr)	ug/L	<0.10	<0.10	0.10	B649993
Dissolved Calcium (Ca)	mg/L	57.7	24.4	0.050	B648777
Dissolved Magnesium (Mg)	mg/L	8.94	5.65	0.050	B648777
Dissolved Potassium (K)	mg/L	0.542	0.331	0.050	B648777
Dissolved Sodium (Na)	mg/L	7.09	7.58	0.050	B648777
RDL = Reportable Detection Limit					

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CSR D. METALS (NO CV-HG)-DISS

Bureau Veritas ID		DCN559	DCN560		
Sampling Date		2024/12/18 02:20	2024/12/18 04:20		
COC Number		C#744122-01-01	C#744122-02-01		
	UNITS	MW11-19	MW12-22	RDL	QC Batch
Dissolved Sulphur (S)	mg/L	5.5	6.8	3.0	B648777
RDL = Reportable Detection Limit					

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

GENERAL COMMENTS

Version 4 - Report reissued to exclude Total metals from samples DCN550 (MW2A-16 DUP) and DCN556 (MW9-17 DUP) as per client request received 2025/01/10.

Version 5: Report reissued to include results for unionized hydrogen sulphide on samples DCN550 (MW2A-16 DUP) and DCN556 (MW9-17 DUP) as per client request received 2025/01/13.

Sample DCN548 [MW1-14] : Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Dissolved Solids (Filt. Residue). Sample was analyzed past method specified hold time for Total Sulphide.

Sample DCN549 [MW2-14] : Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Dissolved Solids (Filt. Residue). Sample was analyzed past method specified hold time for Total Sulphide.

Sample DCN550 [MW2A-16 DUP] : Sample analyzed past method specified hold time for EPH in Water when PAH required. Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample analyzed past method specified hold time for PAH in Water by GC/MS (SIM). Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Sulphide. Sample was analyzed past method specified hold time for Alkalinity @25C (pp, total), CO3,HCO3,OH.

Sample DCN551 [MW2A-16] : Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Dissolved Solids (Filt. Residue). Sample was analyzed past method specified hold time for Total Sulphide.

Sample DCN552 [MW3-14] : Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Sulphide.

Sample DCN553 [MW4A-15] : Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Dissolved Solids (Filt. Residue). Sample was analyzed past method specified hold time for Total Sulphide.

Sample DCN554 [MW4B-15] : Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Dissolved Solids (Filt. Residue). Sample was analyzed past method specified hold time for Total Sulphide.

Sample DCN555 [MW6-17] : Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Sulphide.

Sample DCN556 [MW9-17 DUP] : Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was

analyzed past method specified hold time for Total Sulphide. Sample was analyzed past method specified hold time for Alkalinity @25C (pp, total), CO3,HCO3,OH.

Sample DCN557 [MW9-17] : Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Sulphide.

Sample DCN558 [MW10-17] : Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Dissolved Solids (Filt. Residue). Sample was analyzed past method specified hold time for Total Sulphide.

Sample DCN559 [MW11-19] : Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Dissolved Solids (Filt. Residue). Sample was analyzed past method specified hold time for Total Sulphide.

Sample DCN560 [MW12-22] : Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Dissolved Solids (Filt. Residue). Sample was analyzed past method specified hold time for Total Sulphide.

Sample DCN561 [SW15-01] : Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Sulphide.

Sample DCN562 [SW15-02] : Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Sulphide.

Sample DCN563 [S06-21] : Sample was analyzed past method specified hold time for Biochemical Oxygen Demand. Sample was analyzed past method specified hold time for Nitrate + Nitrite (N). Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised. Sample was analyzed past method specified hold time for Nitrite (N) Regular Level Water. Sample was analyzed past method specified hold time for Orthophosphate by Automated Analyzer. Sample was analyzed past method specified hold time for Total Sulphide.

Results relate only to the items tested.

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
B649471	D10-ANTHRACENE (sur.)	2024/12/30			92	50 - 140	90	%		
B649471	D8-ACENAPHTHYLENE (sur.)	2024/12/30			90	50 - 140	89	%		
B649471	D8-NAPHTHALENE (sur.)	2024/12/30			91	50 - 140	90	%		
B649471	TERPHENYL-D14 (sur.)	2024/12/30			94	50 - 140	91	%		
B649473	O-TERPHENYL (sur.)	2024/12/30			99	60 - 140	95	%		
B649910	1,4-Difluorobenzene (sur.)	2024/12/30	101	70 - 130	102	70 - 130	103	%		
B649910	4-Bromofluorobenzene (sur.)	2024/12/30	103	70 - 130	102	70 - 130	100	%		
B649910	D4-1,2-Dichloroethane (sur.)	2024/12/30	89	70 - 130	90	70 - 130	99	%		
B650852	2,4,6-TRIBROMOPHENOL (sur.)	2025/01/04			130	60 - 130	115	%		
B650852	2,4-DIBROMOPHENOL (sur.)	2025/01/04			107	60 - 130	107	%		
B652007	2,4,6-TRIBROMOPHENOL (sur.)	2025/01/06			80	60 - 130	80	%		
B652007	2,4-DIBROMOPHENOL (sur.)	2025/01/06			79	60 - 130	78	%		
B652071	D10-ANTHRACENE (sur.)	2025/01/03	102	50 - 140	103	50 - 140	104	%		
B652071	D8-ACENAPHTHYLENE (sur.)	2025/01/03	101	50 - 140	96	50 - 140	101	%		
B652071	D8-NAPHTHALENE (sur.)	2025/01/03	97	50 - 140	97	50 - 140	104	%		
B652071	TERPHENYL-D14 (sur.)	2025/01/03	75	50 - 140	79	50 - 140	73	%		
B652075	O-TERPHENYL (sur.)	2025/01/03	100	60 - 140	101	60 - 140	107	%		
B648685	Biochemical Oxygen Demand	2025/01/02			104	85 - 115	<2.0	mg/L	4.6	20
B649209	Total Suspended Solids	2024/12/30	102	80 - 120	100	80 - 120	<1.0	mg/L	NC	20
B649241	Total Dissolved Solids	2024/12/30	NC	80 - 120	102	80 - 120	<10	mg/L	4.8	20
B649253	Total Suspended Solids	2024/12/30	104	80 - 120	102	80 - 120	<1.0	mg/L	6.7	20
B649326	Orthophosphate (P)	2024/12/28	0.18 (1)	80 - 120	102	80 - 120	<0.0030	mg/L	NC	20
B649328	Nitrate plus Nitrite (N)	2024/12/28	129 (1)	80 - 120	101	80 - 120	<0.020	mg/L	NC	25
B649329	Nitrite (N)	2024/12/28	124 (1)	80 - 120	102	80 - 120	<0.0050	mg/L	NC	20
B649471	1-Methylnaphthalene	2024/12/30			93	50 - 140	<0.050	ug/L	NC	40
B649471	2-Methylnaphthalene	2024/12/30			93	50 - 140	<0.10	ug/L	NC	40
B649471	Acenaphthene	2024/12/30			98	50 - 140	<0.050	ug/L	NC	40
B649471	Acenaphthylene	2024/12/30			95	50 - 140	<0.050	ug/L	NC	40
B649471	Acridine	2024/12/30			96	50 - 140	<0.050	ug/L	NC	40
B649471	Anthracene	2024/12/30			96	50 - 140	<0.010	ug/L	NC	40
B649471	Benzo(a)anthracene	2024/12/30			82	50 - 140	<0.010	ug/L	NC	40
B649471	Benzo(a)pyrene	2024/12/30			86	50 - 140	<0.0050	ug/L	NC	40
B649471	Benzo(b&j)fluoranthene	2024/12/30			84	50 - 140	<0.030	ug/L	NC	40
B649471	Benzo(g,h,i)perylene	2024/12/30			104	50 - 140	<0.050	ug/L	NC	40

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
B649471	Benzo(k)fluoranthene	2024/12/30			84	50 - 140	<0.050	ug/L	NC	40
B649471	Chrysene	2024/12/30			84	50 - 140	<0.020	ug/L	NC	40
B649471	Dibenz(a,h)anthracene	2024/12/30			100	50 - 140	<0.0030	ug/L	NC	40
B649471	Fluoranthene	2024/12/30			98	50 - 140	<0.020	ug/L	NC	40
B649471	Fluorene	2024/12/30			94	50 - 140	<0.050	ug/L	NC	40
B649471	Indeno(1,2,3-cd)pyrene	2024/12/30			99	50 - 140	<0.050	ug/L	NC	40
B649471	Naphthalene	2024/12/30			97	50 - 140	<0.10	ug/L	NC	40
B649471	Phenanthrene	2024/12/30			93	50 - 140	<0.050	ug/L	NC	40
B649471	Pyrene	2024/12/30			98	50 - 140	<0.020	ug/L	NC	40
B649471	Quinoline	2024/12/30			105	50 - 140	<0.020	ug/L	NC	40
B649473	EPH (C10-C19)	2024/12/30			93	70 - 130	<0.20	mg/L	NC	30
B649473	EPH (C19-C32)	2024/12/30			104	70 - 130	<0.20	mg/L	NC	30
B649829	Total Aluminum (Al)	2024/12/30	106	80 - 120	99	80 - 120	<3.0	ug/L		
B649829	Total Antimony (Sb)	2024/12/30	100	80 - 120	101	80 - 120	<0.50	ug/L		
B649829	Total Arsenic (As)	2024/12/30	101	80 - 120	101	80 - 120	<0.10	ug/L		
B649829	Total Barium (Ba)	2024/12/30	98	80 - 120	97	80 - 120	<1.0	ug/L		
B649829	Total Beryllium (Be)	2024/12/30	94	80 - 120	97	80 - 120	<0.10	ug/L		
B649829	Total Bismuth (Bi)	2024/12/30	94	80 - 120	94	80 - 120	<1.0	ug/L		
B649829	Total Boron (B)	2024/12/30	98	80 - 120	101	80 - 120	<50	ug/L		
B649829	Total Cadmium (Cd)	2024/12/30	99	80 - 120	99	80 - 120	<0.010	ug/L		
B649829	Total Chromium (Cr)	2024/12/30	98	80 - 120	98	80 - 120	<1.0	ug/L		
B649829	Total Cobalt (Co)	2024/12/30	100	80 - 120	101	80 - 120	<0.20	ug/L		
B649829	Total Copper (Cu)	2024/12/30	94	80 - 120	96	80 - 120	<0.50	ug/L		
B649829	Total Iron (Fe)	2024/12/30	111	80 - 120	98	80 - 120	<10	ug/L		
B649829	Total Lead (Pb)	2024/12/30	99	80 - 120	99	80 - 120	<0.20	ug/L		
B649829	Total Lithium (Li)	2024/12/30	92	80 - 120	99	80 - 120	<2.0	ug/L		
B649829	Total Manganese (Mn)	2024/12/30	96	80 - 120	98	80 - 120	<1.0	ug/L		
B649829	Total Molybdenum (Mo)	2024/12/30	107	80 - 120	104	80 - 120	<1.0	ug/L		
B649829	Total Nickel (Ni)	2024/12/30	97	80 - 120	98	80 - 120	<1.0	ug/L		
B649829	Total Selenium (Se)	2024/12/30	103	80 - 120	97	80 - 120	<0.10	ug/L		
B649829	Total Silicon (Si)	2024/12/30	NC	80 - 120	101	80 - 120	<100	ug/L		
B649829	Total Silver (Ag)	2024/12/30	101	80 - 120	99	80 - 120	<0.020	ug/L		
B649829	Total Strontium (Sr)	2024/12/30	100	80 - 120	96	80 - 120	<1.0	ug/L		
B649829	Total Thallium (Tl)	2024/12/30	96	80 - 120	96	80 - 120	<0.010	ug/L		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
B649829	Total Tin (Sn)	2024/12/30	98	80 - 120	100	80 - 120	<5.0	ug/L		
B649829	Total Titanium (Ti)	2024/12/30	104	80 - 120	99	80 - 120	<5.0	ug/L		
B649829	Total Uranium (U)	2024/12/30	94	80 - 120	94	80 - 120	<0.10	ug/L		
B649829	Total Vanadium (V)	2024/12/30	101	80 - 120	100	80 - 120	<5.0	ug/L		
B649829	Total Zinc (Zn)	2024/12/30	101	80 - 120	101	80 - 120	<5.0	ug/L		
B649829	Total Zirconium (Zr)	2024/12/30	109	80 - 120	105	80 - 120	<0.10	ug/L		
B649843	Chloride (Cl)	2024/12/30	NC	80 - 120	98	80 - 120	<1.0	mg/L	0.61	20
B649843	Sulphate (SO4)	2024/12/30	NC	80 - 120	98	80 - 120	<1.0	mg/L	2.4	20
B649845	Chloride (Cl)	2024/12/30			98	80 - 120	<1.0	mg/L		
B649845	Sulphate (SO4)	2024/12/30			97	80 - 120	<1.0	mg/L		
B649910	Benzene	2024/12/30	98	70 - 130	92	70 - 130	<0.40	ug/L	NC	30
B649910	Ethylbenzene	2024/12/30	103	70 - 130	100	70 - 130	<0.40	ug/L	NC	30
B649910	m & p-Xylene	2024/12/30	101	70 - 130	95	70 - 130	<0.40	ug/L	NC	30
B649910	Methyl-tert-butylether (MTBE)	2024/12/30	93	70 - 130	88	70 - 130	<4.0	ug/L	NC	30
B649910	o-Xylene	2024/12/30	101	70 - 130	98	70 - 130	<0.40	ug/L	NC	30
B649910	Styrene	2024/12/30	98	70 - 130	94	70 - 130	<0.40	ug/L	NC	30
B649910	Toluene	2024/12/30	102	70 - 130	98	70 - 130	<0.40	ug/L	NC	30
B649910	VH C6-C10	2024/12/30			100	70 - 130	<300	ug/L	NC	30
B649910	Xylenes (Total)	2024/12/30					<0.40	ug/L	NC	30
B649993	Dissolved Aluminum (Al)	2024/12/30	92	80 - 120	98	80 - 120	<3.0	ug/L	NC	20
B649993	Dissolved Antimony (Sb)	2024/12/30	94	80 - 120	99	80 - 120	<0.50	ug/L	NC	20
B649993	Dissolved Arsenic (As)	2024/12/30	97	80 - 120	101	80 - 120	<0.10	ug/L	NC	20
B649993	Dissolved Barium (Ba)	2024/12/30	92	80 - 120	98	80 - 120	<1.0	ug/L	5.6	20
B649993	Dissolved Beryllium (Be)	2024/12/30	95	80 - 120	95	80 - 120	<0.10	ug/L	NC	20
B649993	Dissolved Bismuth (Bi)	2024/12/30	92	80 - 120	97	80 - 120	<1.0	ug/L	NC	20
B649993	Dissolved Boron (B)	2024/12/30	99	80 - 120	101	80 - 120	<50	ug/L	NC	20
B649993	Dissolved Cadmium (Cd)	2024/12/30	94	80 - 120	98	80 - 120	<0.010	ug/L	NC	20
B649993	Dissolved Chromium (Cr)	2024/12/30	91	80 - 120	97	80 - 120	<1.0	ug/L	NC	20
B649993	Dissolved Cobalt (Co)	2024/12/30	95	80 - 120	101	80 - 120	<0.20	ug/L	NC	20
B649993	Dissolved Copper (Cu)	2024/12/30	89	80 - 120	94	80 - 120	<0.20	ug/L	NC	20
B649993	Dissolved Iron (Fe)	2024/12/30	95	80 - 120	99	80 - 120	<5.0	ug/L	NC	20
B649993	Dissolved Lead (Pb)	2024/12/30	98	80 - 120	103	80 - 120	<0.20	ug/L	NC	20
B649993	Dissolved Lithium (Li)	2024/12/30	99	80 - 120	97	80 - 120	<2.0	ug/L	NC	20
B649993	Dissolved Manganese (Mn)	2024/12/30	92	80 - 120	98	80 - 120	<1.0	ug/L	NC	20

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
B649993	Dissolved Molybdenum (Mo)	2024/12/30	99	80 - 120	104	80 - 120	<1.0	ug/L	NC	20
B649993	Dissolved Nickel (Ni)	2024/12/30	91	80 - 120	97	80 - 120	<1.0	ug/L	NC	20
B649993	Dissolved Selenium (Se)	2024/12/30	91	80 - 120	95	80 - 120	<0.10	ug/L	17	20
B649993	Dissolved Silicon (Si)	2024/12/30	NC	80 - 120	98	80 - 120	<100	ug/L	0.68	20
B649993	Dissolved Silver (Ag)	2024/12/30	95	80 - 120	99	80 - 120	<0.020	ug/L	NC	20
B649993	Dissolved Strontium (Sr)	2024/12/30	102	80 - 120	97	80 - 120	<1.0	ug/L	2.6	20
B649993	Dissolved Thallium (Tl)	2024/12/30	94	80 - 120	98	80 - 120	<0.010	ug/L	NC	20
B649993	Dissolved Tin (Sn)	2024/12/30	94	80 - 120	101	80 - 120	<5.0	ug/L	NC	20
B649993	Dissolved Titanium (Ti)	2024/12/30	95	80 - 120	99	80 - 120	<5.0	ug/L	NC	20
B649993	Dissolved Uranium (U)	2024/12/30	90	80 - 120	92	80 - 120	<0.10	ug/L	NC	20
B649993	Dissolved Vanadium (V)	2024/12/30	95	80 - 120	99	80 - 120	<5.0	ug/L	NC	20
B649993	Dissolved Zinc (Zn)	2024/12/30	96	80 - 120	101	80 - 120	<5.0	ug/L	NC	20
B649993	Dissolved Zirconium (Zr)	2024/12/30	96	80 - 120	101	80 - 120	<0.10	ug/L	NC	20
B650036	pH	2024/12/30			100	97 - 103			0.55	N/A
B650037	Alkalinity (PP as CaCO3)	2024/12/30					<1.0	mg/L	NC	20
B650037	Alkalinity (Total as CaCO3)	2024/12/30			99	80 - 120	<1.0	mg/L	0.27	20
B650037	Bicarbonate (HCO3)	2024/12/30					<1.0	mg/L	0.27	20
B650037	Carbonate (CO3)	2024/12/30					<1.0	mg/L	NC	20
B650037	Hydroxide (OH)	2024/12/30					<1.0	mg/L	NC	20
B650039	Conductivity	2024/12/30			98	90 - 110	<2.0	uS/cm	1.3	10
B650116	Chemical Oxygen Demand	2024/12/30	109	80 - 120	102	80 - 120	<10	mg/L	6.3	20
B650147	Total Ammonia (N)	2024/12/30	110	80 - 120	101	80 - 120	<0.015	mg/L	NC	20
B650231	Total Ammonia (N)	2024/12/30	115	80 - 120	109	80 - 120	<0.015	mg/L	1.2	20
B650481	Total Sulphide	2024/12/31	78 (1)	80 - 120	103	80 - 120	<0.0018	mg/L	NC	20
B650634	Dissolved Aluminum (Al)	2024/12/31	100	80 - 120	102	80 - 120	<3.0	ug/L	2.7	20
B650634	Dissolved Antimony (Sb)	2024/12/31	100	80 - 120	99	80 - 120	<0.50	ug/L	NC	20
B650634	Dissolved Arsenic (As)	2024/12/31	102	80 - 120	101	80 - 120	<0.10	ug/L	0.63	20
B650634	Dissolved Barium (Ba)	2024/12/31	96	80 - 120	97	80 - 120	<1.0	ug/L	2.0	20
B650634	Dissolved Beryllium (Be)	2024/12/31	106	80 - 120	99	80 - 120	<0.10	ug/L	NC	20
B650634	Dissolved Bismuth (Bi)	2024/12/31	100	80 - 120	99	80 - 120	<1.0	ug/L	NC	20
B650634	Dissolved Boron (B)	2024/12/31	NC	80 - 120	98	80 - 120	<50	ug/L	0.55	20
B650634	Dissolved Cadmium (Cd)	2024/12/31	100	80 - 120	100	80 - 120	<0.010	ug/L	NC	20
B650634	Dissolved Chromium (Cr)	2024/12/31	100	80 - 120	101	80 - 120	<1.0	ug/L	NC	20
B650634	Dissolved Cobalt (Co)	2024/12/31	98	80 - 120	100	80 - 120	<0.20	ug/L	NC	20

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
B650634	Dissolved Copper (Cu)	2024/12/31	94	80 - 120	97	80 - 120	<0.20	ug/L	0.93	20
B650634	Dissolved Iron (Fe)	2024/12/31	101	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
B650634	Dissolved Lead (Pb)	2024/12/31	103	80 - 120	101	80 - 120	<0.20	ug/L	NC	20
B650634	Dissolved Lithium (Li)	2024/12/31	103	80 - 120	98	80 - 120	<2.0	ug/L	NC	20
B650634	Dissolved Manganese (Mn)	2024/12/31	98	80 - 120	99	80 - 120	<1.0	ug/L	NC	20
B650634	Dissolved Molybdenum (Mo)	2024/12/31	108	80 - 120	104	80 - 120	<1.0	ug/L	NC	20
B650634	Dissolved Nickel (Ni)	2024/12/31	98	80 - 120	99	80 - 120	<1.0	ug/L	NC	20
B650634	Dissolved Selenium (Se)	2024/12/31	102	80 - 120	97	80 - 120	<0.10	ug/L	5.7	20
B650634	Dissolved Silicon (Si)	2024/12/31	NC	80 - 120	101	80 - 120	<100	ug/L	4.5	20
B650634	Dissolved Silver (Ag)	2024/12/31	101	80 - 120	99	80 - 120	<0.020	ug/L	NC	20
B650634	Dissolved Strontium (Sr)	2024/12/31	98	80 - 120	98	80 - 120	<1.0	ug/L	0.61	20
B650634	Dissolved Thallium (Tl)	2024/12/31	102	80 - 120	99	80 - 120	<0.010	ug/L	13	20
B650634	Dissolved Tin (Sn)	2024/12/31	101	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
B650634	Dissolved Titanium (Ti)	2024/12/31	103	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
B650634	Dissolved Uranium (U)	2024/12/31	106	80 - 120	102	80 - 120	<0.10	ug/L	NC	20
B650634	Dissolved Vanadium (V)	2024/12/31	99	80 - 120	98	80 - 120	<5.0	ug/L	NC	20
B650634	Dissolved Zinc (Zn)	2024/12/31	100	80 - 120	111	80 - 120	<5.0	ug/L	NC	20
B650634	Dissolved Zirconium (Zr)	2024/12/31	106	80 - 120	103	80 - 120	<0.10	ug/L	NC	20
B650852	2,3,4,5-tetrachlorophenol	2025/01/04			105	60 - 130	<0.10	ug/L		
B650852	2,3,4,6-tetrachlorophenol	2025/01/04			101	60 - 130	<0.10	ug/L		
B650852	2,3,4-trichlorophenol	2025/01/04			116	60 - 130	<0.10	ug/L		
B650852	2,3,5,6-tetrachlorophenol	2025/01/04			111	60 - 130	<0.10	ug/L		
B650852	2,3,5-trichlorophenol	2025/01/04			107	60 - 130	<0.10	ug/L		
B650852	2,3,6-Trichlorophenol	2025/01/04			115	60 - 130	<0.10	ug/L		
B650852	2,3-Dichlorophenol	2025/01/04			105	60 - 130	<0.10	ug/L		
B650852	2,4 + 2,5-Dichlorophenol	2025/01/04			112	60 - 130	<0.10	ug/L		
B650852	2,4,5-trichlorophenol	2025/01/04			116	60 - 130	<0.10	ug/L		
B650852	2,4,6-trichlorophenol	2025/01/04			110	60 - 130	<0.10	ug/L		
B650852	2,4-dimethylphenol	2025/01/04			95	60 - 130	<0.50	ug/L		
B650852	2,4-dinitrophenol	2025/01/04			69	30 - 130	<0.50	ug/L		
B650852	2,6-dichlorophenol	2025/01/04			116	60 - 130	<0.10	ug/L		
B650852	2,6-Dimethylphenol	2025/01/04			96	60 - 130	<0.50	ug/L		
B650852	2-chlorophenol	2025/01/04			89	60 - 130	<0.050	ug/L		
B650852	2-methylphenol	2025/01/04			81	60 - 130	<0.50	ug/L		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
B650852	2-nitrophenol	2025/01/04			102	60 - 130	<0.50	ug/L		
B650852	3 & 4-chlorophenol	2025/01/04			103	60 - 130	<0.075	ug/L		
B650852	3 & 4-methylphenol	2025/01/04			82	60 - 130	<0.50	ug/L		
B650852	3,4,5-Trichlorophenol	2025/01/04			99	60 - 130	<0.10	ug/L		
B650852	3,4-Dichlorophenol	2025/01/04			99	60 - 130	<0.10	ug/L		
B650852	3,4-Dimethylphenol	2025/01/04			96	60 - 130	<0.50	ug/L		
B650852	3,5-Dichlorophenol	2025/01/04			99	60 - 130	<0.10	ug/L		
B650852	4,6-dinitro-2-methylphenol	2025/01/04			110	30 - 130	<0.50	ug/L		
B650852	4-chloro-3-methylphenol	2025/01/04			98	60 - 130	<0.10	ug/L		
B650852	4-nitrophenol	2025/01/04			69	60 - 130	<0.50	ug/L		
B650852	Pentachlorophenol	2025/01/04			79	60 - 130	<0.10	ug/L		
B650852	Phenol	2025/01/04			115	60 - 130	<0.50	ug/L		
B652007	2-Hydroxyphenol (Catechol)	2025/01/06			68	60 - 130	<20	ug/L		
B652007	3-Hydroxyphenol (Resorcinol)	2025/01/06			73	60 - 130	<10	ug/L		
B652007	4-Hydroxyphenol (Hydroquinone)	2025/01/06			82	60 - 130	<1.0	ug/L		
B652071	1-Methylnaphthalene	2025/01/05	93	50 - 140	91	50 - 140	<0.050	ug/L	NC	40
B652071	2-Methylnaphthalene	2025/01/05	92	50 - 140	90	50 - 140	<0.10	ug/L	NC	40
B652071	Acenaphthene	2025/01/05	100	50 - 140	97	50 - 140	<0.050	ug/L	NC	40
B652071	Acenaphthylene	2025/01/05	98	50 - 140	94	50 - 140	<0.050	ug/L	NC	40
B652071	Acridine	2025/01/05	90	50 - 140	88	50 - 140	<0.050	ug/L	NC	40
B652071	Anthracene	2025/01/05	101	50 - 140	99	50 - 140	<0.010	ug/L	NC	40
B652071	Benzo(a)anthracene	2025/01/05	94	50 - 140	96	50 - 140	<0.010	ug/L	NC	40
B652071	Benzo(a)pyrene	2025/01/05	101	50 - 140	104	50 - 140	<0.0050	ug/L	NC	40
B652071	Benzo(b&j)fluoranthene	2025/01/05	92	50 - 140	97	50 - 140	<0.030	ug/L	NC	40
B652071	Benzo(g,h,i)perylene	2025/01/05	85	50 - 140	86	50 - 140	<0.050	ug/L	NC	40
B652071	Benzo(k)fluoranthene	2025/01/05	98	50 - 140	94	50 - 140	<0.050	ug/L	NC	40
B652071	Chrysene	2025/01/05	91	50 - 140	91	50 - 140	<0.020	ug/L	NC	40
B652071	Dibenz(a,h)anthracene	2025/01/05	86	50 - 140	95	50 - 140	<0.0030	ug/L	NC	40
B652071	Fluoranthene	2025/01/05	77	50 - 140	82	50 - 140	<0.020	ug/L	NC	40
B652071	Fluorene	2025/01/05	102	50 - 140	97	50 - 140	<0.050	ug/L	NC	40
B652071	Indeno(1,2,3-cd)pyrene	2025/01/05	92	50 - 140	96	50 - 140	<0.050	ug/L	NC	40
B652071	Naphthalene	2025/01/05	90	50 - 140	89	50 - 140	<0.10	ug/L	NC	40
B652071	Phenanthrene	2025/01/05	89	50 - 140	87	50 - 140	<0.050	ug/L	NC	40
B652071	Pyrene	2025/01/05	80	50 - 140	84	50 - 140	<0.020	ug/L	NC	40

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
B652071	Quinoline	2025/01/05	99	50 - 140	99	50 - 140	<0.020	ug/L	NC	40
B652075	EPH (C10-C19)	2025/01/03	97	60 - 140	97	70 - 130	<0.20	mg/L	NC	30
B652075	EPH (C19-C32)	2025/01/03	105	60 - 140	104	70 - 130	<0.20	mg/L	NC	30
B652149	Dissolved Aluminum (Al)	2025/01/03	93	80 - 120	91	80 - 120	<3.0	ug/L	7.8	20
B652149	Dissolved Antimony (Sb)	2025/01/03	102	80 - 120	103	80 - 120	<0.50	ug/L	NC	20
B652149	Dissolved Arsenic (As)	2025/01/03	99	80 - 120	98	80 - 120	<0.10	ug/L	1.4	20
B652149	Dissolved Barium (Ba)	2025/01/03	99	80 - 120	101	80 - 120	<1.0	ug/L	3.2	20
B652149	Dissolved Beryllium (Be)	2025/01/03	99	80 - 120	104	80 - 120	<0.10	ug/L	NC	20
B652149	Dissolved Bismuth (Bi)	2025/01/03	101	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
B652149	Dissolved Boron (B)	2025/01/03	100	80 - 120	100	80 - 120	<50	ug/L	NC	20
B652149	Dissolved Cadmium (Cd)	2025/01/03	101	80 - 120	100	80 - 120	<0.010	ug/L	NC	20
B652149	Dissolved Chromium (Cr)	2025/01/03	98	80 - 120	95	80 - 120	<1.0	ug/L	NC	20
B652149	Dissolved Cobalt (Co)	2025/01/03	102	80 - 120	96	80 - 120	<0.20	ug/L	NC	20
B652149	Dissolved Copper (Cu)	2025/01/03	95	80 - 120	94	80 - 120	<0.20	ug/L	NC	20
B652149	Dissolved Iron (Fe)	2025/01/03	101	80 - 120	100	80 - 120	<5.0	ug/L	NC	20
B652149	Dissolved Lead (Pb)	2025/01/03	101	80 - 120	100	80 - 120	<0.20	ug/L	NC	20
B652149	Dissolved Lithium (Li)	2025/01/03	100	80 - 120	103	80 - 120	<2.0	ug/L	NC	20
B652149	Dissolved Manganese (Mn)	2025/01/03	100	80 - 120	97	80 - 120	<1.0	ug/L	NC	20
B652149	Dissolved Molybdenum (Mo)	2025/01/03	103	80 - 120	100	80 - 120	<1.0	ug/L	NC	20
B652149	Dissolved Nickel (Ni)	2025/01/03	98	80 - 120	97	80 - 120	<1.0	ug/L	NC	20
B652149	Dissolved Selenium (Se)	2025/01/03	97	80 - 120	96	80 - 120	<0.10	ug/L	20	20
B652149	Dissolved Silicon (Si)	2025/01/03	96	80 - 120	105	80 - 120	<100	ug/L	1.6	20
B652149	Dissolved Silver (Ag)	2025/01/03	101	80 - 120	101	80 - 120	<0.020	ug/L	NC	20
B652149	Dissolved Strontium (Sr)	2025/01/03	100	80 - 120	99	80 - 120	<1.0	ug/L	2.1	20
B652149	Dissolved Thallium (Tl)	2025/01/03	103	80 - 120	102	80 - 120	<0.010	ug/L	NC	20
B652149	Dissolved Tin (Sn)	2025/01/03	98	80 - 120	101	80 - 120	<5.0	ug/L	NC	20
B652149	Dissolved Titanium (Ti)	2025/01/03	104	80 - 120	101	80 - 120	<5.0	ug/L	NC	20
B652149	Dissolved Uranium (U)	2025/01/03	109	80 - 120	110	80 - 120	<0.10	ug/L	NC	20
B652149	Dissolved Vanadium (V)	2025/01/03	100	80 - 120	97	80 - 120	<5.0	ug/L	2.8	20
B652149	Dissolved Zinc (Zn)	2025/01/03	103	80 - 120	101	80 - 120	<5.0	ug/L	NC	20
B652149	Dissolved Zirconium (Zr)	2025/01/03	101	80 - 120	101	80 - 120	<0.10	ug/L	NC	20
B652197	Nitrate plus Nitrite (N)	2025/01/03	119	80 - 120	110	80 - 120	<0.020	mg/L	0.35	25
B652200	Nitrite (N)	2025/01/03	112	80 - 120	105	80 - 120	<0.0050	mg/L	NC	20
B652271	Orthophosphate (P)	2025/01/03			99	80 - 120	<0.0030	mg/L		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
B652283	Chloride (Cl)	2025/01/03	98	80 - 120	99	80 - 120	<1.0	mg/L	0.95	20
B652283	Sulphate (SO4)	2025/01/03	100	80 - 120	101	80 - 120	<1.0	mg/L	1.6	20
B652508	Total Sulphide	2025/01/04	92	80 - 120	92	80 - 120	<0.0018	mg/L	NC	20
B652954	Alkalinity (PP as CaCO3)	2025/01/06					<1.0	mg/L	NC	20
B652954	Alkalinity (Total as CaCO3)	2025/01/06			94	80 - 120	<1.0	mg/L	0.33	20
B652954	Bicarbonate (HCO3)	2025/01/06					<1.0	mg/L	0.33	20
B652954	Carbonate (CO3)	2025/01/06					<1.0	mg/L	NC	20
B652954	Hydroxide (OH)	2025/01/06					<1.0	mg/L	NC	20
B652957	pH	2025/01/06			100	97 - 103			0.88	N/A
B652958	Conductivity	2025/01/06			98	90 - 110	<2.0	uS/cm	0.19	10
B653426	Total Ammonia (N)	2025/01/06	116	80 - 120	108	80 - 120	<0.015	mg/L	NC	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

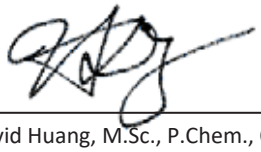
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

Bureau Veritas Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:



David Huang, M.Sc., P.Chem., QP, Scientific Services Manager



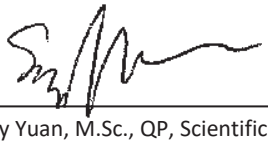
Ghayasuddin Khan, M.Sc., P.Chem., QP, Scientific Specialist, Inorganics



Mauro Oselin, P.Chem., QP, Scientific Specialist



Neenu Jose, Project Solutions Representative



Sandy Yuan, M.Sc., QP, Scientific Specialist



Veronica Falk, B.Sc., P.Chem., QP, Scientific Specialist, Organics

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation, please refer to the Validation Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Raphael Kwan, General Manager, BC and Yukon Regions responsible for British Columbia Environmental laboratory operations.

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Bureau Veritas
2755-B Moray Avenue, Courtenay, British Columbia Canada V9N 8M9 Tel:(833) 282-0227 Toll-free:800-563-6266 Fax:(250) 338 7563 www.bvna.com

Chain Of Custody Record

INVOICE TO:		Report Information		Project Information		Laboratory Use Only	
Company Name	#5940 Envirochem Services Inc.	Company Name		Quotation #	C40232	Bureau Veritas Job #	Bottle Order #:
Contact Name	Accounts Payable	Contact Name	Paul Dawson	P.O. #			744122
Address	#206 - 267 Esplanade West	Address		Project #		Chain Of Custody Record	Project Manager
	North Vancouver BC V7M 1A5			Project Name		C#744122-01-01	Augustina Iaesale
Phone	(604) 986-0233 Ext: 102 Fax: (604) 986-8583	Phone	Fax:	Site #			
Email	accounts.payable@envirochem.com	Email	paul.dawson@envirochem.com	Sampled By			

Regulatory Criteria

Special Instructions

Note: For regulated drinking water samples - please use the Drinking Water Chain of Custody Form

Samples must be kept cool (< 10°C) from time of sampling until delivery to Bureau Veritas

Analysis Requested

Turnaround Time (TAT) Required

Please provide advance notice for rush projects

Regular (Standard) TAT ☐
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: Time Required: ☐
Rush Confirmation Number: (call lab for #)

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Regulated Drinking Water ? (Y/N)	Metals Field Filtered ? (Y/N)	Alkalinity @25C (pp, total), CO3,HCO3,OH	Chloride/Sulphate by Auto Colourimetry	Conductivity @25C	Hardness (calculated as CaCO3)	Hardness Total (calculated as CaCO3)	Orthophosphate by Automated Analyzer	pH @25°C	Un-ionized Hydrogen Sulphide as S Calc	Total Sulphide	Total Dissolved Solids (Filt. Residue)	# of Bottles	Comments
1	SID#369665	MW1-14	24/12/19	4:15	W			✓	✓	✓	✓	✓		✓		✓			
2	SID#369666	MW2-14	24/12/19	12:20	W														
3	SID#369667	MW2A-16 Dup	24/12/19	11:45	W														
4	SID#369668	MW3-14	24/12/20	2:30	W														
5	SID#369669	MW4A-15	24/12/19	1:30	W														
6	SID#369670	MW4B-15	24/12/19	2:35	W														
7	SID#369671	MW6-17	24/12/20	12:45	W														
8	SID#369672	MW9-17 Dup	24/12/20	11:10	W														
9	SID#369673	MW10-17	24/12/18	12:40	W														
10	SID#369674	MW11-19	24/12/18	2:20	W														

MVAN-2024-12-1234

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Lab Use Only: Time Sensitive	Temperature (°C) on Receipt	Custody Seal Intact on Cooler?
Darryl Stowe	24/12/20	4:40	Skylar H.	24/12/20	4:40		☐	8.8.7	☒ Yes ☐ No
			# Maria Zamora	2024/12/24	08:20				

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/COC-TERMS-AND-CONDITIONS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Bureau Veritas Yellow: Client

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Bureau Veritas
2755-B Moray Avenue, Courtenay, British Columbia Canada V9N 8M9 Tel:(833) 282-6227 Toll-free:800-563-6266 Fax:(250) 338 7553 www.bvna.com

Chain Of Custody Record

INVOICE TO:		Report Information		Project Information		Laboratory Use Only	
Company Name	#5940 Envirochem Services Inc.	Company Name		Quotation #	C40232	Bureau Veritas Job #	Bottle Order #:
Contact Name	Accounts Payable	Contact Name	Paul Dawson	P.O. #			744122
Address	#206 - 267 Esplanade West	Address		Project #			
	North Vancouver BC V7M 1A5			Project Name		Chain Of Custody Record	Project Manager
Phone	(604) 986-0233 Ext: 102 Fax: (604) 986-8583	Phone	Fax:	Site #		C#744122-01-02	Augustina Ieasele
Email	accounts.payable@envirochem.com	Email	paul.dawson@envirochem.com	Sampled By			

Regulatory Criteria

Special Instructions

Note: For regulated drinking water samples - please use the Drinking Water Chain of Custody Form

Samples must be kept cool (< 10°C) from time of sampling until delivery to Bureau Veritas

Turnaround Time (TAT) Required

Please provide advance notice for rush projects

Regular (Standard) TAT
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: _____ Time Required: _____
Rush Confirmation Number: _____ (call lab for #)

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Regulated Drinking Water ? (Y / N)	Metals Field Filtered ? (Y / N)	Total Suspended Solids (NFR)	Biochemical Oxygen Demand	COD by Colorimeter	Ammonia-N (Total)	Nitrogen - Nitrate (as N)	CSR D. Metals (No CV-Hg)-Diss	CSR Total Metals (No CV-Hg) in Water	LEPH & HEPH with CSR/CCME PAH in Water	CSR BTEX/VPH in Water	Combined CP/NCP Phenols in Water	# of Bottles	Comments
1	SID#369665	MW1-14																	
2	SID#369666	MW2-14																	
3	SID#369667	MW2A-16																	
4	SID#369668	MW3-14																	
5	SID#369669	MW4A-15																	
6	SID#369670	MW4B-15																	
7	SID#369671	MW6-17																	
8	SID#369672	MW9-17																	
9	SID#369673	MW10-17																	
10	SID#369674	MW11-19																	

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Lab Use Only: Time Sensitive	Temperature (°C) on Receipt	Custody Seal Intact on Cooler?
			Ht Nava Zamora	2024/12/24	08:20			1/2/7	Yes / No

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGEMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/COC-TERMS-AND-CONDITIONS.

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White: Bureau Veritas Yellow: Client

5/6/6

LCE FROZEN

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Chain Of Custody Record

INVOICE TO:		Report Information		Project Information		Laboratory Use Only	
Company Name	#5940 Envirochem Services Inc.	Company Name		Quotation #	C40232	Bureau Veritas Job #	Bottle Order #:
Contact Name	Accounts Payable	Contact Name	Paul Dawson	P.O. #			744122
Address	#206 - 267 Esplanade West	Address		Project #		Chain Of Custody Record	Project Manager
	North Vancouver BC V7M 1A5			Project Name		C#744122-02-01	Augustina Iessie
Phone	(604) 986-0233 Ext: 102 Fax: (604) 986-8583	Phone	Fax:	Site #			
Email	accounts.payable@envirochem.com	Email	paul.dawson@envirochem.com	Sampled By			

Regulatory Criteria

Special Instructions

Note: For regulated drinking water samples - please use the Drinking Water Chain of Custody Form

Samples must be kept cool (< 10°C) from time of sampling until delivery to Bureau Veritas

Analysis Requested

Turnaround Time (TAT) Required

Please provide advance notice for rush projects

Regular (Standard) TAT
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: Time Required:
Rush Confirmation Number: (call lab for #)

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Regulated Drinking Water ? (Y / N)	Metals Field Filtered ? (Y / N)	Alkalinity @25C (pp, total), CO3,HCO3,OH	Chloride/Sulphate by Auto Colourimetry	Conductivity @25C	Hardness (calculated as CaCO3)	Hardness Total (calculated as CaCO3)	Orthophosphate by Automated Analyzer	pH @25°C	Un-ionized Hydrogen Sulphide as S Calc	Total Sulphide	Total Dissolved Solids (Filt. Residue)	# of Bottles	Comments
1	SID#309675	MW12-22	24/12/18	4:20	W														
2	SID#309676	SW15-01	24/12/20	3:45	W														
3	SID#309677	SW15-02	24/12/20	4:10	W														
4	SID#309678	S06-21	24/12/20	3:15	W														
5	SID#309679	S07-24																	
6	SID#309680	TLIP																	
7	SID#309681	LDS																	
8	SID#309682	LDMP																	
9																			
10																			

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Lab Use Only		
Danny Stowe	24/12/20	4:40	Skyler H.	24/12/20	4:40		Time Sensitive ☐	Temperature (°C) on Receipt 8.8.7	Custody Seal Intact on Cooler? ☒ Yes ☐ No
			Maria Zamora	2024/12/20	08:30				

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/COC-TERMS-AND-CONDITIONS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Bureau Veritas Yellow: Client

1/217

5/6/6

LCE

2024/12/20 16:40
C4A063

Bureau Veritas
2755-B Mosay Avenue, Courtenay, British Columbia Canada V9N 8M9 Tel:(833) 262-5227 Toll-free:800-563-6266 Fax:(250) 338 7553 www.bvna.com

Chain Of Custody Record

INVOICE TO:		Report Information		Project Information		Laboratory Use Only	
Company Name	#5940 Envirochem Services Inc.	Company Name		Quotation #	C40232	Bureau Veritas Job #	Bottle Order #:
Contact Name	Accounts Payable	Contact Name	Paul Dawson	P.O. #			T44122
Address	#206 - 267 Esplanade West	Address		Project #			
	North Vancouver BC V7M 1A5			Project Name		Chain Of Custody Record	Project Manager
Phone	(604) 986-0233 Ext: 102 Fax: (604) 986-8583	Phone	Fax:	Site #		C#744122-02-02	Augustina Iweala
Email	accounts.payable@envirochem.com	Email	paul.dawson@envirochem.com	Sampled By			

Regulatory Criteria

Special Instructions

Note: For regulated drinking water samples - please use the Drinking Water Chain of Custody Form

Samples must be kept cool (< 10°C) from time of sampling until delivery to Bureau Veritas

Analysis Requested

Turnaround Time (TAT) Required

Please provide advance notice for rush projects

Regular (Standard) TAT
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: Time Required:
Rush Confirmation Number:
(call lab for #)

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Regulated Drinking Water ? (Y/N)	Metals Field Filtered ? (Y/N)	Total Suspended Solids (NFR)	Biochemical Oxygen Demand	COD by Colorimeter	Ammonia-N (Total)	Nitrogen - Nitrate (as N)	CSR D. Metals (No CV-Hg)-Diss	CSR Total Metals (No CV-Hg) in Water	LEPH & HEPH with CSR/CCME PAH in Water	CSR BTEX/VPH in Water	Combined CP/NCP Phenols in Water	# of Bottles	Comments
1	SID#369675	MW12-22																	
2	SID#369676	SW15-01																	
3	SID#369677	SW15-02																	
4	SID#369678	S06-21																	
5	SID#369679	~~S07-24~~																	
6	SID#369680	~~TUP~~																	
7	SID#369681	~~LDS~~																	
8	SID#369682	~~LDMP~~																	
9																			
10																			

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Lab Use Only: Time Sensitive	Temperature (°C) on Receipt	Custody Seal Intact on Cooler?
			Maria Zamora	2024/12/20	08:00			1/2/7	Yes / No

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/COC-TERMS-AND-CONDITIONS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

5/6/6

White: Bureau Veritas Yellow: Client

LCE FROM

Bureau Veritas Canada (2019) Inc.

C4A063
2024/12/20 16:40

C4A4063
2024/12/20 16:40

	MW2-14	MW2A-16	MW3-14	MW4A-16	MW4B-15	MW6-17	MW9-17	MW10-17	MW11-19	MW12-22	SW16-01	SW16-02	S06-21	S07-24	TLIP	LDS	LDMP
	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
	X	X	X	X	X	X	X	X	X	X	-	-	X	X		X	X
	-	-	-	-	-	-	-	-	-	-	X	X	X	X		X	X
	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X
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	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
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	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
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	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	X	X	X	X	X	X	X	X	X	X	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	X	X	X	X		X	X
	X	X	X	X	X	X	X	X	X	X	-	-	X	X		X	X
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	-	-	-	-	-	-	-	-	-	-	-	-	X	X		X	X
	-	-	-	-	-	-	-	-	-	-	-	-	X	X		X	X

ie labelled S07-24, TLIP, LDMP for field duplicates (I only ordered 1 extra bottle for dissolved metals, so can take 1 DUP at a GW well, 1 DUP at S08-21, and 1 DUP at LDS).
dles) ordered from BV, should be in shipment.
LIP, LDMP-1, LDMP-2, LDMP-3, LDMP-4

Sample ID	MW1-14	MW2-14	MW2A-16	MW3-14	MW4A-16	MW4B-16	MW6-17	MW9-17	MW10-17	MW11-19	MW12-22	SW15-01	SW15-02	S06-21	S07-24	TLIP	LDS	LDMP
Analytical Parameters																		
Alkalinity (as CaCO3 pH=8.3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Alkalinity, total (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Chloride (dissolved)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Conductivity	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Hardness	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Hardness (dissolved)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Hydroxide (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Orthophosphate	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Sulphate (Dissolved)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Total Un-Ionized Hydrogen Sulfide as S	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Total Un-Ionized Hydrogen Sulfide as H2	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Total Sulfide as H2S	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Total Sulfide as S	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Total dissolved solids (TDS)	X	X	X	X	X	X	X	X	X	X	X	-	-	X			X	
Total suspended solids (TSS)	-	-	-	-	-	-	-	-	-	-	-	X	X	X			X	
Biochemical oxygen demand (BOD)	-	-	-	-	-	-	-	-	-	-	-	-	-	X			X	
Chemical oxygen demand (COD)	-	-	-	-	-	-	-	-	-	-	-	-	-	X			X	
Ammonia-N	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Bicarbonate (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Carbonate (as CaCO3)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Nitrate (as N)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Nitrite (as N)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Nitrate/Nitrite	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
Dissolved Metals (CSR)	X	X	X	X	X	X	X	X	X	X	X	-	-	-			-	
Total Metals (CSR)	-	-	-	-	-	-	-	-	-	-	-	X	X	X			X	
LEPH / HEPH / PAH	X	X	X	X	X	X	X	X	X	X	X	-	-	X			X	
BTEX / VPH	-	-	-	-	-	-	-	-	-	-	-	-	-	X			X	
Chlorinated phenols	-	-	-	-	-	-	-	-	-	-	-	-	-	X			X	
Non-chlorinated phenols	-	-	-	-	-	-	-	-	-	-	-	-	-	X			X	
Nitrophenols	-	-	-	-	-	-	-	-	-	-	-	-	-	X			X	
Hydroxy phenols	-	-	-	-	-	-	-	-	-	-	-	-	-	X			X	

Field Duplicates: Use bottles labelled S07-24, TLIP, LDMP for field duplicates (I only ordered 1 extra bottle for dissolved metals, so can take 1 DUP at a GW well, 1 DUP at S06-21, and 1 DUP at LDS).

Trip Blank 1 (for volatiles) ordered from BV, should be in shipment.

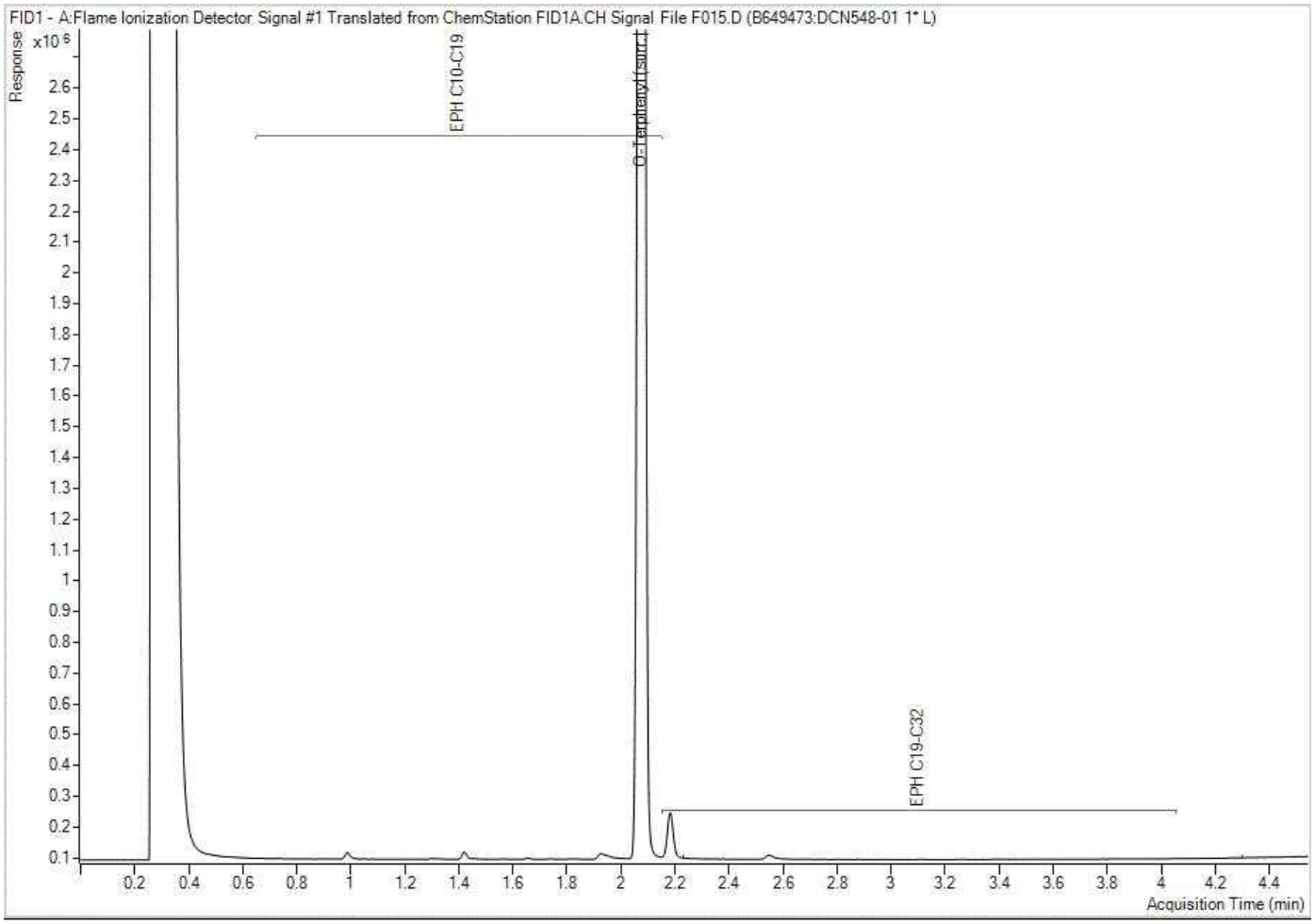
Historically Dry Sampling Points: S07-24, TLIP, LDMP-1, LDMP-2, LDMP-3, LDMP-4

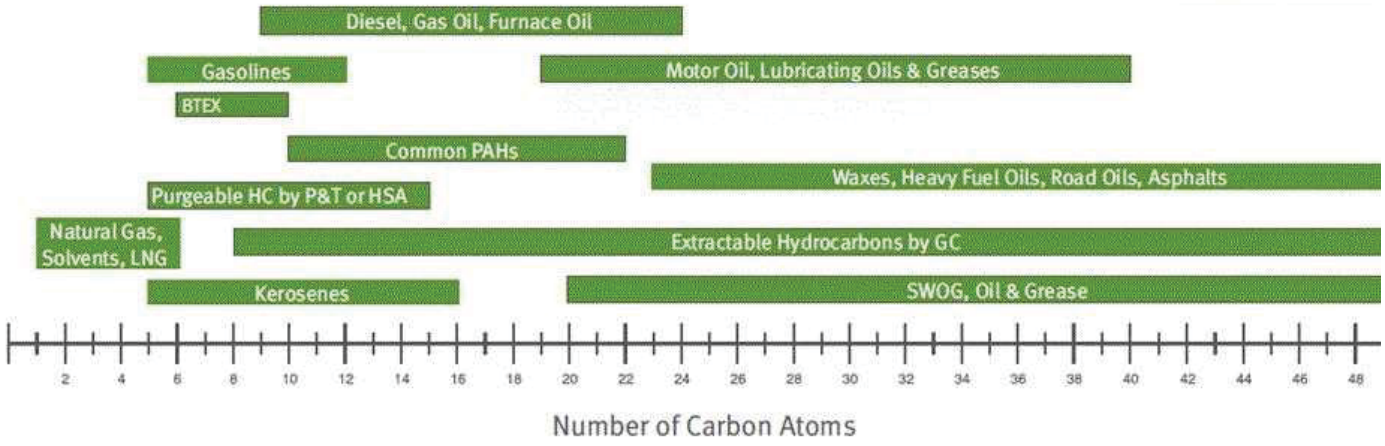
C4A4063_COC

Bureau Veritas Job #: C4A4063
Report Date: 2025/01/15
Bureau Veritas Sample: DCN548

Envirochem Services Inc.
Client ID: MW1-14

EPH in Water when PAH required Chromatogram



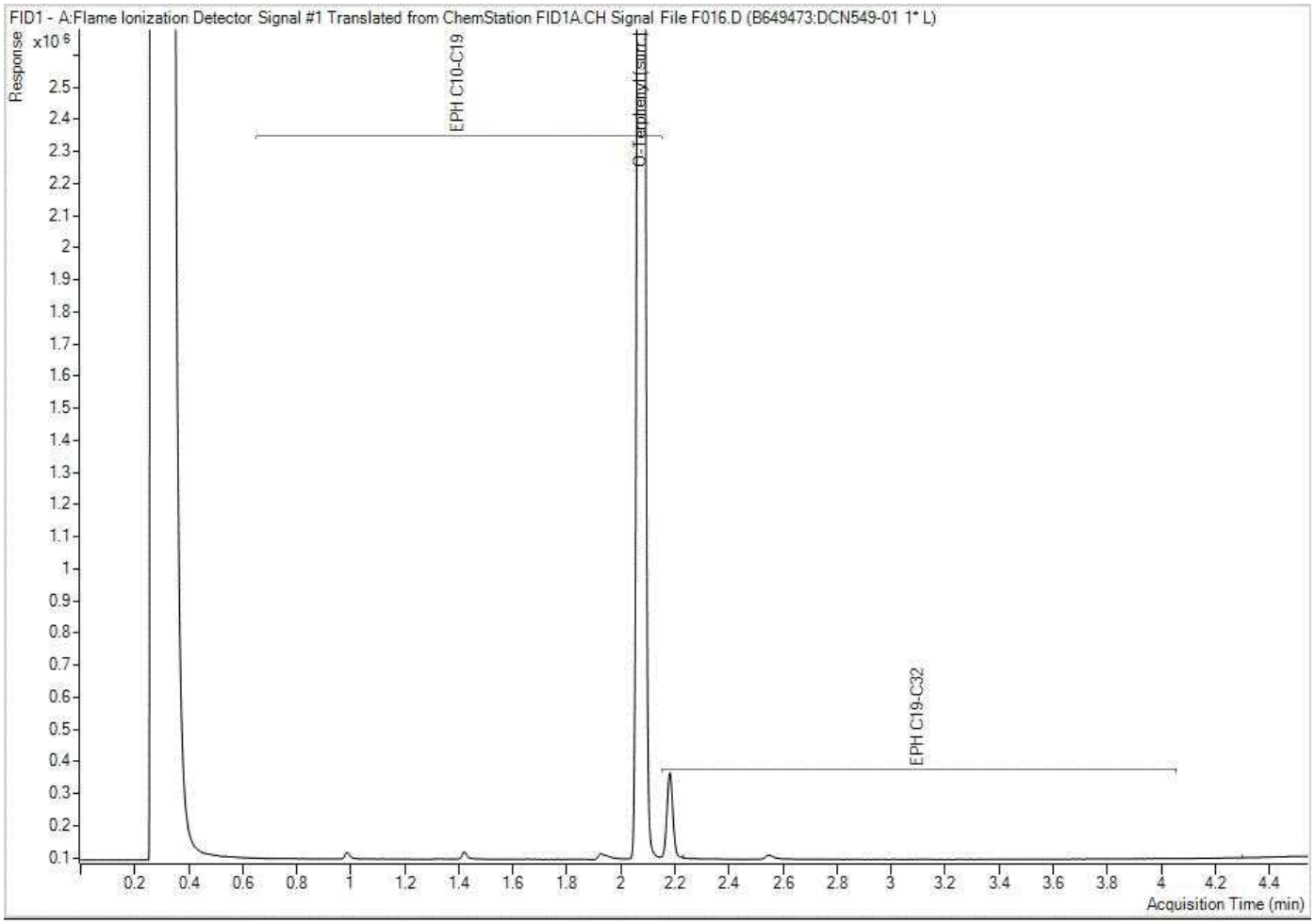


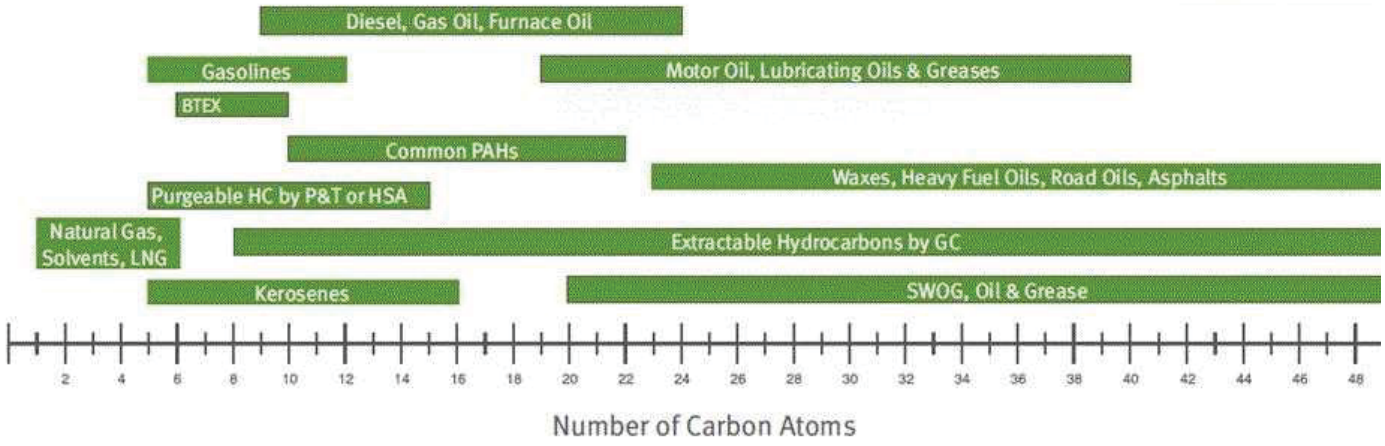
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Bureau Veritas Job #: C4A4063
Report Date: 2025/01/15
Bureau Veritas Sample: DCN549

Envirochem Services Inc.
Client ID: MW2-14

EPH in Water when PAH required Chromatogram



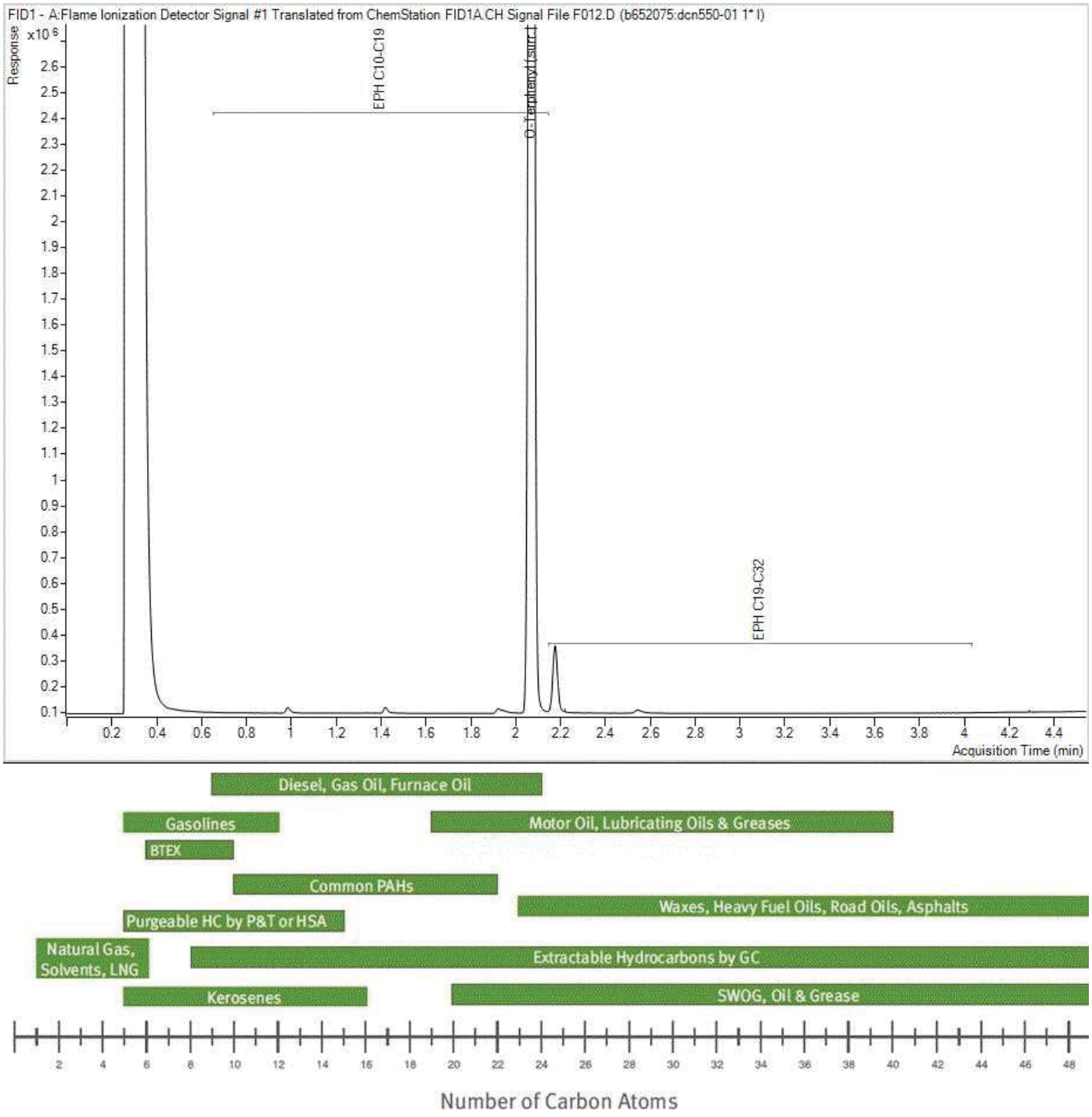


Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Bureau Veritas Job #: C4A4063
Report Date: 2025/01/15
Bureau Veritas Sample: DCN550

Envirochem Services Inc.
Client ID: MW2A-16 DUP

EPH in Water when PAH required Chromatogram

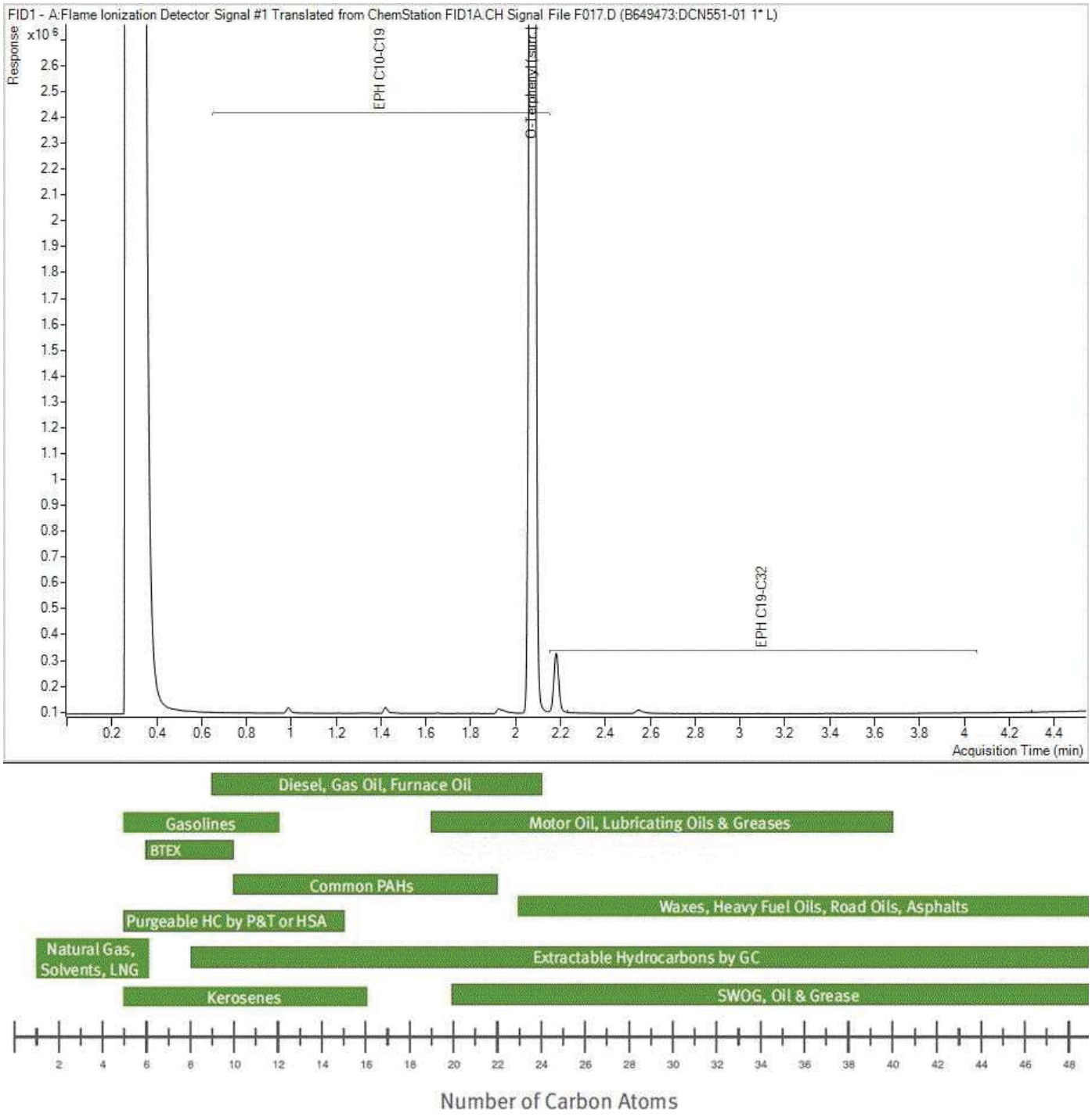


Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Bureau Veritas Job #: C4A4063
Report Date: 2025/01/15
Bureau Veritas Sample: DCN551

Envirochem Services Inc.
Client ID: MW2A-16

EPH in Water when PAH required Chromatogram

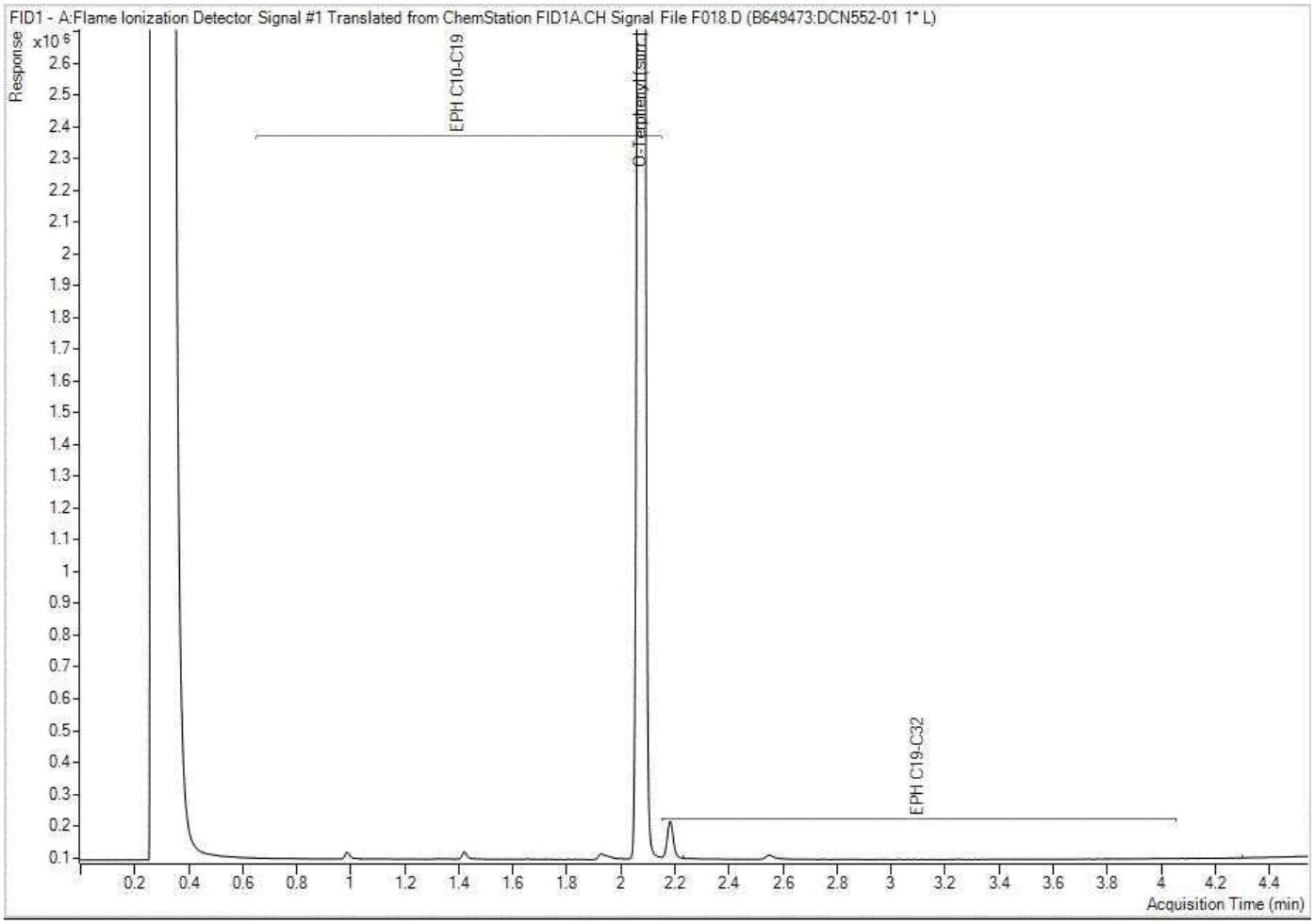


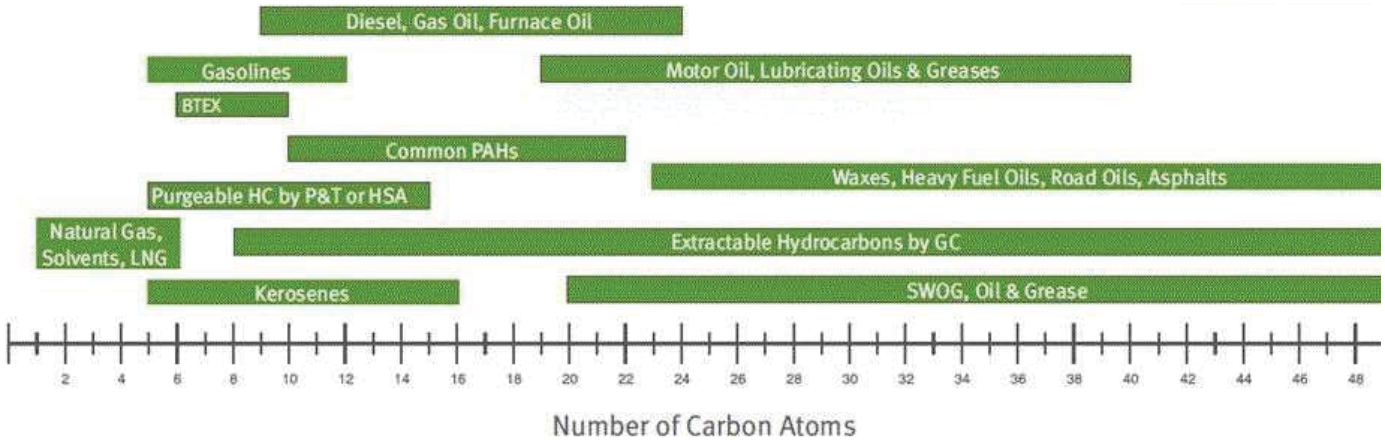
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Bureau Veritas Job #: C4A4063
Report Date: 2025/01/15
Bureau Veritas Sample: DCN552

Envirochem Services Inc.
Client ID: MW3-14

EPH in Water when PAH required Chromatogram



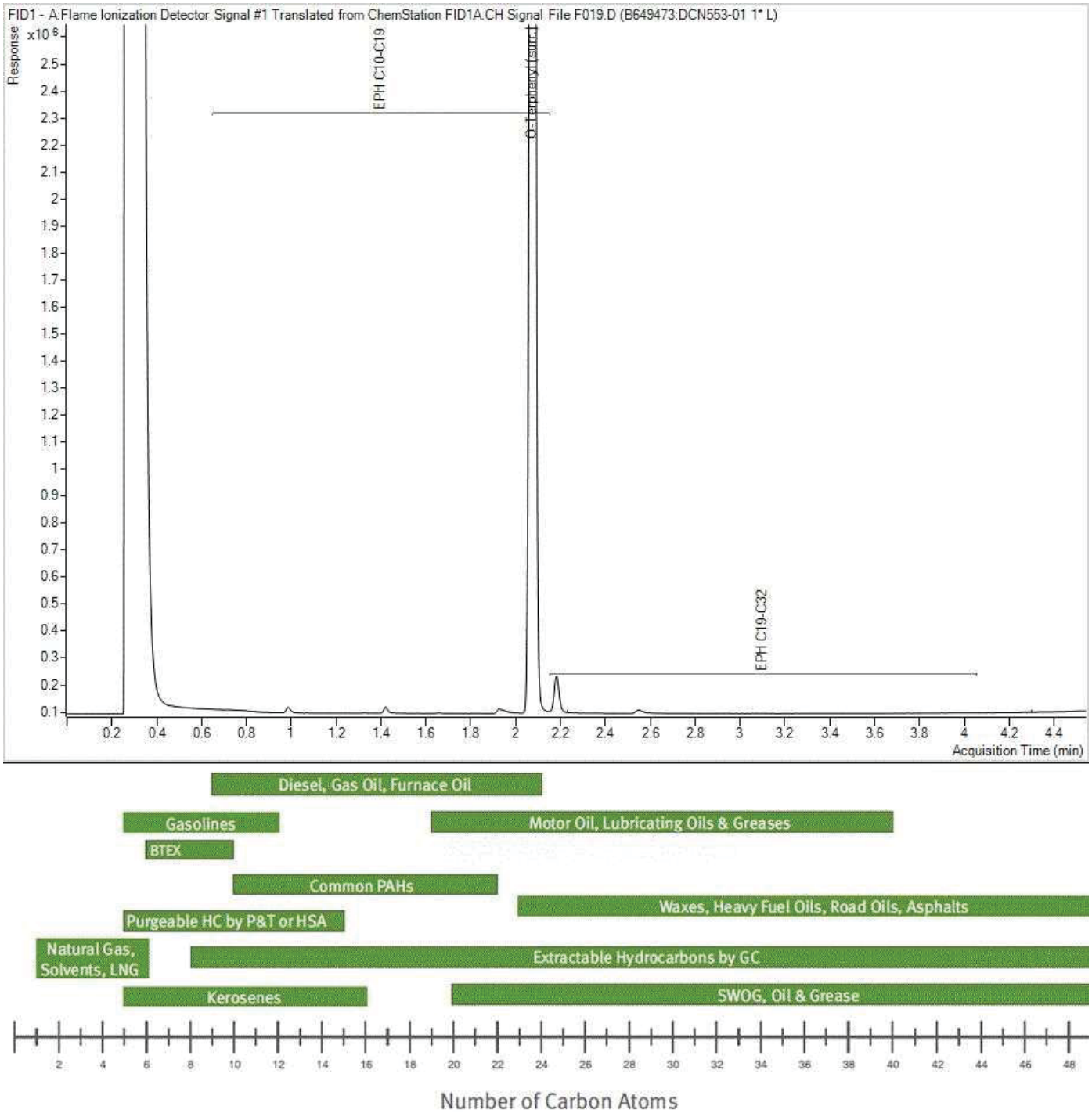


Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Bureau Veritas Job #: C4A4063
Report Date: 2025/01/15
Bureau Veritas Sample: DCN553

Envirochem Services Inc.
Client ID: MW4A-15

EPH in Water when PAH required Chromatogram

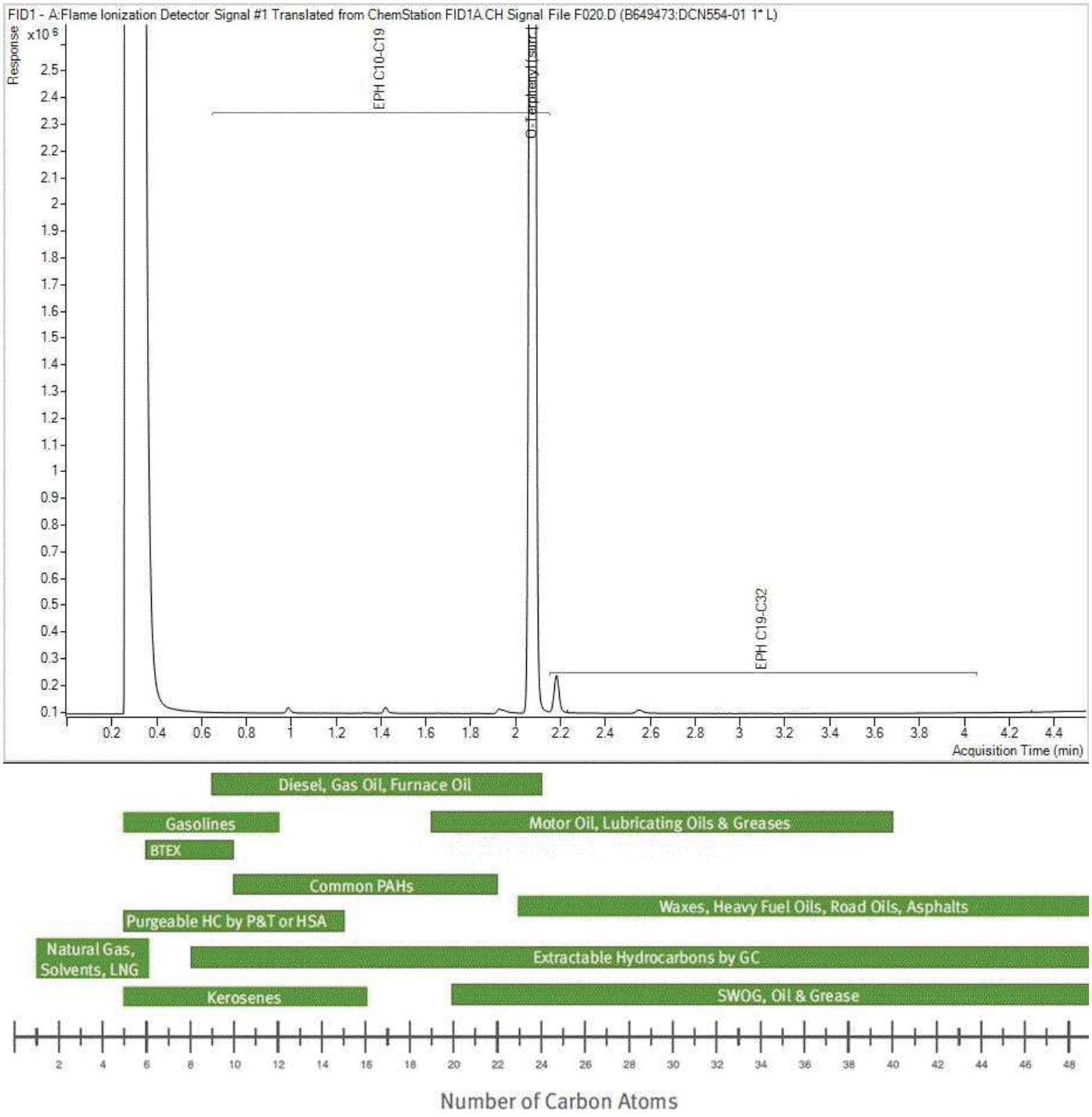


Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Bureau Veritas Job #: C4A4063
Report Date: 2025/01/15
Bureau Veritas Sample: DCN554

Envirochem Services Inc.
Client ID: MW4B-15

EPH in Water when PAH required Chromatogram

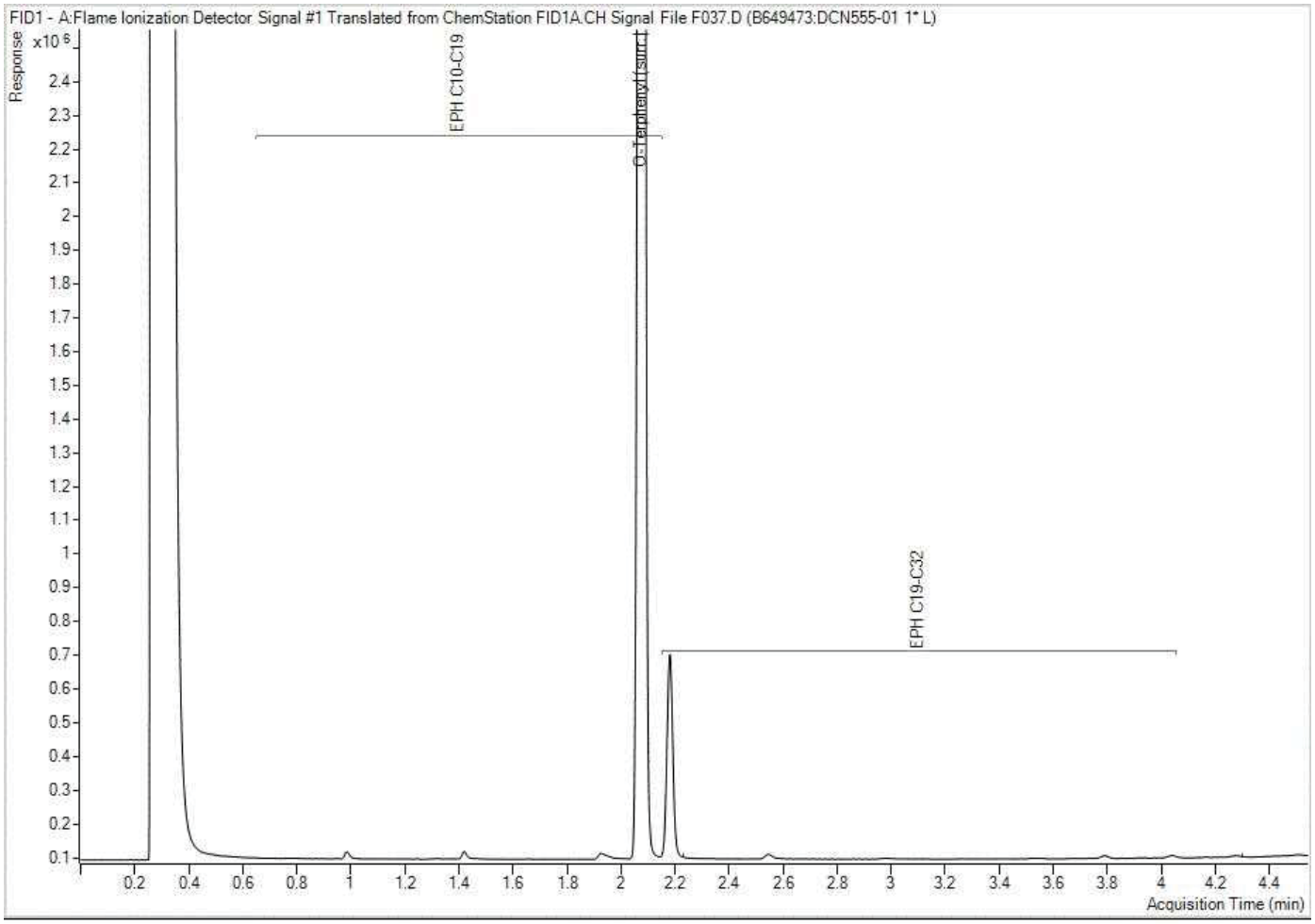


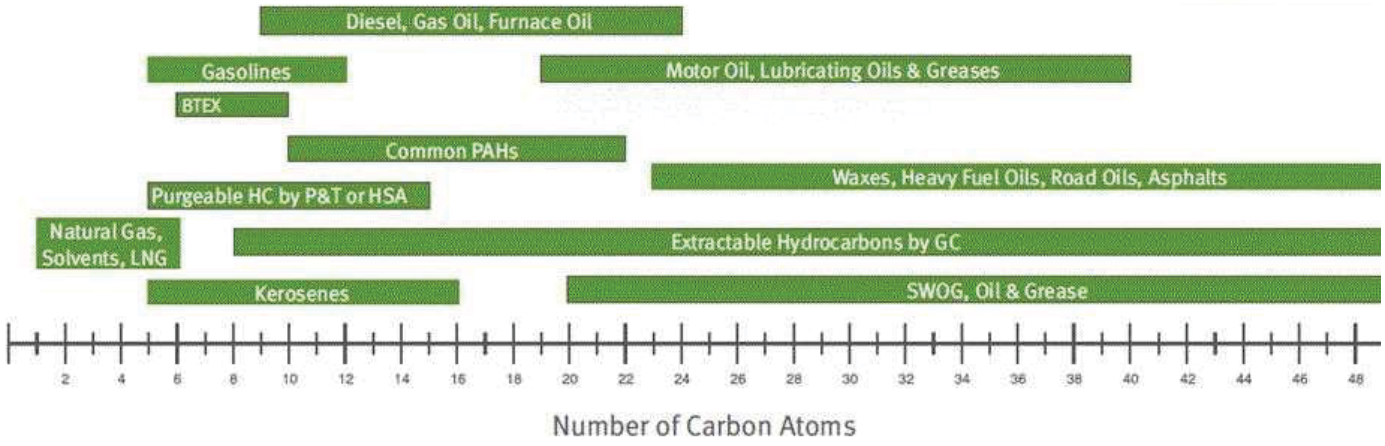
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Bureau Veritas Job #: C4A4063
Report Date: 2025/01/15
Bureau Veritas Sample: DCN555

Envirochem Services Inc.
Client ID: MW6-17

EPH in Water when PAH required Chromatogram



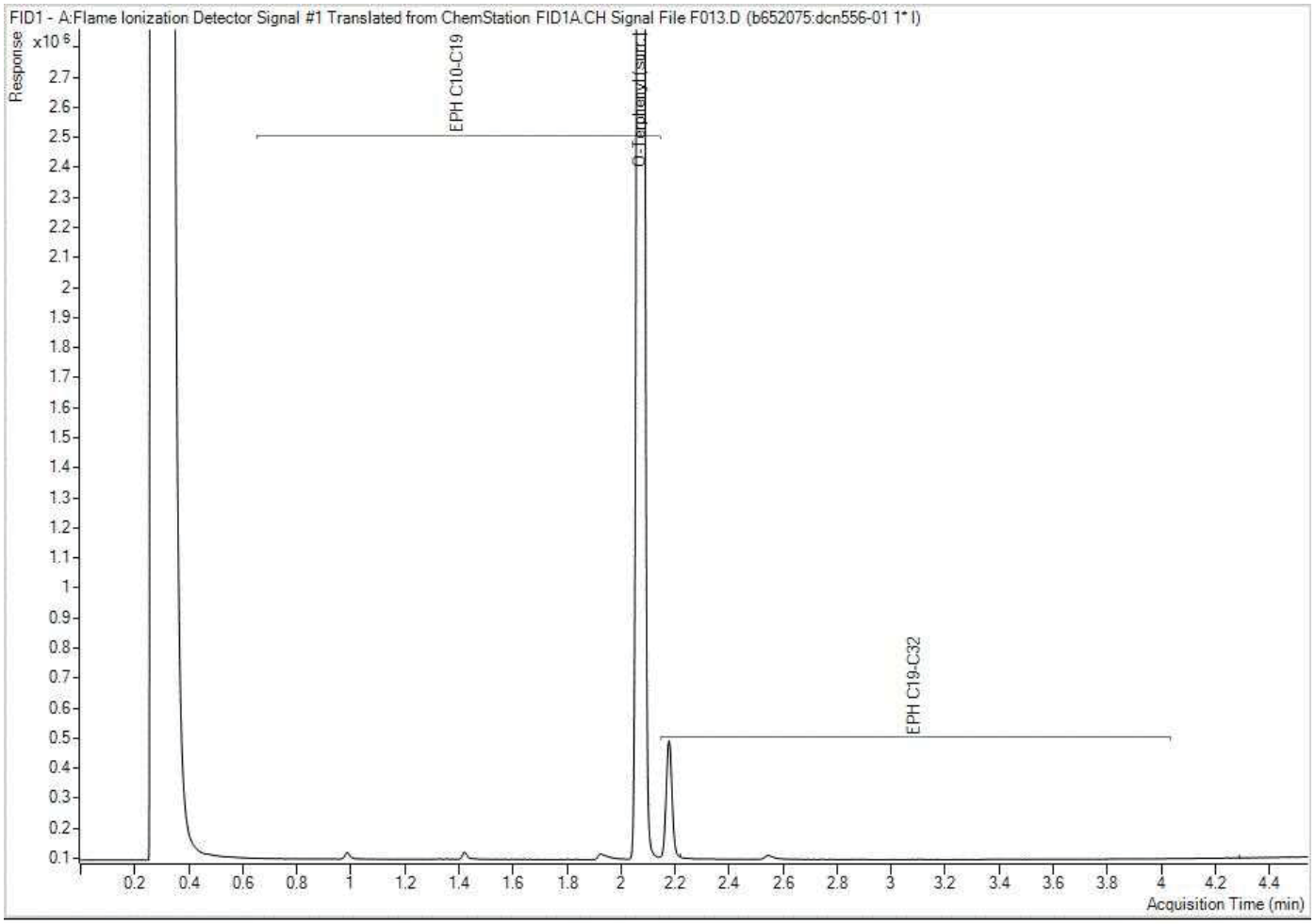


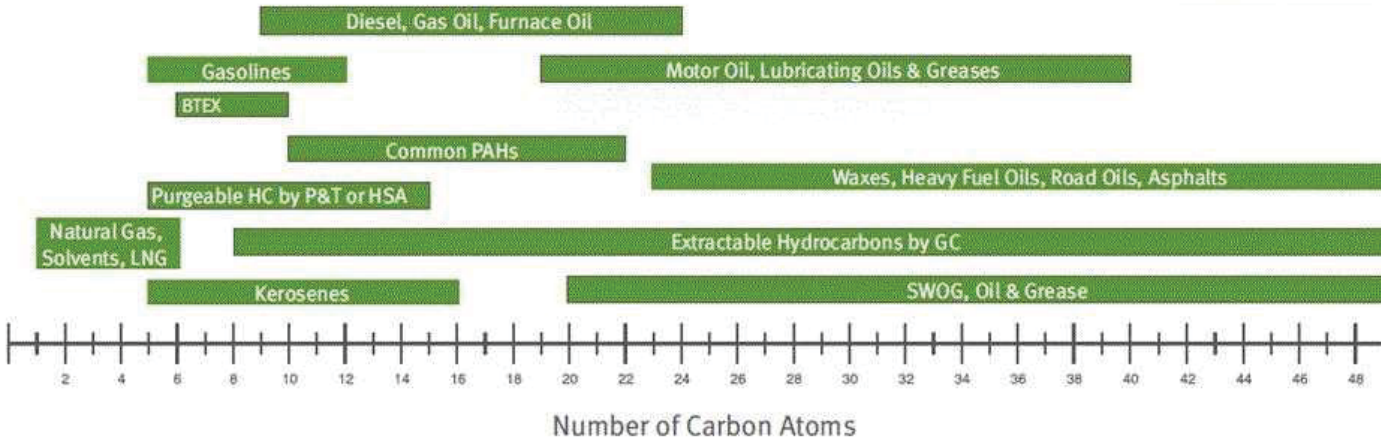
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Bureau Veritas Job #: C4A4063
Report Date: 2025/01/15
Bureau Veritas Sample: DCN556

Envirochem Services Inc.
Client ID: MW9-17 DUP

EPH in Water when PAH required Chromatogram



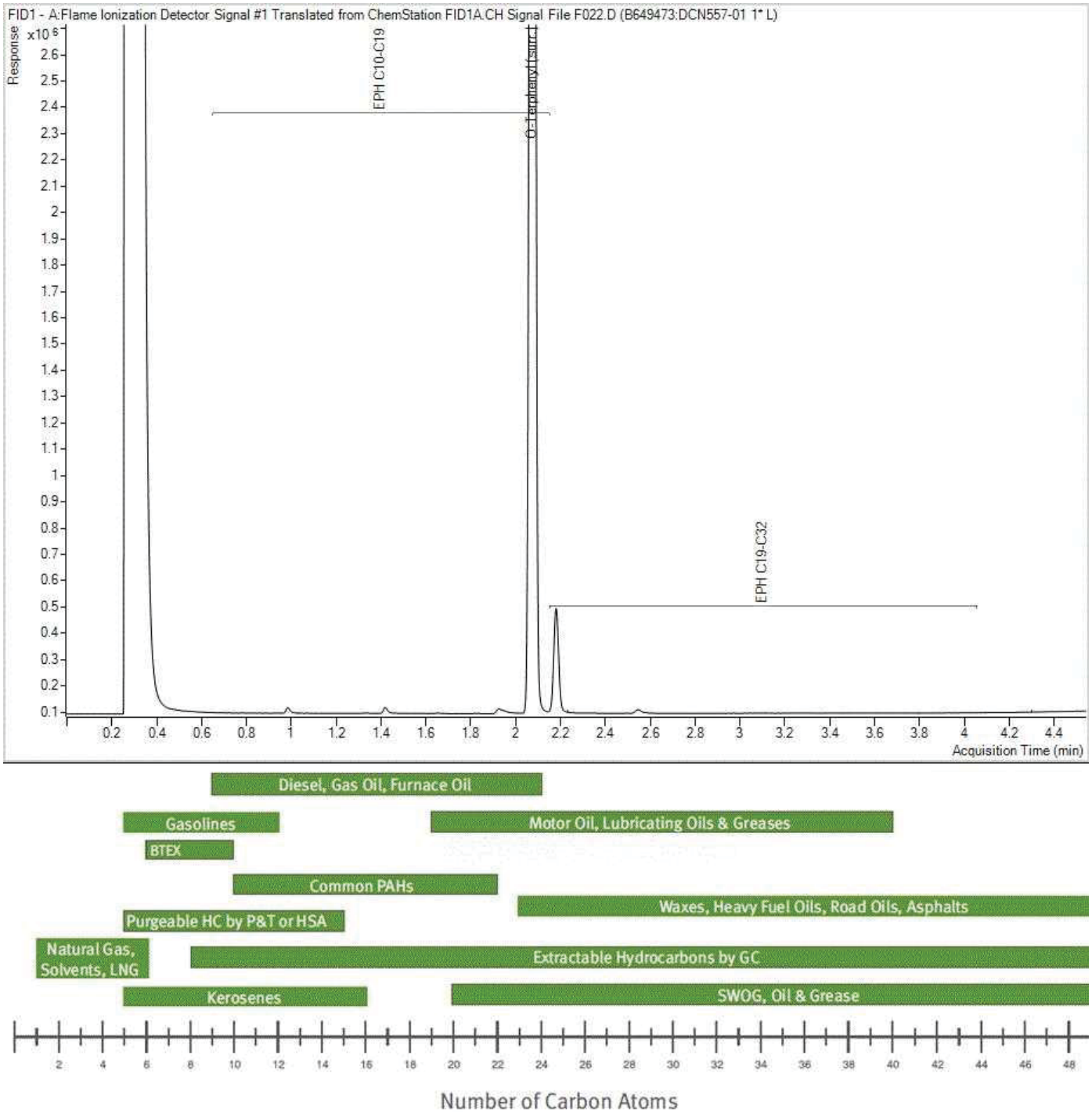


Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Bureau Veritas Job #: C4A4063
Report Date: 2025/01/15
Bureau Veritas Sample: DCN557

Envirochem Services Inc.
Client ID: MW9-17

EPH in Water when PAH required Chromatogram

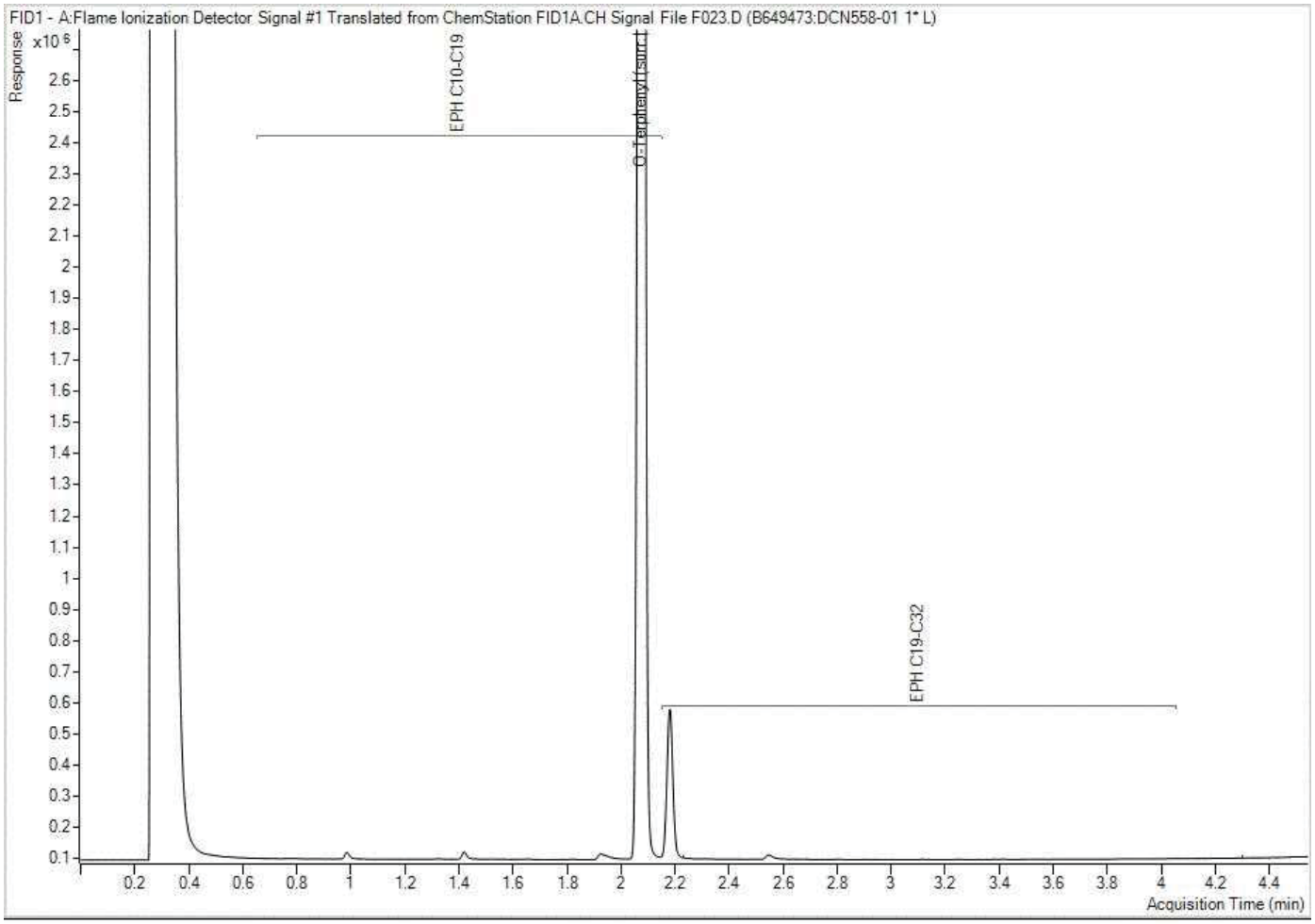


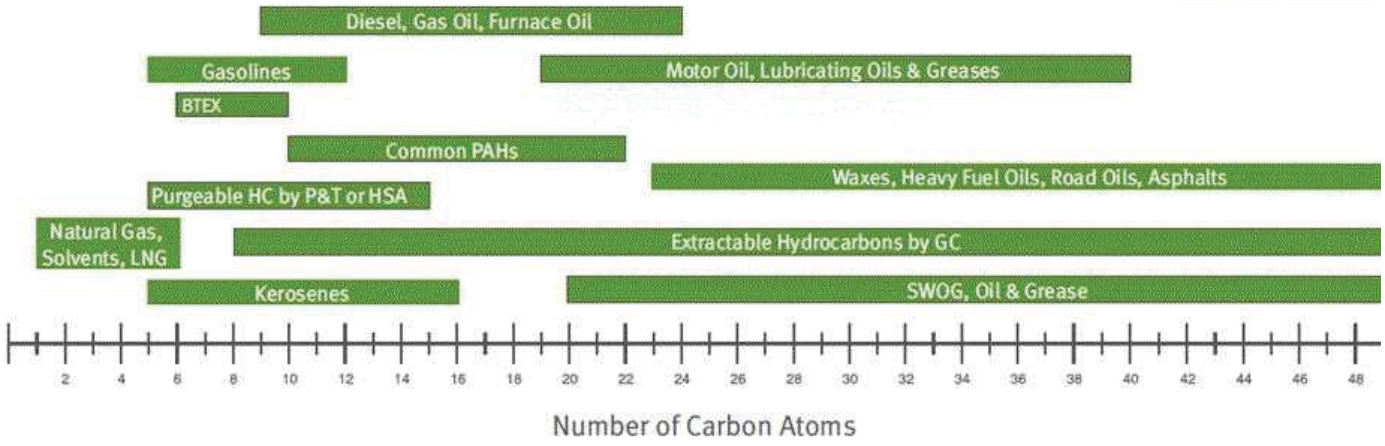
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Bureau Veritas Job #: C4A4063
Report Date: 2025/01/15
Bureau Veritas Sample: DCN558

Envirochem Services Inc.
Client ID: MW10-17

EPH in Water when PAH required Chromatogram



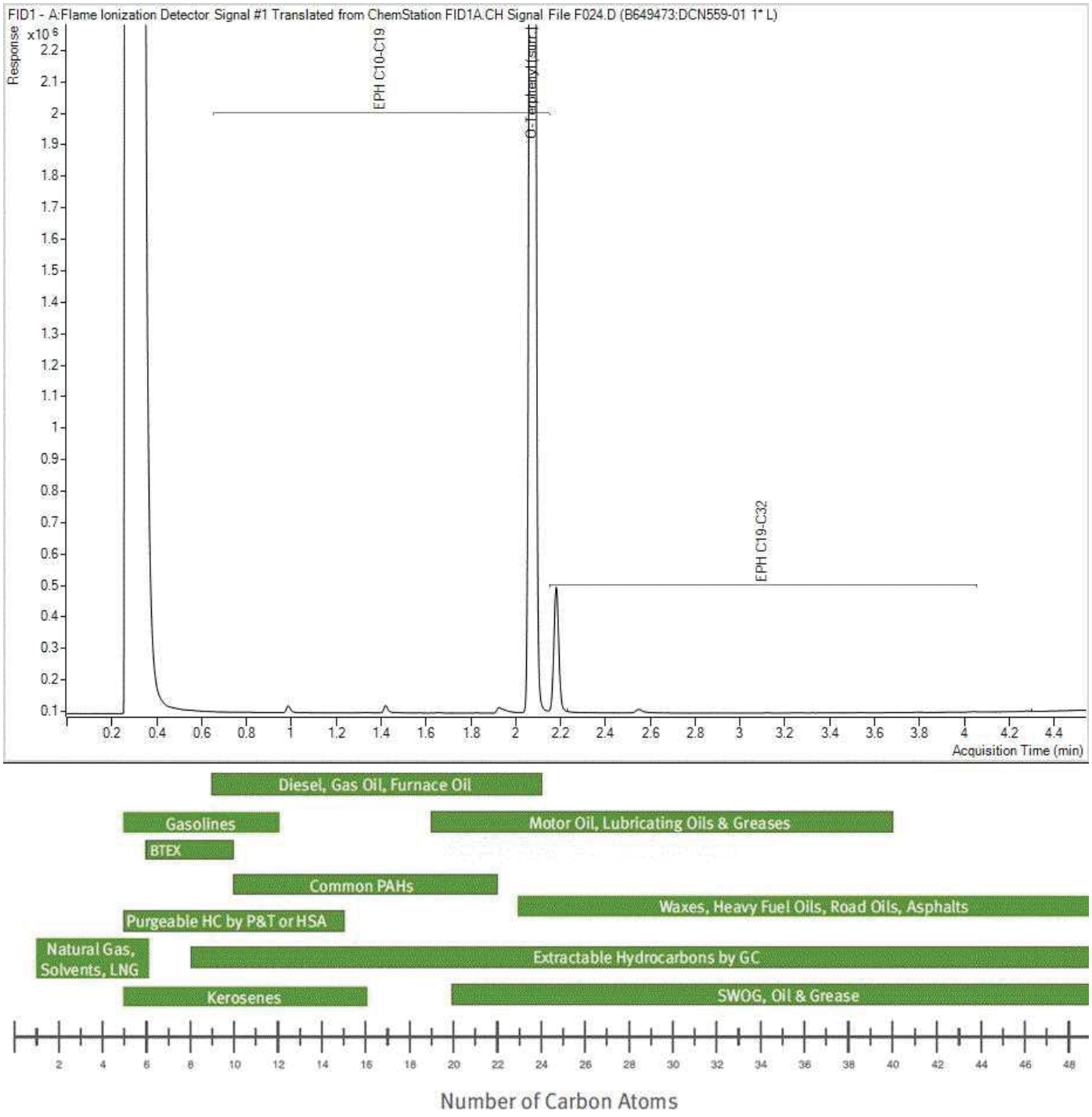


Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Bureau Veritas Job #: C4A4063
Report Date: 2025/01/15
Bureau Veritas Sample: DCN559

Envirochem Services Inc.
Client ID: MW11-19

EPH in Water when PAH required Chromatogram

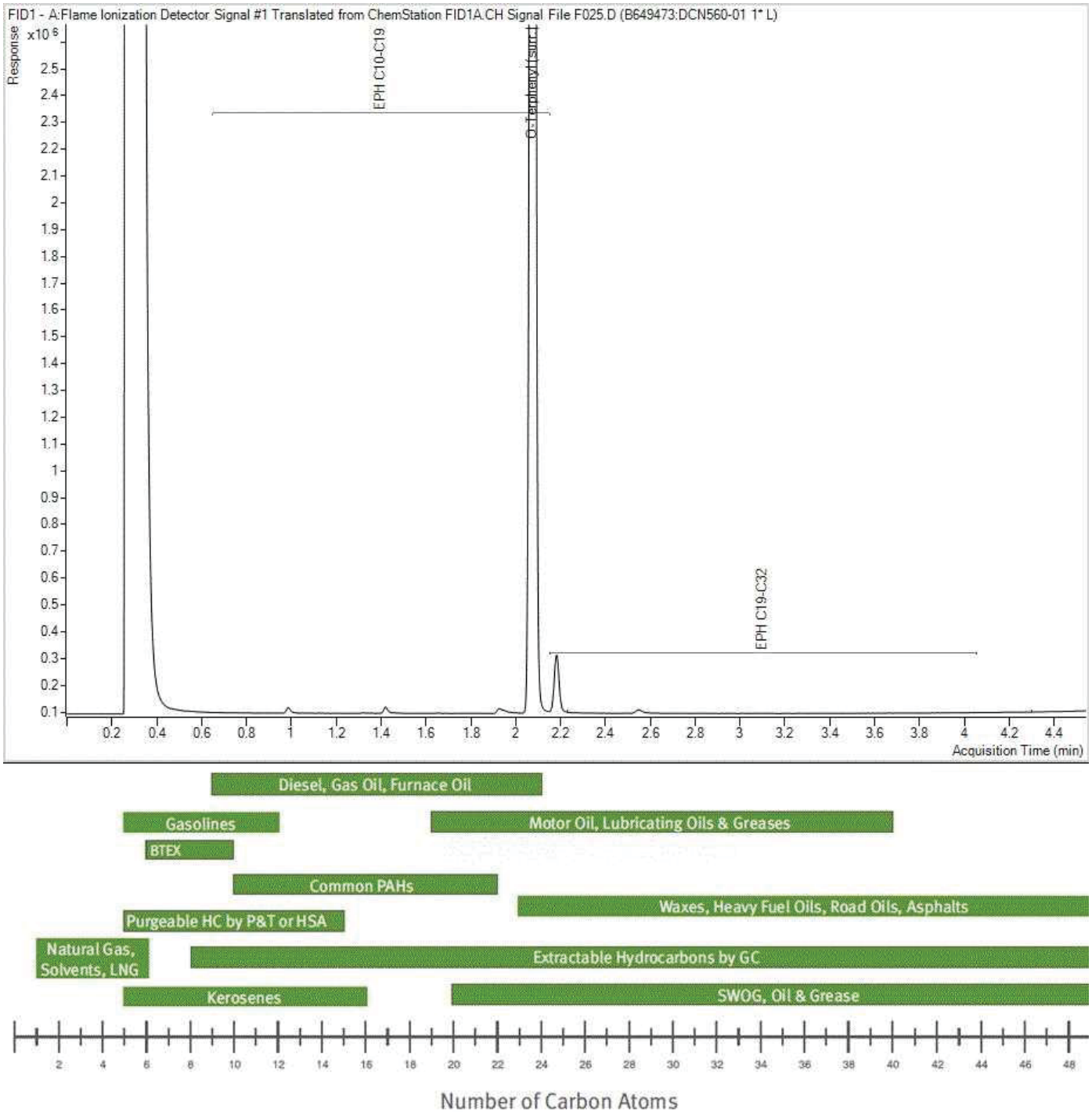


Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Bureau Veritas Job #: C4A4063
Report Date: 2025/01/15
Bureau Veritas Sample: DCN560

Envirochem Services Inc.
Client ID: MW12-22

EPH in Water when PAH required Chromatogram

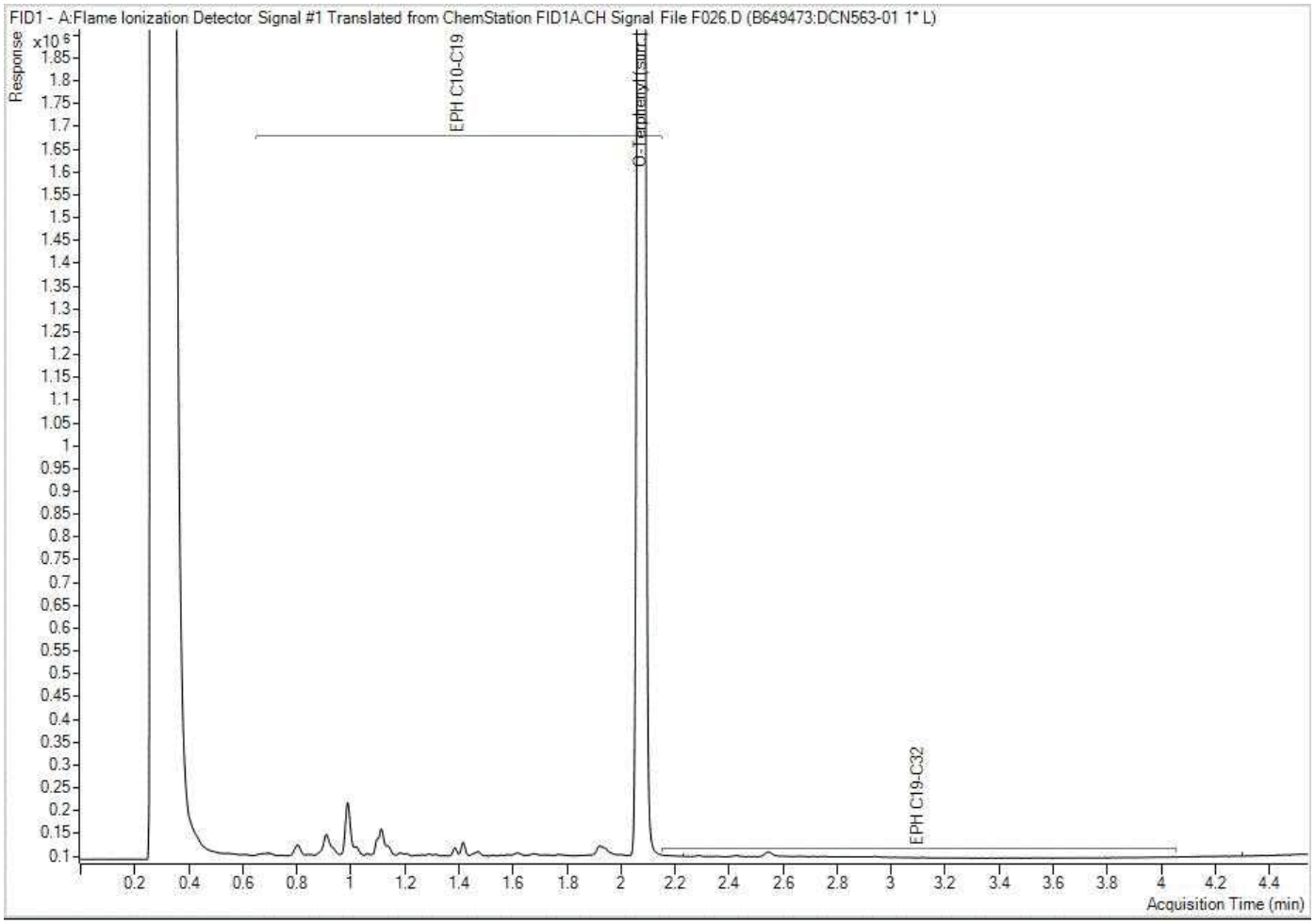


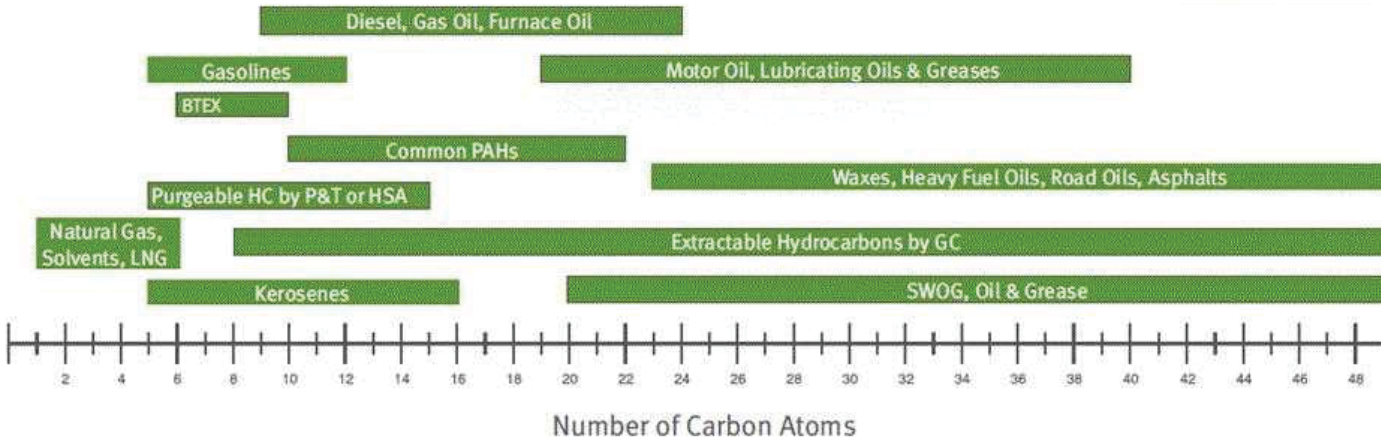
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Bureau Veritas Job #: C4A4063
Report Date: 2025/01/15
Bureau Veritas Sample: DCN563

Envirochem Services Inc.
Client ID: S06-21

EPH in Water when PAH required Chromatogram





Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Your Project #: 24209
Your C.O.C. #: C#746066-01-01

Attention: Paul Dawson

Envirochem Services Inc.
#206 - 267 Esplanade West
North Vancouver, BC
Canada V7M 1A5

Report Date: 2025/01/21
Report #: R3613835
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C507140
Received: 2025/01/15, 09:15

Sample Matrix: Water
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
BTEX/MTBE LH, VH, F1 SIM/MS (1)	3	N/A	2025/01/17	BBY8SOP-00010 / BBY8SOP-00011 / BBY8SOP-00012	BCMOE BCLM Jul 2017
Non-Chlorinated Phenols in Water by GCMS (1)	2	2025/01/20	2025/01/21	BBY8SOP-00054	BCMOE BCLM Jul 2017m
Volatile HC-BTEX (1, 2)	3	N/A	2025/01/18	BBY WI-00033	Auto Calc

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, EPA, APHA or the Quebec Ministry of Environment.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by Bureau Veritas Vancouver, 4606 Canada Way , Burnaby, BC, V5G 1K5
(2) VPH = VH - (Benzene + Toluene + Ethylbenzene + m & p-Xylene + o-Xylene + Styrene)

Your Project #: 24209
Your C.O.C. #: C#746066-01-01

Attention: Paul Dawson

Envirochem Services Inc.
#206 - 267 Esplanade West
North Vancouver, BC
Canada V7M 1A5

Report Date: 2025/01/21
Report #: R3613835
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C507140
Received: 2025/01/15, 09:15

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:
Augustina Isesele, Customer Solutions Representative
Email: Augustina.isesele@bureauveritas.com
Phone# (833) 282-5227
==========
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SEMIVOLATILE ORGANICS BY GC-MS (WATER)

Bureau Veritas ID		DDG484	DDG485		
Sampling Date		2025/01/14 02:50	2025/01/14 02:55		
COC Number		C#746066-01-01	C#746066-01-01		
	UNITS	S06-21	S06-21 DUP	RDL	QC Batch
SEMI-VOLATILE ORGANICS					
Phenol	ug/L	150 (1)	160 (1)	2.5	B663642
2-methylphenol	ug/L	4.4 (1)	3.5 (1)	2.5	B663642
3 & 4-methylphenol	ug/L	170 (1)	130 (1)	2.5	B663642
2-nitrophenol	ug/L	<2.5 (1)	<2.5 (1)	2.5	B663642
2,4-dimethylphenol	ug/L	6.6 (1)	7.5 (1)	2.5	B663642
2,4-dinitrophenol	ug/L	<2.5 (1)	<2.5 (1)	2.5	B663642
4,6-dinitro-2-methylphenol	ug/L	<2.5 (1)	<2.5 (1)	2.5	B663642
4-nitrophenol	ug/L	<2.5 (1)	<2.5 (1)	2.5	B663642
3,4-Dimethylphenol	ug/L	<2.5 (1)	<2.5 (1)	2.5	B663642
2,6-Dimethylphenol	ug/L	<2.5 (1)	<2.5 (1)	2.5	B663642
2-Hydroxyphenol (Catechol)	ug/L	<50 (1)	<50 (1)	50	B663642
3-Hydroxyphenol (Resorcinol)	ug/L	<50 (1)	<50 (1)	50	B663642
4-Hydroxyphenol (Hydroquinone)	ug/L	<5.0 (1)	<5.0 (1)	5.0	B663642
Surrogate Recovery (%)					
2,4,6-TRIBROMOPHENOL (sur.)	%	110	84		B663642
2,4-DIBROMOPHENOL (sur.)	%	101	76		B663642

RDL = Reportable Detection Limit
(1) Detection limit raised due to dilution as a result of sample matrix interference.

Bureau Veritas Courtenay: 2755B Moray Avenue V9N 8M9, Phone: (250) 338-7786. Toll free: (800) 665-8566

CSR BTEX/VPH IN WATER (WATER)

Bureau Veritas ID		DDG484	DDG485	DDG486		
Sampling Date		2025/01/14 02:50	2025/01/14 02:55			
COC Number		C#746066-01-01	C#746066-01-01	C#746066-01-01		
	UNITS	S06-21	S06-21 DUP	TRIP BLANK	RDL	QC Batch
Calculated Parameters						
VPH (VH6 to 10 - BTEX)	ug/L	<300	<300	<300	300	B660147
Volatiles						
Methyl-tert-butylether (MTBE)	ug/L	<4.0	<4.0	<4.0	4.0	B662663
Benzene	ug/L	1.2	1.1	<0.40	0.40	B662663
Toluene	ug/L	9.4	9.1	<0.40	0.40	B662663
Ethylbenzene	ug/L	6.8	6.7	<0.40	0.40	B662663
m & p-Xylene	ug/L	16	17	<0.40	0.40	B662663
o-Xylene	ug/L	8.6	8.5	<0.40	0.40	B662663
Styrene	ug/L	<0.40	<0.40	<0.40	0.40	B662663
Xylenes (Total)	ug/L	25	25	<0.40	0.40	B662663
VH C6-C10	ug/L	<300	<300	<300	300	B662663
Surrogate Recovery (%)						
1,4-Difluorobenzene (sur.)	%	111	108	110		B662663
4-Bromofluorobenzene (sur.)	%	101	99	100		B662663
D4-1,2-Dichloroethane (sur.)	%	102	101	100		B662663
RDL = Reportable Detection Limit						

Bureau Veritas Courtenay: 2755B Moray Avenue V9N 8M9, Phone: (250) 338-7786. Toll free: (800) 665-8566

GENERAL COMMENTS

Results relate only to the items tested.

Bureau Veritas Courtenay: 2755B Moray Avenue V9N 8M9, Phone: (250) 338-7786. Toll free: (800) 665-8566

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
B662663	1,4-Difluorobenzene (sur.)	2025/01/17	109	70 - 130	109	70 - 130	113	%		
B662663	4-Bromofluorobenzene (sur.)	2025/01/17	100	70 - 130	100	70 - 130	100	%		
B662663	D4-1,2-Dichloroethane (sur.)	2025/01/17	95	70 - 130	102	70 - 130	105	%		
B663642	2,4,6-TRIBROMOPHENOL (sur.)	2025/01/20			93	60 - 130	100	%		
B663642	2,4-DIBROMOPHENOL (sur.)	2025/01/20			91	60 - 130	97	%		
B662663	Benzene	2025/01/17	102	70 - 130	106	70 - 130	<0.40	ug/L	NC	30
B662663	Ethylbenzene	2025/01/17	101	70 - 130	98	70 - 130	<0.40	ug/L	NC	30
B662663	m & p-Xylene	2025/01/17	98	70 - 130	96	70 - 130	<0.40	ug/L	NC	30
B662663	Methyl-tert-butylether (MTBE)	2025/01/17	98	70 - 130	103	70 - 130	<4.0	ug/L	NC	30
B662663	o-Xylene	2025/01/17	99	70 - 130	97	70 - 130	<0.40	ug/L	NC	30
B662663	Styrene	2025/01/17	107	70 - 130	105	70 - 130	<0.40	ug/L	NC	30
B662663	Toluene	2025/01/17	99	70 - 130	96	70 - 130	<0.40	ug/L	NC	30
B662663	VH C6-C10	2025/01/17			77	70 - 130	<300	ug/L	NC	30
B662663	Xylenes (Total)	2025/01/17					<0.40	ug/L	NC	30
B663642	2,4-dimethylphenol	2025/01/20			107	60 - 130	<0.50	ug/L		
B663642	2,4-dinitrophenol	2025/01/20			90	30 - 130	<0.50	ug/L		
B663642	2,6-Dimethylphenol	2025/01/20			76	60 - 130	<0.50	ug/L		
B663642	2-Hydroxyphenol (Catechol)	2025/01/20			101	60 - 130	<10	ug/L		
B663642	2-methylphenol	2025/01/20			72	60 - 130	<0.50	ug/L		
B663642	2-nitrophenol	2025/01/20			73	30 - 130	<0.50	ug/L		
B663642	3 & 4-methylphenol	2025/01/20			75	60 - 130	<0.50	ug/L		
B663642	3,4-Dimethylphenol	2025/01/20			87	60 - 130	<0.50	ug/L		
B663642	3-Hydroxyphenol (Resorcinol)	2025/01/20			117	60 - 130	<10	ug/L		
B663642	4,6-dinitro-2-methylphenol	2025/01/20			88	30 - 130	<0.50	ug/L		
B663642	4-Hydroxyphenol (Hydroquinone)	2025/01/20			109	60 - 130	<1.0	ug/L		
B663642	4-nitrophenol	2025/01/20			111	30 - 130	<0.50	ug/L		

Bureau Veritas Courtenay: 2755B Moray Avenue V9N 8M9, Phone: (250) 338-7786. Toll free: (800) 665-8566

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
B663642	Phenol	2025/01/20			111	60 - 130	<0.50	ug/L		

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

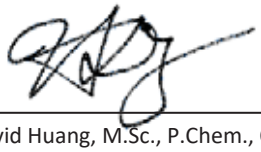
Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

Bureau Veritas Courtenay: 2755B Moray Avenue V9N 8M9, Phone: (250) 338-7786. Toll free: (800) 665-8566

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:



David Huang, M.Sc., P.Chem., QP, Scientific Services Manager



Bureau Veritas Certified by David Huang, M.Sc., P.Chem., QP, Scientific Services Manager

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation, please refer to the Validation Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Raphael Kwan, General Manager, BC and Yukon Regions responsible for British Columbia Food laboratory operations.

Bureau Veritas Courtenay: 2755B Moray Avenue V9N 8M9, Phone: (250) 338-7786. Toll free: (800) 665-8566

Bureau Veritas
2755-B Moray Avenue, Courtenay, British Columbia Canada V9N 8M9 Tel:(833) 262-5227 Toll-free:800-563-6266 Fax:(250) 338 7553 www.bvna.com

Chain Of Custody Record

INVOICE TO:		Report Information		Project Information		Laboratory Use Only	
Company Name	#5940 Envirochem Services Inc.	Company Name		Quotation #	C41722	Bureau Veritas Job #	Bottle Order #:
Contact Name	Accounts Payable	Contact Name	Paul Dawson	P.O. #			746066
Address	#206 - 267 Esplanade West	Address		Project #	24209	Chain Of Custody Record	Project Manager
	North Vancouver BC V7M 1A5			Project Name		C#746066-01-01	Augustina Isesele
Phone	(604) 986-0233 Ext: 102 Fax: (604) 986-8583	Phone	Fax:	Site #			
Email	accounts.payable@envirochem.com	Email	paul.dawson@envirochem.com	Sampled By			

Regulatory Criteria

Special Instructions

Note: For regulated drinking water samples - please use the Drinking Water Chain of Custody Form

Samples must be kept cool (< 10°C) from time of sampling until delivery to Bureau Veritas

Turnaround Time (TAT) Required

Please provide advance notice for rush projects

Regular (Standard) TAT ☐
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission) ☐
Date Required: _____ Time Required: _____
Rush Confirmation Number: _____ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Regulated Drinking Water ? (Y / N)	Metals Field Filtered ? (Y / N)	HARDNESS (DISSOLVED, ICP/OES)	Un-ionized Hydrogen Sulphide as S Calc	Sulphide (as H2S)	Total Sulphide	CSR BTEX/VPH in Water	Non-Chlorinated Phenols in Water by GCMS (Hydroxy phenols)	# of Bottles	Comments
1	SID#370693	SW15-01	25/01/14	4:02	H_2O			✓	✓	✓	✓				
2	SID#370694	SW15-02	↓	3:20	↓			✓	✓	✓	✓				
3	SID#370695	S06-21		2:50				✓	✓	✓	✓	✓	✓		
4	SID#370696	S06-21 DUP	↓	2:55	H_2O			✓	✓	✓	✓	✓	✓		
5		TRIP BLANK										✓			
6															
7															
8															
9															
10															

C507140_COC

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Lab Use Only: Time Sensitive	Temperature (°C) on Receipt	Custody Seal Intact on Cooler?
Darryl Stowe	25/01/15	9:15	Michelle Schuurman MRES	25-01-15	09:15		☐	8.8.8	☐ Yes ☒ No

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/COC-TERMS-AND-CONDITIONS.

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White: Bureau Veritas Yellow: Client

Bureau Veritas Canada (2019) Inc.

Your Project #: 24209
Your C.O.C. #: 746533-01-01

Attention: Paul Dawson

Envirochem Services Inc.
#206 - 267 Esplanade West
North Vancouver, BC
Canada V7M 1A5

Report Date: 2025/02/03
Report #: R3618557
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C510586
Received: 2025/01/29, 16:20

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Un-ionized Hydrogen Sulphide as S Calc (1)	4	N/A	2025/02/03	BBY WI-00033	Auto Calc
Hardness (calculated as CaCO3) (1)	4	N/A	2025/01/31	BBY WI-00033	Auto Calc
Field pH (1)	4	N/A	2025/01/29		
Field Temperature (1)	4	N/A	2025/01/29		

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, EPA, APHA or the Quebec Ministry of Environment.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

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Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
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Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by Bureau Veritas Vancouver, 4606 Canada Way , Burnaby, BC, V5G 1K5

Your Project #: 24209
Your C.O.C. #: 746533-01-01

Attention: Paul Dawson

Envirochem Services Inc.
#206 - 267 Esplanade West
North Vancouver, BC
Canada V7M 1A5

Report Date: 2025/02/03
Report #: R3618557
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C510586
Received: 2025/01/29, 16:20

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:
Augustina Isesele, Customer Solutions Representative
Email: Augustina.isesele@bureauveritas.com
Phone# (833) 282-5227

==========

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RESULTS OF CHEMICAL ANALYSES OF WATER

Bureau Veritas ID		DDW787	DDW789	DDW791	DDW792	
Sampling Date		2025/01/27 12:33	2025/01/27 11:50	2025/01/27 11:20	2025/01/27 11:25	
COC Number		746533-01-01	746533-01-01	746533-01-01	746533-01-01	
	UNITS	SW15-01	SW15-02	S06-21	S06-21 DUP	QC Batch
Field Parameters						
Field pH	pH	6.52	6.27	6.81	6.81	ONSITE
Field Temperature	°C	5.0	2.1	21.2	21.2	ONSITE

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MISCELLANEOUS (WATER)

Bureau Veritas ID		DDW787	DDW789	DDW791	DDW792		
Sampling Date		2025/01/27 12:33	2025/01/27 11:50	2025/01/27 11:20	2025/01/27 11:25		
COC Number		746533-01-01	746533-01-01	746533-01-01	746533-01-01		
	UNITS	SW15-01	SW15-02	S06-21	S06-21 DUP	RDL	QC Batch
Calculated Parameters							
Total Un-ionized Hydrogen Sulfide as S	mg/L	<0.0050	<0.0050	8.2	6.5	0.0050	B674801
Total Un-ionized Hydrogen Sulfide as H2S	mg/L	<0.0050	<0.0050	8.7	6.9	0.0050	B674801
RDL = Reportable Detection Limit							

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CSR D. METALS (NO CV-HG)-DISS

Bureau Veritas ID		DDW787	DDW789	DDW791	DDW792		
Sampling Date		2025/01/27 12:33	2025/01/27 11:50	2025/01/27 11:20	2025/01/27 11:25		
COC Number		746533-01-01	746533-01-01	746533-01-01	746533-01-01		
	UNITS	**SW15-01**	**SW15-02**	**S06-21**	**S06-21 DUP**	**RDL**	**QC Batch**
Calculated Parameters							
Dissolved Hardness (CaCO3)	mg/L	21.8	18.7	1080	1080	0.50	B674663
RDL = Reportable Detection Limit							

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GENERAL COMMENTS

Results relate only to the items tested.

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VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:



Mauro Oselin, P.Chem., QP, Scientific Specialist

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Chain Of Custody Record

INVOICE TO:		Report Information		Project Information		Laboratory Use Only	
Company Name	#5940 Envirochem Services Inc.	Company Name		Quotation #	C41722	Bureau Veritas Job #	Bottle Order #:
Contact Name	Accounts Payable	Contact Name	Paul Dawson	P.O. #			T46533
Address	#206 - 267 Esplanade West North Vancouver BC V7M 1A5	Address		Project #	24209	Chain Of Custody Record	Project Manager
Phone	(604) 986-0233 Ext: 102 Fax (604) 986-8583	Phone	Fax	Project Name		C#746533-01-01	Augustina Iseselo
Email	accounts.payable@envirochem.com	Email	paul.dawson@envirochem.com	Site #			
				Sampled By			

Regulatory Criteria:
- [ ] CSR
- [ ] CCME
- [ ] BC Water Quality
- [ ] Other _____

Special Instructions:

SAMPLES MUST BE KEPT COOL (< 10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

Turnaround Time (TAT) Required:

Please provide advance notice for rush projects

Regular (Standard) TAT: [ ]
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission) [ ]
1 DAY [ ] 2 Day [ ] 3 Day [ ] Date Required: _____
Rush Confirmation Number: _____ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Metals Field Filtered ? (Y / N)	Alkalinity @25C (pp, total), CO3,HCO3,OH	Chloride/Sulphate by Auto Colourimetry	Total Sulphide	CSR D. Metals (No CVI-Hg)-Diss	Un-ionized Hydrogen Sulphide as IS Calc	# of Bottles	Comments
1		SW15-01	25/01/27	17:33	H_2O		✓	✓	✓	✓	✓		
2		SW15-02	"	11:50	"		✓	✓	✓	✓	✓		
3		S06-21	"	11:20	"		✓	✓	✓	✓	✓		
4		S06-21 DUP	"	11:25	"		✓	✓	✓	✓	✓		
5													
6													
7													
8													
9													
10													

C510586_COC

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Lab Use Only: Time Sensitive	Temperature (°C) on Receipt	Custody Seal Intact on Cooler?
Danny Stowe	25/01/28	16:30	Skylar H.	29/01/28	16:20		[ ]	2.2.2	[ ] Yes [X] No

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ATTACHMENT D

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All investigations utilizing this standard of care will involve an inherent risk that some conditions will not be detected, and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to change over time and those making use of this report should be aware of this possibility and understand that the report only presents the conditions of the sampled points at the time of sampling. No warranty expressed or implied is made.

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APPENDIX F:
2021 GHD DOCP



2021 Design, Operations and Closure Plan

Northwin Landfill
Upland Pit Property
Campbell River, British Columbia

Upland Excavating Ltd.

GHD | 138 East 7th Avenue Suite 100 Vancouver British Columbia V5T 1M6 Canada

088877 | Report No 14 | July 8, 2021

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Symbols and Abbreviations

%	Percent
AMSL	Above Mean Sea Level
AW	Fresh Water Aquatic Life
BC	British Columbia
BOD	Biological Oxygen Demand
C&D waste	Construction and Demolition Waste
Ca	Calcium
CH_4	Methane
CHI	Computational Hydraulics International
City	City of Campbell River
CLS	Contaminating Life Span
cm/sec	centimetre per second
CO_2	Carbon Dioxide
COC	Contaminant of Concern
COD	Chemical Oxygen Demand
CSR	Contaminated Sites Regulation
DOCP	Design, Operations, and Closure Plan
DW	Drinking Water
EMA	Environmental Management Act

EMP	Environmental Monitoring Program
Fe	Iron
FOS	Factor of Safety
GCL	Geosynthetic Clay Liner
H2S	Hydrogen Sulfide
Ha	Hectare
HDPE	High Density Polyethylene
HEC-HMS	Hydrologic Engineering Centre-Hydrologic Modelling System
HELP	Hydrologic Evaluation of Landfill Performance
HHCR	Hydrogeology and Hydrology Characterization Report, GHD 2021
HWR	Hazardous Waste Regulation
ID	Identification Number
IDF	Intensity-Duration-Frequency
km	kilometre
Landfill	New Landfill or Northwin Landfill
Landfill Criteria	Second Edition Landfill Criteria for Municipal Solid Waste, dated June 2016
LCP	Leachate Collection Pipe
LFG	Landfill Gas
LTF	Leachate Treatment Facility
m	Metre
m^2	Square Metre
m^3	Cubic Metre
mm	Millimetre
mm^2	Square millimetre
mm/yr	Millimetre per year
MDL	Method Detection Limit
Mg	Magnesium
ENV	British Columbia Ministry of Environment
MOLO	Manager of Landfill Operations
MSW	Municipal Solid Waste
N_2	Nitrogen
NBCC	National Building Code of Canada
O_2	Oxygen
OC	Operational Certificate
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls

Pit	Upland Sand and Gravel Pit
Ppm	Parts Per Million
Property	7295 Gold River Highway
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance and Quality Control
scfm	standard cubic feet per minute
Site	7295 Gold River Highway
SRD	Strathcona Regional District
SWANA	Solid Waste Association of North America
SWMP	Surface Water Management Plan
TAC	Transportation Association of Canada
TDG	Transportation of Dangerous Goods
TDS	Total Dissolved Solids
TEH	Total Extractable Hydrocarbons
US	United States
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Hydrocarbons
WBM	Water Balance Method
WQG	Water Quality Guidelines
Zn	Zinc

1. Introduction

GHD was retained by Upland Excavating Ltd. (Upland) to prepare the 2021 Design, Operations and Closure Plan (DOCP) for the New Landfill, also known as Northwin Landfill (Landfill) located on the Upland Pit Property (Site).

The Site operates as a sand, gravel and rock quarry and a waste management facility. Aggregate and rock extraction activities have been on-going since 1976 within the Upland Pit, which contains large reserves of sand, gravel and basalt. An existing landfill containing a lined cell and an unlined cell (referred to as the Original Landfill) is located in the southeastern corner and has been in operation since 1992. The plan for the development of a new modernized landfill at the Site and discontinuation of the Original Landfill is described within this DOCP.

The Site is owned by Upland Excavating Ltd., which is part of Upland Group, one of the largest and most diversified construction companies on Vancouver Island, British Columbia (BC). The development of the Landfill has been undertaken by Upland Excavating Ltd. Northwin Environmental, an affiliated company, is responsible for Landfill operations. Mining operations of the Pit are carried out by Upland Contracting Ltd.

The New Landfill is authorized to accept demolition waste, construction waste, landfill clearing waste, soil meeting applicable British Columbia Contaminated Sites Regulation (CSR) industrial land use Standards, and sludge from Landfill leachate or water management works, at a maximum rate of 45,000 tonnes per year.

This DOCP was prepared to satisfy the requirements of the Operational Certificate 107689 (OC) issued August 1, 2019 and following the guidelines of the ENV BC Landfill Criteria for Municipal Solid Waste, Second Edition, dated June 2016 (Landfill Criteria).

Upland submitted an application for an OC amendment in June 2021 to request authorization to discharge contaminated soil that is nonhazardous waste to the New Landfill. This DOCP outlines operational procedure that meet the current authorized waste discharge under Section 1.3 of the OC and provides alternative procedures that will be following subsequent to the issuance of an OC amendment. In addition, the DOCP presents the New Landfill design that meets the considerations outlined in ENV's Interim Considerations for Landfill accepting Contaminated Soils Factsheet (Interim Considerations) (March 2021)[1].

1.1 Definitions

Northwin Landfill is referred to as *New Landfill* in the OC, and *Original Landfill* refers to the existing landfill on the Upland Pit Property.

For the purpose of this report, the term *Landfill* refers to the Northwin Landfill footprint including liner systems, leak detection system, leachate collection and treatment system and related appurtenances. *Original Landfill* is used to describe the existing landfill consisting of an unlined cell

[1] https://www2.gov.bc.ca/assets/gov/environment/waste-management/garbage/gui-tec-04_landfilling_contaminated_soil_factsheet.pdf

and a lined cell. The Original Landfill is operated under the Operations and Closure Plan developed specifically for that site (GHD, Oct 2019).

The term *Site* refers to the Upland Pit Property that supports Landfill operations. The Upland Pit Property also supports operations of a sand, gravel and rock quarry authorized under the Mine Act.

1.2 Purpose and Scope

The purpose of this document is to outline the design, operations, and closure planning for the Landfill, and to fulfill the requirements specified in the OC (Appendix A) and the Landfill Criteria.

The scope of the DOCP is as follows:

- Present the conceptual design of the Landfill including base liner system, leak detection system, secondary base liner system, leachate collection and treatment systems, surface water management systems and final cover.
- Present groundwater flow model and water quality impact assessment.
- Present the Surface Water Management Plan and Leachate Management Plan, including the Leachate Management Works Commissioning Plan.
- Present the operational procedures for waste acceptance and landfilling, including the Soil Acceptance Plan and Original Landfill waste relocation plan.
- Present the Environmental Monitoring Plan.
- Present the Trigger Level Assessment Program and Contingency Plan.
- Present the closure and post-closure requirements for the Landfill.
- Present the Financial Security Plan.
- Demonstrate that the Landfill design, operations, and closure will meet the requirements of the Landfill Criteria and the Interim Considerations.

1.3 Site Location

The Site is located on the eastern portion of central Vancouver Island, approximately 7 km southwest of Campbell River, BC, city centre. The Site has an area of approximately 48 hectares (ha) and is located at civic address 7295 and 7311 Gold River Highway, Campbell River, BC. The Site's southern property coincides with the boundary between the Campbell River (City) and the Strathcona Regional District (SRD). The Gold River Highway and McIvor Lake are located to the north and west of the Site. The legal description is LOT A PLAN VIP30709 DISTRICT LOT 85, SAYWARD DISTRICT, PLAN 30709 EXCEPT PART IN PLAN EPP15087 W ½ of DL 85 (PID: 001-223-321). A Site location map is presented in Figure 1.1. The Landfill and Original Landfill are located in the southern portion of the Site.

1.4 Site Zoning and Adjacent Land Use

The Site is zoned as I-3, as defined by the City of Campbell River Zoning Bylaw No. 3250 dated 2006; last amended June 9, 2015.

The land uses in proximity to the Site include residential, industrial and resource extraction activities (logging and gravel extraction). The area surrounding the Site is not serviced by a municipal sanitary sewer system or water distribution system. Highway 28, also referred to as the Gold River Highway, is located to the north of the Site.

Current adjacent land use is presented in Figure 1.2. To the north and west, on the opposite side of the Gold River Highway, lakefront residential properties line the McIvor Lake shore. To the immediate west surrounding Rico Lake are Upland-owned industrial properties, including the K&D Contracting storage yard on the industrial property north of Rico Lake. There is also a residential property west of the Site just north of Rico Lake. To the northeast of the Site on the opposite side of Argonaut Road, there are a number of industrial properties/activities including a gravel extraction pit, concrete redi-mix manufacturer, wood recycling and processing facility and the Campbell River Waste Management Centre. To the east of the Site on the same side of Argonaut Road is an area of industrial land uses including gravel extraction activities; further east is a large undeveloped rural area that extends generally uninterrupted to the Quinsam River. The property located at the northeast corner of the Site on the same side of Gold River Highway and Argonaut Road is crown land occupied by a telecommunication tower. The Site is bound to the south by forested Upland Resource land located within the administrative boundaries of Strathcona Regional District.

1.5 Regulatory Setting

The Landfill will be operated in accordance with the OC. The following Provincial legislation and guidance documents are applicable to the design, operations, and monitoring of the Landfill at this Site:

- Environmental Management Act
- BC Landfill Criteria for Municipal Solid Waste (BC ENV, 2016) (Landfill Criteria)
- Comox Strathcona Waste Management – 2012 Solid Waste Management Plan, December 2012
- Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills, January 1996 (Environmental Monitoring Guidelines)
- A Compendium of Working Water Quality Guidelines for British Columbia
- Contaminated Sites Regulation
- Hazardous Waste Regulation
- BC Mines Act
- Health, Safety and Reclamation Code for Mines in British Columbia (Revised April 2021)
- Interim Considerations for Landfill accepting Contaminated Soils Factsheet (March 2021)

1.5.1 Previous Waste Discharge Permit (Superseded)

Acceptance and discharge of certain waste materials at the Site were previously authorized under Waste Discharge Permit No. PR-10807, issued under the Environmental Management Act. The Permit was first issued on June 1, 1992. Under the Permit, the Site accepted clean wood wastes that were burned in the permitted Burn Area located along the southern boundary of the Site. The Permit also allowed for the discharge of wastes consisting of construction, demolition, and land clearing waste. Land clearing waste included stumps, trees, selected building demolition debris and residue of combustion from the open burning of wood waste. Permit No. PR-10807 has been superseded by the OC issued in August 2019.

1.5.2 Operational Certificate

Operational Certificate No. 107689 was issued to Upland for the Site on August 1, 2019. The OC allows for a New Landfill to be developed in the southern portion of the Site. The OC authorizes the acceptance and discharge of 45,000 tonnes of waste materials per year into the New Landfill at the Site. The characteristics of the authorized waste materials include construction, demolition, and land clearing wastes and soil that meets the industrial land use standards per the Contaminated Site Regulations (CSR).

The OC also authorizes continued discharge of waste to the Original Landfill until waste discharge commences within the New Landfill, at which point waste located in the Original Landfill is required to be removed and relocated to the New Landfill or other approved facility.

In June 2021 Upland submitted an application to amend the OC to request authorization to discharge soils greater than CSR Industrial Land Use Standards (IL+ soils). IL+ soils are defined as soils with parameter concentrations that exceed CSR Industrial Land Use Standards but are less than criteria for hazardous waste per the Hazardous Waste Regulation (HWR). The amendment application is currently under review by ENV.

1.5.3 Mine Act Permit

Quarry activities for excavation of pit run, blasting, crushing, screening and washing are conducted at the Site under the Mines Act Permit G-8-114 issued December 27, 1989, last amended in March 16, 2021.

2. Site Physical Characteristics

The Site physical characteristics are detailed in GHD's 2021 report entitled Hydrogeology and Hydrology Characterization Report Revision 1 (HHCR). A summary of the Site's physical characteristics is provided below. The monitoring well network referenced in this Section is described in Environmental Monitoring Plan in Section 14.

2.1 Site Topography and Drainage

2.1.1 Surface Water Features On-Site

Natural surface water features are not present on Site. There are two surface water points of diversion located within a one km radius of the Site: Rico Lake and McIvor Lake (iMapBC accessed on May 28, 2020).

2.1.2 Topography

The Site is located on a terrace that is partially surrounded by mountainous terrain to the south and southwest. The natural surface topography on-Site has been altered due to aggregate extraction activities. The aggregate extraction area (the Pit) is located in the centre of the terrace and has been excavated down to a base elevation of approximately 168 mAMSL. The on-Site areas surrounding the Pit are relatively level at an approximate elevation of 190 to 192 mAMSL.

To the southeast and east of the Site, the terrace slopes towards the adjoining property, which operates as a gravel extraction pit, and also gradually toward the Quinsam River located approximately 3.8 km from the nearest Site boundary. The Quinsam River channel is at an elevation approximately 100 m below the base of the Site's excavation.

To the west and south of the Site, surface topography steeply slopes in areas to reflect the following prominent topographic features:

- Rico Lake – Rico Lake is held within a topographic depression. The surrounding land dips toward the lake from 192 mAMSL to a base elevation between 168 mAMSL (CREC, August 2016) and 172 mAMSL (GHD, September 2018).
- Small Mountain – A small mountain is located southwest of the Site. The surface topography in this area rises approximately 100 m above the Site to 292 mAMSL. The mountain ridge gradually slopes to the east along the south Site boundary, towards the adjoining property.

2.1.3 Drainage and Watercourses

Two tertiary watersheds are located on-Site: the Campbell River Watershed and the Quinsam River Watershed, both of which are within the Campbell River Watershed Group. The local watershed divide is located within the southwestern portion of the Site.

The Campbell River Watershed is a sub-watershed of the Campbell River Watershed Group and covers an area of 182,000 ha. The Campbell River Watershed is intersected by three manmade dams, which form Upper Campbell Lake, Campbell Lake, John Hart Lake, and McIvor Lake. McIvor Lake is contiguous with Campbell Lake. Rico Lake drains into McIvor Lake. McIvor and Campbell Lakes drain into John Hart Lake north of the Ladore Falls Dam. John Hart Lake drains into Campbell River.

The Quinsam River Watershed is a sub-watershed of the Campbell River Watershed Group and covers an area of 20,900 ha. The Quinsam River Watershed is bound to the north and west by a mountainous divide that isolates it from the Campbell River Watershed (Blackmun, Lukyn, McLean and Ewart, 1985). The confluence of Campbell and Quinsam Rivers is located approximately 6 km northeast of the Site. The principal surface water feature of the Quinsam River Watershed is the Quinsam River, which is located approximately 3.8 km to the southeast of the eastern Site boundary.

Several ephemeral creeks located approximately 1.0 km to the southeast of the Site provides local drainage. Based on the local topographic data in this area, these creeks either loose water to the underlying aquifer or discharge into the Quinsam River. Lost Lake (also known as Hidden Lake) is located 1.8 km to the northeast of the southeast corner of the Site. Lost Lake drains through Cold Creek, which feeds the Quinsam Hatchery before discharging into the Quinsam River.

The watershed divide between the Campbell River and Quinsam River Watersheds passes just north of the Site (north of the Gold River Highway) and turns southward near the western Site boundary to traverse the southwestern portion of the Site. The watershed divide was determined based on information sourced from iMapBC (2019) and Site-specific data. West of the divide is the Campbell River Watershed. East of the divide is the Quinsam River Watershed.

Further details on the surface water flow model, as well as downgradient site drainage are outlined in the HHCR (GHD, 2021).

2.2 Geology

2.2.1 Regional Geology

Vancouver Island is part of the Wrangellia Terrane, which includes most of Vancouver Island, the Queen Charlotte Islands and parts of central Alaska. The Wrangellia Terrane is composed mostly of widespread, late Triassic aged flood basalts, including the Karmutsen Formation. The Karmutsen Formation consists mostly of submarine flood basalts up to 6 km in thickness. Vancouver Island is extensively faulted with thrust faults associated with the subduction of the Juan de Fuca Plate under the North American Plate (BC MOE and Guthrie, 2005) (Greene, Scoates and Weis, 2005).

At several time periods during the Pleistocene Epoch, Vancouver Island was glaciated with ice up to 2 km thick. During the recession of the last glaciation approximately 14,000 years ago, glacial and glacio-fluvial sediments were deposited, and in some cases reworked and redeposited, to make up many of the present surficial deposits of Vancouver Island. These deposits consist of till that was deposited directly by glacial activity[2] and of glacial outwash composed primarily of poorly sorted, coarse-grained sand and gravel sediments deposited by glacial melt water (Greene, Scoates, and Weis, 2005; McCammon, 1977).

2.2.2 Site Geology

The Site-specific geology has been characterized based on the results of the subsurface investigations including test pitting, drilling and geophysical programs, examination of the Pit sidewalls and bedrock outcrops, and documents reviewed by GHD. Documents reviewed included regional maps, previous reports, and well completion logs from private wells. Field investigations are detailed in the HHCR (GHD, 2021).

Based on the results of the investigations, five major stratigraphic units were identified as follows:

1. Cut/Fill unit
2. Sand and silt unit

[2] This till consists of larger clasts supported in a matrix of fine-grained sediment

3. Sand and gravel unit
4. Sand unit
5. Karmutsen basalt bedrock

2.2.3 Surficial Geology

The surficial geology on-Site is comprised of four units including: cut/fill (gravel extraction or fill), a sand and silt unit, a sand and gravel unit, and a sand unit.

Cut/Full Unit

The Surficial cut/fill units include historical gravel extraction and fill material from on-Site sources.

- Gravel Extraction – The Pit has been in operation since 1969 and extensively modified the natural contours of the Site. In its natural condition, the Site terrace gradually sloped southeast and east toward the adjacent property. Prior to 2013, it is estimated that approximately 25 million cubic metres of granular material was removed from the Pit. The rate of extraction of granular material since 2014 has been approximately 190,000 tonnes per year.
- Fill Material – On the northwest (adjacent to the K&D property) and the southwest corners of the Site, granular fill consisting primarily of sand and gravel was encountered in several of the investigative locations up to a maximum thickness of 4.7 m.

Sand and Silt Unit

A discontinuous, interbedded sand and silt unit consisting of layers of sand with silt, silty sand, or silt with clay was encountered underlying a sand and gravel fill unit in the northwest (next to K&D Property) and southwest corners of the Site underlying the fill unit. The maximum thickness of the interbedded layers to the northwest is approximately 2.9 m (at MW15B-18). To the southwest, this unit is approximately 2.1 m in thickness (at MW5A-15).

Sand and Gravel Unit

A native interbedded sand and gravel unit makes up the majority of the overburden material throughout the Site. The unit consists of coarse grained materials, primarily sand and gravel of varying degrees, with occasional seams of sand and silty sand. This unit varies in thickness from less than 0.5 m to greater than 55 m due to the presence of the underlying bedrock. Along the western portion of the Site, the sand and gravel unit is either not present or thin due to the presence of bedrock outcrops and shallow bedrock. Within the remaining portion of the Site, where bedrock was encountered at much lower elevations, the thickness of the sand and gravel unit is substantial.

Sand Unit

Within the sand and gravel unit, a zone of finer grained sand was encountered at MW2A-16, MW4A/B-15 in the central portion of the Site, at MW10-17 in the southeast portion of the Site, and at MW11-19 at the northeast corner of the Site. This sand unit ranges in thickness from approximately 12 m (at MW4A/B-15) to 25 m (at MW10-17) and varies in composition from sand with gravel to silty sand/sandy silt. The sand unit is a minor component of the larger sand and gravel unit.

2.2.4 Bedrock Geology

Bedrock was encountered on and off-Site at numerous locations during Site investigations.

The bedrock at the Site can be described as fine grained, porphyritic, basalt of the Karmutsen Formation, which varies in colour from blueish black to dark grey and green to dark grey and pink to dark brown (Golder, 2014).

Fracturing is apparent within the upper bedrock unit including evidence of weathering (i.e., iron staining) and secondary mineralization. Fractures vary in size, density and orientation (vertical, horizontal, and oblique). The most significant fracturing was noted in the boring advanced within the Pit (MW4A-15). According to laboratory tests, calcite is present in fractures and amygdules (Golder, 2014). Underlying the upper fractured bedrock is competent bedrock.

The bedrock surface at the Site can be characterized with the following:

- A small mountain is present to the southwest of the Site. The foot of the mountain extends to the southwest corner of the Site boundary where bedrock outcrops are encountered at elevations of approximately 216 mAMSL.
- Bedrock can be described as competent or fractured. Competent bedrock was encountered at MW5A-15 which has a high rock quality designation (RQD), low hydraulic conductivity (1.4×10^{-5} cm/sec), and few fractures. Fractured bedrock was encountered at MW15A-18 which has a low RQD, higher hydraulic conductivity (8.3×10^{-3} cm/sec) and shows signs of weathering. At this location, no primary porosity or obvious weathering on fractured surfaces was apparent within the upper 1.2 m of bedrock. Weathered and sub-vertical and horizontal fractures were observed below the upper 1.2 m of bedrock from 9.5 to 15.2 m BGS. Precipitate of fractured surface was observed.
- The bedrock surface dips sharply across the Site towards the northeast and east. Underlying the Pit, bedrock was encountered between 183.0 mAMSL (outcrop in the southwest corner) to 145.25 mAMSL in the central portion of the Pit. Bedrock was not encountered in the investigation locations east of BH1-16. MW2A-16 was completed at an elevation of 127.68 mAMSL and did not intersect the bedrock surface. Thus, bedrock is at an elevation below 127.68 mAMSL.
- A bedrock highpoint was encountered northwest of the Pit, on the K&D Contracting property. This localized highpoint is present at elevations 183.5 to 182.1 mAMSL.
- South of the highpoint on the K&D Contracting property and northwest of the foot of the mountain, bedrock dips steeply towards Rico Lake.
- Several outcrops of competent bedrock were identified between the Small Mountain and the bedrock highpoint on the K&D Contracting property. This line of bedrock outcrops is interpreted to be a bedrock high within the western portion of the Site. Bedrock topography is the primary controlling feature on groundwater flow and overland surface water flow within the western portion of the Site. Bedrock in this area is interpreted to form a flow divide, which is part of the watershed divide between the Campbell River and Quinsam River Watersheds. Groundwater and overland flow east of the bedrock high is interpreted to flow towards the Site and into the Pit area, while groundwater and overland flow to the west is directed towards Rico or McIvor Lake.
- Borehole and geophysical data identified the presence of a sand and gravel scour channel that extends northeast from Rico Lake through the vicinity of MW15A/B-18.

2.3 Hydrogeology

2.3.1 Site Hydrogeology

The following three hydrostratigraphic units have been identified for the Site:

1. Sand and gravel aquifer
2. Shallow aquifer
3. Bedrock aquifer

The hydrogeologic properties and division of these aquifers are discussed in the following sections.

2.3.1.1 Sand and Gravel Aquifer

The sand and gravel aquifer occurs across the Site in the sand and gravel unit where the sand and silt unit is not present (northwest and southwest). As no bedrock was encountered during drilling along the northern Site boundary (MW8-17 and MW9-17) the sand and gravel aquifer is inferred to extend off Site to the north to intersect McIvor Lake.

The sand and gravel aquifer identified on-Site is a major aquifer in the region and is identified in iMapBC (May 29, 2020) as Aquifer 975. This aquifer is interpreted to be the principal groundwater flow zone at the Site. In the context of the future Landfill, this aquifer is the receptor of infiltrated treated effluent and infiltrated stormwater runoff. As such, this aquifer is of particular importance to this hydrogeologic characterization.

Groundwater elevations within the sand and gravel aquifer, (measured on March 11, May 7, and September 30, 2019), ranged from 144.8 mAMSL (MW11-19) to 184.8 mAMSL (MW7-17). Groundwater within the sand and gravel aquifer flows from northwest to southeast (i.e., from McIvor Lake to the southeast corner of the Site).

The McIvor Lake surface water elevation is partially controlled by BC Hydro's Ladore Dam located on the northern shore of McIvor Lake approximately 1.7 km northwest of Site. BC Hydro attempts to maintain a preferred water elevation at Ladore Dam between 176 and 178 mAMSL and has established a minimum operational water elevation of 174 mAMSL (BC Hydro, 2016). Based on BC Hydro records, water elevations at Ladore Dam have fluctuated between 174.5 and 177.9 mAMSL since 2008.

An average hydraulic gradient of 0.03 m/m is calculated for the sand and gravel aquifer across the Site (gradient calculated between McIvor Lake and MW10-17).

Based on single well response testing and pumping tests, the conservative estimate of hydraulic conductivity for the sand and gravel aquifer is approximately 2×10^{-2} cm/s.

Across the Site, the vadose zone ranged in thickness from 2.5 m at MW4B-15 to 49.2 m (MW11-19). Underlying the landfill footprint and downgradient of the landfill, the thickness of the vadose zone ranged from 13.1 m (MW3-14) and 49.2 m (MW11-19), respectively.

Further discussion on the properties of the sand and gravel aquifer, as well as seasonal variability can be found in the HHCR (GHD, 2021).

2.3.1.2 Shallow Aquifer

A relatively thin, discontinuous shallow aquifer is present in an area within the northern portion of the Site and throughout the K&D Property, between Rico Lake and the Pit, and in the southeastern corner of the Site (outside of the Pit). Groundwater flow in this area is largely controlled by bedrock surface topography.

Groundwater flow within the shallow aquifer in the northern portion of the Site varies west and east of the groundwater divide. West of the divide, groundwater flows to north toward McIvor Lake and south to Rico Lake. East of the divide, groundwater flows east towards the Pit and recharges the underlying sand and gravel.

Between Rico Lake and the Pit, groundwater within the shallow aquifer flows horizontally toward the Pit, and the scour channel and well nest MW15A/B-18 before recharging the sand and gravel aquifer.

Groundwater at the southeastern corner of the Site, in the vicinity of MW5A/B-15 is present within a thin overburden layer overlying competent bedrock. Groundwater at this location is approximately 23 m above the base of the Pit. Based on the presence of a mountain to the south, groundwater will likely flow downwards (potentially daylighting as seepage or through overburden materials as unsaturated flow) towards the Pit area where it will ultimately join the principal flow zone within the sand and gravel aquifer, flowing to the southeast. Flow from the vicinity of MW5A/B-15, is expected to be limited. This is evidenced by the relatively thin saturated thickness compared to the remaining sand and gravel aquifer monitoring wells.

2.3.1.3 Bedrock Aquifer

Groundwater movement through the upper bedrock is variable across the Site based on the presence of fractures. Shallow fractured bedrock was encountered underlying the sand and gravel aquifer at MW3-14, MW4A-15, BH1-16, BH2-16 and MW15A-18. Competent bedrock was encountered at MW5A-15. Due to the significant thickness of the sand and gravel aquifer in the eastern portion of the Site the bedrock was not encountered in the eastern portion of the Site.

Groundwater within the shallow fractured bedrock is monitored at MW15A-18 and MW4A-15. Monitoring well MW15A-18 is located on the K&D property. MW4A-15 is located in the central portion of the Site[3]. The bedrock aquifer in competent bedrock is monitored at MW5A-15, which is located southwest of the Pit.

Groundwater elevations at bedrock monitoring well MW15A-18 were 0.3 to 0.9 m higher than MW15B-18, which is screened within the shallow aquifer. This well nest is also screened in fractured bedrock and the shallow aquifer. The differences in elevation indicate the presence of an upward vertical hydraulic gradient between the fractured bedrock and the overlying shallow aquifer. As such, the bedrock recharges the shallow aquifer.

Groundwater elevations at bedrock monitoring well MW4A-15 were on average 0.2 m higher than at MW4B-15 which is screened within the sand and gravel aquifer, with the exception of the 2.2 m difference recorded during the April 6, 2017 monitoring event which appears to be anomalous.

[3] MW3-14 is located in the west side of the aggregate pit and is partially screened in the bedrock aquifer and partially screened in the sand and gravel aquifer. The predominant flow system in this area is in the sand and gravel aquifer. Groundwater elevations measured in MW3-14 are more representative of overburden groundwater conditions in the sand and gravel aquifer.

The difference in elevation indicates the presence of an upward vertical hydraulic gradient between the shallow fractured bedrock and the overlying sand and gravel aquifer. As such, the bedrock recharges the sand and gravel aquifer in this area.

It is expected that the flow in the shallow fractured bedrock will follow regional flow (i.e., southeast towards the Quinsam River). This groundwater flow movement within bedrock is expected since the upper fractured bedrock is in direct hydraulic contact with the overlying sand and gravel aquifer and the similar hydraulic conductivity measured in the sand and gravel aquifer and the shallow fractured bedrock unit will limit groundwater flow-line inflections (i.e., direction changes).

The upward gradient noted above indicates that a component of groundwater from the shallow fractured bedrock aquifer will flow upwards and join the principal groundwater flow in the sand and gravel aquifer towards the south-southeast.

2.4 Climate

The climate of the east coast of Mid Vancouver Island, where the Site is located, is marked by wet and mild winters, and warmer drier summers.

Climatic data for the Site are based on Environment Canada's Climate Normals measured between 1980 and 2010 at the Campbell River Airport (Climate ID: 1021261). The average total monthly precipitation data and average daily temperature records are presented in Table 2.1, following the text. The average annual precipitation is reported to be 1,489 millimetres (mm) with over 75 percent of the precipitation occurring between October and March. November and December experience the most precipitation with an average of 232 and 226 mm, respectively. On average 84 mm of snowfall is recorded per year.

The Pacific Climate Impacts Consortium Plan2Adapt tool[4] was used to estimate the potential climate impacts that may be observed in the Campbell River area during the life of the Landfill as a result of climate change. The tool was used to model current climate change predictions in terms of precipitation rates. The model results for the Strathcona Region are summarized in the table below.

Table 2.1 Plan2Adapt Estimated Change in Precipitation (2050s)

		Projected Change from 1961-1990 Baseline to 2050s (2040-2069) Study Period for Comox Valley	
	Season	Ensemble Median	Range (10th to 90th Percentile)
Precipitation (%)	Annual	+2.7%	-1.4% to +6.7%
	Summer	-15%	-41% to +3.6%
	Winter	+5.2%	+0.004% to +10%

[4] https://services.pacificclimate.org/plan2adapt/app/ Accessed June 26, 2021.

3. Landfill Design

3.1 Design and Siting Criteria

The Landfill design is based on the design requirements outlined in the Landfill Criteria and the OC. The following design criteria were considered in developing this DOCP:

3.1.1 Design Criteria from the Landfill Criteria

Siting Criteria

- Minimum 50 metre (m) buffer zone between limit of refuse and the property boundary.
- Minimum 30 m of natural or landscaped screening (berms and/or vegetative screens) adjacent to the property boundary.
- Minimum 500 m buffer zone between the limit of refuse and an existing or planned sensitive land use. Sensitive land uses include, but are not limited to: schools, residences, hotels, restaurants, cemeteries, food processing facilities, churches and municipal parks.
  - One residence is approximately 450 m upgradient from the Landfill footprint. As the waste will not contain significant quantities of organic material, the potential for nuisance impacts from odour or birds will not occur, as further discussed in Section 6.8.
- Minimum 100 m buffer zone between the limit of refuse and a heritage or archaeological site.
- Minimum 8 km buffer zone between the limit of refuse and an airport.
  - The nearest airport is located approximately 6.5 km from the Site; however, it is not anticipated that this will cause a problem as birds will not be attracted to the non-putrescible waste to be deposited at the Site.
- Minimum 300 m buffer zone between the limit of refuse and a water supply well or water supply intake.
- Minimum 500 m buffer zone between the limit of refuse and a municipal or other high-capacity water supply well.
- Minimum 100 m buffer zone between the limit of refuse and a geologically unstable area.
- Minimum 100 m buffer zone between the limit of refuse and an environmentally sensitive area.
- Minimum 100 m buffer zone between the limit of refuse and surface water.
- Minimum 100 m buffer zone between the limit of refuse and the sea level maximum high tide or seasonal high watermark of an inland lake shoreline.

Landfill Design

- Landfill base shall be a minimum 1.5 m above groundwater.
- Landfill base shall be graded to provide a minimum 2 percent grade for the primary drainage path (leachate collection piping) and minimum 0.5 percent for the secondary drainage path (drainage blanket).

- 300 mm thick stone drainage blanket with perforated collector pipes with protective geotextile layers. Stone drainage blanket shall be constructed of 50 mm diameter clear stone with minimal fines. The maximum drainage path in the drainage blanket to a leachate collection pipe shall be 50 m.
- The final cover barrier layer (permeability less than 1 x 10^{-7} cm/s) shall have a minimum compacted thickness of 0.6 m measured perpendicular to the slope with a minimum 0.15 m topsoil layer capable of establishment and sustained growth of the vegetative cover.
- Minimum top slope of 10H:1V (10 percent).
- Maximum side slope of 3H:1V (33 percent).

3.1.2 Design Criteria from the OC

- The secondary base liner and the primary base liner must each include an upper high-density polyethylene double sided textured geomembrane of minimum 1.5 mm thickness underlain by a lower geosynthetic clay liner of hydraulic conductivity less than or equal to 1 x 10^{-7} cm/s. However, geosynthetic clay liners are not required on the south slope of the base more than 1 m above the primary base liner.
- The leachate treatment pond must include from bottom to top; a secondary base liner, leak detection drainage layer and leak collection pipe(s), and a primary base liner. The secondary base liner and the primary base liner must each include an upper high-density polyethylene double sided textured geomembrane of minimum 1.5 mm thickness and a lower geosynthetic clay liner of hydraulic conductivity less than or equal to 1 x 10^{-7} cm/s.
- The leachate treatment pond(s) and treated leachate infiltration pond must maintain a minimum freeboard of 0.6 m at all times.
- Stormwater infiltration area (i.e., pond) must maintain a minimum freeboard of 0.6 m and all other authorized works (i.e., ditches) must maintain a freeboard of 0.3 m.

3.1.3 Design Criteria from the Interim Considerations

- Double composite liner systems should be considered for large landfills and/or any size of landfill that is nearby (less than 1 km) to a drinking water source. (Interim Consideration #5)
- A double composite liner at the leachate collection point with the ability to detect and contain a leak in the secondary leachate collection system should be considered. (Interim Consideration #6)
- Retention ponds and surface water ditches should be designed to retain water from and withstand a 200-year storm event. (Interim Consideration #7)

3.2 Site Layout

The Site activities include active aggregate extraction in the central Pit area and Landfill operations in the southern portion of the Site. The Site layout includes an access road network to facilitate both operations. The Site layout and operations is shown on Drawing C-02.

Site access to Gold River Highway is located in the northwest corner of the Site. A Site office, weigh scale, and operations shop is located near the entrance. An access road descends from the entrance area into the adjacent Pit, which is currently excavated to a depth of approximately 20 m below the surrounding topography. The base of Pit is not intended to be further excavated beyond

the current bottom elevation for the purposes of gravel extraction. An aggregate wash plant is located near the centre of the Pit. The Original Landfill Area is located in the southeast corner of the Site and is accessed by an on-site access road around the perimeter of the central Pit area.

The Landfill footprint is shown on Drawing C-02 and located 50 m north of the southern property boundary to provide a buffer zone in accordance with the Landfill Criteria. The Original Landfill will be decommissioned as part of executing the plan of removal all waste from the Original Landfill, required under Section 2.9 (a) of the OC.

The Landfill leachate treatment facility (LTF) will be located northeast of the landfill footprint, adjacent to the current Original Landfill footprint. The LTF includes a leachate treatment pond and a treated effluent holding pond or equally sized tank. Treated effluent that meets the applicable quality criteria will be discharged into the infiltration pond located north of the Landfill footprint and infiltrated into the aquifer beneath the Site. In the future, the leachate treatment pond and effluent holding pond/tank may be re-located to facilitate aggregate extraction activities.

Surface water infiltration areas will be located north of the Landfill at the base of the Pit, away from the landfilling and aggregate extraction operations.

3.3 Landfill Base Contours

To maximize airspace and to conform with Landfill Criteria design criteria of maintaining the base of the Landfill a minimum of 1.5 m above the groundwater table, the Landfill base will have a grade of 2.75 percent west to east, which will act as the primary drainage pathway, and a two percent grade along the secondary drainage path from south to north. The southern portion of the Landfill will be constructed on the slope of the Pit. The slope will be excavated to slope of two horizontal to one vertical (2H:1V).

The base contours will be constructed on the in-situ sand, gravel, and bedrock material. The geotechnical characteristics of the in-situ soils are discussed in Section 7.

The base contours extend to a maximum depth of approximately 3.5 m below the existing Pit floor elevation, with the exception of the leak detection and leachate collection sumps which extend deeper than the surrounding base contours, as discussed in Sections 3.5 and 3.6. The maximum depth is located at the north-east corner of the Landfill footprint. The base contours extend to the existing Pit floor elevation toward the south-west of the Landfill footprint. The excavation required for construction of the Landfill cells is shown in Drawing C-03.

3.4 Base Liner Systems

The *primary* base liner refers to the composite liner system comprised of an HDPE geomembrane liner and geosynthetic clay liner which underlies the leachate collection system, and the *secondary* base liner refers to the composite liner system comprised from of an HDPE geomembrane liner and geosynthetic clay liner which underlies the leak detection system. Detail 2 on Drawing C-13 shows the base liner layers from bottom to top as: Geosynthetic clay liner, HDPE geomembrane, geocomposite drainage layer (for leak detection), Geosynthetic clay liner, HDPE geomembrane, non-woven geotextile, stone drainage blanket (for leachate collection) and woven geotextile.

For both the primary and secondary liner systems:

High Density Polyethylene (HDPE) geomembrane

The HDPE geomembrane liner will meet or exceed the following specifications:

- Minimum thickness of 1.5 mm (60 mil)
- Minimum service life of 100 years
- High quality seams

A leak detection survey will be completed on the HDPE geomembrane after installation to ensure a quality installation.

A review of HPDE liner performance is included in Appendix B.

Geosynthetic clay liner

Per the Landfill Criteria, the geosynthetic clay liner will have equivalent performance to the following compacted clay liner specifications:

- Soil will contain minimum 25 percent clay and minimum 60 percent silt and clay by weight
- Minimum compacted thickness of 0.75 m
- Maximum compacted hydraulic conductivity of 1 x 10^{-7} cm/sec
- Minimum organic carbon content of 0.1 percent

A QA/QC program conducted by a qualified professional will be implemented during the construction of the base liner systems to minimize the occurrence of installation defects. The QA/QC program will include non-destructive testing of each seam.

3.5 Leak Detection System

The leak detection system will comprise a geocomposite drainage layer (comprised of a geonet laminated with geotextiles on both surfaces) underlain by the secondary base liner, as described in Section 3.4 above. A sand cushion layer will separate the secondary base liner from the excavated base.

The leak detection system includes the following components:

- Geosynthetic drainage layer.
- Minimum 2.75 percent slope along primary flow path.
- Minimum 2 percent slope along the secondary flow path.
- A leak detection sump at elevation 161.1 m AMSL with a diameter 300 mm riser pipe bedded in a sand drainage layer for monitoring of potential leakage through the Landfill primary base liner.
- Six monitoring ports used for monitoring potential leakage through the Landfill primary base liner.

The leak detection system will lie directly beneath the primary Landfill base liner.

3.6 Leachate Collection System

The leachate collection system for the Landfill includes the following components:

- 300 mm thick, 50 mm diameter, clear, round stone drainage blanket, with minimal fines
- Perforated leachate collection pipes (LCP) with minimum diameter of 200 mm
- Maximum 15 m lateral spacing between leachate collection pipes (LCP) running south to north
- Maximum 50 m drainage path for leachate to travel before it is intercepted by the LCPs
- 2.75 percent slope along primary flow path of the LCPs
- 2 percent slope along the secondary flow path to the LCPs
- Clean-outs at each end of the LCPs
- Maximum leachate head of 0.3 m at any point on the Landfill base liner
- Leachate collection header pipe at the east end of the Landfill running towards the leachate collection sump at a minimum slope of 2 percent
- Leachate sump at elevation 161.1 m AMSL with two leachate sump riser pipes with minimum diameters of 600 mm

3.7 Perimeter Containment Berms

A perimeter containment berm will be constructed on all sides of the Landfill. The purpose of the perimeter containment berm is to:

1. Ensure containment of the leachate within the Landfill. The perimeter containment berm will be lined consistent with the base liner to ensure leachate from within the waste is contained and directed to the leachate collection system. The berm will ensure that precipitation that comes in contact with the side slope of waste and/or daily cover, will not enter the clean surface water perimeter ditching. The berm will separate the runoff within the Landfill and the clean surface water outside of the Landfill. The berm will direct all runoff from within the Landfill to the leachate collection system during fill operations.
2. Provide an embankment to facilitate construction of perimeter ditching, the Site perimeter maintenance road, and the intermediate/final cover tie-in. After placement of intermediate or final cover, surface water run-off will be directed to the perimeter ditch outside of the containment berm.
3. Prevent surface water run-on to the Landfill from the adjacent aggregate pit side slopes and the upper portion of the Site above the Pit. The southern perimeter containment berm will extend on top of the Landfill and will direct surface water run-off from south of the Pit to the east. This surface water berm will extend beyond the limit of waste in the east and west direction, as shown in Drawing C-06.
4. Provide support for the toe of slope of the waste mass.

Details of the berms are presented on Drawings C-16 and C-17 as part of the perimeter tie-in details.

3.7.1 Interim Containment Berms and Rain Flaps

Interim containment berms will be constructed along the inner perimeter of landfill cells where waste will be placed against the berm during filling of an adjacent landfill cell. The interim perimeter berms will ensure containment of waste and leachate within the active cell footprint. Rain flaps will reduce the infiltration area by temporarily covering the inactive portion of a constructed cell with HDPE geomembrane. Surface water diversion swales will also be constructed to promote clean surface water diversion.

3.8 Final Contours

The final contours (top of waste) are presented in Drawing C-06. The final contours were designed in accordance with the Landfill Criteria and provide a maximum side slope of 3H:1V (33 percent) and minimum top slope of 10H:1V (10 percent). The top final cover will have a crest elevation of 192.3 m AMSL, and a peak elevation of 195.3 m AMSL.

The final cover ties into the top of the perimeter berm to minimize the potential for leachate seepage from the perimeter of the Landfill. By constructing the perimeter berm and final cover in this manner, the perimeter ditching and maintenance road may be constructed independently of the final cover and therefore effectively manage storm water run-off at the Site during waste placement activities.

3.9 Surface Water Management Works

The surface water management works will be designed and constructed to meet the following criteria:

- Prevent surface water run-on onto the active Landfill footprint
- Minimize the potential for erosion of cover soils
- Control surface water flow from the clean soil covers from the Landfill
- Design storm water ditching for the conveyance of 1:200-year, 24-hour storm event
- Include allowances for additional precipitation due to climate change, snow-melt, and multi-day precipitation events

The surface water management works are described in Section 8.

3.10 Landfill Gas Management Works

The Landfill gas (LFG) management works will be designed to meet the following criteria:

- Soil gas concentrations at the Landfill boundary will not exceed the lower explosive limit of methane.
- Combustible gas concentrations in on-site buildings will not exceed 20 percent of the lower explosive limit of methane at any time.
- To meet the requirements of LFG Management Regulations and WorkSafeBC requirements.
- All federal, provincial and local ambient air quality objectives for LFG emissions.

Generally, the LFG management works will include a passive LFG venting system within the Landfill footprint and Landfill site perimeter soil gas monitoring probes. The layout of the LFG venting system will be presented at the time of final cover design. The LFG generation assessment and forecasted management works are described in Section 10.

3.11 Final Cover

Final Cover will be applied to the Landfill upon reaching final contours to achieve the following objectives:

- Prevent exposure of waste to humans and wildlife
- Control infiltration of precipitation
- Minimize the uncontrolled release of methane to the atmosphere
- Limit erosion and release of sediment to the surrounding area
- Control the release of odours
- Minimize oxygen infiltration and fire risks
- Provide compatibility with the planned Site end use

The final cover design consists of, from bottom to top:

- 150 mm sand grading layer
- Geosynthetic Clay Liner (GCL)
- 600 mm sand protective layer
- 150 mm vegetated topsoil layer

Topsoil with a minimum thickness of 150 mm and vegetation will be placed on the final cover to promote runoff, evapo-transpiration, and reduce erosion of the cover soil. Topsoil will be comprised of suitable soil to support growth of local vegetation. The vegetation selected will consist of non-invasive plant species with root depths that will not compromise the integrity of the final cover barrier system.

The final cover characteristics are discussed in Section 6.5.3.

3.12 Site Security and Fencing

The Site is fenced along Gold River Highway to prevent unauthorized access to the Site outside of the Landfill operating hours. The security fencing along the Highway includes 2 m high chain link fencing. The Site entrance is secured with a gate and vandal proof locking mechanism.

3.13 Access Roads

The existing Site layout includes a network of safe all-weather access roads to various parts of the Site. The same access roads will be maintained throughout the Landfill operations to provide access to the on-site facilities and to allow for inspection and maintenance. Additional access roads are planned for the future to facilitate access to Landfill and Pit operation areas as shown on Drawing C-02.

3.14 Vector and Wildlife Management and Nuisance Controls

Vector, wildlife, and nuisance management strategies will be employed at the Landfill as discussed in Section 6.9.

4. Life Span Analysis

4.1 Landfill Layout Criteria

Based on the maximum allowable annual discharge volume of 45,000 tonnes per year, and a maximum design capacity of 532,365 m^3 or 692,076 tonnes the Landfill has an approximate lifespan of 13.3 years as shown on Table 4.1. The area of the limit of waste is approximately 180 m by 200 m (Landfill footprint).

4.2 Total Site Volume and Airspace Consumption

The Landfill has a total airspace volume of approximately 532,365 m^3 for waste and cover material. The Landfill is expected to have a lifespan of 13.3 years based on an annual airspace consumption of approximately 106,337 m^3 in the first year (based on 74,746 m^3 from the Original Landfill and up to a maximum of 34,615 m^3 new waste to fill Cell 1 East) and 34,615 m^3 annually each subsequent year. The assumed apparent density, as discussed in Section 4.4, is 1.3 tonnes per m^3, which results in 138,238 tonnes of waste disposed in the first year and 45,000 tonnes annually subsequently. As discussed in Section 1.5.2, waste from the Original Landfill Area is planned to be relocated into the Landfill. The waste relocated from the Original Landfill to the Landfill does not contribute to the allowable 45,000 tonnes per year (see Section 2.9 (b) of the OC). For the purpose of airspace consumption calculations, it is assumed that waste relocation will occur in the first year of operations. The actual timing of waste relocation will depend on factors such on the timing of the issuance of an amended OC by ENV. The first year's airspace consumption is estimated based on the volume of waste in the Original Landfill and the capacity of the Cell 1 East of the Landfill.

4.3 Apparent Density

The apparent waste density, which is used to calculate airspace consumption, is not a true density but a performance measure that represents the mass of waste discharged into each cubic metre of landfill air space. The apparent waste density is a more accurate measure of the efficiency of landfilling since cover soil is excluded from the ratio. The apparent waste density is based on the comparison of the waste tonnage landfilled and the airspace consumed. Soil used as daily and intermediate cover is excluded from consideration since an increase in cover soil usage can increase the true density and provide a skewed representation of landfilling efficiency. In contrast, an increase in cover soil usage will reduce the apparent density.

The forecasted apparent density at the Site is interpolated by comparing typical apparent densities of the two sources of waste streams to be accepted at the Site. Generally, the apparent density observed at waste soil landfills are in the range of 1.5 to 1.8 tonnes per m^3. The apparent density observed at construction and demolition landfills is generally in the range of 0.6 to 1.0 tonne per m^3. As it is anticipated that approximately half of the waste disposed of in the Landfill will originate from each waste stream, an average apparent density of 1.3 tonnes of waste per m^3 of airspace is forecasted for the Site.

5. Development and Progressive Closure Plan

The Landfill development plan has been designed to minimize the area of the active cell, maintain access for operations, and allow for progressive closure of the Landfill. The general north to south filling allows for the continued gravel extraction in the southern Landfill footprint while landfilling commences in the north and allows for integration with Upland Pit Mine Plan (GHD, 2020). The base liner and leak detection system will be constructed in three stages. Similarly, the final closure will be placed in a minimum of three applications.

The conceptual Landfill development plan is presented in Drawings C-08 through to C-12. The conceptual Landfill development plan includes a three-phase approach. Phase 1 contains two stages of filling and Phases 2 and 3 contain three stages of filling.

The Sections below describe the development plan. A summary of the Landfill stages and corresponding airspace is presented in Table 5.1. Table 5.2 provides a material requirement summary for each phase.

5.1 Phase 1

Phase 1 contains two stages, 1 East and 1 West as presented on Drawings C-08 and C-09. The total estimated airspace is 207,784 m^3. The major construction activities during this phase are as follows:

- Construction of the perimeter berms to north and east and required excavation
- Construction of the north eastern most lined cell
- Construction of temporary divider berm to the west and south of the first cell
- Construction of the leak detection system including geocomposite liner, sump and leak detection monitoring ports
- Construction of leachate collection system including collection pipes, leachate header pipes and sump
- Construction of associated leachate management systems, including leachate pump station, leachate treatment pond, effluent holding pond (or equivalent tanks), and treated leachate infiltration pond
- Filling in Stage 1 East
- Construction of the second cell and corresponding leak detection and leachate collection systems to the west including required excavation, perimeter berm and temporary containment berm construction
- Filling in Stage 1 West and application of intermediate cover over eastern, northern and southern portions of Stage 1 East
- Intermediate cover over a portion of Stage 1 East
- Construction of the third lined cell and corresponding leak detection and leachate collection system to the south including excavation and grading of southern slope
- Deployment of final cover over the northeast corner slopes of Stage 1 East (where the slopes have reached final conditions)

5.2 Phase 2

Phase 2 contains three Stages – 2A, 2B, 2C as presented on Drawings C-09 and C-10. The total estimated airspace is 178,820 m^3. The major construction activities during this phase are as follows:

- Filling in Stage 2A
- Removal of intermediate cover as required and filling in Stage 2B
- Application of intermediate cover over southern portion of Stage 2A
- Filling in Stage 2C
- Extension of liner up the southern slope in preparation for Phase 3

5.3 Phase 3

Phase 3 contains three stages, 3A, 3B, 3C as presented on Drawings C-11 and C-12. The total estimated airspace is 145,761 m^3. The major construction activities during this phase are as follows:

- Filling in Stage 3A
- Final cover over side slopes extended
- Filling in Stage 3B
- Filling in Stage 3C
- Complete final cover application over entire Landfill

6. Site Operations

6.1 Authorized Waste

The waste authorized by the OC to be accepted at the Site and discharged into the Landfill is:

- Demolition waste
- Construction waste
- Land clearing waste
- Soil that meets industrial land use standards (<IL), as defined by the CSR
- Sludge from New Leachate Management Works or New Stormwater Works
- Waste asbestos containing materials (ACM) managed according to Section 40 of the HWR
- Other wastes as authorized in writing by the director

The waste not authorized to be accepted at the Site and discharged into the Landfill is:

- Hazardous waste according to HWR, except waste asbestos
- Controlled wastes as defined by the Landfill Criteria
- Attractants (such as domestic waste)
- Waste or recyclables prohibited in writing by the director

6.1.1 Anticipated Change to Authorized Waste

As described in Section 1, Upland has applied for an OC amendment to request authorization for the acceptance of contaminated soils that are not hazardous waste. Subsequent to receiving an OC amendment, the following waste will be accepted for discharge to the Landfill:

- Demolition waste
- Construction waste
- Land clearing waste
- Soil that is not hazardous waste
- Sludge from New Leachate Management Works or New Stormwater Works
- Waste asbestos containing materials (ACM) managed according to Section 40 of the HWR
- Other wastes as authorized in writing by the director

The waste not authorized to be accepted at the Site and discharged into the Landfill is:

- Controlled wastes as defined by the Landfill Criteria
- Attractants (such as domestic waste)
- Waste or recyclables prohibited in writing by the director

6.2 Material Recovery

Materials recovered from the incoming waste streams for re-use/recycling include:

- Yard waste
- Clean wood
- Concrete
- Asphalt
- Gypsum drywall

6.3 Waste Acceptance Policy

This section describes the policies for waste acceptance and adherence to the list of authorized wastes listed in Section 6.1.

6.3.1 Soil Acceptance Plan

The Soil Acceptance Plan provides the procedure that will be carried out before soil is accepted for discharge at the Landfill including screening, receipt of a signed soil acceptance agreement, and review of documents, if necessary. Documents supporting the Soil Acceptance Plan are provided in Appendix C.

The OC states that soil discharge must be “soil in which the concentrations of all substances that are less than the lowest applicable industrial land use standard specified for those substances in (i) the generic numerical soil standards and (ii) the matrix numerical soil standards or (iii) a director’s

interim standard for soil, referred to in Section 41(1)(a) of the Contaminated Sites Regulation, B.C. Reg. 375/96." Subsequent to obtaining a revised OC, Upland will update soil acceptance procedures to allow for acceptance of IL+ soil (soil that is not hazardous waste) per the revised authorization.

Per the OC Section 2.7 (b)(iii), a Qualified Professional is to certify that characterization of fill and soil from sites that may be contaminated is carried out in accordance with ministry procedures and applicable CSR Guidance, Protocols and Procedures prior to acceptance for discharge in the lined cell.

Prior to the acceptance of soil for disposal, Northwin will require a completed Soil Acceptance Agreement (Agreement) and the completion of a soil screening process at the Site by Northwin staff. The Agreement as presented in Appendix C may be amended from time to time.

The Agreement must be executed before any soil can be received and accepted at the Site. With an executed Agreement, the soil screening process, which is a two phased approach, will be completed on soil arriving at the Site for disposal. First, Northwin staff will visually inspect the soil for presence of waste materials or any non-compliance with the soil acceptance plan. Suspect loads will be rejected. Next, Northwin staff will complete an additional visual inspection of the soil following receipt at the Landfill active face to confirm that the accepted soil does not contain waste material and is compliant with the soil acceptance plan. Suspect loads will be isolated and tested or removed off-site by Northwin staff at the cost of the generating company. All rejected or non-compliant loads will be recorded and included in the annual report. The soil screening process is outlined in Appendix C.

6.3.2 Construction and Demolition Waste

Prior to the acceptance of construction and demolition (C&D) waste, the C&D waste will be subject to a waste screening process. Material from deconstructed buildings should be accompanied with a record of Hazard Assessment, as per WorkSafeBC's requirement to confirm the presence of asbestos or other hazardous materials. Additional testing to confirm the C&D waste is non-hazardous may be required as per the requirements of the HWR and ENV Technical Guidance. The submitted data will be compared by Northwin to the Site acceptance criteria to ensure compliance with the OC. Construction debris from new construction will not require a hazard assessment.

6.3.3 Plan to Remove all Waste from Original Landfill

The plan to remove all waste from the Original Landfill is outlined below, as per the requirements of Section 2.9 of the OC:

> *The DOCP submitted pursuant to section 2.5 of this operational certificate must include a plan to remove all waste from the Original Landfill, categorize such waste, discharge all such waste to the New Landfill or to other identified and authorized waste management facility(ies), carry out sampling to confirm all such waste has been removed, and decommission the Original Landfill and the Original Leachate Management Works.*

6.3.3.1 Original Landfill Background

The Original Landfill is located near the southeast corner of the Site and includes an approximately 0.7 hectare (ha) un-lined cell and a 0.72 ha (85 m x 85 m) lined cell, material sorting area, leachate treatment system and related appurtenances.

The unlined waste discharge area has received waste from the early 1990s until the lined cell was constructed in 2015. The OC does not authorize any further discharge to the un-lined portion of the Original Landfill.

The lined cell is equipped with two 20 mil Coated Woven Polyethylene (CWPE) liners and a leak detection layer between the liners. The leak detection layer consists of a 0.3 m granular material and a 100 millimetre (mm) polyvinyl chloride (PVC) riser pipe that extends from within the granular layer at the toe of the slope of the north and east perimeter berms to the top of the berms.

The lined cell's leachate collection system includes leachate sumps, a leachate extraction chamber located within the west side of the cell and a series of tanks for leachate treatment and temporary storage.

As outlined in Section 1.5, the Original Landfill was previously permitted under Permit PR-10807 issued in June 1992, which was superseded by the OC issued in 2019.

6.3.3.2 Original Landfill Waste

Unlined Area

The unlined portion of the Original Landfill contains an estimated volume of 35,000 m^3 of waste in place at a thickness of approximately 5 m, as reported in the Location and Volume of Existing Waste letter addressed to ENV, dated May 12, 2017. The waste in the unlined portion of the landfill consists of:

- Land clearing waste – 25,000 m^3
- Combustion residue – 10,000 m^3

No further waste has been discharged to the unlined area of the Original Landfill.

Lined Cell

The following non-hazardous wastes are accepted for discharge to the Original Landfill lined cell, under the OC:

- Demolition waste
- Construction waste
- Land clearing waste
- Sludge from the Original Landfill leachate management works
- Soil meeting applicable CSR industrial land use standards
- Other waste as authorized in writing by the Director

Previously, under Permit PR-10807, the Original Landfill was authorized to accept:

- Stumps and trees
- Land clearing waste
- Select building demolition debris
- Residue of combustion for open burning of wood waste

As of December 31, 2020, the lined cell of the Original Landfill contains approximately 17,703 m^3 of waste in place (2020 Annual Report GHD, 2021). The waste types and approximate volume of waste placed in 2020 include:

- Construction and demolition waste – 653 m^3
- Soil meeting applicable CSR industrial land use standards – 7,159 m^3

Wastes placed in the lined cell between 2015 and August 2019, pursuant to then-Permit PR-10807, include:

- Contaminated soil below the HCR – 2,910 m^3
- Demolition debris – 114 m^3
- Treated wood waste/demolition debris – 1,275 m^3
- Wood waste – 147 m^3

The discharge of contaminated soil below HCR criteria was authorized under Section 42 of the CSR.

6.3.3.3 Plan for Removal of Waste and Discharge to New Landfill

Per Section 1.4.1 of the OC, authorization to discharge waste to the Original Lined Cell ceases on the earlier of the date the Original Lined Cell is filled to capacity or the date of commencement of waste discharge to the Landfill. After this time, the Original Landfill and Original Landfill leachate management works will be decommissioned.

Waste from the Original Landfill, including the unlined and lined portions, will be exhumed and segregated by category for relocation to the Landfill, as authorized by Section 2.9(b) of the OC. Waste will be segregated into soil, fine debris and coarse debris. The segregation of the materials will allow for placement of the waste into the Landfill cell under proper procedures. To protect the integrity of the base liner, coarse debris is not suitable for landfilling in the first lift. The first lift of waste shall consist primarily of soil.

Materials will be excavated from the Original Landfill area until a clean base is encountered through visual inspection. The CWPE liners at the base of the lined cell will also be removed and disposed of as waste to the Landfill. The leachate management works will be decommissioned. Components of the leachate management works may be salvaged for re-use.

A confirmatory soil sampling program will be carried out to ensure clean closure of the entire Original Landfill area footprint and adjacent buffer zone (50 m), and the soils in-place meet the applicable industrial land use standard.

The relocation of waste from the Original landfill to the Landfill will occur once Upland has received an amended OC to authorize the discharge of contaminated soil (IL+).

6.4 Landfilling of Wastes

All waste will be placed within the Landfill footprint in accordance with the recommended fill methods described in the Landfill Criteria for a landfill receiving 20,000 to 50,000 tonnes of waste per year. The recommendations include the following:

- The active face will be kept to a minimum, while maintaining sufficient area for safe unloading of waste and traffic operations. The Landfill Criteria recommended maximum area of 243 square metres will be maintained when possible.
- The lift height will be kept to the Landfill Criteria recommended maximum of 2.5 m.
- The waste will be compacted to achieve an efficient compaction density.

6.4.1 Landfilling of Waste Asbestos Containing Materials

ACM, as defined by the HWR, will be transported in compliance with the Transportation of Dangerous Good (TDG) Act and Regulations. The disposal of ACM will be completed in accordance with Part 6, Section 40 of the HWR.

6.5 Cover Placement

Covering of placed waste is generally required to control landfill nuisances such as vectors, wildlife, fire, wind-blown litter, odour, infiltration, landfill gas, scavenging, etc.

6.5.1 Daily Cover

As waste will be received intermittently by appointment and will consist primarily of C&D material and soil, application of cover on a daily basis may not be required. As such, daily cover shall be applied over placed waste as a means of landfill nuisance control on an as-needed basis, as determined by landfill staff.

Daily cover, when used, will consist of either 150 mm of soil that meets industrial land use standards, as defined by the CSR or approved alternative cover. Polyethylene tarps may be used as temporary and re-useable daily cover. Soil used for daily cover may be removed from the active face immediately prior to landfilling in the same area. Soil used for daily cover will have minimal fines to minimize the potential for perched leachate within the waste and to minimize dust migration from the Landfill.

Surface water contact with the daily cover will be treated as leachate and will be contained and conveyed to the leachate management system discussed in Section 9.

6.5.2 Intermediate Cover

Intermediate Cover will be placed on areas of the Landfill that are not scheduled to receive the placement of additional waste for 30 days or more. Intermediate cover will consist of 300 mm of soil that meets industrial soil quality standards, as defined by the CSR or approved alternative cover. The thickness may include daily cover if daily cover is present in the area. Soil used for intermediate cover may be removed from the active face immediately prior to landfilling in the same area.

The surface water runoff from the intermediate cover will be treated as clean surface water and will be conveyed through the surface water management system, as discussed in Section 8.

6.5.3 Final Cover

Final Cover will be placed within 365 days on any part of the Landfill footprint within that has reached final contours and is large enough to warrant final cover application. The final cover barrier layer will consist of the following layers from top to bottom:

- 150 millimetres of topsoil with suitable vegetation
- 600 millimetres of sand as a protective cover
- GCL
- 150 millimetres sand cushion layer over the waste

The final cover system is shown in Drawing C-06. A water balance model, as discussed in Section 9.6.1, was used to determine the resulting infiltration through the final cover system. The results forecast this final cover system to exceed the performance of the minimum final cover specified in the Landfill Criteria (600 millimetres of low permeable soil).

The surface water runoff from the final cover will be treated as clean surface water and will be conveyed through the surface water management system, as discussed in Section 8.

The soil used for final cover will meet the applicable CSR industrial land use standards.

6.6 Hours of Operation

The hours of operations of the overall site are Monday to Friday 7:30 a.m. to 4:00 p.m. The Landfill hours will generally be restricted to the overall site hours. Special arrangements may be made to receive waste outside of these hours from time to time. The Landfill will not be open for receiving waste unless otherwise scheduled in advance, and waste characterization procedures have been completed to ensure the waste is suitable for disposal at the Site. When required, the Landfill will be open on Saturday and Sunday to receive incoming waste from approved sources.

6.7 Neighbour Relations Plan

Upland and Northwin recognize the need to maintain positive relations with landowners adjacent to and nearby the Site. Ongoing efforts to mitigate the impacts of nuisance factors such as dust, litter and odour will be carried out in accordance with the protocols discussed in the following sections.

All operational complaints received by Landfill personnel will be recorded and directed to the Site Manager. The Landfill personnel will undertake corrective action(s) as soon as possible after identification of need. A complaint response procedure, including an email address and phone number, will be provided at the Site entrance for the submission of nuisance complaints from the public. The complaint, nature of complaint, time received, and corrective action taken for resolution will be documented. The records must be kept in accordance with the record keeping procedures described in Sections 6.16 and 14.9, and included in the next annual operations report, as discussed in Section 14.10.

6.8 Nuisance Controls

The Landfill will comply with all local government nuisance bylaws.

6.8.1 Dust Control

Dust generation occurs at landfill sites due to the handling of soils, dry waste such as demolition waste, plaster, and concrete, as well as the movement of vehicles along gravel and dirt access roads. Dust mitigation measures will be employed at the Site on an as-needed basis and may include the following:

- Use of granular daily cover material with minimal fines content (i.e., silts and clays)
- Reduction of vehicular speeds on Site
- Application of water to control dust
- Seeding programs
- Proper placement of stockpiles and covers to minimize dispersion
- Vegetative buffer zones around the Site to provide shelter to the landfill
- The topographical changes and Pit walls to provide shelter to the landfill

Soil stockpiles not used for more than one year are to be seeded.

6.8.2 Noise Control

Potential noise impacts from the Site may result from the operation of the landfill equipment. The operation of this equipment will comply with the noise emission standards as outlined in the Society of Automotive Engineers (S.A.E.) J88 – Latest Edition "Sound Measurement – Earth moving Machinery". Noise mitigation will also be provided by the following Site features:

- Vegetative buffer zones
- Distance of Landfill operations from Site boundary and neighbouring properties
- The topographical changes and Pit walls

6.8.3 Litter Control

Preventative litter control measures are steps taken to minimize wind-blown litter from the active area of the Landfill and from incoming waste loads. Litter must not migrate beyond the Landfill property boundary. The following measures will be used at the Site to control and minimize wind-blown litter:

- All vehicle loads must be tarped to prevent litter from blowing out of the vehicle. Northwin reserves the right to not accept loads that are not tarped.
- The active face will be selected based on the direction and intensity of the wind to provide maximum shelter for the active area. The aerial extend of the working face will be kept to a minimum on windy days.
- Litter will be collected within the Site and along the Site boundaries when necessary.

- Appropriate use of cover soil.
- Installation of litter fences and use of operational berms within the Landfill, as necessary.
- The topographical changes and Pit walls.

6.8.4 Odour Control

The waste streams that will be discharged at the Landfill are generally not a source of odour due to low-organic content. The Landfill operations will, however, be carried out in a manner that prevents generation of nuisance odours. The following measures will be used at the Site to control and minimize nuisance odours:

- Appropriate cover will be applied as outlined in Section 6.5.
- Leachate management systems will include adequate odour controls such as aeration to prevent unpleasant odours.
- Implementation of odour control measures will be planned for when odorous waste is anticipated.

6.8.5 Sight Lines

The sight lines from the Gold River Highway to the active face of Landfill will be minimized. To minimize the sight lines, the following measures will be in place:

- Vegetated perimeter buffer zone
- Landfill footprint location within the base of the Pit
- Final contours will be below the adjacent tree lines
- Berms constructed within the Landfill to minimize sightlines to exposed waste, when necessary
- Application of daily and intermediate cover
- Application of final cover on the northern edge of the Landfill including vegetative cover as soon as reasonably possible

6.9 Vector and Wildlife Management

The Landfill is not expected to attract vectors or wildlife due to the lack of organic matter in the waste and soil to be disposed of in the Landfill. Furthermore, the Landfill will comply with the daily, intermediate, and final cover requirements stated in Section 6.5. If vector and wildlife become problematic at the Site, these measures will be revised to ensure the protection of the wildlife and the environment.

The leachate aerated equalization pond is not expected to attract wildlife or waterfowl, due to the aerators that will operate intermittently and will deter access to the pond at that time. Should waterfowl become an issue in the aeration pond during the passive filling or decanting portions of the treatment cycle, bird abatement strategies will be employed, such as the use of a falconer.

6.10 Landfill Fire Management

The Landfill will be operated in a manner that reduces the risk of landfill fires. The following measures will be in place:

- Appropriate placement, thickness, and compaction of inert daily and intermediate cover and compaction as outlined in Section 6.5 to minimize oxygen intrusion.
- Fire breaks will be maintained surrounding the Landfill footprint with a minimum width of 15 m. The Fire breaks will be free of trees, brush, tall grass, and other combustible materials.
- The Landfill has year-round and immediate access to a water supply from the wash plant ponds.
- Fire safety measures in place in accordance with the fire safety plan discussed in Section 15.

6.11 Scavenging

Scavenging is defined in the Landfill Criteria as the informal and unauthorized recovery and removal of waste. Scavenging of waste from the active face and within the Site is prohibited due to health and safety concerns. Recovery of items from the incoming waste that has potential re-use value will occur as discussed in Section 6.2.

6.12 Site Health and Safety Plan

A Site Health and Safety Plan (HASP) will be prepared and kept on Site at all times. The Site operations will meet the requirements of WorkSafeBC.

6.13 Site Security and Signage

Access to the Site will continue to be via the existing Site entrance off Gold River Highway, which enters the Site from the north, as shown on Drawing C-01. The Site entrance gate is locked outside of normal operating hours to prohibit vehicle entrance and uncontrolled disposal when the Site is closed. A chain link fence is present along the northern property boundaries along Gold River Highway and Argonaut Road.

Signage will be erected and maintained at the Site entrance and will include the following information:

- Name of Owner/Site Operator
- Owner/Site Operator Contact Information
- Hours of Operation
- Emergency Contact Information
- Waste and recyclable material accepted, prohibited, and restricted

The existing signage will be maintained for continued operation of the Site. The signage will be reviewed from time to time by Landfill staff for adequacy and additional signage implemented as required.

6.14 Weigh Scale

A weigh scale is currently located at the Site entrance. The weigh scale will be maintained in proper working order and meet the requirements of the federal Weights and Measures Act.

6.15 Traffic Volumes

Traffic volumes will be dependent on the amount of waste destined for the Landfill during any given period. The waste may be received at specific times of the year and be distributed unequally throughout the year. In general, future traffic flow volume is expected to increase marginally from the existing traffic volumes to the Site.

6.16 Records

All relevant records will be maintained by the Site owner for the entire operating life of the Landfill and for the duration of the contaminating lifespan, as estimated in Section 12. Relevant records will be maintained on-site for a minimum of 7 years, and all records will be submitted to the Director within 14 days of a request from the ENV. Records will include the following:

- The Operational Certificate
- All plans and reports prepared in support of the development for the Site
- Inspection records conducted by regulatory agencies
- Public complaints including source of complaint, nature of complaint, time received and actions taken
- Waste tonnages and volumes disposed of in the Landfill for each category of waste received
- Waste sources, characterization, and approvals

6.17 Operational Personnel

The Landfill will employ a Site Manager/Operator who oversees all daily Landfill operations.

The Site Manager or Operator will be present at all times that the facility is open for business and will inspect every load of incoming waste to ensure it matches the waste characterization, and complies with the requirements of the OC.

The Site Manager, Operator, or other designated staff members are responsible for accepting and recording waste loads, as discussed above, and also for collecting tipping fees, stockpiling, placement of waste, and placement of daily cover, as required. An equipment operator is responsible for the operation of the front-end loader, bulldozer, hydraulic excavator, and compactor.

Additional staff will be used at the Site as the workload demands to meet environmental control requirements including dust, litter, and odour control measures.

6.18 Operator Training

At least one supervisor will successfully complete the Solid Waste Association of North America's (SWANA) Manager of Landfill Operations (MOLO) course. At least one of the operations staffs working regularly at the Landfill active face will successfully complete SWANA BC's Qualified Landfill Operator's course. These certifications will be kept current as per by SWANA's requirements.

Under the Environmental Management Act, Municipal Wastewater Regulations, Part 4, Division 1, Section 47, the aeration pond must be operated by a person certified by, and in accordance with, the Environmental Operators Certification Program.

6.19 Equipment Requirements

Adequate equipment will be maintained at the Site to ensure that operational requirements will be met. The equipment to be used on-site will include:

- Front-end loader
- Dozer
- Waste Compactor
- Excavator

6.20 Winter and Wet Weather Operation

Winter operations require advanced planning for Site preparation, snow removal, and the stockpiling and storage of cover material. Winter operations for the Landfill will be coordinated with the active aggregate extraction activities.

Many operational problems can occur as a direct result of failure to prepare an adequate disposal area in advance of winter weather. An area sufficient to hold more than the expected volume of waste will be prepared in advance of the onset of winter.

During the winter months the active disposal area will be located in such a manner so as to be free draining, sheltered from the prevailing winds and if possible, located with a southern exposure. Up to twice the estimated required area for disposal through the winter months, will be prepared to minimize problems due to heavy snow and equipment failure. During winter conditions, flatter grades may be required at the daily working face to facilitate equipment travel.

Snow plowing and a snow storage area will be considered in advance of winter conditions. A snow storage area will be created adjacent to the active disposal area to permit storage of snow removed from the tipping face, such that it does not interfere with daily Landfill operations. The snow storage area will be located such that during snow melt events, the runoff will be treated as storm water and not flow into the active disposal area. Snow which has contacted waste will be managed as leachate. In the event of extreme weather conditions, or at the discretion of the operator, the Site may temporarily close and stop receiving waste material.

Snow maintenance and wet weather operation will be conducted in such a manner as to minimize infiltration.

During wet weather operations surface water will be directed away from the active disposal area by means of temporary soil berms constructed upgradient of the active area, as required. Under extremely wet weather conditions the waste disposal operations may be moved to drier working areas to facilitate vehicle travel at the working face.

On-site equipment used for continued Landfill operations during rainfall events, will be provided with closed cabs.

Site roadways will be maintained in a passable condition during wet weather conditions. Should washouts of the Site roadways occur due to rainfall events, the roadways will be reconstructed in a timely fashion.

7. Seismic Assessment

7.1 Geotechnical Overview

Site geology consists of a native interbedded sand and gravel unit consistent with glacio-fluvial and outwash depositional sources and an underlying competent bedrock unit. The surface of the bedrock unit is highly variable across the Site.

The native interbedded sand and gravel unit is present throughout the majority of the Site varying in thickness from not present to greater than 55 m bgs. Along the western portion of the Site, bedrock outcrops and shallow bedrock are present. In this area, the sand and gravel unit is not present or thin as a result. Within the remaining portion of the Site, where bedrock is present at lower elevations, the thickness of the sand and gravel unit is substantial.

The sandy overburden is generally in dense to very dense conditions, with SPT ‘N’ values in the ranges of 30 blows per 0.3 m of penetration.

Bedrock can be described as competent, fine grained, porphyritic, igneous rock of the Karmutsen Formation, which varies in colour from blueish black to dark grey and green to dark grey and pink to dark brown (Golder, 2014). Fracturing is apparent within the upper bedrock unit including evidence of weathering (i.e., iron staining) and secondary mineralization. Fractures vary in size, density and orientation (vertical, horizontal, and oblique). The most significant fracturing was noted in the boring advanced within the Pit (MW4A-15). According to laboratory tests calcite is present in fractures and amygdules (Golder, 2014).

The bedrock surface orientation differs across the Site:

- West of the Pit, bedrock dips steeply toward Rico Lake and a sand and gravel filled scour channel, which extends northeast of Rico Lake. Bedrock elevations in this area range between 215 mAMSL at the small mountain to the south and 170 mAMSL at the base of the scour channel toward the north. The top of bedrock to the southeast and east of Rico Lake occur at elevations above the Rico Lake water level.
- Northwest of the Pit, at K&D Contracting, bedrock is orientated around a bedrock outcrop. This localized highpoint is present at elevations 183.5 to 182.1 mAMSL.
- Underlying the Pit, bedrock generally dips steeply from west to east from 183.0 mAMSL (outcrop) to at least 145 mAMSL.

7.2 Landfill Settlement

The Landfill area was analyzed for three types of potential settlement (total or differential). The results will be considered during detailed design to ensure the design provides allowance for forecasted settlement.

7.2.1 Short-term Settlement

Short-term settlement, or elastic settlement, may occur almost immediately after changes in loading occurs. Immediate settlements in the order of 100 mm to 200 mm are expected during the vertical expansion of the Landfill.

7.2.2 Long-term Settlements

Long Term settlements, or primary consolidation settlements, occurs due to the expulsion of pore water from the waste material. Depending of the loading, saturation degree, and the drainage path within the Landfill, this settlement may take years to complete and can be differential in nature. Due to the compaction of the waste and the duration of the construction, these settlements are expected to be tolerable.

7.2.3 Creep Settlement

Creep settlement, or secondary consolidation, occurs under nearly constant effective stresses and is associated with plastic adjustment of the material. Theoretically, this type of settlement will never end, but will slow down with time. Due to the compaction of the material and the staged construction approach, these settlements are expected to be tolerable.

7.3 Seismic Evaluation

A seismic evaluation was carried out based on hazard values recommended by the National Building Code of Canada (NBCC 2010), as discussed in GHD's 2016 Geotechnical Investigation Report, considering the low consequence of failure at the Site, seismic hazard values with 2 percent and 5 percent probability in 50 years (return period of 2475 and 1000 years, respectively) were used in the seismic evaluation. The evaluation concluded that the historical data does not show the potential for liquefaction within the waste material, and the liquefaction potential in the existing native soils is very low to low during extreme seismic events with return periods of 2475 years or less.

7.4 Slope Stability

Slope stability analysis was carried out, as discussed in GHD's 2016 Geotechnical Investigation Report. Limit equilibrium method was utilized to evaluate the stability of the slopes across the Landfill under different material, water level, and loading conditions.

Considering the low consequences of failure of the Landfill, as further discussed in the GHD's 2016 Geotechnical Investigation Report, a target Factor of Safety (FOS) of 1.2 to 1.3 is considered adequate for short term (during construction) stability of the slopes under static loading. For long term (post construction) conditions, a target FOS of 1.5 is considered adequate. For seismic events with a return period of 2,475 years, FOS of 1.1 is considered adequate. The slope stability study concluded that the target FOS are obtained along the studies cross sections and that the FOS will increase with time due to the nature of the material.

8. Surface Water Management Plan (SWMP)

8.1 SWMP Objectives

Completion of the Landfill closure design will result in changes in landform and surface water runoff patterns within the lower Pit area of the Site. The SWMP will ensure the following objectives are met:

- The runoff from the Landfill is conveyed in a manner that does not cause erosion or possible damage to the Landfill.
- The runoff from the watershed around the Landfill is conveyed and directed away from the Landfill to minimize surface water contact with waste and minimize leachate generation.
- The potential for on-site erosion and sediment loading in the base of the Pit minimized (there are no downstream water courses that will be impacted by sediment loading).

This SWMP has been developed for the Landfill only and does not consider the overall Property storm water management system.

8.2 SWMP Design Criteria

8.2.1 SWMP Design Criteria – Landfill Criteria

Section 5.6 of the Landfill Criteria requires hydrologic modeling to assess the performance of the surface water management works under minor and major storm events, and is to be completed for 5-, 10-, and 100-year design storm events. Per the Interim Considerations, hydrologic modeling for the 1:200-year design storm event was also completed.

Based upon these objectives, the SWMP design criteria is as follows:

- The storm water channels shall be designed to convey the discharge of a 1:200-year, 24-hour storm event.
- Maintain a positive grade to prevent sedimentation and maintain hydraulic design capacity. Ditches shall be designed to accommodate localized settlement (no grade reversals).
- Armor (rip rap, erosion control matting, or vegetative cover) ditches to prevent erosion of bottom and side slopes, as necessary.
- Make allowances for additional water that may result from snowmelt.
- Consideration for the effects of multi-day precipitation events.

8.2.2 Additional SWMP Design Criteria Considered

The following design criteria were used as guidance documents for the design of the SWMP:

1. In accordance with the BC Supplement to TAC (Transportation Association of Canada) Geometric Design Guide 2007 Edition (Tab 10-1000 Hydraulics Chapter) (BCMOT, 2007) the channels shall have the following characteristics:
    - The maximum allowable depth of flow is 0.6 m.
    - The recommended minimum freeboard is 0.3 m for small drainage channels.
    - Typical channel side slopes range between 1.5:1 (H: V) to 4:1.

2. In accordance with the Best Management Practices Guide for Stormwater, prepared for Greater Vancouver Sewerage and Drainage District (Gibb, Kelly & Schueler, 1999), the sediment forebay should meet the following criteria:
    - Sediment forebay should provide 10% volume of permanent pool storage for wet pond.
    - Sediment forebay should provide 10% volume of total design storage volume for dry pond.
3. In accordance with the Storm Water Management Planning and Design Manual (ENV Ontario, 2003), the infiltration areas should meet the following criteria:
    - Minimum length to width ratio is 3:1.
    - Maximum ponding depth is 0.6 m.
    - Minimum 1 m depth for sediment forebay.
    - Minimum 2:1 length to width ratio for sediment forebay.
4. In additional criteria include:
    - The storm water management system will be designed using the 24-hour, 25-year and 200-year synthetic design storm with a Type 1A distribution.
    - To account for frozen or saturated ground conditions and the Landfill cap liner design, the sub-catchment parameters for depression storage and infiltration will be adjusted to be lower than would be typically considered for this type of soil and vegetative cover.
    - Allowances for additional precipitation and greater storm events to consider climate change.
    - Allowances for additional precipitation over multi-day precipitation events.

8.3 SWMP Overview

The SWMP includes the following elements:

- Perimeter berms to ensure the run-off from the landfill sides slopes (i.e. with daily cover or exposed waste) will remain within the landfill and separate from the surface water system.
- Mid-slope swales incorporated into the final cover approximately halfway up the side slopes to shorten the drainage path and help prevent erosion.
- Drop-down channels where the southern edge of the Landfill final contours intercepts the excavated slope of the Pit.
- Energy dissipation pools at the base of the drop-down channels along the southern edge of the Landfill.
- Ditches on the east and west sides of the Landfill to convey surface water to the north of the Landfill into the infiltration areas located in the base of the Pit.
- A surface water diversion berm south of the Landfill on the upper portion of the Site to convey water from the upper portion of the Site around the Landfill to the base of the Pit or to other areas of the Site. The purpose of this diversion is to ensure the upper portion of the Site is not part of the Landfill surface water catchment.

- Energy dissipaters and infiltration area sediment forebays located at the ditch outlets north of the Landfill will also act as sediment traps to minimize larger sediment migration into the infiltration areas.
- Infiltration area in the base of the Pit sized to accept surface water flow that matches the pre-Landfill surface water flow.

8.4 Hydrologic Assessment

8.4.1 Model Overview

A hydrologic assessment of the Site watershed was completed to provide estimates of the peak discharge that is expected within the proposed channels. The hydrologic assessment was completed by developing a hydrologic model of the Site to estimate the runoff volume and discharge rate for post-development condition. Storm water modeling for the Site was conducted using the software program PCSWMM 2015 developed by Computational Hydraulics International (CHI). PCSWMM uses the USEPA SWMM5 engine (currently version 5.1.010) and is a spatial decision support system for the USEPA SWMM5 program. The USEPA Storm Water Management Model (SWMM) is a dynamic rainfall-runoff simulation model that can be used for either single event or long-term (continuous) simulation of runoff quantity and quality.

PCSWMM allows modelling of runoff and conceptual design of drainage works such as piping network, open channel (rivers, creeks and ditches), weirs, dams, orifices, and storage/detention units. The computer model uses hydrologic and hydraulic methods to calculate and route hydrographs. The model requires input of a hyetograph, topographical features (catchment area, width, slope and hydraulic roughness), soil parameters, ground cover conditions (land use and vegetation cover) and drainage paths (rivers, pipes and storage units).

8.4.2 Design Storms

There are three Environment Canada weather stations in relatively close vicinity of the Site which generate Intensity-Duration-Frequency (IDF) reports that are used to develop the synthetic design storms. The locations of these three weather stations, Strathcona Dam (ID 1027775), Campbell River Airport weather station (Station No. 1021261), and Campbell River STP (ID 1021265) are presented on Figure 8.1.

The Campbell River Airport station IDF report was selected based on the proximity to the project site, length of record and physiographic characteristics. The elevation for Campbell River Airport is 108 m, which is lower than the minimum elevation of the site (approximately 167 m). The Campbell River Airport IDF report is provided in Appendix D.

The design of the storm water management system is based upon the return-period rainfall depths derived from the Campbell River Airport Intensity-Duration-Frequency (IDF) reports developed by Environment Canada. The total rainfall depths were increased by 10% to compensate for the change in elevation between the Campbell River Airport and Site elevation. Synthetic design storms were developed to assess the performance of the proposed storm water management features which are based upon the IDF total rainfall depths.

To account for the potential increase in rainfall depths as a result of climate change, as discussed in Section 2.4, GHD also increased the synthetic design storm rainfall depths by 5.2%, which represents a total increase of 15.2% over the IDF reported values.

Synthetic design storms were created for the 5-year, 10-year, 100-year, and 200-year, 24-hour storm event using the Soil Conservation Service's Type 1A distribution which is appropriate for this geographic area. Rainfall parameters representing design storms are listed in Table 8.1.

Multi-day precipitation events were also considered. The probability of a multi-day precipitation event with the same intensity as the 100-year, 24-hour storm event for all days within the multi-day event is low. It is more likely that a multi-day precipitation event would result in a lower intensity than the design storm used (100-year, 24-hour storm). For this reason, the 100-year storm event was used as the design storm parameter for the design of the surface water channels and sediment forebays. The infiltration areas were sized to accommodate the 200-year, 24-hour storm with allowance for additional water from snowmelt and multi-day precipitation events, as discussed in Section 8.4.4.

8.4.3 Hydrologic Model

The SWMP was developed for the full Landfill closure condition. The Landfill cover will be fully vegetated and consist of 150 mm of topsoil over 600 mm sand over a GCL, as described in Section 6.5.3. The design of the SWMP features has assumed that there will be little to no storage capacity within the Landfill cover system and the majority of rainfall will result in runoff from the Landfill cover. This assumption would account for frozen ground conditions or antecedent wet moisture conditions, such as during a multi-day precipitation event. Therefore, the sub-catchment parameters for depression storage and infiltration will be adjusted to be lower than would be typically considered for this type of soil and vegetative cover which would have a greater infiltration capacity.

The Landfill cover system is divided into a series of catchments. The catchment boundary delineation is presented on Figure 8.2. Corresponding catchment model input parameters are summarized in Table 8.2. A surface water diversion berm will be required to route surface runoff away from the Landfill area that is not considered within the overall catchment boundary.

Runoff generated from each catchment is routed to a series of channels which will convey it away from the Landfill cover. A flow schematic, describing the SWM conveyance features (i.e., channels, ponds) and flow direction is presented in Figure 8.3.

8.4.4 Infiltration Area Configuration

The infiltration capacity of the overburden soils on the floor of the Pit is relatively high (Section 4.9, HHCR). The existing surface of the base of the Pit may be used as the infiltration areas. The designated infiltration area will contain an overflow route that will convey excess surface water to other portions of the Pit for infiltration, in the event of a large multi-day precipitation event temporarily overwhelming the infiltration areas.

It is proposed that the infiltration area for stormwater runoff from the Landfill should be divided into two portions. A west infiltration area will be used to store and infiltrate the surface runoff from west part of the Landfill and an east infiltration area will be used to store and infiltrate the surface runoff from east part of the Landfill. The bottom elevation of both areas will be approximately 167.3 m which is approximately 10 m higher than the groundwater table. The infiltration areas may be delineated by berms and existing ground features and may be shaped to allow for the continued use of the Site during storm events.

The required bottom surface area for each of the infiltration area is estimated at 2,930 m^2, while the top surface area of both infiltration areas will be 3,969 m^2 excluding sediment forebay area. The total available storage volume from each of the pond is approximately 1,232 m^3 from bottom of the pond to the maximum ponding depth at 0.4 m, and approximately 3,313 m^3 from bottom of pond to top of pond for the entire depth (1.0m). These volumes are based on an assumed length to width ratio of 3:1, and a horizontal to vertical slope of 3:1 at the pond perimeter. A stage-area table for pond configuration is included in Appendix D.

8.4.5 Infiltration Rate

The area to the adjacent north of the Landfill is proposed as an infiltration area. Stratigraphic and single well response tests were completed for this area and are presented in the HHCR.

The borehole log for this area indicates:

1. Groundwater elevation is greater than 1.5 m below the ground surface.
2. Gravel and sand are the predominant soil types.

According to the Best Management Practices Guide Prepared for Greater Vancouver Sewerage and Drainage District, an infiltration rate of 60 mm/hr was conservatively assumed to represent the infiltration rate.

8.4.6 Infiltration Discharge Estimation

Using the stage area table provided in Appendix D, the infiltration area at an elevation of 167.3 m was interpolated as 2,682 m^2. Infiltration discharge was calculated as the product of infiltration rate and the infiltration area bottom area. This infiltration discharge was applied in the PCSWMM model as outflow from the infiltration areas.

8.4.7 Sediment Forebay

A sediment forebay will be installed at the inlet of the stormwater infiltration areas to preferentially settle large particulates in the sediment load within an area that can be conveniently accessed for maintenance. The sediment forebays for the infiltration areas were sized according to the design guidelines given in Section 8.2.2. Detailed calculations for the length and width for the sediment forebays are provided in Appendix D.

An energy dissipation structure at the outlet of the steep channels is required to prevent erosion of the base of the Pit. A basin approximately 1 m deep that is 5 m wide and 10 m in length will be constructed to transition the discharge from super-critical to sub-critical flow. The basin will be lined with the concrete block lining similar to the channel lining.

8.4.8 Modelling Results

All hydrologic models were analyzed using synthetic design storms with return periods of 5-year, 10-year,100-year, and 200-year design storms.

Table 8.3 provides a summary of the estimated peak discharge rates from each catchment. Table 8.4 provides a summary of the estimated runoff volume from each catchment. The model results indicate during the 200-year design storm that in excess of 90% of the rainfall results in runoff. Hydrologic model outputs files are provided in Appendix D.

The model also calculates the peak discharge within the channels. The channels were designed to convey the peak discharge from the 200-year design storm event with at least 0.3 m of freeboard. A summary of the channel characteristics and performance is provided in Table 8.5. Table 8.5 also provides recommendations for the addition of erosion protection (i.e. turf reinforcement matting or ditch lining) for ditches with excessive grades resulting in a higher shear stress. Ditch lining is recommended for any ditch that would have an estimated shear stress in excess of 50 Pascal's (U.S. Soil Conservation Service Channel Design Handbook for Retardance Class C Vegetation) during the 100-Year event.

Table 8.6 provides a summary of the ponding depths and storage volumes for the infiltration areas. The infiltration areas will provide sufficient volume to store the 200-year design storm event and have a sufficient surface area to drain in less than the maximum limit for all storms (48-hours). As discussed in Section 8.4.4, overflow infiltration areas will be designated as a contingency.

9. Leachate Management Plan

9.1 Leachate Management Objectives

The objective of the leachate management plan is to achieve water quality compliance at the Site by minimizing leachate generation, collecting, and treating all leachate, discharge all treated leachate through on-Site infiltration and provide on-Site attenuation for further polishing.

The leachate generation will be minimized by:

- Maintaining a small active face
- Applying appropriate intermediate and final cover at the earliest opportunity
- Promoting clean surface water diversion away from the Landfill
- Pursuing progressive closure of the Landfill

9.2 Typical Construction and Demolition (C&D), Land Clearing, and Contaminated Soil Leachate General Overview

Principle factors affecting the composition of leachate include (McBean et al., 1995):

- Waste composition
- Age of refuse
- Landfill operations
- Climatic conditions
- Hydrogeological conditions
- Conditions within the landfill (e.g., chemical and biological activities, temperature, pH, and redox conditions)

The mass of refuse stored in a landfill represents a finite source of pollutants. Typical construction and demolition (C&D), land clearing, and contaminated soil waste leachate is a mixture of organic and inorganic compounds produced from refuse materials by a combination of physical, chemical

and biochemical processes. Physical processes, related to leachate generation, involve the flushing and dissolution of pollutants as water percolates through the refuse material. Chemical processes, including ion exchange, sorption/desorption, and change in pH, contribute to leachate production by enhancing the mobilization of various pollutants (leachate constituents). Biological processes contribute to leachate production via the degradation of organic constituents into simpler and more mobile compounds.

The mass of pollutants available for leaching is largely a function of the physio-chemical nature of the waste, the extent of waste stabilization, and the volume of infiltration into the landfill (Lu et al., 1984). As a result, the leachate composition may be significantly impacted by not only the above-stated factors, but also key elements of the landfill design and operations.

Leachate produced from typical Demolition, Land Clearing and Construction (DLC) waste landfills is generally considered to be less threatening to human health and the environment compared to leachate from other types of disposal facilities, such as municipal solid waste (MSW) landfills (Townsend, 2000) that contain large quantities of putrescible waste. Unlike MSW, DLC waste consists largely of inorganic components and organic matter with a low degree of biodegradability. Preliminary investigation results of DLC lysimetric testing show concentrations of Chemical Oxygen Demand (COD) in the range of 44 to 1,700 mg/L (Townsend, 2000) which is significantly lower than the typical COD concentration range of 3,000 to 45,000 mg/L in MSW (SWANA, 1991).

Typically, the most potentially prominent contaminants in the leachate from C&D landfills are sulphate, arsenic, iron, manganese, and Total Dissolved Solids (TDS).

A major source of sulphate can be attributed to the presence of gypsum drywall in typical C&D landfills. Gypsum drywall has widely been used as interior walls in construction due to its high fire resistance. When gypsum drywall is landfilled and comes in contact with infiltrating water, calcium and sulphate are released into solution.

In the 1970's to 1980's, wood was preserved with chromated copper arsenate (CCA-treated wood) and used in the construction of decks, patios, gazebos, and other wooden structures. CCA-treated wood in typical C&D waste landfills contributes to arsenic, chromium, and copper levels in typical C&D waste leachate. It is anticipated the technological advancements of wood treatment will eventually lead to a phase-out of CCA-treated wood products. CCA-disposal rates at typical C&D waste landfills will peak and then eventually level-off (Jambeck, 2004).

Manganese is found in alloys, paints, and naturally in plant tissue. In a study of demolition waste leachate, high concentrations of manganese (17 mg/L) were found from wood-based laboratory landfill experiments. Therefore, wood waste is likely a source of manganese present in C&D waste leachate.

High TDS concentrations in C&D leachate are mostly likely attributed to calcium, sulphate and alkalinity ions from the dissolution of gypsum drywall and the leaching of calcium carbonate and calcium hydroxide from concrete.

Non-hazardous contaminated soil may contain a large variety of contaminants depending on the source of the waste material. Common soil contaminants include metals, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and petroleum hydrocarbons (PHCs). Some metal-contaminated soils may increase metals concentrations in the leachate but this is dependent on the form of the metal in the soil, the metal solubility and the conditions in the landfill.

Contaminated soil could increase the concentrations of PAHs, VOCs, and PHCs in leachate but these compounds are readily biodegradable within the leachate. Contaminated soil must be considered non-hazardous for acceptance at the Site, as defined by the HWR. The leachability of the pollutants in non-hazardous contaminated soil will be low compared to hazardous waste and free-product concentrations.

ACM does not affect the quality of the leachate in terms of impacts from the asbestos material, as asbestos does not have the leachability characteristic that distinguished hazardous chemicals, identified in the HWR. ACM is only hazardous when the potential for asbestos fibres to become airborne prior to and during landfilling, once landfilled ACM is an inert material.

9.3 Typical C&D Leachate Generation Lifecycle

The composition of typical C&D leachate will vary over time as conditions within the waste material change. Biological activity is a major influence affecting leachate chemistry. An awareness of the microbial activity degrading the refuse throughout landfill development is central to understanding the resultant leachate chemistry. Biological degradation generally involves aerobic and anaerobic phases, which can occur simultaneously and have varying impacts on leachate chemistry.

When refuse is landfilled in an active cell, the initial biodegradation phase occurs under aerobic conditions resulting in the partial degradation of organic components in the refuse material. The aerobic decomposition typically results in high carbon dioxide (CO_2) concentrations, a lowering of pH and an increase in temperature, COD, biochemical oxygen demand (BOD) and specific conductance levels in leachate.

As the availability of oxygen is limited, the organic material will undergo anaerobic decomposition. In the beginning of this anaerobic phase, generally elevated levels of organic acids, ammonia, hydrogen and carbon dioxide are produced. The production of organic acids and carbon dioxide can lower the pH in the leachate, enhancing the dissolution of inorganic constituents including iron (Fe), magnesium (Mg), zinc (Zn) and calcium (Ca). This phase is also characterized by elevated levels of BOD, COD, and specific conductance. As the degradation of organics into simpler and more mobile compounds continues, lower BOD levels will be reached and the pH will stabilize. Inorganic elements such as sulphate, chloride, iron, sodium and potassium, however, can continue to leach and dissolve for a prolonged period of time.

In anaerobic conditions, the three most important bacteria capable of degrading organics include Iron(III)-reducing (Fe(III)-reducing bacteria), sulphate-reducing and methanogenic bacteria. The Fe(III)-reducing bacteria oxidate organic matter with the reduction of Fe(III), sulphate-reducing bacteria oxidize organic matter by reducing sulphate and producing hydrogen sulphide, while methanogenic bacteria convert organic matter to carbon dioxide and methane. Typically, these bacteria are not active simultaneously, thus no hydrogen sulphide or methane production will occur until the Fe(III) reduction is complete and no methane production until sulphate is depleted (Lovley, 1987). In other words, Fe(III)-reducing bacteria can out-compete both sulphate-reducing and methanogenic bacteria for fermentable substrates until Fe(III) becomes depleted, then sulphate-reducing bacteria can out-compete methanogenic bacteria for organics until sulphate is depleted. Generally, over time, more methane generation will occur as this is the last phase of anaerobic decomposition.

Over time, generated leachate typically decreases in "strength" or chemical concentration as a result of "washout" (i.e., tendency of contaminants to be transported away from the Site by infiltrating water) (Reinhart, 1995). This does not present a problem to the surrounding environment so long as careful monitoring of both the leachate quantity and quality are carried out, and leachate is collected and treated in an appropriate manner.

9.4 Leachate Indicator Parameters

A number of leachate parameters can be used as indicators of leachate derived impacts. As chemicals are transported in landfill leachate, their concentrations can be reduced or attenuated by a variety of processes including dilution, dispersion, sorption, ion exchange and biological degradation. An indicator parameter of landfill derived impacts should be a chemical which is subject to minimal attenuation so that it can signal the early movement of a leachate plume.

Chloride is one of the preferred indicator parameters as it is usually present in landfill leachate at elevated concentrations and is attenuated only by dilution and dispersion. Chloride, which is commonly found in MSW leachate at elevated concentrations, is also found in C&D landfill leachate but at lower levels. Typical MSW landfill leachate contains chloride concentrations in the range of 100 to 3,000 mg/L (SWANA, 1991) whereas C&D landfill leachate chloride concentrations are reported to typically range from 5 to 62 mg/L (Townsend, 2000). The use of chloride as an indicator parameter must be evaluated further based on the observed leachate quality for the Site.

The major contaminants of concern with respect to C&D, land clearing and contaminated soil landfills are metals and hydrocarbons. Hydrocarbons do not make good indicator parameters as there are many processes that degrade these parameters within the landfill. Metals can make good indicator parameters depending on the type, quantity, solubility, and other variables; however, in many cases metals are not sufficiently mobile due to their ability to adsorb to soil particles.

Site specific leachate indicator parameters will be finalized during the commissioning phase of the leachate collection and treatment system during the first year of the landfill operation. These leachate indicator parameters will be selected based on the actual leachate chemistry observed. The leachate indicator parameters will be reviewed annually as part of the annual operations and monitoring report discussed in Section 14.10.

At this time, the forecasted leachate indicator parameters include the following, consistent with the HHCR.

- Hardness
- Total Dissolved Solids (TDS) (lab)
- Conductivity (lab)
- Chloride
- Alkalinity (total)
- Hydrogen Sulphide
- Sulphate
- Ammonia
- Boron
- Iron
- Manganese

9.5 Site Specific Leachate Quality Forecast

This section presents the conceptual leachate quality forecast. The leachate treatment design is based on a pilot scale treatment study undertaken on Original Landfill leachate.

For the purpose of this DOCP, a forecasted leachate profile has been developed using leachate quality data from similar landfills in BC, including the Original Landfill located at the Site, and compared with similar landfills in other parts of Canada for verification purposes. The forecasted leachate profile contained in this report serves as a baseline for the leachate quality but will be revised based on Site specific conditions and incoming waste types to continue to assess the level of treatment required. Leachate quality will be reviewed as part of the annual operations and monitoring report discussed in Section 14.10.

Table 9.1 provides a range of leachate concentrations from four similar landfills and the historic Site landfill that are used to forecast the leachate quality profile for the Site. As shown in Table 9.1, parameters that are expected to exceed the CSR Schedule 3.2 Column 6 DW Standards within the untreated leachate include iron, manganese, and PAHs. Parameters forecasted to potentially exceed the CSR Schedule 3.2 Column 6 DW Standards within the untreated leachate include:

- Chloride
- Sulphide
- Arsenic
- Boron
- Iron
- Manganese
- Sodium
- PAHs

9.6 Leachate Quantity

The principal factors governing the quantity of leachate generated at a landfill include:

- Moisture addition
- Thickness of refuse layer
- Compaction and permeability of refuse mass
- Slope, thickness, and permeability of intermediate and final cover

Moisture addition to a landfill can arise from several possible sources (McBean et al., 1995):

- Water present in waste mass when landfilled
- Percolation of water (precipitation) through the landfill surface
- Horizontal flow through sides (not applicable to Northwin due to lined slope and berms)
- Upgradient flow from the bottom (not applicable to Northwin due to lined base)

Water entering the landfill is retained within the waste by surface tension and capillary pressure until the waste reaches field capacity, which is defined as the point at which the force of gravity on the leachate overcomes the forces retaining the leachate (El-Fadel et. al., 2002). In general, waste is placed at a water content below field capacity, hence percolation and inflow are considered to be the principal sources of water infiltration for leachate generation. The specific moisture content of the waste at field capacity varies with the waste composition, density, and porosity. The heterogeneous nature of the waste and channeling of leachate through paths of low hydraulic

resistance causes leachate generation prior to the waste mass reaching field capacity, however, it can be expected that leachate flow rates will increase once field capacity has been reached.

Horizontal flow into the Landfill through the sides will not occur at this Site. The north, west, and east sides of the Landfill are not connected to adjacent land mass and, therefore, horizontal flow into the Landfill could only be possible through the buried portion of the landfill. The buried portion of the landfill on the southern side of the Landfill will not be subjected to horizontal flow into the Landfill due to the base liner system extended up the southern side slope and over the perimeter berm. A vadose zone exists between the groundwater and the base liner system. The high hydraulic conductivity of the underlying soils will provide a preferential pathway for groundwater flow through the soils and not through the liner system.

9.6.1 Estimating Leachate Quantities

The Hydrologic Evaluation of Landfill Performance (HELP) Model was used to estimate leachate generation under daily cover, intermediate cover and final cover scenarios. The HELP Model is a quasi-two-dimensional hydrologic model for conducting water balance analysis of landfills, cover systems, and other solid waste containment facilities. It is a long-accepted standard model for landfill cover performance developed by the US Army Corp of Engineers.

Leachate generated from a landfill area with daily cover applied was estimated based on the infiltration rate through daily cover as well as the surface runoff rate. Surface water coming into contact with waste or daily cover will be intercepted by the perimeter containment berms and managed as leachate. HELP Model outputs are presented in Appendix E.

9.6.2 Conceptual Leachate Generation Model

The generation of leachate is dependent on a number of factors including the precipitation rates, landfill cover systems, landfill development, and the duration of each stage of landfill development.

Precipitation data for the Campbell River Airport (Station 1021262) from 1981 to 2010 is summarized in Table 2.1, following the text. The precipitation data is provided by month and used to calculate average daily precipitation rates. It is noted that November, December, and January account for 45% of the annual precipitation. As discussed in Section 8, climate change models forecast an increase of up to 5.2 percent during winter months. To conservatively estimate leachate generation, an increase of 5.2 percent was applied on the total estimated generation rate.

The cover systems are discussed in Section 6.5. A summary of the HELP results, or monthly, annual, and peak leachate generation for each cover system is provided in Table 9.2.

The Landfill development is described in Section 5. During each of the eight stages, the estimated area that will be covered with daily, intermediate and final cover varies. Furthermore, when a new cell is initially constructed, the leachate generation rate will be higher due to the lack of waste with the capacity to retain moisture. The estimated area of each type of cover during each stage is presented in Table 9.3.

During construction of Stage 1 East and Stage 1 West, elevated leachate generation rates would be expected during the period immediately after the new cell is opened. Precipitation in this area will not have a waste mound to retain any moisture. To mitigate this situation, a temporary rain flap will be constructed in the base liner, including a berm constructed in the granular drainage blanket and a

HDPE geomembrane flap welded to the base liner and ballasted to prevent damage from wind. This will divide precipitation falling in the new cell to collect leachate in the active side and clean surface water on the other side. The clean surface water will be manually pumped from the non-active side.

The development plan includes a Landfill footprint of 34,148 square metres. The Landfill will have varying combinations of daily, intermediate, and final cover throughout the life of the Landfill that will affect the leachate generation, as presented in Table 9.4. Annual leachate volumes were calculated by multiplying the corresponding leachate generation rate of each cover system, presented in Table 9.2, by the respective areas during each stage of development, presented in Table 9.3. The approximate annual collected leachate volumes will range from 8,805 m^3 (24 m^3/day) in first half of Stage 1 East, to 24,303 m^3 (67 m^3/day) in Stage 2A to 573 m^3 (2 m^3/day) post-closure, as shown in Table 9.4.

Once a waste mound has been developed, the waste in the landfill will provide a significant amount of detention capacity that will prevent instantaneous surcharges in leachate volumes in the Landfill leachate collection system as a result of a large precipitation event.

9.7 Leachate Collection

The Landfill leachate will be collected by a series of perforated collection pipes installed at the bottom of each cell, as shown in Drawing C-04. The collection pipes will discharge to a sump to be constructed at the low point of the Landfill the north-east corner of the footprint. The leachate will be pumped from the sump via a submersible pump housed in one of the two sump riser pipes. The leachate will be conveyed to the aeration pond for treatment, after which it will be decanted to the effluent holding pond and once the water quality is confirmed, to the infiltration pond. The location of the treatment ponds is shown on Drawings C-03 and C-04.

9.8 Leachate Treatment

9.8.1 Treatment Objectives

The leachate treatment system will be designed to treat the leachate to meet the applicable CSR water quality standards (Schedule 3.2 Column 6 DW) prior to discharge to the Infiltration Pond. The CSR standards are published by the BC ENV and are designed to be protective of human health and the environment. The DW standards protect the potential for future drinking water use of the overburden, sand and gravel aquifer downgradient of the Site.

As noted in Section 13.1.1 the average groundwater flow in the shallow aquifer beneath the Pit is approximately 640 m^3/day, one order of magnitude above the average annual daily leachate generation rate. As such the available on-Site attenuation capacity within the overburden, sand and gravel aquifer provides for contingent reduction of treated leachate concentrations further protecting the off-Site receiving environment.

9.8.2 Treatment Capacity

As discussed in Section 9.6, the leachate volume was estimated using the HELP model and the development Stages of the Landfill. For the purposes of designing a leachate treatment system, it is assumed that all leachate generated will be collected and treated as any losses that occur from Landfill base liner leakage are negligible.

Based on the leachate generation rates during the individual stages of the Landfill development plan, the maximum annual average leachate generation will occur in Stage 2A. During Stage 2A, the annual leachate generation rate is estimated to be 24,303 cubic metres (67 m^3/day).

The leachate treatment system has been designed to manage the maximum annual average leachate generated with 100% redundancy. The treatment pond capacity was also verified to ensure sufficient capacity is available to treat the maximum monthly average of leachate generated through the winter months (highest precipitation months) during Stage 2A as shown on Table 9.4. An equalization system at the front-end of the treatment system will serve to buffer peak flows to the treatment system.

As an additional measure of redundancy, the Landfill storage capacity was evaluated. Because the Landfill is lined, leachate can be temporarily stored within the Landfill. It is noted that the design criteria for the leachate collection system and landfill liner indicates that the leachate head should not exceed 0.3 m. Based on an average head of 0.3 m over the base area of the Landfill and an assumed leachate collection system porosity of 0.3, the maximum capacity of the leachate collection system to temporarily store leachate is 2,572 cubic metres.

If the leachate volumes are found to differ during detailed design, commissioning, or at any point in the landfill lifespan, modifications to the treatment system capacity may be required.

9.8.3 Conceptual Treatment Process

The treatment system will operate in a batch treatment setup, generating a batch of effluent for infiltration. To target operation of a weekly batch at the peak daily rate, a batch size is considered to be approximately 466 m^3, based on seven times the average daily leachate generation in Stage 2A. The batch sizes will vary with seasonality and landfill development stages, requiring operational adjustments to the treatment system. Based on the pond sizing described in Section 9.8.3.1, the maximum batch size is 932 m^3. The conceptual leachate treatment process is shown in Figure 8.1 below.

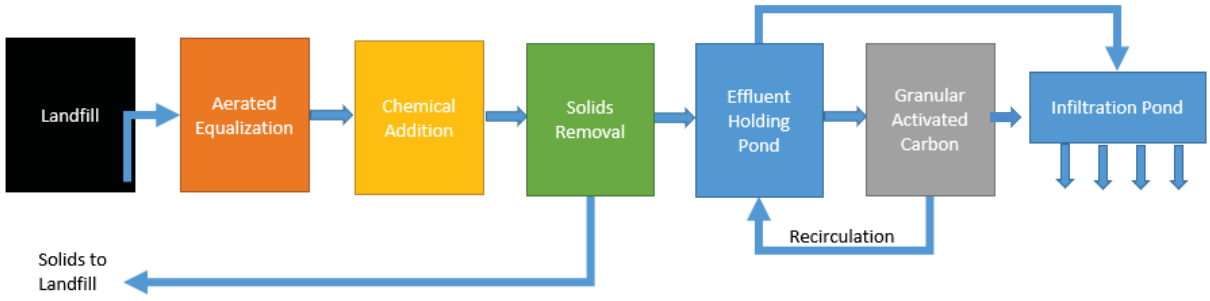


Figure 9.1 Leachate Treatment Process Schematic

9.8.3.1 Process Components

Lined Cells

The entire footprint of the Landfill will be lined and equipped with the leachate collection system as it is developed. The lined Landfill allows for containment of leachate prior to treatment. As discussed above, several processes occur within the Landfill to reduce concentrations of contaminants and these processes vary over time with the development of the Landfill. The details of the liner system are shown in Drawing C-13.

Leachate Collection

The leachate collection system will include the installation of leachate collection pipes and drain rock layer (Drawing C-04), as described in Section 3.7. The details of the leachate collection system are shown on Drawing C-13. Leachate will be conveyed via the leachate collection system to the north of the cell, where a leachate sump will be installed. The sump details are provided on Drawings C-14 and C-16. A pump will be installed in one of the sump risers and the second sump riser provides redundancy to allow for maintenance and cleaning and the use of a secondary pump, if required.

Aerated Equalization

Equalization will be used to attenuate peak generation rates in conjunction with the storage available within the landfill. The addition of aeration to the equalization system accomplished the first step in the treatment process.

Aeration oxidizes dissolved metals such as iron and manganese to less soluble forms and produces flocs that will be removed through filtration. Concentrations of other metals present in the leachate that are not readily oxidized in an aeration lagoon will also be reduced when the suspended (not dissolved) components of these metals are filtered.

Though not anticipated as a contaminant of concern, should hydrocarbons and volatile organic compounds be present, they will be readily volatized in an aeration lagoon. Some PAHs are also reduced through aeration.

Aerated equalization will be accomplished through a lined lagoon. For the purpose of conceptual sizing, a lagoon has been assumed.

The conceptual design features of the aerated equalization lagoon include:

- 2.5H:1V side walls double lined with two layers of 60-mil HDPE liner overlying a GCL with a Geosynthetic drainage layer between the two liner layers.
- Leak collection sump with 300 mm HDPE riser pipe to facilitate the removal of liquid collected within the drainage layer.
- A submerged coarse bubble aeration system.
- Positive displacement blowers, sized to provide the required air demand.
- Submerged decant pump.
- Approximate bottom dimensions of the aeration pond will be 15 m by 15 m. The approximate top dimensions of the aeration pond will be 30 m by 30 m.
- Approximate depth of 3 m with a 0.6 m freeboard.
- Provides storage capacity of over 7 days at the target average daily generation rate with 100 percent redundancy to account for peak storm events. This facilitates operation of a weekly batch treatment.
- Resulting available volume is approximately 1,087 m^3, accounting for precipitation over the pond area (based on above bullet plus 10 percent).
- Aeration is anticipated to require a retention time of 1-3 days.

- The aerated equalization system is anticipated to be filled with automated pump shutoffs based on liquid level in the Landfill and in the pond. To fill the aeration basin over the course of 2 days. Therefore, pumping capacity to fill the aerated equalization system should be 0.77 litres per second (L/s) (12 gallons per minute [gpm]) for an average size batch, and 1.7 L/s (27 gpm) for a maximum size batch.

Solids Removal

Effluent from the aerated equalization system will contain elevated concentrations of suspended solids following oxidation of metals and the presence of other inorganics. The next step is solids removal. This can be accomplished through settling in a clarifier or filtration.

Clarification or filtration will require a capacity of 5.4 L/s (86 gpm) for an average size batch and 11.9 L/s (188 gpm) for a maximum size batch to complete solids removal within one day.

Chemical Addition

Aeration and solids removal will remove the majority of dissolved iron and manganese. Additional dissolved metals removal may be required to achieve the discharge criteria. The dissolved metals will be removed, if required by chemical precipitation, by adding a volume of chemical that will cause an increase or decrease of pH of the leachate to facilitate the formation of an insoluble salt. Chemical addition will take place in a complete mixed reactor or with inline mixing.

Following chemical addition, the formulation of additional suspended solids will require solids removal using a solids removal system as described above.

Effluent Holding Pond or Tank(s)

Effluent from the chemical addition and solids removal step will be collected in a holding pond (or tank(s) of the same capacity). The effluent holding pond or tank(s) will have sufficient capacity to store effluent prior to batch discharge to the Infiltration Pond. The conceptual design features of the effluent holding pond include:

- 2.5H:1V side walls lined with one layer of 60-mil HDPE liner
- Approximate bottom dimensions of the aeration pond will be 15 m by 15 m. The approximate top dimensions of the aeration pond will be 30 m by 30 m.
- Approximate depth of 3 m with a 0.6 m freeboard.
- Provides storage capacity of over 7 days at the target average daily generation rate with 100 percent redundancy to account for peak storm events.
- Approximately 1,087 m^3 available volume.

Tank(s) may be selected in lieu of constructing an effluent holding pond.

Effluent in the effluent holding pond (or tank) will be sampled to determine if the discharge criteria have been achieved. If the discharge criteria are achieved, effluent will be conveyed directly to the infiltration pond.

If discharge criteria have not been achieved, the effluent will be recirculated through a granular activated carbon (GAC) filter as described below and resampled to confirm the discharge criteria are achieved prior to infiltration.

Granular Activated Carbon

An optional GAC filter will be used to polish effluent stored in the effluent holding pond should an initial sample indicate that the effluent does not achieve the discharge criteria. A GAC filter has been selected to ensure the effluent PAH criteria can be consistently achieved.

Treated Leachate Infiltration Pond

The infiltration pond will be used to infiltrate treated leachate and any intercepted storm water into the groundwater system. The design and construction of the infiltration pond is supported by the results of the hydrogeologic characterization of the Site, as provided in the HHCR.

The location of the infiltration pond has been selected to allow for natural attenuation to occur while allowing for continued Site operations. The Site is underlain by a vadose zone of varying thickness, and will be used to attenuate, via sorption, diffusion, dilution, dispersion, and biodegradation, the treated leachate to further reduce the concentrations of the leachate constituents prior to reaching the sand and gravel aquifer and the downgradient property line.

The forecasted treated leachate quality is presented in Table 9.1. The results of pilot studies conducted on Original Landfill leachate will be used to inform leachate treatment design to ensure an adequate level of treatment is attained. The leachate treatment process may be modified throughout the life of the Landfill to ensure the performance and compliance criteria are met.

9.8.4 Operating Sequence

The treatment system will operate in batches. First, the aerated equalization pond will be filled and the aeration system will be on during the filling process. Following aeration, the leachate will be pumped through a solids removal process, dosed with chemical in a complete mixed reactor or inline mixing system, and pumped through a solids removal process into the effluent holding pond. During the LTF commissioning period, once the batch is fully pumped through the chemical addition and solids removal process, the effluent batch will be sampled with a 3-day turnaround on the laboratory analysis. Following receipt of sample results, the batch will be pumped to the infiltration pond or recirculated through the GAC, if PAHs do not meet discharge criteria. During operations the batches will be tested periodically to confirm discharge criteria are being met.

At the Stage 2A average daily leachate generation rate, a batch will be approximately 466 m^3 and the aerated equalization system and effluent holding pond will have 100 percent redundancy to manage a batch if an effluent sample result fails and it needs to be recirculated through the treatment system. As operations are optimized and batches are consistently treated, the system will be capable of operating a maximum batch size in a 7-day period as illustrated in Table 9.1, below.

Table 9.1 Leachate Treatment – Example Operating Sequence

Operating Sequence	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thur.
Fill	X	X					
Aerate	X	X	X				
Solids Removal, Chem. Dose/Mix, Solids Removal				X	X		
Sample					X		
Sample Turnaround	X					X	X
Recirculate/Infiltrate		X	X				

9.8.5 Leachate Treatment Facility Commissioning and Sampling Program

The Leachate Treatment Facility Commissioning Plan is presented in Appendix F.

During the commissioning of the leachate treatment system and during the operation in Stage 1 East, the leachate treatment system will not be at maximum capacity. The untreated leachate and treated effluent will be sampled regularly during the commissioning to develop a relationship between the parameters of concern within the leachate and the batch treatment sampling program. Because the treatment system will not be operating at full capacity the batches may be held while the commissioning program is underway to ensure only leachate meeting the treatment objectives is infiltrated. The finalized leachate treatment sampling program will outline the parameters sampled in every batch to indicate the effectiveness of the treatment process and the confirmatory sampling required at the quarterly environmental monitoring events. Additional confirmatory sampling may be conducted.

Subsequent to commissioning, samples will be collected at a minimum on a quarterly basis to analyze for the parameter list below. The collection of the samples sent to for laboratory analysis may be collected more frequently to verify the batch sampling program, and to assist in the operation and maintenance of the leachate treatment facility.

- COD
- Alkalinity
- Metals
- pH
- PAHs
- Sulphate

10. Landfill Gas (LFG) Management Plan

10.1 LFG Production

LFG is primarily generated as a result of biological decomposition of organic waste material. The processes involved in biological decomposition of solid waste are highly variable. In the early stages of decomposition (typically less than 2 years after initial placement), microbial activity is oxygen consuming (aerobic). This results in relatively high in-situ temperatures, production of gases composed primarily of carbon dioxide (CO2) with other trace compounds, and production of acidic leachate.

As the oxygen in the solid waste mass is consumed, activity of anaerobic microbes increases and eventually results in production of LFG that is predominantly methane (CH_4) and CO_2, and in some cases hydrogen sulphide gas (H_2S). In this phase of the decomposition, the in-situ temperatures are

typically in the range of 30 to 40°C and the leachate has a more basic pH. This methanogenic phase of decomposition will reach an equilibrium level, which will continue for some length of time. The equilibrium condition and the duration of methanogenic decomposition are the primary determinants of the LFG production over time. Within a few years, this anaerobic stage typically becomes and remains dominant until all organic matter in the Landfill has been fully decomposed. The typical LFG production stages are illustrated in Figure 10.1.

These processes are dependent upon the following primary parameters:

- Age of solid waste
- Quantity of solid waste
- Solid waste composition
- Moisture content
- Density and filling practices
- Climate (i.e., precipitation and temperatures)
- Landfill chemistry

This list is not considered comprehensive but serves to illustrate the complexity of the processes involved in the production of LFG. The solid waste age, quantity, and composition, along with site moisture content are considered the primary influences on the rate and duration of LFG production.

The composition and quantity of the solid waste placed in a landfill will determine the amount of material available for decomposition. Materials with a higher organic content are more readily decomposable than those wastes with a low or no organic content. For example, food and agricultural wastes contribute more readily to LFG production than construction rubble. In general, waste that is derived from residential sources contains a higher decomposable fraction than those derived from other sources.

LFG may contain varying amounts of nitrogen (N_2) and oxygen (O_2) due to intrusion of outside ambient air into the landfill. The typical composition of the gas may be in the following range depending on the operation of the LFG collection system:

- Methane – 35 to 60 % by volume
- Carbon dioxide – 35 to 60 % by volume
- Oxygen – 0 to 5 % by volume
- Nitrogen – 0 to 15 % by volume

For modelling and design purposes, the composition of LFG produced and collected is assumed to be 50% CH_4 and 50% CO_2, each by volume.

The optimal range of moisture content in refuse for methane production is reported to be 40 to 70% by weight (Reinhart & Townsend, 1998). Actual LFG production is sensitive to moisture; however, the degree of moisture distribution and saturation within the landfill are difficult to determine. Furthermore, there are various technical difficulties in ensuring adequate leachate distribution and collection within a landfill.

Due to the complexity of the processes involved in LFG production, the methods available to predict variations in production over the life of a site provide only estimates to permit the design of control systems. Flexibility to address changes in the LFG production should always be a primary design consideration in any LFG management program.

The use of predictive models provides the best method of defining a particular site's LFG generation potential. The following subsections present the results of estimated LFG production at the Site with mathematical models.

10.2 Regulatory Criteria

The BCENV Landfill Gas Management Regulation requires the following:

- Landfills receiving over 10,000 tonnes of waste per year, or landfills that have over 100,000 tonnes of waste in place, complete a LFG generation assessment every five years.
- The assessment of the forecasted LFG generation rate in the year of the assessment and for the next 5 years be prepared by a qualified professional and submitted to the ENV.
- If the landfill is currently generating over 1,000 tonnes of methane per year, according to the LFG generation assessment, then a LFG Management Facilities Design Plan must be submitted to the ENV within one year.
- Once the LFG design plan is accepted, an active landfill gas collection system is required to be installed within four years of the LFG design plan acceptance.

The production of hydrogen sulphide gas is related to health and safety concerns, as well as nuisance impacts, and is regulated under WorksafeBC, as discussed in Section 10.5.

10.3 LFG Generation Model

There are numerous models available for estimating rates of production of LFG. Accepted industry standard models are generally first order kinetic models that rely on a number of basic assumptions. These models are used to predict the variation of LFG generation rates with time for a typical unit mass of solid waste. This generation rate curve is then applied to records (or projections) of solid waste filling at a site to produce an estimate of the landfill's LFG production rate over time.

The Scholl Canyon model, a first-order kinetic function, is the accepted industry standard model to evaluate LFG production and emission rates for the purpose of assessing potential LFG impacts. The Scholl Canyon model is used to estimate LFG production over time as a function of the LFG generation constant (k), the methane generation potential (L), historic filling records, and future projections for waste filling rates. Typical values of k range from 0.006 per year for dry sites to 0.07 per year for wet sites. Depending upon the regional precipitation and waste composition, production of LFG may continue for more than 50 years after closure and can result in total yields ranging from approximately 10 to 350 cubic metres of methane per tonne of waste.

The formula for the Scholl Canyon model can be expressed as follows:

$$Q_T = \sum_{t=1}^{n} 2\, L_0 k M_t e^{-kt}$$

Where:

Q_T = total LFG emissions (50 % CH_4 and 50 % CO_2 by volume)

K = LFG generation constant ($year^{-1}$)

L_O = methane generation potential (m^3 CH_4/tonne of waste)

M = mass of waste (tonnes) placed in year t

T = time in years

10.4 LFG Generation Assessment

10.4.1 Landfill Gas Generation Assessment Requirements

As required by Section 4(5) of the Regulation, this Section relates to the tonnage thresholds that determine the regulatory requirement to prepare a landfill gas (LFG) generation assessment. A landfill is termed a regulated landfill site under the Regulation if it has 100,000 tonnes or more of MSW in place or receives 10,000 or more tonnes of MSW in any calendar year after 2008.

Based on the estimated annual tonnages, the Landfill will be considered a 'regulated landfill site' as per Section 4(5) of the Regulation and a landfill gas (LFG) generation assessment report will need to be submitted to the ENV following the first year of landfill operations as required in Section 4(5) of the Regulation.

10.4.2 Waste Characterization

This section summarizes characteristics at the Site, anticipated waste tonnage, and waste characterization, as required by Sections 4(2)(a), 4(2)(b), 4(2)(c), 4(3)(a), and 4(3)(d) of the Regulation and described in Section 5.1 of the Guidelines.

For this assessment, waste landfilled was segregated into the following three categories by mass:

- Relatively inert (waste includes waste materials with low or no degradable organic carbon, such as metal, glass, plastic, soil, contaminated soils, and water treatment plant screened fines).
- Moderately decomposable (includes materials with a degradable organic carbon fraction that will decompose at a moderate or slower rate such as paper, wood, wooden furniture, rubber, textiles, and construction and demolition material).
- Decomposable (includes materials with a high degradable organic carbon fraction that will decompose relatively quickly such as food waste, yard waste, and slaughterhouse waste).

As per Section 4(3)(d) of the Regulation and described in Section 5.1 of the Guidelines, waste characterization information is required as part of the generation assessment. This information should include the historical, where possible, and projected annual waste mass categorized into mass of relatively inert, moderately decomposable, and decomposable wastes, and historical and projected waste mass.

The site-specific waste characterization is presented in Table 10.1. As shown, the waste that will be received at the Site is categorized into 75 percent relatively inert, 25 percent moderately decomposable, and zero percent decomposable.

10.4.2.1 Climate

The moisture content within a landfill is one of the most important parameters affecting the gas generation rate. Moisture provides an aqueous environment necessary for anaerobic processes responsible for LFG production, and serves as a medium for transporting nutrients and bacteria that play a major role in the decomposition process. The precipitation data, as discussed in Section 2.4 was used to determine appropriate values for model input parameters. The potential effects of climate change on the annual precipitation rate were evaluated. It was found that the model inputs do not change for annual increase of up to 25 percent, which exceeds the forecasted precipitation rate change due to climate change, as discussed in Section 2.4 and 8.4.2.

10.4.2.2 Model Input Parameters Used and Justification

The following section presents the information required by Section 4(3)(d) of the Regulation and described in Sections 5.2 (Methane Generation Rate Selection Matrix) and 5.3 (Water Addition Factor) of the Guidelines.

The methane generation potential, L_o, represents the total potential yield of methane from a mass of waste (m^3 of methane per tonne of waste). The L_o value is dependent on the composition of waste, and in particular the fraction of organic matter present. The methane generation rate, k, represents the first-order biodegradation rate at which methane is generated following waste placement. This constant is influenced by moisture content, the availability of nutrients, pH, and temperature.

Moisture content is influenced primarily by the infiltration of precipitation through the Landfill cover and the nature and composition of the waste. For this assessment, a water addition factor of 1.0 was selected. The water addition factor may increase or decrease the LFG generation rate by 10 percent. The potential Landfill leachate storage in the Landfill during the winter months will not significantly increase the moisture within the Landfill, as the leachate will be stored primarily within the leachate collection system, and not within the waste.

10.4.2.3 Landfill Gas Generation Model Results

The Regulation Sections 4(2)(d), 4(2)(e), and 4(3)(a)] requires that a LFG generation assessment include the following:

- The annual tonnage of waste received for disposal at the Site in the calendar year immediately preceding the year in which the assessment is conducted.
- An estimate of the quantity of methane generated at the Landfill in the calendar year immediately preceding the calendar year in which the assessment is conducted.
- Projections for methane anticipated to be generated annually at the Site in the calendar year of the assessment and in each of the four calendar years following the calendar year of the assessment.

For this assessment, the maximum annual waste tonnages throughout the life of the Landfill were used (45,000 tonnes per year, except if landfilling waste from the Original Landfill). When an actual LFG assessment is produced for submission to the ENV, the recorded waste tonnages will need to be used for the assessment.

This assessment projects the methane generated annually at the Landfill for each calendar year that the Landfill is anticipated to be operational.

Table 10.2 presents a summary of the above information. As noted on the table, the peak methane generation occurs in the year after closure. The maximum annual methane generation is estimated to be approximately 560 tonnes per year in the year following closure. The methane generation rate will steadily decline in post-closure years.

Table 10.3 presents the input values for the Scholl Canyon Model and LFG generation results. Figure 10.2 shows a graphical representation of the annual LFG generation estimate commencing in 2021 (assumed Landfill start date) to 2063 (end of the 30 post-closure monitoring period).

10.4.2.4 Future Considerations

The estimated 2035 (Landfill closure year) methane generation for the Site is approximately 649 tonnes. As the regulatory threshold is 1,000 tonnes of methane per year, the Landfill is not expected to surpass the threshold during the Landfill lifespan. If the methane generation rate surpasses the threshold due to higher annual tonnages, more decomposable waste, the Landfill continuing for a longer timeframe than originally plan, or due to a regulatory revision, an LFG Management Facility Design Plan will be submitted to the ENV director. Within 4 years of submitting the LFG Management Facility Design Plan, a LFG Management system designed to target a landfill gas collection efficiency of 75 percent must be commissioned and operational. The LFG regulation may change between now and the closure of the Site.

The LFG Management Facility Design Plan must be prepared by a qualified professional in accordance with the Landfill Gas Management Regulation.

10.5 LFG and Safety

As indicated in Section 10.1, LFG is produced primarily due to biological decomposition, generating CO_2 and CH_4. Predominantly due to pressure gradients, LFG migrates through either the landfill cover or adjacent soil and enters the atmosphere, contributing greenhouse gas (GHG) emissions, creating health and toxicity issues, and creating nuisance odours. These impacts are largely dependent upon the pathway by which humans and the environment are exposed.

Sub-surface migration of LFG is influenced by pressure differentials within the waste mass, LFG migration from areas of high pressure to areas of low pressure, diffusion of LFG through from areas of high concentrations to low concentrations, and the permeability of the waste, liner, and cover systems.

Sub-surface migration of LFG poses two primary concerns related to the accumulation of gases within or below structures near the Landfill. First, accumulation of LFG in a subsurface structure (i.e., basement, buried manhole, etc.) may expose those required to enter the structure to an oxygen deficient environment. Second, accumulation of LFG introduces the risk of an explosion if a

source of ignition is present. The risk of explosion occurs when the concentration of methane in air exceeds its Lower Explosive Limit (LEL). Due to the fact that the LEL of methane is approximately 5% by volume in air, only a small proportion of LFG (containing approximately 50% methane by volume) is necessary to create explosive conditions.

Visual observation of the sub-surface migration of LFG is possible through identification of areas impacted by vegetative stress. Vegetative stress occurs due to the displacement of oxygen in the soil and the resultant oxygen deprivation of the plant roots. Deterioration of vegetation on or near landfills may be both an aesthetic and a practical issue. In areas where vegetative cover is diminished, erosion of the cover may occur. This may result in a "cascade" effect resulting in increased LFG emissions.

H_2S, if present, presents immediate danger to the health and safety of workers. WorkSafeBC regulations and guidelines must be followed. At a minimum, the following procedures are recommended, if the potential for H_2S becomes an issue.

- No persons shall traverse or operate equipment within the limit of waste or in the vicinity of the leachate management infrastructure without wearing a 4-gas meter.
- All leachate collection system cleanout and sump riser pipes blind flanges should be completely sealed, bolted, locked, and identified with appropriate signage.
- Appropriate measures should be taken to prevent persons untrained in H2S safety and without the appropriate personal protective equipment from entering the site. Appropriate signage should be installed around the limit of waste.
- Appropriate chain link fencing and signage should be installed around leachate sumps, leachate manhole, and toe drains.
- All workers and contractors working in designated Site “Hot Zones” (fenced areas) should be required to have completed the H2S Alive course.
- All workers and contractors working on-site should be required to have reviewed and acknowledged the Site health and safety plan which discusses the H2S safety plan and restricts smoking anywhere onsite.

10.6 LFG as a Greenhouse Gas

As discussed in Section 10.1, LFG consists of varying levels of CH_4, CO_2, oxygen, and nitrogen. For modelling and design purposes, the composition of LFG produced is often assumed to be 50% CH_4 and 50% CO_2, each by volume. These two gases are two of the recognized greenhouse gases that contribute to climate change. CH_4 has a global warming potential approximately 25 times that of CO_2.

10.7 LFG Control

The Landfill will use a geosynthetic liner system, which will limit subsurface migration of LFG into the subsurface surrounding the landfill. As such, migration of LFG will likely primarily occur through the final cover, resulting in potential degradation of the final cover and vegetative stress. As such, the LFG Management Plan for the Landfill will involve the installation of a passive gas venting system as part of the final cover design.

The use of passive bio-filters will be evaluated as part of the detailed design of the final cover and passive gas venting system. Methane from the Landfill would be directed to a biofilter(s) via the passive venting system. Biofilters are typically a mix of sand and wood chips that facilitate the growth of aerobic bacteria that oxidizes methane to carbon dioxide, reducing the greenhouse gas emissions from the landfill. Passive biofilters will be considered at the detailed design stage of the final cover system, when it is possible to assess the actual methane generation rates based on the characteristics of the waste landfilled.

The guidance document entitled “Technologies and Best Management Practices for Reducing GHG Emissions from Landfills Guidelines” provides guidance for the selection of technologies and best management practices for reducing GHG emissions from landfills.

10.8 LFG Monitoring and Assessment

The highly permeable overburden unit at the Site may allow the LFG to migrate away from the Landfill if there is a breach in the Landfill base liner system. It is therefore recommended that the potential for off-Site LFG migration be monitored at the periphery of the Site, and into the existing on-site buildings currently occupied by the operational personnel. The soil gas concentrations at the Site boundary must not exceed the lower explosive limit of methane (five percent by volume). The soil gas concentrations in on-Site buildings must not exceed 20 percent of the lower-explosive limit of methane (one percent by volume) at any time.

In accordance with the above-noted recommendation, two soil-vapour monitoring locations will be installed at site as part of the construction of the cells.

1. Near the Wash Plant
2. At the southern property boundary to monitor migration of LFG off site

The monitoring requirements are further discussed in Section 14.

11. Closure Plan

The following sections outline site-specific closure activities and post-development care requirements in accordance with the Landfill Criteria.

11.1 Total Site Capacity

The total and remaining Site capacity is estimated to be 532,365 m^3.

11.2 Landfill Site Life

The estimated Landfill Site life is approximately 13.3 years and landfilling in the Landfill is assumed to start in 2022.

11.3 Final Closure Design

The final contours for the Landfill area are based on the construction of a 0.90-metre-thick final cover (0.15 metres of sand overlain by a GCL, 0.6 metres of protective sand layer, 0.15 m of

topsoil) constructed over top of the final waste grades presented on Drawing C-06. In accordance with the Landfill Criteria, the final cover slopes will be a maximum of 3H:1V (33 percent) on all side slopes and a minimum of 10H:1V (10 percent) on the top slopes of the Site.

Details concerning final cover design and construction, including final cover soils, topsoil, and cover vegetation are discussed in Section 3.12. When a section of the Landfill reaches final contour elevations, final cover will be installed by an experienced contractor and inspected by a qualified professional engineer to ensure that construction has been completed in accordance with detailed design.

11.4 Progressive Closure Strategy

In keeping with a progressive closure strategy at the Site, areas of the Landfill that reach final waste contours in accordance with the Landfill Development plan presented on Drawings C-08 through to C-12 will be closed once sufficient area to warrant construction of final cover is available.

The Site life will be updated in the annual operations and monitoring report based on the final waste contours and the average annual fill rates.

11.5 End Use

The End Use Plan for the Landfill has been developed as part of the Reclamation Plan for the Upland Pit. It is anticipated that the Site will remain industrial land use and continue the aggregate extraction activities.

A detailed End Use Plan will be developed for the Site within one to two years prior to closure. The end use plan will comply with the requirements of the CSR and a new declaration under Part 8 of the CSR may be submitted to the ENV Director. The End Use Plan will be submitted to the City and the Regional Waste Manager for review and approval prior to implementation.

11.6 Post-Closure Requirements

11.6.1 Site Monitoring

The long-term environmental monitoring program for the Site will include hydraulic monitoring and chemical analysis of surface water and groundwater at the Site in accordance with the Environmental Monitoring Plan (EMP) discussed in Section 14. The EMP will be maintained during and after Site closure and will be evaluated on an annual basis. In accordance with the Landfill Criteria, the long-term monitoring program will be maintained for a minimum post-closure period of 30 years. Any proposed amendments to the long-term monitoring program will be submitted to the Director for review and approval prior to implementation.

11.6.2 Vector, Vermin and Animal Control

After closure, the Site will continue to be monitored for the presence of vectors, vermin, and wildlife and should problems become evident, the appropriate steps will be taken to address the issue.

11.6.3 Surface Water Control

The strategy outlined in the SWMP (Section 8) will be implemented into the post closure surface water control measures. The mid-slope swales, surface water diversion berm, ditches, sediment

forebays, and infiltration areas will be completed and maintained around the landfill. Channels with steep slopes will require reinforcement to prevent erosion, as discussed in the SWMP. The ditches and ditch outlets will require reassessment upon closure to ensure that they are functioning satisfactorily. Vegetation will be maintained on the Landfill surface and in the channels to ensure channels flow freely and are not overloaded at peak rainfall events. Monitoring of the Landfill surface conditions will be required, and if damage due to erosion, settlement, or other factors are found, maintenance will be performed.

11.6.4 Post-Closure Infiltration Areas

The post-closure conditions of the Landfill will require the designation of infiltration areas within the base of the Pit to manage the surface water in large rainfall events. The conceptual design of the infiltration areas is discussed in Section 8.4.

11.6.5 Post Closure Maintenance and Monitoring Requirements

The EMP should be maintained for a minimum period of 30 years post-closure. This will be to assess the need to implement a contingency measure to further reduce the environmental risk. If monitoring results are as expected, the frequency of the monitoring events may be decreased to annually. The parameters should be analyzed annually until they completely stabilize at which time a monitoring program every 5 years is appropriate. It is important to continue monitoring for any change in Site conditions.

11.6.6 Site Facilities

The Landfill facilities for storm water and leachate management will remain intact and operational post-closure of the Landfill. A closure plan shall be submitted to the Director for approval at least 6 months prior to the closure of the Landfill.

12. Contaminating Lifespan Assessment

The purpose of this assessment is to evaluate the contaminating lifespan (CLS) of the Landfill. The CLS is the time period after the final closure of the Landfill until which the Landfill leachate no longer poses a risk to the environment because the concentrations of leachate contaminants have decreased sufficiently that the leachate constituent concentrations meet the applicable CSR standards for regulatory compliance.

During the CLS, the Landfill will require treatment, monitoring, and maintenance of the leachate management system to manage the post-closure Landfill conditions. These measures can be terminated at the end of the CLS.

The CLS of the Site was estimated based on the available data, and relevant models acquired through a literature review. In this case, GHD has utilized a first order decay function to estimate the CLS of the Site. The contaminants modeled to estimate the CLS include chloride and sulphate. These contaminants were selected as conservative parameters, as they decay only through dissolution and are not subject to biological degradation. GHD also investigated chromium, copper, and cadmium, however, forecasted leachate concentrations are below applicable environmental

protection guidelines. GHD used the Rowe (1995, 2004) CLS model to confirm/evaluate the first order decay results for chloride.

The potential effects of climate change on the annual precipitation rate were evaluated. It was found that forecasted precipitation rate change of 6% was due to climate change, as discussed in Section 2.4. However, for the CLS it is more conservative to not include the potential increase in precipitation due to climate change as this will have a negligible effect on the infiltration into the Landfill through the final cover system but will increase the rate of decay resulting in a shorter contaminating lifespan.

The CLS assessment should be updated regularly and include amendments to the list of parameters, where required, based on the actual parameters within the Landfill leachate. The CLS assessment updates should form part of the updates to the Design, Operation, and Closure Plan, as required by the Landfill Criteria.

12.1 First Order Decay Model

Contaminant transport was simulated utilizing the 1DTRANSEN model. The leachate source concentration in the one-dimensional transport model is governed by the time function.

$$C_0 = \begin{cases} (t/t_1)C_B + C_A & 0 < t < t_1 \\ C_B & t_1 \le t < t_2 \\ C_B e^{-\mu t} & t \ge t_2 \end{cases}$$

For the purpose of this assessment the time period where t is greater than or equal to t_2, was used representing Landfill closure. When the simulation time is greater than t_2, the source concentration is assumed to decay exponentially at a rate of μ, the first order decay constant. The initial concentration, C_B, was estimated for each contaminant of concern (COC), based on data from existing C&D landfills that accept a similar waste stream as the Landfill.

12.1.1 Constituents of Concern

Based on the nature of waste normally found in C&D, land clearing, and contaminated soil landfills, the quality of leachate is generally much weaker in comparison to leachate from municipal landfills and also tends to have a lower organic content. The landfill leachate strength at any given time depends primarily on waste composition. Concentrations of the leachate constituents of concern were estimated based on data from existing similar landfills. The data was compiled from several similar landfills and utilized the maximum concentrations forecasted for the Landfill.

The forecasted constituents of concern concentrations in leachate are provided in Table 9.1.

12.1.2 Results

The CLS as estimated by the First Order Decay method in years for the constituents of concern identified for the Site, are as shown in the table below. The supporting calculations are provided in Appendix G.

Parameter	Years to Meet CSR DW Criteria
Chloride	28.0
Sulphate	9.0

12.2 Rowe Model

12.2.1 Model Based On Rowe (1995, 2004)

Rowe (1991) examined the issue of leachate strength decrease for conservative contaminant species (e.g., chloride) where the decrease in strength is essentially due to dilution (i.e., no biological breakdown or precipitation) as water infiltrated through the waste with time. Assuming that the decrease is due to dilution, the variation in concentration at any time t is given by:

$$C_{(t)} = C_0^{-q_0 t/H_r}$$

Where:

$$H_r = \frac{M_a}{A_0 * C_0}$$

Source: Rowe, 1994

$$M_a = H_w * \rho_{dw} * P$$

Where:

M_a = mass of contaminant per unit area (kg)

H_r = reference height of leachate (m)

A_o = area (m^2)

H_w = maximum waste thickness (m)

ρ_{dw} = dry density of waste (kg/m^3)

p = proportion of the total mass of waste that is contributed by chloride

C_o = peak or average chloride concentration (mg/L)

q_o = average rate of infiltration (m/yr)

$C_{(t)}$ = target concentration [i.e., ODWS] (kg/m^3)

T = time required (yr)

This model was used to validate the results of the First Order Decay Model. Note that this model was utilized for two scenarios, as follows:

- Scenario 1: maximum chloride concentration, average proportion of chloride in waste
- Scenario 2: maximum chloride concentration, maximum proportion of chloride in waste

Scenario 2 represents the worst case conditions.

12.2.2 Site Parameters

Concentrations of Leachate Constituents of Concern

As described in Section 12.1.1.

Dry Density of Waste

The estimated dry density of waste, based on expected waste stream, is 1,300 kg/m^3.

Volume of Waste

The total volume of waste is 532,365 m^3 within an area of 36,000 m^2.

Chloride Percentage in Waste

The mass of contaminant can be characterized in terms of the mass of waste and proportion of that mass which is the chemical of interest. Rowe (1995) reports that the data on the mass of contaminants in waste are relatively sparse and published data of chloride representative of municipal waste are in the range of 0.07 percent and 0.21 percent of the in-situ mass of refuse. Laner et al. (2011) reported a range of 0.003 to 0.09 percent of chloride in the dry mass of waste. Fellner et al. (2009) reported that chloride in the dry mass of waste is 0.05 percent.

As noted above, based on the nature of waste normally found in C&D, land clearing, and contaminated soil landfills, the chloride concentration in waste is generally less than in municipal solid waste landfills. An investigation at another landfill included advancement of three boreholes into waste to characterize the chloride contribution. Chloride was found to be 0.064 percent, 0.042 percent, and 0.014 percent of the total waste in the three boreholes (Genivar, 2012a). The average measured chloride in the waste is 0.04 percent. This parameter is of paramount importance since it determines the mass of chloride present in the landfill, which has to be carried out by the infiltration water.

Target Concentration

The target concentration is defined by the CSR standards required to achieve compliance in the groundwater. The Drinking Water standard is 250 mg/L. For the purpose of the CLS assessment, a resulting concentration above this threshold would be defined as an "unacceptable impact" at the Site boundary.

12.2.3 Results

The CLS for chloride was evaluated using the Rowe Model to confirm the result of the First Order Decay Method for estimated CLS. The estimated CLS, in years, for each scenario modelled is presented in the table below. The supporting calculations are provided in Appendix G.

Scenario	Years to Meet CSR DW Criteria
Maximum chloride concentration, average proportion of chloride in waste	26
Maximum chloride concentration, maximum proportion of chloride in waste	27

12.3 Summary

The CLS of the Landfill was estimated using the First Order Decay Method to determine the time period required after the closure of the Landfill for the concentration of select leachate constituents to reach the compliance criteria. The governing leachate constituent was determined to be chloride as it had the longest CLS of the modelled parameters. The First Order Decay Method determined that the time period for chloride to decrease to meet the CSR DW standards was 28 years. The Rowe Model was used to verify the CLS of chloride from the Landfill. The result of the Rowe Model was a CLS of 26 to 27 years, which confirms the results of the First Order Decay Method. Based on these results, the CLS of the Landfill is estimated to be 28 years. For the purpose of calculating Financial Security, the CLS will be set to 30 years, the minimum post-closure period according to Section 8.3 of the Landfill Criteria.

13. Groundwater and Surface Water Impact Assessment

In order to estimate potential impacts to groundwater quality at the downgradient Site boundary, a generalized water balance and mass balance approach has been used. The following sections provide discussion of the calculations and assumptions used to assess future groundwater quality compliance at the Site as well as the predicted groundwater quality under 'worst-case' conditions.

13.1 Water Balance

A generalized water balance has been developed for the Site to quantify and characterize the basic hydrogeologic functioning in the vicinity of the Landfill. The water balance considers the primary inputs, and movement of water within and across the Site using both empirically derived data and theoretical calculations where data is unavailable (e.g., leachate leakage from the Landfill). These inputs are then used in combination with forecasted contaminant mass inputs to derive the predicted future groundwater concentrations at the downgradient Site boundary.

The inputs to the water balance are as follows:

- Groundwater flow into the Landfill area, below the liner, from upgradient sources
- Precipitation over the Landfill area that results in:
    - Leachate generation, which, in turn, results in:
        - Leakage into the underlying aquifer
        - Leachate that is collected for treatment

- Runoff infiltrating into overburden soils
- Infiltration of the treated leachate effluent
- Infiltration of precipitation falling downgradient of the Landfill footprint and effluent infiltration pond

As discussed in Section 2.4, precipitation in the winter months is anticipated to increase by 5.2 percent due to climate change. However, for the impact assessment it is more conservative to not include this potential increase in precipitation as this will have a negligible effect on the rate of leakage through the liner system but will increase the rate of dilution downstream of the Landfill due to increased infiltration.

13.1.1 Groundwater Flow beneath the Landfill

Groundwater flow beneath the Landfill footprint was estimated using aquifer properties as measured using the on-Site monitoring well network. The locations of the monitoring well network is discussed in Section 14.

Seasonal changes in precipitation are anticipated to be reflected in changing groundwater elevations. It is expected that, in general, groundwater elevations will rise and fall uniformly across the Site with the seasons so that, while the saturated thickness may change, the average hydraulic gradient across the Site should remain generally consistent.

The groundwater flow direction and gradient were calculated using groundwater monitoring data previously collected during the months of January, March, April, September, October, and November between 2015 and 2017. Hydraulic gradients for these periods range from 0.026 to 0.031 m/m with an average of 0.028 m/m. Groundwater elevations at MW3-14 have varied from 155.30 to 157.25 mAMSL over the same time period which corresponds to a range of saturated thickness of 4.45 to 6.42 m in the sand and gravel aquifer (November 27, 2017 and January 25, 2016).

Groundwater flow beneath the Landfill is directed to the southeast. To determine the cross-sectional area through which groundwater flow occurs beneath the Landfill perpendicular to the direction of groundwater flow, the northeast to southwest diagonal of the Landfill footprint, approximately 250 m in length, is multiplied by the saturated thickness of the sand and gravel aquifer beneath the Landfill.

The hydraulic conductivity value for the shallow aquifer is conservatively estimated at 2×10^{-2} cm/sec based on single well response testing carried out in 2015 and confirmed by pumping tests carried out in 2018.

Using Darcy's flow equation, an estimate of groundwater flux (or groundwater flow through the cross-section area perpendicular to groundwater flow beneath the Landfill) can be made using the hydraulic conductivity (estimated from single well response testing), maximum and minimum hydraulic gradient, and saturated thicknesses measured at the Site.

$$\text{Groundwater flux } (Q) = K \times i \times b \times W$$

Where

K = Hydraulic conductivity

i = Horizontal hydraulic gradient

b = Saturated thickness of the shallow aquifer

W = Diagonal width across Landfill perpendicular to groundwater flow

The range in hydraulic gradients and saturated thicknesses with the rounded hydraulic conductivity results in a flux estimate ranging from approximately 500 to 865 m^3/day with an average value of approximately 640 m^3/day.

13.2 Potential Leachate Leakage

A series of HELP models were developed to evaluate the potential leakage rate through the primary base liner generated under daily, intermediate and final cover for the following scenarios:

- Scenario 1 – Base case with good quality primary liner installation
- Scenario 2 – Partial degradation of the primary HDPE geomembrane equivalent to a poor installation quality (2 pinholes and 12 installation defects per hectare)
- Scenario 3 – Total degradation of the primary HDPE geomembrane (no geomembrane)
- Scenario 4 – Total degradation of the primary HDPE geomembrane (no geomembrane) with an underlying secondary liner system

Table 12.1 in-text below summarizes modeled leakage rates. The HELP model outputs for liner leakage scenarios are provided in Appendix H.

Table 13.1 Modelled Leakage Rates

Scenario	Landfill Leakage Rate (mm)		
	Daily Cover	Intermediate	Final Cover
1 - Base Case with Good Quality Installation	0.0058	0.0053	0.0001
2 - Base Case with Poor Quality Installation	0.0367	0.0341	0.0005
3 - Complete failure of Geomembrane	8.2910	7.7746	0.9662
4 - Complete failure of Geomembrane with underlying Secondary Liner System	0.0018	0.0016	0.0002

As can be seen from the modeling results the deployment of intermediate cover reduces the leakage rates while deployment final cover reduces the leakage rate to nearly zero in all cases except for Scenario 3. The inclusion of the secondary liner system with no primary geomembrane shows a further decrease in the overall leakage rate. The leakage rate modeling illustrates the inclusion of a secondary liner system is effective in eliminating leakage to the underlying aquifer in the event of a complete failure of the primary liner system.

Table 12.2 below provides the daily leakage rates for the Landfill for each of the scenarios during the period of highest leachate generation (Stage 2A of Landfill development). Although highly unlikely, the complete failure of geomembrane (Scenario 3) was modeled as a worst-case scenario by removing the geomembrane and modeling the performance of the primary liner system with only the GCL. Holding all other model inputs constant, it is determined that the maximum leachate leakage rate through the primary liner system would increase to approximately 480 L/day from the base case of 0.32 L/day. Scenario 3 was used to determine the appropriate trigger levels for the Trigger Level Assessment Program (TLAP) described in Section 16.

Under a primary geomembrane failure scenario leachate would enter the Landfill's leak detection system drainage layer. The leakage rate through the secondary liner system below the leak

detection system drainage layer is modeled by Scenario 4 to be 0.037 m^3/year or 0.10 L/day. This leakage rate is carried forward in the groundwater quality compliance assessment.

Table 13.2 Leachate leakage through Landfill – Stage 2A

Scenario	Landfill Leakage Rate (m^3/yr)			
	Daily Cover	Intermediate Cover	Final Cover	**Total**
	A = 8,135 m^2	A = 12,639 m^2	A = 9,650 m^2	**A = 30,424 m^2**
1 - Base Case with Good Quality Installation	0.047	0.067	0.001	0.115 (0.315 L/day)
2 - Base Case with Poor Quality Installation	0.568	0.196	0	0.734 (2.012 L/day)
3 - Complete failure of Geomembrane	0.299	0.431	0.005	175.034 (479.547 L/day)
4 - Complete failure of Geomembrane with Secondary Liner System	0.027	0.009	0	0.037 (0.101 L/day)

13.2.1 Infiltration from Treated Effluent

It can be assumed that all leachate generated and collected is ultimately treated and infiltrated into the shallow aquifer. Based on the anticipated maximum leachate generation rate occurring during Stage 2A, the maximum annual average daily leachate collection and treatment rate is 67 m^3/day.

13.2.2 Downgradient Precipitation

Precipitation that falls downgradient of the Landfill footprint and infiltration pond will provide an additional source of un-impacted water entering the saturated shallow, sand and gravel, overburden aquifer. The downgradient area between the Landfill footprint and the southern Site boundary is approximately 78,400 m^2.

Using the precipitation data from the Campbell River Airport Station (summarized in Table 2.1) precipitation near the Site falls annually at an average rate of 1,489 mm annually. Periods of lower or higher precipitation result in changing volumes of infiltration downgradient of the Site, and changes in volumes of runoff and lateral drainage from the Landfill surface. Low precipitation will result in a lower volume of non-impacted water available to dilute potential Landfill-derived impacts downgradient of the Landfill. Periods of high precipitation will have the opposite effect. November is typically the wettest month with approximately 232 mm of precipitation over the course of the month (on average - 7.5 mm/day), and conversely, July is the driest month with approximately 39 mm of precipitation throughout the month (average - 1.3 mm/day).

A HELP model simulating the downgradient portion of the Site was created to estimate the percentage of precipitation that will infiltrate into the subsurface. The outputs of the HELP model are presented in Appendix I.

The results of the HELP model show that of the 1,489 mm of precipitation annually, approximately 24 mm will run-off, 370 mm will be removed from the water balance through evapotranspiration, 24 mm will be stored in in the soil, and the remaining 1,068 mm, or 71.9%, will infiltrate directly into the shallow overburden. Thus, an average of 229 m^3/day will infiltration into the subsurface.

To demonstrate the influence of seasonality on downgradient groundwater quality, the groundwater compliance model also includes scenarios based on precipitation values from the dry (July) and wet (November) periods. This results in infiltration of runoff from the Landfill surface and lateral drainage ranging from 1.0 to 6.6 m^3/day for the dry and wet seasons, respectively, and downgradient infiltration rates of 69 and 432 m^3/day for the dry and wet seasons, respectively. Based on the leachate generation HELP model discussed in Section 9, the annual average daily runoff from the Landfill during Stage 2A is approximately 4.9 m^3/day.

13.3 Contaminant Mass Balance

To predict future groundwater contaminant concentrations, a generalized mass balance approach has been used to estimate the contaminant inputs across the Site. Combining the water balance components calculated above with pre-landfilling groundwater quality, forecasted leachate characteristics, and treated leachate effluent characteristics, the total mass of key landfill contaminants can be estimated.

The water quality for each component of the contaminant mass balance equation was determined as follows:

- Pre-landfilling groundwater quality was determined using the average concentrations from groundwater samples collected from each of the sand and gravel overburden monitoring wells during September and October 2015.
- Leachate quality was determined using the forecasted leachate profile discussed in Section 9.
- As treated effluent must meet CSR DW standards prior to discharge into the infiltration pond, the treated effluent concentrations were conservatively assumed to be equal to the upper limit of the CSR DW standards or the maximum concentration found in the leachate (if below CSR DW standard).

The Interstate Technology and Regulatory Council provides guidance for using mass discharge to evaluate contaminant mass balance (ITRC, 2010), and the contaminant mass balance approach presented below follows this guidance.

Multiplying the average concentrations by the existing groundwater flux provides a mass of each parameter. For example:

$$M_d^{UP} = \bar{C} \times Q \times \frac{1{,}000\ L}{m^3}$$

Where:

M_d^{UP} = Chloride mass discharge from upgradient locations (mg/day)

$\bar{C}$ = Average 2015 measured contaminant concentration (mg/L)

Similarly, the mass discharges resulting from surface water runoff from the Landfill footprint (i.e., M_d^{R-O}) precipitation infiltration downgradient of the Landfill footprint (i.e., M_d^{DG-I}) are calculated as follows:

$$M_d^{R-O} = \bar{C} \times Q_{R-O} \times \frac{1{,}000\ L}{m^3}$$

and

$$M_d^{DG-I} = \bar{C} \times Q_{DG-I} \times \frac{1{,}000\ L}{m^3}$$

Where:

M_d^{R-O} = Chloride mass discharge from Landfill run-off (mg/day)

M_d^{DG-I} = Chloride mass discharge from downgradient precipitation infiltration (mg/day)

Q_{R-O} = Total run-off vertical flow rate from Landfill footprint (m^3/day)

Q_{DG-I} = Infiltration vertical flow rate over downgradient locations (m^3/day)

13.4 Groundwater Compliance Assessment

Adding the mass discharge from each of the groundwater flow inputs (existing groundwater, surface water runoff, leachate, treated leachate effluent, and downgradient precipitation) and dividing by the total volume (i.e., the sum of each input in the water balance) provides an estimate of the final concentration of each parameter. For example:

$$C_{PRED} = \frac{M_d^{UP} + M_d^{R-O} + M_d^{DG-I} + M_d^{LL} + M_d^{EFF}}{Q + Q_{R-O} + Q_{DG-I} + Q_{LL} + Q_{EFF}} \times \frac{1\ m^3}{1{,}000\ L}$$

Where:

C_{PRED} = Predicted contaminant concentration in groundwater at the downgradient property boundary (mg/L)

M_d^{LL} = Contaminant mass discharge from leachate[5] (mg/day)

M_d^{EFF} = Contaminant mass discharge from treated leachate effluent[6] (mg/day)

Q_{LL} = Landfill leachate vertical flow rate (m^3/day)

Q_{EFF} = Landfill leachate treated effluent vertical flow rate (m^3/day)

5 The mass discharge from landfill leachate was estimated based on the forecasted leachate concentrations and the leachate vertical flux rate.

6 The mass discharge from treated leachate effluent was estimated based on the forecasted leachate effluent quality and the effluent vertical flux rate.

The four scenarios have been developed to provide a range in the forecasted groundwater quality to account for variability in the inputs to the model as well as uncertainty in the model. The four scenarios are described below:

1. Primary HDPE Liner Failure – represents the failure of the primary HDPE geomembrane liner, while the secondary liner system remains intact (see Scenario 4 in Table 12.3). The input parameters minimize dilution while maximizing mass loading from the Landfill and treated effluent infiltration to provide a scenario of the largest anticipated contaminant mass loading to the sand and gravel aquifer and represents maximum groundwater quality degradation while including the leak detection system.
2. Base Case – represents the downgradient groundwater quality based on operating the Landfill under average conditions with a primary liner system only (Scenario 1 in Table 12.3). The input parameters include average upgradient groundwater flux and average downgradient infiltration.
3. Dry Season – represents the dry season or periods when precipitation is lower than average. The input parameters include minimum upgradient groundwater flux and low downgradient infiltration.
4. Wet Season - represents the wet season or periods when precipitation is higher than average. The input parameters include maximum upgradient groundwater flux and high downgradient infiltration.

The input parameters for each scenario are summarized in Table 12.3 below.

Table 13.3 Groundwater Compliance Assessment Modelling Scenarios

Scenario	Contaminant Loading from Leachate	Flux into Landfill Footprint Area	Landfill Leakage	Treated Leachate Infiltration	Infiltration of Runoff from Landfill Cap	Infiltration Downgradient of Landfill
		m^3/day				
1 – Primary HDPE Liner Failure	Maximum	500	0.00010	67	1.0	73
2 – Base Case	Average	640	0.00032	67	4.8	225
3 – Dry Season	Average	500	0.00032	67	1.0	73
4 – Wet Season	Average	860	0.00032	67	6.6	430

Table 13.1 A through D (following the text) provides the forecasted contaminant concentrations at the downgradient Site boundary for each of the scenarios described above.

The predicted groundwater quality at the downgradient Site boundary demonstrates some minor variability in response to changes in model inputs related to seasonal conditions or liner system

design and performance. Notwithstanding the variability, the predicted groundwater quality at the downgradient Site boundary meets all applicable CSR DW standards under all scenarios modeled.

13.5 Confirmatory Comparison

The groundwater compliance assessment was also used to confirm that groundwater containing parameters with concentrations above the CSR Schedule 3.1 Fresh Water Aquatic Life (AW) will not migrate beyond 500 m from the property boundary.

As shown in Table 13.1 the predicted concentrations of each of the parameters is below the CSR Schedule AW standard for all scenarios modelled.

14. Environmental Monitoring Program

The EMP for the Site has been developed to monitor the performance of the Landfill design within its environmental setting. The EMP will ensure performance and compliance criteria are met throughout the lifespan of the Landfill through to post-closure. The EMP has been developed in accordance with the following documents:

- Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills
- Landfill Criteria

The EMP includes leachate, groundwater, surface water, soil gas, geotechnical, and refuse/soil volume monitoring. The EMP includes a quality assurance/quality control (QA/QC) plan to ensure representative data is collected. The EMP must be reviewed annually and may be modified in the future if warranted based on findings during routine inspections, monitoring events and any other information related to the effect of discharge on the receiving environment.

14.1 Compliance Criteria

The compliance criteria for the water quality comparison for the on-site groundwater was determined in the HHCR. The compliance criteria are the CSR Schedule 3.1 DW standards. These standards will form the basis of the EMP.

14.2 Leachate Monitoring

The objective of the leachate monitoring program is to provide the following data:

- Leachate Quality to confirm leachate indicator parameters, leachate treatment requirements and efficiencies, and assess the potential impacts to the receiving environment.
- Leachate quantity – to assess the suitability of leachate treatment system components.
- Leachate level in the Landfill – to ensure a maximum depth of 0.3 m on the base liner within the Landfill to ensure geotechnical stability and minimize pore pressure over the base liner system.

Leachate monitoring will be conducted at the leachate sump located at the north end of the Landfill, and from the leachate treatment pond. Leachate samples will be collected and analyzed quarterly. The leachate will be analyzed for field parameters, general chemistry, nutrients, LEPH/HEPH, and

CSR metals. Once annually, the samples collected may be analyzed for a comprehensive set of parameters to determine if additional parameters should be included in the EMP.

The samples collected from the leachate treatment pond will be used to assess the leachate treatment system performance and determine if changes to the treatment process are required.

The leachate monitoring as part of the EMP is in addition to the requirements of the LMP, discussed in Section 9, to assess the treatment effectiveness prior to discharge of treated leachate to the infiltration pond.

14.3 Groundwater

The objective of the groundwater monitoring program is to detect at the earliest opportunity the potential for impacts to groundwater associated with landfilling activities. The groundwater monitoring will provide information regarding the extent and magnitude of potential impacts, identify the need to mitigate potential environmental risk, and ensure regulatory compliance.

The groundwater monitoring program also includes the assessment of upgradient groundwater quality for comparison to the down-gradient and cross-gradient groundwater quality.

Groundwater samples will be collected and analyzed quarterly. The groundwater samples will be analyzed for field parameters, general chemistry, nutrients, LEPH/HEPH, and CSR metals. The monitoring locations are shown on Figure 14.1. The existing monitoring wells that will be included in the EMP are shown in yellow. The well completion details are presented in Table 14.1. The proposed monitoring wells to be installed at the Site that will be included in the EMP are shown in magenta. The groundwater monitoring program will include the following monitoring wells:

- Up-gradient – MW6-17, MW9-17, MW1-14, MW4A-15, MW4B-15
- Cross-gradient – MW2-14, MW2A-16
- Immediate Downgradient – MW13-17 (proposed)
- Downgradient Compliance wells: MW-10-17, MW11-17 (proposed), MW12-17 (proposed)

The existing upgradient monitoring wells, MW7-17 and MW8-17, were installed to characterize the groundwater regime in the vicinity of the Site and are not included in the EMP. MW3-14 may be included as supplemental information in the EMP early in the Landfill lifespan, however, the monitoring well will be decommissioned to allow for the construction of the Landfill cells during Phase 2 of the Landfill development. The existing monitoring wells MW5A-15 and MW5B-15 are not included in the EMP as they are hydraulically upgradient and disconnected from the overburden, sand and gravel aquifer.

Hydraulic monitoring of groundwater levels will be conducted at each groundwater monitoring event and the data included in the Annual Operation and Monitoring Report discussed in Section 14.10. Pre-landfilling water levels were measured during the baseline monitoring events in September 2015, October 2015, January 2016, February 2016, and April 2017. The hydraulic monitoring results are presented in Table 14.2.

14.4 Surface Water

The objective of the surface water monitoring program is to continue to obtain supplementary information from nearby lakes to characterize background water quality. The two lakes, McIvor Lake and Rico Lake, will be included in the EMP for this purpose. Surface water samples from the Lakes will be collected annually.

There are no permanent surface water features on the Site or downgradient of the Site to include as part of the surface water compliance monitoring.

The location of the lakes and the monitoring locations are shown on Figure 14.1.

The water level in the lakes will be recorded as part of the EMP and the data included in the Annual Operations and Monitoring Report discussed in Section 14.10. The Rico lake level will be recorded using the existing Rico Lake gauge, as shown on Figure 14.1. The McIvor Lake level will be obtained from the BC Hydro reservoir level records.

Additional surface water sampling may be conducted within the surface water ditches on the east and west side of the Landfill when water is present.

14.5 Quality Assurance/Quality Control

In order to ensure adequate quality control for water quality samples, the following quality assurance/quality control (QA/QC) measures will be used as a minimum:

- Activities performed by qualified and trained personnel
- Field QA/QC including field duplicate and field blank analysis
- Use of charge balance calculations
- Analytical testing by an accredited laboratory

14.6 LFG Monitoring

LFG monitoring will be undertaken to protect the health and safety of the Northwin/Upland staff, users of the Site and the public. The LFG monitoring will be conducted annually using subsurface soil vapour probes, consistent with the BC Landfill Gas Management Facilities Design Guidelines, Section 6 of the Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills, and Sections 4.2 and 9.3 of the Landfill Criteria. The soil gas concentration limits are discussed in Section 10.8.

The proposed locations of the soil vapour probes are shown on Figure 14.1 and will include one location near the Site office, and one location at the northern property boundary along Gold River Highway.

14.7 Geotechnical

The geotechnical condition of the landfill will be monitored as part of the EMP. Monitoring staff will record the condition of the Landfill including observations of evidence of the following conditions:

- Distress (i.e., berms, cover, vegetation, ditches, etc.)
- Slope stability

- Settlement
- Potential for leachate breakout/pore pressure building up
- Erosion on side slopes, ditches, or sediment forebays (once constructed during progressive final closure)

All notable observations will be reported to Landfill Staff and included in the Annual Operations and Monitoring Report discussed in Section 14.10. If appropriate, a qualified professional will be engaged to complete a supplemental Site inspection.

14.8 Refuse/Soil Volume Monitoring

A topographic survey of the active Landfill area will be conducted on a regular basis (i.e., every 1 to 2 years) during Landfill operations. The survey data will be used to calculate the volume of airspace consumed, an estimate of the apparent waste density obtained, and the remaining airspace available. From this data, predictions of remaining Site life will be updated and included in the Annual Operations and Monitoring Report discussed in Section 14.10.

14.9 Inspection and Record Keeping

Regular Landfill inspections will be conducted by Landfill personnel and include inspections of the following:

- Nuisance factors associated with the Landfill
- Regular housekeeping procedures such as dust, litter, and odour
- Locations of distress (i.e., berms, cover, vegetation, ditches, etc.)

The Landfill staff will maintain a checklist of housekeeping items that need to be implemented on a regular basis. Records of observations made during the Landfill inspections and all regular housekeeping activities carried out will also be maintained.

14.10 Annual Operations and Monitoring Report

An annual operations and monitoring report will be submitted to the Director by March 31 of each year. The annual report will include the following information as per Section 3.2 of the OC:

- An executive summary
- Tonnage and disposition of each type of waste received at the facility for the year including tonnage received, stored on-Site, and discharged to the Landfill
- Remaining selected waste Landfill life and capacity
- Recommendations to improve operational efficiencies, if applicable
- Leachate management monitoring results including leachate quantities and qualities
- Landfill gas monitoring results
- Review of the preceding year of operation, plans for the next year and a summary of any new information or changes to the facilities and plans, programs, assessments, surveys and reports

- In the event of any non-compliance with the conditions of the operational certificate, an action plan and schedule to achieve compliance
- Updated groundwater contours and discussion of seasonal fluctuations
- Comparison of the monitoring data with the performance criteria in Section 4 of the Updated Landfill and the Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills, interpretation of the monitoring data, identification and interpretation of irregularities and trends, recommendations, and any proposed changes to the monitoring program

The annual reports will be made available to the City of Campbell River staff and the Regional Districts Waste Management Board.

15. Fire Safety and Emergency Response Plan

15.1 Overview

The introduction of ambient air (i.e., oxygen) into a landfill can potentially lead to landfill fires. The prevention and control of landfill fires is an important operational consideration. While the occurrence of landfill fires is still relatively infrequent, it is critical to understand landfill fires, their prevention, and control.

Effective fire management can be achieved by understanding the causes of landfill fires as part of a preventative strategy and by understanding the means of addressing a landfill fire if one occurs.

15.2 Background

A landfill fire will only occur if the following conditions are present:

- A fuel is provided (e.g., waste and/or the methane component of LFG is a combustible fuel source)
- Oxygen is present (oxygen can be present in the voids of uncompacted waste)
- An ignition source is provided

Fires can occur for a variety of different reasons or combinations of conditions including:

- Introduction of an ignition source to the landfill
- Deposition of hot loads in the landfill
- Chemical reactions occurring within the landfill

Landfill fires can be surficial, subterranean, or both, depending on the transmission and migration pathways within the waste matrix. Surficial fires typically occur along the working surface of the landfill and are easily observable.

Subterranean fires occur under the cover of the landfill and may not be visually observable by site personnel. Subterranean fires typically start out small and in a localized area, spreading beneath the landfill cover as conditions permit. Landfill operations can also affect the spread of landfill fires, with landfill fires following preferential flow paths along waste lift lines or in areas of low waste

densities (i.e., upper levels of waste, new and uncompacted waste), where the mixture of oxygen and methane is optimal as a fuel.

Signs that a subterranean fire may be occurring or has occurred include:

- High oxygen and carbon monoxide (1,000 ppm) concentrations
- High LFG temperatures (> 60 degrees Celsius indicates aerobic conditions; > 75 degrees Celsius indicates that combustion is likely occurring at some location within the waste)
- Accelerated landfill settlement in localized areas
- Impacted infrastructure (e.g., melted piping)
- Smoke, odour, or residue

A landfill fire can be confirmed through monitoring for incomplete combustion compounds (e.g., carbon monoxide) using field-monitoring equipment or for more accurate results, laboratory analysis. Field samples collected from installed LFG probes for laboratory analysis should be collected in tedlar bags or in evacuated canisters.

15.3 Implications of Landfill Fires

Implications of a landfill fire include:

- Risks to health and safety which include release of toxic gases, site hazards, sink holes on the landfill surface, and equipment interaction
- Impacts to the surrounding environment including surface water impacts, leachate generation, and air emissions
- Damage to site infrastructure including landfill liner damage and leachate collection system impacts
- Potential damage to equipment

Landfill fires pose a health and safety risk to humans due to the unsafe conditions that the fires create. The burning waste can emit toxic gases. Sink-holes and waste settlement may occur as a result of waste combustion, posing additional hazards to site personnel and equipment.

Landfill fires also pose a great risk to environmental conditions of the landfill and the surrounding area. As previously stated, fires can generate toxic air emissions; uncontrolled combustion of halogenated compounds often results in emission of dioxins and furans.

15.4 Fire Prevention

There are several obvious means of preventing fires at landfills, including rules and plans that prevent smoking, welding, or equipment repair on or near the Landfill. If work is absolutely necessary within the Landfill, permit requirements should be developed for performing hot work in areas of potential LFG generation.

Recognition of changing Site conditions will provide site personnel with the necessary information and time to take preventative measures. Conditions that may be observed prior to a subterranean fire include problems at the surface of the Landfill that may be indicative of high oxygen infiltration

potential (e.g., poor final cover quality, final cover erosion, vegetative stress). Particular note should be made of any protrusions through the interim and/or final cover system such as vertical extraction wells, gas vents, monitoring points, etc., as these are potentially weak points in a final cover system.

The above conditions should be closely monitored, and a fire control strategy implemented, if it is determined that a landfill fire is occurring. The following Landfill operations can be instrumental in preventing and controlling landfill fires:

- Placement of intermediate cover material
- Adequate stockpile of soil material for intermediate cover and fire control
- Availability and maintenance of appropriate equipment for fire control

It is recommended that all intermediate cover material be removed subsequent to additional waste placement to aid in maintaining the interconnectivity of waste lifts for the improved LFG collection efficiencies. Leaving intermediate cover material in place as a permanent fire control measure (i.e., fire breaks) is an incorrect approach and is not recommended.

15.5 Fire Control and Extinguishment

The methods used to control and terminate a landfill fire are dependent on several site-specific factors including:

- The location of the landfill fire (i.e., active disposal areas, passive LFG venting areas)
- Waste composition (i.e., C&D)

A single solution for managing landfill fires does not exist. Therefore, a multifaceted approach to preventing and controlling landfill fires is necessary. The following approaches need to be considered individually or in combination to most effectively determine if there is a fire and to control and extinguish a landfill fire:

- Supplemental soil cover material to cut off the supply of oxygen to a fire, returning the waste to anaerobic conditions.
- Availability of water to hydrate low permeability soil cover material.
- Fire suppressant foams to assist in sealing the surface where there may be air infiltration to the waste mass.
- Fire breaks and containment berms can be possible augments for very specific applications and locations but should not be considered as primary control mechanisms.
- Injection systems such as steam, carbon dioxide, or nitrogen are possible if they are necessary to cut off air supply to the fire.
- Operational considerations including the use of cover material, stockpiling of soil material on Site, availability of information on historic waste placement, as-recorded drawings, and equipment availability.
- Confirmatory/field investigations including thermographic imaging, intrusive investigations (i.e., boreholes), and thermistors.

An operator needs to be aware of the type of landfill fire (i.e., waste or LFG). If it is a waste fire within the waste mass and not simply at the surface, it may not be possible to physically cut off the source of fuel and/or air. The operator must also be aware of the many different approaches associated with extinguishing landfill fires.

The primary mechanism for extinguishing a landfill fire is its fuel source (i.e., methane). By allowing methane concentrations to increase within the waste matrix, conditions will reach a point whereby the oxygen-methane fuel mixture will be too methane rich for combustion and the fire will no longer be self-sustaining. In short, the subterranean fire will be extinguished through an abundance of methane and a deficiency of oxygen (i.e., creating an environment that cannot support continued combustion). Creating this environment can be enhanced through the use of a low permeability cover material. The low permeability cover material will provide a layer that will minimize the venting of LFG and the intrusion of atmospheric air (i.e., oxygen). The use of low permeability cover material in combination with the application of water will be effective in helping to seal the surface and remove the air infiltration pathway that allows oxygen to feed and support the fire (i.e., to decrease the hydraulic conductivity of low permeability material).

While this type of response may be counter intuitive to typical fire management programs, more common approaches such as excavation of the landfill cover in the vicinity of a suspected fire to expose the source should never be undertaken; it merely serves to introduce additional air, and thus oxygen, into the waste, thereby potentially propagating/feeding the fire. Excavation of suspected fires also puts equipment and equipment operators at risk. The operation of heavy equipment in the vicinity of a landfill fire should be undertaken with care, and only to develop access to the area in question or to spread soil cover material.

15.6 Fire Safety and Emergency Contingency Plan

A Fire Safety and Emergency Contingency Plan has been developed for the Site operating in accordance with the BC Occupational Health and Safety Regulation 296/97 Part 4, S.4.13 - 4.18 (Emergency Preparedness and Response) and Part 5, s.5.97 - 5.102 (Emergency Procedures), as well as Section 2.8 of the BC Fire Code. The Fire Safety and Emergency Contingency Plan has been submitted to the appropriate fire authority(ies), the responding fire department(s), the Director, and the City.

A copy of the draft Fire Safety and Emergency Contingency Plan is provided in Appendix J. This plan will be reviewed and updated at least once annually.

16. Contingency Plan

The Contingency Plan presents site-specific, practical, and implementable contingency measures to address possible failure and/or non-compliance scenarios of the landfill operating systems. The Contingency Plan was developed based on planning that included review of the Landfill base liner performance, modeling of liner leakage rates, development of a trigger level assessment program (TLAP) and identification of practical and implementable contingency measures. This Plan satisfies Section 10.3 of the Landfill Criteria.

A site-specific tiered TLAP has been developed to assess primary liner system leakage rates and groundwater quality at the Site. The TLAP outlines a procedure to investigate and confirm a possible failure or non-compliance condition and to identify appropriate contingency or remedial actions. The two TLAP triggers are:

1. Primary liner leakage rate detected in the leak detection system(s) above the trigger level threshold.
2. Leachate constituent concentration in downgradient water exceeding trigger level concentrations.

The TLAP and the trigger thresholds are discussed in detail within Appendix K of the DOCP.

16.1 Conditions Indicating Possibility of Failure or Non-Compliance

The following are descriptions of possible conditions associated with failure of the landfill operating systems or non-compliance with the landfill performance criteria. If present, these conditions provide indication of a potential issue and would warrant contingency or remedial measures to be put in place.

Primary Liner Non-Performance

- Increasing volume of leachate detected in the leak detection system of either the landfill or the leachate aeration pond.

Groundwater Quality Alterations

- Increasing concentrations of leachate indicator parameters in groundwater adjacent to and/or downgradient of the Landfill or leachate treatment pond.

Surface Water Quality Alterations

- Elevated concentrations of leachate indicator parameters in surface water discharging to the infiltration pond.

Leachate Treatment Facility (LTF) Non-Performance

- Worsening trend observed in leachate effluent quality
- Treated leachate effluent does not meet CSR DW standards
- Volume of leachate exceeds forecasted treatment capacity

Nuisance Impacts

- Nuisance odours are detected in the vicinity of the landfill
- Receipt of nuisance complaint

16.2 Contingency Measures

The table below provides a description of practical and implementable contingency measures to address the potential failure or non-compliance conditions listed in Section 16.1. The contingency measures developed for the Site include the following operational controls:

Table 16.1 Contingency Measures/Actions

Condition	Contingency Measure/ Action
Primary liner non-performance (landfill or aeration pond)	Replace or repair the primary liner system in the leachate treatment pond. If possible, waste may be locally excavated to complete repairs to the primary landfill liner. It is noted, however; that the integrity of each liner system will be tested at the time of construction prior to acceptance and placement of waste.
	Operate the leachate collection system under drained condition to eliminate leachate head on the primary liner system to minimize leakage. Leachate levels in the sump will be kept at a level below the crest of the sump.
	Deploy intermediate or final geomembrane cover over completed/inactive phases of the Landfill in advance of planned schedule to reduce/eliminate generation of leachate.
Groundwater quality alterations	Address infiltration of surface water with elevated leachate constituents by implementing contingency measures associated with surface water quality alterations. (See surface water quality alterations row in this table.)
	Reduce concentration of leachate constituents in infiltration pond influent by increasing level of treatment in LTF.
	Address leachate leakage from landfill or aeration pond by implementing contingency measures associated with primary liner non-performance. Increase deployment of final cover and/or use of low permeable tarps for daily cover.
Surface water quality alterations	Improve surface water containment measures and/or landfill containment berms.
	Remediate any identified leachate seeps.

Condition	Contingency Measure/ Action
LTF Non-performance	Re-circulate aeration pond effluent into the landfill for re-treatment in the LTF.
	Review leachate treatment process modelling and refine leachate treatment process.
	Pre-treat leachate on-site and haul to off-site wastewater treatment facility for further treatment.
Nuisance Impacts	Increase use of daily and intermediate cover.
	Develop and implement an odour monitoring program.
	Install passive landfill gas (LFG) venting and filtration system.

16.3 Contingency Measure Implementation

In the event that one or more conditions are present that warrant contingency or remedial measures/actions, this Plan will serve as a guide to respond appropriately and in a timely manner. Implementing contingency measures involves the following sequence of actions:

- Selection of appropriate measure based on the conditions present on site
- Design of measure
- Submission of design and implementation schedule for regulatory concurrence, if applicable
- Notification to regulators of proposed actions
- Implementation
- Confirmatory monitoring and reporting

17. Financial Security Plan

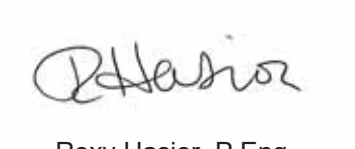
Financial security is required for all private landfills in accordance with *Section 8.0 - Financial Security* of the Landfill Criteria. The amount of the financial security provided in each year must be adequate to fund the closure of the landfill in that year and fund post-closure operations, monitoring, and maintenance for the estimated contaminated lifespan.

The Financial Security Plan is provided in Appendix L.

18. Closure

All of Which is Respectfully Submitted,

GHD



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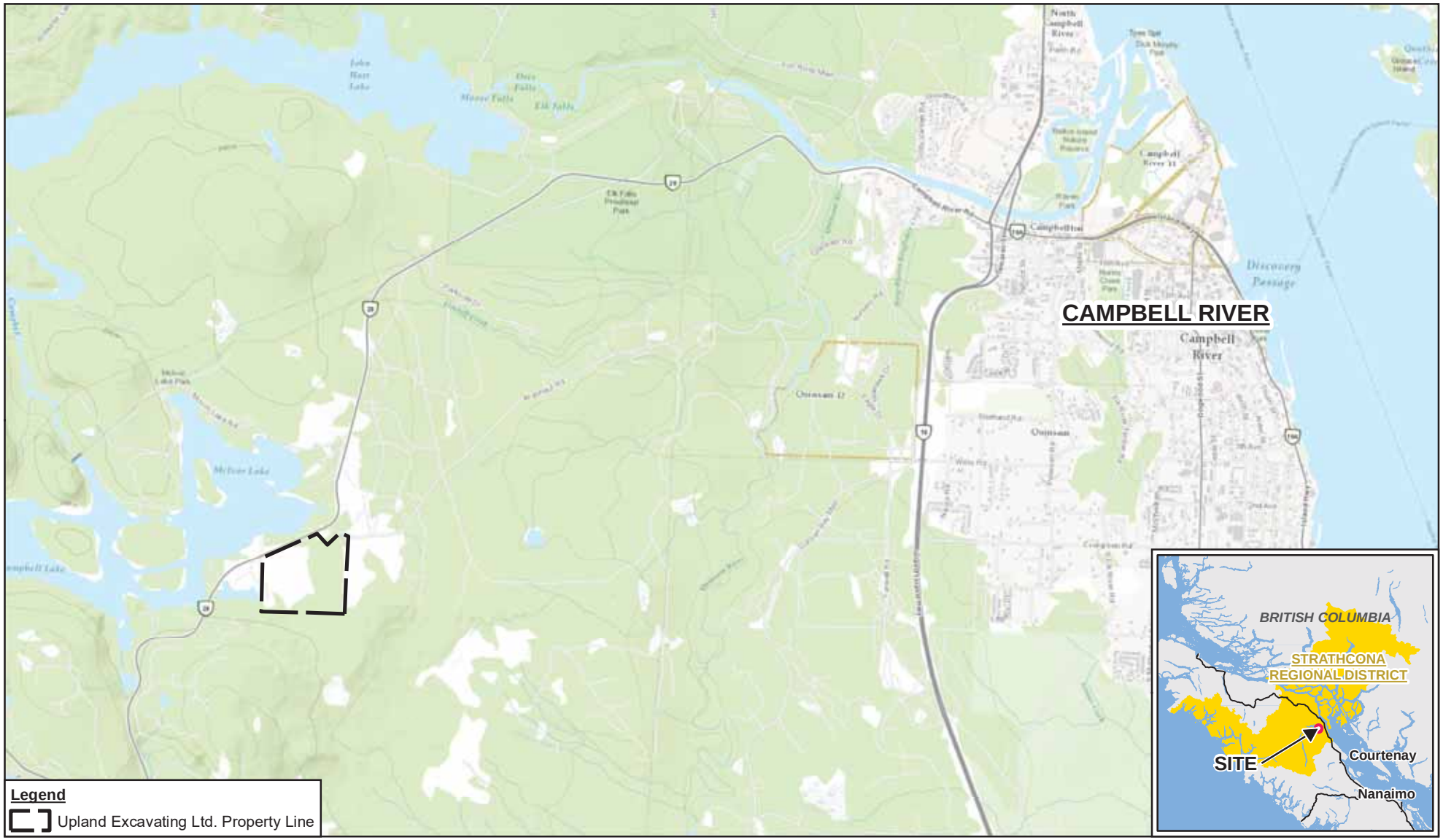
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Figures



Source: ESRI Topographic Basemapping, Accessed 2020

0 500 1,000 1,500
Meters

Coordinate System:
NAD 1983 UTM Zone 10N

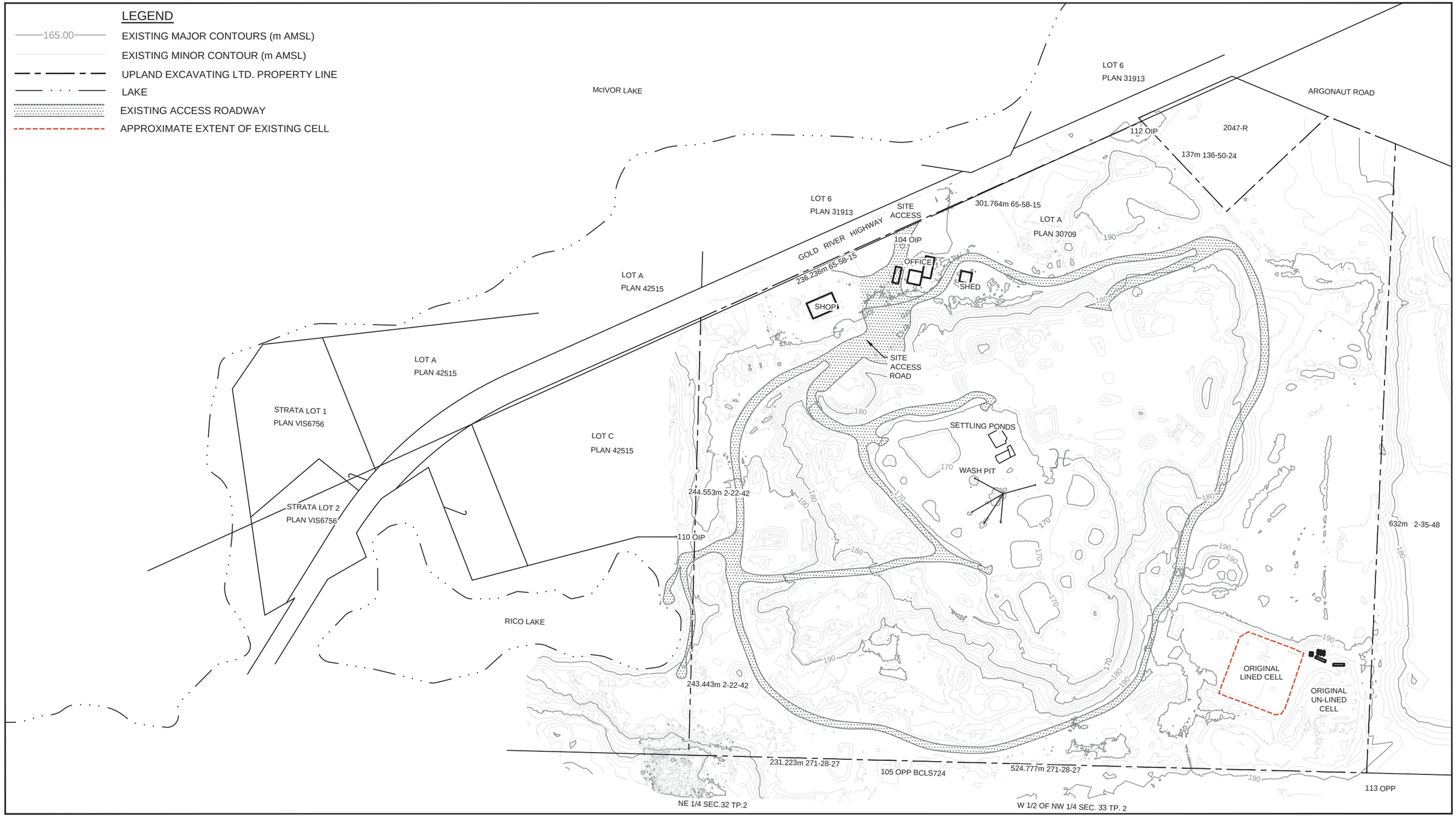
UPLAND EXCAVATING LTD.
2021 DESIGN, OPERATIONS AND CLOSURE PLAN
NORTHWIN LANDFILL, CAMPBELL RIVER, B.C.

SITE LOCATION MAP

088877
Jun 24, 2020

FIGURE 1.1

GIS File: Q:\GIS\PROJECTS\88000s\88877\Layouts\014\088877(014)GIS-OT001.mxd



SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY McELHANNEY ASSOCIATES LAND SURVEYING LTD., NOVEMBER 21, 2016.

0 40 80 120m

SCALE = 1:4000

UPLAND EXCAVATING LTD.
2021 DESIGN, OPERATIONS AND CLOSURE PLAN
NEW LANDFILL (NORTHWIN LANDFILL), CAMPBELL RIVER, B.C.

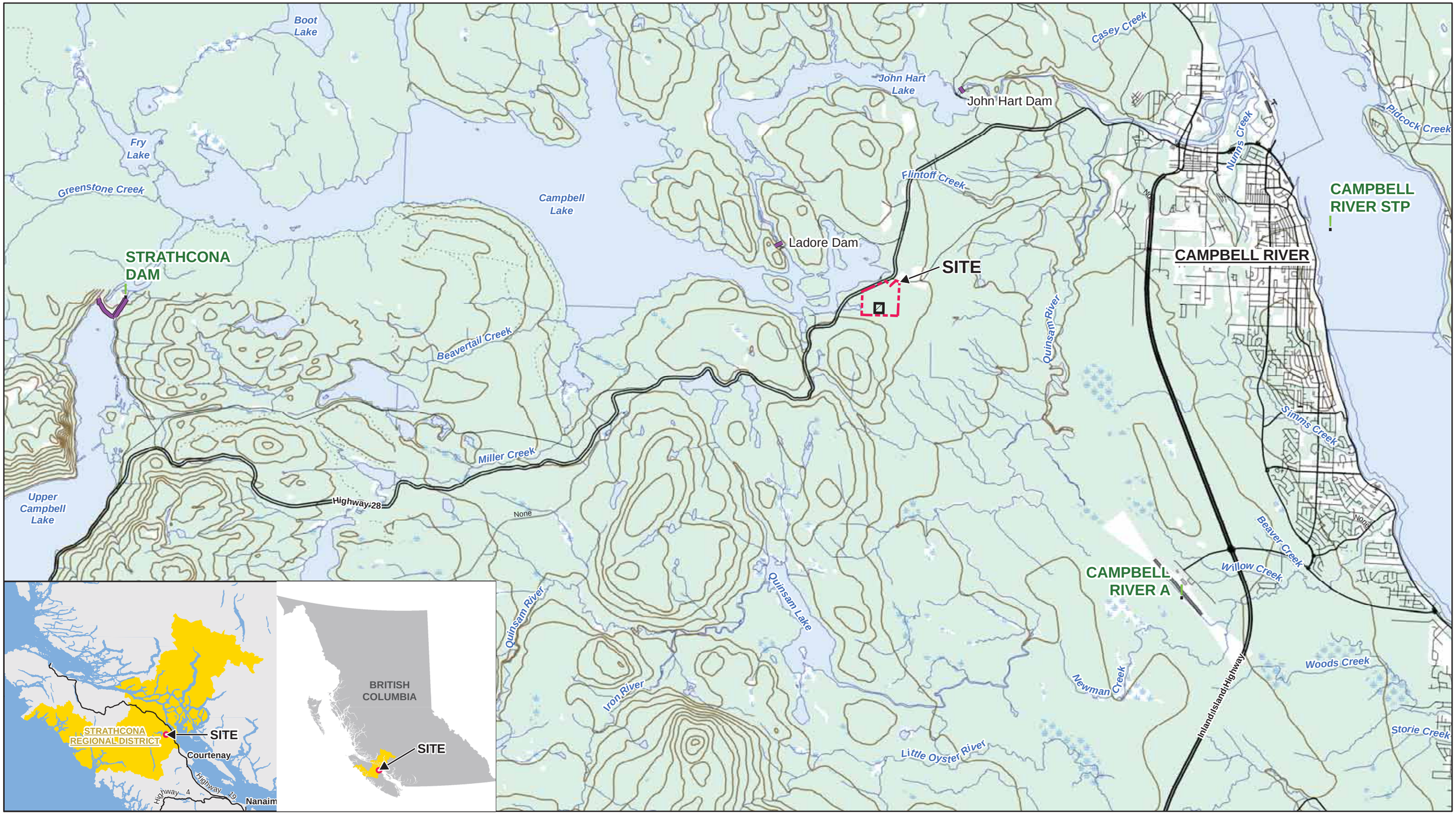
088877-11

Jul 7, 2021

EXISTING SITE PLAN

FIGURE 1.2

CAD File: 88877-11(014)GN-WA001.dwg



Source: CanVec Edition 1.1 © Department of Natural Resources Canada, all rights reserved. National Road Network 2.0 GeoBase. ESRI Base Data, 2008.

0 750 1,500 2,250
Meters

Coordinate System:
NAD 1983 UTM Zone 10N

Legend

- IDF Station
- Manmade Hydrographic Entity (Dam)
- Discharge Area
- Upland Excavating Ltd. Property Line

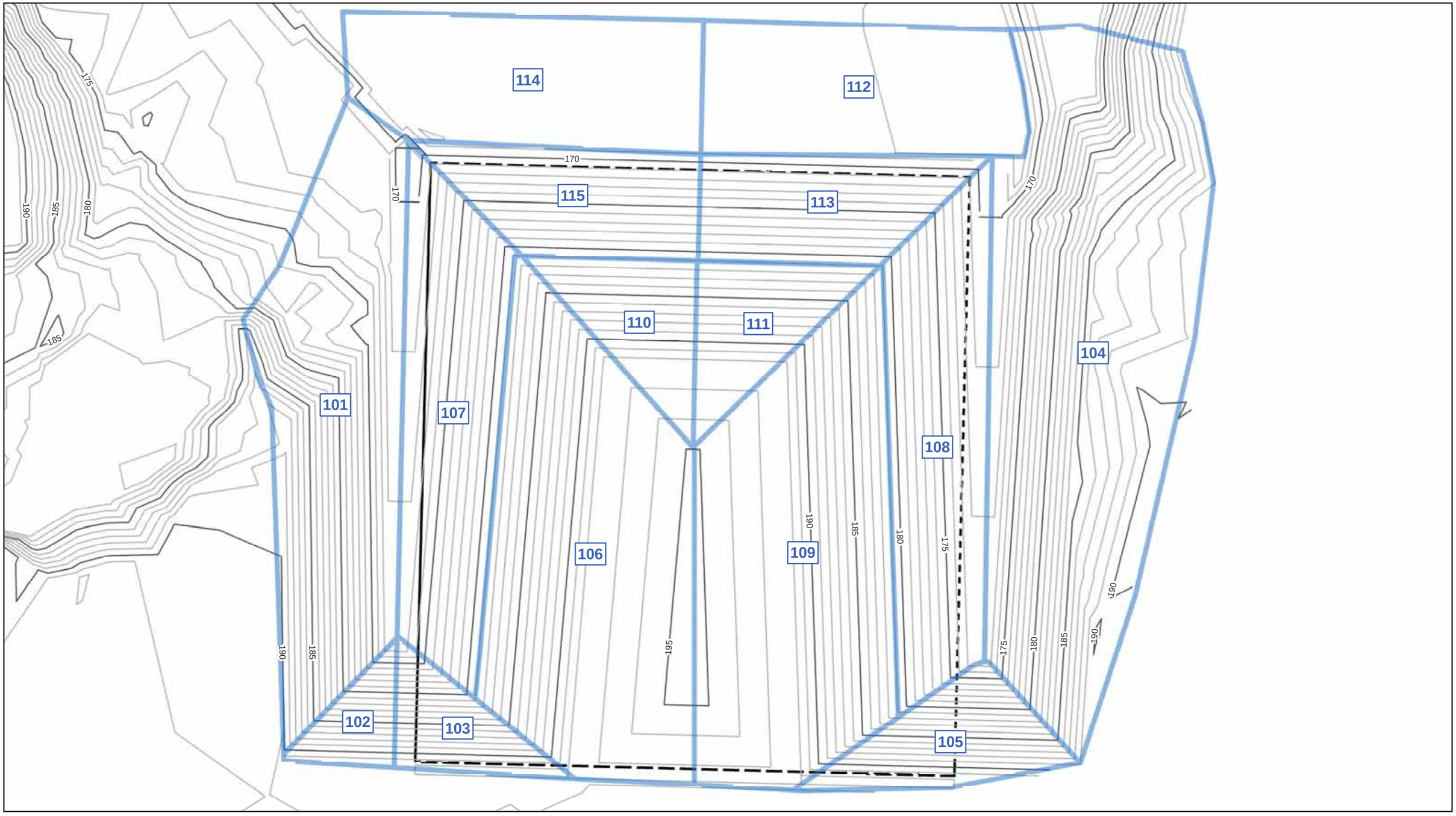
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2021 DESIGN, OPERATIONS, AND CLOSURE PLAN
NORTHWIN LANDFILL, CAMPBELL RIVER, B.C.

SITE LOCATION & IDF STATION LOCATIONS

088877-03
Jun 28, 2021

FIGURE 8.1

GIS File: Q:\GIS\PROJECTS\88000s\88877\Layouts\010\88877-03(010)GIS-OT005.mxd



Source: CanVec Edition 1.1 © Department of Natural Resources Canada, all rights reserved. National Road Network 2.0 GeoBase. ESRI Base Data, 2008.

0 12 24 36
Meters

Coordinate System:
NAD 1983 UTM Zone 10N

Legend

- Limit of Waste
- Major Contour (5 m)
- Minor Contour (1 m)
- Subcatchment Boundary
- 100 Subcatchment Number

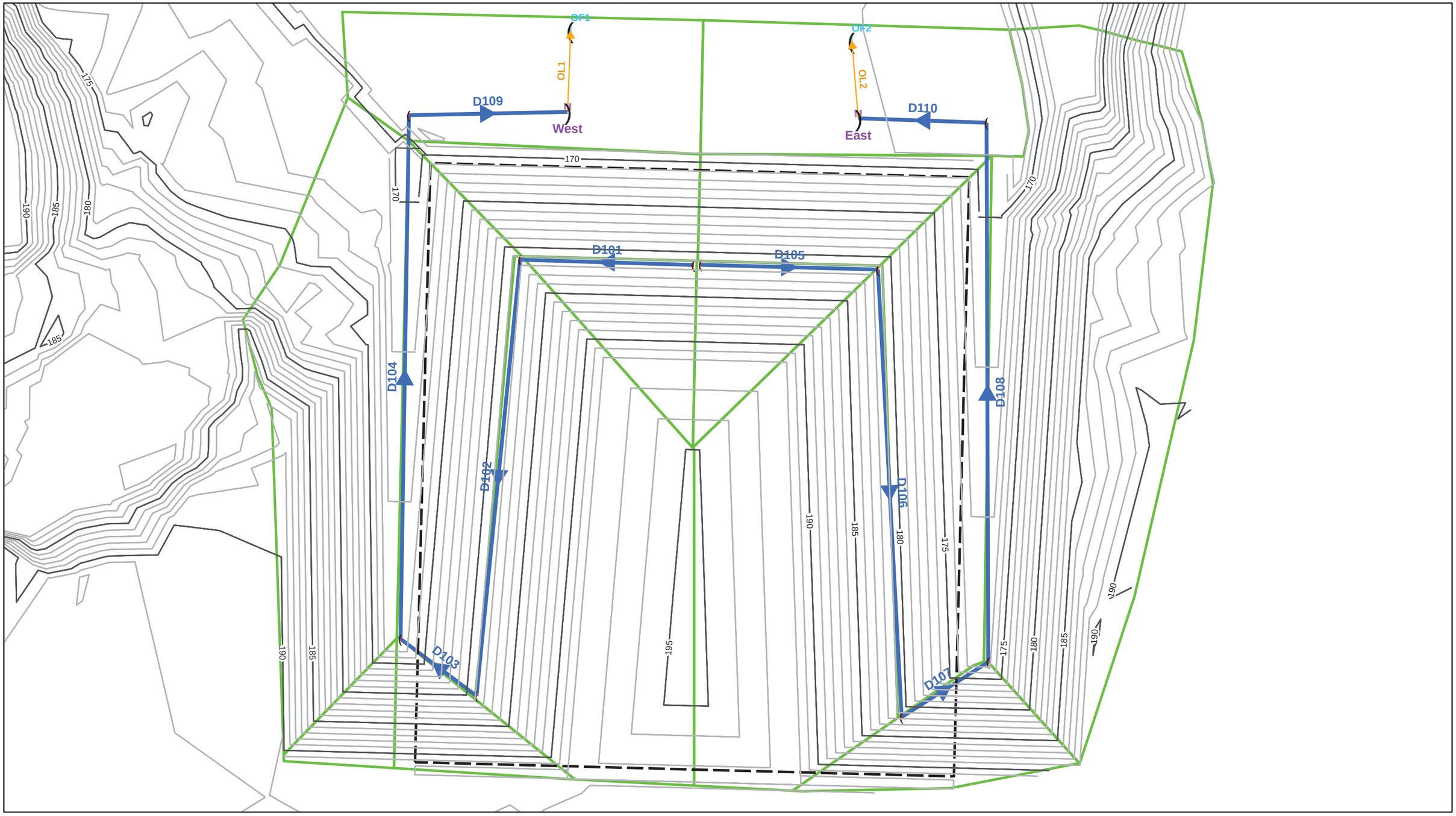
UPLAND EXCAVATING LTD.
2021 DESIGN, OPERATIONS, AND CLOSURE PLAN
NORTHWIN LANDFILL, CAMPBELL RIVER, B.C.

SURFACE WATER CATCHMENT BOUNDARIES

088877-03
June 28, 2021

FIGURE 8.2

GIS File: Q:\GIS\PROJECTS\88000s\88877\Layouts\010\88877-03(010)GIS-OT002.mxd



0 12 24 36
Meters

Coordinate System:
NAD 1983 UTM Zone 10N

Legend

- Limit of Waste
- Major Contour (5 m)
- Minor Contour (1 m)
- Conduits
- Outlets
- Sediment Forebay
- Junctions
- Infiltration Area

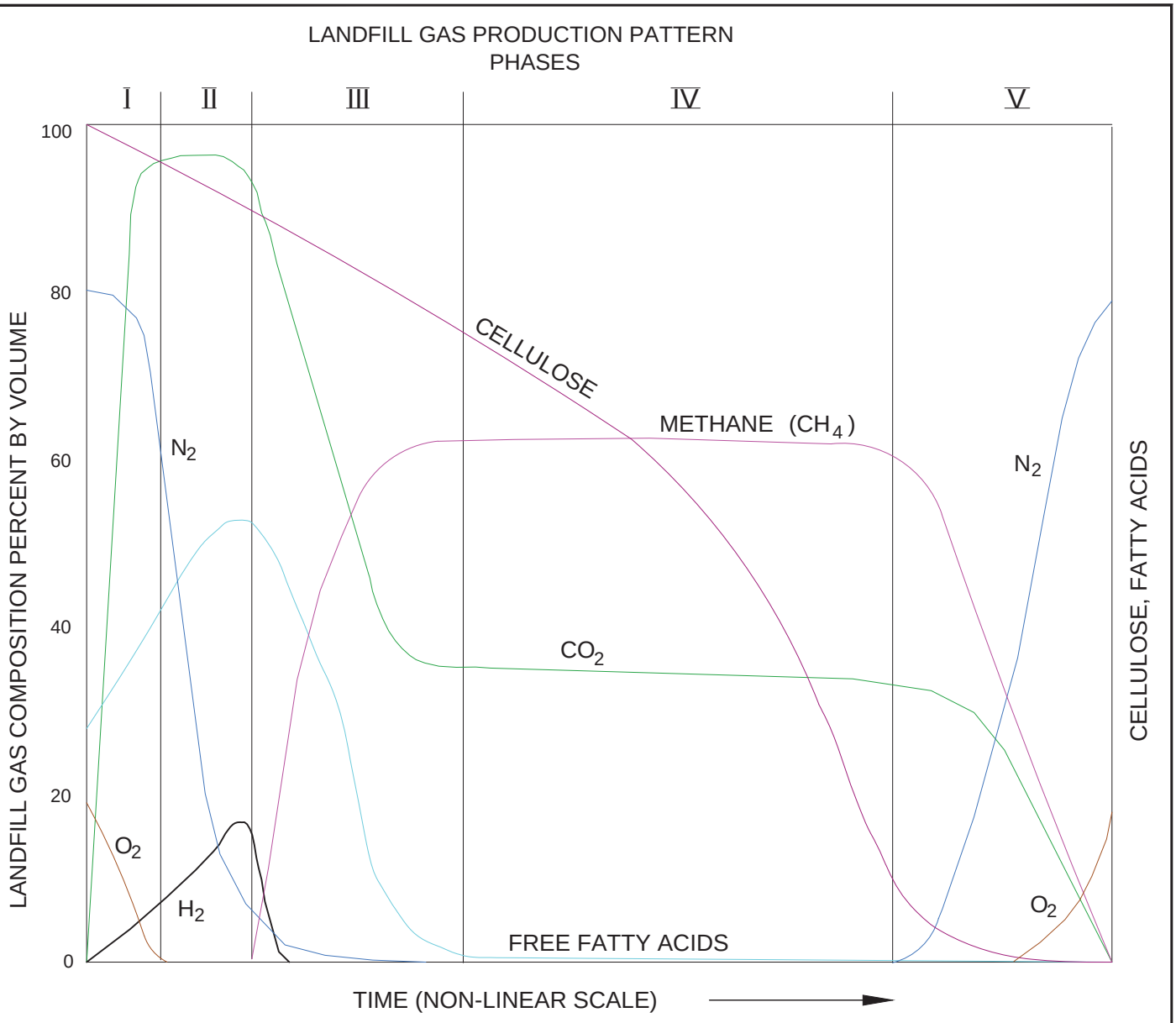
UPLAND EXCAVATING LTD.
2021 DESIGN, OPERATIONS, AND CLOSURE PLAN
NORTHWIN LANDFILL, CAMPBELL RIVER, B.C.

SURFACE WATER FLOW SCHEMATIC

088877-03
June 28, 2021

FIGURE 8.3

GIS File: Q:\GIS\PROJECTS\88000s\88877\Layouts\010\88877-03(010)GIS-OT003.mxd



PHASES	CONDITION	TIME FRAME - TYPICAL
Ⅰ	AEROBIC	HOURS TO 1 WEEK
Ⅱ	ANOXIC	1 TO 6 MONTHS
Ⅲ	ANAEROBIC, METHANOGENIC, UNSTEADY	3 MONTHS TO 3 YEARS
Ⅳ	ANAEROBIC, METHANOGENIC, STEADY	8 TO 40 YEARS
Ⅴ	ANAEROBIC, METHANOGENIC, DECLINING	1 TO 40+ YEARS
TOTAL		10 TO 80+ YEARS

SOURCE:

FARQUHAR AND ROVERS, 1973,
AS MODIFIED BY REES, 1980,
AND AUGENSTEIN & PACEY, 1991.

UPLAND EXCAVATING LTD.
2021 DESIGN, OPERATIONS AND CLOSURE PLAN
NORTHWIN LANDFILL, CAMPBELL RIVER, B.C.

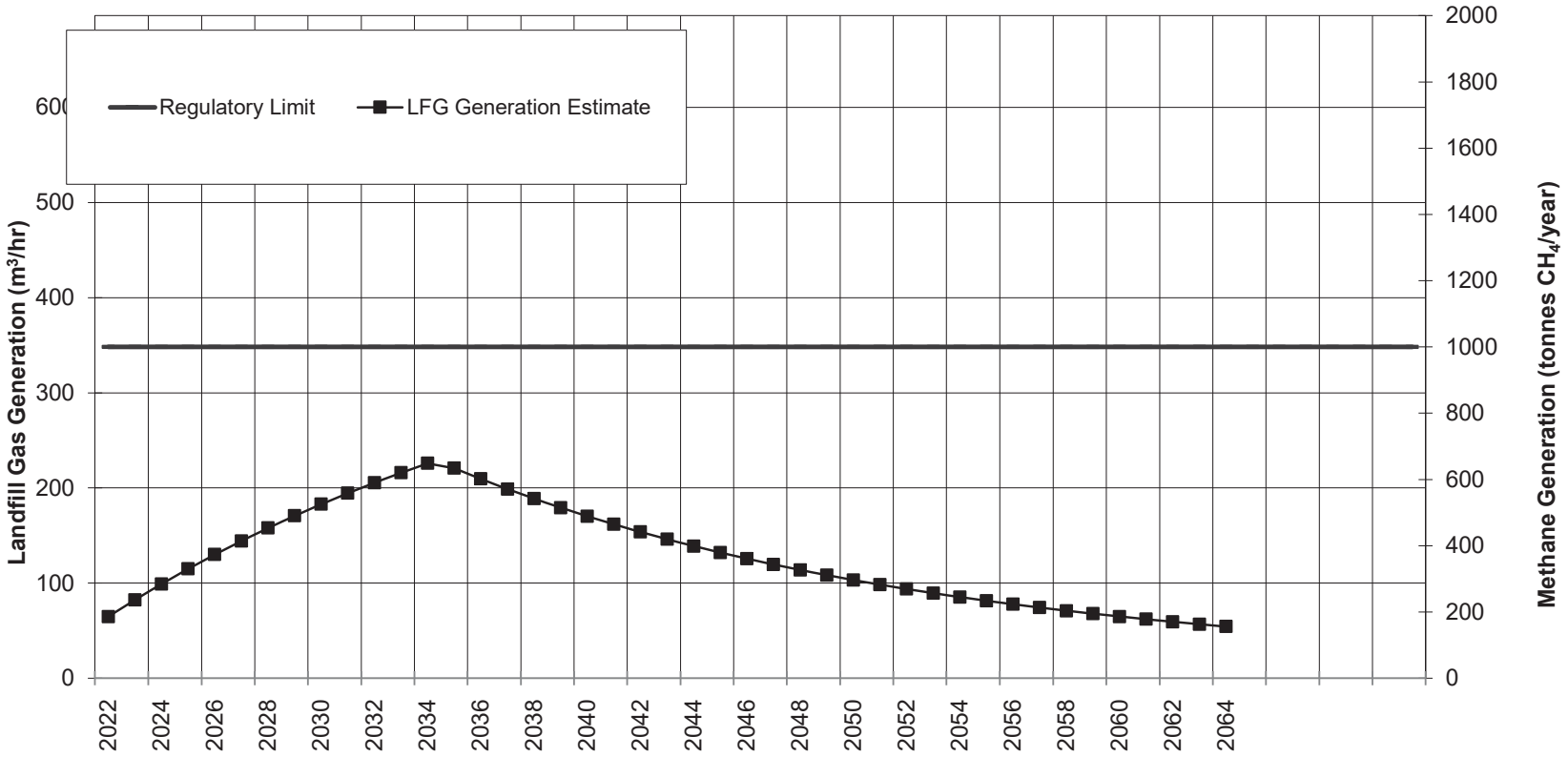
88877

Jun 10, 2020

TYPICAL LANDFILL GAS PRODUCTION STAGES

FIG. 10.1

CAD File: N:\CA\Waterloo\Legacy\CAD\drawings\88000s\88877\88877 - REPORTS\88877-11(014)\88877-11(014)GN\88877-11(014)GN-WA004.dwg

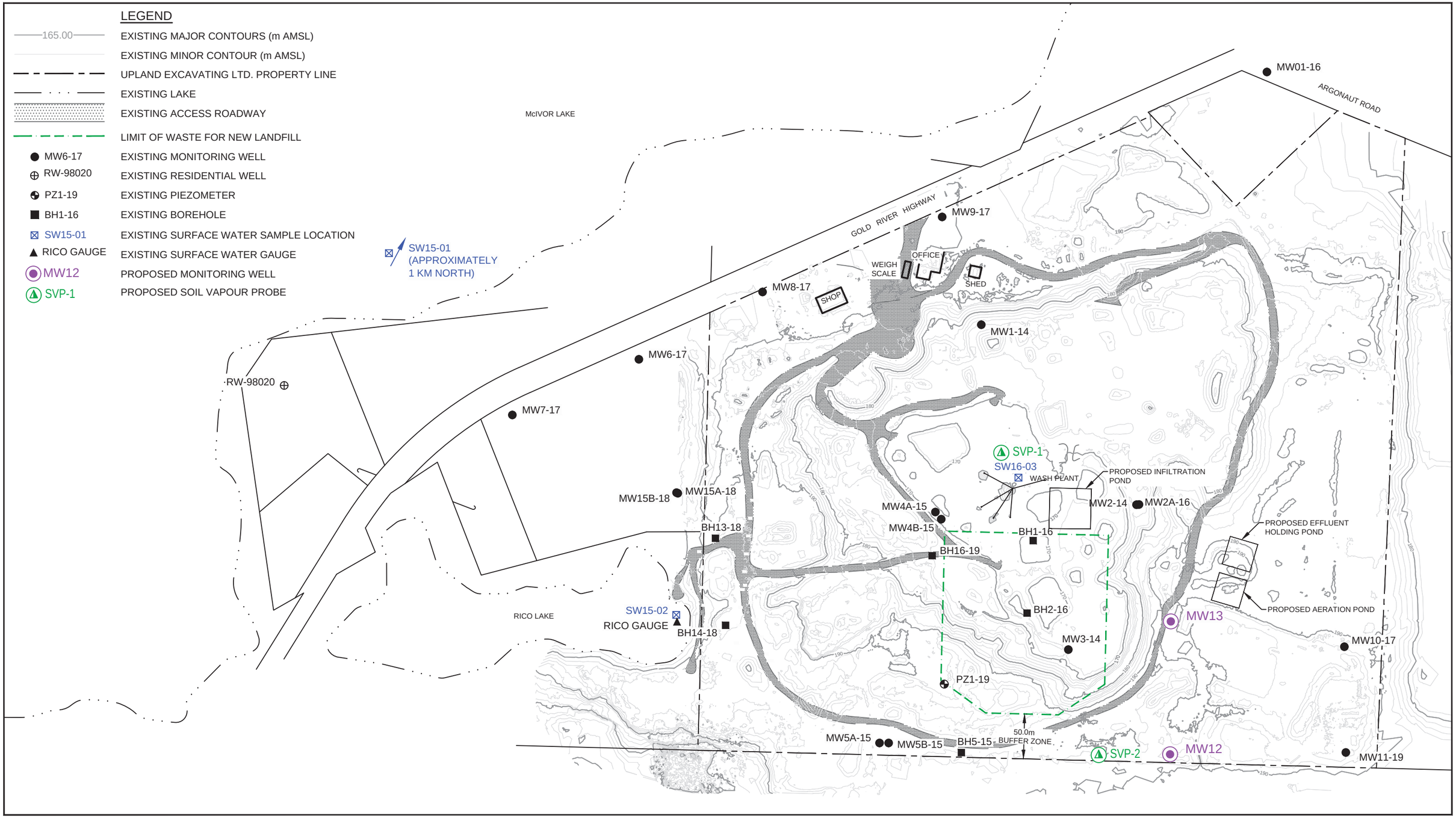


k values (year^{-1})	0.02, 0.06, 0.11	Waste Composition	
L_o (weighted) (m^3 CH4/tonne)	20, 120, 160	Relatively Inert (%)	75.0%
Precipitation (mm/year)	1,489	Moderately Decomposable (%)	25.0%
Volumetric LFG Composition (percent methane)	50%	Decomposable (%)	0.0%

FIGURE 10.2
LANDFILL GAS GENERATION ESTIMATE
2021 DESIGN, OPERATIONS, AND CLOSURE PLAN
NORTHWIN LANDFILL
Upland Excavations Ltd.
Campbell River, British Columbia

LEGEND

- 165.00 — EXISTING MAJOR CONTOURS (m AMSL)
- EXISTING MINOR CONTOUR (m AMSL)
- UPLAND EXCAVATING LTD. PROPERTY LINE
- EXISTING LAKE
- EXISTING ACCESS ROADWAY
- LIMIT OF WASTE FOR NEW LANDFILL
- MW6-17 — EXISTING MONITORING WELL
- RW-98020 — EXISTING RESIDENTIAL WELL
- PZ1-19 — EXISTING PIEZOMETER
- BH1-16 — EXISTING BOREHOLE
- SW15-01 — EXISTING SURFACE WATER SAMPLE LOCATION
- RICO GAUGE — EXISTING SURFACE WATER GAUGE
- MW12 — PROPOSED MONITORING WELL
- SVP-1 — PROPOSED SOIL VAPOUR PROBE



SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY McELHANNEY ASSOCIATES LAND SURVEYING LTD., NOVEMBER 21, 2016.

0 40 80 120m

GHD

UPLAND EXCAVATING LTD.
2021 DESIGN, OPERATIONS AND CLOSURE PLAN
NORTHWIN LANDFILL, CAMPBELL RIVER, B.C.

ENVIRONMENTAL MONITORING PROGRAM
PROPOSED INVESTIGATION LOCATIONS

88877

July 3, 2020

FIGURE 14.1

CAD File: N:\CA\Waterloo\Legacy\CAD\drawings\88000s\88877\88877 - REPORTS\88877-11(014)\88877-11(014)GN\88877-11(014)GN-WA007.DWG

Tables

Climate Data
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Month	Daily Average Temperature (Celcius)	Daily Maximum Temperature (Celcius)	Daily Minimum Temperature (Celcius)	Rainfall (mm)	Snowfall (cm) [1]	Precipation (mm) [1]
January	2.4	5.5	-0.8	195	23	218
February	3.2	7.2	-0.7	136	14	150
March	5.2	9.7	0.7	128	12	140
April	8	13.2	2.8	92	1	92
May	11.6	17	6.2	68	0	68
June	14.7	20.1	9.3	63	0	63
July	17.3	23	11.5	39	0	39
August	17.2	23.3	11.1	45	0	45
September	13.7	19.8	7.6	55	0	55
October	8.6	13.1	4.0	161	1	162
November	4.4	7.7	1.0	222	11	232
December	2.1	4.9	-0.8	204	23	226
Annual	**9.0**	**13.7**	**4.3**	**1408**	**84**	**1489**
Plan2Adapt Climate Change Factor	**+ 1.5**					**+ 5.2%**
Annual (Adjusted for Climate Change)	**10.5**					**1567**

Notes:
Source: Environment Canada: Climate Normals - Campbell River Airport (Station No. - 1021261), 1981 - 2010 Station Data
[1] 1 cm of snowfall corresponds to 1 mm of precipation

Average Annual Tonnes of Waste to be Disposed in Landfill
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

	Year	Stage	Forecasted Annual Waste Discharged (tonnes)	Waste in Place Cummulative (tonnes)
1	2022	Stage 1 East	138,238	138,238
2	2023	Stage 1 West	45,000	183,238
3	2024	Stage 1 West	45,000	228,238
4	2025	Stage 1 West/ Stage 2 A	45,000	273,238
5	2026	Stage 2 A	45,000	318,238
6	2027	Stage 2 A	45,000	363,238
7	2028	Stage 2 A	45,000	408,238
8	2029	Stage 2 A/ Stage 2 B	45,000	453,238
9	2030	Stage 2 B/ Stage 2 C	45,000	498,238
10	2031	Stage 3 A	45,000	543,238
11	2032	Stage 3 A	45,000	588,238
12	2033	Stage 3 A / Stage 3 B	45,000	633,238
13	2034	Stage 3 B / Stage 3C	45,000	678,238
14	2035	Stage 3 C	13,836	692,075

Table 5.1

Landfill Stages
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

	Landfill Capacity				
Landfill Phase	**m^3**	**tonnes**	**No. of Years**	**Years Active**	
Phase 1 East	106,337	138,238	1.0	2022	2023
Phase 1 West	101,447	131,881	2.9	2023	2025
Phase 2A	106,823	138,870	3.1	2025	2029
Phase 2B	44,912	58,386	1.3	2029	2030
Phase 2C	27,085	35,211	0.8	2030	2031
Phase 3A	67,949	88,334	2.0	2031	2033
Phase 3B	44,266	57,546	1.3	2033	2034
Phase 3C	33,546	43,610	1.0	2034	2035
Total	**532,365**	**692,075**	**13.3**	**2022**	**2035**

Notes:

Apparent Density of Waste
1.3 t/m^3

Allowable Discharge Year 1 = original landfill tonnes + allowable tonnes
138,238 tonnes

Allowable Discharge Year 2 onward
45,000 t/yr

Table 5.2

Material Requirement
2020 Design, Operations and Closure Plan
New Landfill (Northwin Landfill)
Upland Excavating Ltd.
Campbell River, British Columbia

		Cell Construction						Operations	Final Cover		
		Area					Volume	Volume	Area	Volume	
Phase	Stage	Base Liner Geomembrane + GCL Area (m²)	Secondary Liner Geomembrane + GCL Area (m²)	Non-Woven Geotextile (m²)	Woven Geotextile (m²)	Geocomposite drainage layer (m^2)	Drain Rock (m³)	Intermediate Cover Volume (m³)	Final Cover GCL Area (m²)	Final Cover Sand (m³)	Final Cover Topsoil (m³)
1	East	13,763	13,763	13,763	13,763	13,763	4,129	0	0	0	0
1	West	8,527	8,527	8,527	8,527	8,527	2,558	2,744	0	0	0
2	2A	9,117	9,117	9,117	9,117	9,117	2,735	3,792	9,650	5,790	1,448
2	2B	0	0	0	0	0	0	2,975	0	0	0
2	2C	0	0	0	0	0	0	3,843	0	0	0
3	3A	3,225	3,225	3,225	3,225	3,225	968	263	8,165	4,899	1,225
3	3B	0	0	0	0	0	0	2,390	0	0	0
3	3C	0	0	0	0	0	0	0	16,330	9,798	2,450
	Total	**34,632**	**34,632**	**34,632**	**34,632**	**34,632**	**10,390**	**16,006**	**34,145**	**20,487**	**5,122**

[1]Intermediate Cover 300 mm thickness

Table 8.1

Design Storm Parameters
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Return Period	Type	Depth	Snowmelt Correction Factor	Climate Change Correction Factor	Rainfall Depth with Snowmelt and Climate Change Correction	Peak Intensity	Duration
		(mm)	(%)	(%)	(mm)	(mm/hr)	(hour)
5-year	SCS Type 1A	70.0	10	5.2	80.6	12.65	24
10-year	SCS Type 1A	77.7	10	5.2	89.5	14.05	24
100-year	SCS Type 1A	101.9	10	5.2	117.4	18.43	24
200-year	SCS Type 1A	110.1	10	5.2	126.8	19.91	24

Note:

1. 5-year, 10-year and 100-year design storm depths obtained from Environment Canada intensity-duration-frequency data for the Campbell River A (1021261) IDF Station. 200-year storm depth extrapolated

Table 8.2

Post Development Conditions Catchment Parameters
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Subcatchment ID	Area (ha)	Flow length (m)	Slope (%)	Imperviousness (%)	Manning' n		Depression Storage		Infiltration	
					Impervious (-)	Pervious (-)	Impervious (mm)	Pervious (mm)	Maximum (mm/hr)	Minimum (mm/hr)
101	0.79	40	45	0	0.01	0.05	1.27	2.5	7	0.2
102	0.08	40	45	0	0.01	0.05	1.27	2.5	7	0.2
103	0.13	40	45	0	0.01	0.05	1.27	2.5	7	0.2
104	1.35	55	35	0	0.01	0.05	1.27	2.5	7	0.2
105	0.20	30	20	0	0.01	0.05	1.27	2.5	7	0.2
106	0.95	65	22	0	0.01	0.24	1.27	5.1	5	0.1
107	0.51	35	30	0	0.01	0.24	1.27	5.1	5	0.1
108	0.53	35	30	0	0.01	0.24	1.27	5.1	5	0.1
109	0.92	65	22	0	0.01	0.24	1.27	5.1	5	0.1
110	0.18	45	22	0	0.01	0.24	1.27	5.1	5	0.1
111	0.19	45	22	0	0.01	0.24	1.27	5.1	5	0.1
115	0.28	35	30	0	0.01	0.24	1.27	5.1	5	0.1
112	0.46	25	15	100	0.01	0.24	1.27	5.1	5	0.1
114	0.50	25	15	100	0.01	0.24	1.27	5.1	5	0.1
113	0.29	35	30	0	0.01	0.24	1.27	5.1	5	0.1
Total	7.38									

Post Development Conditions Peakflow Summary
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Subcatchment ID	*Peak Discharge Rate*			
	5-year (m^3/s)	10-year (m^3/s)	100-year (m^3/s)	200-year (m^3/s)
101	0.03	0.03	0.04	0.04
102	0.00	0.00	0.00	0.00
103	0.00	0.01	0.01	0.01
104	0.05	0.05	0.07	0.07
105	0.01	0.01	0.01	0.01
106	0.03	0.04	0.05	0.05
107	0.02	0.02	0.03	0.03
108	0.02	0.02	0.03	0.03
109	0.03	0.04	0.05	0.05
110	0.01	0.01	0.01	0.01
111	0.01	0.01	0.01	0.01
115	0.01	0.01	0.01	0.02
112	0.02	0.02	0.02	0.03
114	0.02	0.02	0.03	0.03
113	0.01	0.01	0.01	0.02

Table 8.4

Post Development Conditions Runoff Volume Summary
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Subcatchment ID	*Runoff Volume*			
	5-year (m^3)	10-year (m^3)	100-year (m^3)	200-year (m^3)
101	570	640	860	940
102	60	70	90	100
103	100	110	150	160
104	980	1100	1480	1610
105	150	170	220	240
106	680	770	1030	1120
107	370	410	560	600
108	380	420	570	620
109	660	740	1000	1080
110	130	150	200	210
111	140	150	210	220
115	200	230	310	330
112	370	410	540	580
114	400	440	580	630
113	210	230	310	340

Table 8.5

Channel Performance Summary
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Channel Section	Length (m)	Slope (m/m)	Cross-Section (-)	Depth (m)	Bottom Width (m)	Left Side Slope (H:V)	Right Side Slope (H:V)	Manning's 'n' Value	200-Year Storm					
									Max. Flowrate (m^3/s)	Max. Velocity (m/s)	Max. Depth (m)	Minimum Freeboard (m)	Max. Shear Stress (Pa)	Recommended Channel Lining
D101	58	0.003	TRIANGULAR	0.6	3.6	NA	NA	0.03	0.02	0.02	0.29	0.31	10	Vegetation, Unreinforced
D102	146	0.002	TRIANGULAR	0.6	3.6	NA	NA	0.03	0.07	0.10	0.22	0.38	4	Vegetation, Unreinforced
D103	32	0.261	TRAPEZOIDAL	0.5	0.5	3	3	0.03	0.08	0.01	0.12	0.39	294	FLEXMAT
D104	175	0.017	TRAPEZOIDAL	0.5	0.5	3	3	0.03	0.16	0.08	0.15	0.35	25	Vegetation, Unreinforced
D105	59	0.003	TRIANGULAR	0.6	3.6	NA	NA	0.03	0.00	0.00	0.25	0.35	8	Vegetation, Unreinforced
D106	150	0.002	TRIANGULAR	0.6	3.6	NA	NA	0.03	0.05	0.07	0.20	0.40	4	Vegetation, Unreinforced
D107	34	0.241	TRAPEZOIDAL	0.5	0.5	3	3	0.03	0.06	0.01	0.12	0.39	271	FLEXMAT
D108	180	0.017	TRAPEZOIDAL	0.5	0.5	3	3	0.03	0.16	0.09	0.16	0.35	25	Vegetation, Unreinforced

Post-Development Conditions Infiltration Pond Performance Summary
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

West Infiltration Pond

Design Storm	Peak Inflow (m^3/s)	Infiltration Discharge (m^3/s)	Maximum Depth (m)	Maximum Elevation (AMSL m)	Maximum Storage (m^3)	Minimum Freeboard (m)	Duration Time (Hour)	Peak Time	Baseline Time	
5-Year	0.13	0.049	0.13	150.13	375	0.87	6	9:35 AM	3:30 PM	5:55
10-Year	0.14	0.049	0.16	150.16	481	0.84	8	9:55 AM	5:35 PM	7:40
100-Year	0.18	0.049	0.30	150.30	902	0.70	14	11:30 AM	1:10 AM	13:40
200-Year	0.20	0.049	0.35	150.35	1082	0.65	15	11:55 AM	3:10 AM	15:15

East Infiltration Pond

Design Storm	Peak Inflow (m^3/s)	Infiltration Discharge (m^3/s)	Maximum Depth (m)	Maximum Elevation (AMSL m)	Maximum Storage (m^3)	Minimum Freeboard (m)	Duration Time (Hour)			
5-Year	0.13	0.049	0.14	150.14	404	0.86	7	9:40 AM	4:05 PM	6:25
10-Year	0.14	0.049	0.17	150.17	520	0.83	9	10:00 AM	6:15 PM	8:15
100-Year	0.19	0.049	0.32	150.32	975	0.68	14	11:40 AM	1:30 AM	13:50
200-Year	0.21	0.049	0.38	150.38	1164	0.62	16	12:00 PM	3:50 AM	15:50

Table 9.1

Forecasted Leachate Quality Profile
2020 Design, Operations and Closure Plan
New Landfill (Northwin Landfill)
Upland Excavating Ltd.
Campbell River, British Columbia

Parameters	Units	Historical Results from Similar Landfills for Comparison							Original Upland Landfill 2019	Forecasted Upland Landfill Leachate Concentrations		Discharge Criteria	Treatment Efficiency		Forecasted Upland Landfill Treated Leachate Concentrations	
		HWMF Lowest Concentration Observed in Leachate 2012-2015 [1]	HWMF Average Concentration Observed in Leachate 2012-2015 [2]	Confiential BC Contaminated Soil Landfill - Average Concentrations Observed in Leachate 2012[6]	Confidential BC Contaminated Soil Landfill - Average Concentration Observed in Leachate 2013 [7]	Highest observed - C&D Levis Landfill, Quebec 2003 [3]	Highest observed - Mayer Waste Disposal Site 1994-2001 [4]	Highest observed - Inter-Recycling Systems Landfill 1988-2001 [5]		Minimum	Maximum	CSR Schedule 3.2 DW	Minimum Percent Reduction From Leachate Treatment	Maximum Percent Reduction From Leachate Treatment	Minimum	Maximum
GENERAL CHEMISTRY																
Alkalinity (total)	mg/L	327	1152	-	-	--	1550	3050	-	50	2500	-	50%	90%	25	250
Ammonia-N	mg/L	1.07	20.1	24.1	25.7	--	27	--	0.57	1	30	-	10%	90%	0.9	3
BOD	mg/L	8.3	13.5	9	10	17	69	648	41	10	50	-	10%	65%	9	17.5
Chloride (Cl) (dissolved)	mg/L	75	1642	710	667	243	98.9	702	16	50	700	250	-	64%	50	250
COD	mg/L	52	431	300	390	132	517	--	144	50	500	-	25%	70%	37.5	150
Conductivity	us/cm	1800	7974	4100	3920	--	2730	6900	618	200	5000	-	-	-	200	5000
Hardness	mg/L	581	1855	980	1050	--	1341	3100	323	750	2500	-	-	-	750	2500
pH	pH units	6.84	7.35	7.02	6.88	6.2-7.3	6.2-7.1	6.1-8.4	7.77	6	8	-	-	-	6	8
Phenols	mg/L	0.005	0.044	-	-	0.026	0.0075	0.172	-	0.005	0.1	1	25%	90%	0.00375	0.01
Sulphate (S04)	mg/L	36	529	40	40	742	521	356	74	50	500	500	-	-	50	500
Sulphide	mg/L	0.023	1.979	-	-	-	-	-	0.03	0.01	1	0.05	25%	95%	0.0075	0.05
Total Suspended Solids (TSS)	mg/L	13.7	27.2	100	237	-	-	-	55.2	10	150	-	50%	50%	5	75
Total Dissolved Solids (TDS)	mg/L	1180	5742	-	-	-	-	-	504	500	1000	-	50%	50%	250	500
Total Kjeldahl Nitrogen (TKN)	mg/L	2.89	26.3	36.1	43.1	-	-	-	-	3	50	-	25%	65%	2.25	17.5
Phosphorus	mg/L	0.08	0.31	0.2[8]	-	-	-	-	-	0.1	0.5	-	-	-	0.1	0.5
HYDROCARBONS																
HEPH	mg/L	0.49	1.10	-	-	-	-	-		0.5	2	-	-	-	0.5	2
LEPH	mg/L	0.36	1.08	-	-	-	-	-		0.5	2	-	25%	75%	0.375	0.5
METALS																
Aluminum (Dissolved)	mg/L	0.022	0.063	0.100	0.070				0.0174	0.01	0.1	9.5	-	-	0.01	0.1
Arsenic	mg/L	0.001	0.009	0.008	0.042	-	0.001	0.019 [10]	0.003	0.001	0.04	0.01	-	75%	0.001	0.01
Arsenic (Dissolved)	mg/L	0.006	0.010	0.003	0.003				0.00182	0.001	0.04	0.01	-	75%	0.001	0.01
Barium	mg/L	0.060	0.284	1.000	3.760	-	-	0.97	0.0218	0.05	0.7	1	-	-	0.05	0.7
Barium (Dissolved)	mg/L	0.059	0.289	0.550	0.724				0.0161	0.05	0.7	1	-	-	0.05	0.7
Boron	mg/L	1.74	7.81	10.4	10.9	-	-	-	0.063	0.1	10	5	-	50%	0.1	5
Boron (Dissolved)	mg/L	1.71	7.78	11.4	11.4				0.057	0.1	10	5	-	50%	0.1	5
Cadmium	mg/L	0.0001	0.0001	0.0003	0.0003	<0.001	0.0006	0.005	0.000095	0.0001	0.0003	0.005	-	-	0.0001	0.0003
Cadmium (Dissolved)	mg/L	0.0001	0.0001	0.0005	0.0005				0.000015	0.0001	0.0003	0.005	-	-	0.0001	0.0003
Calcium	mg/L	179	548	262	288	-	376	720	121	200	700	-	-	-	200	700
Calcium (Dissolved)	mg/L	179	550	243	226				113	200	700		-	-	200	700
Chromium	mg/L	0.002	0.011	0.006	0.020	0.11	0.054	0.241	0.003	0.005	0.05	0.05	-	-	0.005	0.05
Chromium (Dissolved)	mg/L	0.001	0.009	0.007	0.007				0.0012	0.005	0.05	0.05	-	-	0.005	0.05
Cobalt	mg/L	0.001	0.002	0.003	0.005	-	0.02	0.018	0.00324	0.001	0.02	0.02	-	-	0.001	0.02
Cobalt (Dissolved)	mg/L	0.001	0.002	0.003	0.004				0.00235	0.001	0.02	0.02	-	-	0.001	0.02
Copper	mg/L	0.002	0.043	0.007	0.023	0.32	0.06	0.067	0.017	0.005	0.05	1.5	-	-	0.005	0.05
Copper (Dissolved)	mg/L	0.007	0.031	0.007	0.007				0.001	0.005	0.05	1.5	-	-	0.005	0.05
Iron	mg/L	0.418	5.46	47.6	267	69	65	180	10.3	10	70	6.5	35%	91%	6.5	6.5
Iron (Dissolved)	mg/L	0.032	3.31	0.130	2.39				6.97	0.1	7	6.5	-	7%	0.1	6.5
Lead	mg/L	0.0015	0.0024	0.001	0.038	<0.05	0.062	0.053	0.00046	0.001	0.01	0.01	-	-	0.001	0.01
Lead (Dissolved)	mg/L	--	--	0.001	0.001				<0.001	0.001	0.01	0.01	-	-	0.001	0.01
Magnesium	mg/L	30	115	77.8	77.7	-	111	365	20.1	30	300	-	-	-	30	300
Magnesium (Dissolved)	mg/L	30	118	75.7	71.2				19.5	30	300	-	-	-	30	300
Manganese	mg/L	0.300	1.93	1.47	0.846	-	6.01	2.62	3.68	2	5	1.5	25%	89%	1.5	0.55
Manganese (Dissolved)	mg/L	0.297	1.81	1.31	0.360				3.86	2	5	1.5	25%	89%	1.5	0.55
Mercury	mg/L	--	--	0.00003	0.00001	<0.0002	<0.00005	<0.00005	0.0000026	0.00001	0.00003	0.001	-	-	0.00001	0.00003
Mercury (Dissolved)	mg/L	--	--	0.00001	0.00001				<0.000002	0.00001	0.00001	0.001	-	-	0.00001	0.00001
Molybdenum	mg/L	0.0017	0.0018	0.001	0.001	-	<0.05	0.006	<0.0001	0.001	0.002	0.25	-	-	0.001	0.002
Molybdenum (Dissolved)	mg/L	0.0012	0.0016	0.001	0.001				<0.001	0.001	0.002	0.25	-	-	0.001	0.002
Nickel	mg/L	0.0075	0.0120	0.020	0.017	0.13	0.02	0.086	0.0026	0.0075	0.02	0.08	-	-	0.0075	0.02
Nickel (Dissolved)	mg/L	0.0052	0.0114	0.010	0.016				0.0012	0.0075	0.02	0.08	-	-	0.0075	0.02
Selenium	mg/L	ND	ND	0.005	0.004	-	0.021	0.046	0.00022	0.0001	0.005	0.01	-	-	0.0001	0.005
Selenium (Dissolved)	mg/L	-	-	0.004	0.004				0.00022	0.0001	0.005	0.01	-	-	0.0001	0.005
Silver	mg/L	0.0001	0.0001	0.0002	0.0002	-	0.0002	<0.0001	<0.00002	0.0001	0.0002	0.02	-	-	0.0001	0.0002
Silver (Dissolved)	mg/L	--	--	0.0002	0.0002				<0.00002	0.0001	0.0002	0.02	-	-	0.0001	0.0002
Sodium	mg/L	107	1153	541	516	-	256	889	25.1	50	550	200	-	64%	50	200
Sodium (Dissolved)	mg/L	92.3	1173	577	518				27.2	50	550	200	-	64%	50	200
Zinc	mg/L	0.027	0.238	0.050	0.110	0.72	2.12	2.57	0.0622	0.05	2	3	-	-	0.05	2

Table 9.1

Forecasted Leachate Quality Profile
2020 Design, Operations and Closure Plan
New Landfill (Northwin Landfill)
Upland Excavating Ltd.
Campbell River, British Columbia

Parameters	Units	Historical Results from Similar Landfills for Comparison							Original Upland Landfill 2019	Forecasted Upland Landfill Leachate Concentrations		Discharge Criteria	Treatment Efficiency		Forecasted Upland Landfill Treated Leachate Concentrations	
		HWMF Lowest Concentration Observed in Leachate 2012-2015 [1]	HWMF Average Concentration Observed in Leachate 2012-2015 [2]	Confiential BC Contaminated Soil Landfill - Average Concentrations Observed in Leachate 2012 [6]	Confidential BC Contaminated Soil Landfill - Average Concentration Observed in Leachate 2013 [7]	Highest observed - C&D Levis Landfill, Quebec 2003 [3]	Highest observed - Mayer Waste Disposal Site 1994-2001 [4]	Highest observed - Inter-Recycling Systems Landfill 1988-2001 [5]		Minimum	Maximum	CSR Schedule 3.2 DW	Minimum Percent Reduction From Leachate Treatment	Maximum Percent Reduction From Leachate Treatment	Minimum	Maximum
Zinc (Dissolved)	mg/L	0.006	0.137	0.020	0.030				0.01	0.025	1	3	-	-	0.025	1
PAHs																
1-Methylnaphthalene	ug/L	-	-	-	-	-	-	-	74	50	150	5.5	89%	96%	5.5	5.5
2-Methylnaphthalene	ug/L	-	-	-	-	-	-	-	100	50	150	15	70%	90%	15	15
Acenaphthene	ug/L	-	-	-	-	-	-	-	70	50	150	250	50%	90%	25	15
Anthracene	ug/L	-	-	-	-	-	-	-	6.1	1	10	1000	50%	90%	0.5	1
Benzo(a)anthracene	ug/L	-	-	-	-	-	-	-	2.1	0.1	5	0.07	30%	99%	0.07	0.07
Benzo(a)pyrene	ug/L	-	-	-	-	-	-	-	1.2	0.1	5	0.01	90%	100%	0.01	0.01
Benzo(b)fluoranthene/Benzo(j)fluo	ug/L	-	-	-	-	-	-	-	1.6	0.1	5	0.07	30%	99%	0.07	0.07
Benzo(b)pyridine (Quinoline)	ug/L	-	-	-	-	-	-	-	1.2	0.1	5	0.05	50%	99%	0.05	0.05
Chrysene	ug/L	-	-	-	-	-	-	-	2.7	0.1	5	7	50%	90%	0.05	0.5
Dibenz(a,h)anthracene	ug/L	-	-	-	-	-	-	-	0.11	0.01	1	0.01	50%	99%	0.005	0.01
Fluoranthene	ug/L	-	-	-	-	-	-	-	11	1	50	150	50%	90%	0.5	5
Fluorene	ug/L	-	-	-	-	-	-	-	28	1	50	150	50%	90%	0.5	5
Naphthalene	ug/L	-	-	-	-	-	-	-	900	100	1500	80	20%	95%	80	80
Pyrene	ug/L	-	-	-	-	-	-	-	8.8	1	50	100	50%	90%	0.5	5

Notes:
(1) Chemical analyses results - HWMF surface water - Highest concentration -1995 (Appendix B).
(2) Chemical analyses results - HWMF ash leachate - Highest concentration -1995 (Appendix B).
(3) Highest concentration reported for the C&D Landfill in Levis, Quebec in 2005 (Appendix C).
(4) Highest concentration reported for the Mayer Industrial Landfill Site between 1994 and 2001 (Appendix C).
(5) Highest concentration reported for the Inter-Recycling Systems Landfill Site between 1988 and 2001 (Appendix C).
(6) Confidential Landfill Leachate - Treatment Program 2013 - Tables 5,6,7. Concentrations represent average of 4 samples.
(7) Confidential Landfill Leachate - Leachate Treatment Program 2013 - Tables 5,6,7. Concentrations represent average of 3 samples.
(8) Concentration represents average of 2 samples.

Table 9.2

HELP Model Results
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

	Daily Cover - New cell	Daily Cover	Intermediate Cover	Final Cover
		mm		
Jan	222.68	176.93	177.40	2.92
Feb	155.72	162.00	165.02	2.69
Mar	124.98	157.48	160.20	2.40
Apr	68.62	122.23	122.31	1.96
May	34.31	50.57	37.41	1.48
Jun	26.80	26.91	13.18	0.91
Jul	22.54	22.34	10.61	0.62
Aug	18.67	18.87	8.44	0.43
Sep	27.85	26.60	13.98	0.29
Oct	108.64	59.91	46.16	0.12
Nov	187.21	117.04	110.28	0.20
Dec	209.02	162.09	160.08	1.81
Total:	**1207.05**	**1102.97**	**1025.06**	**15.82**
Peak Daily:	**20.56**	**14.79**	**14.76**	**0.21**

Table 9.3

Cover Areas
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

	Areas (m²)			
Stage	**New Cell**	**Daily Cover**	**Intermediate Cover**	**Final Cover**
1 East - Half	6,882	0	0	0
1 East	6,882	6,882	0	0
1 West - Half	4,559	3,053	10,710	0
1 West	4,559	7,612	7,710	3,720
2A	10,590	0	10,217	9,050
2B	0	10,160	10,647	9,050
2C	0	7,047	13,854	9,050
3A	3,212	13,583	207	16,235
3B	0	8,393	8,609	16,235
3C	0	0	0	34,145

Table 9.4

Estimated Leachate Generation Per Stage
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

	Days in Month	Stage 1 East Half Cell w Rain Flap	Stage 1 East	Stage 1 West Half Cell w Rain Flap	Stage 1 West	Stage 2A	Stage 2B	Stage 2C	Stage 3A	Stage 3B	Stage 3C
						m^3					
January	31	1532	2,750.0	3,455.2	3,740.4	4,197.1	3,712.8	3,731.0	3,202.6	3,059.6	99.6
February	28	1072	2,186.4	2,971.8	3,225.2	3,359.4	3,427.2	3,452.1	2,778.4	2,824.0	91.8
March	31	860	1,943.8	2,766.3	3,012.5	2,982.0	3,327.4	3,350.9	2,612.6	2,739.9	81.8
April	30	472	1,313.4	1,995.9	2,193.4	1,994.1	2,561.8	2,573.5	1,937.8	2,110.6	66.9
May	31	236	584.1	711.5	835.3	759.0	925.5	888.1	828.9	770.6	50.6
June	30	184	369.6	345.5	431.9	426.7	421.9	380.4	469.0	354.0	31.0
July	31	155	308.8	284.5	356.9	352.7	345.5	310.0	388.0	288.8	21.1
August	31	129	258.4	233.2	295.5	287.9	285.5	253.9	325.1	238.1	14.7
September	30	192	374.7	357.9	438.3	440.4	421.8	383.8	458.3	348.3	9.9
October	31	748	1,159.9	1,172.5	1,307.6	1,623.2	1,101.2	1,062.7	1,174.2	902.1	4.0
November	30	1288	2,093.7	2,391.8	2,595.3	3,111.1	2,365.1	2,354.4	2,217.1	1,935.0	6.8
December	31	1438	2,553.8	3,162.1	3,427.5	3,865.4	3,367.5	3,376.3	2,935.5	2,767.9	61.8
Annual Leachate		8,306.3	15,896.4	19,848.2	21,859.7	23,398.9	22,263.2	22,117.0	19,327.7	18,338.8	540.1
Peak Daily Rate		141.5	243.3	297.0	320.1	370.4	309.4	310.6	273.4	254.6	7.2
Average Daily Rate		22.8	43.6	54.4	59.9	64.1	61.0	60.6	53.0	50.2	1.5
+ 5.2% Climate Change Factor											
Annual Leachate		**8,738**	**16,723**	**20,880**	**22,996**	**24,616**	**23,421**	**23,267**	**20,333**	**19,292**	**568**
Peak Daily Rate		**149**	**256**	**312**	**337**	**390**	**325**	**327**	**288**	**268**	**8**
Average Daily Rate		**24**	**46**	**57**	**63**	**67**	**64**	**64**	**56**	**53**	**2**

Table 10.1

Waste Characterization
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Waste Type	Percent of Total Waste Composition	Percent Relatively Inert	Percent Moderately Decomposable	Percent Decomposable
Waste Soil	50%	100%	0%	0%
Construction, Demolition and Land Clearing Debris	50%	50%	50%	0%
Total	**100%**	**75%**	**25%**	**0%**

Table 10.2

Landfill Gas Generation Summary
2021 Design, Operations and Closure Plan
New Landfill (Northwin Landfill)
Upland Excavating Ltd.
Campbell River, British Columbia

Year	Annual Waste Tonnage (tonnes)	Methane Generation (tonnes CH4/year)	Total Waste in Place (tonnes)
2022	138,238	0	138,238
2023	45,000	186	183,238
2024	45,000	236	228,238
2025	45,000	285	273,238
2026	45,000	330	318,238
2027	45,000	373	363,238
2028	45,000	414	408,238
2029	45,000	453	453,238
2030	45,000	490	498,238
2031	45,000	525	543,238
2032	45,000	559	588,238
2033	45,000	590	633,238
2034	45,000	620	678,238
2035	13,836	649	692,075
2036	0	634	692,075
2037	0	602	692,075
2038	0	571	692,075
2039	0	542	692,075
2040	0	515	692,075
2041	0	489	692,075
2042	0	464	692,075
2043	0	441	692,075
2044	0	419	692,075
2045	0	399	692,075
2046	0	379	692,075
2047	0	361	692,075
2048	0	343	692,075
2049	0	327	692,075
2050	0	311	692,075
2051	0	297	692,075
2052	0	283	692,075
2053	0	269	692,075
2054	0	257	692,075
2055	0	245	692,075
2056	0	234	692,075
2057	0	223	692,075
2058	0	213	692,075
2059	0	204	692,075
2060	0	195	692,075
2061	0	186	692,075
2062	0	178	692,075
2063	0	170	692,075
2064	0	163	692,075

Note:
This table presents the results of the landfill gas (LFG) assessment from the anticipated year where waste placement will begin to the estimated year of closure with anticipated annual waste tonnages.

Table 10.3

Landfill Gas Generation Results
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

	Relatively Inert	Moderately Decomposable	Decomposable	
Gas Production potential, Lo =	20	120	160	m^3 CH_4/tonne
Waste Composition (2006 SWMP)	75.0%	25.0%	0.0%	
lag time before start of gas production, lag =	1 years			
Historical Data Used (years)	30			
1st Year of Historical Data Used	2021			
Proposed year of closure	2033			
methane (by volume)	50%			
carbon dioxide (by volume)	50%			
methane (density)	0.6557 kg/m^3		(25°C,1ATM)	
carbon dioxide (density)	1.7988 kg/m^3		(25°C,1ATM)	

Year	Annual Tonnage (tonnes)	Cumulative Waste-in-place (tonnes)	Waste Tonnage			Methane Generation Rate, k			Annual Methane Production (tonnes/yr)	Landfill Gas Production (m^3/hr)	Greenhouse Gas Emissions (as CO_2e/year)
			Relatively Inert (tonnes)	Moderately Decomposable (tonnes)	Decomposable (tonnes)	Relatively Inert ($year^{-1}$)	Moderately Decomposable ($year^{-1}$)	Decomposable ($year^{-1}$)			
2022	138,238	138,238	103,679	34,560	0	0.02	0.06	0.11	185.8	64.7	3,901
2023	45,000	183,238	33,750	11,250	0	0.02	0.06	0.11	236.5	82.3	4,966
2024	45,000	228,238	33,750	11,250	0	0.02	0.06	0.11	284.5	99.1	5,975
2025	45,000	273,238	33,750	11,250	0	0.02	0.06	0.11	330.1	114.9	6,932
2026	45,000	318,238	33,750	11,250	0	0.02	0.06	0.11	373.3	130.0	7,840
2027	45,000	363,238	33,750	11,250	0	0.02	0.06	0.11	414.3	144.3	8,701
2028	45,000	408,238	33,750	11,250	0	0.02	0.06	0.11	453.2	157.8	9,518
2029	45,000	453,238	33,750	11,250	0	0.02	0.06	0.11	490.2	170.7	10,293
2030	45,000	498,238	33,750	11,250	0	0.02	0.06	0.11	525.2	182.9	11,030
2031	45,000	543,238	33,750	11,250	0	0.02	0.06	0.11	558.5	194.5	11,729
2032	45,000	588,238	33,750	11,250	0	0.02	0.06	0.11	590.1	205.5	12,393
2033	45,000	633,238	33,750	11,250	0	0.02	0.06	0.11	620.2	215.9	13,024
2034	45,000	678,238	33,750	11,250	0	0.02	0.06	0.11	648.7	225.9	13,623
2035	13,836	692,075	10,377	3,459	0	0.02	0.06	0.11	634.0	220.8	13,314
2036	0	692,075	0	0	0	0.02	0.06	0.11	601.5	209.4	12,632
2037	0	692,075	0	0	0	0.02	0.06	0.11	570.9	198.8	11,989
2038	0	692,075	0	0	0	0.02	0.06	0.11	541.9	188.7	11,380
2039	0	692,075	0	0	0	0.02	0.06	0.11	514.6	179.2	10,806
2040	0	692,075	0	0	0	0.02	0.06	0.11	488.7	170.2	10,263
2041	0	692,075	0	0	0	0.02	0.06	0.11	464.3	161.7	9,750
2042	0	692,075	0	0	0	0.02	0.06	0.11	441.2	153.6	9,266
2043	0	692,075	0	0	0	0.02	0.06	0.11	419.4	146.0	8,808
2044	0	692,075	0	0	0	0.02	0.06	0.11	398.8	138.9	8,375
2045	0	692,075	0	0	0	0.02	0.06	0.11	379.3	132.1	7,965
2046	0	692,075	0	0	0	0.02	0.06	0.11	360.9	125.6	7,578
2047	0	692,075	0	0	0	0.02	0.06	0.11	343.4	119.6	7,212
2048	0	692,075	0	0	0	0.02	0.06	0.11	326.9	113.8	6,866
2049	0	692,075	0	0	0	0.02	0.06	0.11	311.3	108.4	6,538
2050	0	692,075	0	0	0	0.02	0.06	0.11	296.6	103.3	6,228
2051	0	692,075	0	0	0	0.02	0.06	0.11	282.6	98.4	5,935
2052	0	692,075	0	0	0	0.02	0.06	0.11	269.4	93.8	5,657
2053	0	692,075	0	0	0	0.02	0.06	0.11	256.9	89.4	5,395
2054	0	692,075	0	0	0	0.02	0.06	0.11	245.0	85.3	5,146
2055	0	692,075	0	0	0	0.02	0.06	0.11	233.8	81.4	4,910
2056	0	692,075	0	0	0	0.02	0.06	0.11	223.2	77.7	4,687
2057	0	692,075	0	0	0	0.02	0.06	0.11	213.1	74.2	4,476
2058	0	692,075	0	0	0	0.02	0.06	0.11	203.6	70.9	4,276
2059	0	692,075	0	0	0	0.02	0.06	0.11	194.6	67.7	4,086
2060	0	692,075	0	0	0	0.02	0.06	0.11	186.0	64.8	3,906
2061	0	692,075	0	0	0	0.02	0.06	0.11	177.9	61.9	3,735
2062	0	692,075	0	0	0	0.02	0.06	0.11	170.2	59.2	3,573
2063	0	692,075	0	0	0	0.02	0.06	0.11	162.9	56.7	3,420
2064	0	692,075	0	0	0	0.02	0.06	0.11	155.9	54.3	3,274

Sources:
-Landfill Gas Generation Assessment Procedure Guidance Report, Conestoga-Rovers & Associates, March 2009
-Annual waste tonnage data is estimated.

Table 13.1 A
Groundwater Compliance Forecast
Scenario 1 - Liner Failure
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Parameters	Units	Average Pre-Landfilling Concentrations (1) 2015 - 2017	Forecasted Upland Landfill Leachate Concentrations	Forecasted Upland Landfill Treated Leachate Concentrations	Contaminant Masses & Source Volumes (2)						Final Forecasted Groundwater Concentrations (3)	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017
						Flux into Landfill Footprint Area (minimum)	Landfill Leakage (primary liner failure with leak detection system)	Treated Leachate Infiltration (Designed)	Infiltration of Runoff and Lateral Drainage from Landfill Cap (dry periods)	Infiltration Downgradient of Landfill (5) (dry periods)	liner failure (with leak detection system), max. mass loading (leachate & effluent), min. upgradient flux, dry season runoff & downgradient infiltration	Drinking Water (DW)	Aquatic Life (AW)
			Maximum	Maximum	Units								
			mg/L	mg/L	m3/day	500	0.00010	67	1.0	73		(mg/L)	(mg/L)
					L/day	500,000	0.10	67,000	1750.0	73,000	Scenario Liner Failure		
GENERAL CHEMISTRY							Contaminant Masses				(mg/L)		
							Maximum						
Alkalinity (total)	mg/L	54.7	2500	250	mg/day	27350000	250	16750000	95725	3993100	75.1	-	-
Ammonia-N	mg/L	0.08	30	3	mg/day	40000	3.0	201000	140	5840	0.38	-	11.3 [a]
BOD	mg/L	2.07	50	17.5	mg/day	1035000	5.0	1172500	3622.5	151110	3.68	-	-
Chloride (Cl) (dissolved)	mg/L	4.15	1500	250	mg/day	2075000	150	16750000	7262.5	302950	29.82	250	1500
COD	mg/L	39.1	500	150	mg/day	19550000	50	10050000	68425	2854300	50.68	-	-
Conductivity(4)	us/cm	137	7500	7500	us/cm	-	-	-	-	-	846	-	-
Hardness	mg/L	60	2500	2500	mg/day	30000000	250	167500000	105000	4380000	315	-	-
pH(4)	pH units	7.86	8	8	std. units	-	-	-	-	-	7-8	-	-
Phenols	mg/L	0.0	0.1	0.01	mg/day	0	0.01	670	0	0	0.00104	1	2
Sulphate (S042-)	mg/L	5.72	1000	500	mg/day	2860000	100	33500000	10010	417560	57.32	500	2180 - 4290 [b]
Sulphide	mg/L	0.006	5	0.05	mg/day	3000	0.50	3350	10.5	438	0.0106	0.05	0.02
Total Suspended Solids (TSS)	mg/L	390	150	75	mg/day	1.95E+08	15.0	5025000	682500	28470000	357	-	-
Total Dissolved Solids (TDS)	mg/L	31	10000	5000	mg/day	15500000	1000	335000000	54250	2263000	550	-	-
Total Kjeldahl Nitrogen (TKN)	mg/L	0.143	60	21	mg/day	71500	6.00	1407000	250.25	10439	2.321	-	-
Phosphorus	mg/L	0.551	0.5	0.5	mg/day	275500	0.05	33500	964.25	40223	0.546	-	-
HYDROCARBONS													
HEPH	mg/L	0.0	2	2	mg/day	0	0.20	134000	0	0	0.2088	-	-
LEPH	mg/L	0.0	2	0.5	mg/day	0	0.20	33500	0	0	0.0522	-	0.5
METALS													
Aluminum	mg/L	-	1	1		-	0.100	67000				-	-
Aluminum (Dissolved)	mg/L	0.00737	0.1	0.1	mg/day	3685	0.010	6700	12.8975	538.01	0.02	9.5	-
Arsenic	mg/L	-	0.04	0.01	mg/day	-	0.004	670				-	-
Arsenic (Dissolved)	mg/L	0.00014	0.04	0.01	mg/day	70	0.004	670	0.245	10.22	0.0012	0.01	0.05
Barium	mg/L	-	0.7	0.7	mg/day	-	0.070	46900				-	-
Barium (Dissolved)	mg/L	0.0014	0.7	0.7	mg/day	700	0.07	46900	2.45	102.2	0.074	1	10
Boron	mg/L	-	10	5	mg/day	-	1.00	335000				-	-
Boron (Dissolved)	mg/L	0.0	10	5	mg/day	0	1.00	335000	0	0	0.522	5	12
Cadmium	mg/L	-	0.0003	0.0003	mg/day	-	3.0E-05	20.1				-	-
Cadmium (Dissolved)	mg/L	0.00001	0.0003	0.0003	mg/day	5.0	3.0E-05	20.1	0.0175	0.73	0.00004	0.005	0.0015 - 0.004 [b]
Calcium	mg/L	-	700	700	mg/day	-	70.00	46900000				-	-
Calcium (Dissolved)	mg/L	18.842	700	700	mg/day	9421000	70	46900000	32973.5	1375466	89.96	-	-
Chromium	mg/L	-	0.05	0.05	mg/day	-	0.005	3350				-	-
Chromium (Dissolved)	mg/L	0.0	0.05	0.05	mg/day	0	0.005	3350	0	0	0.00522	0.05	0.01 [c]
Cobalt	mg/L	-	0.01	0.01	mg/day	-	0.0010	670				-	-
Cobalt (Dissolved)	mg/L	0.0	0.01	0.01	mg/day	0	0.0010	670	0	0	0.0010	0.001	0.04
Copper	mg/L	-	0.05	0.05	mg/day	-	0.0050	3350				-	-
Copper (Dissolved)	mg/L	0.0008	0.05	0.05	mg/day	400	0.005	3350	1.4	58.4	0.0059	1.5	0.03-0.09 [b]
Iron	mg/L	-	70	6.5	mg/day	-	7.0	435500				-	-
Iron (Dissolved)	mg/L	0.056	7	6.5	mg/day	28000	0.7	435500	98	4088	0.73	6.5	-
Lead	mg/L	-	0.01	0.01	mg/day	-	0.0010	670				-	-
Lead (Dissolved)	mg/L	0.0	0.01	0.01	mg/day	0	0.0010	670	0	0	0.0010	0.01	0.05 - 0.16 [b]
Magnesium	mg/L	-	300	100	mg/day	-	30.0	6700000				-	-
Magnesium (Dissolved)	mg/L	3.28	300	100	mg/day	1640000	30.0	6700000	5740	239440	13.38	-	-
Manganese	mg/L	-	5	0.55	mg/day	-	0.5	36850				-	-
Manganese (Dissolved)	mg/L	0.03	5	0.55	mg/day	15000	0.5	36850	52.5	2190	0.084	1.5	-
Mercury	mg/L	-	0.00003	0.00003	mg/day	-	3.0E-06	2.01				-	-
Mercury (Dissolved)	mg/L	0.0	0.00001	0.00001	mg/day	0	1.0E-06	0.67	0	0	0.000001	0.001	0.00025
Molybdenum	mg/L	-	0.002	0.002	mg/day	-	0.0002	134				-	-
Molybdenum (Dissolved)	mg/L	0.0	0.002	0.002	mg/day	0	0.0002	134	0	0	0.0002	0.25	10
Nickel	mg/L	-	0.02	0.02	mg/day	-	0.002	1340				-	-
Nickel (Dissolved)	mg/L	0.0	0.02	0.02	mg/day	0	0.002	1340	0	0	0.0021	0.08	0.65-1.5 [b]
Selenium	mg/L	-	0.005	0.005	mg/day	-	0.0005	335				-	-
Selenium (Dissolved)	mg/L	0.0002	0.005	0.005	mg/day	100	0.001	335	0.35	14.6	0.0007	0.01	0.02
Silver	mg/L	-	0.00002	0.00002	mg/day	-	2.0E-06	1.34				-	-
Silver (Dissolved)	mg/L	0.0	0.0002	0.0002	mg/day	0	2.0E-05	13.4	0	0	0.00002	0.02	0.0005-0.015
Sodium	mg/L	-	1000	200	mg/day	-	100	13400000				-	-
Sodium (Dissolved)	mg/L	3.89	1000	200	mg/day	1945000	100	13400000	6807.5	283970	24.36	200	-
Zinc	mg/L	-	2	2	mg/day	-	0.20	134000				-	-
Zinc (Dissolved)	mg/L	0.002	1	1	mg/day	1000	0.10	67000	3.5	146	0.106	3	0.075-2.4 [b]

Notes:
(1) Concentrations have been calculated using the average concentration of each sample collected from the overburden, sand and gravel aquifer between 2015 and 2017.
For the purposes of predicting the mass inputs, concentrations of 0.0 mg/L have been used whereever samples were below detection limits (ND or less than the reporting limit).
(2) Contaminant masses are calculated by multipling the forcasted concentration by the volume of the respective source
(3) Final Forecasted Groundwater Concentrations = (sum of masses)/(sum of source volumes)
(4) The forecasted concentration approach is inappropriate for pH and conductivity.
conductivity is estimated as TDS/0.67, pH is expected to fall within the min. and max. range in pre-Landfill, leachate, or effluent.
(5) Infiltation rates used are 72% in the pit (with no vegetation) and 50% for above the pit (with vegetation) - derived from HELP modeling.
- not analyzed or no standard/criteria available.
ND - not detected above the respective laboratory reporting limit
[a] - Limit varies with pH. Ranges are calculated using average pre-landfilling and final predicted concentrations
[b] - Limit varies with Hardness. Ranges are calculated using average pre-landfilling and final predicted concentrations
[c] - Limit is set for hexavalent chromium
(SAD)/(WAD) - strong acid dissolvable/weak acid dissolvable

exceeds the BC CSR Drinking Water (DW) Standards
exceeds the BC CSR Aquatic Life (AW) Standards

Table 13.1 B
Groundwater Compliance Forecast
Scenario 2 - Base Case
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Parameters	Units	Average Pre-Landfilling Concentrations [1] 2015 - 2017	Forecasted Upland Landfill Leachate Concentrations			Forecasted Upland Landfill Treated Leachate Concentrations			Contaminant Masses & Source Volumes [2]					Final Forecasted Groundwater Concentrations [3]	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017
			Minimum	Average	Maximum	Minimum	Average	Maximum		Flux into Landfill Footprint Area (average)	Landfill Leakage (primary liner only)	Treated Leachate Infiltration (Designed)	Infiltration of Runoff and Lateral Drainage from Landfill Cap (average)	Infiltration Downgradient of Landfill [5] (average)	max mass loading (leachate & effluent), average upgradient flux, average runoff & downgradient infiltration	Drinking Water (DW)	Aquatic Life (AW)
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Units								
									m3/day	640	0.00032	67	4.8	225			
									L/day	640,000	0.32	67,000	4,800	225,000	Scenario	(mg/L)	(mg/L)
GENERAL CHEMISTRY															Base Case		
											Maximum	Maximum			(mg/L)		
Alkalinity (total)	mg/L	54.7	500	1500	2500	50	150	250	mg/day	35008000	826	16750000	191450	12307500	68.6	-	-
Ammonia-N	mg/L	0.08	1	15.5	30	0.10	1.55	3	mg/day	51200	9.9	201000	280	18000	0.29	-	11.3 [a]
BOD	mg/L	2.07	10	30	50	3.5	10.5	17.5	mg/day	1324800	16.5	1172500	7245	465750	3.17	-	-
Chloride (Cl) (dissolved)	mg/L	4.15	100	800	1500	16.7	133.3	250	mg/day	2656000	495	16750000	14525	933750	21.73	250	1500
COD	mg/L	39.1	50	275	500	15	82.5	150	mg/day	25024000	165	10050000	136850	8797500	46.98	-	-
Conductivity[4]	us/cm	137	200	3850	7500	200	3850	7500	us/cm	-	-	-	-	-	595.20	-	-
Hardness	mg/L	60	750	1625	2500	750	1625	2500	mg/day	38400000	826	167500000	210000	13500000	234	-	-
pH[4]	pH units	7.86	6	7	8	6	7	8	std. units	-	-	-	-	-	7-8	-	-
Phenols	mg/L	0.0	0.005	0.0525	0.1	0.0005	0.00525	0.01	mg/day	0	0.03	670	0	0	0.00072	1	2
Sulphate (S042-)	mg/L	5.72	50	525	1000	25	263	500	mg/day	3660800	330	33500000	20020	1287000	41.06	500	2180 - 4290 [b]
Sulphide	mg/L	0.006	0.1	2.55	5	0.001	0.026	0.05	mg/day	3840	1.65	3350	21	1350	0.0091	0.05	0.02
Total Suspended Solids (TSS)	mg/L	390	10	80	150	5	40	75	mg/day	2.50E+08	49.5	5025000	1365000	87750000	367	-	-
Total Dissolved Solids (TDS)	mg/L	31	2000	6000	10000	1000	3000	5000	mg/day	19840000	3302	335000000	108500	6975000	386	-	-
Total Kjeldahl Nitrogen (TKN)	mg/L	0.143	3	31.5	60	1.05	11.03	21	mg/day	91520	19.81	1407000	501	32175	1.635	-	-
Phosphorus	mg/L	0.551	0.1	0.3	0.5	0.1	0.3	0.5	mg/day	352640	0.17	33500	1928.5	123975	0.547	-	-
HYDROCARBONS																	
HEPH	mg/L	0.0	0.5	1.25	2	0.5	1.25	2	mg/day	0	0.66	134000	0	0	0.1430	-	-
LEPH	mg/L	0.0	0.5	1.25	2	0.125	0.313	0.5	mg/day	0	0.66	33500	0	0	0.0358	-	0.5
METALS																	
Aluminum	mg/L	-	0.1	0.55	1	0.1	0.55	1		-	0.330	67000			0.07	-	-
Aluminum (Dissolved)	mg/L	0.00737	0.01	0.055	0.1	0.01	0.055	0.1	mg/day	4717	0.033	6700	25.8	1658	0.01	9.5	-
Arsenic	mg/L	-	0.001	0.0205	0.04	0.00025	0.005	0.01	mg/day	-	0.013	670				-	-
Arsenic (Dissolved)	mg/L	0.00014	0.001	0.0205	0.04	0.00025	0.005	0.01	mg/day	90	0.013	670	0.49	32	0.0008	0.01	0.05
Barium	mg/L	-	0.05	0.375	0.7	0.05	0.375	0.7	mg/day	-	0.231	46900				-	-
Barium (Dissolved)	mg/L	0.0014	0.05	0.375	0.7	0.05	0.375	0.7	mg/day	896	0.23	46900	5	315	0.051	1	10
Boron	mg/L	-	5	7.5	10	2.5	3.75	5	mg/day	-	3.30	335000				-	-
Boron (Dissolved)	mg/L	0.0	5	7.5	10	2.5	3.75	5	mg/day	0	3.30	335000	0	0	0.358	5	12
Cadmium	mg/L	-	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	mg/day	-	9.9E-05	20.1				-	-
Cadmium (Dissolved)	mg/L	0.00001	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	mg/day	6.4	9.9E-05	20.1	0.04	2	0.00003	0.005	0.0015 - 0.004 [b]
Calcium	mg/L	-	200	450	700	200	450	700	mg/day	-	231.15	46900000				-	-
Calcium (Dissolved)	mg/L	18.842	200	450	700	200	450	700	mg/day	12058880	231	46900000	65947	4239450	67.53	-	-
Chromium	mg/L	-	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	-	0.017	3350				-	-
Chromium (Dissolved)	mg/L	0.0	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	0	0.017	3350	0	0	0.00358	0.05	0.01 [c]
Cobalt	mg/L	-	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	-	0.0033	670				-	-
Cobalt (Dissolved)	mg/L	0.0	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	0	0.0033	670	0	0	0.0007	0.001	0.04
Copper	mg/L	-	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	-	0.0165	3350				-	-
Copper (Dissolved)	mg/L	0.0008	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	512	0.017	3350	2.8	180	0.0043	1.5	0.03-0.09 [b]
Iron	mg/L	-	1	35.5	70	0.09	3.3	6.5	mg/day	-	23.1	435500				-	-
Iron (Dissolved)	mg/L	0.056	0.1	3.55	7	0.09	3.3	6.5	mg/day	35840	2.3	435500	196	12600	0.52	6.5	-
Lead	mg/L	-	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	-	0.0033	670				-	-
Lead (Dissolved)	mg/L	0.0	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	0	0.0033	670	0	0	0.0007	0.01	0.05 - 0.16 [b]
Magnesium	mg/L	-	30	165	300	10	55	100	mg/day	-	99.1	6700000				-	-
Magnesium (Dissolved)	mg/L	3.28	30	165	300	10	55	100	mg/day	2099200	99.1	6700000	11480	738000	10.19	-	-
Manganese	mg/L	-	1	3	5	0.11	0.33	0.55	mg/day	-	1.7	36850				-	-
Manganese (Dissolved)	mg/L	0.03	1	3	5	0.11	0.33	0.55	mg/day	19200	1.7	36850	105	6750	0.067	1.5	-
Mercury	mg/L	-	0.00001	0.00002	0.00003	0.00001	0.00002	0.00003	mg/day	-	9.9E-06	2.01				-	-
Mercury (Dissolved)	mg/L	0.0	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	mg/day	0	3.3E-06	0.67	0.0	0	0.000001	0.001	0.00025
Molybdenum	mg/L	-	0.001	0.0015	0.002	0.001	0.0015	0.002	mg/day	-	0.0007	134				-	-
Molybdenum (Dissolved)	mg/L	0.0	0.001	0.0015	0.002	0.001	0.0015	0.002	mg/day	0	0.0007	134	0.0	0	0.0001	0.25	10
Nickel	mg/L	-	0.0075	0.01375	0.02	0.0075	0.014	0.02	mg/day	-	0.007	1340				-	-
Nickel (Dissolved)	mg/L	0.0	0.0075	0.01375	0.02	0.0075	0.014	0.02	mg/day	0	0.007	1340	0.0	0	0.0014	0.08	0.65-1.5 [b]
Selenium	mg/L	-	0.001	0.003	0.005	0.001	0.003	0.005	mg/day	-	0.0017	335				-	-
Selenium (Dissolved)	mg/L	0.0002	0.001	0.003	0.005	0.001	0.003	0.005	mg/day	128	0.002	335	0.70	45	0.0005	0.01	0.02
Silver	mg/L	-	0.0001	0.00006	0.00002	0.0001	0.00006	0.00002	mg/day	-	6.6E-06	1.34				-	-
Silver (Dissolved)	mg/L	0.0	0.0001	0.00015	0.0002	0.0001	0.00015	0.0002	mg/day	0	6.6E-05	13.4	0	0	0.00001	0.02	0.0005-0.015
Sodium	mg/L	-	100	550	1000	20	110	200	mg/day	-	330	13400000				-	-
Sodium (Dissolved)	mg/L	3.89	100	550	1000	20	110	200	mg/day	2489600	330	13400000	13615	875250	17.91	200	-
Zinc	mg/L	-	0.05	1.025	2	0.05	1.03	2	mg/day	-	0.66	134000				-	-
Zinc (Dissolved)	mg/L	0.002	0.025	0.5125	1	0.025	0.51	1	mg/day	1280	0.33	67000	7	450	0.073	3	0.075-2.4 [b]

Notes:
(1) Concentrations have been calculated using the average concentration of each sample collected from the overburden, sand and gravel aquifer between 2015 and 2017.
For the purposes of predicting the mass inputs, concentrations of 0.0 mg/L have been used whereever samples were below detection limits (ND or less than the reporting limit).
(2) Contaminant masses are calculated by multipling the forcasted concentration by the volume of the respective source
(3) Final Forecasted Groundwater Concentrations = (sum of masses)/(sum of source volumes)
(4) The forecasted concentration approach is inappropriate for pH and conductivity.
conductivity is estimated as TDS/0.67; pH is expected to fall within the min. and max. range in pre-Landfill, leachate, or effluent.
(5) Infiltation rates used are 72% in the pit (with no vegetation) and 50% for above the pit (with vegetation) - derived from HELP modeling.
- not analyzed or no standard/criteria available.
ND - not detected above the respective laboratory reporting limit
[a] - Limit varies with pH. Ranges are calculated using average pre-landfilling and final predicted concentrations
[b] - Limit varies with Hardness. Ranges are calculated using average pre-landfilling and final predicted concentrations
[c] - Limit is set for hexavalent chromium
(SAD)/(WAD) - strong acid dissolvable/weak acid dissolvable

exceeds the BC CSR Drinking Water (DW) Standards
exceeds the BC CSR Aquatic Life (AW) Standards

Table 13.1 C
Groundwater Compliance Forecast
Scenario 3 - Dry Season
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Parameters	Units	Average Pre-Landfilling Concentrations (1) 2015 - 2017	Forecasted Upland Landfill Leachate Concentrations			Forecasted Upland Landfill Treated Leachate Concentrations			Contaminant Masses & Source Volumes (2)						Final Forecasted Groundwater Concentrations (3)	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017
										Flux into Landfill Footprint Area (minimum)	Landfill Leakage (primary liner only)	Treated Leachate Infiltration (Designed)	Infiltration of Runoff and Lateral Drainage from Landfill Cap (dry periods)	Infiltration Downgradient of Landfill (5) (dry periods)	min. upgradient flux, average mass loading (leachate & effluent), dry season runoff & downgradient infiltration		
			Minimum	Average	Maximum	Minimum	Average	Maximum	Units							Drinking Water (DW)	Aquatic Life (AW)
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	m3/day	500	0.00032	67	1.0	73		(mg/L)	(mg/L)
									L/day	500,000	0.32	67,000	1049	73,000	Scenario Dry Season		
GENERAL CHEMISTRY											Contaminant Masses Maximum	Contaminant Masses Maximum			(mg/L)		
Alkalinity (total)	mg/L	54.7	500	1500	2500	50	150	250	mg/day	27350000	826	16750000	95725	3993100	75.2	-	-
Ammonia-N	mg/L	0.08	1	15.5	30	0.10	1.55	3	mg/day	40000	9.9	201000	140	5840	0.39	-	11.3 [a]
BOD	mg/L	2.07	10	30	50	3.5	10.5	17.5	mg/day	1035000	16.5	1172500	3622.5	151110	3.68	-	-
Chloride (Cl) (dissolved)	mg/L	4.15	100	800	1500	16.7	133.3	250	mg/day	2075000	495	16750000	7262.5	302950	29.85	250	1500
COD	mg/L	39.1	50	275	500	15	82.5	150	mg/day	19550000	165	10050000	68425	2854300	50.73	-	-
Conductivity(4)	us/cm	137	200	3850	7500	200	3850	7500	us/cm	-	-	-	-	-	845.81	-	-
Hardness	mg/L	60	750	1625	2500	750	1625	2500	mg/day	30000000	826	167500000	105000	4380000	315.09	-	-
pH(4)	pH units	7.86	6	7	8	6	7	8	std. units	-	-	-	-	-	7-8	-	-
Phenols	mg/L	0.0	0.005	0.0525	0.1	0.0005	0.00525	0.01	mg/day	0	0.03	670	0	0	0.00105	1	2
Sulphate (S042-)	mg/L	5.72	50	525	1000	25	263	500	mg/day	2860000	330	33500000	10010	417560	57.39	500	2180 - 4290 [b]
Sulphide	mg/L	0.006	0.1	2.55	5	0.001	0.026	0.05	mg/day	3000	1.65	3350	10.5	438	0.0106	0.05	0.02
Total Suspended Solids (TSS)	mg/L	390	10	80	150	5	40	75	mg/day	1.95E+08	49.5	5025000	682500	28470000	358	-	-
Total Dissolved Solids (TDS)	mg/L	31	2000	6000	10000	1000	3000	5000	mg/day	15500000	3302	335000000	54250	2263000	550	-	-
Total Kjeldahl Nitrogen (TKN)	mg/L	0.143	3	31.5	60	1.05	11.03	21	mg/day	71500	19.81	1407000	250.25	10439	2.323	-	-
Phosphorus	mg/L	0.551	0.1	0.3	0.5	0.1	0.3	0.5	mg/day	275500	0.17	33500	964.25	40223	0.546	-	-
HYDROCARBONS																	
HEPH	mg/L	0.0	0.5	1.25	2	0.5	1.25	2	mg/day	0	0.66	134000	0	0	0.2090	-	-
LEPH	mg/L	0.0	0.5	1.25	2	0.125	0.313	0.5	mg/day	0	0.66	33500	0	0	0.0523	-	0.5
METALS																	
Aluminum	mg/L	-	0.1	0.55	1	0.1	0.55	1		-	0.330	67000				-	-
Aluminum (Dissolved)	mg/L	0.00737	0.01	0.055	0.1	0.01	0.055	0.1	mg/day	3685	0.033	6700	12.8975	538.01	0.02	9.5	-
Arsenic	mg/L	-	0.001	0.0205	0.04	0.00025	0.005	0.01	mg/day	-	0.013	670				-	-
Arsenic (Dissolved)	mg/L	0.00014	0.001	0.0205	0.04	0.00025	0.005	0.01	mg/day	70	0.013	670	0.245	10.22	0.0012	0.01	0.05
Barium	mg/L	-	0.05	0.375	0.7	0.05	0.375	0.7	mg/day	-	0.231	46900				-	-
Barium (Dissolved)	mg/L	0.0014	0.05	0.375	0.7	0.05	0.375	0.7	mg/day	700	0.23	46900	2.45	102.2	0.074	1	10
Boron	mg/L	-	5	7.5	10	2.5	3.75	5	mg/day	-	3.30	335000				-	-
Boron (Dissolved)	mg/L	0.0	5	7.5	10	2.5	3.75	5	mg/day	0	3.30	335000	0	0	0.523	5	12
Cadmium	mg/L	-	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	mg/day	-	9.9E-05	20.1				-	-
Cadmium (Dissolved)	mg/L	0.00001	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	mg/day	5.0	9.9E-05	20.1	0.0175	0.73	0.00004	0.005	0.0015 - 0.004 [b]
Calcium	mg/L	-	200	450	700	200	450	700	mg/day	-	231.15	46900000				-	-
Calcium (Dissolved)	mg/L	18.842	200	450	700	200	450	700	mg/day	9421000	231	46900000	32973.5	1375466		-	-
Chromium	mg/L	-	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	-	0.017	3350				-	-
Chromium (Dissolved)	mg/L	0.0	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	0	0.017	3350	0	0	0.00523	0.05	0.01 [c]
Cobalt	mg/L	-	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	-	0.0033	670				-	-
Cobalt (Dissolved)	mg/L	0.0	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	0	0.0033	670	0	0	0.0010	0.001	0.04
Copper	mg/L	-	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	-	0.0165	3350				-	-
Copper (Dissolved)	mg/L	0.0008	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	400	0.017	3350	1.4	58.4	0.0059	1.5	0.03-0.09 [b]
Iron	mg/L	-	1	35.5	70	0.09	3.3	6.5	mg/day	-	23.1	435500				-	-
Iron (Dissolved)	mg/L	0.056	0.1	3.55	7	0.09	3.3	6.5	mg/day	28000	2.3	435500	98	4088	0.73	6.5	-
Lead	mg/L	-	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	-	0.0033	670				-	-
Lead (Dissolved)	mg/L	0.0	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	0	0.0033	670	0	0	0.0010	0.01	0.05 - 0.16 [b]
Magnesium	mg/L	-	30	165	300	10	55	100	mg/day	-	99.1	6700000				-	-
Magnesium (Dissolved)	mg/L	3.28	30	165	300	10	55	100	mg/day	1640000	99.1	6700000	5740	239440	13.39	-	-
Manganese	mg/L	-	1	3	5	0.11	0.33	0.55	mg/day	-	1.7	36850				-	-
Manganese (Dissolved)	mg/L	0.03	1	3	5	0.11	0.33	0.55	mg/day	15000	1.7	36850	52.5	2190	0.084	1.5	-
Mercury	mg/L	-	0.00001	0.00002	0.00003	0.00001	0.00002	0.00003	mg/day	-	9.9E-06	2.01				-	-
Mercury (Dissolved)	mg/L	0.0	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	mg/day	0	3.3E-06	0.67	0	0	0.000001	0.001	0.00025
Molybdenum	mg/L	-	0.001	0.0015	0.002	0.001	0.0015	0.002	mg/day	-	0.0007	134				-	-
Molybdenum (Dissolved)	mg/L	0.0	0.001	0.0015	0.002	0.001	0.0015	0.002	mg/day	0	0.0007	134	0	0	0.0002	0.25	10
Nickel	mg/L	-	0.0075	0.01375	0.02	0.0075	0.014	0.02	mg/day	-	0.007	1340				-	-
Nickel (Dissolved)	mg/L	0.0	0.0075	0.01375	0.02	0.0075	0.014	0.02	mg/day	0	0.007	1340	0	0	0.0021	0.08	0.65-1.5 [b]
Selenium	mg/L	-	0.001	0.003	0.005	0.001	0.003	0.005	mg/day	-	0.0017	335				-	-
Selenium (Dissolved)	mg/L	0.0002	0.001	0.003	0.005	0.001	0.003	0.005	mg/day	100	0.002	335	0.35	14.6	0.0007	0.01	0.02
Silver	mg/L	-	0.0001	0.00006	0.00002	0.0001	0.00006	0.00002	mg/day	-	6.6E-06	1.34				-	-
Silver (Dissolved)	mg/L	0.0	0.0001	0.00015	0.0002	0.0001	0.00015	0.0002	mg/day	0	6.6E-05	13.4	0	0	0.00002	0.02	0.0005-0.015
Sodium	mg/L	-	100	550	1000	20	110	200	mg/day	-	330	13400000				-	-
Sodium (Dissolved)	mg/L	3.89	100	550	1000	20	110	200	mg/day	1945000	330	13400000	6807.5	283970	24.39	200	-
Zinc	mg/L	-	0.05	1.025	2	0.05	1.03	2	mg/day	-	0.66	134000				-	-
Zinc (Dissolved)	mg/L	0.002	0.025	0.5125	1	0.025	0.51	1	mg/day	1000	0.33	67000	3.5	146	0.106	3	0.075-2.4 [b]

Notes:
(1) Concentrations have been calculated using the average concentration of each sample collected from the overburden, sand and gravel aquifer between 2015 and 2017.
For the purposes of predicting the mass inputs, concentrations of 0.0 mg/L have been used whereever samples were below detection limits (ND or less than the reporting limit).
(2) Contaminant masses are calculated by multipling the forcasted concentration by the volume of the respective source
(3) Final Forecasted Groundwater Concentrations = (sum of masses)/(sum of source volumes)
(4) The forecasted concentration approach is inappropriate for pH and conductivity.
conductivity is estimated as TDS/0.67; pH is expected to fall within the min. and max. range in pre-Landfill, leachate, or effluent.
(5) Infiltation rates used are 72% in the pit (with no vegetation) and 50% for above the pit (with vegetation) - derived from HELP modeling.
- not analyzed or no standard/criteria available.
ND - not detected above the respective laboratory reporting limit
[a] - Limit varies with pH. Ranges are calculated using average pre-landfilling and final predicted concentrations
[b] - Limit varies with Hardness. Ranges are calculated using average pre-landfilling and final predicted concentrations
[c] - Limit is set for hexavalent chromium
(SAD)/(WAD) - strong acid dissolvable/weak acid dissolvable

exceeds the BC CSR Drinking Water (DW) Standards

exceeds the BC CSR Aquatic Life (AW) Standards

Table 13.1 D
Groundwater Compliance Forecast
Scenario 4 - Wet Season
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Parameters	Units	Average Pre-Landfilling Concentrations (1) 2015 - 2017	Forecasted Upland Landfill Leachate Concentrations			Forecasted Upland Landfill Treated Leachate Concentrations			Contaminant Masses & Source Volumes (2)						Final Forecasted Groundwater Concentrations (3)	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017
			Minimum	Average	Maximum	Minimum	Average	Maximum	Units	Flux into Landfill Footprint Area (maximum)	Landfill Leakage (primary liner only)	Treated Leachate Infiltration (Designed)	Infiltration of Runoff and Lateral Drainage from Landfill Cap (wet periods)	Infiltration Downgradient of Landfill (5) (wet periods)	max. upgradient flux, average mass loading (leachate & effluent), wet season runoff & downgradient infiltration	Drinking Water (DW)	Aquatic Life (AW)
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	m3/day L/day	860 860,000	0.00032 0.32	67 67,000	6.6 6,640	430 430,000	Scenario Wet Season	(mg/L)	(mg/L)
GENERAL CHEMISTRY									Contaminant Masses		Maximum	Maximum			(mg/L)		
Alkalinity (total)	mg/L	54.7	500	1500	2500	50	150	250	mg/day	47042000	826	16750000	363208	23521000	64.3	-	-
Ammonia-N	mg/L	0.08	1	15.5	30	0.10	1.55	3	mg/day	68800	9.9	201000	531	34400	0.22	-	11.3 [a]
BOD	mg/L	2.07	10	30	50	3.5	10.5	17.5	mg/day	1780200	16.5	1172500	13744.8	890100	2.83	-	-
Chloride (Cl) (dissolved)	mg/L	4.15	100	800	1500	16.7	133.3	250	mg/day	3569000	495	16750000	27556	1784500	16.23	250	1500
COD	mg/L	39.1	50	275	500	15	82.5	150	mg/day	33626000	165	10050000	259624	16813000	44.55	-	-
Conductivity(4)	us/cm	137	200	3850	7500	200	3850	7500	us/cm	-	-	-	-	-	423.30	-	-
Hardness	mg/L	60	750	1625	2500	750	1625	2500	mg/day	51600000	826	167500000	398400	25800000	180	-	-
pH(4)	pH units	7.86	6	7	8	6	7	8	std. units	-	-	-	-	-	7-8	-	-
Phenols	mg/L	0.0	0.005	0.0525	0.1	0.0005	0.00525	0.01	mg/day	0	0.03	670	0	0	0.00049	1	2
Sulphate (S042-)	mg/L	5.72	50	525	1000	25	263	500	mg/day	4919200	330	33500000	37980.8	2459600	30.01	500	2180 - 4290 [b]
Sulphide	mg/L	0.006	0.1	2.55	5	0.001	0.026	0.05	mg/day	5160	1.65	3350	40	2580	0.0082	0.05	0.02
Total Suspended Solids (TSS)	mg/L	390	10	80	150	5	40	75	mg/day	3.35E+08	49.5	5025000	2589600	167700000	375	-	-
Total Dissolved Solids (TDS)	mg/L	31	2000	6000	10000	1000	3000	5000	mg/day	26660000	3302	335000000	205840	13330000	275	-	-
Total Kjeldahl Nitrogen (TKN)	mg/L	0.143	3	31.5	60	1.05	11.03	21	mg/day	122980	19.81	1407000	950	61490	1.168	-	-
Phosphorus	mg/L	0.551	0.1	0.3	0.5	0.1	0.3	0.5	mg/day	473860	0.17	33500	3658.64	236930	0.548	-	-
HYDROCARBONS																	
HEPH	mg/L	0.0	0.5	1.25	2	0.5	1.25	2	mg/day	0	0.66	134000	0	0	0.0983	-	-
LEPH	mg/L	0.0	0.5	1.25	2	0.125	0.313	0.5	mg/day	0	0.66	33500	0	0	0.0246	-	0.5
METALS																	
Aluminum	mg/L	-	0.1	0.55	1	0.1	0.55	1		-	0.330	67000				-	-
Aluminum (Dissolved)	mg/L	0.00737	0.01	0.055	0.1	0.01	0.055	0.1	mg/day	6338.2	0.033	6700	48.9	3169	0.01	9.5	-
Arsenic	mg/L	-	0.001	0.0205	0.04	0.00025	0.005	0.01	mg/day	-	0.013	670				-	-
Arsenic (Dissolved)	mg/L	0.00014	0.001	0.0205	0.04	0.00025	0.005	0.01	mg/day	120.4	0.013	670	0.93	60	0.0006	0.01	0.05
Barium	mg/L	-	0.05	0.375	0.7	0.05	0.375	0.7	mg/day	-	0.231	46900				-	-
Barium (Dissolved)	mg/L	0.0014	0.05	0.375	0.7	0.05	0.375	0.7	mg/day	1204	0.23	46900	9	602	0.036	1	10
Boron	mg/L	-	5	7.5	10	2.5	3.75	5	mg/day	-	3.30	335000				-	-
Boron (Dissolved)	mg/L	0.0	5	7.5	10	2.5	3.75	5	mg/day	0	3.30	335000	0	0	0.246	5	12
Cadmium	mg/L	-	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	mg/day	-	9.9E-05	20.1				-	-
Cadmium (Dissolved)	mg/L	0.00001	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	mg/day	8.6	9.9E-05	20.1	0.07	4	0.00002	0.005	0.0015 - 0.004 [b]
Calcium	mg/L	-	200	450	700	200	450	700	mg/day	-	231.15	46900000				-	-
Calcium (Dissolved)	mg/L	18.842	200	450	700	200	450	700	mg/day	16204120	231	46900000	125111	8102060	52.31	-	-
Chromium	mg/L	-	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	-	0.017	3350				-	-
Chromium (Dissolved)	mg/L	0.0	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	0	0.017	3350	0	0	0.00246	0.05	0.01 [c]
Cobalt	mg/L	-	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	-	0.0033	670				-	-
Cobalt (Dissolved)	mg/L	0.0	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	0	0.0033	670	0	0	0.0005	0.001	0.04
Copper	mg/L	-	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	-	0.0165	3350				-	-
Copper (Dissolved)	mg/L	0.0008	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	688	0.017	3350	5.3	344	0.0032	1.5	0.03-0.09 [b]
Iron	mg/L	-	1	35.5	70	0.09	3.3	6.5	mg/day	-	23.1	435500				-	-
Iron (Dissolved)	mg/L	0.056	0.1	3.55	7	0.09	3.3	6.5	mg/day	48160	2.3	435500	372	24080	0.37	6.5	-
Lead	mg/L	-	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	-	0.0033	670				-	-
Lead (Dissolved)	mg/L	0.0	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	0	0.0033	670	0	0	0.0005	0.01	0.05 - 0.16 [b]
Magnesium	mg/L	-	30	165	300	10	55	100	mg/day	-	99.1	6700000				-	-
Magnesium (Dissolved)	mg/L	3.28	30	165	300	10	55	100	mg/day	2820800	99.1	6700000	21779	1410400	8.03	-	-
Manganese	mg/L	-	1	3	5	0.11	0.33	0.55	mg/day	-	1.7	36850				-	-
Manganese (Dissolved)	mg/L	0.03	1	3	5	0.11	0.33	0.55	mg/day	25800	1.7	36850	199	12900	0.056	1.5	-
Mercury	mg/L	-	0.00001	0.00002	0.00003	0.00001	0.00002	0.00003	mg/day	-	9.9E-06	2.01				-	-
Mercury (Dissolved)	mg/L	0.0	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	mg/day	0	3.3E-06	0.67	0.0	0	0.000000	0.001	0.00025
Molybdenum	mg/L	-	0.001	0.0015	0.002	0.001	0.0015	0.002	mg/day	-	0.0007	134				-	-
Molybdenum (Dissolved)	mg/L	0.0	0.001	0.0015	0.002	0.001	0.0015	0.002	mg/day	0	0.0007	134	0.0	0	0.0001	0.25	10
Nickel	mg/L	-	0.0075	0.01375	0.02	0.0075	0.014	0.02	mg/day	-	0.007	1340				-	-
Nickel (Dissolved)	mg/L	0.0	0.0075	0.01375	0.02	0.0075	0.014	0.02	mg/day	0	0.007	1340	0.0	0	0.0010	0.08	0.65-1.5 [b]
Selenium	mg/L	-	0.001	0.003	0.005	0.001	0.003	0.005	mg/day	-	0.0017	335				-	-
Selenium (Dissolved)	mg/L	0.0002	0.001	0.003	0.005	0.001	0.003	0.005	mg/day	172	0.002	335	1.33	86	0.0004	0.01	0.02
Silver	mg/L	-	0.0001	0.00006	0.00002	0.0001	0.00006	0.00002	mg/day	-	6.6E-06	1.34				-	-
Silver (Dissolved)	mg/L	0.0	0.0001	0.00015	0.0002	0.0001	0.00015	0.0002	mg/day	0	6.6E-05	13.4	0	0	0.00001	0.02	0.0005-0.015
Sodium	mg/L	-	100	550	1000	20	110	200	mg/day	-	330	13400000				-	-
Sodium (Dissolved)	mg/L	3.89	100	550	1000	20	110	200	mg/day	3345400	330	13400000	25830	1672700	13.53	200	-
Zinc	mg/L	-	0.05	1.025	2	0.05	1.03	2	mg/day	-	0.66	134000				-	-
Zinc (Dissolved)	mg/L	0.002	0.025	0.5125	1	0.025	0.51	1	mg/day	1720	0.33	67000	13	860	0.051	3	0.075-2.4 [b]

Notes:
(1) Concentrations have been calculated using the average concentration of each sample collected from the overburden, sand and gravel aquifer between 2015 and 2017.
For the purposes of predicting the mass inputs, concentrations of 0.0 mg/L have been used whereever samples were below detection limits (ND or less than the reporting limit).
(2) Contaminant masses are calculated by multipling the forcasted concentration by the volume of the respective source
(3) Final Forecasted Groundwater Concentrations = (sum of masses)/(sum of source volumes)
(4) The forecasted concentration approach is inappropriate for pH and conductivity.
conductivity is estimated as TDS/0.67; pH is expected to fall within the min. and max. range in pre-Landfill, leachate, or effluent.
(5) Infiltation rates used are 72% in the pit (with no vegetation) and 50% for above the pit (with vegetation) - derived from HELP modeling.
- not analyzed or no standard/criteria available.
ND - not detected above the respective laboratory reporting limit
[a] - Limit varies with pH. Ranges are calculated using average pre-landfilling and final predicted concentrations
[b] - Limit varies with Hardness. Ranges are calculated using average pre-landfilling and final predicted concentrations
[c] - Limit is set for hexavalent chromium
(SAD)/(WAD) - strong acid dissolvable/weak acid dissolvable

exceeds the BC CSR Drinking Water (DW) Standards

exceeds the BC CSR Aquatic Life (AW) Standards

Table 14.1

Well, Borehole and Test Pit Completion Details
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Monitoring ID	Installation Date	Completed By	Borehole Depth (mBGS)	Easting	Northing	2015 Reference Elevation Ground Surface (mAMSL)[2]	2015 Reference Elevation TOR (mAMSL)[2]	2017 Reference Elevation Ground Surface (mAMSL)[1]	2017 Reference Elevation TOR (mAMSL)[1]	Stick-up (m)	Screened Interval (mBGS)		Screen Interval (mAMSL)		Screen Length (m)	Well Diameter (mm)	Primary Constinuent of Completed Unit
Date:																	
MW1-14	12/4/2014	RWD	10.97	330788.539	5541791.638	154.5	172.9	-	-	1.1	11.0	4.9	160.8	149.6	6.1	50.8	Sand/gravel
MW2-14	12/4/2014	RWD	21.64	330961.402	5541591.181	155.8	156.5	-	-	0.8	21.6	15.5	151.4	140.2	6.1	50.8	Sand/gravel
MW2A-16	1/27/2016	Drillwell	45.42	330964.560	5541591.419	155.8	156.6	173.1	173.9	0.8	40.5	37.5	132.6	118.3	6.1	50.8	Sand
MW3-14	12/4/2014	RWD	18.59	330885.439	5541429.793	150.3	151.3	-	-	1.0	17.4	11.3	150.2	139.0	6.1	50.8	Sand/gravel
MW4A-15	8/5/2015	Blue Max	21.33	330737.351	5541583.042	151.2	152.0	-	-	0.8	21.4	19.8	147.2	131.4	1.5	50.8	Bedrock
MW4B-15	8/5/2015	Blue Max	18.28	330743.926	5541575.024	151.1	152.0	-	-	0.9	18.3	15.2	150.1	135.9	3.0	50.8	Sand
MW5A-15	8/7/2015	Blue Max	10.66	330675.167	5541325.831	174.0	174.6	-	-	0.6	10.7	9.1	180.6	164.8	1.5	50.8	Bedrock
MW5B-15	8/7/2015	Blue Max	8.23	330685.323	5541325.831	191.3	174.7	-	-	1.7	7.9	4.9	182.4	186.4	3.0	50.8	Sand/Silt with clay
MW6-17	3/22/2017	Drillwell	11.89	330407.086	5541753.092	-	-	185.5	185.4	-0.1	11.3	9.8	174.2	175.7	1.5	50.8	Sand
MW7-17	3/14/2017	Drillwell	5.03	330266.457	5541691.359	-	-	186.9	187.5	0.7	4.3	2.7	182.6	184.1	1.5	50.8	Gravel
MW8-17	2/22/2017	Blue Max	28.96	330544.895	5541828.138	-	-	191.3	192.5	1.2	18.8	15.8	172.5	175.5	3.0	50.8	Gravel
MW9-17	3/14/2017	Drillwell	33.53	330744.892	5541911.675	-	-	190.9	191.7	0.8	33.5	30.5	157.3	160.4	3.0	50.8	Sand/gravel
MW10-17	3/27/2017	Drillwell	47.87	331208.625	5541441.665	-	-	188.2	189.1	0.8	46.3	43.2	142.0	145.0	3.0	50.8	Sand
RW-98020	5/13/2008	RWD	60.96	330012.000	5541724.000	178.3	179.6	-	-	1.3	61.0	1.8	134.7	176.5	41.8	152.4	Bedrock
BH1-16	1/27/2016	Drillwell	24.08	330846.010	5541551.180	168.41	-	-	-	-	-	-	-	-	-	-	Bedrock
BH2-16	1/28/2016	Drillwell	16.46	330839.010	5541470.180	167.83	-	-	-	-	-	-	-	-	-	-	Bedrock
BH5-15	8/6/2015	Blue Max	24.38	330765.701	5541327.331	ns	-	-	-	-	-	-	-	-	-	-	Sand/gravel
TP1-17	3/23/2017	Upland	4.57	330375.872	5541665.807	-	-	182.14	-	-	-	-	-	-	-	-	Sand with gravel
TP2-17	3/23/2017	Upland	2.44	330340.223	5541649.458	-	-	182.78	-	-	-	-	-	-	-	-	Bedrock
TP3-17	3/23/2017	Upland	5.49	330445.9487	5541608.703	-	-	182.61	-	-	-	-	-	-	-	-	Bedrock
TP4-17	3/23/2017	Upland	4.11	330471.1766	5541750.688	-	-	191.23	-	-	-	-	-	-	-	-	Sand with gravel
TP5-17	3/23/2017	Upland	5.64	330467.1592	5541418.59	-	-	189.44	-	-	-	-	-	-	-	-	Silty Sand
TP6-17	3/24/2017	Upland	5.79	330407.0856	5541753.092	-	-	191.89	-	-	-	-	-	-	-	-	Sand with gravel
TP7-17	3/24/2017	Upland	6.40	330509.0192	5541457.215	-	-	191.82	-	-	-	-	-	-	-	-	Sand with gravel
TP8-17	3/24/2017	Upland	3.35	330492.9906	5541417.832	-	-	192.15	-	-	-	-	-	-	-	-	Bedrock
TP9-17	3/24/2017	Upland	0.61	330535.6659	5541369.794	-	-	191.99	-	-	-	-	-	-	-	-	Bedrock

Notes:
1 - Surveys completed by McElhanney on April 6, 2016 and March 16 and 31, 2017
2 - Survey completed by Upland Excavating Ltd. on January 29th, 2015, March 8, 2016 and April 6th, 2016. Elevations measured with respect to AMSL.
mBGS - metres below ground surface
mAMSL - metres above mean sea level
TOR - top of riser
ns - not surveyed
RWD - Red Williams Well Drilling Ltd.
Upland - Upland Excavating Ltd.
Drillwell - Drillwell Enterprises Ltd.
Blue Max - Blue Max Drilling Inc.

Table 14.2

Hydraulic Monitoring Results
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Monitoring ID	Borehole Depth (m BGS)	2015/2016 Reference Elevation TOR (m AMSL)[2]	2017 Reference Elevation TOR (m AMSL)[1]	Depth to Water (m BTOR)									Water Elevation (m AMSL)								Hydraulic Conductivity (cm/s)	Screened Unit/Aquifer
Date:				**11-Sep-15**	**17-Sep-15**	**5-Oct-15**	**25-Jan-16**	**29-Jan-16**	**15-Feb-16**	**8-Mar-16**	**15-Mar-17**	**6-Apr-17**	**11-Sep-15**	**17-Sep-15**	**5-Oct-15**	**25-Jan-16**	**29-Jan-16**	**15-Feb-16**	**8-Mar-16**	**6-Apr-16**	**15-Mar-17**	**6-Apr-17**		**Primary Constituent**
MW1-14	10.97	172.9	-	5.6	6.3	6.1	6.0	-	-	-	8.1	7.7	167.3	166.6	166.9	166.9	-	-	-	-	164.8	165.2	-	Sand/gravel (S&G Aquifer
MW2-14	21.64	173.8	-	14.5	14.7	15.2	14.7	-	14.6	-	15.9	15.8	159.4	159.1	158.6	159.1	-	159.3	-	-	158.0	158.0	-	Sand/gravel (S&G Aquifer)
MW2A-16	45.42	173.9	173.9	-	-	-	14.5	-	14.5	-	15.9	15.8	-	-	-	159.3	-	159.3	-	-	158.0	158.1	-	Sand (S&G Aquifer)
MW3-14	18.59	168.6	-	12.8	12.7	12.8	11.3	-		-	12.1	12.1	155.8	155.9	155.8	157.2	-	-	-	-	156.5	156.4	-	Sand/gravel (S&G Aquifer)
MW4A-15	21.33	169.3	-	3.9	4.3	4.9	4.0	-	-	-	5.7	3.4	165.4	165.0	164.4	165.3	-	-	-	-	163.6	165.9	2.2×10^{-2}	Bedrock (S&G Aquifer)
MW4B-15	18.28	169.3	-	4.1	4.5	5.1	4.2	-	-	-	5.9	5.7	165.2	164.8	164.1	165.0	-	-	-	-	163.3	163.6	2.0×10^{-2}	Sand (S&G Overburden)
MW5A-15	10.66	191.9	-	9.0	9.0	8.3	7.3	-	-	-	8.1	7.7	182.9	182.9	183.6	184.6	-	-	-	-	183.8	184.2	1.4×10^{-5}	Bedrock Ridge (S&G Aquifer)
MW5B-15	8.22	192.0	-	7.1	7.2	7.0	5.4	-	-	-	7.1	6.1	184.9	184.9	185.0	186.6	-	-	-	-	184.9	185.9	-	Sand/Silt with clay (S&G Aquifer)
MW6-17	11.28	-	185.4	-	-	-	-	-	-	-	-	7.5	-	-	-	-	-	-	-	-	-	177.9	-	Sand (S&G Aquifer)
MW7-17	4.29	-	187.5	-	-	-	-	-	-	-	3.3	2.9	-	-	-	-	-	-	-	-	184.2	184.6	-	Gravel (Shallow Aquifer)
MW8-17	18.80	-	192.5	-	-	-	-	-	-	-	19.7	19.7	-	-	-	-	-	-	-	-	172.8	172.8	-	Gravel (S&G Aquifer)
MW9-17	33.54	-	191.7	-	-	-	-	-	-	-	24.8	24.4	-	-	-	-	-	-	-	-	166.8	167.2	-	Sand/gravel (S&G Aquifer)
MW10-17	46.25	-	189.1	-	-	-	-	-	-	-	-	39.0	-	-	-	-	-	-	-	-	-	150.1	-	Sand (S&G Aquifer)
RW-98020	60.96	196.9	-	-	-	-	-	-	17.1	-	-	-	-	-	-	-	-	179.9	-	-	-	-	-	Bedrock Ridge
McIvor Lake	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	177.5[3]	-	177.9[2]	177.0[2]	177.6[3]	177.6[3]	-	-
SW15-02 Rico Lake	-	180.33*		-	-	-	-	0.88	-	0.91	0.06	0.09	-	-	-	-	181.2	-	181.2[2]	180.8[2]	180.4	180.4	-	-

Notes:
1 - Surveys completed by McElhanney on April 6, 2016 and March 16 and 31, 2017
2 - Survey completed by Upland Excavating Ltd. on January 29th, 2015, March 8, 2016 and April 6th, 2016. Elevations measured with respect to AMSL.
3 - Based on BC Hydro record of water elevations at Ladore Dam recorded every three hours. (https://www.bchydro.com/energy-in-bc/our_system/transmission_reservoir_data/previous_reservoir_elevations/vancouver_island/ladore_ldr.html)

* Surface water gauge reference elevation refers to the bottom of the gauge. (0 m on gauge = 180.33 m amsl)
m BGS - metres below ground surface
m AMSL - metres above mean sea level (WGS1984)
TOR - top of riser
S&G - Sand and gravel

Drawings

UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

NORTHWIN LANDFILL
2021 DESIGN, OPERATIONS AND CLOSURE PLAN
JUNE 2021



LOCATION MAP

DRAWING LIST

DWG. No.	DRAWING TITLE
G-01	COVER
C-01	EXISTING CONDITIONS
C-02	SITE OPERATIONS
C-03	BASE GRADES AND LEAK DETECTION SYSTEM
C-04	LEACHATE COLLECTION SYSTEM
C-05	LEACHATE COLLECTION SYSTEM - TOP OF DRAINAGE LAYER
C-06	FINAL GRADES (TOP OF FINAL COVER)
C-07	CROSS-SECTIONS - A-A', B-B' AND C-C'
C-08	FILL PLAN - STAGE 1 EAST
C-09	FILL PLAN - STAGE 1 WEST & STAGE 2A
C-10	FILL PLAN - STAGE 2B & STAGE 2C
C-11	FILL PLAN - STAGE 3A & STAGE 3B
C-12	FILL PLAN - STAGE 3C
C-13	DETAILS - LINER DETAILS
C-14	DETAILS - LEACHATE COLLECTION SUMP
C-15	DETAILS - LEACHATE LEAK DETECTION SUMP
C-16	DETAILS - LEACHATE COLLECTION SYSTEM
C-17	DETAILS - PERIMETER TIE-IN DETAILS I
C-18	DETAILS - PERIMETER TIE-IN DETAILS II
C-19	DETAILS - LEACHATE MANAGEMENT

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Project
2021 DESIGN, OPERATIONS, AND CLOSURE PLAN

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020

Drawn T.WAGSTAFF | Designer R. HASIOR
Drafting Check | Design Check
Project Manager D. LIDDY | Date Jun 10, 2016
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Original Size ANSI D | Bar is 20mm on original size drawing 0 20mm

Project No. 88877-11

Title
COVER

Sheet No.
G-01

Sheet 1 of 20



LEGEND

- 165 — EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOUR
- PROPERTY LINE
- EXISTING LAKE SHORELINE
- EXISTING FENCELINE
- EXISTING ACCESS ROADWAY
- MW3-14 EXISTING MONITORING WELLS

SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY McELHANNEY ASSOCIATES LAND SURVEYING LTD. ,MARCH 2020 AND SEPTEMBER 2020.

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Drafting Check		Design Check	
Project Manager	D. LIDDY	Date	July 2, 2021
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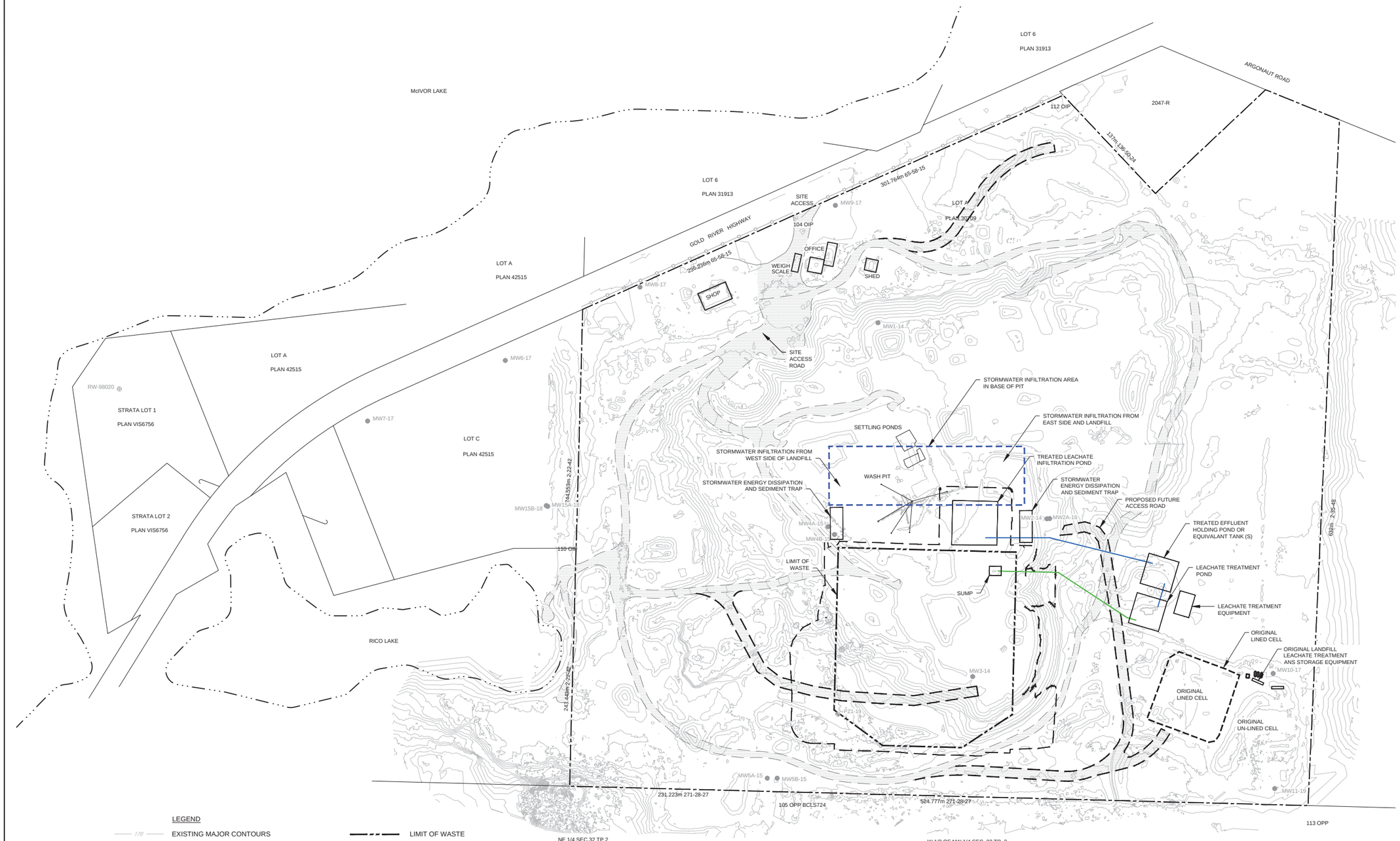
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Title
EXISTING CONDITIONS

Sheet No.
C-01

Sheet 2 of 20

Plot Date: 2 July 2021 - 9:25 AM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(014)\88877-11(014)CI\88877-11(014)CI-WA001.dwg



LEGEND

- EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOUR
- PROPERTY LINE
- EXISTING LAKE SHORELINE
- EXISTING ACCESS ROADWAY
- PROPOSED FUTURE ACCESS ROADWAY
- LIMIT OF WASTE
- LIMIT OF EXCAVATION
- LEACHATE CONVEYANCE PIPE
- TREATED EFFLUENT CONVEYANCE PIPE
- EXISTING FENCELINE
- MW3-14 EXISTING MONITORING WELL
- PZ1-19 EXISTING PIEZOMETER

SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY McELHANNEY ASSOCIATES LAND SURVEYING LTD. ,MARCH 2020 AND SEPTEMBER 2020.

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Project
2021 DESIGN, OPERATIONS AND CLOSURE PLAN

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020

Drawn	T. WAGSTAFF	Designer	R. HASIOR
Drafting Check		Design Check	
Project Manager	D. LIDDY	Date	July 2, 2021
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Project No. 88877-11

Title
SITE OPERATIONS

Sheet No.
C-02

Sheet 3 of 20

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LEGEND
- EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS
- MAJOR CONTOURS (2 m) BASE OF EXCAVATION (TOP OF SUBGRADE)
- MINOR CONTOUR (1 m) BASE OF EXCAVATION (TOP OF SUBGRADE)
- LIMIT OF WASTE
- PERIMETER BERM
- PROPERTY LINE
- ANCHOR TRENCH
- EXISTING ACCESS ROADWAY
- PROPOSED FUTURE ACCESS ROADWAY

TREATED LEACHATE INFILTRATION POND

LEAK DETECTION SYSTEM CLEAN-OUT AND PUMP STATION (17 C-16, 9 C-13)

LEACHATE DETECTION SUMP (13 C-15, 16 C-16)

19 C-17 PERIMETER TIE-IN - NORTH SIDE (TYPICAL)

24 C-19 LEAK DETECTION MONITORING PORT (TYP.)

21 C-18 PERIMETER TIE-IN - WEST SIDE (TYPICAL)

182.4 m

LIMIT OF WASTE

10 m

10.6 m

2:1

2.75%

2.0%

201.2 m

26 C-19 TREATED EFFLUENT HOLDING POND LINER SYSTEM

23 C-19 LEACHATE TREATMENT POND LINER SYSTEM

EFFLUENT HOLDING POND OR EQUIVALENT SIZED TANK(S)

LEACHATE TREATMENT POND

LEACHATE TREATMENT EQUIPMENT

30 m

2 C-13 BASE LINER SYSTEM

24 C-19 LYSIMETER (TYPICAL)

4 C-13 LINER SYSTEM (TOE OF SLOPE)

24 C-19 LEAK DETECTION MONITORING PORT (TYP.)

21 C-18 PERIMETER TIE-IN - EAST SIDE (TYPICAL)

8 C-13 ANCHOR TRENCH

3 m

7 C-13 ANCHOR TRENCH

20 C-17 PERIMETER TIE-IN - SOUTH SIDE (TYPICAL)

A C-07 A' C-07 B C-07 B' C-07 C C-07 C' C-07

0 6 12 18m

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Client
UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.

Project
2021 DESIGN, OPERATIONS AND CLOSURE PLAN

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020

Drawn T.WAGSTAFF	Designer R. HASIOR
Drafting Check	Design Check
Project Manager D. LIDDY	Date July 5, 2021
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Project No. 88877-11

Title
BASE GRADES AND LEAK DETECTION SYSTEM

Sheet No.
C-03

Sheet 4 of 20

Plot Date: 5 July 2021 - 5:09 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(014)\88877-11(014)CI\88877-11(014)CI-WA003.dwg

SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY McELHANNEY ASSOCIATES LAND SURVEYING LTD. , MARCH 2020 AND SEPTEMBER 2020

LEGEND
- EXISTING MAJOR CONTOURS
- EXISTING MINOR CONTOURS
- MAJOR CONTOURS (2 m) TOP OF LINER SYSTEM
- MINOR CONTOUR (1 m) TO OF LINER SYSTEM
- LIMIT OF WASTE
- PERIMETER BERM
- PROPERTY LINE
- ANCHOR TRENCH
- EXISTING ACCESS ROADWAY
- PROPOSED FUTURE ACCESS ROADWAY

TREATED LEACHATE INFILTRATION POND
182.4 m
LIMIT OF WASTE
10 m
10.6 m
201.2 m
15 m TYPICAL
3 m
2.75%
2.75%
2.75%
2.75%
2.75%
19 C-17 PERIMETER TIE-IN NORTH SIDE (TYPICAL)
9 C-13 LEACHATE COLLECTION SYSTEM CLEANOUT RISER PIPE (TYPICAL)
21 C-18 PERIMETER TIE-IN - WEST SIDE (TYPICAL)
17 C-16 LEACHATE COLLECTION SYSTEM PIPE (TYPICAL)
2 C-13 BASE LINER SYSTEM
20 C-17 PERIMETER TIE-IN - SOUTH SIDE (TYPICAL)
LEACHATE COLLECTION SYSTEM HEADER
3 C-12
LINER SYSTEM (TOE OF SLOPE)
5 C-13
LEACHATE LEAK DETECTION SUMP RISER PIPE
14 C-15
LEACHATE COLLECTION SYSTEM SUMP RISER PIPE
12 C-14
LEACHATE COLLECTION SYSTEM SUMP (TYPICAL)
12 C-14 11 C-14 16 C-16
LEACHATE COLLECTION SYSTEM CLEANOUT RISER PIPE (TYPICAL)
9 C-13
PERIMETER TIE-IN - EAST SIDE (TYPICAL)
21 C-18
ANCHOR TRENCH
8 C-13
LEACHATE COLLECTION SYSTEM CLEAN-OUT RISER PIPE
23 C-19 TREATED EFFLUENT HOLDING POND LINER SYSTEM
23 C-19 LEACHATE TREATMENT POND LINER SYSTEM
TREATED EFFLUENT HOLDING POND OR EQUIVALANT SIZED TANK(S)
37.5 m
40 m
LEACHATE TREATMENT POND
LEACHATE TREATMENT EQUIPMENT
36 m
35 m
A C-07 A' C-07 B C-07 B' C-07 C C-07 C' C-07

0 6 12 18m

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Project Manager D. LIDDY	Date July 5, 2021
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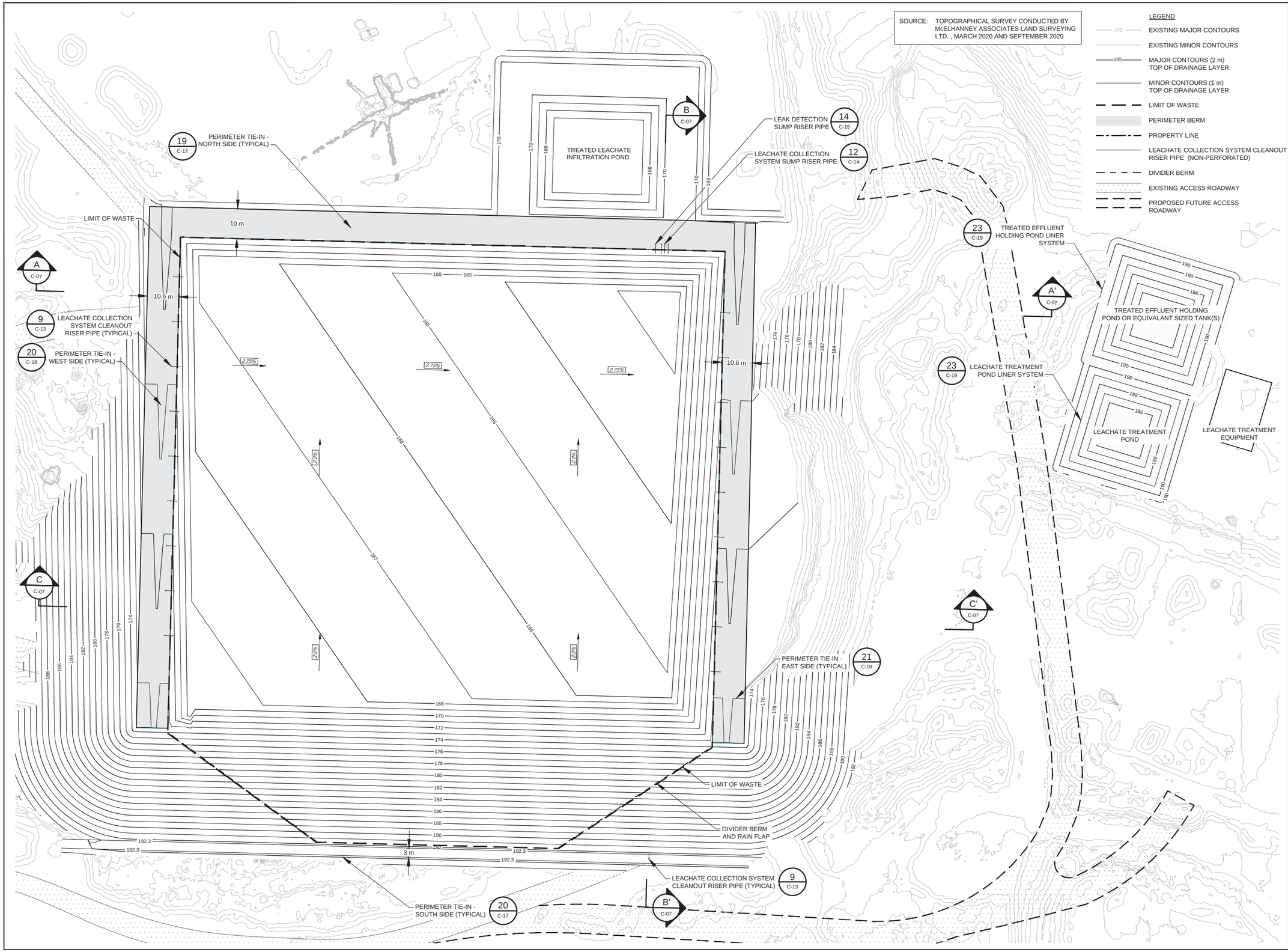
Project No. 88877-11

Title
LEACHATE COLLECTION SYSTEM

Sheet No.
C-04

Sheet 5 of 20

Plot Date: 5 July 2021 - 5:12 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(014)\88877-11(014)CI\88877-11(014)CI-WA004.dwg



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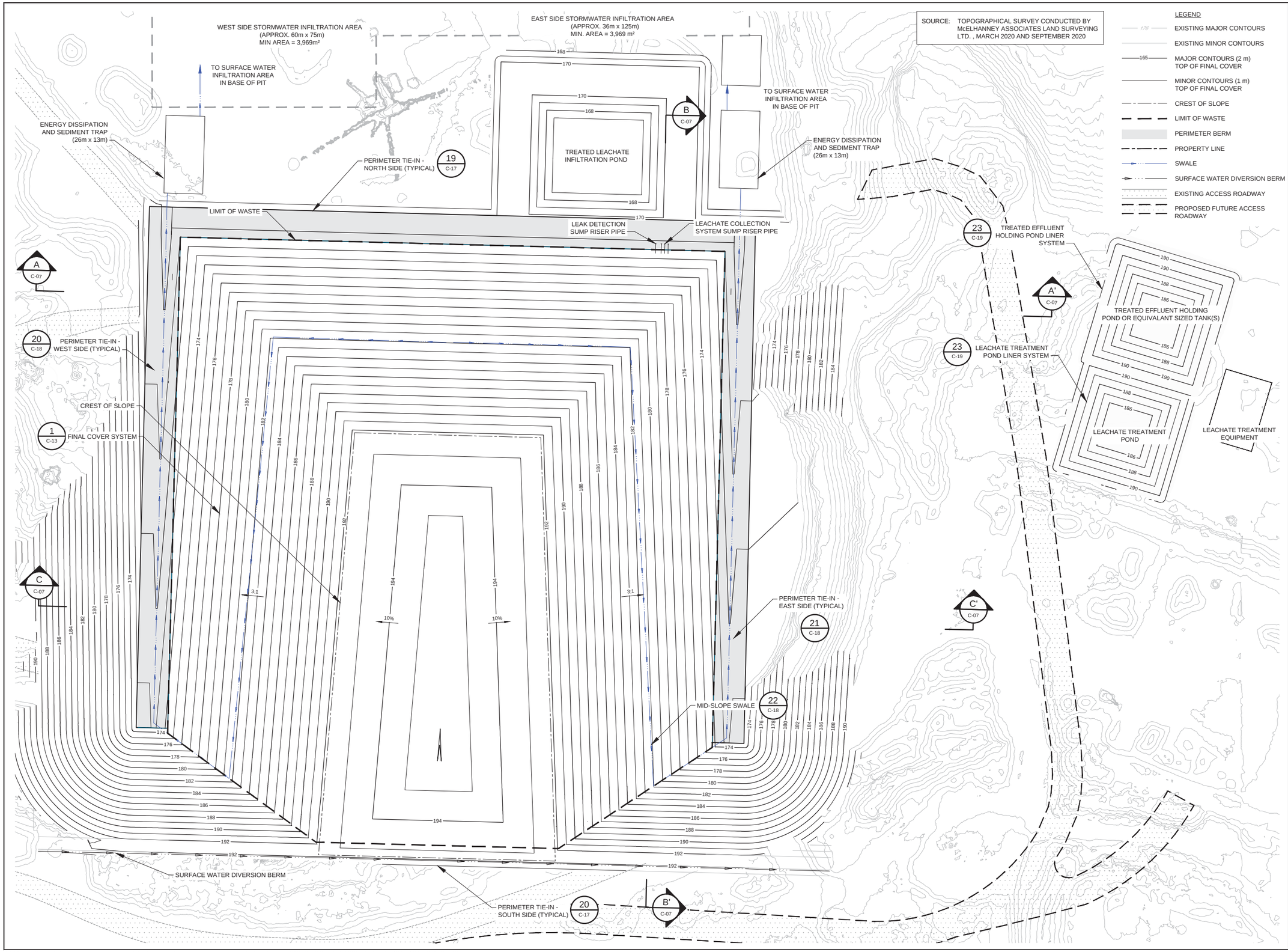
Project No. 88877-11

Title
LEACHATE COLLECTION SYSTEM TOP OF DRAINAGE LAYER

Sheet No.
C-05

Sheet 6 of 20

Plot Date: 5 July 2021 - 5:16 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(014)\88877-11(014)CI\88877-11(014)CI-WA005.dwg



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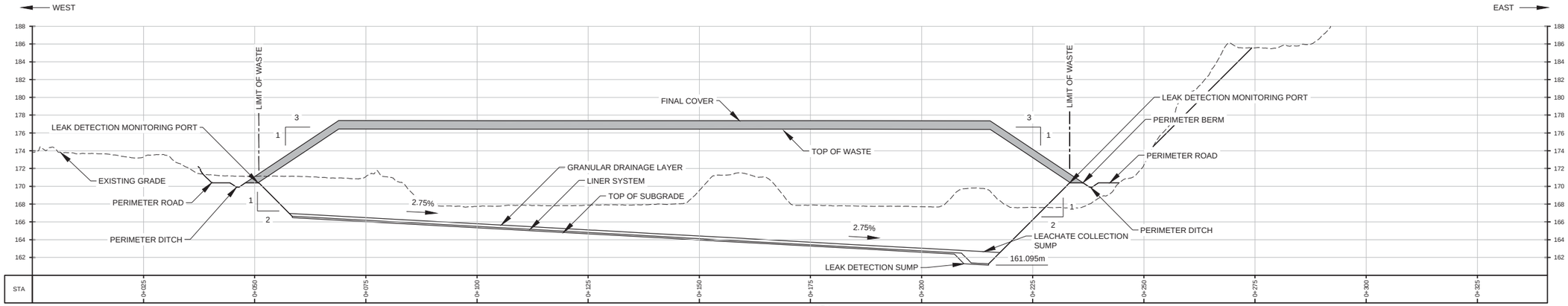
Drawn T.WAGSTAFF
Designer R. HASIOR
Drafting Check
Design Check
Project Manager D. LIDDY
Date July 5, 2021
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Scale 1:600
Original Size ANSI D
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0 20mm

Project No. 88877-11

Title
FINAL GRADES
(TOP OF FINAL COVER)

Sheet No.
C-06

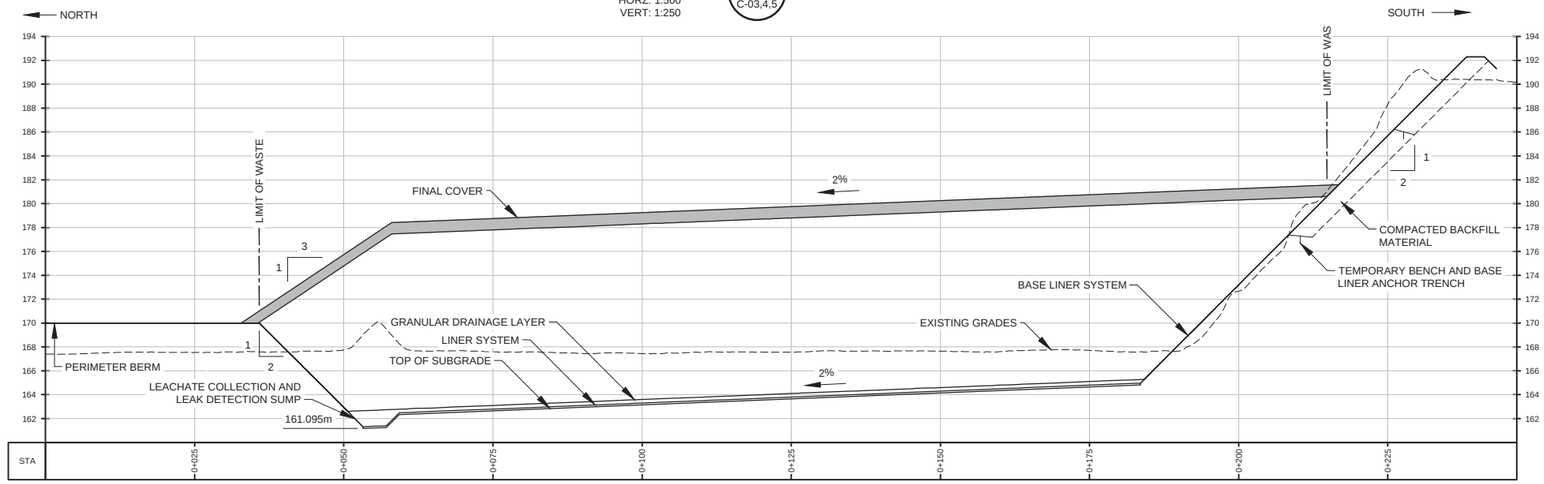
Sheet 7 of 20



SECTION A-A'

HORZ: 1:500
VERT: 1:250

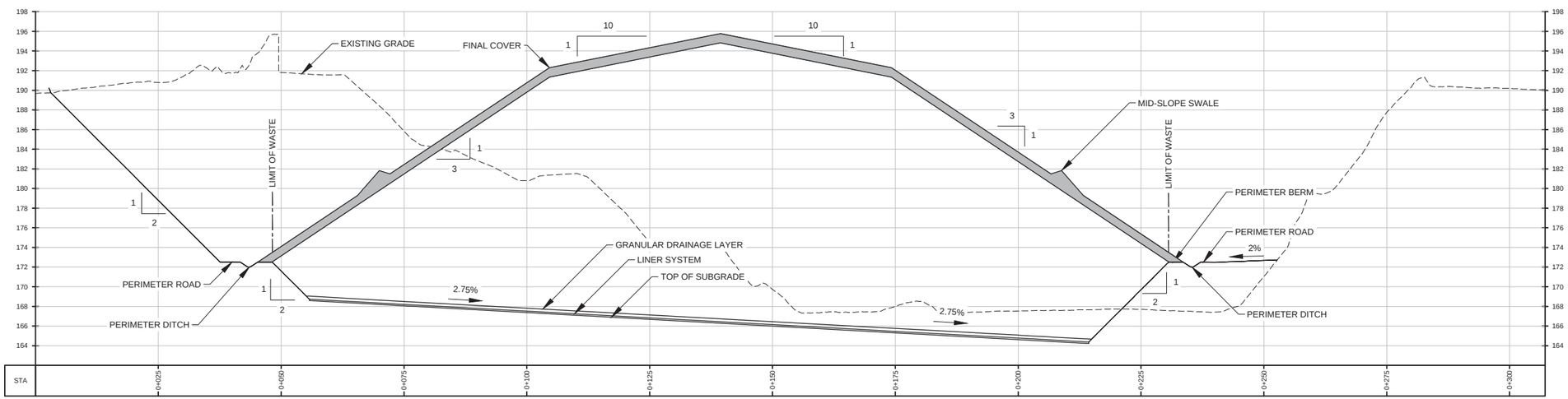
C-03,4,5



SECTION B-B'

HORZ: 1:500
VERT: 1:250

C-03,4,5



SECTION C-C'

HORZ: 1:500
VERT: 1:250

C-03,4,5

SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY McELHANNEY ASSOCIATES LAND SURVEYING LTD. , DECEMBER 18, 2018.

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Project Manager D. LIDDY	Date July 5, 2021
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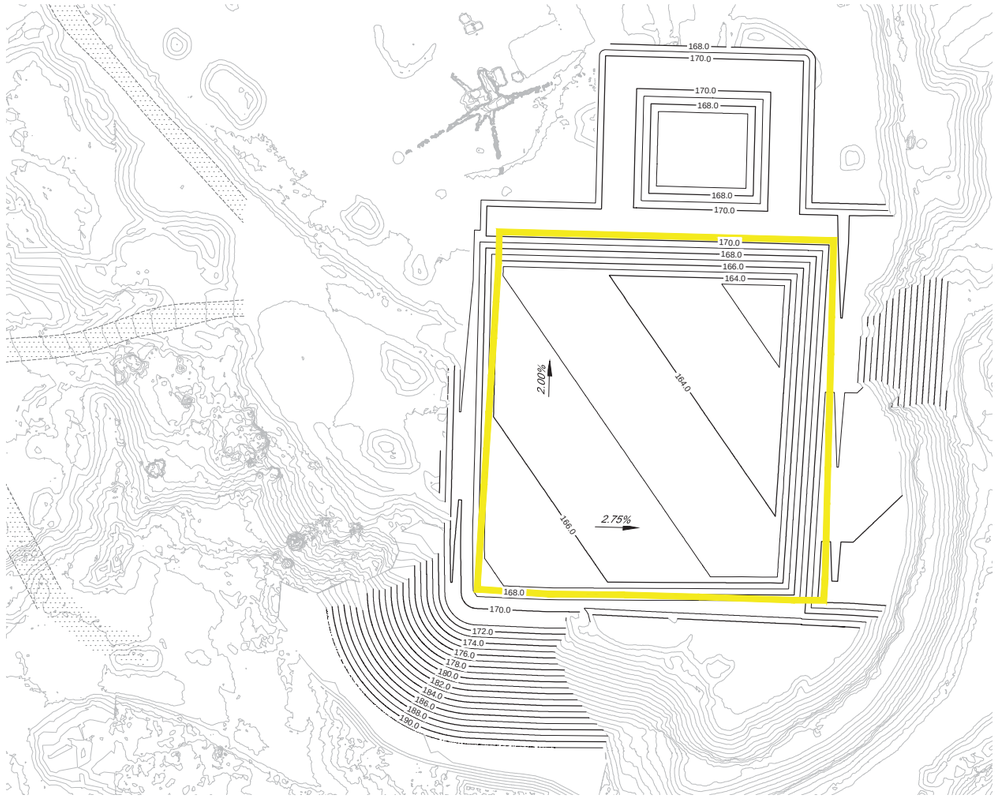
Project No. 88877-11

Title
CROSS-SECTIONS A-A', B-B' AND C-C'

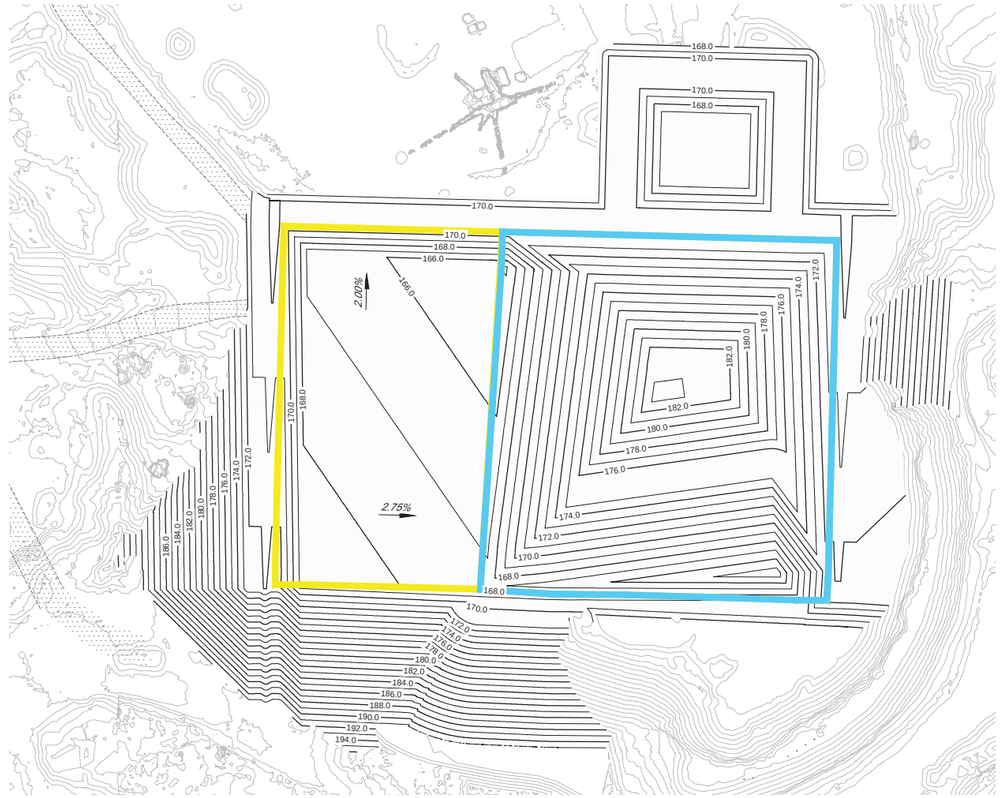
Sheet No.
C-07

Sheet 8 of 20

Plot Date: 5 July 2021 - 5:38 PM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(014)\88877-11(014)CI\88877-11(014)CI-WA007.dwg



STAGE 1 EAST BASE LINER INSTALLATION



PHASE I: STAGE 1 EAST
(INCLUDING RELOCATION OF WASTE FROM ORIGINAL LANDFILL)
FILL VOLUME = 106,337 m³

LEGEND

- BASE LINER PREPARATION / CONSTRUCTION FOR NEXT STAGE
- DAILY COVER AREA
- INTERMEDIATE COVER AREA

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N
0 10 20 30m

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Project Manager D. LIDDY	Date June 29, 2021
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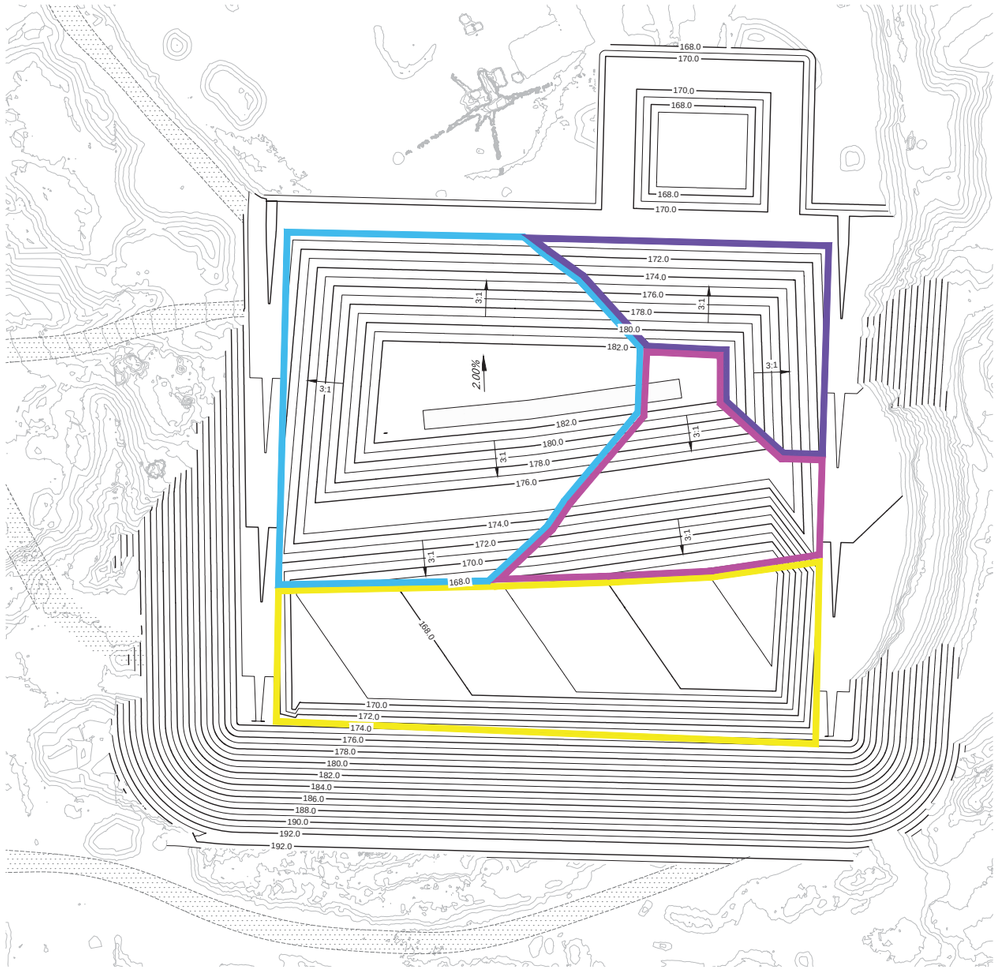
Project No. 88877-11

Title
FILL PLAN
STAGE 1 EAST

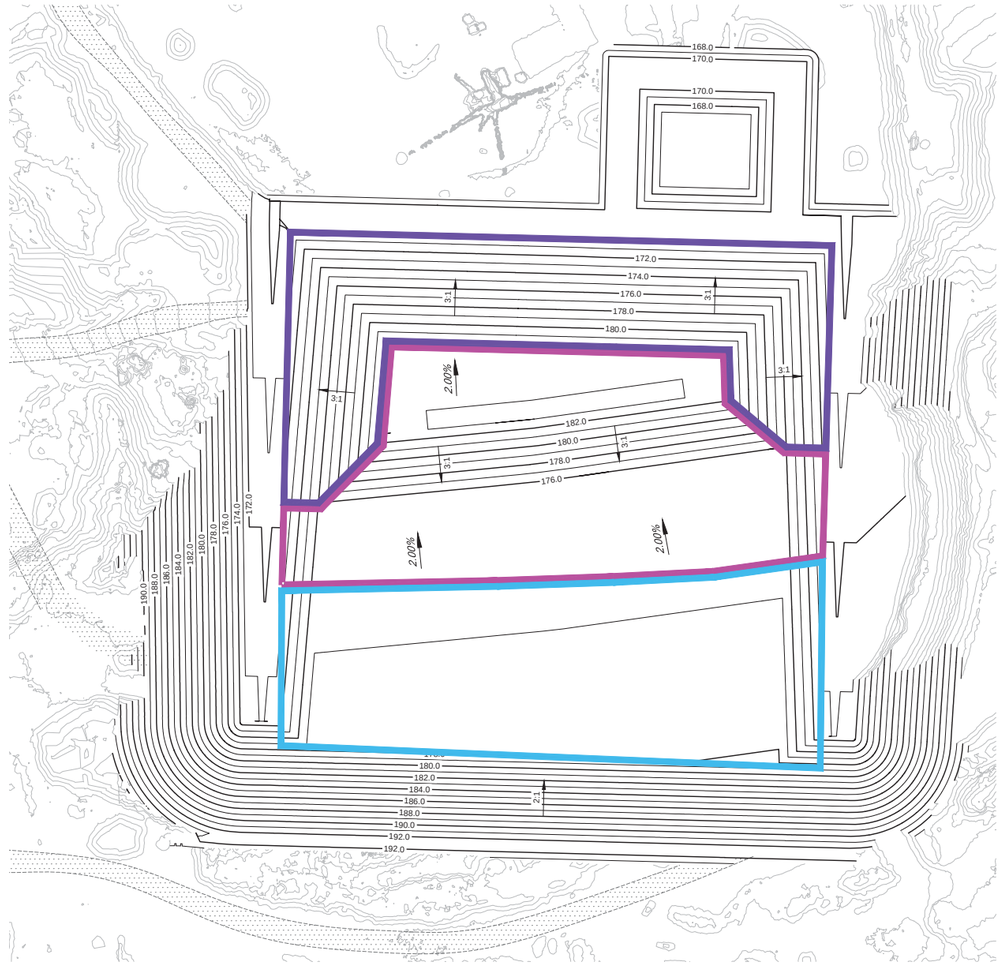
Sheet No.
C-08

Sheet 9 of 20

Plot Date: 2 July 2021 - 10:09 AM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(014)\88877-11(014)CI\88877-11(014)CI-WA008.dwg



PHASE I: STAGE 1 WEST
FILL VOLUME = 101,447 m³



PHASE II: STAGE 2A
FILL VOLUME = 106,823 m³

LEGEND

- BASE LINER PREPARATION / CONSTRUCTION FOR NEXT STAGE
- DAILY COVER AREA
- INTERMEDIATE COVER AREA
- FINAL COVER AREA

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Project Manager D. LIDDY	Date July 5, 2021
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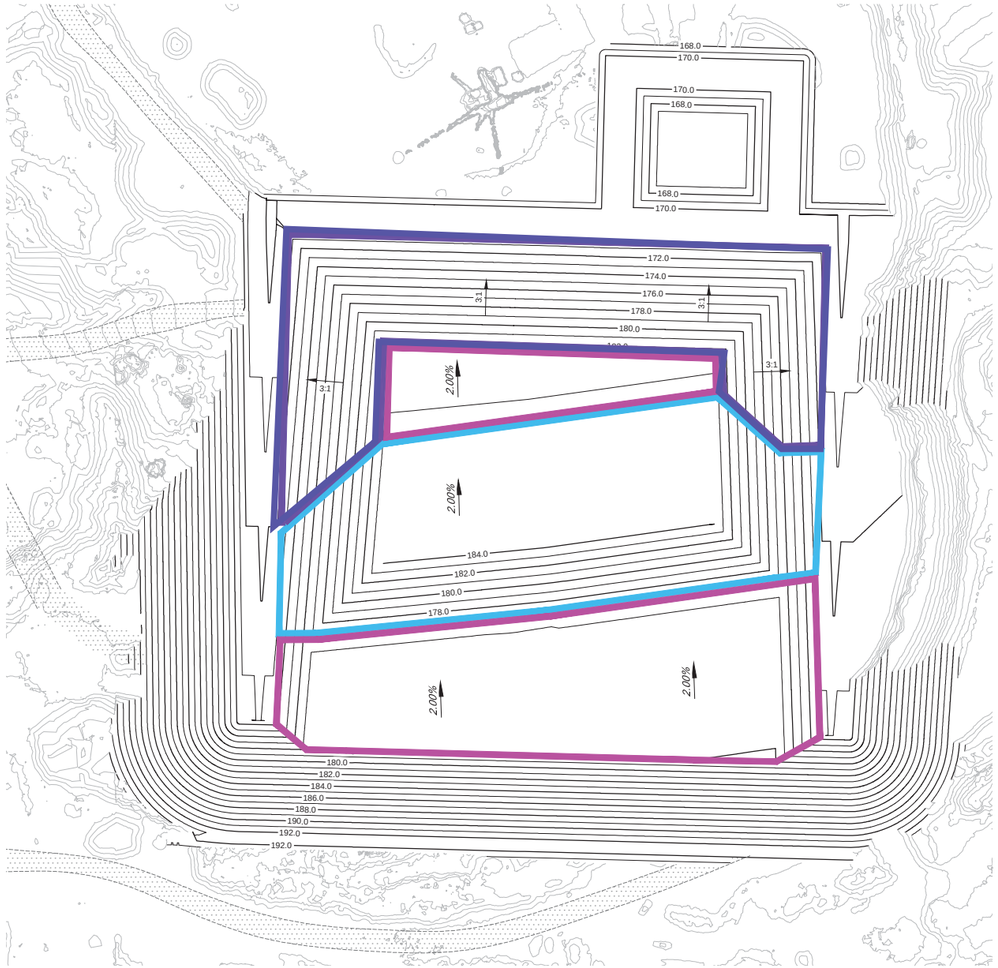
Project No. 88877-11

Title
FILL PLAN
STAGE 1 WEST & STAGE 2A

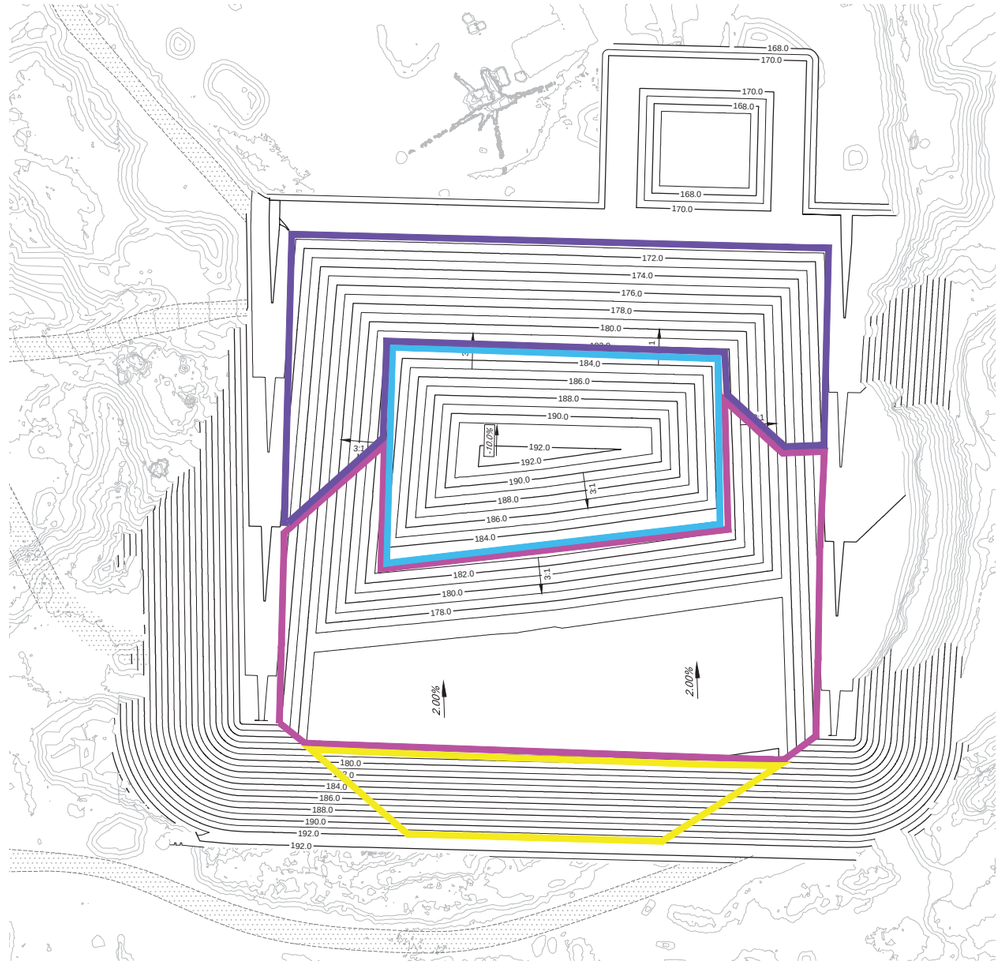
Sheet No.
C-09

Sheet 10 of 20

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PHASE II: STAGE 2B
FILL VOLUME = 44,912 m³



PHASE II: STAGE 2C
FILL VOLUME = 27,085 m³

LEGEND

- BASE LINER PREPARATION / CONSTRUCTION FOR NEXT STAGE
- DAILY COVER AREA
- INTERMEDIATE COVER AREA
- FINAL COVER AREA

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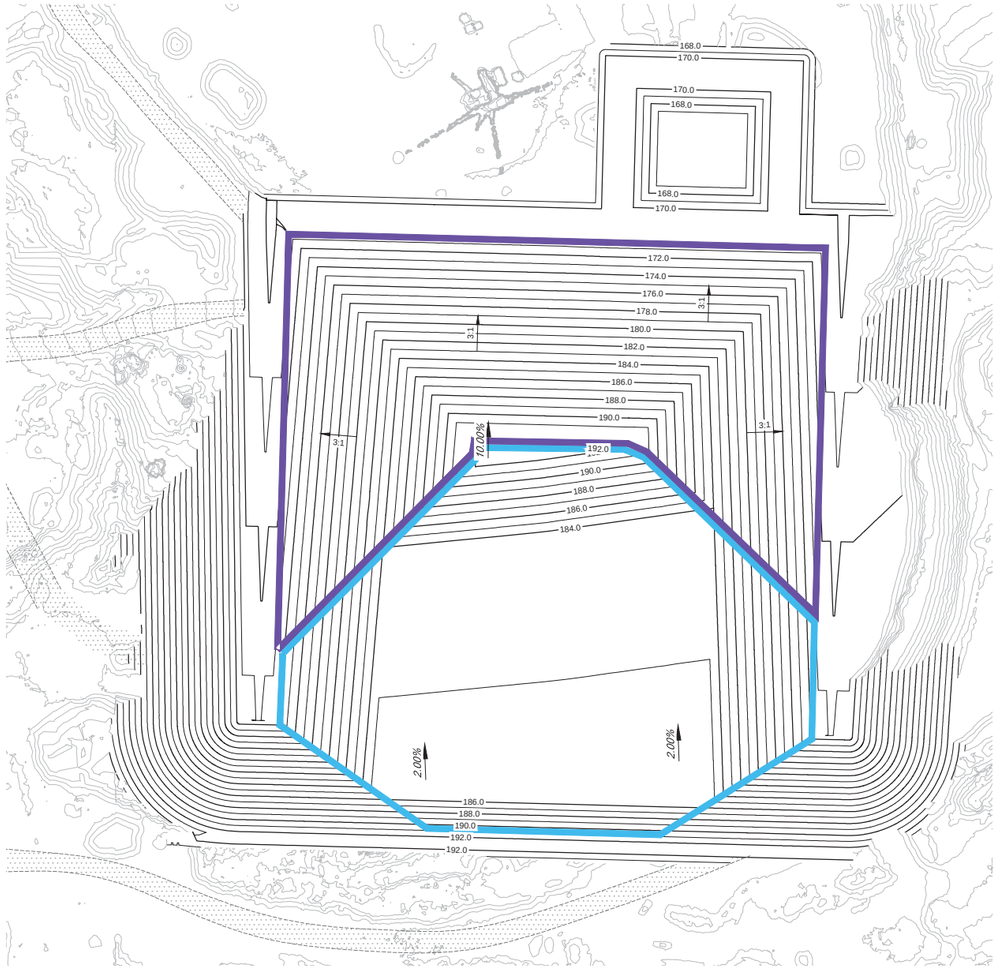
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Project Manager D. LIDDY | Date July 2, 2021
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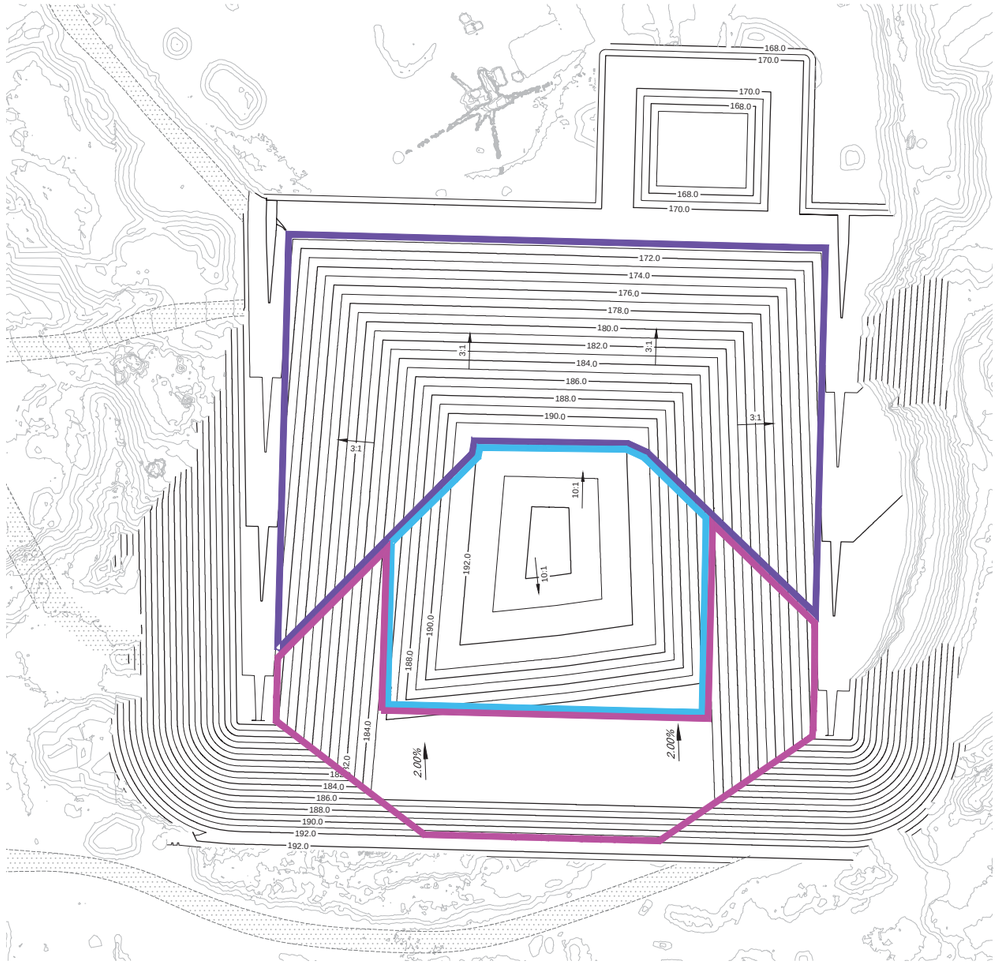
Title
FILL PLAN
STAGE 2B & STAGE 2C

Sheet No.
C-10

Plot Date: 2 July 2021 - 10:13 AM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(014)\88877-11(014)CI\88877-11(014)CI-WA010.dwg



PHASE III: STAGE 3A
FILL VOLUME = 67,949 m³



PHASE III: STAGE 3B
FILL VOLUME = 44,266 m³

LEGEND

- DAILY COVER AREA
- INTERMEDIATE COVER AREA
- FINAL COVER AREA

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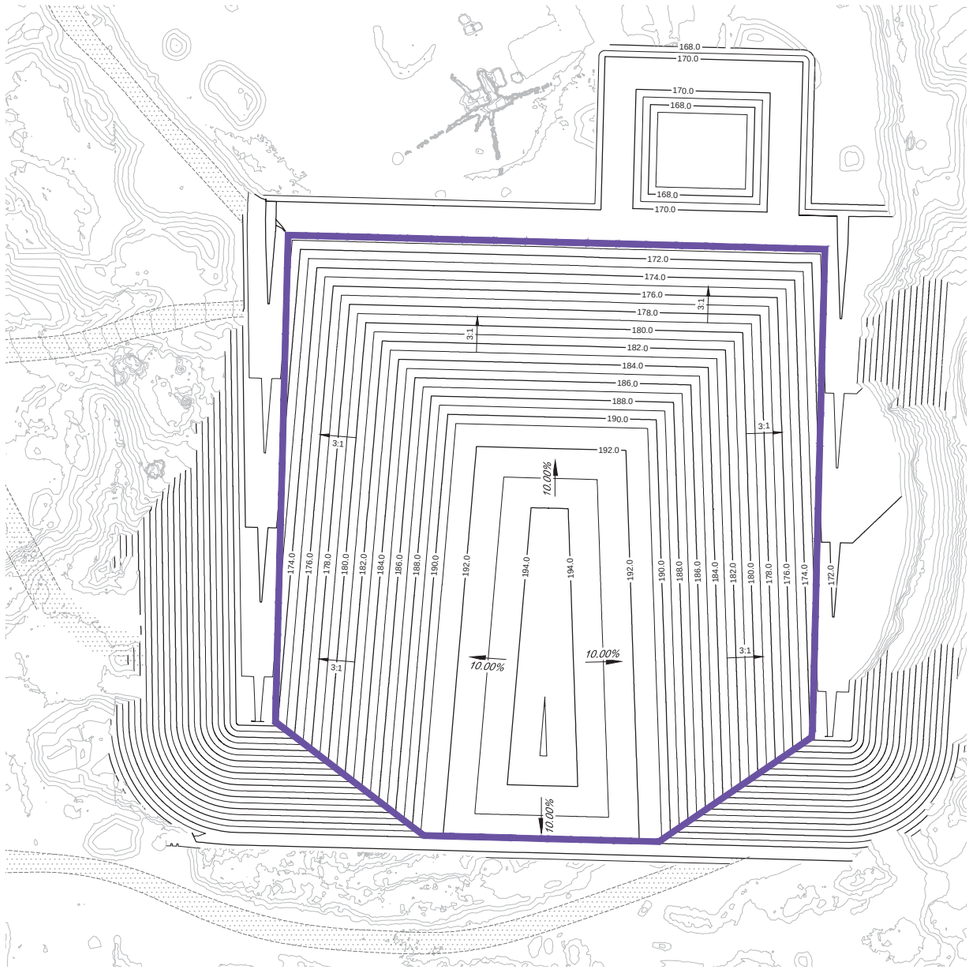
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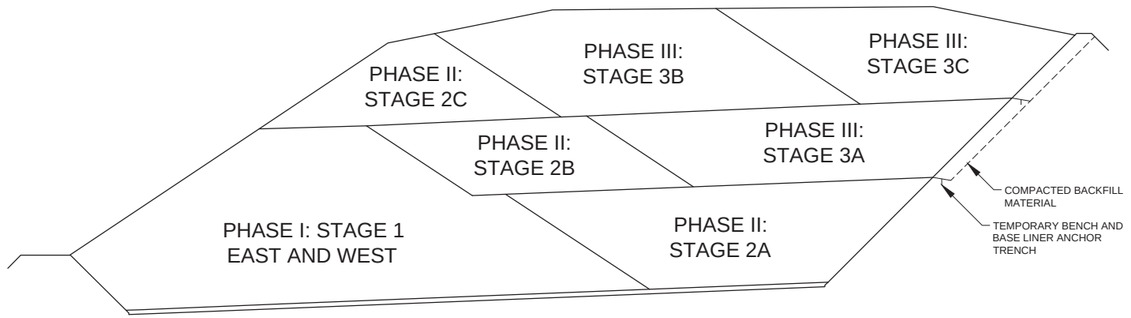
Title
FILL PLAN
STAGE 3A & STAGE 3B

Sheet No.
C-11

Sheet 12 of 20



PHASE III: STAGE 3C
FILL VOLUME = 33,546 m³



FILL SEQUENCE
HOR. SCALE 1:600
VERT. SCALE 1:300

LEGEND

- DAILY COVER AREA
- INTERMEDIATE COVER AREA
- FINAL COVER AREA

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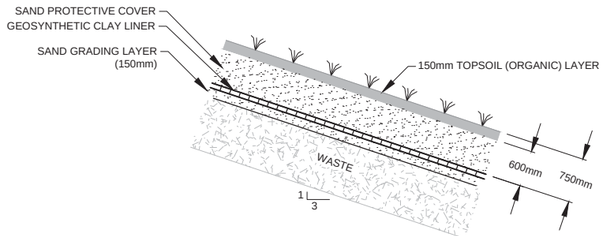
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Drafting Check		Design Check	
Project Manager	D. LIDDY	Date	July 2, 2021
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Project No. 88877-11

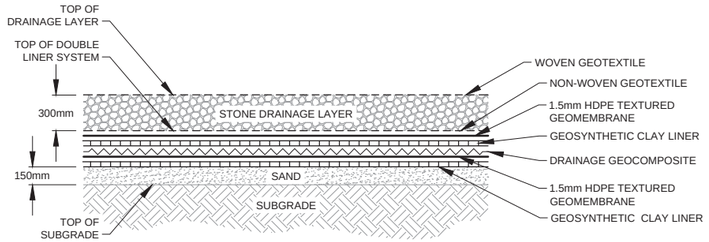
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FILL PLAN
STAGE 3C

Sheet No.
C-12

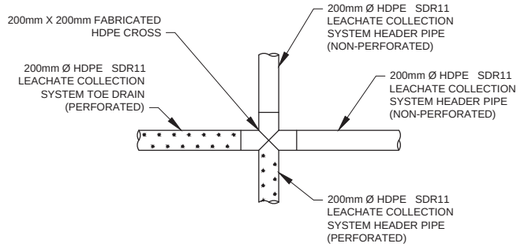
Sheet 13 of 20



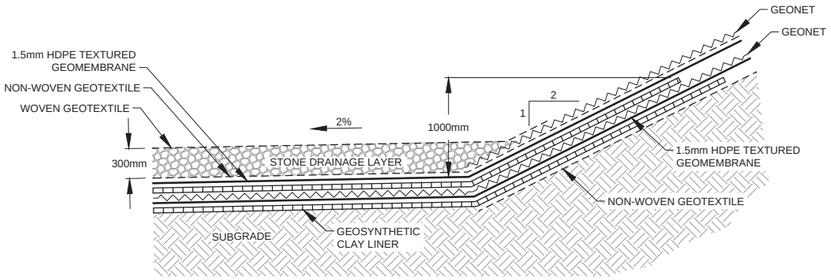
DETAIL 1 (C-06,17) 1:50 — FINAL COVER SYSTEM



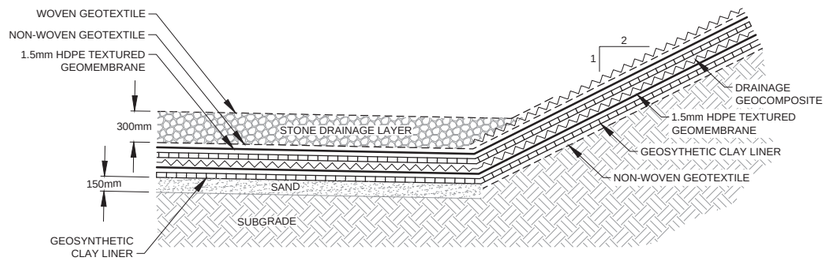
DETAIL 2 (C-03,04,13) 1:25 — BASE LINER AND LEAK DETECTION SYSTEM



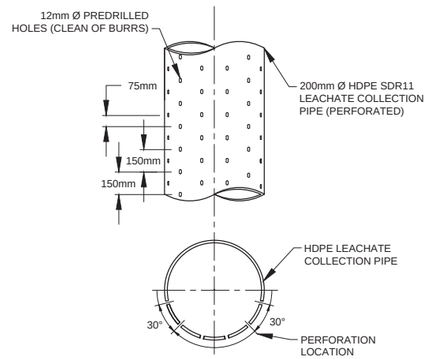
DETAIL 3 (C-04) 1:30 — LEACHATE COLLECTION SYSTEM TOE DRAIN / LEACHATE COLLECTION SYSTEM PIPE CONNECTION



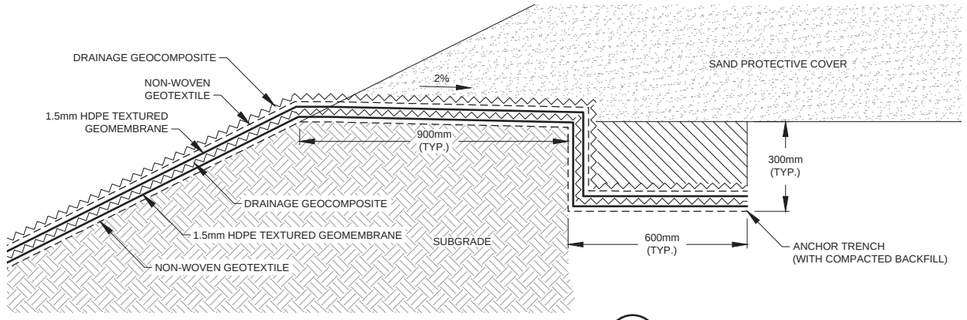
DETAIL 4 (C-03) 1:30 — LINER SYSTEM (TOE OF SLOPE) SOUTH (TYP.)



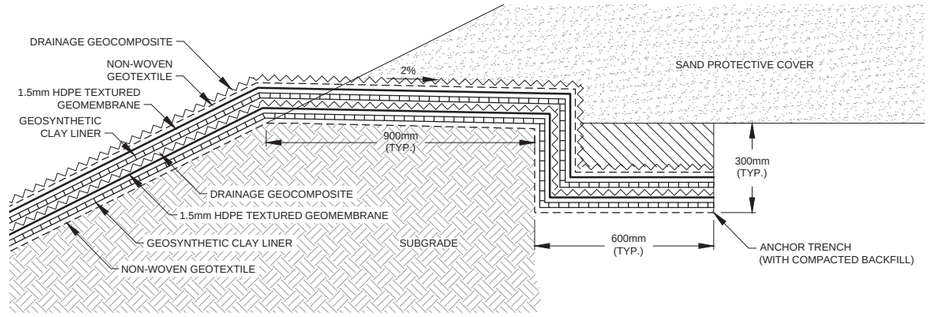
DETAIL 5 (C-04) 1:30 — LINER SYSTEM (TOE OF SLOPE) NORTH, WEST AND EAST (TYP.)



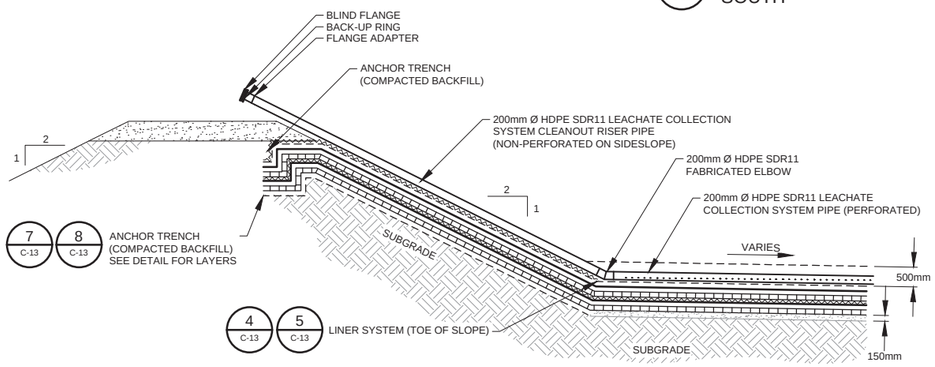
DETAIL 6 (C-04) N.T.S. — LEACHATE COLLECTION SYSTEM TOE DRAIN / LEACHATE COLLECTION SYSTEM PIPE PERFORATIONS



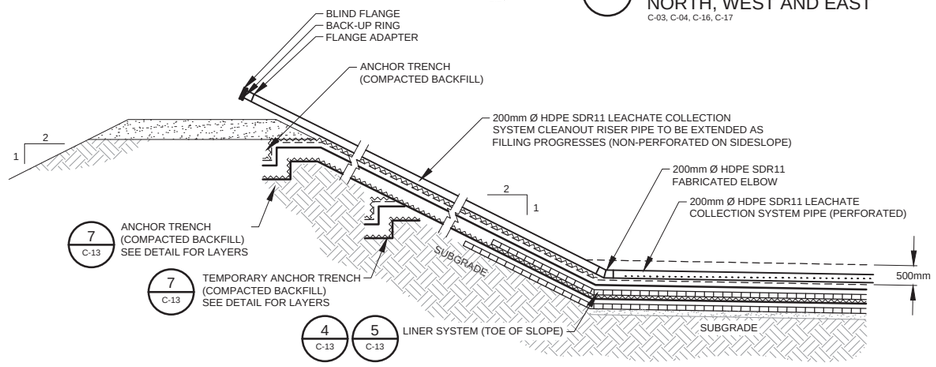
DETAIL 7 (C-03) 1:10 — ANCHOR TRENCH (TYPICAL) SOUTH



DETAIL 8 (C-03, C-04, C-16, C-17) 1:10 — ANCHOR TRENCH (TYPICAL) NORTH, WEST AND EAST



DETAIL 9 (C-04,05) 1:75 — LEACHATE COLLECTION SYSTEM CLEANOUT RISER PIPE (TYPICAL) NORTH



DETAIL 10 (C-04.05) 1:75 — LEACHATE COLLECTION SYSTEM CLEANOUT RISER PIPE (TYPICAL) SOUTH

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Project: 2021 DESIGN, OPERATIONS, AND CLOSURE PLAN

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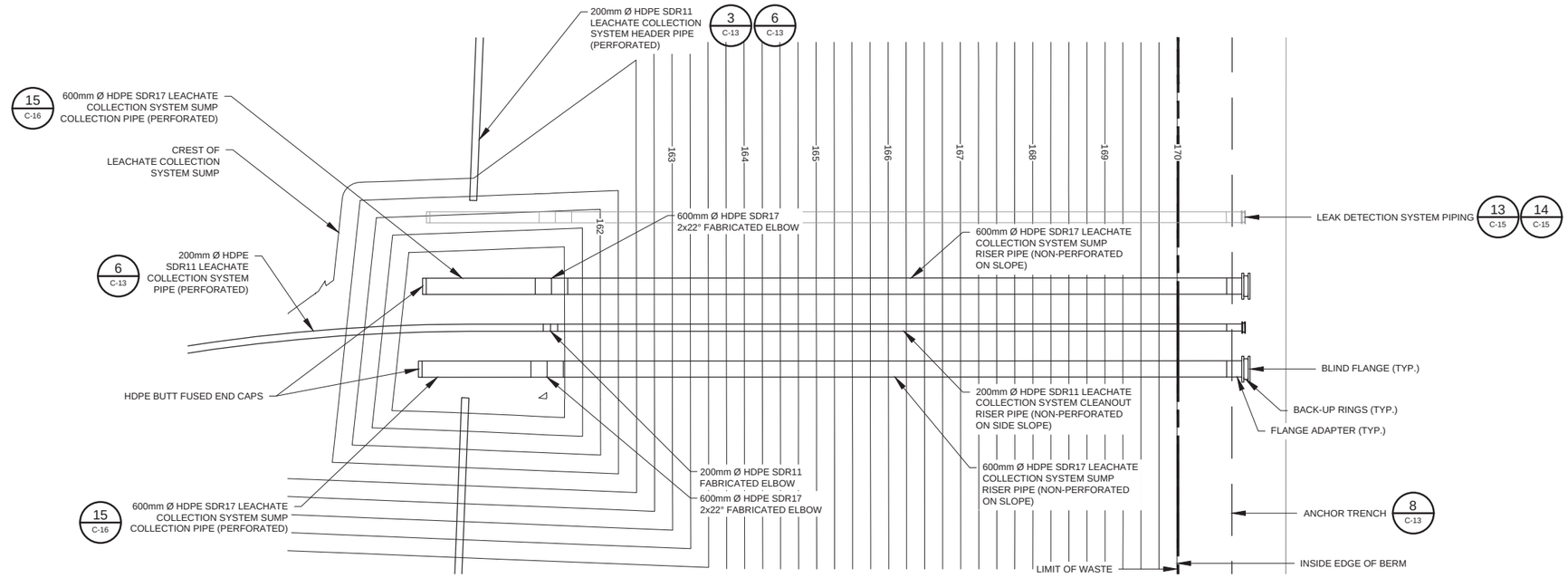
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Project Manager	D. LIDDY	Date	July 5, 2021
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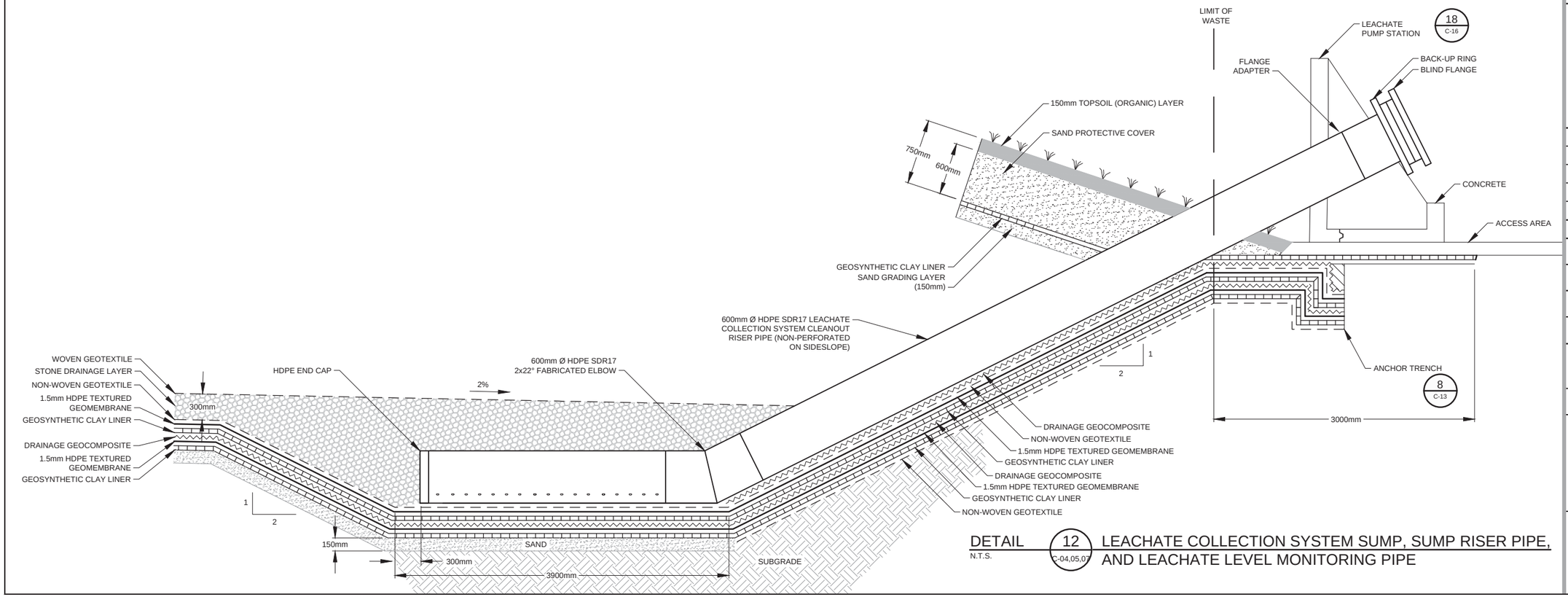
Title: DETAILS LINER DETAILS

Sheet No. C-13

Sheet 14 of 20



DETAIL 11 (C-04) LEACHATE COLLECTION SYSTEM SUMP (TOP OF LINER)
1:75



DETAIL 12 (C-04,05,07) LEACHATE COLLECTION SYSTEM SUMP, SUMP RISER PIPE, AND LEACHATE LEVEL MONITORING PIPE
N.T.S.

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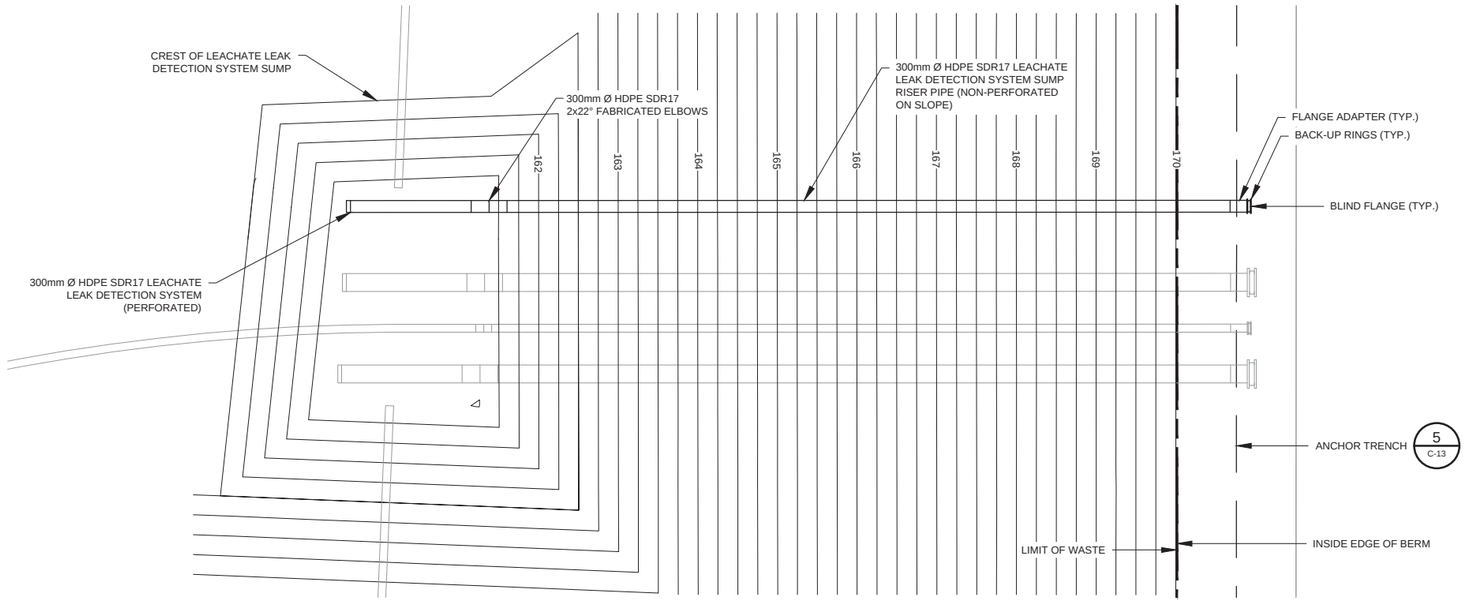
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Title
DETAILS
LEACHATE
COLLECTION SUMP

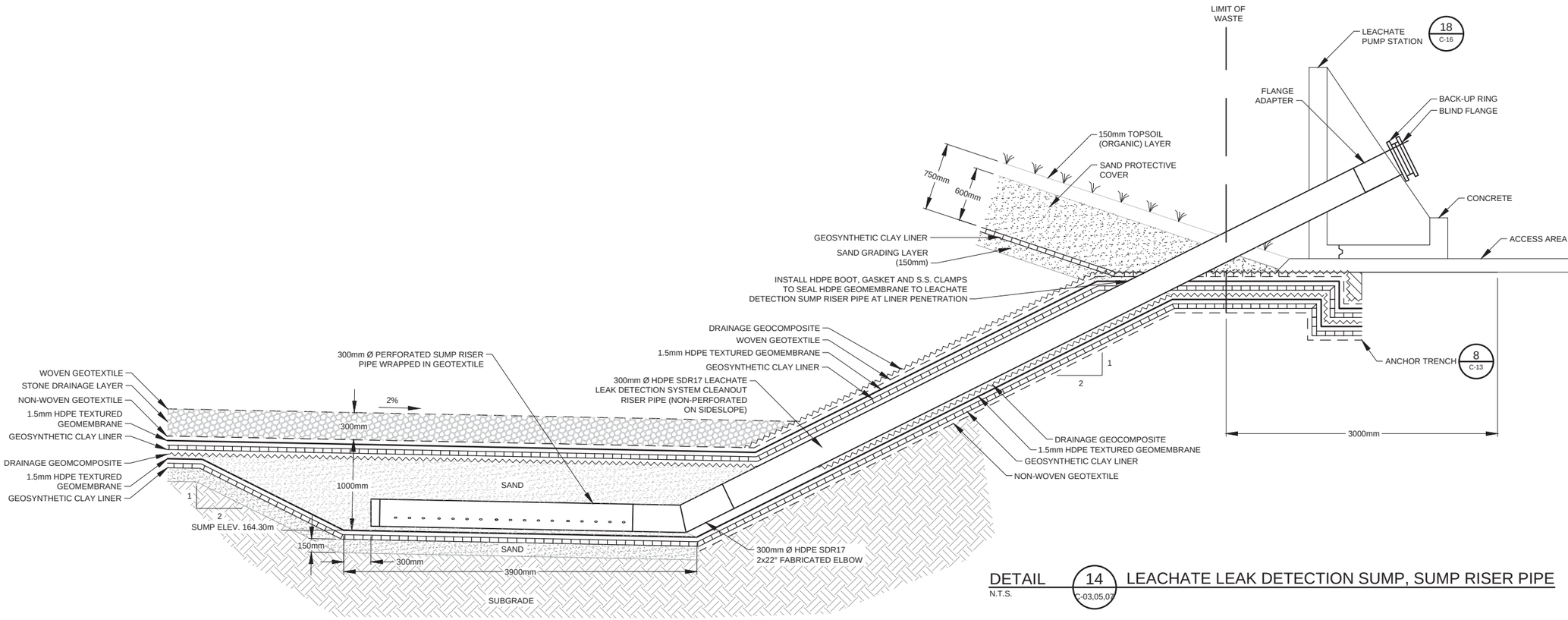
Sheet No.
C-14

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Plot Date: 2 July 2021 - 11:03 AM Plotted By: Tyler Wagstaff CAD File: P:\drawings\88000s\88877\88877 - REPORTS\88877-11(014)\88877-11(014)CI\88877-11(014)CI-WA014.dwg



DETAIL 13 C-03 LEACHATE LEAK DETECTION SUMP
1:75



DETAIL 14 C-03,05,07 LEACHATE LEAK DETECTION SUMP, SUMP RISER PIPE
N.T.S.

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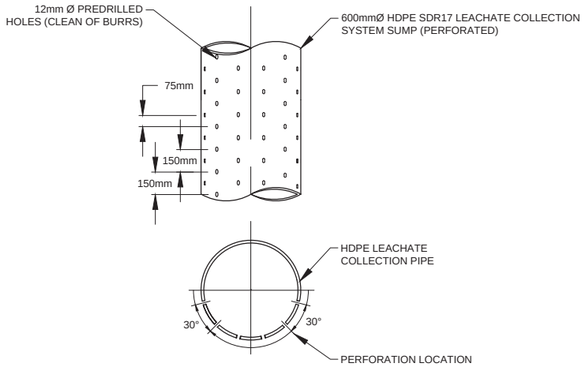
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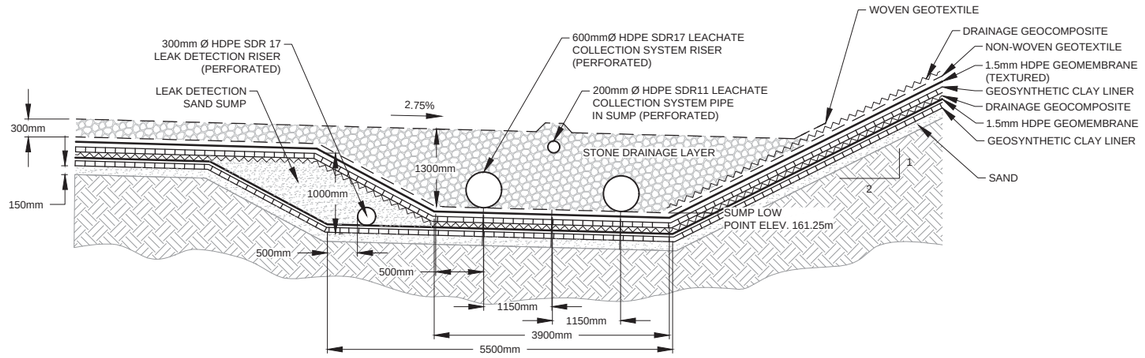
Title
DETAILS
LEACHATE LEAK
DETECTION SUMP

Sheet No.
C-15

Sheet 16 of 20



DETAIL 15 (C-04) 600mmØ LEACHATE COLLECTION SYSTEM SUMP PIPE PERFORATIONS
NTS

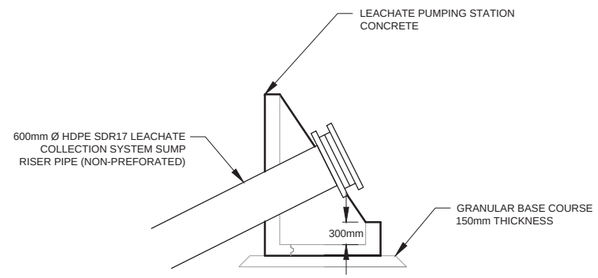


DETAIL 16 (C-03.04.07) LEACHATE COLLECTION SYSTEM SUMP
1:50

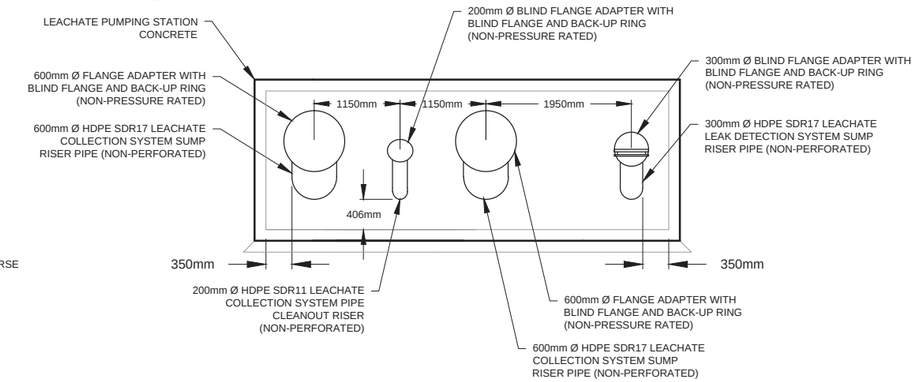


DETAIL 17 (C-04) LEACHATE COLLECTION SYSTEM TOE DRAIN/ LEACHATE COLLECTION SYSTEM PIPE
1:30

DETAIL 18 (C-03) LEACHATE PUMP STATION (PLAN VIEW)
1:40



SECTION C-C' (C-16)
1:40



SECTION D-D' (C-16)
1:40

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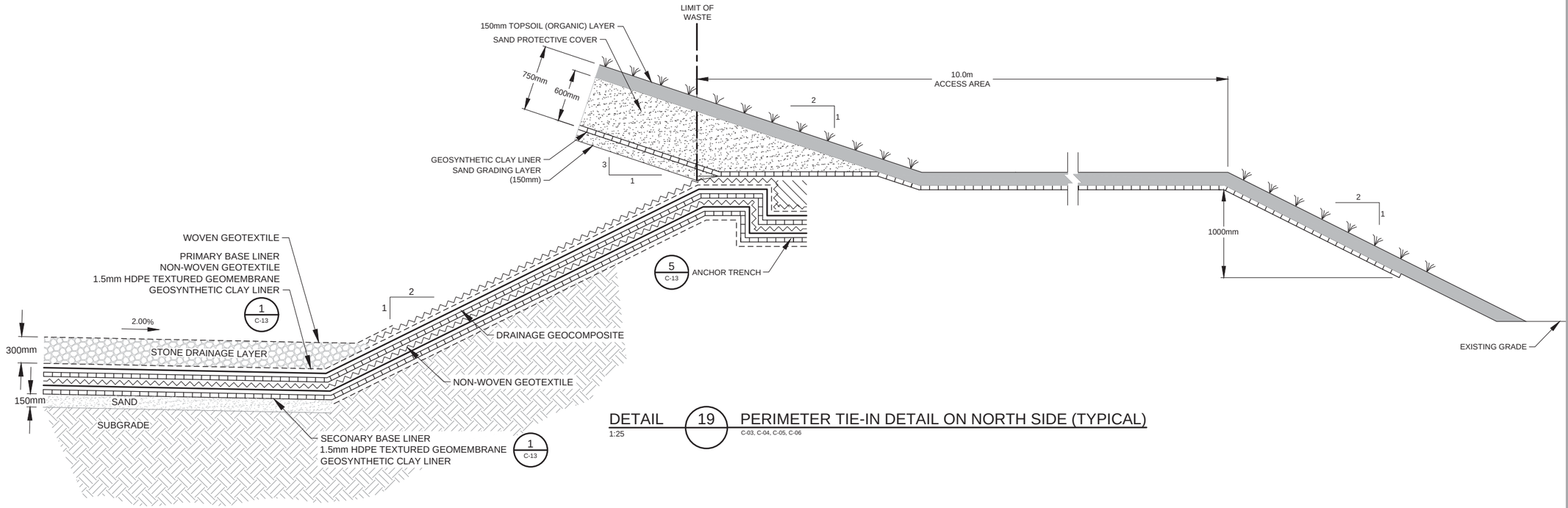
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Drafting Check	Design Check
Project Manager D. LIDDY	Date July 2, 2021
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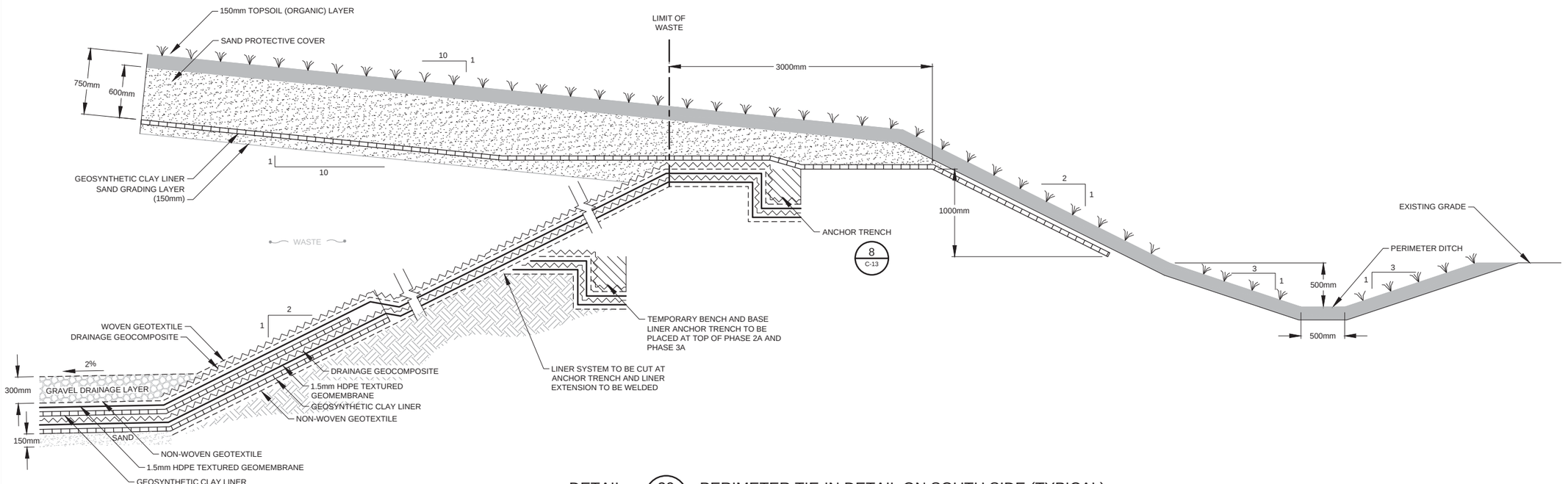
Title
DETAILS
LEACHATE COLLECTION SYSTEM

Sheet No.
C-16

Sheet 17 of 20



DETAIL 19 PERIMETER TIE-IN DETAIL ON NORTH SIDE (TYPICAL)
1:25
C-03, C-04, C-05, C-06



DETAIL 20 PERIMETER TIE-IN DETAIL ON SOUTH SIDE (TYPICAL)
1:25
C-03, C-04, C-05, C-06

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Project Manager D. LIDDY	Date July 2, 2021
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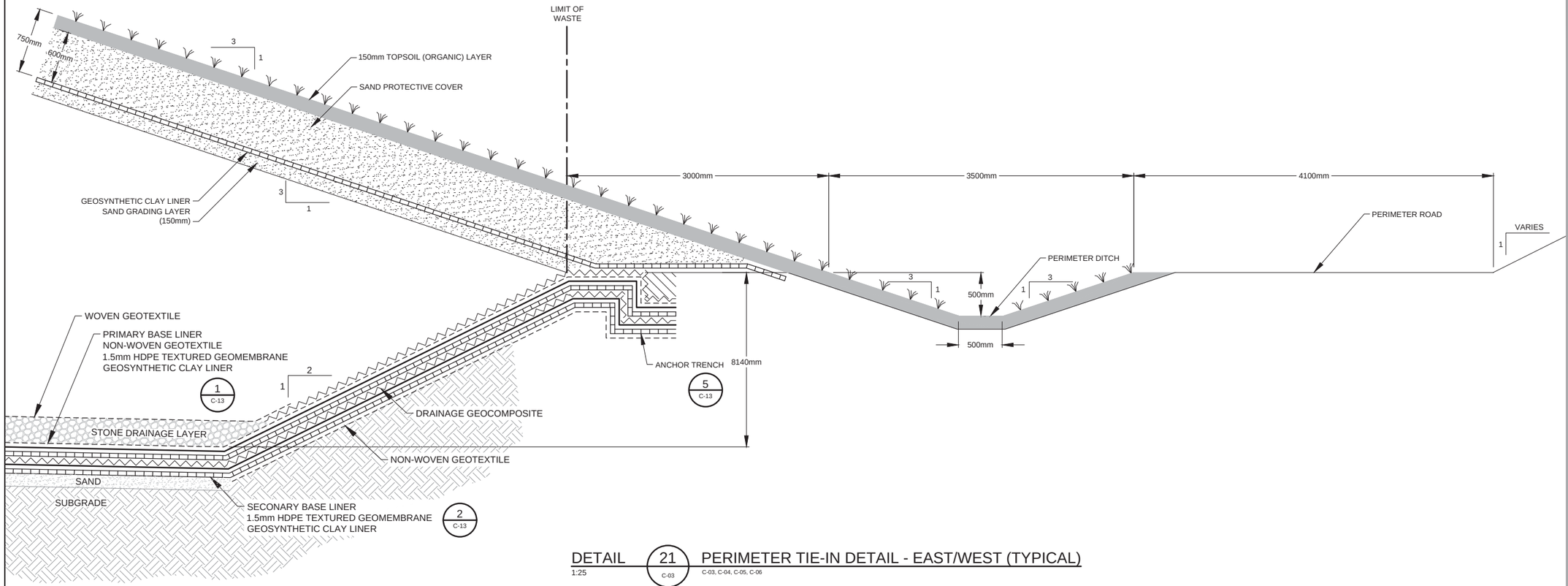
Project No. 88877-11

Title
DETAILS
PERIMETER TIE-IN DETAILS I

Sheet No.
C-17

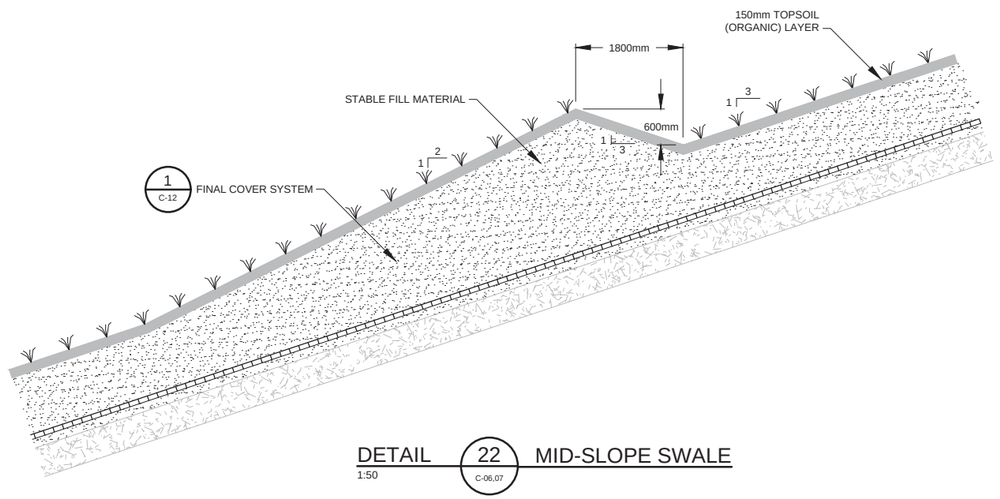
Sheet 18 of 20

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DETAIL 21 (C-03) PERIMETER TIE-IN DETAIL - EAST/WEST (TYPICAL)
1:25

C-03, C-04, C-05, C-06



DETAIL 22 (C-06,07) MID-SLOPE SWALE
1:50

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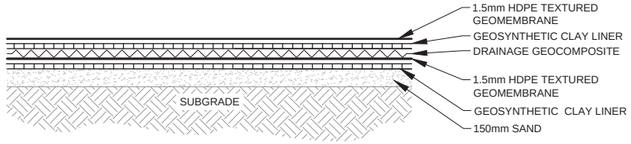
Project No. 88877-11

Title
DETAILS
PERIMETER TIE-IN DETAILS II

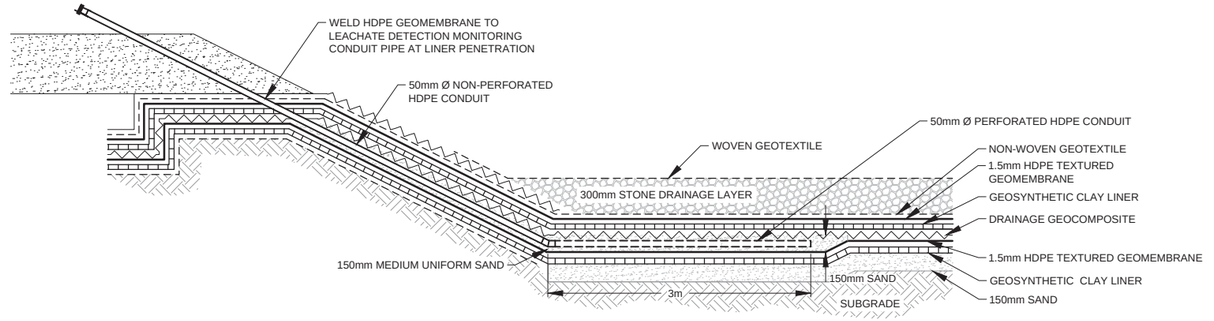
Sheet No.
C-18

Sheet 19 of 20

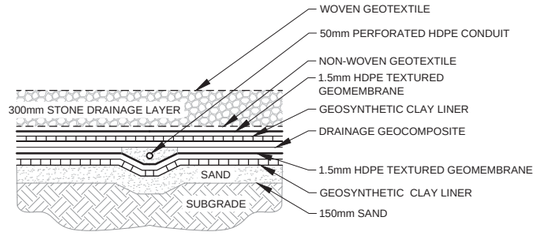
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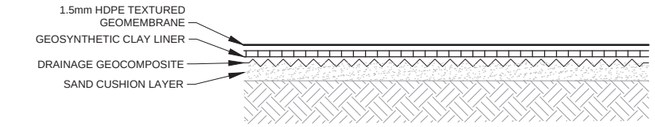
DETAIL 23 (C-04) LEACHATE TREATMENT POND LINER SYSTEM
1:25



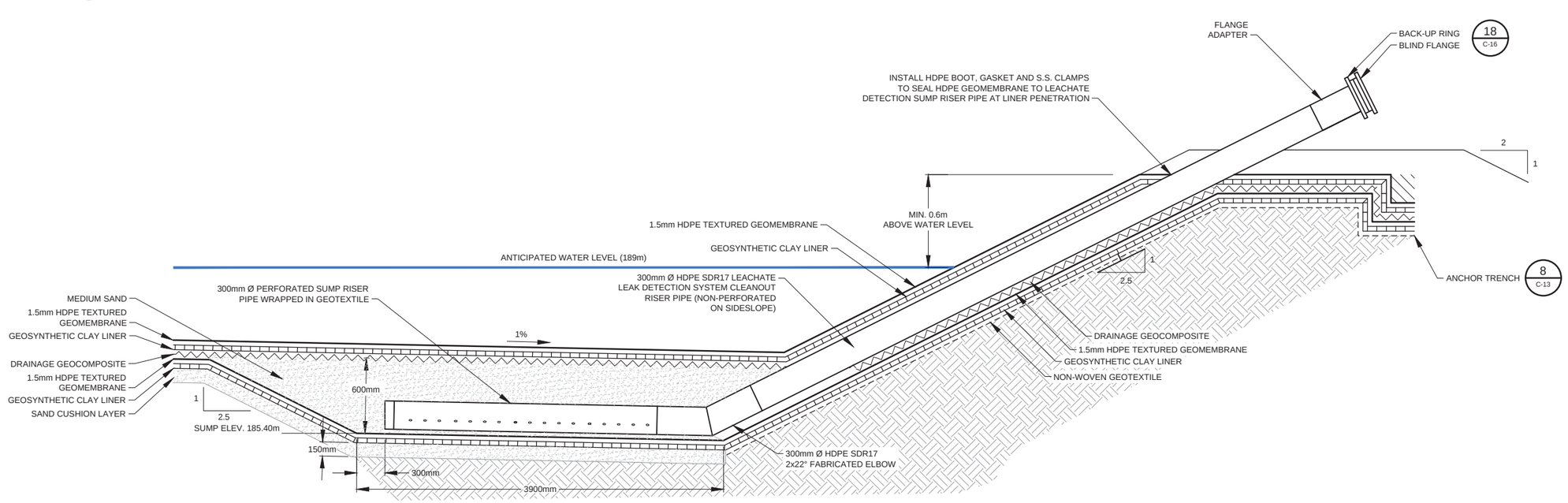
DETAIL 24 (C-04) LEAK DETECTION LYSIMETER MONITORING PORT
1:25



DETAIL 25 (C-18) LEAK DETECTION LYSIMETER MONITORING PORT CROSS-SECTION
1:25



DETAIL 26 (C-04) TREATED EFFLUENT HOLDING POND LINER SYSTEM
1:25



DETAIL 27 N.T.S. LEACHATE TREATMENT POND LEAK DETECTION SUMP RISER PIPE

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Project Manager	D. LIDDY	Date	July 5, 2021
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Title
DETAILS
LEACHATE MANAGEMENT

Sheet No.
C-19

Sheet 20 of 20



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2021 Design, Operations and Closure Plan

Northwin Landfill
Upland Pit Property
Campbell River, British Columbia

Upland Excavating Ltd.

GHD | 138 East 7th Avenue Suite 100 Vancouver British Columbia V5T 1M6 Canada

088877 | Report No 14 | July 8, 2021

Appendices

Appendix A
Operational Certificate

August 1, 2019

Tracking Number: 335965
Authorization Number: 107689

REGISTERED MAIL

UPLAND EXCAVATING LTD.
#201-909 ISLAND HIGHWAY
CAMPBELL RIVER BC V9W 2C2

Dear operational certificate holder:

Enclosed is Operational Certificate 107689 issued under the provisions of the *Environmental Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the operational certificate. An annual fee will be determined according to the Permit and Approval Fees and Charges Regulation.

This operational certificate does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the operational certificate holder. It is also the responsibility of the operational certificate holder to ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties, and comply with other applicable legislation that may be in force.

Requirements may also be specified by the *Environmental Management Act* and regulations including, but not limited to, the Contaminated Sites Regulation, Environmental Data Quality Assurance Regulation, Hazardous Waste Regulation, Landfill Gas Management Regulation, Organic Matter Recycling Regulation, Ozone Depleting Substances and Other Halocarbons Regulation, Recycling Regulation, Spill Reporting Regulation, Storage of Recyclable Material Regulation, Waste Discharge Regulation and Codes of Practice.

This decision may be appealed to the Environmental Appeal Board in accordance with Part 8 of the *Environmental Management Act*. An appeal must be delivered within 30 days from the date that notice of this decision is given. For further information, please contact the Environmental Appeal Board at (250) 387-3464.

Administration of this operational certificate will be carried out by staff from the Environmental Protection Division's Regional Operations Branch. Documents pertinent to the operational certificate are to be submitted by email or electronic transfer to the director, in accordance with the ministry Data & Report Submissions website at: http://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions, or as further instructed.

If you have any questions or concerns, please contact Authorizations - South at Authorizations.South@gov.bc.ca.

Yours truly,



Luc Lachance, P.Eng
for Director, *Environmental Management Act*
Authorizations - South Region

Enclosure

MINISTRY OF ENVIRONMENT &
CLIMATE CHANGE STRATEGY

OPERATIONAL CERTIFICATE

107689

Under the Provisions of the Environmental Management Act

Pursuant to the Approved

Comox Valley Regional District Solid Waste Management Plan

UPLAND EXCAVATING LTD.

#201-909 ISLAND HIGHWAY
CAMPBELL RIVER BC V9W 2C2

Is authorized to manage waste at the Facility located in Campbell River, British Columbia, subject to the requirements listed below. Contravention of any of these requirements is a violation of the *Environmental Management Act* and may lead to prosecution.

Pursuant to section 24(10) of the *Environmental Management Act*, this operational certificate supersedes and cancels Permit PR-10807 issued under section 14 of the *Environmental Management Act*.

1. AUTHORIZED DISCHARGES, FACILITIES AND WORKS

1.1 Original Landfill

This section applies to the Original Landfill.

1.1.1 The maximum rate of waste discharge to the Original Lined Cell is 45,000 tonnes per calendar year.

1.1.2 The characteristics of the waste discharge to the Original Lined Cell must be:

(a) demolition waste,
(b) construction waste,
(c) land clearing waste,
(d) soil in which the concentrations of all substances are less than the lowest applicable industrial land use standard specified for those substances in
(i) the generic numerical soil standards,
(ii) the matrix numerical soil standards, or

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(iii) a director's interim standard for soil,
referred to in section 41(1)(a) of the Contaminated Sites Regulation, B.C. Reg. 375/96,
(e) sludge from the Original Leachate Management Works, or,
(f) other waste as authorized in writing by the director,
but does not include:
(g) hazardous waste except as authorized pursuant to the Hazardous Waste Regulation, controlled waste, Attractants, and,
(h) waste and/or recyclable material prohibited in writing by the director.

1.1.3 The waste discharge is authorized to the Original Lined Cell approximately located as shown on Site Plan A. Waste discharge to the Original Un-Lined Cell is not authorized.

1.1.4 Authorization to discharge waste to the Original Lined Cell ceases on the earlier of:
(i) the date the Original Lined Cell is filled to capacity with grades not steeper than 3H:1V (33%),
(ii) the date of commencement of waste discharge to the New Landfill.

1.1.5 The authorized works are:
(i) a lined landfill footprint with a maximum area of 0.72 ha (85 m x 85 m) including from bottom to top a base with perimeter berm, 0.3 m sand cushion layer, 0.5 mm thick coated woven polyethylene liner, 0.3 m granular leak detection layer, leak detection riser pipe, 0.5 mm thick coated woven polyethylene liner, 0.3 m sand protection layer, leachate extraction chamber, final cover, and,
(ii) an un-lined landfill footprint with an approximate area of 0.7 ha, final cover,
and related appurtenances, approximately located as shown on Site Plan A.

1.1.6 The operational certificate holder must ensure the Original Landfill, excluding final cover, is complete and fully operational on or before the date of issuance of this operational certificate, and at all times thereafter, until the Original Landfill is decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.

1.2 **Original Leachate Management Works**

This section applies to the management of leachate from the Original Lined Cell.

1.2.1 The operational certificate holder must convey the leachate from the Original Lined Cell, that is to be discharged on the Facility site, to the Original Leachate Management Works.

1.2.2 The maximum rate of treated leachate effluent discharge to the treated leachate infiltration pond is 7,139 m^3 per calendar year.

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1.2.3 The concentration of any substance in the treated leachate effluent discharge to the treated leachate infiltration pond must not be greater than the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance.

1.2.4 The treated leachate effluent is authorized to be discharged to the treated leachate infiltration pond and infiltrated into the ground. This authorization ceases on the date the Original Leachate Management Works are decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.

1.2.5 The authorized works are leachate conveyance, storage, treatment and discharge works including pumps, pipes, leachate storage and treatment tanks, treated leachate infiltration pond, flow monitoring works, and related appurtenances approximately located as shown on Site Plan A.

1.2.6 Minimum Freeboard must be maintained at all times as follows:
treated leachate infiltration pond: 0.6 m

1.2.7 The operational certificate holder must ensure the Original Leachate Management Works are complete and fully operational on or before the date of commencement of discharge to the treated leachate infiltration pond, and at all times thereafter, until the Original Leachate Management Works are decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.

1.3 **New Landfill**

This section applies to the New Landfill.

1.3.1 The maximum rate of waste discharge to the New Landfill is: (45,000 minus the waste discharge to the Original Lined Cell) tonnes per calendar year.

1.3.2 The characteristics of the waste discharge to the New Landfill must be:
(a) demolition waste,
(b) construction waste,
(c) land clearing waste,
(d) soil in which the concentrations of all substances are less than the lowest applicable industrial land use standard specified for those substances in
(i) the generic numerical soil standards,
(ii) the matrix numerical soil standards, or
(iii) a director's interim standard for soil,
referred to in section 41(1)(a) of the Contaminated Sites Regulation, B.C. Reg. 375/96,
(e) sludge from the New Leachate Management Works or the New Stormwater

Management Works, or,

(f) other waste as authorized in writing by the director,

but does not include:

(g) hazardous waste except as authorized pursuant to the Hazardous Waste Regulation, controlled waste, Attractants, and,

(h) waste and/or recyclable material prohibited in writing by the director.

1.3.3 The waste discharge is authorized to the New Landfill approximately located as shown on Site Plan A.

1.3.4 The authorized works are a lined landfill footprint with a maximum area of 3.60 ha including from bottom to top a base with perimeter berm, secondary base liner, leak detection drainage layer and leak collection pipes and sump, primary base liner, leachate collection drainage layer and leachate collection pipes and sump, pumps, pipes, final cover, and related appurtenances, approximately located as shown on Site Plan A.

1.3.5 The secondary base liner and the primary base liner must each include an upper high density polyethylene double sided textured geomembrane of minimum 1.5 mm thickness and a lower geosynthetic clay liner of hydraulic conductivity less than or equal to 1×10^{-7} cm/s. However, on the south slope of the base more than 1 m above the primary base liner, the geosynthetic clay liners are not required.

1.3.6 The operational certificate holder must ensure the New Landfill, excluding final cover, is complete and fully operational on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

1.4 New Leachate Management Works

This section applies to the management of leachate from the New Landfill.

1.4.1 The operational certificate holder must convey the leachate from the New Landfill, that is to be discharged on the Facility site, to the New Leachate Management Works.

1.4.2 The maximum rate of treated leachate effluent discharge to the treated leachate infiltration pond is 24,633 m^3 per calendar year.

1.4.3 The concentration of any substance in the treated leachate effluent discharge to the treated leachate infiltration pond must not be greater than the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance.

1.4.4 The treated leachate effluent is authorized to be discharged to the treated leachate infiltration

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pond and infiltrated into the ground.

1.4.5 The authorized works are leachate conveyance, treatment and discharge works including pumps, pipes, leachate treatment pond(s), treated leachate infiltration pond, flow monitoring works, and related appurtenances approximately located as shown on Site Plan A.

1.4.6 The leachate treatment pond(s) must include from bottom to top a secondary base liner, leak detection drainage layer and leak collection pipe(s), and a primary base liner. The secondary base liner and the primary base liner must each include an upper high density polyethylene double sided textured geomembrane of minimum 1.5 mm thickness and a lower geosynthetic clay liner of hydraulic conductivity less than or equal to 1×10^{-7} cm/s.

1.4.7 Minimum Freeboard must be maintained at all times as follows:
leachate treatment pond(s): 0.6 m
treated leachate infiltration pond: 0.6 m

1.4.8 The operational certificate holder must ensure the New Leachate Management Works are complete and fully operational on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

1.5 New Stormwater Management Works

This section applies to the management of stormwater from the New Landfill.

1.5.1 The operational certificate holder must manage stormwater from the New Landfill such that stormwater is infiltrated into the ground with the authorized works.

1.5.2 The stormwater must not include leachate and the concentration of any substance in the stormwater must not be greater than the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance.

1.5.3 The authorized works are diversion berm, perimeter berm, mid slope swales, drop down channels, ditches, energy dissipation and sediment traps, stormwater infiltration area, and related appurtenances approximately located as shown on Site Plan A.

1.5.4 Minimum Freeboard must be maintained at all times as follows:
stormwater infiltration area: 0.6 m
all other authorized works: 0.3 m

1.5.5 The operational certificate holder must ensure that adequate authorized works to manage stormwater, such that stormwater is infiltrated into the ground with the authorized works, are

complete and fully operational on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

1.6 Facility Entrance

This section applies to the Facility entrance.

1.6.1 The authorized works are sign(s), gate, fence, weigh scale, and related appurtenances approximately located as shown on Site Plan A.

1.6.2 The operational certificate holder must ensure the authorized works are complete and fully operational on or before the date of issuance of this operational certificate and at all times thereafter.

1.7 Location of Facility

This section applies to the location of the Facility.

1.7.1 The location of the Facility is PID 001-223-321, LOT A, DISTRICT LOT 85, SAYWARD DISTRICT, PLAN 30709 EXCEPT PART IN PLAN EPP15087, approximately located as shown on Site Plan A.

2. GENERAL REQUIREMENTS

2.1 Glossary

The following capitalized terms referred to in this authorization are defined in the Glossary below. Other terms used in this authorization have the same meaning as those defined in the *Environmental Management Act*, applicable regulations, and the Landfill Criteria;

"Attractant" means food or food waste, compost, carcass or part of an animal, fish, or other meat, or other waste or garbage, that could attract bears, birds, rodents, insects, vectors or wildlife, but does not include grass, leaves, weeds, branches and woodwaste;

"Facility" means the Original Landfill, Original Leachate Management Works, New Landfill, New Leachate Management Works, New Stormwater Management Works and the authorized works in section 1.6.1 (Facility Entrance) of this operational certificate;

"Freeboard" means the difference in elevation between the contained liquid level and the top of the containment works at its lowest point;

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"Landfill Criteria" means the Landfill Criteria for Municipal Solid Waste Second Edition June 2016, as amended or replaced from time to time;

"New Landfill" means the authorized works in section 1.3.4 of this operational certificate;

"New Leachate Management Works" means the authorized works in section 1.4.5 of this operational certificate;

"New Stormwater Management Works" means the authorized works in section 1.5.3 of this operational certificate;

"Original Landfill" means the Original Lined Cell and the Original Un-Lined Cell;

"Original Leachate Management Works" means the authorized works in section 1.2.5 of this operational certificate;

"Original Lined Cell" means the authorized works in section 1.1.5(i) of this operational certificate;

"Original Un-Lined Cell" means the authorized works in section 1.1.5(ii) of this operational certificate;

"Province" means Her Majesty the Queen in right of British Columbia;

"Regulatory Document" means any document that the operational certificate holder is required to cause to be prepared, prepare or submit to the director or the Province, pursuant to: (i) this authorization; (ii) any regulation made under the *Environmental Management Act* that regulates the Facility described in this authorization or the discharge of waste from that Facility; or (iii) any order issued under the *Environmental Management Act* directed against the operational certificate holder that is related to the Facility described in this authorization or the discharge of waste from that Facility;

"Significant Works" means the Facility excluding the authorized works in section 1.6.1 (Facility Entrance) of this operational certificate.

2.2 **Use of Qualified Professional(s)**

The operational certificate holder must cause a Qualified Professional to:

(a) Design and inspect the construction of the Facility, and,

(b) Certify documents related to the Facility including plans, specifications, drawings, construction

reports, assessments, reviews, investigations, studies, surveys, programs, reports and as-built record drawings.

(d) Submit a completed Declaration of Competency and a Conflict of Interest Disclosure Statement with each document.

2.3 Operations and Closure Plan (OCP)

(a) The operational certificate holder must cause a Qualified Professional to certify and submit an up to date OCP for the Original Landfill and the Original Leachate Management Works, to the director, on or before the earlier of:

(i) 30 days before the date of commencement of waste discharge to the Original Lined Cell,
(ii) 30 days after the date of issuance of this operational certificate.

(b) The OCP must comply with the requirements of this operational certificate, include information specified in relevant items listed in the Landfill Criteria Section 10.3 Design, Operations and Closure Plan including a site layout plan, a filling plan, a lifespan analysis table, a stormwater management plan, a leachate management plan, an environmental monitoring plan, an operations plan, a closure plan, and the information specified in the following sections of this operational certificate:

2.7(a) (soil acceptance plan), and,
2.10(a) (financial security plan).

(c) The operational certificate holder must carry out the most recent OCP and design, construct, operate, inspect, maintain, monitor and close the Original Landfill and the Original Leachate Management Works, in compliance with the most recent OCP and this operational certificate, until the Original Landfill and the Original Leachate Management Works are decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.

2.4 Hydrogeology and Hydrology Characterization Report (HHCR)

(a) The operational certificate holder must cause a Qualified Professional to certify and submit an up to date HHCR, to the director, on or before 90 days before the date of commencement of waste discharge to the New Landfill.

(b) The HHCR must include characterization of the geology, hydrogeology, and surface hydrology at and near the Facility site, and the information specified in all the items listed in the Landfill Criteria, section 10.1 Hydrogeology and Hydrology Characterization Report.

(c) The operational certificate holder must cause a Qualified Professional to certify and submit an updated HHCR to the director, at least once every five years after the date of commencement of waste

discharge to the New Landfill.

2.5 **Design, Operations and Closure Plan (DOCP)**

(a) The operational certificate holder must cause a Qualified Professional to certify and submit an up to date DOCP, for the Facility, to the director, on or before 90 days before the date of commencement of waste discharge to the New Landfill.

(b) The DOCP must comply with the requirements of this operational certificate, include the information specified in all the items listed in the Landfill Criteria Section 10.3 Design, Operations and Closure Plan, and the information specified in the following sections of this operational certificate:

2.6(a) (New Leachate Management Works commissioning plan),
2.7(a) (soil acceptance plan),
2.8(a) (trigger level assessment plan),
2.9(a) (plan to remove all waste from the Original Landfill), and,
2.10(b) (financial security plan).

(c) The operational certificate holder must cause a Qualified Professional to certify and submit an updated DOCP to the director, as necessary to keep the DOCP up to date, at least once every five years after the date of commencement of waste discharge to the New Landfill.

(d) The operational certificate holder must carry out the most recent DOCP and design, construct, operate, inspect, maintain, monitor, and close the Facility, in compliance with most recent DOCP and this operational certificate.

2.6 **New Leachate Management Works Commissioning Plan and Report**

(a) The DOCP submitted pursuant to section 2.5 of this operational certificate must include a New Leachate Management Works commissioning plan that includes:

(i) the expected duration of the New Leachate Management Works commissioning period,
(ii) description of the New Leachate Management Works and design, including treatment of leachate from soil and treated leachate infiltration pond design and infiltration tests,
(iii) the monitoring, sampling and analyses that will be carried out during the New Leachate Management Works commissioning period including the quantity and quality of leachate and treated leachate effluent, and confirmatory sampling before the discharge of any treated leachate effluent to the treated leachate infiltration pond,
(iv) operating procedures that will be carried out during the New Leachate Management Works commissioning period including review of confirmatory sampling results before the discharge of any treated leachate effluent to the treated leachate infiltration pond,
(v) contingency measures that will be carried out during the New Leachate Management Works

commissioning period if the treated leachate effluent quality does not comply with this operational certificate, including storage, retreatment, and transport to an off-site authorized treatment facility,
(vi) New Leachate Management Works commissioning report description, table of contents and summary of contents.

(b) The operational certificate holder must cause a Qualified Professional to certify and submit a New Leachate Management Works commissioning report, that includes the information contemplated in section 2.6(a)(vi) of this operational certificate, to the director, on or before 30 days after the completion of the New Leachate Management Works commissioning period, or as specified by the director.

2.7 Soil Acceptance Plan

(a) The OCP submitted pursuant to section 2.3, and the DOCP submitted pursuant to section 2.5, of this operational certificate, must include a soil acceptance plan that includes procedures that will be carried out before soil is accepted at the Facility including receipt and review of documents required by section 2.7(b) of this operational certificate, and consideration of the applicable Original Leachate Management Works or New Leachate Management Works adequacy to treat leachate from the soil.

(b) Before a specific quantity of soil is accepted at the Facility, the operational certificate holder must cause a Qualified Professional to certify and submit to the operational certificate holder, a document pertaining to the specific quantity of soil that includes:
(i) the soil tonnage(s) and soil quality class(es) as described in the most recent version of Technical Guidance 1 on Contaminated Sites Site Characterization and Confirmation Testing,
(ii) the soil origin including applicable civic address, site identification number, parcel identifier, parcel identification number, legal description, and,
(iii) characterization of the soil in accordance with ministry procedures and applicable Contaminated Sites Regulation Guidance, Protocols and Procedures.

2.8 Trigger Level Assessment Plan

(a) The DOCP submitted pursuant to section 2.5 of this operational certificate must include a trigger level assessment plan that includes:
(i) Description of the routine monitoring of the quantity and quality of leachate leakage through the primary liner and into the leak detection layer for the New Landfill, and for the leachate treatment pond(s), and related leachate leakage quantities and qualities that will trigger corresponding described increased monitoring, investigations, contingency measures and actions.
(ii) Description of the routine monitoring of groundwater quality immediately downgradient of the New Landfill, the leachate treatment pond(s), and the treated leachate infiltration pond, and related groundwater substance concentrations that will trigger corresponding described increased

monitoring, investigations, contingency measures and actions.

2.9 Plan to Remove all Waste from the Original Landfill

(a) The DOCP submitted pursuant to section 2.5 of this operational certificate must include a plan to remove all waste from the Original Landfill, categorize such waste, discharge all such waste to the New Landfill or to other identified and authorized waste management facility(ies), carry out sampling to confirm all such waste has been removed, and decommission the Original Landfill and the Original Leachate Management Works.

(b) Subject to section 1.3.2 of this operational certificate, waste removed from the Original Landfill is authorized to be discharged to the New Landfill. The tonnage of such waste must not be included for the purpose of determining compliance with section 1.3.1 of this operational certificate.

(c) The director may require the operational certificate holder to carry out and complete the plan referred to in section 2.9(a) of this operational certificate, in accordance with the director's requirements.

(d) If the plan referred to in section 2.9(a) of this operational certificate is carried out, the operational certificate holder must cause a Qualified Professional to certify and submit a report to the director that confirms that the plan has been carried out and completed in accordance with the director's requirements, describes the plan implementation, describes and provides the waste categorization, describes and provides the sampling and results, describes the decommissioning of the Original Landfill and the Original Leachate Management Works, provides photos documenting the implementation of the plan referred to in section 2.9(a) of this operational certificate, and lists the tonnages or volumes, and categories of waste removed and discharged to the New Landfill and to other identified and authorized waste management facility(ies), on or before 60 days after the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed.

2.10 Financial Security

(a) The OCP submitted pursuant to section 2.3 of this operational certificate must include a financial security plan that includes:

(i) the calculations of the amounts of financial security and time periods for each phase of development for the Original Landfill in accordance with the Landfill Criteria Section 8.0 Financial Security, and,

(ii) the amounts of financial security for the corresponding time periods.

(b) The DOCP submitted pursuant to section 2.5 of this operational certificate must include a financial security plan that includes:

(i) the tasks, estimated costs, contingency costs, calculations of the amounts of financial security

and time periods, to carry out and complete the plan referred to in section 2.9(a) of this operational certificate (plan to remove all waste from the Original Landfill),
(ii) the calculations of the amounts of financial security and time periods for each phase of development for the New Landfill in accordance with the Landfill Criteria Section 8.0 Financial Security, and,
(iii) the amounts of financial security for the corresponding time periods.

(c) The operational certificate holder must provide the director with financial security, on or before the earlier of:
(i) 30 days before the date of commencement of waste discharge to the Original Lined Cell,
(ii) 30 days after the date of issuance of this operational certificate,
(iii) 90 days before the date of commencement of waste discharge to the New Landfill,
and at all times thereafter.

(d) The amount of financial security at any time must be equal to or greater than:
(i) Before the report referred to in section 2.9(d) (report that confirms that the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed) of this operational certificate is submitted to the director, the greater amount specified for the corresponding time period in:
- the financial security plan in the most recent OCP,
- the financial security plan in the most recent DOCP.
(ii) On and after the report referred to in section 2.9(d) (report that confirms that the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed) of this operational certificate is submitted to the director, the amount specified for the corresponding time period in the financial security plan in the most recent DOCP.

(e) The form of financial security must be satisfactory to the director.

(f) At the discretion of the director, such financial security may be used among other things:
(i) to correct any inadequacy of the Facility relating to its design, construction, operation, inspection, maintenance, monitoring, closure, and post-closure;
(ii) to correct any default in compliance with this operational certificate or the *Environmental Management Act*; and,
(iii) for remediation of the Facility.

(g) The operational certificate holder must replenish any amounts drawn from the posted financial security within 60 days of such amounts being drawn or as otherwise specified by the director.

2.11 **Construction Report(s)**

(a) The operational certificate holder must cause a Qualified Professional to carry out inspections

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before and during the construction or modification of Significant Works, and, after the completion of construction or modification of Significant Works, to certify and submit construction report(s) to the director:

(i) for construction of the New Landfill and the New Leachate Management Works, on or before 30 days before the date of commencement of waste discharge to those new Significant Works, and,
(ii) for all Significant Works, on or before 60 days after the completion of construction or modification of the Significant Works.

(b) The construction report(s) must demonstrate that the Significant Works have been constructed in accordance with this operational certificate and the applicable most recent OCP or DOCP, describe any technical concerns that arose from the inspections and testing and how they were addressed, and include as-built record drawings of the constructed Significant Works, all the inspection and testing reports and results including geologic inspection report, quality control and quality assurance testing, soil test data including field and laboratory data, as described in the Landfill Criteria section 10.2 Construction Report(s).

2.12 **Notification of Commencement of Waste Discharge**

The operational certificate holder must notify the director of:
(a) the date of commencement of waste discharge to the Original Lined Cell, on that date,
(b) the date of commencement of waste discharge to the New Landfill, on that date,
(c) the date the Original Lined Cell has reached capacity, on that date, and,
(d) the date the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed, on that date.

2.13 **Buffer Zone**

The operational certificate holder must ensure that the New Landfill, New Leachate Management Works, and New Stormwater Management Works, are located a minimum of 50 m from the Facility site boundary.

2.14 **Depth to Groundwater**

The operational certificate holder must ensure that the New Landfill secondary base liner, and the New Leachate Management Works leachate treatment pond(s) secondary base liner, are a minimum of 1.5 m above groundwater at all times.

2.15 **Covenant**

On or before the date of commencement of waste discharge to the New Landfill, the operational certificate holder must register a covenant under section 219 (1) of the *Land Title Act*, in a form

acceptable to the director, that binds successors in title to uphold the continued implementation of the closure plan in the most recent DOCP, and prohibits development of the Facility other than as contemplated by this operational certificate or approved by the director. Such covenant must include an acknowledgement that the property was used for the purpose of waste disposal, must be registered as a charge against title to the property on which the facility is located and must be registered in priority to all charges except charges which do not give the holders any rights which might conflict with the covenant.

2.16 Additional Requirements

The director may require the operational certificate holder to:

(a) Cause a Qualified Professional to certify and submit to the director additional, amended or improved documents of the Facility including plans, specifications, drawings, construction reports, assessments, reviews, investigations, studies, surveys, programs, reports and as-built record drawings.

(b) Carry out actions in accordance with the additional, amended or improved documents submitted, and additional actions as specified.

(c) Repair, alter, remove, improve or add to existing facilities and works, or construct new facilities and works, at the Facility.

(d) Temporarily or permanently cease waste discharge to the Original Lined Cell and/or the New Landfill, cover part(s) or all of the Original Landfill and/or the New Landfill with final cover, and close and decommission the Facility, as specified.

2.17 Authorization Requirements

Where this authorization provides that the director may specify a matter or require an action to be carried out, the operational certificate holder must comply with the specification and carry out the action in accordance with the requirements of the director.

3. OPERATING AND PERFORMANCE REQUIREMENTS

3.1 Multiple and/or Spare Works and Auxiliary Power Facilities

The operational certificate holder must provide and install multiple and/or spare works and auxiliary power facilities to ensure the Original Lined Cell, Original Leachate Management Works, New Landfill, New Leachate Management Works, and New Stormwater Management Works, are complete and fully operational as specified in this operational certificate, including during maintenance, breakdowns and electrical power outages.

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3.2 **Maintenance of the Facility**

(a) The operational certificate holder must cause persons that are qualified and trained to operate, regularly inspect, and maintain the Facility, in good working order. If components of the Facility have a manufacturer's recommended maintenance schedule, then those components must, at a minimum, be maintained in accordance with that schedule.

(b) The operational certificate holder must prepare documents of the qualification and training of the persons operating, inspecting and maintaining the Facility, and of Facility inspections, operation and maintenance.

3.3 **Facility Manager and Operator Certification**

(a) The operational certificate holder must ensure that at least one person responsible for the management of the Facility is certified, and maintains certification, by The Solid Waste Association of North America (SWANA) as a Manager of Landfill Operations, and at least one person responsible for the operation of the Facility has, within the preceding five years, successfully completed the SWANA Landfill Operations Basics course, on or before the earlier of:

(i) the date of commencement of waste discharge to the Original Lined Cell,

(ii) the date of commencement of waste discharge to the New Landfill,

and at all times thereafter.

(b) The operational certificate holder must prepare documents of the SWANA certification and training of the person(s) responsible for the management and operation of the Facility.

3.4 **New Leachate Management Works Classification and Operator Certification**

(a) The operational certificate holder must have the New Leachate Management Works classified by the Environmental Operators Certification Program (EOCP), on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

(b) The operational certificate holder must ensure that the person(s) responsible for the operation and maintenance of the New Leachate Management Works is(are) certified at an EOCP certification level equivalent to or higher than the EOCP classification level of the New Leachate Management Works, on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.

(c) The operational certificate holder must prepare documents of the EOCP classification level of the New Leachate Management Works and the EOCP certification level(s) of the person(s) responsible for the operation and maintenance of the New Leachate Management Works.

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3.5 Groundwater Quality

(a) The operational certificate holder must ensure that the Facility does not cause the concentration of any substance in groundwater flowing from the Facility site boundary to be greater than:

(i) the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance,

or,

(ii) if the local background concentration of any substance is greater than (i), the local background concentration of that substance.

(b) If section 3.5(a)(ii) of this operational certificate is being used, the operational certificate holder must cause a Qualified Professional to determine the local background concentration of substance(s) in (a), in accordance with the latest approved version of Protocol 9 for Contaminated Sites, Determining Background Groundwater Quality, and include such determination(s) in the Annual Operations and Monitoring Report.

(c) The director may specify more stringent groundwater quality standards than those set out in this section.

3.6 Landfill Gas Management

The operational certificate holder must ensure that:

(a) The Facility does not cause:

(i) combustible gas concentrations to exceed the lower explosive limit of methane (5 percent by volume), or a lower concentration specified by the director, in soil at the Facility site boundary;

(ii) combustible gas concentrations to exceed 20 percent of the lower explosive limit of methane (1 percent by volume) in any building; and

(iii) federal, provincial, or local ambient air quality objectives and standards to be exceeded in air at the Facility site boundary.

(b) Landfill gas is managed in accordance with all migration and health and safety requirements.

3.7 Nuisance

The operational certificate holder must ensure that the Facility does not cause a nuisance including with regard to birds, rodents, insects, odour, noise, dust, litter, vector and wildlife attraction.

3.8 Complaints

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The operational certificate holder must prepare documents of complaints with regard to matters relevant to this operational certificate, including environmental and nuisance complaints. These documents must include the source and nature of the complaint, actions, responses, and corresponding dates and times.

3.9 Regulatory Documents

(a) The operational certificate holder must retain all Regulatory Documents.

(b) The operational certificate holder must retain all Regulatory Documents for the last seven years at the Facility and such documents must be available for immediate inspection at the Facility by a director or an officer.

(c) If requested by a director or an officer, the operational certificate holder must submit the requested Regulatory Documents to the director or officer within 14 days of the request.

4. SAMPLING REQUIREMENTS

4.1 Sampling Procedures

The operational certificate holder must carry out required sampling in accordance with the procedures described in the "British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples, 2013 Edition (Permittee)" or most recent edition, or by alternative procedures as authorized by the director. A copy of the above manual is available on the Ministry web page at https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance.

4.2 Analytical Procedures

The operational certificate holder must carry out required analyses in accordance with procedures described in the "British Columbia Laboratory Manual (2015 Permittee Edition)", or the most recent edition or by alternative procedures as authorized by the director. A copy of the above manual is available on the Ministry web page at https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance.

4.3 Quality Assurance

(a) The operational certificate holder must obtain from the analytical laboratory(ies) their precision, accuracy and blank data for each sample set submitted by the operational certificate holder and an evaluation of the data acceptability, based on criteria set by such laboratory.

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(b) The operational certificate holder must submit samples to analytical laboratory(ies) that meet the definition of a qualified laboratory under the Environmental Data Quality Assurance Regulation.

(c) The operational certificate holder must collect, prepare and submit for analysis by the analytical laboratory(ies) quality control (QC) samples for each parameter. As a minimum,

(i) The number of QC samples should be 20% of all samples collected (environmental + QC samples) within 48 hours of each other, and

(ii) Include duplicate, field and trip blank samples for each parameter.

5. REPORTING REQUIREMENTS

5.1 Routine Reporting

The operational certificate holder must submit all routine Regulatory Documents required by this operational certificate by email to the Ministry's Routine Environmental Reporting Submission Mailbox at EnvAuthorizationsReporting@gov.bc.ca or as otherwise instructed by the director. For guidelines on how to properly name the files and email subject lines or for more information visit the Ministry website http://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/routine-environmental-reporting-submission-mailbox.

5.2 Non-compliance Notification

(a) The operational certificate holder must immediately notify the director or designate by email at EnvironmentalCompliance@gov.bc.ca, or as otherwise instructed by the director of any non-compliance with the requirements of this authorization by the operational certificate holder and must take remedial action to remedy any effects of such non-compliance.

(b) The operational certificate holder must provide the director with written confirmation of all such non-compliance events, including available test results within 24 hours of the original notification by email at EnvironmentalCompliance@gov.bc.ca, or as otherwise instructed by the director.

5.3. Non-compliance Reporting

(a) If the operational certificate holder fails to comply with any of the requirements of this authorization, the operational certificate holder must, within 30 days of such non-compliance, submit to the director a written report that is satisfactory to the director and includes, but is not necessarily limited to, the following:

(i) all relevant test results obtained by the operational certificate holder related to the non-compliance,

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(ii) an explanation of the most probable cause(s) of the non-compliance, and
(iii) a description of remedial action planned and/or taken by the operational certificate holder to prevent similar non-compliance(s) in the future.

(b) The operational certificate holder must submit all non-compliance reporting required to be submitted under this section by email to the Ministry's Compliance Reporting Submission Mailbox at EnvironmentalCompliance@gov.bc.ca or as otherwise instructed by the director. For guidelines on how to report a non-compliance or for more information visit the Ministry website http://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/non-compliance-reporting-mailbox.

5.4 **Annual Operations and Monitoring Report**

(a) The operational certificate holder must cause a Qualified Professional to certify and submit an Annual Operations and Monitoring Report in a format suitable for public release, for the preceding calendar year, to the director on or before March 31 of each year. On or before March 31 of each year, the operational certificate holder must post a copy of the Annual Operations and Monitoring Report online, on a website accessible to the public, and in accordance with any requirements of the director.

(b) The Annual Operations and Monitoring Report must include the following information:
Operations Report:
(i) Summary of OCP implementation that addresses the information in section 2.3(b), and summary of DOCP implementation that addresses the information in 2.5(b), of this operational certificate,
(ii) Summary of construction report(s),
(iii) Annual and cumulative tonnages and categories of waste including soil tonnage(s) and soil quality class(es) discharged to the Original Lined Cell and to the New Landfill,
(iv) Remaining volume and life of the Original Lined Cell and of the New Landfill,
(v) Summary of treated leachate effluent quantity and quality discharged to the treated leachate infiltration pond,
(vi) Summary of complaints and nuisances and description of remedial action planned and/or taken by the operational certificate holder to prevent similar complaints and nuisances in the future,
(vii) Summary of non-compliance notifications and non-compliance reporting and description of remedial action planned and/or taken by the operational certificate holder to prevent similar non-compliance(s) in the future ,
(viii) Annual status form in accordance with the instructions and template at the ministry website https://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/annual-status-form
(ix) Summary of OCP and DOCP implementation, and construction of Significant Works, planned for the next calendar year,

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Environmental Monitoring Plan Report:

(x) Site plan(s), sampling locations, stormwater flow paths, groundwater elevations, gradients and flow directions,
(xi) Sampling facilities, frequencies, substances, sampling and analytical procedures,
(xii) Data including laboratory analysis and quality assurance and quality control results,
(xiii) Data tabulation, trend analysis, graphs, diagrams, and interpretation,
(xiv) Trigger level assessment plan monitoring, data, results and interpretation,
(xv) Any determination(s) of the local background concentration of substance(s) in accordance with section 3.5 of this operational certificate,
(xvi) Comparison of the data with the standards for treated leachate effluent discharge, stormwater quality, groundwater quality, and landfill gas management, specified in sections 1.2, 1.4, 1.5, 3.5 and 3.6 of this operational certificate, and identification of any non-compliance and predicted future non-compliance,
(xvii) Results, conclusions, recommendations and changes to the environmental monitoring plan.

(c) The operational certificate holder must upload monitoring data associated with this operational certificate to the Ministry's Environmental Monitoring System (EMS) database, within 45 days of the end of the 3 month period in which the data is collected.

5.5 **Licence to Publish Documents**

(a) Subject to paragraph (b), the operational certificate holder authorizes the Province to publish on the Ministry of Environment and Climate Change Strategy website the entirety of any Regulatory Document.

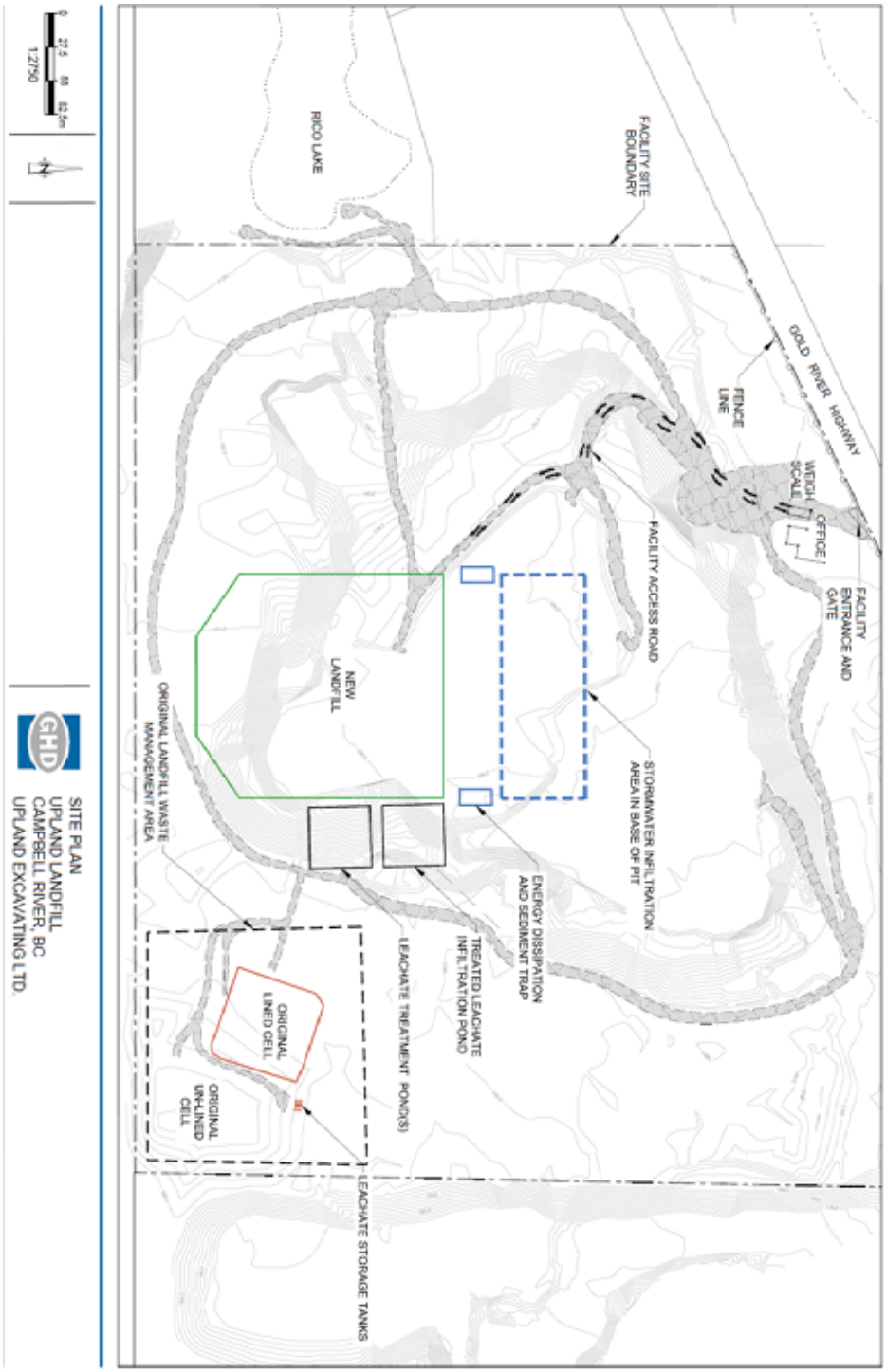
(b) The Province will not publish any information that could not, if it were subject to a request under section 5 of the *Freedom of Information and Protection of Privacy Act*, be disclosed under that Act.

(c) The operational certificate holder will indemnify and save harmless the Province and the Province's employees and agents from any claim for infringement of copyright or other intellectual property rights that the Province or any of the Province's employees or agents may sustain, incur, suffer or be put to at any time that arise from the publication of a Regulatory Document.

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Site Plan A



Date issued: August 1, 2019

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Appendix B
HDPE Geomembrane Liner Performance Review

Appendix B Liner Performance Review

1. Liner Performance Review

High-density polyethylene (HDPE) geomembranes have very high performance in containing common leachate constituents at concentrations found in landfill leachate. Geomembranes are an excellent barrier to ionic contaminants such as chloride and heavy metals, and when used in composite liners, the secondary layer provides resistance to diffusive transport of vapour phase contaminants (Rowe et al. 2004). The use of HDPE geomembranes in composite liner systems is an industry standard for all types of landfills, worldwide.

The United States Environmental Protection Agency (USEPA) promotes the use of HDPE geomembranes in composite liner systems for both hazardous and non-hazardous waste landfills (Resource Conservation and Recovery Act (RCRA) Subtitle C and Subtitle D regulations) (USOFR, 2006). The Canadian Council of Ministers of the Environment (CCME) National Guidelines for Hazardous Waste Landfills, 2006 specifies the use of HDPE geomembranes in combination with a clay layer or GCL for the containment of hazardous wastes due the complimentary properties of the two different liner materials. Many North American regulatory jurisdictions generically accept the performance life of HDPE membranes in landfill liner systems as being over 100 years, well beyond the contaminating life span of most landfills.

The Landfill has an estimated operating site life of 13 years. The Contaminating Lifespan (CLS) Assessment for the landfill as presented in the DOCP, is estimated to be 28 years and rounded up to 30 years per the Landfill Criteria requirements. The CLS is the period of time during which the Site could produce leachate contaminants at concentrations that could have an unacceptable impact if they were discharged from the Site.

1.1 Expected Leachate Quality

As in the 2020 DOCP, the Landfill will accept waste select municipal solid waste, as defined by the Environmental Management Act, and will include the following:

- Construction and demolition waste
- Land clearing debris
- Soil meeting Industrial land use standards, per the BC CSR
- Waste asbestos containing materials (ACM), managed according to Section 40 of the HWR

The Landfill leachate is expected to be characteristic of demolition, land clearing and construction (DLC) waste landfills (C&D landfills). Typically, the most potentially prominent contaminants in the leachate from C&D landfills are sulphate, arsenic, iron, manganese, and total dissolved solids (TDS). Non-hazardous contaminated soil may contain a variety of contaminants depending on the source of the waste material. Common soil contaminants include metals, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and petroleum hydrocarbons (PHCs). The leachability of the contaminants in non-hazardous contaminated soil is low compared to hazardous waste that may contain elevated concentrations and potentially include free-product. Soil must meet Industrial land use standards per the CSR to be accepted at the Site. ACM does not affect the quality of the leachate in terms of impacts from the asbestos material, as asbestos does not have the leachability characteristic that distinguish hazardous chemicals, identified in the HWR. Once landfilled ACM is an inert material.

HDPE geomembranes are used in landfill applications, especially for bottom liners, because of their relatively high resistance to aggressive leachate components (Rowe, 2001). However, unlike putrescible municipal solid waste (MSW), DLC waste consists largely of inorganic components and organic matter with a low degree of biodegradability. Typical concentration ranges of leachate parameters for DLC landfills are lower than for MSW (Weber et al., 2002).

Based on accepted waste management practices, and forecasted leachate quality, a composite liner consisting of an HDPE geomembrane and a GCL is an appropriate base liner for the Landfill.

1.2 HDPE Geomembrane Durability

Examinations of both laboratory and field data available in the literature indicate that the projected service lives of HDPE geomembranes may range depending on the material and exposure conditions. HDPE liner durability or lifetime is typically described as the material half-life, the time at which design properties have been reduced to 50%. The ageing process of HDPE geomembranes involves a combination of physical and chemical ageing that will, over time, eventually lead to material degradation. This sub-section describes the structure of HDPE and its potential failure mechanisms and reviews the predicted durability of the HDPE liner system in the context of the Site life and contaminating lifespan of the Landfill.

1.3 Structure of HDPE

HDPE is formulated by percentage based on weight 95 - 98% resin, 2- 3% carbon black (colourant) and 0.25 – 1% additives, such as antioxidants and other stabilizers (Rowe and Sangam, 2001). If the formulation changes (particularly the additives), the predicted lifetime will also change. The typical structure of a polyethylene consists of linked carbon atoms that are bonded to hydrogen with the molecular chains folded together to form ordered regions called lamellae (Rowe and Sangam, 2001). HDPE is defined as a semi-crystalline polymer with partially aligned molecular chains. Some of the inherent properties of HDPE depend on its molecular packing structure and therefore, changes at the molecular level many alter the durability and the overall field performance of the geomembrane (Tarnowski and Baldauf, 2006).

1.4 Failure Mechanisms

HDPE can be degraded to only a limited extent by most inorganic and organic chemicals (Tarnowski and Baldauf, 2006). Photo and/or thermo-oxidative ageing, depending on the application, is the primary cause of degradation of the polymer (Tarnowski and Baldauf, 2006). Under covered conditions in medium temperature and in the absence of UV radiation, oxidation takes place very slowly. The failure mechanisms that are potentially applicable for buried HDPE geomembranes include:

- Oxidation – is the major mechanisms of degradation in polyethylenes, including HDPE under all conditions. The polymer chains undergo reactions with oxygen leading eventually to changes in molecular structure and in morphology.
- Chemical – can occur when one or more components are removed from the material due to long-term exposure to chemicals or liquids (Rowe and Sangam, 2001). In HDPE geomembranes, the additives incorporated in the polymer formation may be susceptible to extraction, which would leave the geomembrane unprotected and susceptible to subsequent oxidative degradation (Koerner et al., 2005).
- Temperature – the higher the temperature the more rapid the degradation via the oxidation and chemical mechanisms described above.
- Stress state – typically geomembranes are subjected to vertical compressive stress but actual stress is site-specific. The presence of tensile stresses less than the short-term mechanical strength of the material lead to environmental stress cracking (Koerner et al., 2005). The presence of chemicals may accelerate cracking (Koerner et al., 2005).

1.5 Lifetime Stages of HDPE

Hsuan and Koerner (1998) describe that the oxidative degradation of HDPE geomembrane can be divided into three distinct stages:

- Stage A – Antioxidant depletion time.
- Stage B – Induction Time to the Onset of Degradation.
- Stage C – Time to reach 50% Degradation (Half-life), based on change of the molecular structure accompanied by a deterioration of the decisive mechanical properties.

The duration of the antioxidant depletion stage (Stage A) is dependent on both the type and amount of various antioxidants used in the precise formulation of the HDPE, the service temperature and the nature of the site-specific environment (Rowe and Sangam, 2001). The depletion of anti-oxidants is a consequence of chemical reactions with oxygen diffusing into the geomembrane and the physical loss of anti-oxidants from the geomembrane. The physical loss of anti-oxidants is related to their physical distribution in the geomembrane and their volatility and extractability in the in-situ environment (Koerner et al., 2005).

Once anti-oxidants are depleted, the rate of oxidation follows an S-shaped curve: the initial rate of oxidation is very slow, followed by an accelerated period and then the rate slows again. The initial period of slow oxidation is referred to as induction time or Stage B (Hsuan and Koerner, 1998). During Stage B the polymer reacts with oxygen forming hydroperoxide (ROOH), however the amount of ROOH formed is very small and the compound does not decompose further into other free radicals at this stage. As oxidation continues and ROOH is being formed, the concentration of ROOH will eventually reach a critical level at which ROOH begins to decompose into other free radicals. The presence of additional free radicals causes an increased rate of oxidation, which signifies the end of Stage B.

In Stage C oxidation continues and the polymer begins to degrade with noticeable change in the physical properties, including decreases in both tensile strength and break strain until the material reaches the limit of service life (half-life) (Hsuan and Koerner, 1998).

1.6 Service Life Estimate

Sangam (2001) examined the service lives of HDPE geomembranes under various exposure condition scenarios that the geomembranes may be subjected to when used as bottom liners for MSW landfills. For the typical groundwater temperature range of 7–10°C, Sangam (2001) estimated that the geomembrane used as a secondary liner will last at least 400 years provided that it has a suitable antioxidant package, is not subjected to significant tensile stress and is covered by an adequate protection layer. Koerner, Hsuan and Koerner (2005) used test-derived data and modeling to estimate that the total predicted half-life (Stages A, B and C) of HDPE is between 446 years at 20°C and 69 years at 40°C. The predicated time of Stage C was based on Arrhenius modeling and is dependent on the activation energy.

The average annual surface temperature in Campbell River, BC is 9.0°C and ranges from a daily average of 2.1°C in December to 17.3°C in July (Government of Canada, 2018). Due the nature of the waste, being DLC and not containing significant volumes of putrescible waste, biological activity will not be significant, therefore the temperature on the liner is not expected to be elevated. Based on the preceding, the HDPE geomembrane will be exposed to temperatures below or within the range of 20°C resulting in a service life well beyond the estimated CLS of the Landfill.

2. References

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Appendix C
Soil Acceptance Plan

Northwin Landfill
#210-909 Island Highway
Campbell River, BC
V9W 2C2
Phone (250) 286-1148
Fax (250) 286-3546

Soil Screening Process

Upland staff will complete the following steps prior to the acceptance of soil and during discharge at the Original Landfill lined cell.

Phase 1 – Prior to Discharge

Ask the Company the following questions and confirm their responses by visual inspection.

1. Is the soil generated from a site that may be contaminated? Y/N

2. Does the soil contain or is intermixed with waste including but not limited to plastic, metal debris, PVC pipe, or insulation? Y/N

3. Does the soil have any visible stains? Y/N

4. Is the soil odorous? Y/N

5. Does the soil comply with the OCP Soil Acceptance Plan? Y/N

The generating company must sign the Soil Acceptance Agreement, answered No to Questions 1 to 4, and answered Yes to Question 5, before proceeding with soil discharge to the Original Landfill lined cell.

If the answer to Question 1 is yes, the soil characterization must be certified by Qualified Professional.

Phase 2 – During/Following Discharge

During discharge (i.e., dumping) at the lined cell, confirm that the soil does not contain any waste material including but not limited to:

1. Plastic

2. Metal debris

3. PVC pipe

4. Insulation

5. Asbestos Containing Material

6. Other waste material

7. Staining

8. Odorous soil (i.e., gasoline, chemical, paint; etc. odour)

If the soil contains one or more waste materials, isolate the soil for testing or removal. Record non-compliant or rejected loads on the corresponding Soil Acceptance Agreement and contact your supervisor for further direction.

Northwin Landfill
#210-909 Island Highway
Campbell River, BC
V9W 2C2
Phone (250) 286-1148 Fax (250) 286-3546

Soil Acceptance Agreement

This Agreement must be executed before any soil can be accepted by Upland Excavating Ltd. at the Northwin Landfill located at 7295 Gold River Highway (Northwin Landfill). The Northwin Landfill requires this agreement to be executed by an authorized signatory of your firm (the "Company").

By signing this agreement, the Company represents and warrants to Northwin Landfill that none of the soil delivered to Northwin Landfill by the Company is hazardous waste and does not contain any hazardous waste constituents as defined by the Qualified Professional for the Northwin Landfill (the "Criteria") or any other criteria stipulated by Northwin Landfill and which may be amended from time to time at its sole discretion upon notice to the Company.

Northwin Landfill further serves the right to inspect and sample and/or may require the Company to sample any and all soil before accepting the soil. The right of Northwin Landfill to inspect or sample the soil does not reduce, restrict or otherwise affect the Company's liability in relation to soil that that contains any waste material or does not meet the Criteria. Any soil that contains waste material or does not meet the Criteria may be rejected by Northwin Landfill acting in its discretion and Northwin Landfill may request the Company to remove and dispose of such soil/material, such removal and disposal being the sole cost, risk and responsibility of the Company. If after acceptance by Northwin Landfill, the soil is discovered to include waste material or not meet the Criteria, Northwin Landfill will notify the Company. If requested the Company shall remove the soil/material within 24 hours of notification and dispose of the same in accordance with all applicable laws.

The Company agrees to defend, indemnify and hold Northwin Landfill harmless from and against any and all claims, demands, orders, causes of action, damages, liabilities, losses, expenses, penalties and all costs of defense relative thereto, including legal fees, caused by or resulting from the Company's breach of this agreement, including without limitation, any breach of the Company's obligation to deliver only soil and meets the Criteria.

This Agreement does not confer a right on the Company to deliver soil to the Northwin Landfill. Northwin Landfill reserves the right to reject for any reason, any and all deliveries of soil made by or desired to be made by the Company.

This Agreement commences effective as of the first day on which the Company delivers soil to the Northwin Landfill.

Any waiver of any provisions of this Agreement must be in writing signed by the Northwin Landfill.

Name:	Title:
Company:	Company Address:
Site Name:	Site Address:
Signature:	Date:

Appendix D
Surface Water Management Plan Supporting Documents

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Short Duration Rainfall Intensity-Duration-Frequency Data
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée

Gumbel - Method of moments/Méthode des moments

2021/03/26

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CAMPBELL RIVER A BC 1021261
(composite)
Latitude: 49 57'N Longitude: 125 16'W Elevation/Altitude: 108 m

Years/Années : 1970 - 2002 # Years/Années : 21

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Table 1 : Annual Maximum (mm)/Maximum annuel (mm)

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Year / Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1970	-99.9	-99.9	-99.9	-99.9	9.4	16.0	25.7	43.7	55.1
1971	-99.9	-99.9	-99.9	-99.9	9.1	15.5	29.2	46.0	57.7
1972	-99.9	-99.9	-99.9	-99.9	15.5	22.9	38.9	57.9	73.9
1973	-99.9	-99.9	-99.9	-99.9	9.1	14.0	26.2	39.4	53.3
1974	-99.9	-99.9	-99.9	-99.9	8.1	12.4	26.4	39.9	65.5
1975	-99.9	-99.9	-99.9	-99.9	18.3	20.6	41.9	44.2	59.7
1976	-99.9	-99.9	-99.9	-99.9	8.1	15.7	41.1	45.7	48.5
1981	-99.9	-99.9	-99.9	-99.9	12.4	18.6	33.4	39.8	63.2
1982	3.3	5.2	7.8	13.7	17.7	19.6	32.4	49.2	62.9
1983	2.8	3.9	4.7	7.4	10.9	17.7	33.6	53.1	79.6
1984	4.2	5.6	6.9	12.3	20.2	29.6	48.6	59.3	62.0
1985	2.6	2.9	3.6	6.3	9.0	12.0	21.4	24.7	36.8
1986	5.1	5.9	6.1	7.3	7.8	13.9	27.5	40.7	56.1
1987	2.4	3.2	3.7	4.6	8.5	16.4	39.0	43.6	65.7
1988	1.8	2.2	3.0	4.9	8.6	16.9	36.1	45.7	50.5
1989	4.6	7.1	9.0	13.0	14.5	14.6	18.5	29.2	39.2
1990	5.2	7.7	9.6	12.9	15.8	16.2	24.7	45.9	69.8
1991	1.7	2.8	3.9	5.9	9.6	16.9	42.5	64.1	72.3
1992	3.1	4.3	6.1	8.6	11.4	13.6	28.6	-99.9	61.6
1993	2.1	3.6	4.1	6.5	9.3	16.0	36.2	61.9	97.4
1994	3.6	4.8	5.3	6.8	9.7	15.3	31.9	49.6	58.3

1995	7.4	10.4	11.6	12.4	14.1	19.5	34.8	53.6	68.1
1996	5.5	5.9	6.1	8.0	11.5	14.9	27.6	39.9	50.9
1997	4.9	5.8	7.0	9.5	10.9	13.5	35.1	41.6	63.6
1998	5.5	8.8	10.3	13.1	15.3	18.8	32.5	-99.9	61.0
1999	2.2	3.6	4.5	6.0	9.1	17.2	33.2	63.6	81.0
2000	5.5	8.4	10.2	13.1	14.7	14.7	20.2	28.4	37.8
2001	3.5	4.8	5.4	8.9	13.5	18.1	32.3	38.3	46.8
2002	3.9	4.9	6.2	6.9	9.7	13.1	26.1	43.5	55.7
# Yrs. Années	21	21	21	21	29	29	29	27	29
Mean Moyenne	3.9	5.3	6.4	9.0	11.8	16.7	31.9	45.6	60.5
Std. Dev. Écart-type	1.5	2.2	2.5	3.1	3.5	3.6	7.1	10.1	13.2
Skew. Dissymétrie	0.45	0.75	0.62	0.35	0.86	1.84	0.21	0.06	0.50
Kurtosis	3.03	3.42	2.78	1.93	2.98	8.31	3.13	3.19	4.36

*-99.9 Indicates Missing Data/Données manquantes

Warning: annual maximum amount greater than 100-yr return period amount
Avertissement : la quantité maximale annuelle excède la quantité pour une période de retour de 100 ans

Year/Année	Duration/Durée	Data/Données	100-yr/ans
1984	2 h	29.6	27.8

****

Table 2a : Return Period Rainfall Amounts (mm)
Quantité de pluie (mm) par période de retour

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	3.6	4.9	5.8	7.0	7.8	8.6	21
10 min	5.0	6.9	8.1	9.7	10.9	12.1	21
15 min	6.0	8.2	9.7	11.5	12.9	14.2	21
30 min	8.4	11.2	13.0	15.3	17.0	18.7	21
1 h	11.2	14.3	16.3	18.9	20.8	22.6	29
2 h	16.1	19.3	21.3	24.0	25.9	27.8	29
6 h	30.8	37.0	41.2	46.4	50.3	54.2	29
12 h	44.0	52.9	58.9	66.3	71.9	77.4	27
24 h	58.3	70.0	77.7	87.5	94.7	101.9	29

****

Table 2b :

Return Period Rainfall Rates (mm/h) - 95% Confidence limits
Intensité de la pluie (mm/h) par période de retour - Limites de confiance de 95%

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	43.2	59.4	70.1	83.6	93.6	103.5	21
	+/- 7.2	+/- 12.1	+/- 16.3	+/- 22.0	+/- 26.3	+/- 30.7	21
10 min	29.8	41.3	48.9	58.4	65.5	72.6	21
	+/- 5.1	+/- 8.6	+/- 11.6	+/- 15.6	+/- 18.7	+/- 21.8	21
15 min	24.1	32.9	38.7	46.0	51.5	56.9	21
	+/- 3.9	+/- 6.6	+/- 8.9	+/- 12.0	+/- 14.3	+/- 16.7	21
30 min	16.9	22.4	26.0	30.6	34.1	37.4	21
	+/- 2.4	+/- 4.1	+/- 5.6	+/- 7.5	+/- 9.0	+/- 10.4	21
1 h	11.2	14.3	16.3	18.9	20.8	22.6	29
	+/- 1.2	+/- 1.9	+/- 2.6	+/- 3.5	+/- 4.2	+/- 4.9	29
2 h	8.1	9.6	10.7	12.0	13.0	13.9	29
	+/- 0.6	+/- 1.0	+/- 1.4	+/- 1.8	+/- 2.2	+/- 2.5	29
6 h	5.1	6.2	6.9	7.7	8.4	9.0	29
	+/- 0.4	+/- 0.7	+/- 0.9	+/- 1.2	+/- 1.4	+/- 1.7	29
12 h	3.7	4.4	4.9	5.5	6.0	6.5	27
	+/- 0.3	+/- 0.5	+/- 0.7	+/- 0.9	+/- 1.1	+/- 1.2	27
24 h	2.4	2.9	3.2	3.6	3.9	4.2	29
	+/- 0.2	+/- 0.3	+/- 0.4	+/- 0.6	+/- 0.7	+/- 0.8	29

Table 3 : Interpolation Equation / Équation d'interpolation: R = A*T^B

R = Interpolated Rainfall rate (mm/h)/Intensité interpolée de la pluie (mm/h)
RR = Rainfall rate (mm/h) / Intensité de la pluie (mm/h)
T = Rainfall duration (h) / Durée de la pluie (h)

Statistics/Statistiques	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans
Mean of RR/Moyenne de RR	16.1	21.5	25.1	29.6	33.0	36.3
Std. Dev. /Écart-type (RR)	13.9	19.4	23.1	27.8	31.2	34.7
Std. Error/Erreur-type	0.7	1.1	1.4	1.7	2.0	2.3
Coefficient (A)	12.0	15.5	17.7	20.6	22.7	24.7
Exponent/Exposant (B)	-0.499	-0.529	-0.543	-0.556	-0.563	-0.569
Mean % Error/% erreur moyenne	3.3	4.2	4.9	5.5	5.8	6.1

Design Calculations - Forebay Desgin
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbiaa

Task: Design forebay for the inlet of Infiltration Pond

In accordance with "Best Management Practices Guide for Stormwater", Sedimentation forebay should provide 10% volume of total design storage volume for pond.

Infiltration Basin Volume=	3313	m^3
Sediment Forebay Volume=	10% of Infiltration Basin Volume	
Sediment Forebay Volume=	331	m^3
Forebay Length to width ratio=	2:1	
Forebay Depth=	1	m
Forebay Length=	**26**	m
Forebay Width=	**13**	m
Forebay Depth=	**1**	m

Reference: Allan Gibb, Harlan Kelly, and Thomas Schueler, 1999, Best Management Practices Guide for Stormwater, Prepared for Greater Vancouver Sewerage and Drainage District.

Design Calculations - Infiltration Pond
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

East and West Infiltration Pond
Stage/Storage Relationship

Elevation		Area		Depth		Total Storage	
(m)	(ft)	(m^2)	(ft^2)	(m)	(ft)	(m^3)	(ft^3)
150	492.1	2930	31533	0			
150.20	492.8	3078	33128	0.2	0.7	601	21214
150.40	493.4	3228	34751	0.4	1.3	1232	43493
150.60	494.1	3382	36401	0.6	2.0	1893	66864
150.80	494.8	3538	38080	0.8	2.6	2587	91356
151.00	495.4	3696	39787	1	3.3	3313	116994

Note:

* Volume for an interval calculated by Average End Area Method.
* Length to width ratio of infiltration pond assumed as 3:1.
* Assume vertical to horizontal slope of 1:3 on all sides of infiltration pond
*Area calculated for 1m depth assumes 10% goes into sedimentation bay so uses 0.9 fac

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)

****
Element Count
****
Number of rain gages 4
Number of subcatchments ... 15
Number of nodes 14
Number of links 12
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
100yr_SCS_Type_IA_117.4mm	100yr_SCS_Type_IA_117.4mm	INTENSITY	15 min.
10yr_SCS_Type_IA_89.5mm	10yr_SCS_Type_IA_89.5mm	INTENSITY	15 min.
200yr_SCS_Type_IA_126.8mm	200yr_SCS_Type_IA_126.8mm	INTENSITY	15 min.
5yr_SCS_Type_IA_80.6mm	5yr_SCS_Type_IA_80.6mm	INTENSITY	15 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
101	0.79	196.75	0.00	45.0000	5yr_SCS_Type_IA_80.6mm	J5
102	0.08	21.05	0.00	45.0000	5yr_SCS_Type_IA_80.6mm	J5
103	0.13	33.30	0.00	45.0000	5yr_SCS_Type_IA_80.6mm	J4
104	1.35	245.89	0.00	35.0000	5yr_SCS_Type_IA_80.6mm	J8
105	0.20	67.73	0.00	20.0000	5yr_SCS_Type_IA_80.6mm	J7
106	0.95	146.54	0.00	22.0000	5yr_SCS_Type_IA_80.6mm	J2
107	0.51	146.63	0.00	30.0000	5yr_SCS_Type_IA_80.6mm	J5
108	0.53	150.14	0.00	30.0000	5yr_SCS_Type_IA_80.6mm	J8
109	0.92	141.63	0.00	22.0000	5yr_SCS_Type_IA_80.6mm	J3
110	0.18	40.56	0.00	22.0000	5yr_SCS_Type_IA_80.6mm	J1
111	0.19	42.33	0.00	22.0000	5yr_SCS_Type_IA_80.6mm	J1
112	0.46	185.00	100.00	15.0000	5yr_SCS_Type_IA_80.6mm	POND_East
113	0.29	82.37	0.00	30.0000	5yr_SCS_Type_IA_80.6mm	J9
114	0.50	200.56	100.00	15.0000	5yr_SCS_Type_IA_80.6mm	POND_West
115	0.28	81.14	0.00	30.0000	5yr_SCS_Type_IA_80.6mm	J6

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J1	JUNCTION	164.50	0.60	0.0	
J10	JUNCTION	164.50	0.60	0.0	
J2	JUNCTION	164.30	0.60	0.0	
J3	JUNCTION	164.30	0.60	0.0	
J4	JUNCTION	164.00	0.60	0.0	
J5	JUNCTION	156.00	0.60	0.0	
J6	JUNCTION	153.00	0.50	0.0	
J7	JUNCTION	164.00	0.60	0.0	
J8	JUNCTION	156.00	0.60	0.0	
J9	JUNCTION	153.00	0.50	0.0	
OF1	OUTFALL	149.50	0.00	0.0	
OF2	OUTFALL	149.50	0.00	0.0	
POND_East	STORAGE	150.00	1.00	0.0	
POND_West	STORAGE	150.00	1.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
D101	J1	J2	CONDUIT	57.9	0.3454	0.0300
D102	J2	J4	CONDUIT	146.4	0.2050	0.0300
D103	J4	J5	CONDUIT	31.7	26.0720	0.0300
D104	J5	J6	CONDUIT	174.8	1.7166	0.0300
D105	J10	J3	CONDUIT	59.2	0.3376	0.0300
D106	J3	J7	CONDUIT	149.5	0.2006	0.0300
D107	J7	J8	CONDUIT	34.2	24.0519	0.0300
D108	J8	J9	CONDUIT	180.0	1.6664	0.0300
D109	J6	POND_West	CONDUIT	53.0	4.7258	0.0300
D110	J9	POND_East	CONDUIT	42.9	5.8372	0.0300
OL1	POND_West	OF1	OUTLET			
OL2	POND_East	OF2	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
D101	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.92
D102	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.71
D103	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	7.16
D104	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.84
D105	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.91
D106	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.70
D107	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	6.88
D108	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.81
D109	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.05
D110	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.39

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... NO
Infiltration Method ..... HORTON
Flow Routing Method ..... DYNWAVE
Starting Date JAN-19-2016 00:00:00
Ending Date JAN-25-2016 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:00:01
Dry Time Step 00:00:01
Routing Time Step ..... 1.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.595	80.600
Evaporation Loss	0.000	0.000
Infiltration Loss	0.055	7.446
Surface Runoff	0.539	73.029
Final Storage	0.001	0.124

```
  Continuity Error (%) .....         0.000


  **************************        Volume        Volume
  Flow Routing Continuity        hectare-m      10^6 ltr
  **************************     ---------     ---------
  Dry Weather Inflow .......         0.000         0.000
  Wet Weather Inflow .......         0.539         5.390
  Groundwater Inflow .......         0.000         0.000
  RDII Inflow ..............         0.000         0.000
  External Inflow ..........         0.000         0.000
  External Outflow .........         0.560         5.600
  Flooding Loss ............         0.000         0.000
  Evaporation Loss .........         0.000         0.000
  Exfiltration Loss ........         0.000         0.000
  Initial Stored Volume ....         0.000         0.000
  Final Stored Volume ......         0.000         0.000
  Continuity Error (%) .....        -3.899


  ************************
  Highest Continuity Errors
  ************************
  Node POND_West (-4.00%)
  Node POND_East (-3.80%)


  ***************************
  Time-Step Critical Elements
  ***************************
  None


  *******************************
  Highest Flow Instability Indexes
  *******************************
  Link OL1 (4)
  Link OL2 (3)


  ************************
  Routing Time Step Summary
  ************************
  Minimum Time Step           :     0.50 sec
  Average Time Step           :     1.00 sec
  Maximum Time Step           :     1.00 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     2.00
  Percent Not Converging      :     0.00


  ***************************
  Subcatchment Runoff Summary
  ***************************

  ---------------------------------------------------------------------------------------------------
----
                           Total      Total      Total      Total      Total       Total     Peak
Runoff
                          Precip      Runon       Evap      Infil     Runoff      Runoff   Runoff
Coeff
  Subcatchment                mm         mm         mm         mm         mm    10^6 ltr      CMS
  ---------------------------------------------------------------------------------------------------
----
  101                      80.60       0.00       0.00       7.91      72.69        0.57     0.03
0.902
  102                      80.60       0.00       0.00       7.91      72.69        0.06     0.00
0.902
  103                      80.60       0.00       0.00       7.91      72.69        0.10     0.00
0.902
  104                      80.60       0.00       0.00       7.94      72.66        0.98     0.05
0.902
  105                      80.60       0.00       0.00       7.92      72.68        0.15     0.01
0.902
  106                      80.60       0.00       0.00       9.05      71.55        0.68     0.03
0.888
```

107	80.60	0.00	0.00	8.92	71.68	0.37	0.02	0.889
108	80.60	0.00	0.00	8.92	71.68	0.38	0.02	0.889
109	80.60	0.00	0.00	9.05	71.55	0.66	0.03	0.888
110	80.60	0.00	0.00	8.98	71.62	0.13	0.01	0.889
111	80.60	0.00	0.00	8.98	71.62	0.14	0.01	0.889
112	80.60	0.00	0.00	0.00	79.65	0.37	0.02	0.988
113	80.60	0.00	0.00	8.92	71.68	0.21	0.01	0.889
114	80.60	0.00	0.00	0.00	79.65	0.40	0.02	0.988
115	80.60	0.00	0.00	8.92	71.68	0.20	0.01	0.889

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.01	0.14	164.64	0 08:00	0.04
J10	JUNCTION	0.00	0.10	164.60	0 08:01	0.03
J2	JUNCTION	0.04	0.33	164.63	0 08:00	0.10
J3	JUNCTION	0.03	0.30	164.60	0 08:00	0.09
J4	JUNCTION	0.00	0.04	164.04	0 08:00	0.01
J5	JUNCTION	0.01	0.13	156.13	0 08:00	0.04
J6	JUNCTION	0.01	0.10	153.10	0 08:00	0.03
J7	JUNCTION	0.00	0.04	164.04	0 08:00	0.01
J8	JUNCTION	0.01	0.14	156.14	0 08:00	0.04
J9	JUNCTION	0.01	0.10	153.10	0 08:00	0.03
OF1	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
OF2	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
POND_East	STORAGE	0.01	0.14	150.14	0 09:41	0.04
POND_West	STORAGE	0.00	0.13	150.13	0 09:36	0.04

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
J1	JUNCTION	0.013	0.013	0 08:00	0.267	0.267	-0.084
J10	JUNCTION	0.000	0.001	0 07:15	0	0.00178	1.356
J2	JUNCTION	0.033	0.046	0 08:00	0.681	0.949	0.030
J3	JUNCTION	0.032	0.032	0 08:00	0.659	0.66	0.010
J4	JUNCTION	0.005	0.050	0 08:00	0.0968	1.05	-0.004
J5	JUNCTION	0.048	0.098	0 08:00	1	2.05	-0.003
J6	JUNCTION	0.010	0.108	0 08:00	0.204	2.25	0.002
J7	JUNCTION	0.007	0.038	0 08:00	0.148	0.806	-0.009
J8	JUNCTION	0.065	0.104	0 08:00	1.36	2.17	-0.004
J9	JUNCTION	0.010	0.114	0 08:00	0.207	2.37	0.003
OF1	OUTFALL	0.000	0.049	0 04:11	0	2.76	0.000
OF2	OUTFALL	0.000	0.049	0 04:08	0	2.84	0.000
POND_East	STORAGE	0.016	0.130	0 08:00	0.368	2.74	-3.665
POND_West	STORAGE	0.018	0.126	0 08:00	0.399	2.65	-3.842

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
POND_East	0.016	0	0	0	0.404	12	0 09:41	0.049
POND_West	0.014	0	0	0	0.375	11	0 09:36	0.049

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	14.78	0.036	0.049	2.755
OF2	14.94	0.037	0.049	2.845
System	14.86	0.073	0.098	5.600

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
D101	CONDUIT	0.013	0 08:00	0.10	0.01	0.40
D102	CONDUIT	0.046	0 08:00	0.42	0.06	0.32
D103	CONDUIT	0.050	0 08:00	0.75	0.01	0.18
D104	CONDUIT	0.098	0 08:00	0.96	0.05	0.24
D105	CONDUIT	0.001	0 07:15	0.01	0.00	0.33
D106	CONDUIT	0.031	0 08:00	0.38	0.05	0.28
D107	CONDUIT	0.038	0 08:00	0.57	0.01	0.18
D108	CONDUIT	0.104	0 08:00	0.99	0.06	0.24
D109	CONDUIT	0.108	0 08:00	1.27	0.04	0.21
D110	CONDUIT	0.114	0 08:00	1.39	0.03	0.20
OL1	DUMMY	0.049	0 04:11			
OL2	DUMMY	0.049	0 04:08			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
D101	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.97	0.00
D102	1.00	0.02	0.01	0.00	0.98	0.00	0.00	0.00	0.00	0.00
D103	1.00	0.48	0.21	0.00	0.31	0.00	0.00	0.00	0.37	0.00
D104	1.00	0.48	0.00	0.00	0.50	0.02	0.00	0.00	0.08	0.00
D105	1.00	0.02	0.02	0.00	0.96	0.00	0.00	0.00	0.93	0.00
D106	1.00	0.02	0.01	0.00	0.98	0.00	0.00	0.00	0.00	0.00
D107	1.00	0.48	0.21	0.00	0.31	0.00	0.00	0.00	0.38	0.00

D108	1.00	0.48	0.00	0.00	0.49	0.03	0.00	0.00	0.03	0.00
D109	1.00	0.68	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00
D110	1.00	0.69	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Mon Jun 28 15:51:36 2021
Analysis ended on: Mon Jun 28 15:51:43 2021
Total elapsed time: 00:00:07

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)

****
Element Count
****
Number of rain gages 4
Number of subcatchments ... 15
Number of nodes 14
Number of links 12
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
100yr_SCS_Type_IA_117.4mm	100yr_SCS_Type_IA_117.4mm	INTENSITY	15 min.
10yr_SCS_Type_IA_89.5mm	10yr_SCS_Type_IA_89.5mm	INTENSITY	15 min.
200yr_SCS_Type_IA_126.8mm	200yr_SCS_Type_IA_126.8mm	INTENSITY	15 min.
5yr_SCS_Type_IA_80.6mm	5yr_SCS_Type_IA_80.6mm	INTENSITY	15 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
101	0.79	196.75	0.00	45.0000	10yr_SCS_Type_IA_89.5mm	J5
102	0.08	21.05	0.00	45.0000	10yr_SCS_Type_IA_89.5mm	J5
103	0.13	33.30	0.00	45.0000	10yr_SCS_Type_IA_89.5mm	J4
104	1.35	245.89	0.00	35.0000	10yr_SCS_Type_IA_89.5mm	J8
105	0.20	67.73	0.00	20.0000	10yr_SCS_Type_IA_89.5mm	J7
106	0.95	146.54	0.00	22.0000	10yr_SCS_Type_IA_89.5mm	J2
107	0.51	146.63	0.00	30.0000	10yr_SCS_Type_IA_89.5mm	J5
108	0.53	150.14	0.00	30.0000	10yr_SCS_Type_IA_89.5mm	J8
109	0.92	141.63	0.00	22.0000	10yr_SCS_Type_IA_89.5mm	J3
110	0.18	40.56	0.00	22.0000	10yr_SCS_Type_IA_89.5mm	J1
111	0.19	42.33	0.00	22.0000	10yr_SCS_Type_IA_89.5mm	J1
112	0.46	185.00	100.00	15.0000	10yr_SCS_Type_IA_89.5mm	POND_East
113	0.29	82.37	0.00	30.0000	10yr_SCS_Type_IA_89.5mm	J9
114	0.50	200.56	100.00	15.0000	10yr_SCS_Type_IA_89.5mm	POND_West
115	0.28	81.14	0.00	30.0000	10yr_SCS_Type_IA_89.5mm	J6

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J1	JUNCTION	164.50	0.60	0.0	
J10	JUNCTION	164.50	0.60	0.0	
J2	JUNCTION	164.30	0.60	0.0	
J3	JUNCTION	164.30	0.60	0.0	
J4	JUNCTION	164.00	0.60	0.0	
J5	JUNCTION	156.00	0.60	0.0	
J6	JUNCTION	153.00	0.50	0.0	
J7	JUNCTION	164.00	0.60	0.0	
J8	JUNCTION	156.00	0.60	0.0	
J9	JUNCTION	153.00	0.50	0.0	
OF1	OUTFALL	149.50	0.00	0.0	
OF2	OUTFALL	149.50	0.00	0.0	
POND_East	STORAGE	150.00	1.00	0.0	
POND_West	STORAGE	150.00	1.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
D101	J1	J2	CONDUIT	57.9	0.3454	0.0300
D102	J2	J4	CONDUIT	146.4	0.2050	0.0300
D103	J4	J5	CONDUIT	31.7	26.0720	0.0300
D104	J5	J6	CONDUIT	174.8	1.7166	0.0300
D105	J10	J3	CONDUIT	59.2	0.3376	0.0300
D106	J3	J7	CONDUIT	149.5	0.2006	0.0300
D107	J7	J8	CONDUIT	34.2	24.0519	0.0300
D108	J8	J9	CONDUIT	180.0	1.6664	0.0300
D109	J6	POND_West	CONDUIT	53.0	4.7258	0.0300
D110	J9	POND_East	CONDUIT	42.9	5.8372	0.0300
OL1	POND_West	OF1	OUTLET			
OL2	POND_East	OF2	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
D101	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.92
D102	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.71
D103	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	7.16
D104	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.84
D105	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.91
D106	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.70
D107	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	6.88
D108	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.81
D109	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.05
D110	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.39

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... NO
Infiltration Method ..... HORTON
Flow Routing Method ..... DYNWAVE
Starting Date JAN-19-2016 00:00:00
Ending Date JAN-25-2016 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:00:01
Dry Time Step 00:00:01
Routing Time Step ..... 1.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.661	89.503
Evaporation Loss	0.000	0.000
Infiltration Loss	0.055	7.454
Surface Runoff	0.605	81.924
Final Storage	0.001	0.124

```
  Continuity Error (%) .....         0.000


  **************************        Volume        Volume
  Flow Routing Continuity        hectare-m      10^6 ltr
  **************************     ---------     ---------
  Dry Weather Inflow .......         0.000         0.000
  Wet Weather Inflow .......         0.605         6.047
  Groundwater Inflow .......         0.000         0.000
  RDII Inflow ..............         0.000         0.000
  External Inflow ..........         0.000         0.000
  External Outflow .........         0.613         6.131
  Flooding Loss ............         0.000         0.000
  Evaporation Loss .........         0.000         0.000
  Exfiltration Loss ........         0.000         0.000
  Initial Stored Volume ....         0.000         0.000
  Final Stored Volume ......         0.000         0.000
  Continuity Error (%) .....        -1.395


  ************************
  Highest Continuity Errors
  ************************
  Node POND_East (-1.53%)
  Node POND_West (-1.25%)


  ***************************
  Time-Step Critical Elements
  ***************************
  None


  *******************************
  Highest Flow Instability Indexes
  *******************************
  Link OL1 (4)
  Link OL2 (3)


  ************************
  Routing Time Step Summary
  ************************
  Minimum Time Step           :     0.50 sec
  Average Time Step           :     1.00 sec
  Maximum Time Step           :     1.00 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     2.00
  Percent Not Converging      :     0.00


  ***************************
  Subcatchment Runoff Summary
  ***************************

  ---------------------------------------------------------------------------------------------------
----
                           Total      Total      Total      Total      Total       Total     Peak
Runoff
                          Precip      Runon       Evap      Infil     Runoff      Runoff   Runoff
Coeff
  Subcatchment                mm         mm         mm         mm         mm    10^6 ltr      CMS
  ---------------------------------------------------------------------------------------------------
----
  101                      89.50       0.00       0.00       7.92      81.58        0.64     0.03
0.912
  102                      89.50       0.00       0.00       7.92      81.58        0.07     0.00
0.912
  103                      89.50       0.00       0.00       7.92      81.58        0.11     0.01
0.912
  104                      89.50       0.00       0.00       7.95      81.55        1.10     0.05
0.911
  105                      89.50       0.00       0.00       7.93      81.58        0.17     0.01
0.911
  106                      89.50       0.00       0.00       9.06      80.44        0.77     0.04
0.899
```

107	89.50	0.00	0.00	8.92	80.58	0.41	0.02
0.900							
108	89.50	0.00	0.00	8.92	80.58	0.42	0.02
0.900							
109	89.50	0.00	0.00	9.06	80.44	0.74	0.04
0.899							
110	89.50	0.00	0.00	8.99	80.51	0.15	0.01
0.900							
111	89.50	0.00	0.00	8.99	80.51	0.15	0.01
0.900							
112	89.50	0.00	0.00	0.00	88.55	0.41	0.02
0.989							
113	89.50	0.00	0.00	8.92	80.58	0.23	0.01
0.900							
114	89.50	0.00	0.00	0.00	88.55	0.44	0.02
0.989							
115	89.50	0.00	0.00	8.92	80.58	0.23	0.01
0.900							

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.01	0.15	164.65	0 08:00	0.05
J10	JUNCTION	0.00	0.11	164.61	0 08:01	0.03
J2	JUNCTION	0.04	0.35	164.65	0 08:00	0.11
J3	JUNCTION	0.03	0.31	164.61	0 08:00	0.09
J4	JUNCTION	0.00	0.05	164.05	0 08:00	0.01
J5	JUNCTION	0.01	0.14	156.14	0 08:00	0.04
J6	JUNCTION	0.01	0.11	153.11	0 08:00	0.03
J7	JUNCTION	0.00	0.04	164.04	0 08:00	0.01
J8	JUNCTION	0.01	0.15	156.15	0 08:00	0.05
J9	JUNCTION	0.01	0.11	153.11	0 08:00	0.03
OF1	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
OF2	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
POND_East	STORAGE	0.01	0.17	150.17	0 10:02	0.05
POND_West	STORAGE	0.01	0.16	150.16	0 09:58	0.05

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
J1	JUNCTION	0.014	0.014	0 08:00	0.3	0.3	-0.078
J10	JUNCTION	0.000	0.001	0 07:15	0	0.00208	1.072
J2	JUNCTION	0.037	0.051	0 08:00	0.766	1.07	0.028
J3	JUNCTION	0.035	0.035	0 08:00	0.741	0.743	0.011
J4	JUNCTION	0.005	0.056	0 08:00	0.109	1.18	-0.004
J5	JUNCTION	0.054	0.109	0 08:00	1.12	2.3	-0.003
J6	JUNCTION	0.011	0.120	0 08:00	0.229	2.53	0.002
J7	JUNCTION	0.008	0.043	0 08:00	0.166	0.906	-0.009
J8	JUNCTION	0.073	0.115	0 08:00	1.53	2.43	-0.004
J9	JUNCTION	0.011	0.127	0 08:00	0.232	2.67	0.003
OF1	OUTFALL	0.000	0.049	0 04:01	0	3.01	0.000
OF2	OUTFALL	0.000	0.049	0 03:56	0	3.12	0.000
POND_East	STORAGE	0.018	0.144	0 08:00	0.41	3.07	-1.510
POND_West	STORAGE	0.020	0.140	0 08:00	0.444	2.97	-1.236

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
POND_East	0.026	1	0	0	0.520	16	0 10:02	0.049
POND_West	0.022	1	0	0	0.481	15	0 09:58	0.049

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	15.03	0.039	0.049	3.009
OF2	15.32	0.039	0.049	3.122
System	15.18	0.078	0.098	6.131

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
D101	CONDUIT	0.014	0 08:00	0.10	0.02	0.42
D102	CONDUIT	0.051	0 08:00	0.44	0.07	0.33
D103	CONDUIT	0.056	0 08:00	0.78	0.01	0.19
D104	CONDUIT	0.109	0 08:00	0.99	0.06	0.25
D105	CONDUIT	0.001	0 07:15	0.01	0.00	0.34
D106	CONDUIT	0.035	0 08:00	0.39	0.05	0.29
D107	CONDUIT	0.043	0 08:00	0.59	0.01	0.19
D108	CONDUIT	0.115	0 08:00	1.02	0.06	0.26
D109	CONDUIT	0.120	0 08:00	1.31	0.04	0.22
D110	CONDUIT	0.126	0 08:00	1.43	0.04	0.21
OL1	DUMMY	0.049	0 04:01			
OL2	DUMMY	0.049	0 03:56			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
D101	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.97	0.00
D102	1.00	0.01	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00
D103	1.00	0.48	0.21	0.00	0.31	0.00	0.00	0.00	0.37	0.00
D104	1.00	0.48	0.00	0.00	0.50	0.02	0.00	0.00	0.08	0.00
D105	1.00	0.02	0.02	0.00	0.97	0.00	0.00	0.00	0.93	0.00
D106	1.00	0.01	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00
D107	1.00	0.48	0.21	0.00	0.31	0.00	0.00	0.00	0.38	0.00

D108	1.00	0.48	0.00	0.00	0.49	0.04	0.00	0.00	0.03	0.00
D109	1.00	0.68	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00
D110	1.00	0.69	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Mon Jun 28 15:50:23 2021
Analysis ended on: Mon Jun 28 15:50:30 2021
Total elapsed time: 00:00:07

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)

****
Element Count
****
Number of rain gages 4
Number of subcatchments ... 15
Number of nodes 14
Number of links 12
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
100yr_SCS_Type_IA_117.4mm	100yr_SCS_Type_IA_117.4mm	INTENSITY	15 min.
10yr_SCS_Type_IA_89.5mm	10yr_SCS_Type_IA_89.5mm	INTENSITY	15 min.
200yr_SCS_Type_IA_126.8mm	200yr_SCS_Type_IA_126.8mm	INTENSITY	15 min.
5yr_SCS_Type_IA_80.6mm	5yr_SCS_Type_IA_80.6mm	INTENSITY	15 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
101	0.79	196.75	0.00	45.0000	100yr_SCS_Type_IA_117.4mm	J5
102	0.08	21.05	0.00	45.0000	100yr_SCS_Type_IA_117.4mm	J5
103	0.13	33.30	0.00	45.0000	100yr_SCS_Type_IA_117.4mm	J4
104	1.35	245.89	0.00	35.0000	100yr_SCS_Type_IA_117.4mm	J8
105	0.20	67.73	0.00	20.0000	100yr_SCS_Type_IA_117.4mm	J7
106	0.95	146.54	0.00	22.0000	100yr_SCS_Type_IA_117.4mm	J2
107	0.51	146.63	0.00	30.0000	100yr_SCS_Type_IA_117.4mm	J5
108	0.53	150.14	0.00	30.0000	100yr_SCS_Type_IA_117.4mm	J8
109	0.92	141.63	0.00	22.0000	100yr_SCS_Type_IA_117.4mm	J3
110	0.18	40.56	0.00	22.0000	100yr_SCS_Type_IA_117.4mm	J1
111	0.19	42.33	0.00	22.0000	100yr_SCS_Type_IA_117.4mm	J1
112	0.46	185.00	100.00	15.0000	100yr_SCS_Type_IA_117.4mm	POND_East
113	0.29	82.37	0.00	30.0000	100yr_SCS_Type_IA_117.4mm	J9
114	0.50	200.56	100.00	15.0000	100yr_SCS_Type_IA_117.4mm	POND_West
115	0.28	81.14	0.00	30.0000	100yr_SCS_Type_IA_117.4mm	J6

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J1	JUNCTION	164.50	0.60	0.0	
J10	JUNCTION	164.50	0.60	0.0	
J2	JUNCTION	164.30	0.60	0.0	
J3	JUNCTION	164.30	0.60	0.0	
J4	JUNCTION	164.00	0.60	0.0	
J5	JUNCTION	156.00	0.60	0.0	
J6	JUNCTION	153.00	0.50	0.0	
J7	JUNCTION	164.00	0.60	0.0	
J8	JUNCTION	156.00	0.60	0.0	
J9	JUNCTION	153.00	0.50	0.0	
OF1	OUTFALL	149.50	0.00	0.0	
OF2	OUTFALL	149.50	0.00	0.0	
POND_East	STORAGE	150.00	1.00	0.0	
POND_West	STORAGE	150.00	1.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
D101	J1	J2	CONDUIT	57.9	0.3454	0.0300
D102	J2	J4	CONDUIT	146.4	0.2050	0.0300
D103	J4	J5	CONDUIT	31.7	26.0720	0.0300
D104	J5	J6	CONDUIT	174.8	1.7166	0.0300
D105	J10	J3	CONDUIT	59.2	0.3376	0.0300
D106	J3	J7	CONDUIT	149.5	0.2006	0.0300
D107	J7	J8	CONDUIT	34.2	24.0519	0.0300
D108	J8	J9	CONDUIT	180.0	1.6664	0.0300
D109	J6	POND_West	CONDUIT	53.0	4.7258	0.0300
D110	J9	POND_East	CONDUIT	42.9	5.8372	0.0300
OL1	POND_West	OF1	OUTLET			
OL2	POND_East	OF2	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
D101	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.92
D102	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.71
D103	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	7.16
D104	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.84
D105	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.91
D106	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.70
D107	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	6.88
D108	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.81
D109	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.05
D110	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.39

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... NO
Infiltration Method ..... HORTON
Flow Routing Method ..... DYNWAVE
Starting Date JAN-19-2016 00:00:00
Ending Date JAN-25-2016 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:00:01
Dry Time Step 00:00:01
Routing Time Step ..... 1.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.867	117.399
Evaporation Loss	0.000	0.000
Infiltration Loss	0.055	7.470
Surface Runoff	0.810	109.804
Final Storage	0.001	0.124

```
  Continuity Error (%) .....         0.000

  **************************        Volume        Volume
  Flow Routing Continuity        hectare-m      10^6 ltr
  **************************     ---------     ---------
  Dry Weather Inflow .......         0.000         0.000
  Wet Weather Inflow .......         0.810         8.105
  Groundwater Inflow .......         0.000         0.000
  RDII Inflow ..............         0.000         0.000
  External Inflow ..........         0.000         0.000
  External Outflow .........         0.811         8.115
  Flooding Loss ............         0.000         0.000
  Evaporation Loss .........         0.000         0.000
  Exfiltration Loss ........         0.000         0.000
  Initial Stored Volume ....         0.000         0.000
  Final Stored Volume ......         0.000         0.000
  Continuity Error (%) .....        -0.129

  ***************************
  Time-Step Critical Elements
  ***************************
  None

  *******************************
  Highest Flow Instability Indexes
  *******************************
  Link OL1 (1)
  Link OL2 (1)

  ************************
  Routing Time Step Summary
  ************************
  Minimum Time Step           :     0.50 sec
  Average Time Step           :     1.00 sec
  Maximum Time Step           :     1.00 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     2.00
  Percent Not Converging      :     0.00

  ***************************
  Subcatchment Runoff Summary
  ***************************

  ------------------------------------------------------------------------------------------------------
----
                           Total      Total      Total      Total      Total       Total     Peak
Runoff
                          Precip      Runon       Evap      Infil     Runoff      Runoff   Runoff
Coeff
  Subcatchment                mm         mm         mm         mm         mm    10^6 ltr      CMS
  ------------------------------------------------------------------------------------------------------
----
  101                     117.40       0.00       0.00       7.94     109.46        0.86     0.04
0.932
  102                     117.40       0.00       0.00       7.94     109.46        0.09     0.00
0.932
  103                     117.40       0.00       0.00       7.94     109.46        0.15     0.01
0.932
  104                     117.40       0.00       0.00       7.97     109.42        1.48     0.07
0.932
  105                     117.40       0.00       0.00       7.95     109.45        0.22     0.01
0.932
  106                     117.40       0.00       0.00       9.08     108.32        1.03     0.05
0.923
  107                     117.40       0.00       0.00       8.94     108.46        0.56     0.03
0.924
  108                     117.40       0.00       0.00       8.94     108.46        0.57     0.03
0.924
  109                     117.40       0.00       0.00       9.08     108.32        1.00     0.05
0.923
```

110	117.40	0.00	0.00	9.00	108.39	0.20	0.01	0.923
111	117.40	0.00	0.00	9.00	108.39	0.21	0.01	0.923
112	117.40	0.00	0.00	0.00	116.45	0.54	0.02	0.992
113	117.40	0.00	0.00	8.94	108.46	0.31	0.01	0.924
114	117.40	0.00	0.00	0.00	116.45	0.58	0.03	0.992
115	117.40	0.00	0.00	8.94	108.46	0.31	0.01	0.924

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.01	0.18	164.68	0 08:00	0.06
J10	JUNCTION	0.00	0.14	164.64	0 08:00	0.04
J2	JUNCTION	0.04	0.38	164.68	0 08:00	0.12
J3	JUNCTION	0.04	0.34	164.64	0 08:00	0.10
J4	JUNCTION	0.00	0.05	164.05	0 08:00	0.02
J5	JUNCTION	0.01	0.16	156.16	0 08:00	0.05
J6	JUNCTION	0.01	0.13	153.13	0 08:00	0.04
J7	JUNCTION	0.00	0.05	164.05	0 08:00	0.01
J8	JUNCTION	0.01	0.17	156.17	0 08:00	0.05
J9	JUNCTION	0.01	0.12	153.12	0 08:00	0.04
OF1	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
OF2	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
POND_East	STORAGE	0.03	0.32	150.32	0 11:45	0.10
POND_West	STORAGE	0.03	0.30	150.30	0 11:34	0.09

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
J1	JUNCTION	0.019	0.019	0 08:00	0.404	0.404	-0.066
J10	JUNCTION	0.000	0.001	0 07:14	0	0.00299	0.689
J2	JUNCTION	0.048	0.067	0 08:00	1.03	1.44	0.024
J3	JUNCTION	0.047	0.047	0 08:00	0.997	1	0.011
J4	JUNCTION	0.007	0.074	0 08:00	0.146	1.58	-0.004
J5	JUNCTION	0.070	0.144	0 08:00	1.51	3.09	-0.003
J6	JUNCTION	0.014	0.159	0 08:00	0.308	3.4	0.002
J7	JUNCTION	0.010	0.057	0 08:00	0.222	1.22	-0.008
J8	JUNCTION	0.095	0.152	0 08:00	2.05	3.27	-0.003
J9	JUNCTION	0.015	0.167	0 08:00	0.313	3.58	0.002
OF1	OUTFALL	0.000	0.049	0 02:50	0	3.99	0.000
OF2	OUTFALL	0.000	0.049	0 02:37	0	4.12	0.000
POND_East	STORAGE	0.024	0.190	0 08:00	0.539	4.12	-0.076
POND_West	STORAGE	0.026	0.184	0 08:00	0.584	3.98	-0.184

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
POND_East	0.089	3	0	0	0.975	29	0 11:45	0.049
POND_West	0.077	2	0	0	0.902	27	0 11:34	0.049

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	16.47	0.047	0.049	3.991
OF2	16.96	0.047	0.049	4.124
System	16.71	0.094	0.098	8.115

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
D101	CONDUIT	0.019	0 08:00	0.11	0.02	0.47
D102	CONDUIT	0.067	0 08:00	0.48	0.10	0.36
D103	CONDUIT	0.074	0 08:00	0.84	0.01	0.22
D104	CONDUIT	0.144	0 08:00	1.06	0.08	0.29
D105	CONDUIT	0.001	0 07:14	0.01	0.00	0.39
D106	CONDUIT	0.046	0 08:00	0.42	0.07	0.32
D107	CONDUIT	0.057	0 08:00	0.64	0.01	0.22
D108	CONDUIT	0.152	0 08:00	1.10	0.08	0.29
D109	CONDUIT	0.158	0 08:00	1.41	0.05	0.25
D110	CONDUIT	0.167	0 08:00	1.54	0.05	0.25
OL1	DUMMY	0.049	0 02:50			
OL2	DUMMY	0.049	0 02:37			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
D101	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.97	0.00
D102	1.00	0.01	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00
D103	1.00	0.47	0.21	0.00	0.32	0.00	0.00	0.00	0.38	0.00
D104	1.00	0.47	0.00	0.00	0.50	0.03	0.00	0.00	0.08	0.00
D105	1.00	0.02	0.01	0.00	0.97	0.00	0.00	0.00	0.91	0.00
D106	1.00	0.01	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00
D107	1.00	0.47	0.21	0.00	0.32	0.00	0.00	0.00	0.38	0.00
D108	1.00	0.47	0.00	0.00	0.46	0.07	0.00	0.00	0.03	0.00
D109	1.00	0.68	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00
D110	1.00	0.69	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00

****

Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Mon Jun 28 15:49:00 2021
Analysis ended on: Mon Jun 28 15:49:06 2021
Total elapsed time: 00:00:06

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.010)

****
Element Count
****
Number of rain gages 4
Number of subcatchments ... 15
Number of nodes 14
Number of links 12
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
100yr_SCS_Type_IA_117.4mm	100yr_SCS_Type_IA_117.4mm	INTENSITY	15 min.
10yr_SCS_Type_IA_89.5mm	10yr_SCS_Type_IA_89.5mm	INTENSITY	15 min.
200yr_SCS_Type_IA_126.8mm	200yr_SCS_Type_IA_126.8mm	INTENSITY	15 min.
5yr_SCS_Type_IA_80.6mm	5yr_SCS_Type_IA_80.6mm	INTENSITY	15 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
101	0.79	196.75	0.00	45.0000	200yr_SCS_Type_IA_126.8mm	J5
102	0.08	21.05	0.00	45.0000	200yr_SCS_Type_IA_126.8mm	J5
103	0.13	33.30	0.00	45.0000	200yr_SCS_Type_IA_126.8mm	J4
104	1.35	245.89	0.00	35.0000	200yr_SCS_Type_IA_126.8mm	J8
105	0.20	67.73	0.00	20.0000	200yr_SCS_Type_IA_126.8mm	J7
106	0.95	146.54	0.00	22.0000	200yr_SCS_Type_IA_126.8mm	J2
107	0.51	146.63	0.00	30.0000	200yr_SCS_Type_IA_126.8mm	J5
108	0.53	150.14	0.00	30.0000	200yr_SCS_Type_IA_126.8mm	J8
109	0.92	141.63	0.00	22.0000	200yr_SCS_Type_IA_126.8mm	J3
110	0.18	40.56	0.00	22.0000	200yr_SCS_Type_IA_126.8mm	J1
111	0.19	42.33	0.00	22.0000	200yr_SCS_Type_IA_126.8mm	J1
112	0.46	185.00	100.00	15.0000	200yr_SCS_Type_IA_126.8mm	POND_East
113	0.29	82.37	0.00	30.0000	200yr_SCS_Type_IA_126.8mm	J9
114	0.50	200.56	100.00	15.0000	200yr_SCS_Type_IA_126.8mm	POND_West
115	0.28	81.14	0.00	30.0000	200yr_SCS_Type_IA_126.8mm	J6

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
J1	JUNCTION	164.50	0.60	0.0	
J10	JUNCTION	164.50	0.60	0.0	
J2	JUNCTION	164.30	0.60	0.0	
J3	JUNCTION	164.30	0.60	0.0	
J4	JUNCTION	164.00	0.60	0.0	
J5	JUNCTION	156.00	0.60	0.0	
J6	JUNCTION	153.00	0.50	0.0	
J7	JUNCTION	164.00	0.60	0.0	
J8	JUNCTION	156.00	0.60	0.0	
J9	JUNCTION	153.00	0.50	0.0	
OF1	OUTFALL	149.50	0.00	0.0	
OF2	OUTFALL	149.50	0.00	0.0	
POND_East	STORAGE	150.00	1.00	0.0	
POND_West	STORAGE	150.00	1.00	0.0	

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
D101	J1	J2	CONDUIT	57.9	0.3454	0.0300
D102	J2	J4	CONDUIT	146.4	0.2050	0.0300
D103	J4	J5	CONDUIT	31.7	26.0720	0.0300
D104	J5	J6	CONDUIT	174.8	1.7166	0.0300
D105	J10	J3	CONDUIT	59.2	0.3376	0.0300
D106	J3	J7	CONDUIT	149.5	0.2006	0.0300
D107	J7	J8	CONDUIT	34.2	24.0519	0.0300
D108	J8	J9	CONDUIT	180.0	1.6664	0.0300
D109	J6	POND_West	CONDUIT	53.0	4.7258	0.0300
D110	J9	POND_East	CONDUIT	42.9	5.8372	0.0300
OL1	POND_West	OF1	OUTLET			
OL2	POND_East	OF2	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
D101	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.92
D102	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.71
D103	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	7.16
D104	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.84
D105	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.91
D106	TRIANGULAR	0.60	1.08	0.28	3.60	1	0.70
D107	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	6.88
D108	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.81
D109	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.05
D110	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	3.39

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... NO
Infiltration Method ..... HORTON
Flow Routing Method ..... DYNWAVE
Starting Date JAN-19-2016 00:00:00
Ending Date JAN-25-2016 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:00:01
Dry Time Step 00:00:01
Routing Time Step ..... 1.00 sec
Variable Time Step ..... YES
Maximum Trials 8
Number of Threads 1
Head Tolerance ..... 0.001500 m

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	0.936	126.800
Evaporation Loss	0.000	0.000
Infiltration Loss	0.055	7.474
Surface Runoff	0.880	119.202
Final Storage	0.001	0.124

Continuity Error (%) 0.000

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.880	8.798
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	0.880	8.802
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	-0.040	

Time-Step Critical Elements

None

Highest Flow Instability Indexes

Link OL2 (1)
Link OL1 (1)

Routing Time Step Summary

Minimum Time Step	:	0.50 sec
Average Time Step	:	1.00 sec
Maximum Time Step	:	1.00 sec
Percent in Steady State	:	0.00
Average Iterations per Step	:	2.00
Percent Not Converging	:	0.00

Subcatchment Runoff Summary

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
101	126.80	0.00	0.00	7.95	118.85	0.94	0.04	0.937
102	126.80	0.00	0.00	7.95	118.85	0.10	0.00	0.937
103	126.80	0.00	0.00	7.95	118.85	0.16	0.01	0.937
104	126.80	0.00	0.00	7.98	118.82	1.61	0.07	0.937
105	126.80	0.00	0.00	7.95	118.85	0.24	0.01	0.937
106	126.80	0.00	0.00	9.08	117.72	1.12	0.05	0.928
107	126.80	0.00	0.00	8.94	117.86	0.60	0.03	0.929
108	126.80	0.00	0.00	8.94	117.86	0.62	0.03	0.929
109	126.80	0.00	0.00	9.08	117.72	1.08	0.05	0.928

110	126.80	0.00	0.00	9.01	117.79	0.21	0.01	0.929
111	126.80	0.00	0.00	9.01	117.79	0.22	0.01	0.929
112	126.80	0.00	0.00	0.00	125.85	0.58	0.03	0.992
113	126.80	0.00	0.00	8.94	117.86	0.34	0.02	0.929
114	126.80	0.00	0.00	0.00	125.85	0.63	0.03	0.992
115	126.80	0.00	0.00	8.94	117.86	0.33	0.02	0.929

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.01	0.19	164.69	0 08:00	0.06
J10	JUNCTION	0.00	0.14	164.64	0 08:00	0.04
J2	JUNCTION	0.04	0.39	164.69	0 08:00	0.12
J3	JUNCTION	0.04	0.34	164.64	0 08:00	0.10
J4	JUNCTION	0.00	0.06	164.06	0 08:00	0.02
J5	JUNCTION	0.01	0.17	156.17	0 08:00	0.05
J6	JUNCTION	0.01	0.13	153.13	0 08:00	0.04
J7	JUNCTION	0.00	0.05	164.05	0 08:00	0.02
J8	JUNCTION	0.01	0.18	156.18	0 08:00	0.05
J9	JUNCTION	0.01	0.13	153.13	0 08:00	0.04
OF1	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
OF2	OUTFALL	0.00	0.00	149.50	0 00:00	0.00
POND_East	STORAGE	0.04	0.38	150.38	0 12:32	0.12
POND_West	STORAGE	0.04	0.35	150.35	0 11:53	0.11

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
J1	JUNCTION	0.021	0.021	0 08:00	0.439	0.439	-0.063
J10	JUNCTION	0.000	0.002	0 07:14	0	0.00328	0.652
J2	JUNCTION	0.052	0.073	0 08:00	1.12	1.56	0.023
J3	JUNCTION	0.051	0.051	0 08:00	1.08	1.09	0.010
J4	JUNCTION	0.007	0.080	0 08:00	0.158	1.72	-0.004
J5	JUNCTION	0.076	0.156	0 08:00	1.64	3.36	-0.003
J6	JUNCTION	0.016	0.171	0 08:00	0.335	3.69	0.002
J7	JUNCTION	0.011	0.061	0 08:00	0.241	1.33	-0.008
J8	JUNCTION	0.103	0.164	0 08:00	2.23	3.55	-0.003
J9	JUNCTION	0.016	0.180	0 08:00	0.34	3.89	0.002
OF1	OUTFALL	0.000	0.049	0 02:37	0	4.33	0.000
OF2	OUTFALL	0.000	0.049	0 02:23	0	4.47	0.000
POND_East	STORAGE	0.026	0.206	0 08:00	0.582	4.47	-0.005
POND_West	STORAGE	0.028	0.199	0 08:00	0.631	4.32	-0.076

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
POND_East	0.122	4	0	0	1.164	35	0 12:32	0.049
POND_West	0.107	3	0	0	1.082	33	0 11:53	0.049

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	17.72	0.047	0.049	4.328
OF2	18.27	0.047	0.049	4.473
System	18.00	0.094	0.098	8.802

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
D101	CONDUIT	0.020	0 08:00	0.11	0.02	0.48
D102	CONDUIT	0.073	0 08:00	0.49	0.10	0.37
D103	CONDUIT	0.080	0 08:00	0.86	0.01	0.23
D104	CONDUIT	0.156	0 08:00	1.09	0.08	0.30
D105	CONDUIT	0.002	0 07:14	0.02	0.00	0.41
D106	CONDUIT	0.050	0 08:00	0.43	0.07	0.33
D107	CONDUIT	0.061	0 08:00	0.66	0.01	0.23
D108	CONDUIT	0.164	0 08:00	1.13	0.09	0.31
D109	CONDUIT	0.171	0 08:00	1.44	0.06	0.26
D110	CONDUIT	0.180	0 08:00	1.58	0.05	0.26
OL1	DUMMY	0.049	0 02:37			
OL2	DUMMY	0.049	0 02:23			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
D101	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.97	0.00
D102	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00
D103	1.00	0.48	0.20	0.00	0.32	0.00	0.00	0.00	0.38	0.00
D104	1.00	0.48	0.00	0.00	0.49	0.03	0.00	0.00	0.08	0.00
D105	1.00	0.01	0.01	0.00	0.98	0.00	0.00	0.00	0.90	0.00
D106	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00
D107	1.00	0.48	0.20	0.00	0.32	0.00	0.00	0.00	0.38	0.00
D108	1.00	0.48	0.00	0.00	0.44	0.09	0.00	0.00	0.03	0.00
D109	1.00	0.68	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00
D110	1.00	0.69	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00

****

Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Mon Jun 28 15:24:09 2021
Analysis ended on: Mon Jun 28 15:24:15 2021
Total elapsed time: 00:00:06

Appendix E
Leachate Generation HELP Model Outputs

Appendix E - Leachate Generation HELP Model Input Parameters

Description of Cover System	Layer Type	Layer Decription
Daily Cover		
	Vegetative Coverage	Bare (Leaf Area Index 0)
	Evaporative Zone Depth	100 mm
	Slope	10 % slope
Sand-Daily Cover	Vertical Percolation Layer	100 mm of Sand (Soil Texture No. 2), Hyd.Cond. $5.8x10^{-3}$cm/sec
Sand-Daily Cover	Barrier Soil	50 mm of Sand (Soil Texture No. 2), Hyd.Cond. $5.8x10^{-3}$cm/sec
Municipal Waste	Vertical Percolation Layer	24 m of Municipal Solid Waste (Soil Texture No. 18), Hyd.Cond. $1x10^{-3}$cm/sec
Geotextile	Flexible Membrane Liner	Drainage Net (model default, Soil Texture No. 20), Hyd.Cond. 10cm/sec
		Good placement quality, 2 pinholes/hectare, 6 installation defects/hectare
Drain Rock	Lateral Drainage Layer	300 mm of Gravel (Soil Texture No. 21), Hyd.Cond. $3x10^{-1}$cm/sec
Intermediate Cover		
	Vegetative Coverage	Bare (Leaf Area Index 1)
	Evaporative Zone Depth	250 mm
	Slope	10 % slope
Sand-Intermediate Cover	Vertical Percolation Layer	300 mm of Sand (Soil Texture No. 2), Hyd.Cond. $5.8x10^{-3}$cm/sec
Sand-Intermediate Cover	Barrier Soil	50 mm of Sand (Soil Texture No. 2), Hyd.Cond. $5.8x10^{-3}$cm/sec
Municipal Waste	Vertical Percolation Layer	24 m of Municipal Solid Waste (Soil Texture No. 18), Hyd.Cond. $1x10^{-3}$cm/sec
Geotextile	Flexible Membrane Liner	Drainage Net (model default, Soil Texture No. 20), Hyd.Cond. 10cm/sec
		Good placement quality, 2 pinholes/hectare, 6 installation defects/hectare
Drain Rock	Lateral Drainage Layer	300 mm of Gravel (Soil Texture No. 21), Hyd.Cond. $3x10^{-1}$cm/sec
Final Cover		
	Vegetative Coverage	Good stand of grass
	Evaporative Zone Depth	300 mm
	Slope	10%
Topsoil	Vertical Percolation Layer	150 mm of Loamy Sand 9Soil Texture No. 4), Hyd.Cond. $1.7x10^{-3}$cm/sec
Sand	Lateral Drainage Layer	600 mm of Sand (Soil Texture No. 2), Hyd.Cond. $5.8x10^{-3}$cm/sec
Geosynthetic Clay Liner	Barrier Soil Liner	Bentonite Mat (model default, Soil Texture No. 17), Hyd.Con. $3x10^{-9}$cm/sec
Sand	Vertical Percolation Layer	150 mm of Sand (Soil Texture No. 2), Hyd.Cond. $5.8x10^{-3}$cm/sec
Municipal Waste	Vertical Percolation Layer	24 m of Municipal Solid Waste (Soil Texture No. 18), Hyd.Cond. $1x10^{-3}$cm/sec
Geotextile	Flexible Membrane Liner	Drainage Net (model default, Soil Texture No. 20), Hyd.Cond. 10cm/sec
		Good placement quality, 2 pinholes/hectare, 6 installation defects/hectare
Drain Rock	Lateral Drainage Layer	300 mm of Gravel (Soil Texture No. 21), Hyd.Cond. $3x10^{-1}$cm/sec

Daily Cover

	Lateral Drainage Collected from Layer 5	Run-off	
Jan	65.1089	34.035	
Feb	84.2772	26.786	
Mar	102.4533	5.216	
Apr	123.0865	0.55	
May	138.0491	0.336	
Jun	123.4093	0.253	
Jul	117.0968	0.335	
Aug	106.9451	0.489	
Sep	86.7352	0.129	
Oct	60.5727	6.234	
Nov	43.3287	11.463	
Dec	50.4224	20.108	
Sum:	1101.4852	105.934	1207.419

LATERAL DRAINAGE COLLECTED FROM LAYER 5

TOTALS	65.1089	84.2772	102.4533	123.0865	138.04
	117.0968	106.9451	86.7352	60.5727	43.32
STD. DEVIATIONS	24.4978	28.8200	30.3134	31.9586	29.09
	18.4311	17.3214	15.8749	16.8588	14.97

RUNOFF

TOTALS	34.035	26.786	5.216	0.550	0.33
	0.335	0.489	0.129	6.234	11.46
STD. DEVIATIONS	67.175	67.695	13.713	1.344	1.12
	1.002	2.820	0.565	7.952	13.01

Intermediate Cover

	Lateral Drainage from Layer 5
Jan	54.2613
Feb	73.35
Mar	92.706
Apr	117.4078
May	139.5856
Jun	122.926
Jul	112.8487
Aug	101.057
Sep	82.7143
Oct	54.8109
Nov	32.8243
Dec	39.5423
Sum:	1024.0342

LATERAL DRAINAGE COLLECTED FROM LAYER 5

TOTALS	54.2613	73.3592	92.7060	117.4078	139.58
	112.8487	101.0570	82.7143	54.8109	32.82
STD. DEVIATIONS	23.4180	26.8001	29.4715	31.4007	28.07
	20.3881	21.6544	19.3005	17.9345	12.51

Final Cover

Jan	2.9168
Feb	2.6859
Mar	2.386
Apr	1.9599
May	1.4829
Jun	0.9079
Jul	0.6186
Aug	0.431
Sep	0.2893
Oct	0.1173
Nov	0.1984
Dec	1.808
Sum:	15.802

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	2.9168	2.6859	2.3986	1.9599	1.48
	0.6186	0.4310	0.2893	0.1173	0.19
STD. DEVIATIONS	0.8955	0.8772	0.8500	0.5565	0.35
	0.1340	0.1000	0.0949	0.0888	0.29

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**               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE       **
**                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)       **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY          **
**                     USAE WATERWAYS EXPERIMENT STATION            **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY      **
**                                                                  **
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PRECIPITATION DATA FILE: C:\HELP3\88877PD.D4
TEMPERATURE DATA FILE: C:\HELP3\88877TD.D7
SOLAR RADIATION DATA FILE: C:\HELP3\88877SRD.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\88877ETD.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\88877DF8.D10
OUTPUT DATA FILE: C:\HELP3\88877df8.OUT

TIME: 13:23 DATE: 5/28/2020

****

TITLE: Upland Landfill - Daily Cover HDPE Failure C&D

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	10.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1434	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	2400.00	CM
POROSITY	=	0.1680	VOL/VOL
FIELD CAPACITY	=	0.0730	VOL/VOL
WILTING POINT	=	0.0190	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0838	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL

FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1597	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	10.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	1.434	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.370	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.240	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	209.980	CM
TOTAL INITIAL WATER	=	209.980	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	

START OF GROWING SEASON (JULIAN DATE) = 91
END OF GROWING SEASON (JULIAN DATE) = 305
EVAPORATIVE ZONE DEPTH = 10.0 CM
AVERAGE ANNUAL WIND SPEED = 8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53

	28.36	30.28	30.04	68.74	74.24	69.47

RUNOFF

TOTALS	34.035	26.786	5.216	0.550	0.336	0.253
	0.335	0.489	0.129	6.234	11.463	20.108
STD. DEVIATIONS	67.175	67.695	13.713	1.344	1.127	0.629
	1.002	2.820	0.565	7.952	13.010	40.118

EVAPOTRANSPIRATION

TOTALS	7.270	10.909	32.661	50.909	38.585	34.688
	19.103	18.345	23.951	19.526	8.926	6.344
STD. DEVIATIONS	2.877	4.501	6.050	12.277	16.674	16.545
	13.384	13.132	11.467	4.334	1.619	2.045

PERCOLATION/LEAKAGE THROUGH LAYER 2

TOTALS	184.9617	124.8822	110.9308	54.5503	29.5131	27.0398
	20.0543	19.7217	28.2646	134.8827	186.5648	187.1910
STD. DEVIATIONS	82.3606	64.2705	45.3760	29.2116	20.9264	19.1694
	18.4242	18.2704	20.5887	61.0835	63.2804	71.2859

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	180.9979	156.5872	156.9727	111.9285	40.3257	26.9729
	21.2218	18.5651	29.2020	73.4767	126.3587	168.5397
STD. DEVIATIONS	63.5396	64.1078	51.8090	49.4760	27.7111	19.9570
	21.7540	16.4440	20.3996	26.8081	40.0389	46.5411

LATERAL DRAINAGE COLLECTED FROM LAYER 5

TOTALS	176.9316	162.1197	157.4841	122.2302	50.5715	26.9056
	22.3385	18.8743	26.5993	59.9102	117.0397	162.0860
STD. DEVIATIONS	55.2198	60.7850	53.8837	46.7045	31.7294	18.2236
	18.9747	16.8879	18.4590	22.3651	35.4900	42.5217

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	1.2600	1.1540	1.1304	0.8927	0.4175	0.2560
	0.2259	0.1974	0.2513	0.4793	0.8581	1.1611
STD. DEVIATIONS	0.3681	0.4049	0.3593	0.3114	0.2116	0.1233
	0.1304	0.1212	0.1277	0.1497	0.2366	0.2834

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1754	0.1345	0.1128	0.0588	0.0295	0.0299
	0.0207	0.0206	0.0312	0.1313	0.1855	0.1773
STD. DEVIATIONS	0.0790	0.0695	0.0476	0.0312	0.0224	0.0239
	0.0196	0.0180	0.0240	0.0619	0.0683	0.0707

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.7718	0.7304	0.6655	0.4914	0.1730	0.1189
	0.0908	0.0794	0.1289	0.3097	0.5510	0.7141
STD. DEVIATIONS	0.2726	0.3011	0.2218	0.2170	0.1180	0.0872
	0.0927	0.0705	0.0897	0.1133	0.1775	0.2009

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	8.8090	8.8574	7.8410	6.2886	2.5179	1.3843
	1.1122	0.9397	1.3685	2.9829	6.0216	8.0699
STD. DEVIATIONS	2.7489	3.3251	2.6828	2.4029	1.5798	0.9376
	0.9447	0.8408	0.9497	1.1135	1.8259	2.1166

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	105.931	(128.5090)	1059.31	7.129
EVAPOTRANSPIRATION	271.217	(37.8267)	2712.17	18.252
PERCOLATION/LEAKAGE THROUGH LAYER 2	1108.55688	(180.96466)	11085.568	74.60322
AVERAGE HEAD ON TOP OF LAYER 2	0.923	(0.156)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1111.14868	(193.93793)	11111.486	74.77763
AVERAGE HEAD ON TOP OF LAYER 4	4.021	(0.714)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1103.09058	(192.71375)	11030.906	74.23534
PERCOLATION/LEAKAGE THROUGH LAYER 6	8.28386	(1.28800)	82.839	0.55748

AVERAGE HEAD ON TOP OF LAYER 6	46.827 (	8.247)		
CHANGE IN WATER STORAGE	-2.586 (	4.3345)	-25.86	-0.174

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	87.653	876.5259
PERCOLATION/LEAKAGE THROUGH LAYER 2	60.615021	606.15021
AVERAGE HEAD ON TOP OF LAYER 2	25.039	
PERCOLATION/LEAKAGE THROUGH LAYER 4	19.712858	197.12859
AVERAGE HEAD ON TOP OF LAYER 4	26.039	
DRAINAGE COLLECTED FROM LAYER 5	14.79354	147.93542
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.099692	0.99692
AVERAGE HEAD ON TOP OF LAYER 6	224.771	
MAXIMUM HEAD ON TOP OF LAYER 6	286.035	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	29.9 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	3.7450	0.3745
2	2.1850	0.4370
3	175.2000	0.0730
4	0.0000	0.0000
5	2.5355	0.0845
6	0.4500	0.7500
SNOW WATER	0.000	

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**               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE       **
**                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)       **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY          **
**                     USAE WATERWAYS EXPERIMENT STATION            **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY      **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE: C:\HELP3\88877PD.D4
TEMPERATURE DATA FILE: C:\HELP3\88877TD.D7
SOLAR RADIATION DATA FILE: C:\HELP3\88877SRD.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\88877ETD.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\88877DF7.D10
OUTPUT DATA FILE: C:\HELP3\88877df7.OUT

TIME: 15:58 DATE: 5/26/2020

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TITLE: Upland Landfill - Daily Cover HDPE Failure C&D

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	10.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1434	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	240.00	CM
POROSITY	=	0.1680	VOL/VOL
FIELD CAPACITY	=	0.0730	VOL/VOL
WILTING POINT	=	0.0190	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0776	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL

FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2717	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	10.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	1.434	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.370	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.240	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	30.855	CM
TOTAL INITIAL WATER	=	30.855	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	

START OF GROWING SEASON (JULIAN DATE) = 91
END OF GROWING SEASON (JULIAN DATE) = 305
EVAPORATIVE ZONE DEPTH = 10.0 CM
AVERAGE ANNUAL WIND SPEED = 8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79

STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47

RUNOFF

TOTALS	34.035	26.786	5.216	0.550	0.336	0.253
	0.335	0.489	0.129	6.234	11.463	20.108
STD. DEVIATIONS	67.175	67.695	13.713	1.344	1.127	0.629
	1.002	2.820	0.565	7.952	13.010	40.118

EVAPOTRANSPIRATION

TOTALS	7.270	10.909	32.661	50.909	38.585	34.688
	19.103	18.345	23.951	19.526	8.926	6.344
STD. DEVIATIONS	2.877	4.501	6.050	12.277	16.674	16.545
	13.384	13.132	11.467	4.334	1.619	2.045

PERCOLATION/LEAKAGE THROUGH LAYER 2

TOTALS	184.9617	124.8822	110.9308	54.5503	29.5131	27.0398
	20.0543	19.7217	28.2646	134.8827	186.5648	187.1910
STD. DEVIATIONS	82.3606	64.2705	45.3760	29.2116	20.9264	19.1694
	18.4242	18.2704	20.5887	61.0835	63.2804	71.2859

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	186.7819	125.4513	113.2133	58.6388	30.8218	26.7040
	20.9745	18.0658	29.6386	126.4795	184.1192	187.7798
STD. DEVIATIONS	80.2050	63.7018	46.5574	30.0269	19.8723	18.7225
	19.8969	15.6496	20.6210	56.9506	63.5764	66.5428

LATERAL DRAINAGE COLLECTED FROM LAYER 5

TOTALS	188.6486	128.9355	119.7612	68.0736	33.9717	26.5464
	22.2037	18.1844	27.7207	102.4087	175.7489	188.9156
STD. DEVIATIONS	77.3292	63.2177	46.8353	31.0103	18.5991	17.8725
	19.4788	16.0282	19.5871	47.7744	59.0323	59.0145

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	1.3349	0.9319	0.8788	0.5316	0.3067	0.2530
	0.2249	0.1920	0.2587	0.7622	1.2482	1.3379
STD. DEVIATIONS	0.5111	0.4207	0.3121	0.2068	0.1243	0.1221
	0.1338	0.1161	0.1352	0.3182	0.3916	0.3906

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1754	0.1345	0.1128	0.0588	0.0295	0.0299
	0.0207	0.0206	0.0312	0.1313	0.1855	0.1773
STD. DEVIATIONS	0.0790	0.0695	0.0476	0.0312	0.0224	0.0239
	0.0196	0.0180	0.0240	0.0619	0.0683	0.0707

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.7943	0.5852	0.4853	0.2626	0.1344	0.1208
	0.0919	0.0795	0.1330	0.5385	0.8090	0.7990
STD. DEVIATIONS	0.3393	0.2970	0.1996	0.1318	0.0860	0.0840
	0.0878	0.0694	0.0929	0.2413	0.2828	0.2805

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	9.3680	7.0421	5.9621	3.5023	1.6914	1.3658
	1.1055	0.9054	1.4262	5.0953	9.0314	9.3906
STD. DEVIATIONS	3.8164	3.4486	2.3307	1.5954	0.9260	0.9195
	0.9698	0.7980	1.0077	2.3729	3.0217	2.9170

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	105.931	(128.5090)	1059.31	7.129
EVAPOTRANSPIRATION	271.217	(37.8267)	2712.17	18.252
PERCOLATION/LEAKAGE THROUGH LAYER 2	1108.55688	(180.96466)	11085.568	74.60322
AVERAGE HEAD ON TOP OF LAYER 2	0.923	(0.156)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1108.66833	(182.04721)	11086.684	74.61072
AVERAGE HEAD ON TOP	4.028	(0.658)		

OF LAYER 4				
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1101.11902	(183.70462)	11011.190	74.10267
PERCOLATION/LEAKAGE THROUGH LAYER 6	8.26081	(1.22634)	82.608	0.55593
AVERAGE HEAD ON TOP OF LAYER 6	46.572	(7.806)		
CHANGE IN WATER STORAGE	-0.592	(2.3864)	-5.92	-0.040

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	87.653	876.5259
PERCOLATION/LEAKAGE THROUGH LAYER 2	60.615021	606.15021
AVERAGE HEAD ON TOP OF LAYER 2	25.039	
PERCOLATION/LEAKAGE THROUGH LAYER 4	50.805981	508.05981
AVERAGE HEAD ON TOP OF LAYER 4	75.712	
DRAINAGE COLLECTED FROM LAYER 5	20.55753	205.57533
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.132190	1.32190
AVERAGE HEAD ON TOP OF LAYER 6	300.000	
MAXIMUM HEAD ON TOP OF LAYER 6	367.829	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	33.6 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	3.7450	0.3745
2	2.1850	0.4370
3	17.5200	0.0730
4	0.0000	0.0000
5	1.0381	0.0346
6	0.4500	0.7500
SNOW WATER	0.000	

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**               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE       **
**                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)       **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY          **
**                     USAE WATERWAYS EXPERIMENT STATION            **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY      **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PI.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TI.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRI.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETI.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877IF6.D10
OUTPUT DATA FILE:           C:\HELP3\88877if6.OUT


TIME:  13: 1     DATE:   5/28/2020


**********************************************************************

     TITLE:  Upland Landfill - Intermediate Cover HDPE Failure C&D

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   2
          THICKNESS                    =     25.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1416 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.579999993000E-02 CM/SEC
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LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	2400.00	CM
POROSITY	=	0.1680	VOL/VOL
FIELD CAPACITY	=	0.0730	VOL/VOL
WILTING POINT	=	0.0190	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0845	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL

FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1493	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	25.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	3.540	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.925	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.600	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	213.377	CM
TOTAL INITIAL WATER	=	213.377	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	

START OF GROWING SEASON (JULIAN DATE) = 91
END OF GROWING SEASON (JULIAN DATE) = 305
EVAPORATIVE ZONE DEPTH = 25.0 CM
AVERAGE ANNUAL WIND SPEED = 8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53

	28.36	30.28	30.04	68.74	74.24	69.47

RUNOFF

TOTALS	31.887	24.870	4.887	0.496	0.262	0.200
	0.222	0.399	0.102	6.164	11.299	18.928
STD. DEVIATIONS	62.872	63.609	12.642	1.150	0.918	0.540
	0.761	2.229	0.500	8.004	12.912	37.191

EVAPOTRANSPIRATION

TOTALS	7.259	10.995	36.327	65.831	57.276	48.516
	31.708	27.282	34.370	21.141	8.928	6.318
STD. DEVIATIONS	2.842	4.575	6.141	11.974	20.883	21.160
	20.687	19.099	17.596	4.743	1.608	2.028

PERCOLATION/LEAKAGE THROUGH LAYER 2

TOTALS	186.6601	125.6402	111.8985	45.9513	15.3922	12.4864
	10.1460	8.7020	15.9593	123.3714	185.9916	187.6318
STD. DEVIATIONS	81.1768	64.1526	46.8856	29.5841	15.6416	14.4724
	13.5229	12.9562	16.5228	60.4221	63.0770	70.4321

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	181.7890	159.4316	160.1953	110.0303	25.7250	12.9628
	10.3462	8.2745	15.9669	60.2012	120.0866	167.5739
STD. DEVIATIONS	64.0056	63.7747	51.0165	53.3308	26.3330	16.5620
	16.0027	12.9388	17.0056	26.7836	40.0943	47.3464

LATERAL DRAINAGE COLLECTED FROM LAYER 5

TOTALS	177.4010	165.0154	160.2038	122.3063	37.4109	13.1796
	10.6072	8.4422	13.9848	46.1568	110.2817	160.0766
STD. DEVIATIONS	55.6627	60.3891	52.6477	48.6307	32.3400	15.5460
	14.3900	12.5511	14.9529	21.9186	34.9547	43.6375

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	1.2631	1.1723	1.1483	0.8933	0.3287	0.1537
	0.1359	0.1071	0.1549	0.3833	0.8131	1.1476
STD. DEVIATIONS	0.3711	0.4049	0.3514	0.3243	0.2168	0.1125
	0.1065	0.1010	0.1112	0.1506	0.2331	0.2908

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1967	0.1453	0.1275	0.0505	0.0167	0.0135
	0.0106	0.0087	0.0175	0.1250	0.1970	0.1944
STD. DEVIATIONS	0.0803	0.0779	0.0588	0.0325	0.0168	0.0157
	0.0140	0.0149	0.0184	0.0620	0.0702	0.0736

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.7717	0.7442	0.6801	0.4846	0.1104	0.0574
	0.0443	0.0354	0.0704	0.2524	0.5214	0.7095
STD. DEVIATIONS	0.2734	0.3001	0.2163	0.2344	0.1129	0.0726
	0.0683	0.0556	0.0743	0.1131	0.1758	0.2046

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	8.8321	9.0153	7.9764	6.2925	1.8627	0.6781
	0.5281	0.4203	0.7195	2.2981	5.6739	7.9697
STD. DEVIATIONS	2.7706	3.3036	2.6212	2.5020	1.6102	0.7998
	0.7165	0.6249	0.7693	1.0913	1.7984	2.1718

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	99.716	(120.3010)	997.16	6.711
EVAPOTRANSPIRATION	355.950	(51.2605)	3559.50	23.955
PERCOLATION/LEAKAGE THROUGH LAYER 2	1029.83081	(173.63248)	10298.309	69.30514
AVERAGE HEAD ON TOP OF LAYER 2	0.919	(0.145)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1032.58350	(187.03522)	10325.835	69.49039
AVERAGE HEAD ON TOP OF LAYER 4	3.735	(0.687)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1025.06604	(185.51189)	10250.660	68.98448
PERCOLATION/LEAKAGE THROUGH LAYER 6	7.70132	(1.25354)	77.013	0.51828

AVERAGE HEAD ON TOP OF LAYER 6	43.556	(7.941)		
CHANGE IN WATER STORAGE	-2.497	(4.3731)	-24.97	-0.168

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	86.028	860.2754
PERCOLATION/LEAKAGE THROUGH LAYER 2	69.487221	694.87219
AVERAGE HEAD ON TOP OF LAYER 2	53.465	
PERCOLATION/LEAKAGE THROUGH LAYER 4	19.819096	198.19095
AVERAGE HEAD ON TOP OF LAYER 4	26.185	
DRAINAGE COLLECTED FROM LAYER 5	14.76017	147.60168
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.099524	0.99524
AVERAGE HEAD ON TOP OF LAYER 6	224.383	
MAXIMUM HEAD ON TOP OF LAYER 6	285.534	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	29.9 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3710
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	7.9385	0.3175
2	2.1850	0.4370
3	175.2000	0.0730
4	0.0000	0.0000
5	2.6365	0.0879
6	0.4500	0.7500
SNOW WATER	0.000	

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**               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE       **
**                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)       **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY          **
**                     USAE WATERWAYS EXPERIMENT STATION            **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY      **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE: C:\HELP3\88877PF.D4
TEMPERATURE DATA FILE: C:\HELP3\88877TF.D7
SOLAR RADIATION DATA FILE: C:\HELP3\88877SRF.D13
EVAPOTRANSPIRATION DATA: C:\HELP3\88877ETF.D11
SOIL AND DESIGN DATA FILE: C:\HELP3\88877FF6.D10
OUTPUT DATA FILE: C:\HELP3\88877ff6.OUT

TIME: 14:32 DATE: 5/28/2020

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TITLE: Upland Landfill - Final Cover HDPE Failure C&D

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

THICKNESS	=	15.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.1050	VOL/VOL
WILTING POINT	=	0.0470	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1785	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.170000002000E-02	CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	60.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3227	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC
SLOPE	=	10.00	PERCENT
DRAINAGE LENGTH	=	35.0	METERS

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	15.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1250	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	2400.00	CM

POROSITY	=	0.1680	VOL/VOL
FIELD CAPACITY	=	0.0730	VOL/VOL
WILTING POINT	=	0.0190	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0730	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0336	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 8

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	56.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	30.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	5.060	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	13.110	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.065	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	201.028	CM
TOTAL INITIAL WATER	=	201.028	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	91	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	30.0	CM
AVERAGE ANNUAL WIND SPEED	=	8.00	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	21.382	20.117	3.223	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.140	8.023
STD. DEVIATIONS	61.417	62.057	12.268	0.000	0.000	0.000
	0.000	0.000	0.000	0.003	0.842	33.796
EVAPOTRANSPIRATION						
TOTALS	6.991	10.459	35.089	66.199	66.348	57.095
	36.757	32.885	36.444	17.871	7.401	5.790
STD. DEVIATIONS	2.382	4.007	5.824	10.244	20.874	24.694
	24.988	20.829	18.091	3.718	1.437	1.722
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	198.2982	143.5541	130.1599	73.7398	27.9560	10.4772
	5.3721	4.0402	6.3776	70.6105	170.1666	196.9461

STD. DEVIATIONS	73.5734	59.6388	42.8260	29.5571	15.4583	11.1173
	7.3795	9.0126	10.6322	41.1663	57.6571	56.0787

PERCOLATION/LEAKAGE THROUGH LAYER 3

TOTALS	3.1005	2.2607	2.0637	1.2014	0.5063	0.2374
	0.1622	0.1412	0.1732	1.1557	2.6706	3.0813
STD. DEVIATIONS	1.1182	0.9087	0.6526	0.4504	0.2356	0.1694
	0.1124	0.1378	0.1632	0.6281	0.8784	0.8543

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	3.1054	2.6921	2.4105	1.9812	1.4585	0.9155
	0.6563	0.4892	0.3439	0.1257	0.3705	2.2315
STD. DEVIATIONS	0.9461	0.8941	0.8601	0.5131	0.3294	0.1857
	0.1275	0.1010	0.1021	0.1032	0.4572	1.0633

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	2.9175	2.6867	2.3969	1.9595	1.4814	0.9074
	0.6181	0.4307	0.2890	0.1172	0.1999	1.8106
STD. DEVIATIONS	0.8955	0.8763	0.8482	0.5565	0.3509	0.2053
	0.1336	0.0999	0.0949	0.0890	0.2910	1.0083

PERCOLATION/LEAKAGE THROUGH LAYER 8

TOTALS	0.0998	0.0911	0.0958	0.0908	0.0902	0.0838
	0.0845	0.0828	0.0782	0.0490	0.0328	0.0870
STD. DEVIATIONS	0.0060	0.0060	0.0077	0.0037	0.0023	0.0014
	0.0009	0.0029	0.0068	0.0204	0.0224	0.0174

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	22.5526	17.9315	14.8102	8.6702	3.1810	1.2319
	0.6113	0.4597	0.7499	8.0344	20.0066	22.4089
STD. DEVIATIONS	8.3496	7.4634	4.8729	3.4753	1.7589	1.3071
	0.8397	1.0255	1.2501	4.6841	6.7776	6.3795

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0133	0.0127	0.0103	0.0088	0.0063	0.0041
	0.0029	0.0022	0.0016	0.0006	0.0016	0.0095
STD. DEVIATIONS	0.0040	0.0042	0.0037	0.0023	0.0014	0.0008
	0.0005	0.0004	0.0005	0.0005	0.0020	0.0045

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.1453	0.1468	0.1193	0.1008	0.0738	0.0467
	0.0308	0.0214	0.0149	0.0058	0.0103	0.0902
STD. DEVIATIONS	0.0446	0.0480	0.0422	0.0286	0.0175	0.0106
	0.0066	0.0050	0.0049	0.0044	0.0150	0.0502

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	52.886	(114.1105)	528.86	3.559
EVAPOTRANSPIRATION	379.329	(55.0845)	3793.29	25.528
LATERAL DRAINAGE COLLECTED FROM LAYER 2	1037.69824	(180.34677)	10376.982	69.83460
PERCOLATION/LEAKAGE THROUGH LAYER 3	16.75417	(2.74737)	167.542	1.12752
AVERAGE HEAD ON TOP OF LAYER 3	100.540	(17.590)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	16.78042	(2.82040)	167.804	1.12928
AVERAGE HEAD ON TOP OF LAYER 6	0.062	(0.010)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	15.81481	(2.77546)	158.148	1.06430
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.96599	(0.03470)	9.660	0.06501
AVERAGE HEAD ON TOP OF LAYER 8	0.672	(0.119)		
CHANGE IN WATER STORAGE	-0.757	(2.5400)	-7.57	-0.051

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	84.875	848.7458
DRAINAGE COLLECTED FROM LAYER 2	22.22717	222.27165
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.320248	3.20248
AVERAGE HEAD ON TOP OF LAYER 3	735.327	
MAXIMUM HEAD ON TOP OF LAYER 3	985.790	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	11.3 METERS	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.257808	2.57808
AVERAGE HEAD ON TOP OF LAYER 6	0.343	
DRAINAGE COLLECTED FROM LAYER 7	0.20964	2.09641
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.003990	0.03990
AVERAGE HEAD ON TOP OF LAYER 8	3.236	
MAXIMUM HEAD ON TOP OF LAYER 8	6.271	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	2.5 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0355

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	6.5550	0.4370
2	8.1823	0.1364
3	0.4500	0.7500
4	1.6144	0.1076
5	175.2018	0.0730
6	0.0000	0.0000
7	1.0044	0.0335
8	0.4500	0.7500
SNOW WATER	0.000	

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Appendix F
Leachate Treatment Facility Commissioning Plan

Appendix F Leachate Treatment Facility Commissioning Plan

1. Description of Leachate Treatment Works and Design

Leachate will be collected by a series of perforated pipes installed at the base of each landfill cell that discharge to a sump. Leachate will be stored temporarily in the Landfill and pumped from the sump to the Leachate Treatment Facility (LTF). Leachate will be pumped from the Landfill to the LTF for batch treatment on an as-needed basis.

The treatment system will operate in a batch treatment setup, generating a batch of effluent for infiltration. To target operation of a weekly batch at the peak daily leachate generation rate, an average batch size is considered to be 625 m^3. A batch size may vary, requiring operational adjustments to the treatment system. Based on the pond sizing described below, the maximum batch size is 1,400 m^3.

The leachate collection system for the Landfill includes the following components:

- Perforated leachate collection pipes (LCP) with minimum diameter of 150 mm wrapped in protective geotextile layers within the stone drainage blanket
- A 2.75 percent slope along primary flow path and 2 percent slope along the secondary flow path to the LCPs
- Clean-outs at each end of the LCPs
- Maximum leachate head of 0.3 m at any point on the Landfill base liner
- Leachate collection header pipe along the east side of the Landfill sloping at 2 percent towards a leachate collection sump located at the north east corner of the Landfill footprint
- A sump with bottom dimension of 3,900 mm^2
- Two leachate sump riser pipes with minimum diameters of 450 mm
- Manually operated submersible leachate pump housed in one of the two sump riser pipes

The detailed design of the treatment system will be based on process modeling results and refined based on site-specific leachate chemistry. The conceptual design is described herein. The LTF consists of an aerated equalization system, solids removal, chemical addition, further solids removal, an effluent holding pond, a granular activated carbon (GAC) filter, and an infiltration pond.

The conceptual design features of the aerated equalization pond include:

- 2.5H:1V side walls double lined with 60-mil HDPE liner overlying a GCL
- A submerged coarse bubble aeration system
- Positive displacement blowers sized to provide the required air demand
- Decant pump
- Approximate bottom dimensions of the aeration pond will be 15 metres (m) by 15 m. The approximate top dimensions of the aeration pond will be 34 m by 32 m.
- Approximate depth of 3 m with a 0.6 m freeboard

- Resulting available volume is approximately 1,400 m^3
- Provides storage capacity of over 7 days at the target average daily generation rate with 100 percent redundancy to account for peak storm events. This facilitates operation of a weekly batch treatment.
- Aeration is anticipated to require a retention time of 1-3 days
- The aerated equalization system is anticipated to be filled with automated pump shutoffs based on liquid level in the Landfill and in the pond. To fill the aeration basin over the course of 2 days. Therefore pumping capacity to fill the aerated equalization system should be 2.4 litres per second (L/s) (38 gallons per minute [gpm]) for an average size batch and 5.4 L/s (86 gpm) for a maximum size batch.

Effluent from the aerated equalization system will contain elevated concentrations of suspended solids following oxidation of metals and the presence of other inorganics. The next step is solids removal. This will be accomplished through settling in a clarifier or filtration.

Clarification or filtration will require a capacity of 7.2 L/s (115 gpm) for an average size batch and 16 L/s (259 gpm) for a maximum size batch to complete solids removal within one day.

Aeration and solids removal will remove the majority of dissolved iron and manganese. Additional dissolved metals removal may be required to achieve the discharge criteria. The dissolved metals will be removed if required by chemical precipitation, by adding a volume of chemical that will cause an increase or decrease of pH of the leachate to facilitate the formation of an insoluble salt. Chemical addition will take place in a complete mixed reactor or inline mixer.

Following chemical addition, the formulation of additional suspended solids will require solids removal using a solids removal system as described above.

Effluent from the chemical addition and solids removal step will be collected in a holding pond or tank. The effluent holding pond or tank will therefore have the necessary capacity to store a full batch with 0.6 m of freeboard.

Effluent in the effluent holding pond or tank will be sampled to determine if the discharge criteria have been achieved. If the discharge criteria are achieved, effluent will be conveyed directly to the infiltration pond.

If discharge criteria have not been achieved, the effluent will be recirculated through a granular activated carbon (GAC) filter as described below and resampled to confirm the discharge criteria are achieved prior to infiltration.

An optional GAC filter will be used to polish effluent stored in the effluent holding pond should an initial sample indicate that the effluent does not achieve the discharge criteria. A GAC filter has been selected to ensure the effluent PAH criteria can be consistently achieved.

The infiltration pond will be used to infiltrate treated leachate and some of the collected storm water into the groundwater system. The design and construction of the infiltration pond is supported by the results of the hydrogeologic characterization of the Site, as provided in the Hydrology and Hydrogeology Characterization Report (HHCR).

Discharge to the infiltration pond will meet the British Columbia (BC) Contaminated Sites Regulation (CSR) Schedule 3.2 Drinking Water (DW) Criteria. The location of the infiltration pond has been selected to allow for further natural attenuation to occur while allowing for continued Site operations. The Site is underlain by a vadose zone of varying thickness, and will be used to attenuate, via sorption, diffusion,

dilution, dispersion, and biodegradation, the treated leachate to further reduce the concentrations of the leachate constituents prior to reaching the sand and gravel aquifer and the downgradient property line.

The design and construction of the infiltration pond is supported by the results of the HHCR, and includes:

- 2:5H:1V side walls
- Maximum draining time is 48 hours
- Maximum water ponding depth is 0.3 m
- Infiltration capacity between 13 mm/hr (minimum) and 61 mm/hr (maximum)
- Minimum 600 mm free board

1.1 Treatment Process

The leachate treatment system will reduce the concentration of leachate constituents by the processes described below:

- Aeration oxidizes dissolved metals such as iron and manganese to less soluble forms and produces flocs that will be filtered. Concentrations of other metals present in the leachate that are not readily oxidized in an aeration lagoon will also be reduced when the suspended (not dissolved) components of these metals are filtered.
- Hydrocarbons and volatile organic compounds will be readily volatized in an aeration lagoon thereby reducing the concentration. If concentrations of organic compounds are required to be further reduced, the effluent will be filtered through a GAC filter.
- The dissolved metals will be removed, if required by chemical precipitation, by adding a volume of chemicals (i.e., mild acids or bases) that will cause an increase or decrease of pH of the leachate to facilitate the formation of an insoluble salt.

Should leachate quality change over time and additional leachate constituents require treatment, the process is capable of including a polishing step to continue to meet the BC CSR Schedule 3.2 Criteria.

The forecasted treated leachate quality is presented in the DOCP. Further studies will be performed on the actual leachate during the commissioning and operation of the LTF to ensure adequate level treatment is attained. The leachate treatment process may be modified throughout the life of the Landfill to ensure the performance and compliance criteria are met.

2. Commissioning Period Operating Procedures

This LTF Commissioning Plan provides for a commissioning period during which initial leachate characterization and confirmation of treatment process capabilities is conducted. The LTF will be constructed and operational prior to landfilling in Stage 1 East. The anticipated commissioning period schedule is outlined in Section 2.4.

Initial leachate batches are expected to have low concentrations of leachate parameters derived from newly placed waste as well as waste relocated from the former on-site landfill. The commissioning period operating procedure will support leachate quality characterization, and ensure that only treated leachate meeting the discharge criteria is decanted to the infiltration pond. The following sections describe the commissioning period operating procedures.

2.1 Clean Water Testing

Clean water testing is the initial step in the LTF commissioning. The hydraulic integrity of all major process ponds, tanks, pumps, piping, and appurtenance will be verified via clean water testing prior to the commencement of start-up and commissioning activities. The process equipment (blowers, pumps and aeration system) shall also be commissioned by manufacturer representatives prior to start-up activities. All necessary process chemicals must be delivered to Site prior to commissioning. Testing of all control systems should be executed to verify automatic control functions prior to initiating start-up activities.

2.2 Chemical Jar Testing

To optimize chemical dosing to suit the influent leachate characteristics, a period of on-site jar testing will be conducted at the same time as clean water testing. Influent samples will be collected to create an initial leachate profile. Chemical manufacturer's representatives or LTF operators will conduct jar tests with various chemicals and dosages to evaluate the effectiveness and appropriate dose conditions for removal of target parameters. The jar tests will be used to set initial batch volume chemical dosage rates.

2.3 Initial Batch Treatment

Initial batches will be kept small. The objective of introducing small initial batches of leachate is to develop a relationship between initial leachate quality, the effectiveness of the aeration system, the chemical dosage required to achieve effluent criteria, and the need for the GAC system. Based on the leachate quantity modeling described in the DOCP, the anticipated average volume of leachate to be treated in a batch is 625 m^3, which results in 100 percent excess capacity in the treatment system. The modeling considered the landfill stage with the highest leachate generation potential (Stage 2A). The initial small batch runs will introduce approximately 25% of the anticipated average volume of leachate. This allows for excess capacity in the LTF in the event that initial batches do not pass discharge criteria and need to be recirculated along with additional leachate.

Approximately 150 m^3 of leachate will be pumped in the aeration pond for treatment. The influent will be allowed to aerate for 2 days. The mixed liquor will then be pumped through a solids removal process, a chemical dosing/mixing tank, and a second solids removal process prior to discharging into the lined effluent holding pond. The treatment times for small initial batch treatment process will mirror the regular treatment cycle, which will be typically completed in 7 days, as follows:

Operating Sequence	Fri.	Sat.	Sun.	Mon.	Tue.	Wed.	Thur.
Fill	X	X					
Aerate	X	X	X				
Solids Removal, Chem. Dose/Mix, Solids Removal				X	X		
Sample					X		
Sample Turnaround	X					X	X
Recirculate/Infiltrate		X	X				

Collected leachate will be sampled, according to the commissioning period sampling program described in Section 3.0. Dependent on the analytical sampling results, leachate will either be recirculated back into the landfill for additional treatment or, if the effluent meets CSR Schedule 3.2 DW criteria, discharged into the infiltration pond.

2.4 Schedule

As previously stated, the leachate commissioning process will provide for leachate characterization and chemical dosage optimization that will allow the treatment process to be refined. Adjustments to the treatment process will be made from time to time as the leachate profile changes, though these changes are expected to occur over months and years, not days. The initial commissioning procedure described in Sections 2.1 and 2.3 is anticipated to be completed in the following timeframe:

- Clean water testing and equipment commissioning – 7 days
- Influent testing and chemical jar testing – within above 7 days
- 3 cycles of initial small batches (150 m^3 each) with sampling of influent and effluent – 21 days, with adjustments in operation to refine optimized conditions.

The anticipated duration of the commissioning period is 4 weeks.

3. Commissioning Plan

The Commissioning Plan has been developed to outline the framework for required monitoring, sampling and analysis that will be carried out during the commissioning period of the leachate treatment works.

3.1 Commissioning Period Sampling Program

During the LTF commissioning period, untreated leachate and treated leachate will be sampled regularly to develop a relationship between the parameters of concern within the leachate and the batch treatment sampling program and well to monitor the performance of the leachate treatment system and chemical dosage.

3.1.1 Raw Leachate Sampling

During the commissioning period, untreated leachate samples will be collected from the collection sump prior to discharge into the aerated equalization pond. Samples will be analyzed for the comprehensive set of parameters presented in the attached Table 1 to confirm the parameters of concern within the leachate. The raw leachate samples will aid in leachate characterization and establish a baseline for determining the effectiveness of the leachate treatment process.

3.1.2 Effluent Quality Sampling

During the commissioning period, each batch of effluent will be sampled from the effluent holding pond and analyzed for a comprehensive set of parameters to determine if a batch can be discharged to the infiltration pond. The effluent will only be discharged to the infiltration pond if the effluent meets the CSR Schedule 3.2 DW criteria. As such, timely analytical results/provision for on-site analytical testing will be critical to the successful commissioning of the LTF.

The commissioning period effluent sampling results will be used to establish the parameter list for compliance sampling throughout the operation of LTF. Based on leachate quality forecasting discussed in the DOCP, the key leachate parameters will be chemical constituents commonly found in C&D and contaminated soil leachate, including:

- Chloride
- Sulphate
- Sulphide
- Arsenic

- Boron
- Iron
- Manganese
- Sodium
- PAHs

3.1.3 Start-Up Treatment Performance Monitoring

In addition to sampling to meet discharge quality objectives, leachate will also be sampled to monitor the performance of the treatment process and to observe changes to leachate quality over time as additional waste is added to the landfill. The following parameters will be used to develop an understanding of the system performance and to assist in the operation and maintenance of the LTF:

- COD
- Alkalinity
- pH
- CSR metals
- Hardness
- TDS
- TSS

The sampling results allow the process to be refined over time in comparison to the process modeling completed during the LTF detailed design and identify trends in changes in leachate quality. Necessary changes or additions to the treatment process will be identified based on the results of this analysis.

3.2 Leachate Batch Sampling and Leachate Monitoring

Subsequent to the completion of the start-up phase, a regular leachate batch sampling program will be implemented. The program will be developed based on the results of the start-up phase sampling program and will outline the parameters to be sampled in every batch to indicate the effectiveness of the treatment process, as well as the confirmatory sampling required at the quarterly environmental monitoring events. Treated leachate batch samples will be collected from the effluent holding pond to verify compliance with the discharge criteria prior to discharge to the infiltration pond.

Samples sent to for laboratory analysis may be collected more frequently to verify the batch sampling program, and to assist in the operation and maintenance of the LTF.

4. Commissioning Report

A report summarizing the LTF commissioning activities and the results of analytical sampling will be prepared and submitted to the Director subsequent the completion of the commissioning period (outlined in Section 2.4). In general, the commissioning report will include the following information:

- Summary of commission activities including sampling activities.
- Summary of analytical results of influent leachate and effluent sampling.
- Copy of all calibration reports and laboratory analytical reports.
- Comments on any observed deficiencies in the LTF design or performance, and a plan for addressing any such deficiencies.
- Maintenance and performance monitoring plan.

5. Contingency Measures

Contingency measures are practical and implementable measures that can put in place in the event of a failure or non-compliance with site performance criteria. The following is a list of potential LTF conditions and associated potential contingency measures that could be implemented:

- Treated leachate effluent does not meet CSR Schedule 3.2 DW standards:
  - Re-circulate batch into the Landfill for retreatment in the LTF
  - Pump and haul to an off-site authorized treatment facility
- Volume of leachate exceeds forecasted treatment capacity:
  - Store leachate in approved leachate containment tanks on-site
  - Evaluate if increased volume is expected long-term and necessitates an expansion of the LTF
- Worsening trend observed in leachate effluent quality:
  - Review leachate process modeling and refine treatment process with addition of chemical
  - Modify/upgrade the leachate treatment process
  - Pre-treat and haul to an off-site authorized treatment facility
- Worsening trend observed in influent leachate quality and/or identification of new parameters of concern:
  - Review leachate process modeling and refine treatment process with addition of chemical
  - Modify/upgrade the leachate treatment process
  - Pre-treat and haul to an off-site authorized treatment facility

Analytical Parameters for Leachate
Leachate Treatment Facility Commissioning Plan
Northwin Landfill
Upland Contracting Ltd.

Field Parameters
Conductivity (field)
Dissolved oxygen
Oxidation reduction potential
pH (field)
Temperature
Total dissolved solids (TDS)
Turbidity

General Chemistry
Alkalinity (speciated)
Chemical oxygen demand (COD)
Chloride (dissolved)
Conductivity
Hardness
Hardness (dissolved)
Hydrogen sulfide
pH
Sulfate (dissolved)
Sulfide
Total dissolved solids (TDS)
Total suspended solids (TSS)

Nutrients
Ammonia-N
Nitrate (as N)
Nitrite (as N)
Nitrite/Nitrate
Total Kjeldahl Nitrogen (TKN)
Orthophosphate
Total Phosphorous (P)

Dissolved CSR Metals

Total CSR Metals

Polycyclic Aromatic Hydrocarbons

BTEX/Volatile Petroleum Hydrocarbons

Extractable petroleum hydrocarbons (EPH)

Appendix G
Contaminating Lifespan Assessment Calculations

Appendix G

Chloride (1st Order)
British Columbia CSR Contaminating Life Span of Chloride

Drinking Water Land Use
Maximum Anticipated Concentration

C_t	250	mg/L	
C_B	1500	mg/L	
λ	0.065	y^{-1}	
t	27.57	y	Time to reduce below Criteria
t	28	y	Time, rounded up
C_o	243.04	mg/L	Check at t (rounded up)

Note: This calculation uses the average concentration from the investigated Sites listed in the Leachate Profile tab.

Note: First order decay rate obtained from Lu et al., 1981, Leachate Production and Management from Municipal Landfill: Summary and Assessment, Land Disposal: Municipal Solid Waste – Proceedings of the Seventh Annual Research Symposium, EPA 600/9 81, pp. 1 17, 1981.

Appendix G

Chloride - Rowe Model
British Columbia CSR Contaminating Life Span of Chloride

Drinking Water Land Use

	Scenario 1	Scenario 2	Units	Comments
C_t	250	250	mg/L	Target concentration
C_t	0.25	0.25	kg/m^3	Target concentration
q_o	0.017	0.017	m/y	Average rate of infiltration
p	0.0004	0.00064	-	Proportion of total waste mass that is chloride
A_o	36,000	36,000	m^2	Unit area[2]
V_o	532,365	532,365	m^3	Volume of landfill
C_o	1500	1500	mg/L	Chloride concentration (peak or average)
C_o	1.5	1.5	kg/m^3	Chloride concentration (peak or average)
r_{dw}	1300	1300	kg/m^3	Dry density of waste
M_o	692,074,500	692,074,500	kg	
H_r	5.13	8.20	m	Reference height of leachate
λ	0.065	0.065	y^{-1}	First Order decay constant
k	0.0683	0.0671	y^{-1}	
k	0.0033	0.0021	y^{-1}	
t	**26.23**	**26.71**	**years**	
t			years	
q_o			m/y	Infiltration rate required to achieve CLS = 30 years

Scenario 1 Maximum chloride concentration, average proportion of chloride in waste
Scenario 2 Maximum chloride concentration, maximum proportion of chloride in waste

Notes

1. The Modified Rowe Model calculates the contaminating life span using a unit area of 1 sq. m. at the highest point of the landfill.

2. The Rowe Model, utilizes the total area of the landfill, as described in "*Rowe, 1995, Leachate characteristics for MSW landfills, R.K. Rowe, Geotechnical Research Centre Report, GEOT 8 95*".

3. The proportion of total waste mass that is chloride was determined for Brooks Road Landfill, based on analytical studies.

4. First order decay rate obtained from *Lu et al., 1981, Leachate Production and Management from Municipal Landfill: Summary and Assessment, Land Disposal: Municipal Solid Waste – Proceedings of the Seventh Annual Research Symposium, EPA 600/9 81, pp. 1 17, 1981.*

Appendix G

Copper - 1st Order
British Columbia CSR Contaminating Life Span of Copper

Drinking Water Land Use
Maximum Anticipated Concentration

C_t	1	mg/L	
C_B	0.05	mg/L	
λ	0.2	y^{-1}	
t	-14.98	y	Time to reduce below Criteria
t	-15	y	Time, rounded up
C_o	1.00	mg/L	Check at t (rounded up)

From Column AI

C_t	0.5	mg/L	
C_B	0.05	mg/L	
λ	0.2	y^{-1}	
t	-11.51	y	Time to reduce below Criteria
t	-12	y	Time, rounded up
C_o	0.55	mg/L	Check at t (rounded up)

Note: This calculation uses the average concentration from the investigated Sites listed in the Leachate Profile tab.

Note: First order decay rate obtained from Lu et al., 1981, Leachate Production and Management from Municipal Landfill: Summary and Assessment, Land Disposal: Municipal Solid Waste – Proceedings of the Seventh Annual Research Symposium, EPA 600/9 81, pp. 1 17, 1981.

Appendix G

Sulphate 1st Order
British Columbia CSR Contaminating Life Span of Sulphate

Drinking Water Land Use
Maximum Anticipated Concentration

C_t	500	mg/L	
C_B	1000	mg/L	
λ	0.079	y^{-1}	
t	8.77	y	Time to reduce below Criteria
t	9	y	Time, rounded up
C_o	491.15	mg/L	Check at t (rounded up)

Note: This calculation uses the average concentration from the investigated Sites listed in the Leachate Profile tab.

Note: First order decay rate obtained from Lu et al., 1981, Leachate Production and Management from Municipal Landfill: Summary and Assessment, Land Disposal: Municipal Solid Waste – Proceedings of the Seventh Annual Research Symposium, EPA 600/9 81, pp. 1 17, 1981.

Appendix H
Liner Leakage HELP Model Results

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**                                                                           **
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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                     USAE WATERWAYS EXPERIMENT STATION                     **
**                FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                           **
**                                                                           **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PD.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TD.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRD.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETD.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877DF6.D10
OUTPUT DATA FILE:           C:\HELP3\88877DF6.OUT


TIME:  17:16     DATE:   3/20/2018



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     TITLE:  Upland Landfill - Daily Cover HDPE Failure, Secondary Liner

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.



                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   2
          THICKNESS                    =     10.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1434 VOL/VOL
```

EFFECTIVE SAT. HYD. COND. = 0.579999993000E-02 CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3171	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0389	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	30.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0700	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	150.0	METERS

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.15	CM

POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY	=	2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00 HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60 CM
POROSITY	=	0.7500 VOL/VOL
FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	10.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	1.434	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.370	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.240	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	768.778	CM
TOTAL INITIAL WATER	=	768.778	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	91
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	10.0 CM
AVERAGE ANNUAL WIND SPEED	=	8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	34.035	26.786	5.216	0.550	0.336	0.253
	0.335	0.489	0.129	6.234	11.463	20.108
STD. DEVIATIONS	67.175	67.695	13.713	1.344	1.127	0.629
	1.002	2.820	0.565	7.952	13.010	40.118
EVAPOTRANSPIRATION						
TOTALS	7.270	10.909	32.661	50.909	38.585	34.688
	19.103	18.345	23.951	19.526	8.926	6.344
STD. DEVIATIONS	2.877	4.501	6.050	12.277	16.674	16.545
	13.384	13.132	11.467	4.334	1.619	2.045
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	184.9617	124.8822	110.9308	54.5503	29.5131	27.0398
	20.0543	19.7217	28.2646	134.8827	186.5648	187.1910
STD. DEVIATIONS	82.3606	64.2705	45.3760	29.2116	20.9264	19.1694
	18.4242	18.2704	20.5887	61.0835	63.2804	71.2859
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	69.2439	87.4646	106.1008	128.8358	138.5320	121.7064
	116.7813	105.4236	84.6364	53.9413	43.1807	54.1387
STD. DEVIATIONS	25.0072	31.9981	33.4254	32.8829	29.1002	22.3601
	18.7912	16.9541	17.0074	16.5754	15.7972	19.9535
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	65.1089	84.2772	102.4533	123.0865	138.0491	123.4093
	117.0968	106.9451	86.7352	60.5727	43.3287	50.4224
STD. DEVIATIONS	24.4978	28.8200	30.3134	31.9586	29.0905	23.2966
	18.4311	17.3214	15.8749	16.8588	14.9788	17.0222
PERCOLATION/LEAKAGE THROUGH LAYER 6						

TOTALS	0.5145	0.6352	0.7635	0.8985	1.0008	0.9006
	0.8611	0.7934	0.6561	0.4842	0.3667	0.4165
STD. DEVIATIONS	0.1633	0.1923	0.2021	0.2131	0.1940	0.1553
	0.1229	0.1155	0.1058	0.1124	0.0999	0.1135

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	0.6456	0.5848	0.6505	0.6482	0.7019	0.7062
	0.7462	0.7551	0.7290	0.7374	0.6806	0.6708
STD. DEVIATIONS	0.0759	0.0686	0.0741	0.0698	0.0734	0.0730
	0.0750	0.0748	0.0717	0.0725	0.0683	0.0676

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1754	0.1345	0.1128	0.0588	0.0295	0.0299
	0.0207	0.0206	0.0312	0.1313	0.1855	0.1773
STD. DEVIATIONS	0.0790	0.0695	0.0476	0.0312	0.0224	0.0239
	0.0196	0.0180	0.0240	0.0619	0.0683	0.0707

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0748	0.1027	0.1130	0.1417	0.1474	0.1339
	0.1243	0.1123	0.0931	0.0583	0.0487	0.0588
STD. DEVIATIONS	0.0262	0.0367	0.0354	0.0362	0.0310	0.0245
	0.0201	0.0180	0.0187	0.0175	0.0170	0.0209

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	3.2417	4.6031	5.1011	6.3327	6.8734	6.3493
	5.8302	5.3247	4.4624	3.0159	2.2292	2.5105
STD. DEVIATIONS	1.2197	1.5665	1.5093	1.6442	1.4484	1.1986
	0.9177	0.8624	0.8167	0.8394	0.7706	0.8475

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	1.5592	1.5497	1.5711	1.6177	1.6952	1.7623
	1.8021	1.8236	1.8193	1.7809	1.6984	1.6200
STD. DEVIATIONS	0.1833	0.1783	0.1788	0.1742	0.1774	0.1822
	0.1812	0.1807	0.1789	0.1751	0.1705	0.1632

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	105.931	(128.5090)	1059.31	7.129
EVAPOTRANSPIRATION	271.217	(37.8267)	2712.17	18.252
PERCOLATION/LEAKAGE THROUGH LAYER 2	1108.55688	(180.96466)	11085.568	74.60322
AVERAGE HEAD ON TOP OF LAYER 2	0.923	(0.156)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1109.98572	(153.82428)	11099.857	74.69937
AVERAGE HEAD ON TOP OF LAYER 4	1.007	(0.139)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1101.48511	(150.58197)	11014.852	74.12730
PERCOLATION/LEAKAGE THROUGH LAYER 6	8.29104	(1.00393)	82.910	0.55797
AVERAGE HEAD ON TOP OF LAYER 6	46.562	(6.368)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	8.25641	(0.77981)	82.564	0.55564
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00175	(0.00017)	0.017	0.00012

AVERAGE HEAD ON TOP OF LAYER 8	16.916 (	1.597)		
CHANGE IN WATER STORAGE	-0.955 (	7.3122)	-9.55	-0.064

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	87.653	876.5259
PERCOLATION/LEAKAGE THROUGH LAYER 2	60.615021	606.15021
AVERAGE HEAD ON TOP OF LAYER 2	25.039	
PERCOLATION/LEAKAGE THROUGH LAYER 4	8.922950	89.22950
AVERAGE HEAD ON TOP OF LAYER 4	2.946	
DRAINAGE COLLECTED FROM LAYER 5	7.72807	77.28065
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.054120	0.54120
AVERAGE HEAD ON TOP OF LAYER 6	119.280	
MAXIMUM HEAD ON TOP OF LAYER 6	170.266	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	22.9 METERS	
DRAINAGE COLLECTED FROM LAYER 7	0.02983	0.29826
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000006	0.00006
AVERAGE HEAD ON TOP OF LAYER 8	22.330	
MAXIMUM HEAD ON TOP OF LAYER 8	42.487	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	7.2 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	3.7450	0.3745
2	2.1850	0.4370
3	746.7070	0.3111
4	0.0000	0.0000
5	3.2624	0.1087
6	0.4500	0.7500
7	2.4275	0.0809
8	0.0000	0.0000
9	0.4500	0.7500
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                     USAE WATERWAYS EXPERIMENT STATION                     **
**                FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                           **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PD.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TD.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRD.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETD.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877DF5.D10
OUTPUT DATA FILE:           C:\HELP3\88877DF5.OUT


TIME:  17: 0     DATE:   3/20/2018



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     TITLE:  Upland Landfill - Daily Cover HDPE Failure

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.



                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   2
          THICKNESS                    =     10.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1434 VOL/VOL
```

EFFECTIVE SAT. HYD. COND. = 0.579999993000E-02 CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3171	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0389	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	10.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	1.434	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.370	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.240	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	766.230	CM
TOTAL INITIAL WATER	=	766.230	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	91
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	10.0 CM
AVERAGE ANNUAL WIND SPEED	=	8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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             AVERAGE MONTHLY VALUES (MM) FOR YEARS    1 THROUGH  100
 ------------------------------------------------------------------------------
-
                          JAN/JUL   FEB/AUG   MAR/SEP   APR/OCT   MAY/NOV   JUN/DEC
                          -------   -------   -------   -------   -------   -------
   PRECIPITATION
   -------------
     TOTALS               216.01    144.89    142.48    102.27     67.19     62.06
                           37.45     39.26     52.65    167.86    220.02    233.79

     STD. DEVIATIONS       63.32     48.38     46.44     37.98     33.77     32.53
                           28.36     30.28     30.04     68.74     74.24     69.47

   RUNOFF
   ------
     TOTALS                34.035    26.786     5.216     0.550     0.336     0.253
                            0.335     0.489     0.129     6.234    11.463    20.108

     STD. DEVIATIONS       67.175    67.695    13.713     1.344     1.127     0.629
                            1.002     2.820     0.565     7.952    13.010    40.118

   EVAPOTRANSPIRATION
   ------------------
     TOTALS                 7.270    10.909    32.661    50.909    38.585    34.688
                           19.103    18.345    23.951    19.526     8.926     6.344

     STD. DEVIATIONS        2.877     4.501     6.050    12.277    16.674    16.545
                           13.384    13.132    11.467     4.334     1.619     2.045

   PERCOLATION/LEAKAGE THROUGH LAYER  2
   -------------------------------------
     TOTALS               184.9617  124.8822  110.9308   54.5503   29.5131   27.0398
                           20.0543   19.7217   28.2646  134.8827  186.5648  187.1910

     STD. DEVIATIONS       82.3606   64.2705   45.3760   29.2116   20.9264   19.1694
                           18.4242   18.2704   20.5887   61.0835   63.2804   71.2859

   PERCOLATION/LEAKAGE THROUGH LAYER  4
   -------------------------------------
     TOTALS                69.2439   87.4646  106.1008  128.8358  138.5320  121.7064
                          116.7813  105.4236   84.6364   53.9413   43.1807   54.1387

     STD. DEVIATIONS       25.0072   31.9981   33.4254   32.8829   29.1002   22.3601
                           18.7912   16.9541   17.0074   16.5754   15.7972   19.9535

   LATERAL DRAINAGE COLLECTED FROM LAYER  5
   ----------------------------------------
     TOTALS                65.1089   84.2772  102.4533  123.0865  138.0491  123.4093
                          117.0968  106.9451   86.7352   60.5727   43.3287   50.4224
```

STD. DEVIATIONS	24.4978	28.8200	30.3134	31.9586	29.0905	23.2966
	18.4311	17.3214	15.8749	16.8588	14.9788	17.0222

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.5145	0.6352	0.7635	0.8985	1.0008	0.9006
	0.8611	0.7934	0.6561	0.4842	0.3667	0.4165
STD. DEVIATIONS	0.1633	0.1923	0.2021	0.2131	0.1940	0.1553
	0.1229	0.1155	0.1058	0.1124	0.0999	0.1135

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1754	0.1345	0.1128	0.0588	0.0295	0.0299
	0.0207	0.0206	0.0312	0.1313	0.1855	0.1773
STD. DEVIATIONS	0.0790	0.0695	0.0476	0.0312	0.0224	0.0239
	0.0196	0.0180	0.0240	0.0619	0.0683	0.0707

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0748	0.1027	0.1130	0.1417	0.1474	0.1339
	0.1243	0.1123	0.0931	0.0583	0.0487	0.0588
STD. DEVIATIONS	0.0262	0.0367	0.0354	0.0362	0.0310	0.0245
	0.0201	0.0180	0.0187	0.0175	0.0170	0.0209

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	3.2417	4.6031	5.1011	6.3327	6.8734	6.3493
	5.8302	5.3247	4.4624	3.0159	2.2292	2.5105
STD. DEVIATIONS	1.2197	1.5665	1.5093	1.6442	1.4484	1.1986
	0.9177	0.8624	0.8167	0.8394	0.7706	0.8475

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	105.931	(128.5090)	1059.31	7.129
EVAPOTRANSPIRATION	271.217	(37.8267)	2712.17	18.252
PERCOLATION/LEAKAGE THROUGH LAYER 2	1108.55688	(180.96466)	11085.568	74.60322
AVERAGE HEAD ON TOP OF LAYER 2	0.923	(0.156)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1109.98572	(153.82428)	11099.857	74.69937
AVERAGE HEAD ON TOP OF LAYER 4	1.007	(0.139)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1101.48511	(150.58197)	11014.852	74.12730
PERCOLATION/LEAKAGE THROUGH LAYER 6	8.29104	(1.00393)	82.910	0.55797
AVERAGE HEAD ON TOP OF LAYER 6	46.562	(6.368)		
CHANGE IN WATER STORAGE	-0.988	(7.3143)	-9.88	-0.066

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	87.653	876.5259
PERCOLATION/LEAKAGE THROUGH LAYER 2	60.615021	606.15021
AVERAGE HEAD ON TOP OF LAYER 2	25.039	
PERCOLATION/LEAKAGE THROUGH LAYER 4	8.922950	89.22950
AVERAGE HEAD ON TOP OF LAYER 4	2.946	
DRAINAGE COLLECTED FROM LAYER 5	7.72807	77.28065
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.054120	0.54120
AVERAGE HEAD ON TOP OF LAYER 6	119.280	
MAXIMUM HEAD ON TOP OF LAYER 6	170.266	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	22.9 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	3.7450	0.3745
2	2.1850	0.4370
3	746.7070	0.3111
4	0.0000	0.0000
5	3.2624	0.1087
6	0.4500	0.7500
SNOW WATER	0.000	

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**                                                                           **
**                                                                           **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                     USAE WATERWAYS EXPERIMENT STATION                     **
**                FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                           **
**                                                                           **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PD.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TD.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRD.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETD.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877DO3.D10
OUTPUT DATA FILE:           C:\HELP3\88877DO3.OUT


TIME:  16:43     DATE:   3/20/2018



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     TITLE:  Upland Landfill - Daily Cover DOCP - Poor Liner Install

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.



                                LAYER  1
                                --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   2
          THICKNESS                    =     10.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1434 VOL/VOL
```

EFFECTIVE SAT. HYD. COND. = 0.579999993000E-02 CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3171	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	12.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	4 - POOR	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0390	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.15	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	12.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	4 - POOR	

LAYER 7

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT

SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	10.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	1.434	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.370	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.240	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	766.234	CM
TOTAL INITIAL WATER	=	766.234	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	91	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	10.0	CM
AVERAGE ANNUAL WIND SPEED	=	8.00	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

****

AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	34.035	26.786	5.216	0.550	0.336	0.253
	0.335	0.489	0.129	6.234	11.463	20.108
STD. DEVIATIONS	67.175	67.695	13.713	1.344	1.127	0.629
	1.002	2.820	0.565	7.952	13.010	40.118
EVAPOTRANSPIRATION						
TOTALS	7.270	10.909	32.661	50.909	38.585	34.688
	19.103	18.345	23.951	19.526	8.926	6.344
STD. DEVIATIONS	2.877	4.501	6.050	12.277	16.674	16.545
	13.384	13.132	11.467	4.334	1.619	2.045
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	184.9617	124.8822	110.9308	54.5503	29.5131	27.0398
	20.0543	19.7217	28.2646	134.8827	186.5648	187.1910

STD. DEVIATIONS	82.3606	64.2705	45.3760	29.2116	20.9264	19.1694
	18.4242	18.2704	20.5887	61.0835	63.2804	71.2859

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	69.2439	87.4646	106.1008	128.8358	138.5320	121.7064
	116.7813	105.4236	84.6364	53.9413	43.1807	54.1387
STD. DEVIATIONS	25.0072	31.9981	33.4254	32.8829	29.1002	22.3601
	18.7912	16.9541	17.0074	16.5754	15.7972	19.9535

LATERAL DRAINAGE COLLECTED FROM LAYER 5

TOTALS	65.5990	84.8830	103.1995	123.9468	139.0431	124.3204
	117.9639	107.7494	87.4097	61.1019	43.6985	50.8228
STD. DEVIATIONS	24.6491	28.9861	30.4956	32.1618	29.2816	23.4550
	18.5503	17.4347	15.9752	16.9680	15.0715	17.1150

PERCOLATION/LEAKAGE THROUGH LAYER 7

TOTALS	0.0020	0.0028	0.0035	0.0044	0.0050	0.0043
	0.0040	0.0036	0.0028	0.0018	0.0013	0.0015
STD. DEVIATIONS	0.0009	0.0012	0.0013	0.0015	0.0014	0.0010
	0.0008	0.0007	0.0006	0.0006	0.0005	0.0006

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1754	0.1345	0.1128	0.0588	0.0295	0.0299
	0.0207	0.0206	0.0312	0.1313	0.1855	0.1773
STD. DEVIATIONS	0.0790	0.0695	0.0476	0.0312	0.0224	0.0239
	0.0196	0.0180	0.0240	0.0619	0.0683	0.0707

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0748	0.1027	0.1130	0.1417	0.1474	0.1339
	0.1243	0.1123	0.0931	0.0583	0.0487	0.0588
STD. DEVIATIONS	0.0262	0.0367	0.0354	0.0362	0.0310	0.0245
	0.0201	0.0180	0.0187	0.0175	0.0170	0.0209

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	3.2661	4.6362	5.1382	6.3769	6.9228	6.3961
	5.8733	5.3648	4.4971	3.0422	2.2482	2.5304
STD. DEVIATIONS	1.2273	1.5755	1.5183	1.6547	1.4579	1.2067
	0.9236	0.8681	0.8219	0.8448	0.7754	0.8521

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	105.931	(128.5090)	1059.31	7.129
EVAPOTRANSPIRATION	271.217	(37.8267)	2712.17	18.252
PERCOLATION/LEAKAGE THROUGH LAYER 2	1108.55688	(180.96466)	11085.568	74.60322
AVERAGE HEAD ON TOP OF LAYER 2	0.923	(0.156)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1109.98572	(153.82428)	11099.857	74.69937
AVERAGE HEAD ON TOP OF LAYER 4	1.007	(0.139)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1109.73792	(151.56952)	11097.379	74.68269
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.03697	(0.00634)	0.370	0.00249
AVERAGE HEAD ON TOP OF LAYER 6	46.910	(6.410)		
CHANGE IN WATER STORAGE	-0.987	(7.3146)	-9.87	-0.066

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	87.653	876.5259
PERCOLATION/LEAKAGE THROUGH LAYER 2	60.615021	606.15021
AVERAGE HEAD ON TOP OF LAYER 2	25.039	
PERCOLATION/LEAKAGE THROUGH LAYER 4	8.922950	89.22950
AVERAGE HEAD ON TOP OF LAYER 4	2.946	
DRAINAGE COLLECTED FROM LAYER 5	7.77760	77.77605
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000338	0.00338
AVERAGE HEAD ON TOP OF LAYER 6	120.045	
MAXIMUM HEAD ON TOP OF LAYER 6	171.162	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	23.0 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	3.7450	0.3745
2	2.1850	0.4370
3	746.7070	0.3111
4	0.0000	0.0000
5	3.2790	0.1093
6	0.0000	0.0000
7	0.4500	0.7500
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                     USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                           **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PF.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TF.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRF.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETF.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877FF4.D10
OUTPUT DATA FILE:           C:\HELP3\88877FF4.OUT


TIME:  19:10     DATE:   3/20/2018



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     TITLE:  Upland Landfill - Final Cover HDPE Failure, Secondary Liner

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.



                                LAYER  1
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                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   4
          THICKNESS                   =     15.00   CM
          POROSITY                    =      0.4370 VOL/VOL
          FIELD CAPACITY              =      0.1050 VOL/VOL
          WILTING POINT               =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.1785 VOL/VOL
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EFFECTIVE SAT. HYD. COND. = 0.170000002000E-02 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	60.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3227	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC
SLOPE	=	10.00	PERCENT
DRAINAGE LENGTH	=	35.0	METERS

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	15.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1250	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0337	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 8

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 9

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	30.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0632	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	150.0	METERS

LAYER 10

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.15	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 11

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL

WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	56.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	30.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	5.060	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	13.110	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.065	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	728.972	CM
TOTAL INITIAL WATER	=	728.972	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	91	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	30.0	CM
AVERAGE ANNUAL WIND SPEED	=	8.00	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	21.382	20.117	3.223	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.140	8.023
STD. DEVIATIONS	61.417	62.057	12.268	0.000	0.000	0.000
	0.000	0.000	0.000	0.003	0.842	33.796

EVAPOTRANSPIRATION

TOTALS	6.991	10.459	35.089	66.199	66.348	57.095
	36.757	32.885	36.444	17.871	7.401	5.790
STD. DEVIATIONS	2.382	4.007	5.824	10.244	20.874	24.694
	24.988	20.829	18.091	3.718	1.437	1.722

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	198.2982	143.5541	130.1599	73.7398	27.9560	10.4772
	5.3721	4.0402	6.3776	70.6105	170.1666	196.9461
STD. DEVIATIONS	73.5734	59.6388	42.8260	29.5571	15.4583	11.1173
	7.3795	9.0126	10.6322	41.1663	57.6571	56.0787

PERCOLATION/LEAKAGE THROUGH LAYER 3

TOTALS	3.1005	2.2607	2.0637	1.2014	0.5063	0.2374
	0.1622	0.1412	0.1732	1.1557	2.6706	3.0813
STD. DEVIATIONS	1.1182	0.9087	0.6526	0.4504	0.2356	0.1694
	0.1124	0.1378	0.1632	0.6281	0.8784	0.8543

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	3.1055	2.6911	2.4135	1.9825	1.4584	0.9163
	0.6560	0.4896	0.3444	0.1259	0.3696	2.2274
STD. DEVIATIONS	0.9502	0.8980	0.8627	0.5128	0.3316	0.1868
	0.1274	0.1012	0.1021	0.1036	0.4582	1.0603

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	2.9168	2.6859	2.3986	1.9599	1.4829	0.9079
	0.6186	0.4310	0.2893	0.1173	0.1984	1.8080
STD. DEVIATIONS	0.8955	0.8772	0.8500	0.5565	0.3525	0.2060
	0.1340	0.1000	0.0949	0.0888	0.2906	1.0078

PERCOLATION/LEAKAGE THROUGH LAYER 8

TOTALS	0.0998	0.0911	0.0958	0.0908	0.0902	0.0838
	0.0845	0.0828	0.0782	0.0490	0.0329	0.0870
STD. DEVIATIONS	0.0060	0.0060	0.0077	0.0037	0.0024	0.0014
	0.0009	0.0030	0.0067	0.0205	0.0223	0.0174

LATERAL DRAINAGE COLLECTED FROM LAYER 9

TOTALS	0.0776	0.0728	0.0817	0.0804	0.0840	0.0817
	0.0845	0.0844	0.0815	0.0828	0.0749	0.0760
STD. DEVIATIONS	0.0046	0.0040	0.0039	0.0035	0.0033	0.0029

	0.0027	0.0024	0.0021	0.0024	0.0029	0.0031

PERCOLATION/LEAKAGE THROUGH LAYER 11

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	22.5526	17.9315	14.8102	8.6702	3.1810	1.2319
	0.6113	0.4597	0.7499	8.0344	20.0066	22.4089
STD. DEVIATIONS	8.3496	7.4634	4.8729	3.4753	1.7589	1.3071
	0.8397	1.0255	1.2501	4.6841	6.7776	6.3795

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0030	0.0029	0.0024	0.0020	0.0014	0.0009
	0.0006	0.0005	0.0003	0.0001	0.0004	0.0022
STD. DEVIATIONS	0.0009	0.0010	0.0008	0.0005	0.0003	0.0002
	0.0001	0.0001	0.0001	0.0001	0.0005	0.0010

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.1452	0.1468	0.1194	0.1008	0.0738	0.0467
	0.0308	0.0215	0.0149	0.0058	0.0102	0.0900
STD. DEVIATIONS	0.0446	0.0481	0.0423	0.0286	0.0176	0.0106
	0.0067	0.0050	0.0049	0.0044	0.0150	0.0502

DAILY AVERAGE HEAD ON TOP OF LAYER 10

AVERAGES	0.1875	0.1930	0.1973	0.2006	0.2029	0.2039
	0.2042	0.2039	0.2033	0.2001	0.1868	0.1834
STD. DEVIATIONS	0.0111	0.0100	0.0094	0.0088	0.0080	0.0073
	0.0066	0.0059	0.0053	0.0058	0.0072	0.0075

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	52.886	(114.1105)	528.86	3.559
EVAPOTRANSPIRATION	379.329	(55.0845)	3793.29	25.528
LATERAL DRAINAGE COLLECTED FROM LAYER 2	1037.69824	(180.34677)	10376.982	69.83460
PERCOLATION/LEAKAGE THROUGH LAYER 3	16.75417	(2.74737)	167.542	1.12752
AVERAGE HEAD ON TOP OF LAYER 3	100.540	(17.590)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	16.78025	(2.82458)	167.803	1.12927
AVERAGE HEAD ON TOP OF LAYER 6	0.014	(0.002)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	15.81461	(2.77709)	158.146	1.06429
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.96615	(0.03470)	9.662	0.06502
AVERAGE HEAD ON TOP OF LAYER 8	0.672	(0.119)		
LATERAL DRAINAGE COLLECTED FROM LAYER 9	0.96240	(0.03525)	9.624	0.06477
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.00020	(0.00001)	0.002	0.00001
AVERAGE HEAD ON TOP OF LAYER 10	1.973	(0.072)		
CHANGE IN WATER STORAGE	-0.753	(2.5401)	-7.53	-0.051

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	84.875	848.7458
DRAINAGE COLLECTED FROM LAYER 2	22.22717	222.27165
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.320248	3.20248
AVERAGE HEAD ON TOP OF LAYER 3	735.327	
MAXIMUM HEAD ON TOP OF LAYER 3	985.790	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	11.3 METERS	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.317653	3.17653
AVERAGE HEAD ON TOP OF LAYER 6	0.084	
DRAINAGE COLLECTED FROM LAYER 7	0.21372	2.13717
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.004017	0.04017
AVERAGE HEAD ON TOP OF LAYER 8	3.299	
MAXIMUM HEAD ON TOP OF LAYER 8	6.390	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	2.5 METERS	
DRAINAGE COLLECTED FROM LAYER 9	0.00287	0.02873
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.000001	0.00001
AVERAGE HEAD ON TOP OF LAYER 10	2.151	
MAXIMUM HEAD ON TOP OF LAYER 10	4.253	
LOCATION OF MAXIMUM HEAD IN LAYER 9 (DISTANCE FROM DRAIN)	1.7 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0355

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	6.5550	0.4370
2	8.1823	0.1364
3	0.4500	0.7500
4	1.6144	0.1076
5	700.8000	0.2920
6	0.0000	0.0000
7	1.0047	0.0335
8	0.4500	0.7500
9	1.9316	0.0644
10	0.0000	0.0000
11	0.4500	0.7500
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                     USAE WATERWAYS EXPERIMENT STATION                     **
**                FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                           **
**                                                                           **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PF.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TF.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRF.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETF.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877FF3.D10
OUTPUT DATA FILE:           C:\HELP3\88877FF3.OUT

TIME:  18:51     DATE:   3/20/2018

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     TITLE:  Upland Landfill - Final Cover HDPE Failure

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                LAYER  1
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   4
          THICKNESS                    =     15.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.1050 VOL/VOL
          WILTING POINT                =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1785 VOL/VOL
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EFFECTIVE SAT. HYD. COND. = 0.170000002000E-02 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	60.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3227	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC
SLOPE	=	10.00	PERCENT
DRAINAGE LENGTH	=	35.0	METERS

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	15.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1250	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0337	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 8

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60 CM
POROSITY	=	0.7500 VOL/VOL
FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	56.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	30.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	5.060	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	13.110	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.065	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	726.626	CM
TOTAL INITIAL WATER	=	726.626	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	91
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	30.0 CM
AVERAGE ANNUAL WIND SPEED	=	8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	21.382	20.117	3.223	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.140	8.023

STD. DEVIATIONS	61.417	62.057	12.268	0.000	0.000	0.000
	0.000	0.000	0.000	0.003	0.842	33.796

EVAPOTRANSPIRATION

TOTALS	6.991	10.459	35.089	66.199	66.348	57.095
	36.757	32.885	36.444	17.871	7.401	5.790
STD. DEVIATIONS	2.382	4.007	5.824	10.244	20.874	24.694
	24.988	20.829	18.091	3.718	1.437	1.722

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	198.2982	143.5541	130.1599	73.7398	27.9560	10.4772
	5.3721	4.0402	6.3776	70.6105	170.1666	196.9461
STD. DEVIATIONS	73.5734	59.6388	42.8260	29.5571	15.4583	11.1173
	7.3795	9.0126	10.6322	41.1663	57.6571	56.0787

PERCOLATION/LEAKAGE THROUGH LAYER 3

TOTALS	3.1005	2.2607	2.0637	1.2014	0.5063	0.2374
	0.1622	0.1412	0.1732	1.1557	2.6706	3.0813
STD. DEVIATIONS	1.1182	0.9087	0.6526	0.4504	0.2356	0.1694
	0.1124	0.1378	0.1632	0.6281	0.8784	0.8543

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	3.1055	2.6911	2.4135	1.9825	1.4584	0.9163
	0.6560	0.4896	0.3444	0.1259	0.3696	2.2274
STD. DEVIATIONS	0.9502	0.8980	0.8627	0.5128	0.3316	0.1868
	0.1274	0.1012	0.1021	0.1036	0.4582	1.0603

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	2.9168	2.6859	2.3986	1.9599	1.4829	0.9079
	0.6186	0.4310	0.2893	0.1173	0.1984	1.8080
STD. DEVIATIONS	0.8955	0.8772	0.8500	0.5565	0.3525	0.2060
	0.1340	0.1000	0.0949	0.0888	0.2906	1.0078

PERCOLATION/LEAKAGE THROUGH LAYER 8

TOTALS	0.0998	0.0911	0.0958	0.0908	0.0902	0.0838
	0.0845	0.0828	0.0782	0.0490	0.0329	0.0870
STD. DEVIATIONS	0.0060	0.0060	0.0077	0.0037	0.0024	0.0014
	0.0009	0.0030	0.0067	0.0205	0.0223	0.0174

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	22.5526	17.9315	14.8102	8.6702	3.1810	1.2319
	0.6113	0.4597	0.7499	8.0344	20.0066	22.4089
STD. DEVIATIONS	8.3496	7.4634	4.8729	3.4753	1.7589	1.3071
	0.8397	1.0255	1.2501	4.6841	6.7776	6.3795

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0030	0.0029	0.0024	0.0020	0.0014	0.0009
	0.0006	0.0005	0.0003	0.0001	0.0004	0.0022
STD. DEVIATIONS	0.0009	0.0010	0.0008	0.0005	0.0003	0.0002
	0.0001	0.0001	0.0001	0.0001	0.0005	0.0010

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.1452	0.1468	0.1194	0.1008	0.0738	0.0467
	0.0308	0.0215	0.0149	0.0058	0.0102	0.0900
STD. DEVIATIONS	0.0446	0.0481	0.0423	0.0286	0.0176	0.0106
	0.0067	0.0050	0.0049	0.0044	0.0150	0.0502

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	52.886	(114.1105)	528.86	3.559
EVAPOTRANSPIRATION	379.329	(55.0845)	3793.29	25.528
LATERAL DRAINAGE COLLECTED FROM LAYER 2	1037.69824	(180.34677)	10376.982	69.83460
PERCOLATION/LEAKAGE THROUGH	16.75417	(2.74737)	167.542	1.12752

LAYER 3				
AVERAGE HEAD ON TOP OF LAYER 3	100.540 (17.590)			
PERCOLATION/LEAKAGE THROUGH LAYER 6	16.78025 (2.82458)	167.803	1.12927	
AVERAGE HEAD ON TOP OF LAYER 6	0.014 (0.002)			
LATERAL DRAINAGE COLLECTED FROM LAYER 7	15.81461 (2.77709)	158.146	1.06429	
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.96615 (0.03470)	9.662	0.06502	
AVERAGE HEAD ON TOP OF LAYER 8	0.672 (0.119)			
CHANGE IN WATER STORAGE	-0.757 (2.5401)	-7.57	-0.051	

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	84.875	848.7458
DRAINAGE COLLECTED FROM LAYER 2	22.22717	222.27165
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.320248	3.20248
AVERAGE HEAD ON TOP OF LAYER 3	735.327	
MAXIMUM HEAD ON TOP OF LAYER 3	985.790	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	11.3 METERS	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.317653	3.17653
AVERAGE HEAD ON TOP OF LAYER 6	0.084	
DRAINAGE COLLECTED FROM LAYER 7	0.21372	2.13717
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.004017	0.04017
AVERAGE HEAD ON TOP OF LAYER 8	3.299	
MAXIMUM HEAD ON TOP OF LAYER 8	6.390	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	2.5 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0355

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	6.5550	0.4370
2	8.1823	0.1364
3	0.4500	0.7500
4	1.6144	0.1076
5	700.8000	0.2920
6	0.0000	0.0000
7	1.0047	0.0335
8	0.4500	0.7500
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                     USAE WATERWAYS EXPERIMENT STATION                     **
**                FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                           **
**                                                                           **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PF.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TF.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRF.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETF.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877FO3.D10
OUTPUT DATA FILE:           C:\HELP3\88877FO3.OUT


TIME:  18:31     DATE:   3/20/2018



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     TITLE:  Upland Landfill - Final Cover DOCP, Poor Liner

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.



                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   4
          THICKNESS                    =     15.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.1050 VOL/VOL
          WILTING POINT                =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1785 VOL/VOL
```

EFFECTIVE SAT. HYD. COND. = 0.170000002000E-02 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 4.63
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	60.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3227	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC
SLOPE	=	10.00	PERCENT
DRAINAGE LENGTH	=	35.0	METERS

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	15.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1250	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	12.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	4 - POOR	

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0337	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

THICKNESS	= 0.15	CM
POROSITY	= 0.0000	VOL/VOL
FIELD CAPACITY	= 0.0000	VOL/VOL
WILTING POINT	= 0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	= 0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	= 0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	= 2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	= 12.00	HOLES/HECTARE
FML PLACEMENT QUALITY	= 4 - POOR	

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	= 0.60	CM
POROSITY	= 0.7500	VOL/VOL
FIELD CAPACITY	= 0.7470	VOL/VOL
WILTING POINT	= 0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	= 0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	= 0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	= 56.00	
FRACTION OF AREA ALLOWING RUNOFF	= 100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	= 1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	= 30.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	= 5.060	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	= 13.110	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	= 1.065	CM
INITIAL SNOW WATER	= 0.000	CM
INITIAL WATER IN LAYER MATERIALS	= 726.627	CM
TOTAL INITIAL WATER	= 726.627	CM
TOTAL SUBSURFACE INFLOW	= 0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	91
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	30.0 CM
AVERAGE ANNUAL WIND SPEED	=	8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

****

AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	21.382	20.117	3.223	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.140	8.023
STD. DEVIATIONS	61.417	62.057	12.268	0.000	0.000	0.000
	0.000	0.000	0.000	0.003	0.842	33.796
EVAPOTRANSPIRATION						
TOTALS	6.991	10.459	35.089	66.199	66.348	57.095
	36.757	32.885	36.444	17.871	7.401	5.790
STD. DEVIATIONS	2.382	4.007	5.824	10.244	20.874	24.694
	24.988	20.829	18.091	3.718	1.437	1.722
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	198.2982	143.5541	130.1599	73.7398	27.9560	10.4772
	5.3721	4.0402	6.3776	70.6105	170.1666	196.9461
STD. DEVIATIONS	73.5734	59.6388	42.8260	29.5571	15.4583	11.1173
	7.3795	9.0126	10.6322	41.1663	57.6571	56.0787
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	3.1005	2.2607	2.0637	1.2014	0.5063	0.2374
	0.1622	0.1412	0.1732	1.1557	2.6706	3.0813
STD. DEVIATIONS	1.1182	0.9087	0.6526	0.4504	0.2356	0.1694
	0.1124	0.1378	0.1632	0.6281	0.8784	0.8543
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	3.1055	2.6911	2.4135	1.9825	1.4584	0.9163
	0.6560	0.4896	0.3444	0.1259	0.3696	2.2274
STD. DEVIATIONS	0.9502	0.8980	0.8627	0.5128	0.3316	0.1868
	0.1274	0.1012	0.1021	0.1036	0.4582	1.0603

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	3.0155	2.7773	2.4950	2.0511	1.5738	0.9922
	0.7034	0.5141	0.3679	0.1767	0.2255	1.8878
STD. DEVIATIONS	0.9012	0.8827	0.8567	0.5604	0.3550	0.2075
	0.1349	0.1015	0.0983	0.1032	0.3019	1.0230

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	22.5526	17.9315	14.8102	8.6702	3.1810	1.2319
	0.6113	0.4597	0.7499	8.0344	20.0066	22.4089
STD. DEVIATIONS	8.3496	7.4634	4.8729	3.4753	1.7589	1.3071
	0.8397	1.0255	1.2501	4.6841	6.7776	6.3795

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0030	0.0029	0.0024	0.0020	0.0014	0.0009
	0.0006	0.0005	0.0003	0.0001	0.0004	0.0022
STD. DEVIATIONS	0.0009	0.0010	0.0008	0.0005	0.0003	0.0002
	0.0001	0.0001	0.0001	0.0001	0.0005	0.0010

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.1501	0.1518	0.1242	0.1055	0.0784	0.0510
	0.0350	0.0256	0.0189	0.0088	0.0116	0.0940
STD. DEVIATIONS	0.0449	0.0484	0.0427	0.0288	0.0177	0.0107
	0.0067	0.0051	0.0051	0.0051	0.0155	0.0509

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	52.886	(114.1105)	528.86	3.559
EVAPOTRANSPIRATION	379.329	(55.0845)	3793.29	25.528
LATERAL DRAINAGE COLLECTED FROM LAYER 2	1037.69824	(180.34677)	10376.982	69.83460
PERCOLATION/LEAKAGE THROUGH LAYER 3	16.75417	(2.74737)	167.542	1.12752
AVERAGE HEAD ON TOP OF LAYER 3	100.540	(17.590)		
PERCOLATION/LEAKAGE THROUGH LAYER 6	16.78025	(2.82458)	167.803	1.12927
AVERAGE HEAD ON TOP OF LAYER 6	0.014	(0.002)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	16.78024	(2.80397)	167.802	1.12927
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00052	(0.00007)	0.005	0.00004
AVERAGE HEAD ON TOP OF LAYER 8	0.712	(0.120)		
CHANGE IN WATER STORAGE	-0.757	(2.5401)	-7.57	-0.051

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	84.875	848.7458
DRAINAGE COLLECTED FROM LAYER 2	22.22717	222.27165
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.320248	3.20248
AVERAGE HEAD ON TOP OF LAYER 3	735.327	
MAXIMUM HEAD ON TOP OF LAYER 3	985.790	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	11.3 METERS	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.317653	3.17653
AVERAGE HEAD ON TOP OF LAYER 6	0.084	
DRAINAGE COLLECTED FROM LAYER 7	0.21737	2.17370
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000006	0.00006
AVERAGE HEAD ON TOP OF LAYER 8	3.355	
MAXIMUM HEAD ON TOP OF LAYER 8	6.496	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	2.5 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4370
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0355

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	6.5550	0.4370
2	8.1823	0.1364
3	0.4500	0.7500
4	1.6144	0.1076
5	700.8000	0.2920
6	0.0000	0.0000
7	1.0066	0.0336
8	0.0000	0.0000
9	0.4500	0.7500
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                     USAE WATERWAYS EXPERIMENT STATION                     **
**                FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                           **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PI.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TI.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRI.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETI.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877IF4.D10
OUTPUT DATA FILE:           C:\HELP3\88877IF4.OUT


TIME:  18:12     DATE:   3/20/2018



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     TITLE:  Upland Landfill - Intermediate Cover HDPE Failure, 2nd Liner

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.



                                LAYER  1
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                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   2
          THICKNESS                    =     25.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1416 VOL/VOL
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EFFECTIVE SAT. HYD. COND. = 0.579999993000E-02 CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3168	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0376	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	30.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0686	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	150.0	METERS

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.15	CM

POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY	=	2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00 HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60 CM
POROSITY	=	0.7500 VOL/VOL
FIELD CAPACITY	=	0.7470 VOL/VOL
WILTING POINT	=	0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	25.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	3.540	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.925	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.600	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	770.119	CM
TOTAL INITIAL WATER	=	770.119	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	91
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	25.0 CM
AVERAGE ANNUAL WIND SPEED	=	8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	31.887	24.870	4.887	0.496	0.262	0.200
	0.222	0.399	0.102	6.164	11.299	18.928
STD. DEVIATIONS	62.872	63.609	12.642	1.150	0.918	0.540
	0.761	2.229	0.500	8.004	12.912	37.191
EVAPOTRANSPIRATION						
TOTALS	7.259	10.995	36.327	65.831	57.276	48.516
	31.708	27.282	34.370	21.141	8.928	6.318
STD. DEVIATIONS	2.842	4.575	6.141	11.974	20.883	21.160
	20.687	19.099	17.596	4.743	1.608	2.028
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	186.6601	125.6402	111.8985	45.9513	15.3922	12.4864
	10.1460	8.7020	15.9593	123.3714	185.9916	187.6318
STD. DEVIATIONS	81.1768	64.1526	46.8856	29.5841	15.6416	14.4724
	13.5229	12.9562	16.5228	60.4221	63.0770	70.4321
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	58.0651	76.8939	96.6407	124.7807	140.4466	120.9064
	111.2840	99.9794	80.1117	47.1365	32.8381	42.9325
STD. DEVIATIONS	23.8355	30.0348	33.1503	32.2252	27.5298	22.7987
	21.2783	21.2336	20.0711	16.7919	13.2887	17.5842
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	54.2613	73.3592	92.7060	117.4078	139.5856	122.9260
	112.8487	101.0570	82.7143	54.8109	32.8243	39.5423
STD. DEVIATIONS	23.4180	26.8001	29.4715	31.4007	28.0702	23.4989
	20.3881	21.6544	19.3005	17.9345	12.5164	14.7287
PERCOLATION/LEAKAGE THROUGH LAYER 6						

TOTALS	0.4421	0.5624	0.6985	0.8606	1.0111	0.8974
	0.8328	0.7542	0.6293	0.4457	0.2966	0.3440
STD. DEVIATIONS	0.1561	0.1788	0.1965	0.2094	0.1872	0.1567
	0.1359	0.1444	0.1287	0.1198	0.0835	0.0982

LATERAL DRAINAGE COLLECTED FROM LAYER 7

TOTALS	0.5994	0.5398	0.5987	0.5978	0.6542	0.6655
	0.7071	0.7160	0.6919	0.6997	0.6420	0.6276
STD. DEVIATIONS	0.0760	0.0674	0.0717	0.0664	0.0689	0.0680
	0.0710	0.0728	0.0723	0.0757	0.0709	0.0690

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1967	0.1453	0.1275	0.0505	0.0167	0.0135
	0.0106	0.0087	0.0175	0.1250	0.1970	0.1944
STD. DEVIATIONS	0.0803	0.0779	0.0588	0.0325	0.0168	0.0157
	0.0140	0.0149	0.0184	0.0620	0.0702	0.0736

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0628	0.0903	0.1030	0.1373	0.1495	0.1331
	0.1185	0.1064	0.0881	0.0510	0.0373	0.0469
STD. DEVIATIONS	0.0248	0.0346	0.0350	0.0355	0.0293	0.0250
	0.0226	0.0227	0.0221	0.0177	0.0143	0.0182

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	2.7016	4.0066	4.6158	6.0405	6.9498	6.3244
	5.6186	5.0315	4.2556	2.7290	1.6888	1.9688
STD. DEVIATIONS	1.1660	1.4561	1.4674	1.6155	1.3976	1.2090
	1.0151	1.0781	0.9930	0.8929	0.6440	0.7333

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	1.4475	1.4303	1.4460	1.4918	1.5798	1.6609
	1.7076	1.7292	1.7267	1.6899	1.6022	1.5156
STD. DEVIATIONS	0.1835	0.1756	0.1732	0.1657	0.1663	0.1698
	0.1715	0.1758	0.1805	0.1829	0.1770	0.1666

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	99.716	(120.3010)	997.16	6.711
EVAPOTRANSPIRATION	355.950	(51.2605)	3559.50	23.955
PERCOLATION/LEAKAGE THROUGH LAYER 2	1029.83081	(173.63248)	10298.309	69.30514
AVERAGE HEAD ON TOP OF LAYER 2	0.919	(0.145)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1032.01562	(152.68977)	10320.156	69.45217
AVERAGE HEAD ON TOP OF LAYER 4	0.937	(0.138)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1024.04333	(149.77515)	10240.434	68.91566
PERCOLATION/LEAKAGE THROUGH LAYER 6	7.77460	(0.99879)	77.746	0.52321
AVERAGE HEAD ON TOP OF LAYER 6	43.276	(6.318)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	7.73966	(0.75371)	77.397	0.52086
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00163	(0.00017)	0.016	0.00011

AVERAGE HEAD ON TOP OF LAYER 8	15.856 (	1.544)		
CHANGE IN WATER STORAGE	-1.514 (	7.2416)	-15.14	-0.102

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	86.028	860.2754
PERCOLATION/LEAKAGE THROUGH LAYER 2	69.487221	694.87219
AVERAGE HEAD ON TOP OF LAYER 2	53.465	
PERCOLATION/LEAKAGE THROUGH LAYER 4	8.388575	83.88574
AVERAGE HEAD ON TOP OF LAYER 4	2.770	
DRAINAGE COLLECTED FROM LAYER 5	7.34898	73.48981
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.051592	0.51592
AVERAGE HEAD ON TOP OF LAYER 6	113.429	
MAXIMUM HEAD ON TOP OF LAYER 6	163.361	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	22.4 METERS	
DRAINAGE COLLECTED FROM LAYER 7	0.02808	0.28082
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000006	0.00006
AVERAGE HEAD ON TOP OF LAYER 8	21.024	
MAXIMUM HEAD ON TOP OF LAYER 8	40.090	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	6.9 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3710
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	7.9385	0.3175
2	2.1850	0.4370
3	738.4622	0.3077
4	0.0000	0.0000
5	3.1061	0.1035
6	0.4500	0.7500
7	2.3897	0.0797
8	0.0000	0.0000
9	0.4500	0.7500
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                     USAE WATERWAYS EXPERIMENT STATION                     **
**                FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PI.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TI.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRI.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETI.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877IF3.D10
OUTPUT DATA FILE:           C:\HELP3\88877IF3.OUT


TIME:  17:54     DATE:   3/20/2018



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     TITLE:  Upland Landfill - Intermediate Cover HDPE Failure

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.



                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   2
          THICKNESS                    =     25.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1416 VOL/VOL
```

EFFECTIVE SAT. HYD. COND. = 0.579999993000E-02 CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3168	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	6.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0376	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	25.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	3.540	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.925	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.600	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	767.613	CM
TOTAL INITIAL WATER	=	767.613	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	91
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	25.0 CM
AVERAGE ANNUAL WIND SPEED	=	8.00 KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

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             AVERAGE MONTHLY VALUES (MM) FOR YEARS    1 THROUGH  100
 ------------------------------------------------------------------------------
-
                          JAN/JUL   FEB/AUG   MAR/SEP   APR/OCT   MAY/NOV   JUN/DEC
                          -------   -------   -------   -------   -------   -------
   PRECIPITATION
   -------------
     TOTALS               216.01    144.89    142.48    102.27     67.19     62.06
                           37.45     39.26     52.65    167.86    220.02    233.79

     STD. DEVIATIONS       63.32     48.38     46.44     37.98     33.77     32.53
                           28.36     30.28     30.04     68.74     74.24     69.47

   RUNOFF
   ------
     TOTALS                31.887    24.870     4.887     0.496     0.262     0.200
                            0.222     0.399     0.102     6.164    11.299    18.928

     STD. DEVIATIONS       62.872    63.609    12.642     1.150     0.918     0.540
                            0.761     2.229     0.500     8.004    12.912    37.191

   EVAPOTRANSPIRATION
   ------------------
     TOTALS                 7.259    10.995    36.327    65.831    57.276    48.516
                           31.708    27.282    34.370    21.141     8.928     6.318

     STD. DEVIATIONS        2.842     4.575     6.141    11.974    20.883    21.160
                           20.687    19.099    17.596     4.743     1.608     2.028

   PERCOLATION/LEAKAGE THROUGH LAYER  2
   ----------------------------------
     TOTALS               186.6601  125.6402  111.8985   45.9513   15.3922   12.4864
                           10.1460    8.7020   15.9593  123.3714  185.9916  187.6318

     STD. DEVIATIONS       81.1768   64.1526   46.8856   29.5841   15.6416   14.4724
                           13.5229   12.9562   16.5228   60.4221   63.0770   70.4321

   PERCOLATION/LEAKAGE THROUGH LAYER  4
   ----------------------------------
     TOTALS                58.0651   76.8939   96.6407  124.7807  140.4466  120.9064
                          111.2840   99.9794   80.1117   47.1365   32.8381   42.9325

     STD. DEVIATIONS       23.8355   30.0348   33.1503   32.2252   27.5298   22.7987
                           21.2783   21.2336   20.0711   16.7919   13.2887   17.5842

   LATERAL DRAINAGE COLLECTED FROM LAYER  5
   ----------------------------------------
     TOTALS                54.2613   73.3592   92.7060  117.4078  139.5856  122.9260
                          112.8487  101.0570   82.7143   54.8109   32.8243   39.5423
```

STD. DEVIATIONS	23.4180	26.8001	29.4715	31.4007	28.0702	23.4989
	20.3881	21.6544	19.3005	17.9345	12.5164	14.7287

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.4421	0.5624	0.6985	0.8606	1.0111	0.8974
	0.8328	0.7542	0.6293	0.4457	0.2966	0.3440
STD. DEVIATIONS	0.1561	0.1788	0.1965	0.2094	0.1872	0.1567
	0.1359	0.1444	0.1287	0.1198	0.0835	0.0982

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1967	0.1453	0.1275	0.0505	0.0167	0.0135
	0.0106	0.0087	0.0175	0.1250	0.1970	0.1944
STD. DEVIATIONS	0.0803	0.0779	0.0588	0.0325	0.0168	0.0157
	0.0140	0.0149	0.0184	0.0620	0.0702	0.0736

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0628	0.0903	0.1030	0.1373	0.1495	0.1331
	0.1185	0.1064	0.0881	0.0510	0.0373	0.0469
STD. DEVIATIONS	0.0248	0.0346	0.0350	0.0355	0.0293	0.0250
	0.0226	0.0227	0.0221	0.0177	0.0143	0.0182

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	2.7016	4.0066	4.6158	6.0405	6.9498	6.3244
	5.6186	5.0315	4.2556	2.7290	1.6888	1.9688
STD. DEVIATIONS	1.1660	1.4561	1.4674	1.6155	1.3976	1.2090
	1.0151	1.0781	0.9930	0.8929	0.6440	0.7333

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	99.716	(120.3010)	997.16	6.711
EVAPOTRANSPIRATION	355.950	(51.2605)	3559.50	23.955
PERCOLATION/LEAKAGE THROUGH LAYER 2	1029.83081	(173.63248)	10298.309	69.30514
AVERAGE HEAD ON TOP OF LAYER 2	0.919	(0.145)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1032.01562	(152.68977)	10320.156	69.45217
AVERAGE HEAD ON TOP OF LAYER 4	0.937	(0.138)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1024.04333	(149.77515)	10240.434	68.91566
PERCOLATION/LEAKAGE THROUGH LAYER 6	7.77460	(0.99879)	77.746	0.52321
AVERAGE HEAD ON TOP OF LAYER 6	43.276	(6.318)		
CHANGE IN WATER STORAGE	-1.547	(7.2462)	-15.47	-0.104

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	86.028	860.2754
PERCOLATION/LEAKAGE THROUGH LAYER 2	69.487221	694.87219
AVERAGE HEAD ON TOP OF LAYER 2	53.465	
PERCOLATION/LEAKAGE THROUGH LAYER 4	8.388575	83.88574
AVERAGE HEAD ON TOP OF LAYER 4	2.770	
DRAINAGE COLLECTED FROM LAYER 5	7.34898	73.48981
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.051592	0.51592
AVERAGE HEAD ON TOP OF LAYER 6	113.429	
MAXIMUM HEAD ON TOP OF LAYER 6	163.361	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	22.4 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3710
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	7.9385	0.3175
2	2.1850	0.4370
3	738.4622	0.3077
4	0.0000	0.0000
5	3.1061	0.1035
6	0.4500	0.7500
SNOW WATER	0.000	

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**                                                                           **
**                                                                           **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                 **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                     USAE WATERWAYS EXPERIMENT STATION                     **
**                FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                           **
**                                                                           **
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PRECIPITATION DATA FILE:    C:\HELP3\88877PI.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877TI.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877SRI.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877ETI.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877IO3.D10
OUTPUT DATA FILE:           C:\HELP3\88877IO3.OUT


TIME:  17:35     DATE:   3/20/2018



*******************************************************************************

     TITLE:  Upland Landfill - Intermediate Cover DOCP, Poor Liner

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.



                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   2
          THICKNESS                    =     25.00   CM
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.0620 VOL/VOL
          WILTING POINT                =      0.0240 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1416 VOL/VOL
```

EFFECTIVE SAT. HYD. COND. = 0.579999993000E-02 CM/SEC

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 2

THICKNESS	=	5.00	CM
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4370	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.579999993000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	2400.00	CM
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3168	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.50	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	12.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	4 - POOR	

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	30.00	CM
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0377	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	1.00	PERCENT
DRAINAGE LENGTH	=	80.0	METERS

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.15	CM
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/HECTARE
FML INSTALLATION DEFECTS	=	12.00	HOLES/HECTARE
FML PLACEMENT QUALITY	=	4 - POOR	

LAYER 7

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.60	CM
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT

SOIL DATA BASE USING SOIL TEXTURE # 2 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 10.% AND A SLOPE LENGTH OF 35. METERS.

SCS RUNOFF CURVE NUMBER	=	81.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	25.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	3.540	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.925	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.600	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	767.617	CM
TOTAL INITIAL WATER	=	767.617	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	91	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	25.0	CM
AVERAGE ANNUAL WIND SPEED	=	8.00	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

****

AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	31.887	24.870	4.887	0.496	0.262	0.200
	0.222	0.399	0.102	6.164	11.299	18.928
STD. DEVIATIONS	62.872	63.609	12.642	1.150	0.918	0.540
	0.761	2.229	0.500	8.004	12.912	37.191
EVAPOTRANSPIRATION						
TOTALS	7.259	10.995	36.327	65.831	57.276	48.516
	31.708	27.282	34.370	21.141	8.928	6.318
STD. DEVIATIONS	2.842	4.575	6.141	11.974	20.883	21.160
	20.687	19.099	17.596	4.743	1.608	2.028
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	186.6601	125.6402	111.8985	45.9513	15.3922	12.4864
	10.1460	8.7020	15.9593	123.3714	185.9916	187.6318

STD. DEVIATIONS	81.1768	64.1526	46.8856	29.5841	15.6416	14.4724
	13.5229	12.9562	16.5228	60.4221	63.0770	70.4321

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	58.0651	76.8939	96.6407	124.7807	140.4466	120.9064
	111.2840	99.9794	80.1117	47.1365	32.8381	42.9325
STD. DEVIATIONS	23.8355	30.0348	33.1503	32.2252	27.5298	22.7987
	21.2783	21.2336	20.0711	16.7919	13.2887	17.5842

LATERAL DRAINAGE COLLECTED FROM LAYER 5

TOTALS	54.6802	73.8920	93.3843	118.2234	140.5836	123.8392
	113.6935	101.8211	83.3620	55.3058	33.1269	39.8708
STD. DEVIATIONS	23.5611	26.9538	29.6455	31.6005	28.2545	23.6575
	20.5187	21.7955	19.4253	18.0545	12.5936	14.8075

PERCOLATION/LEAKAGE THROUGH LAYER 7

TOTALS	0.0016	0.0024	0.0031	0.0041	0.0051	0.0043
	0.0038	0.0033	0.0026	0.0016	0.0009	0.0011
STD. DEVIATIONS	0.0008	0.0010	0.0012	0.0014	0.0013	0.0010
	0.0008	0.0008	0.0007	0.0006	0.0004	0.0005

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (CM)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.1967	0.1453	0.1275	0.0505	0.0167	0.0135
	0.0106	0.0087	0.0175	0.1250	0.1970	0.1944
STD. DEVIATIONS	0.0803	0.0779	0.0588	0.0325	0.0168	0.0157
	0.0140	0.0149	0.0184	0.0620	0.0702	0.0736

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0628	0.0903	0.1030	0.1373	0.1495	0.1331
	0.1185	0.1064	0.0881	0.0510	0.0373	0.0469
STD. DEVIATIONS	0.0248	0.0346	0.0350	0.0355	0.0293	0.0250
	0.0226	0.0227	0.0221	0.0177	0.0143	0.0182

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	2.7225	4.0357	4.6495	6.0825	6.9995	6.3714
	5.6607	5.0696	4.2889	2.7536	1.7043	1.9851
STD. DEVIATIONS	1.1731	1.4644	1.4760	1.6258	1.4068	1.2172
	1.0216	1.0852	0.9994	0.8989	0.6479	0.7373

****

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	99.716	(120.3010)	997.16	6.711
EVAPOTRANSPIRATION	355.950	(51.2605)	3559.50	23.955
PERCOLATION/LEAKAGE THROUGH LAYER 2	1029.83081	(173.63248)	10298.309	69.30514
AVERAGE HEAD ON TOP OF LAYER 2	0.919	(0.145)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	1032.01562	(152.68977)	10320.156	69.45217
AVERAGE HEAD ON TOP OF LAYER 4	0.937	(0.138)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	1031.78259	(150.75797)	10317.826	69.43649
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.03408	(0.00607)	0.341	0.00229
AVERAGE HEAD ON TOP OF LAYER 6	43.603	(6.360)		
CHANGE IN WATER STORAGE	-1.546	(7.2464)	-15.46	-0.104

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	86.028	860.2754
PERCOLATION/LEAKAGE THROUGH LAYER 2	69.487221	694.87219
AVERAGE HEAD ON TOP OF LAYER 2	53.465	
PERCOLATION/LEAKAGE THROUGH LAYER 4	8.388575	83.88574
AVERAGE HEAD ON TOP OF LAYER 4	2.770	
DRAINAGE COLLECTED FROM LAYER 5	7.39569	73.95686
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000315	0.00315
AVERAGE HEAD ON TOP OF LAYER 6	114.150	
MAXIMUM HEAD ON TOP OF LAYER 6	164.216	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	22.5 METERS	
SNOW WATER	341.73	3417.2583

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3710
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0240

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

****

****

FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	7.9385	0.3175
2	2.1850	0.4370
3	738.4622	0.3077
4	0.0000	0.0000
5	3.1216	0.1041
6	0.0000	0.0000
7	0.4500	0.7500
SNOW WATER	0.000	

****
****

Appendix I
Downgradient HELP Model Results

```
**********************************************************************************
**********************************************************************************
**                                                                              **
**                                                                              **
**               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                  **
**                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                     USAE WATERWAYS EXPERIMENT STATION                        **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                              **
**                                                                              **
**********************************************************************************
**********************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\88877\PPT1.D4
TEMPERATURE DATA FILE:      C:\HELP3\88877\TEMP.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\88877\SRAD.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\88877\EVAP.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\88877\DWNGR.D10
OUTPUT DATA FILE:           C:\HELP3\88877\DWNGRO.OUT


TIME:  16:36     DATE:   5/30/2017


**********************************************************************************

     TITLE:  Upland Landfill - DOWNGRADIENT

**********************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   1
          THICKNESS                    =   3500.00   CM
          POROSITY                     =      0.4170 VOL/VOL
          FIELD CAPACITY               =      0.0450 VOL/VOL
          WILTING POINT                =      0.0180 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0757 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.999999978000E-02 CM/SEC
```

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 1.80
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 1 WITH BARE
GROUND CONDITIONS, A SURFACE SLOPE OF 3.% AND
A SLOPE LENGTH OF 200. METERS.

SCS RUNOFF CURVE NUMBER	=	71.90	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.0000	HECTARES
EVAPORATIVE ZONE DEPTH	=	30.0	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	3.597	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	12.510	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.540	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	264.820	CM
TOTAL INITIAL WATER	=	264.820	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Campbell River British Columbia

STATION LATITUDE	=	49.95	DEGREES
MAXIMUM LEAF AREA INDEX	=	1.00	
START OF GROWING SEASON (JULIAN DATE)	=	91	
END OF GROWING SEASON (JULIAN DATE)	=	305	
EVAPORATIVE ZONE DEPTH	=	30.0	CM
AVERAGE ANNUAL WIND SPEED	=	8.00	KPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	84.10	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.47	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.95	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	87.08	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY PRECIPITATION (MM)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
217.5	149.5	140.0	92.1	68.4	62.9
39.4	44.6	55.2	162.2	231.9	225.7

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES CELSIUS)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
2.4	3.2	5.2	8.0	11.6	14.7
17.3	17.2	13.7	8.6	4.4	2.1

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR OLYMPIA WASHINGTON
AND STATION LATITUDE = 49.95 DEGREES

****

AVERAGE MONTHLY VALUES (MM) FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	216.01	144.89	142.48	102.27	67.19	62.06
	37.45	39.26	52.65	167.86	220.02	233.79
STD. DEVIATIONS	63.32	48.38	46.44	37.98	33.77	32.53
	28.36	30.28	30.04	68.74	74.24	69.47
RUNOFF						
TOTALS	3.934	14.270	1.151	0.004	0.004	0.000
	0.001	0.065	0.001	0.883	1.951	1.639
STD. DEVIATIONS	13.587	54.972	8.056	0.036	0.032	0.000
	0.014	0.626	0.008	1.913	4.537	2.905
EVAPOTRANSPIRATION						
TOTALS	7.840	13.199	40.143	67.513	56.813	50.345

	32.543	28.117	33.634	22.952	9.510	7.228
STD. DEVIATIONS	2.334	3.971	4.979	12.991	21.388	22.293
	21.697	19.702	17.191	5.052	1.334	1.686

PERCOLATION/LEAKAGE THROUGH LAYER 1

TOTALS	71.9297	98.2503	122.8276	137.1311	137.3340	113.6443
	100.3723	88.5671	71.0573	46.5177	33.3858	47.1655
STD. DEVIATIONS	26.3691	35.3745	38.3219	35.3850	29.2549	22.0743
	17.4402	14.6448	13.3432	13.2981	12.2372	15.9583

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	MM		CU. METERS	PERCENT
PRECIPITATION	1485.94	(190.257)	14859.4	100.00
RUNOFF	23.902	(65.8864)	239.02	1.609
EVAPOTRANSPIRATION	369.840	(52.3562)	3698.40	24.889
PERCOLATION/LEAKAGE THROUGH LAYER 1	1068.18250	(190.94087)	10681.825	71.88612
CHANGE IN WATER STORAGE	24.012	(9.0187)	240.12	1.616

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(MM)	(CU. METERS)
PRECIPITATION	128.90	1289.000
RUNOFF	76.924	769.2419
PERCOLATION/LEAKAGE THROUGH LAYER 1	10.355275	103.55275
SNOW WATER	304.80	3048.0220

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3769
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0180

****

****

FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(CM)	(VOL/VOL)
1	504.9421	0.1443
SNOW WATER	0.000	

****
****

Appendix J
Fire Safety and Emergency Contingency Plan

FIRE SAFETY AND EMERGENCY CONTINGENCY PLAN

NORTHWIN LANDFILL
CAMPBELL RIVER, BRITISH COLUMBIA

Prepared For: **Upland Excavating Ltd.**
Northwin Landfill
7295 and 7311 Gold River Highway
Campbell River, British Columbia

DRAFT

JULY 13, 2020
REF. NO. 088877 (14) APPK

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LIST OF FIGURES

FIGURE 2.1 EMERGENCY HOSPITAL ROUTE (INCLUDED IN TEXT)

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REVISIONS

DATE	REVISION NO.	AUTHOR/COMPANY	

DRAFT

1.0 INTRODUCTION

The operators of the Northwin Landfill, in compliance with British Columbia Occupational Health and Safety (B.C. OH&S) Regulation 296/97 Part 4, s.4.13-4.18 (Emergency Preparedness and Response) and Part 5, s.5.97-5.102 (Emergency Procedures) and Section 2.8 of the British Columbia Fire Code, have developed the following Fire Safety and Emergency Contingency Plan based on an assessment of the risks identified on-site. This plan documents the potential hazards and sets out the safety measures, roles, responsibilities, procedures, and parties to be contacted in the event of a medical or environmental emergency, or the occurrence of any of the identified hazardous situations.

The Northwin Landfill is located on an approximately 10 hectare parcel of land located in the City of Campbell River, British Columbia, within Lot A, District Lot 85, Plan 30709, Sayward District, approximately 10 km west of the city centre of Campbell River. The Site fronts onto Gold River Highway and is situated west of the Island Highway and south of McIvor Lake. The Northwin Landfill is owned by Upland Excavating Ltd. and operated by Northwin Environmental.

The Northwin Landfill is being developed and operated under Operational Certificate 107689. The Landfill is authorized to accept demolition waste, construction waste, landfill clearing waste, soil meeting applicable British Columbia Contaminated Sites Regulation (CSR) industrial land use Standards, sludge from Landfill leachate or water management works, asbestos containing materials (in accordance with Section 40 of the HWR), and other wastes as authorized in writing by the director.

The following sections detail the Fire Safety and Emergency Contingency Plan for waste disposal operations at the Northwin Landfill. It is essential that site personnel be prepared in the event of an emergency. Emergencies can take many forms. The potential health and safety concerns identified in this plan include illnesses or injuries, chemical exposure, fires, explosions, spills, leaks, releases of harmful contaminants, or sudden changes in the weather. The following sections outline the general procedures for dealing with emergency situations that may potentially be experienced at the Northwin Landfill

This Plan will be reviewed by all on-Site personnel and kept at the Northwin Landfill. Emergency information presented herein, will be posted at the Site in locations where it can readily be seen. This Plan will be reviewed at least once annually by the owner/operator of the landfill, in consultation with the employee health and safety representative, to ensure that it remains effective and accurate as a Fire Safety and Emergency Contingency Plan.

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2.0 EMERGENCY CONTACTS

This page is to be posted with the hospital road map in conspicuous workplace locations.

Fire:	911
Police:	911
Ambulance:	911
Poison Control Center:	1-800-567-8911
Hospital:	250-850-2141
	Campbell River Hospital
	375 2nd Ave.
	Campbell River, BC
	V9W 3V1

Directions to Campbell River Hospital (see Figure 2.1):

- Head northeast on Gold River Hwy/BC-28 E toward Argonaut Rd
- Turn right onto Inland Island Hwy/BC-19 S (signs for Nanaimo)
- Turn left onto 14 Ave
- Continue onto Homewood Road
- Continue onto 9 Ave
- Slight right onto Alder St
- Turn right onto 2 Ave, Destination will be on the left

Provincial Emergency Program (PEP), 24 hour Spill Reporting:	1-800-663-3456
ENV Regional Waste Manager (Allan Leuschen)	250-751-3199
Ministry of Forest, Lands and Natural Resources	250-286-9300
Fire Department	250-286-6266
Forest Fire Reporting	1-800-633-5555
	*5555 Cellular

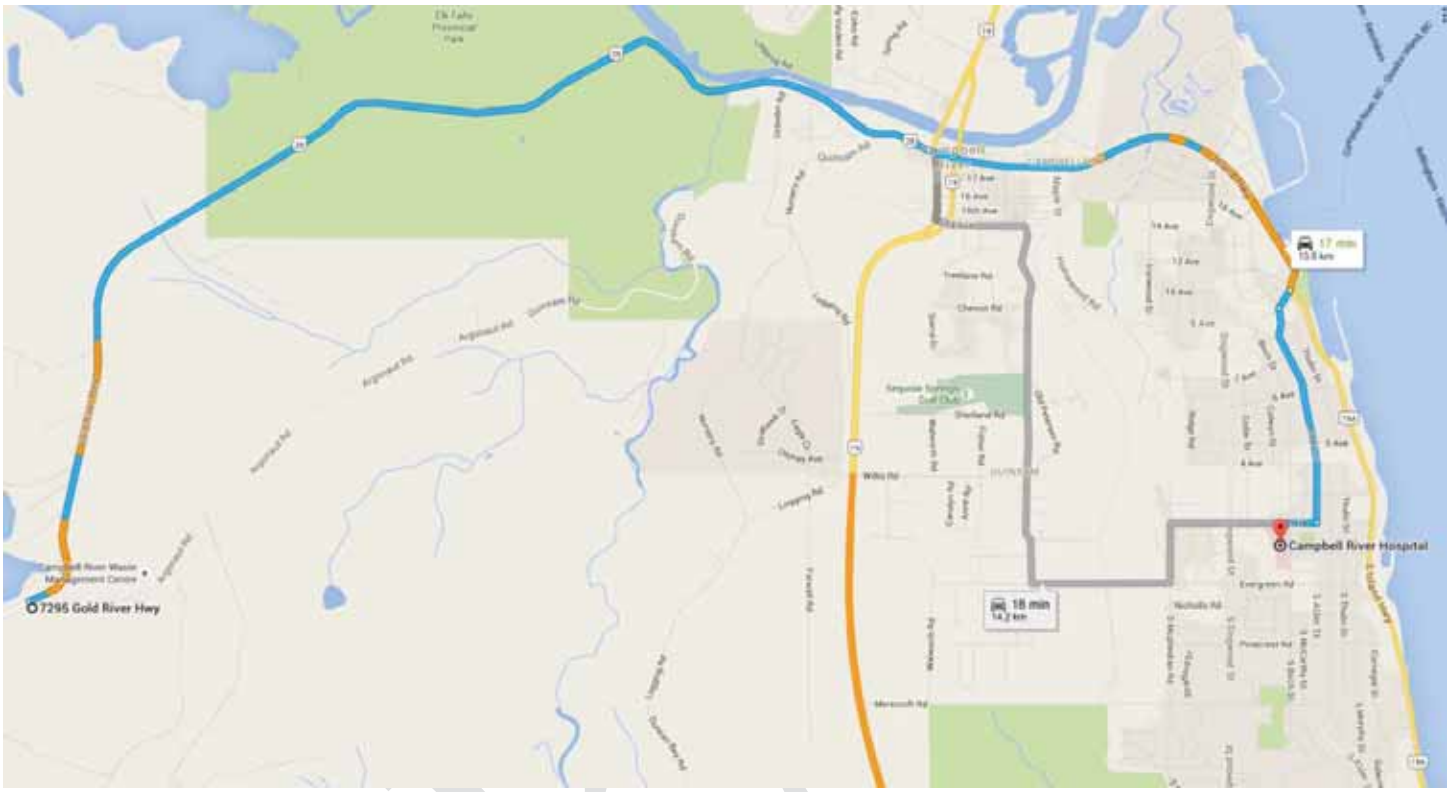
Upland Excavating Ltd. (Northwin Landfill Operator)

- Site Manager (Brian Fagan) 250-202-8644 (Cell)
- Site Manager (Terry Stuart) 250-287-5910 (Cell)

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FIGURE 2.1
EMERGENCY HOSPITAL ROUTE

TO BE POSTED IN CONSPICUOUS AREAS OF THE WORKPLACE



Map Data/Image Source: Google Maps, 2016

Hospital: 250-850-2141
Campbell River Hospital
375 2nd Ave.
Campbell River, BC
V9W 3V1

Directions to Campbell River Hospital (see Figure 2.1):

- Head northeast on Gold River Hwy/BC-28 E toward Argonaut Rd
- Turn right onto Inland Island Hwy/BC-19 S (signs for Nanaimo)
- Turn left onto 14 Ave
- Continue onto Homewood Road
- Continue onto 9 Ave
- Slight right onto Alder St
- Turn right onto 2 Ave, Destination will be on the left

3.0 EMERGENCY EQUIPMENT AVAILABLE ON SITE

The following emergency equipment is available at the Front Desk of the Site Office:

- First aid kit (Level 1 Kit)
- 20 pound Class A, B, and C dry chemical fire extinguisher
- Petroleum spill containment kit
- Telephone
- Portable air horn alarm

All Site vehicles and equipment, including excavators, loaders, rock-trucks, and pick-up trucks, are all equipped with Class A, B, and C dry chemical fire extinguishers.

A suitable pump with appropriate length of hose will be kept available on-site at all times to pump water from the wash plant pond for emergency use.

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4.0 EMERGENCY ROUTES AND ASSEMBLY POINTS

The Northwin Landfill Operator will ensure that emergency exit routes and assembly points are marked on Site by clear signage and in accordance with municipal and provincial requirements.

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5.0 MEDICAL EMERGENCIES

The Northwin Landfill Operator will employ, and assign to the Site, a competent and authorized representative, herein referred to as the HSO. A Site Health & Safety Representative will also be selected. The Site Supervisor will be present at the Northwin Landfill during normal operating hours.

The Northwin Landfill Operator will ensure that all on-Site personnel, as a minimum, are equipped with the appropriate first aid materials and supplies and personnel protective equipment (PPE), and clothing required by municipal and provincial regulations. Safety and emergency equipment and PPE and clothing will be stored in a readily accessible location when not in use and kept clean and well maintained. The location of the equipment will be marked by clear signage.

Emergency and first-aid equipment will be placed at or near the active work area of the Northwin Landfill during normal operating hours. A list of the emergency and first aid equipment available at the Site and where this equipment is located is provided in Section 3.0 of this Plan.

As a minimum, the Northwin Landfill Operator will designate at least one person who is trained in basic first aid and CPR as the First Aid Attendant, to be on-Site at all times. This person may perform other duties, but will be immediately available to render first aid when required.

In the event of injury requiring immediate first-aid / medical attention to on-Site personnel, the following procedures will be implemented:

- Notify the First Aid Attendant and administer initial first aid services
- Notify the HSO/Site Supervisor
- Phone the hospital and/or medical service provider closest to the Northwin Landfill (see Section 2.0) and describe the nature of the injury or event
- As directed by the hospital, administer additional on-going first aid or CPR
- As directed by the hospital, either wait for an ambulance to arrive or transport personnel to the specified hospital along the most direct route
- If the injured person will be transported by ambulance and it is safe to leave them (when only two workers are on Site) meet the ambulance at the gate and direct them to the injured person, otherwise, give the ambulance/hospital complete and accurate directions to your exact location at the Site

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Note: Any person transporting an injured/exposed person to the designated hospital for treatment, should take directions to the hospital with them (Figure 2.1). Details of the injury and a list of the compounds of concern, animal or insect bites, or other injurious circumstances to which the worker may have been exposed should also accompany the injured person.

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6.0 FIRE OR EXPLOSION

All fire fighting equipment present at the Site shall be regularly inspected (monthly minimum) and maintained in accordance with manufacturer's recommendation and a record of these inspections will be kept on Site.

In the event of an uncontrolled fire, explosion, release of hazardous material, or the need for emergency evacuation, the following procedures will be followed:

- Notify all workers on Site by sounding the air horn alarm
- Site personnel will report immediately to the upwind safe assembly area and the Site Supervisor will confirm the safe evacuation of all workers from the hazardous area
- Notify the Fire Department / emergency services immediately
- Notify the HSO
- Notify any adjacent workplaces or residences which may be affected by exposure (**Note:** notification of the public must be in conformity with the requirements of municipal and provincial agencies (BC Reg. 296/97, s.5.100))
- Site personnel will position themselves at the entrance gate and such other safe locations as to effectively direct the Fire Department to the location of the uncontrolled fire or hazardous circumstances
- Site personnel will advise the Fire Commander of the location, nature, and identification of any hazardous materials at the Site as per the Inventory of Hazardous Substances maintained at the Site (see Section 10.0)
- If the Site Supervisor determines that it is safe to do so, before the Fire Department arrives, site personnel may:
    - Use fire equipment available on Site
    - Remove or isolate flammable or other hazardous materials that may contribute to the fire
- If the Fire Commander determines that it is safe to do so, Site personnel may assist the Fire Department

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7.0 SPILLS OR LEAKS

The Northwin Landfill operator will ensure that all on-Site personnel have received the appropriate Work Place Hazardous Materials Information System (WHMIS) training as required by provincial regulations. The Northwin Landfill operator will ensure that personnel assigned to spill clean-up and re-entry duties have been trained in the safe procedures and use of personal protective equipment appropriate to the spill conditions. Written procedures for clean up and record of training will be maintained on Site. The Northwin Landfill operator will ensure that PPE and related clean-up equipment is readily available on Site and maintained in good condition.

In the event of a spill or leak, site personnel will follow the following procedures:

- Notify the Site Supervisor and/or HSO of the accidental release
- Report off-Site spills and releases of hydrocarbon contaminated soils or contaminated water to PEP and the B.C. Ministry of Environment and Climate Change Strategy in accordance with the B.C. Spill Reporting Regulation
    - **B.C. Emergency Management: 800-663-3456**
- Locate the source of the spillage, determine the degree of hazard associated with the clean-up activities, and if it can be done safely, stop the flow or release of the contaminant
- Contain and recover the spilled materials, in a safe manner as appropriate

Where volumes of spilled or leaked material exceed those specified in the BC Spill Reporting Regulation (B.C. Reg. 187/2017) (Attached as Table 1) a report shall be made to PEP including the following information. Reportable limits should be confirmed at least annually during the revision of the report.

1) The reporting person's name and telephone number
2) The name and telephone number of the person who caused the spill
3) The location and time of the spill,
4) The type and quantity of the substance spilled,
5) The cause and effect of the spill,
6) Details of action taken or proposed to comply with section 3,
7) a description of the spill location and of the area surrounding the spill,
8) The details of further action contemplated or required,

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9) The names of agencies on the scene, and

10) The names of other persons or agencies advised concerning the spill.

If the spill is not reportable, under the B.C. Spill Reporting Regulation a Notification of Independent Remediation Initiation form, Site Risk Classification Report Form, and Exposure Pathway Questionnaire is required and the independent remediation may be initiated.

If the spill is reportable, under the B.C. Spill Reporting Regulation, a B.C. Ministry of Environment case manager will be appointed to guide remediation requirements.

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8.0 INCLEMENT WEATHER

The following special procedures will be implemented during periods of severe weather, such as high winds, rain, electrical storms, thermal inversions, and winter conditions.

High Winds

If winds become excessive, the following control measures will be implemented at the Northwin Landfill to ensure that dust and litter does not become problematic or hazardous:

- Low speed limits will be enforced
- All vehicle traffic transporting waste to and around the Northwin Landfill will be appropriately loaded to prevent debris from blowing out of the vehicle
- Landfilling activities will be reduced
- Soil handling operations will be suspended
- If dry conditions warrant, water (dust suppressant) will be applied to roadways and borrow areas, and if required, to the active disposal area
- Personnel will wear appropriate respiratory protection if total dust particulates exceed provincial exposure limits

Rain and Electrical Storms

Rain: is not expected to adversely affect operations; therefore the Northwin Landfill will be operated during all but extremely excessive rain periods. If access roads become impassable due to heavy rain, they will be graded and granular material will be added as necessary to maintain and improve operating conditions.

Electrical Storms: In the event of an electrical storm, all operations will be suspended until the storm subsides and personnel will take safe shelter in the Site Office. All electrical powered equipment will be immediately shut down in a manner that will not endanger personnel.

Winter Conditions

During winter operations, the Northwin Landfill Operator will undertake advanced planning for site preparation/access, snow removal, and the stockpiling and storage of waste cover material.

The following procedures will be taken during winter weather conditions:

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- The Northwin Landfill operator will ensure that all on-Site personnel are suitably clothed for working in winter conditions and monitor ongoing conditions to minimize the potential for cold related stress/hypothermia
- During severe winter conditions the HSO will provide appropriate direction to on-site personnel, regarding the continuance or curtailing of Northwin Landfill operations
- Site equipment will be cleaned and maintained on a daily basis to ensure safe operation during periods of cold or extreme weather
- Snow accumulation will be removed from the access roads and working areas prior to and during each day's landfilling activities, as required to maintain safe working conditions
- Frozen fill materials will not be placed in the landfill
- All runoff from snow, which has contacted waste or soil in the Landfill will be managed as leachate and controlled accordingly

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9.0 EMERGENCY PROCEDURES TRAINING & DRILLS

The following training requirements will be followed as written in the B.C. OH&S Reg. 296/97 Part 4, s.4.16:

- All workers must be given adequate instruction in fire prevention and emergency evacuation procedures applicable to their workplace
- Workers assigned firefighting duties must be given adequate training by a qualified instructor in suppression methods, fire prevention, emergency procedures, company organization and chain of command, and firefighting crew safety and communications applicable to their workplace
- Retraining must occur once per year
- A worker not covered by B.C. OH&S Reg. 296/97 Part 31 (Firefighting), who is assigned firefighting duties, must be physically capable of performing the duties assigned safely and effectively, before being permitted to do them
- At least once per year, emergency drills must be conducted to ensure worker awareness and effectiveness of the exit routes and procedures
- A record of the drills is to be kept at the Site Office

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10.0 HAZARDOUS SUBSTANCE INVENTORY & NOTIFICATION OF FIRE DEPARTMENT

The Northwin Landfill Operator will maintain a Hazardous Substance Inventory (Inventory) at the Site. The Inventory will include safe handling methods for all hazardous substances that are stored at the Site in quantities that may endanger workers in an emergency. The Inventory will include such materials as WHMIS controlled products, explosives, pesticides, radioactive materials, hazardous wastes, and will provide the nature, location, quantity and Material Safety Data Sheets (SDS) for the material.

As part of Site operations, the Northwin Landfill Operator performs visual inspections of all waste loads received at the Site and any material that is not authorized for discharge at the Site, including hazardous substances, is rejected by the operator and sent off Site for disposal. As such, the Inventory is limited to materials that are stored on Site for use by the Northwin Landfill only and not for landfilled materials.

The Inventory is to be kept up to date and located in an area readily accessible by personnel during an emergency. The Fire Department shall be notified of any significant changes to the Inventory.

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Table 1

Reportable Limits for Spills and Releases
Fire and Emergency Contingency Plan
New Landfill (Northwin Landfill)
Upland Excavating Ltd.
Campbell River, British Columbia

Substance spilled[(1)]	**Specified amount**[(1)]
Explosives Class 1 as defined in section 2.9 of the Federal Regulations	50 kg, or less if the substance poses a danger to public safety
Flammable Gases Class 2.1 other than natural gas, as defined in section 2.14 (a) of the Federal Regulations	10 kg
Non-Flammable and Non-Toxic Gases Class 2.2 as defined in section 2.14 (b) of the Federal Regulations	10 kg
Toxic Gases Class 2.3 as defined in section 2.14 (c) of the Federal Regulations	5 kg
Flammable Liquids Class 3 as defined in section 2.18 of the Federal Regulations	100 L
Flammable Solids Class 4 as defined in section 2.20 of the Federal Regulations	25 kg
Oxidizing Substances Class 5.1 as defined in section 2.24 (a) of the Federal Regulations	50 kg or 50 L
Organic Peroxides Class 5.2 as defined in section 2.24 (b) of the Federal Regulations	1 kg or 1 L
Toxic Substances Class 6.1 as defined in section 2.27 (a) of the Federal Regulations	5 kg or 5 L
Infectious Substances Class 6.2 as defined in section 2.27 (b) of the Federal Regulations	1 kg or 1 L, or less if the waste poses a danger to public safety or the environment
Radioactive Materials Class 7 as defined in section 2.37 of the Federal Regulations	Any quantity that could pose a danger to public safety and an emission level greater than the emission level established in section 20 of the Packaging and Transport of Nuclear Substances Regulations, 2015 (Canada)
Corrosives Class 8 as defined in section 2.40 of the Federal Regulations	5 kg or 5 L
Miscellaneous Products, Class 9 Substances or Organisms as defined in section 2.43 of the Federal Regulations	25 kg or 25 L
Waste containing dioxin as defined in section 1 of the Hazardous Waste Regulation	1 kg or 1 L, or less if the waste poses a danger to public safety or the environment
Leachable toxic waste as defined in section 1 of the Hazardous Waste Regulation	25 kg or 25 L
Waste containing polycyclic aromatic hydrocarbons as defined in section 1 of the hazardous Waste Regulation	5 kg or 5 L
Waste asbestos as defined in section 1 of the Hazardous Waste Regulation	50 kg
Waste oil as defined in section 1 of the Hazardous Waste Regulation	100 L
Waste containing a pest control product as defined in section 1 of the Hazardous Waste Regulation	5 kg or 5 L
PCB Wastes as defined in section 1 of the Hazardous Waste Regulation	25 kg or 25 L
Waste containing tetrachloroethylene as defined in section 1 of the Hazardous Waste Regulation	50 kg or 50 L
Biomedical waste as defined in section 1 of the Hazardous Waste Regulation	1 kg or 1 L, or less if the waste poses a danger to public safety or the environment
A hazardous waste as defined in section 1 of the Hazardous Waste Regulation and not covered under items 1 to 22	25 kg or 25 L
A substance, not covered by items 1 to 23, that can cause pollution	200 kg or 200 L
Natural gas	10 kg

NOTES:
(1) Substance definitions and reportable spill amounts from BC Spill Reporting Regulation (B.C. Reg. 187/2017 including amendments upto B.C. Reg 221/2017, December 5,2017) current to July 7, 2020

Federal Regulations: The Transportation of Dangerous Goods Regulations made under the *Transportation of Dangerous Goods Act* (Canada)
Hazardous Waste Regulation: B.C. Reg. 63/88.

Appendix K
Trigger Level Assessment Program

Appendix K Trigger Level Assessment Program

The following Site-specific tiered Trigger Level Assessment Program (TLAP) has been developed for the Upland Landfill. The TLAP follows a three-tiered approach to monitor and assess primary liner leakage rates and potential groundwater quality impacts associated with Landfill activities. The TLAP will trigger the timely implementation of contingency measures related to liner leakage or water quality alterations, if needed.

The trigger level monitoring locations include:

- Landfill leak detection system
- Aeration pond leak detection system
- Aeration pond point of discharge
- Future monitoring well MW13 located adjacent to and downgradient of the aeration pond
- Future monitoring well MW12 located downgradient of the landfill and adjacent to the south property boundary
- Existing monitoring well MW10-17 located at the downgradient south property boundary
- Future monitoring well MW11 located at the downgradient east property boundary

1. Trigger: Primary Liner Leakage Rate

1.1 Tier I – Routine Leakage Rate Monitoring

The Tier I TLAP includes quarterly monitoring of the Landfill and aeration pond leak detection systems. Lysimeters will be installed within the leak detection system(s) drainage layer to monitor for the presence of leakage from the primary liner of the landfill and/or aeration pond at various locations within the system. Leakage rate monitoring will be completed as part of the Environmental Monitoring Program (EMP) prepared for the Site. The EMP is described in Section 14 of the DOCP.

Leakage rate monitoring results will be assessed for the following triggers:

- Leakage rates at the landfill and/or aeration pond leak detection systems show an increasing trend toward 10.1 m^3 in one quarter. Trends will be assessed using statistical analysis such as Mann-Kendall and/or t-test.
- Leakage rate is at or above 10.1 m^3 per quarter during a single monitoring event.

The leakage rate of 10.1 m^3 per quarter represents 25 percent of the leakage associated with the complete geomembrane liner failure scenario. GHD modelled a leakage rate of 40 m^3 per quarter indicative of a complete failure or breach of the geomembrane (Scenario 3), as described in Section 13.3 of the DOCP.

If either trigger occurs, Tier II increased monitoring and primary liner performance investigation will be initiated.

1.2 Tier II – Increased Monitoring and Investigation

The Tier II TLAP includes two parts. The first part of Tier II includes monthly monitoring of the leak detection system(s) to confirm leakage monitoring results. If monitoring results confirm that leakage is occurring, a Tier II investigation will be initiated. The second part of Tier II is an investigation using dedicated lysimeters to determine where the leakage is occurring within the detection system(s). The Tier II investigation includes an assessment of the primary liner(s) to determine where leakage is occurring and the ability to expose the liner for repair.

The completion of the Tier II investigation triggers the Tier III contingency measures and confirmatory monitoring.

1.3 Tier III – Contingency Measures and Confirmatory Monitoring

The Tier III TLAP includes either:

- Repairing the primary liner or
- If the primary liner cannot be repaired due to the practicality in accessing the location, the leachate collection system will be operated under dry conditions to reduce leakage through the primary liner system and an intermediate/final cover deployment plan will be prepared.

The design of the cover deployment plan will be dependent on the stage of the Landfill's development and the location of the primary liner system leakage. The objective of the plan is to proceed with early deployment of intermediate and/or final cover. Confirmatory leakage rate monitoring will continue on a monthly basis until steady state conditions are again achieved.

2. Trigger: Water Quality

2.1 Tier I – Routine Water Quality Monitoring

The Tier I TLAP includes quarterly groundwater quality monitoring at existing monitoring well MW10-17 and future monitoring wells MW11, MW12, and MW13. Water quality monitoring will be completed as part of the EMP prepared for the Site. The EMP is described in Section 14 of the DOCP. Groundwater samples will be analyzed for field parameters, general chemistry, nutrients, LEPH/HEPH, and CSR metals.

The water quality monitoring results for MW10-17, MW11, MW12, and MW13 will be assessed for the following triggers:

- At two or more TLAP monitoring locations, leachate indicator concentrations show an increasing trend toward half of the applicable CSR DW Standard. Increasing trends will be assessed using statistical analysis such as Mann-Kendall and/or t-test; or
- During a single monitoring event, concentrations of two or more leachate indicator parameters at a single TLAP monitoring location meet or exceed half of the applicable CSR DW Standard.

If either trigger occurs, Tier II confirmatory sampling will be initiated.

2.2 Tier II – Confirmatory Sampling and Investigation

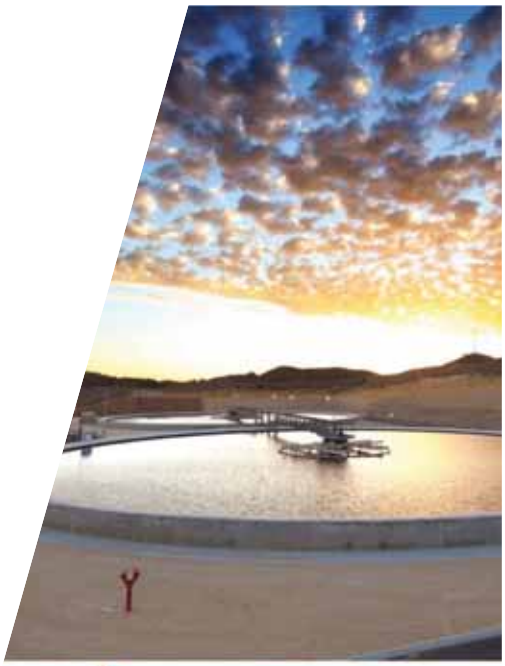
The Tier II confirmatory sampling will consist of resampling the triggered monitoring location(s) under increased frequency (e.g. monthly). If confirmatory sampling results confirm that Landfill water quality impairments are present, as defined under Tier I trigger levels, an investigation will be triggered. The investigation will assess the degree, nature, and potential source(s) of the trigger level exceedance. Increased sampling frequency will continue at the appropriate location(s) during the investigation.

The results of the Tier II investigation will assist in determining the most suitable water quality contingency measure as outlined in the Contingency Plan developed for the Landfill. The implementation of the contingency measure should stabilize or reduce the Landfill-derived water quality impairments at the appropriate location(s). Should the Tier II investigation confirm increasing concentrations above the trigger levels, Tier III contingency measures and compliance monitoring will be initiated.

2.3 Tier III – Implementation of Contingency Measure(s) and Compliance Monitoring

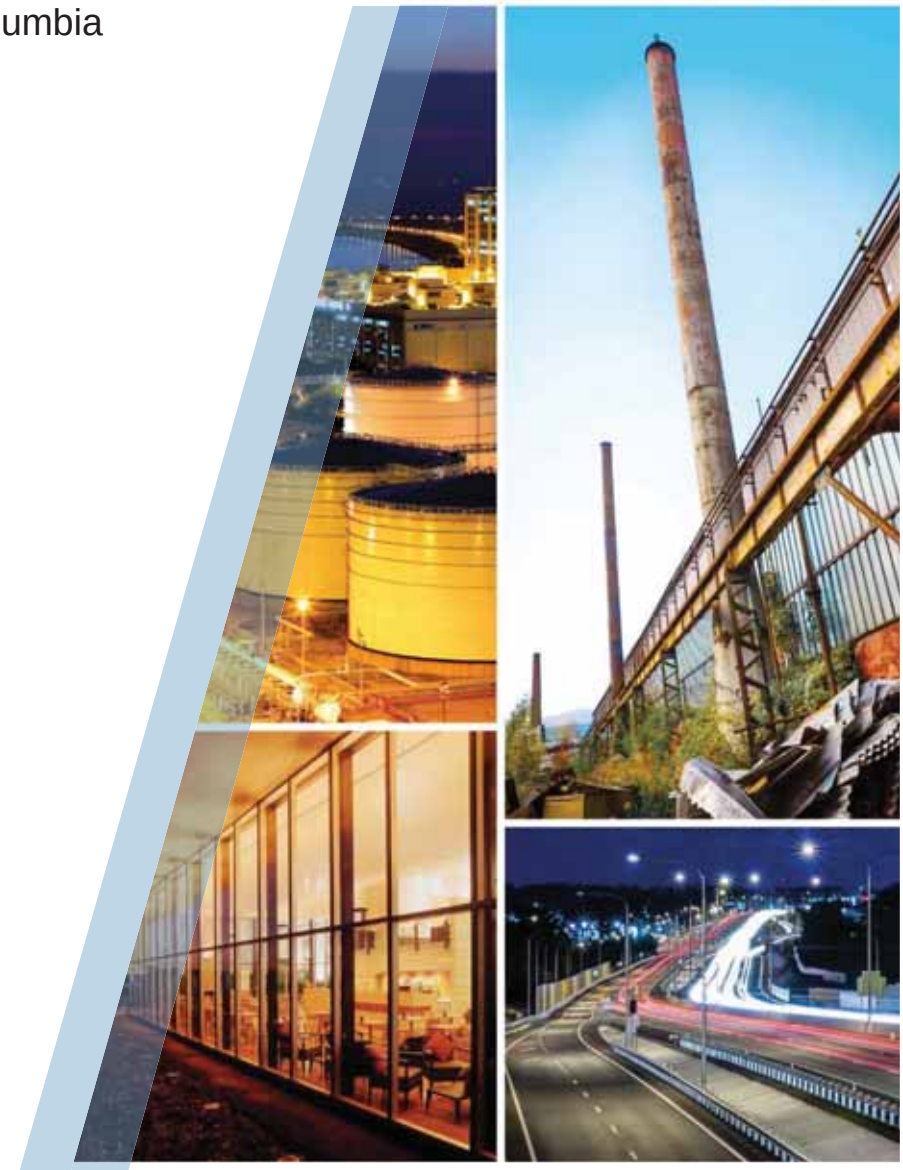
The Tier III TLAP includes the development of an implementation plan for the water quality contingency measures identified under Tier II, the deployment of the water quality contingency measures, and compliance monitoring. Following approval of the plan and implementation of the contingency measures, compliance monitoring will begin at monitoring wells MW10-17, MW11, MW12, and MW13. The purpose of the compliance monitoring will be to assess and evaluate the effectiveness of the contingency measure(s) implemented. A specific compliance monitoring program cannot be detailed in the TLAP as the extent and type of future groundwater quality impacts, if any, are unknown.

Appendix L
Financial Security Plan



Financial Security Plan

Upland Landfill
Campbell River, British Columbia



Upland Excavating Ltd.

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Table 5.1 Closure, Post-Closure and Contingency Cost Estimates

Table 5.2 Financial Security Calculation

1. Introduction

This Financial Security (FS) Plan was prepared by GHD for the New Landfill, known as Northwin Landfill located on the Upland Pit Property (Site) in Campbell River, British Columbia. The FS Plan forms part of the 2021 Design, Operations and Closure Plan (DOCP), and was prepared based on the *"British Columbia Landfill Criteria for Municipal Solid Waste, Second Edition"* (BCMOE, June 2016), herein referred to as the *Landfill Criteria*.

FS is required for all private landfills in accordance with *Section 8.0 - Financial Security* of the Landfill Criteria. The amount of the financial security provided in each year must be adequate to fund the closure of the landfill in that year and fund post-closure operations, monitoring, and maintenance for the estimated contaminated lifespan.

Section 2.10 of the Operational Certificate Number: 107689 (OC) provides additional instruction for calculating the Financial Security. This FS satisfies Section 2.10(b), which states:

> *(b) The DOCP submitted pursuant to section 2.5 of this operational certificate must include a financial security plan that includes:*
>
> *(i) the tasks, estimated costs, contingency costs, calculations of the amounts of financial security and time periods, to carry out and complete the plan referred to in section 2.9(a) of this operational certificate (plan to remove all waste from the Original Landfill),*
>
> *(ii) the calculations of the amounts of financial security and time periods for each phase of development for the New Landfill in accordance with the Landfill Criteria Section 8.0 Financial Security, and,*
>
> *(iii) the amounts of financial security for the corresponding time periods.*

2. Closure, Post-Closure and Contingency Activities Considered for the Security Funds Evaluation

2.1 Closure Costs

The closure costs consist of the estimated capital and engineering cost to install final cover on the Landfill in accordance with DOCP. The final cover design consists of a low permeability ($<1x10^{-7}$ cm/s), barrier layer including a geosynthetic clay liner, 0.6 metre (m) sand cover and a 0.15 m vegetated topsoil layer.

The activities considered in the closure costs to estimate the security fund are:

- Compaction and grading of the landfill surface
- Final cover placement and hydroseeding
- Installation of fences and surface water control works
- Installation of landfill gas collection (LFG) vents

2.2 Post-Closure Costs

The post-closure costs consist of the Site monitoring, operation, and maintenance cost during the post-closure stage in accordance with the DOCP. Activities considered in the post-closure cost estimation include:

- Administration
- Site maintenance including road maintenance/repair, vegetation management, erosion/surface water repairs
- Leachate treatment (on-Site or off-Site)
- Water quality monitoring
- Consultation and reporting

2.3 Costs of Contingency Measure Implementation

Section 16 – Contingency Plan of the DOCP outlines the possible contingency measures or actions that will be taken to address potential failure or non-compliance of the Landfill performance criteria. The activities considered in the financial security contingency cost estimation are those not encompassed in the post-closure costs described in Section 2.2 above, and include:

- Modifications/upgrades to the leachate treatment system
- Replacement/repair of the aeration pond base liner

2.4 Financial Contingency

In accordance with *Section 8.2 – Calculating Financial Security* of the Landfill Criteria, the amount of financial security shall include a contingency of 20 percent of the sum of the closure costs, post-closure costs and the contingency measures cost.

3. Site Operating Parameters

The following Site operating parameters were taken into consideration to establish the closure and post-closure cost estimates:

- Projected rate of fill and landfill lifespan
- Leachate generation rates, landfill gas generation rates, and contaminating lifespan of the landfill with respect to groundwater, surface water, and landfill gas

3.1 Site Capacity and Estimated Site Life

As discussed in the DOCP, the total Site capacity is estimated to be 532,365 cubic metres. The Site life has been estimated based on the maximum annual fill rate of 45,000 tonnes per year. Waste from the Original Landfill to the New Landfill does not contribute to the maximum allowable fill rate. Using a waste density of 1.3 tonnes per cubic metre, the annual airspace consumption is approximately 34,615 cubic metres (except in the year when approximately 71,722 cubic metres of waste will be relocated from the Original Landfill). The Site life is a function of refuse density and

refuse quantities received, and will also be influenced by market conditions in British Columbia. The estimated Site life is 13.3 years, based on the forecasted fill rate.

A summary of the landfill and financial inputs is presented in Table 3.1.

3.2 Contaminating Lifespan

The contaminating lifespan of a landfill is the time required for the leachate concentrations to decrease by a combination of biological decomposition of the organics, physiochemical processes which reduce the solubility of inorganics, dissolution, adsorption, or complexation and dilution by infiltration, to regulatory defined surface water quality objectives (i.e., Contaminated Sites Regulation Water Quality Standards). Post-closure care funding have been estimated for the duration of the contaminating lifespan of the Site, following closure of the Site, to ensure that adequate funds are available to mitigate any potential environmental impacts.

As discussed in the DOCP, it is anticipated that leachate generated from the Site will reduce to concentrations below regulatory levels or Site-specific trigger levels in approximately 28 years from time of closure. This is less than the minimum 30-years specified in *Section 8.3 – Post-Closure Period* of the Landfill Criteria. As such, the post-closure period for the purposes of estimating the amount of financial security required is 30 years.

4. Discount and Inflation Rates

All cost estimates for the financial security are presented in net present values (2021) and adjusted for inflation and discount rates. The discount and inflation rates used for the cost projection were selected based on *Section 8.4 – Cost To Be Presented In Current Dollars* of the Landfill Criteria, which states the following:

All cost estimates should be presented in net present values and adjusted for inflation and discount rates. Inflation rates shall be based on the British Columbia Consumer Price Index averaged over the preceding 10-year period or as recommended by a qualified professional. Discount rates shall be based on the current Government of Canada Long Term Bond Yield or as recommended by a qualified professional.

4.1 Discount Rate

Due to fluctuations in Canadian bond yields in recent years, the discount rate was selected to be the 10-year average Government of Canada benchmark bond yields: long term, as published in the Bank of Canada website: http://www.bankofcanada.ca/rates/interest-rates/lookup-bond-yields/. The Government of Canada 10-year average benchmark bond yields: long term, for the period between 2012 and 2021 is 3.15 percent as presented in Table 3.1.

4.2 Inflation Rate

The inflation rate applied to forecast construction costs, is calculated based on 10-year average monthly % change in Consumer Price Index (CPI) for British Columbia. Statistics Canada, 18-10-0004-01, Data Visualization: 71-607-X2018016, last accessed June 26, 2021. The 10-year average inflation rate for the period between 2011 and 2021 is 1.53 percent as presented in Table 3.1.

5. Cost Estimation Results

Closure, post-closure and contingency costs have been developed based on present day estimates of the cost to complete the activities discussed in Section 2. The present day (year of this report) cost estimates are provided in Table 5.1.

5.1 Closure Costs

As discussed in the DOCP, the Landfill will be developed in three phases and progressively closed throughout the lifespan of the Landfill. The planned closure costs are estimated based on the closure schedule presented in the DOCP Fill Plan, whereas emergency closure costs are based on the cost to close the remaining open landfill footprint area in a given year.

In Phase 1 a total of 27,440 m^2 of lined landfill footprint will be constructed over the four year period. During year one of Phase 1 East only 13,763 m^2 is filled, therefore, the area that could potentially require final cover in that year is 13,763 m^2. In Phase 1 West, 3,720 m^2 of side slopes will be closed. In Phase 2A, the landfill footprint is expanded to 33,471 m^2, however, 9,050 m^2 of area is closed with final cover. In this Phase, 24,421 m^2 could potentially require final cover under an emergency closure scenario.

In Phase 3A, the total footprint is expanded to the maximum size of 36,683 m^2 with 27,633 m^2 remaining open. In Phase 3B, an area of 7,185 m^2 is closed. In both Phase 3B and 3C, the area potentially requiring emergency closure is 16,235 m^2.

Progressive planned closure is scheduled for 2024, 2029 and 2033, and final closure is planned for 2035.

Table 5.2 presents the financial security calculations, including the planned and emergency closure costs based on the area requiring to be closed. The cost of emergency closure is higher than planned closure in each year, except in the year of final landfill closure.

5.2 Post-Closure Costs

Post-closure cost estimates are based on information supplied by Upland Excavating Ltd. and engineer's estimates. During Landfill operations leachate management will consist of on-Site treatment with discharge an infiltration pond, and this method was planned to continue 3 years of post-closure. After 3 years of post-closure, it is anticipated that the volume of leachate generated will be very low (less 2 m^3 per day on average or 573 m^3 per year), as such, the on-Site leachate treatment infrastructure will be decommissioned, and residual leachate will be managed by trucking for disposal off-Site. The calculation of leachate generation rates are presented in the DOCP.

As shown in Table 5.1, the estimated annual cost associated with post-closure activities will decrease over time as the Landfill nears the end of its contaminating lifespan (30 years). Post-closure costs will be highest in the first three years of post-closure. The monitoring and reporting effort are expected to be reduced three years after closure and further reduced after 7-years post-closure. General operations and maintenance requirements are also expected to reduce following a similar schedule.

The annual cost for the first 3 years is estimated to be $161,400 ($2021). The annual for the next three years after closure (years 4, 5 and 6) is estimated as $72,600 per year ($2021), and the annual cost between seven and 30 years after closure is estimated as $42,600 ($2021).

As presented in Table 5.2, the maximum present value sum of post-closure costs, associated with an emergency closure in 2022 is $1,414,695.

5.3 Contingency Costs

The estimated contingency costs for upgrading or modifying the leachate treatment system and repairing or replacing the aeration pond base liner are provided in Table 5.1. A total of $350,000 of contingency costs have been considered in the financial security calculation shown in Table 5.2.

5.4 Financial Contingency

A financial contingency of 20 percent has been applied to the closure and post-closure cost estimation, as introduced in Section 2.4. These costs are included on Table 5.1. Contingency measure costs (Section 5.3) are estimated conservatively and include a 20 percent contingency in the nominal value.

6. Cost to Carry-Out the Plan to Remove All Waste from the Original Landfill

The Plan to Remove All Waste from the Original Landfill is outlined in Section 6.3.3 of the DOCP. The Original Landfill is a historical landfill located in the southeastern corner of the Site. Authorization to discharge a maximum of 45,000 tonnes per year of waste to the Original Landfill is provided under the OC. Authorization to discharge waste to the Original Lined Cell ceases on the earlier of: (i) the date the Original Lined Cell is filled to capacity with grades not steeper than 3H:1V (33 percent), (ii) the date of commencement of waste discharge to the New Landfill.

The fill plan provided in the 2020 Annual Report estimates that the Original Landfill has 2.8 years of remaining capacity. The total capacity of the Landfill, including the lined and unlined portions is 74,746 m^3.

The estimated cost of carrying out the Plan to Remove All Waste from the Original Landfill is $4.63 per cubic metre of waste. The cost was calculated based on the Island Equipment Owners Association's suggested equipment rates for two Class 11 excavators, a Class 3 dozer and a 30 ton rock truck (a combined hourly rate of $925). Based on previous work carried out at the Site, this combination of equipment can move approximately 200 cubic metres of material per hour. A 20 percent contingency was carried, as presented in Table 5.1.

The financial security for the Original Landfill is required until the Plan to Remove All Waste is carried out and a report certified by a Qualified Professional confirming such is submitted to the director, satisfying OC Section 2.9(d):

> *If the plan referred to in section 2.9(a) of this operational certificate is carried out, the operational certificate holder must cause a Qualified Professional to certify and submit a report to the director that confirms that the plan has been carried out and completed in accordance with the director's requirements, describes the plan implementation, describes and provides the waste categorization, describes and provides the sampling and results, describes the decommissioning of the Original Landfill and the Original Leachate Management Works, provides photos documenting the implementation of the plan referred to in section 2.9(a) of this operational certificate, and lists the tonnages or volumes, and categories of waste removed and discharged to the New Landfill and to other identified and authorized waste management facility(ies), on or before 60-days after the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed.*

7. Financial Security Plan Summary

Table 7.1 below presents the amount of financial security required each year of the first five years of operating life of the New Landfill. The maximum amount of security will be required during year four of operations, which corresponds to the maximum open landfill area that would require closure. The financial security amount is calculated in accordance with *Section 8* of the Landfill Criteria and is presented in 2021 Canadian dollars.

In addition, the financial security required for the Original Landfill for each year of the same first five-year period is also presented in Table 7.1.

The total financial security for the Site is calculated to satisfy Section 2.10(d) of the OC:

> *The amount of financial security at any time must be equal to or greater than:*
>
> *(i) Before the report referred to in section 2.9(d) (report that confirms that the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed) of this operational certificate is submitted to the director, the greater amount specified for the corresponding time period in:*
>
> - *the financial security plan in the most recent OCP,*
>
> - *the financial security plan in the most recent DOCP.*
>
> *(ii) On and after the report referred to in section 2.9(d) (report that confirms that the plan referred to in section 2.9(a) of this operational certificate has been carried out and completed) of this operational certificate is submitted to the director, the amount specified for the corresponding time period in the financial security plan in the most recent DOCP.*

On or after the report referred to in Section 2.9(d) is submitted the financial security associated with the Original Landfill will be zero, and only the New Landfill financial security will be required.

Table 7.1 Financial Security – 5 Years

Year (Operating year)	New Landfill Financial Security Required	Original Landfill Financial Security Required
2022 (Year 1)	$2,049,079.57	$408,757.68
2023 (Year 2)	$2,111,347.94	$402,324.82
2024 (Year 3)	$2,095,240.57	$395,993.19
2025 (Year 4)	$2,274,959.57	$389,761.21
2026 (Year 5)	$2,239,157.17	$383,627.31

All of Which is Respectfully Submitted,

GHD



Roxanne Hasior, P.Eng.



Deacon Liddy, P.Eng., MBA

Tables

Financial and Landfill Input Data
Financial Security Plan
Northwin Landfill
Campbell River, British Columbia

Financial

Inflation rate (1)	1.53%
Discount rate (2)	3.15%

Northwin Landfill

Year	Forecasted Average Annual Waste Disposal Rate (Tonne)	Forecasted Cumulative Waste Disposed (tonnes)	Forecasted Average Annual Airspace Consumption (m^3) (3)	Forecasted Cumulative Airspace Consumption (m^3)
2022	138,238	138,238	106,337	106,337
2023	45,000	183,238	34,615	140,952
2024	45,000	228,238	34,615	175,568
2025	45,000	273,238	34,615	210,183
2026	45,000	318,238	34,615	244,799
2027	45,000	363,238	34,615	279,414
2028	45,000	408,238	34,615	314,029
2029	45,000	453,238	34,615	348,645
2030	45,000	498,238	34,615	383,260
2031	45,000	543,238	34,615	417,875
2032	45,000	588,238	34,615	452,491
2033	45,000	633,238	34,615	487,106
2034	45,000	678,238	34,615	521,722
2035	13,836	692,075	10,643	532,365
Total	**678,238**		**521,722**	

Original Landfill

Capacity of Unlined Portion of Original Landfill (m3)	35,000
Waste-In-Place Unlined Portion of Original Landfill (m3)	35,000
Capacity of Lined Cell of Original Landfill (m3)	39,746
Waste-In-Place in Lined Cell of Original Landfill (as of Dec 31, 2020) (m3)	17,703
Total Capacity of Original Landfill (m3)	74,746
Total Waste-In-Place in Original Landfill (as of Dec 31, 2019) (m3)	52,703

Notes:

(1) 'The inflation rate applied to forecast construction costs, calculated based on 10-year average monthly % change in Consumer Price Index (CPI) for British Columbia. Statistics Canada, 18-10-0004-01, Data Visualization: 71-607-X2018016, last accessed June 26, 2021

(2) Discount rate calculated based on 10 year average Government of Canada Benchmark Bond Yields - Long Term. Bank of Canada, http://www.bankofcanada.ca/rates/interest-rates/lookup-bond-yields/, last accessed June 23, 2021

(3) Apparent Density of the waste = 1.3 tonnes per cubic metre

Closure, Post-Closure and Contingency Cost Estimates
Financial Security Plan
Northwin Landfill
Campbell River, British Columbia

Closure Cost Estimate			
Description	**Unit**	**Price per Unit**	**Price per m^2**
Sand (Available on-site)	m^3	$ 3.00	$ 2.25
GCL	m^2	$ 12.00	$ 12.00
Topsoil	m^3	$ 4.00	$ 0.60
Hydroseeding	m^2	$ 1.00	$ 1.00
LFG Vents	L.S.	$ 25,000.00	$ 0.69
Swales and Erosion Control	lin. m	$ 80.00	$ 1.29
Contingency (20%)			$ 3.57
Total			**$21.40**

Post-Closure Costs			
Description	**Annual Cost in the Years Post-Closure**		
	1 to 3	**4 to 6**	**7 to 30**
Administration	$ 2,500.00	$ 2,500.00	$ 2,500.00
Access Road Maintenance/Repair	$ 2,000.00	$ 2,000.00	$ 2,000.00
Vegetation Maintenance	$ 5,000.00	$ 3,000.00	$ 3,000.00
Erosion/Surface Water Repair	$ 5,000.00	$ 3,000.00	$ 3,000.00
Leachate Management System O&M	$ 60,000.00	$ -	$ -
Allowance for Off-Site Disposal of Residual Leachate	$ -	$ 10,000.00	$ 5,000.00
Groundwater/Leachate Monitoring	$ 48,000.00	$ 30,000.00	$ 15,000.00
Consultants (Reporting)	$ 12,000.00	$ 10,000.00	$ 5,000.00
Contingency (20%)	$ 26,900.00	$ 12,100.00	$ 7,100.00
Total	**$ 161,400.00**	**$ 72,600.00**	**$ 42,600.00**

Cost of Implementing Contingency Measures	
Contingencies	**Estimated Cost**
Leachate treatment system modifications	$ 300,000.00
Allowance for aerated equalization pond liner repairs	$ 50,000.00
Total	**$ 350,000.00**

Cost of Removal of All Waste from Original Landfill		
Description	**Unit**	**Price**
Equipment Cost	m^3	$ 4.63
Cost of Removal of All Waste from Original Landfill	-	$ 346,073.98
Contingency (20%)	-	$ 69,214.80
Total		$ 415,293.41

Table 5.2

Financial Security Calculation
Financial Security Plan
Northwin Landfill
Campbell River, British Columbia

Year	Year of Operation	Stage	Lined Area m^2	Open Area m^2	Scheduled Closure m^2	Closed Area m2	A Cost of Planned Closure Cash Flow	A Cost of Planned Closure with inflation	A Cost of Planned Closure (PV)	B Cost of Emergency Closure Cash Flow	B Cost of Emergency Closure with inflation	B Cost of Emergency Closure (PV)	C Sum of 30 Years Post-Closure O&M Costs (PV)	D Cost of Implementing Contingency Measures (PV)	Amount of FS Required for New Landfill (PV) = (MAX A or B) + C + D	Amount FS Required to Carry out Plan to Remove All Waste from Original Landfill* (PV)	Total FS* (PV)
2021																	
2022	1	1 East	13,763	13,763	0	0	$ -	$ -	$ -	$ 294,528.20	$ 299,024.66	$ 289,893.03	$ 1,414,694.69	$ 344,491.84	**$ 2,049,079.57**	**$ 408,757.68**	**$ 2,457,837.25**
2023	2	1 West	18,322	18,322	0	0	$ -	$ -	$ -	$ 392,090.80	$ 404,154.02	$ 379,846.77	$ 1,392,430.80	$ 339,070.37	**$ 2,111,347.94**	**$ 402,324.82**	**$ 2,513,672.76**
2024	3	1 West	22,881	19,161	3,720	3,720	$ 79,608.00	$ 83,309.99	$ 75,908.32	$ 410,045.40	$ 429,113.65	$ 390,989.08	$ 1,370,517.28	$ 333,734.21	**$ 2,095,240.57**	**$ 395,993.19**	**$ 2,491,233.77**
2025	4	1 West/ 2 A	33,471	29,751	0	3,720	$ -	$ -	$ -	$ 636,671.40	$ 676,450.23	$ 597,528.91	$ 1,348,948.63	$ 328,482.04	**$ 2,274,959.57**	**$ 389,761.21**	**$ 2,664,720.79**
2026	5	2 A	33,471	29,751		3,720	$ -	$ -	$ -	$ 636,671.40	$ 686,777.37	$ 588,125.24	$ 1,327,719.41	$ 323,312.52	**$ 2,239,157.17**	**$ 383,627.31**	**$ 2,622,784.48**
2027	6	2 A	33,471	29,751	0	3,720	$ -	$ -	$ -	$ 636,671.40	$ 697,262.18	$ 578,869.56	$ 1,306,824.30	$ 318,224.36	**$ 2,203,918.22**	**$ 377,589.93**	**$ 2,581,508.15**
2028	7	2 A	33,471	29,751	0	3,720	$ -	$ -	$ -	$ 636,671.40	$ 707,907.05	$ 569,759.54	$ 1,286,258.02	$ 313,216.27	**$ 2,169,233.83**	**$ 371,647.57**	**$ 2,540,881.41**
2029	8	2 A/ 2 B	33,471	24,421	5,330	9,050	$ 114,062.00	$ 128,760.31	$ 100,468.09	$ 522,609.40	$ 589,954.12	$ 460,324.81	$ 1,266,015.41	$ 308,287.00	**$ 2,034,627.21**	**$ 365,798.73**	**$ 2,400,425.95**
2030	9	2 B/ 2 C	33,471	24,421	0	9,050	$ -	$ -	$ -	$ 522,609.40	$ 598,960.75	$ 453,080.40	$ 1,246,091.37	$ 303,435.30	**$ 2,002,607.07**	**$ 360,041.94**	**$ 2,362,649.01**
2031	10	3 A	36,683	27,633	0	9,050	$ -	$ -	$ -	$ 591,346.20	$ 688,086.58	$ 504,604.09	$ 1,226,480.88	$ 298,659.96	**$ 2,029,744.92**	**$ 354,375.74**	**$ 2,384,120.67**
2032	11	3 A	36,683	27,633	0	9,050	$ -	$ -	$ -	$ 591,346.20	$ 698,591.37	$ 496,662.83	$ 1,207,179.02	$ 293,959.77	**$ 1,997,801.61**	**$ 348,798.72**	**$ 2,346,600.33**
2033	12	3 A / 3 B	36,683	20,448	7,185	16,235	$ 153,759.00	$ 184,417.48	$ 127,107.53	$ 437,587.20	$ 524,839.05	$ 361,739.02	$ 1,188,180.92	$ 289,333.54	**$ 1,839,253.48**	**$ 343,309.47**	**$ 2,182,562.94**
2034	13	3 B / 3C	36,683	20,448	0	16,235	$ -	$ -	$ -	$ 437,587.20	$ 532,851.59	$ 356,046.11	$ 1,169,481.80	$ 284,780.13	**$ 1,810,308.04**	**$ 337,906.60**	**$ 2,148,214.64**
2035	14	3 C/ Closure	36,683	0	20,448	36,683	$ 437,587.20	$ 540,986.46	$ 350,442.80	$ -	$ -	$ -	$ 1,151,076.97	$ 280,298.37	**$ 1,781,818.14**	**$ 332,588.76**	**$ 2,114,406.90**
2035	N/A	Post-Closure	36,683	0	0	36,683	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,132,961.78	$ -	**$ 1,132,961.78**	**$ 332,588.76**	**$ 1,465,550.54**

Notes:

Costs in columns A, B, C and D are based on the cost estimates provided in Table 5.1 and discounted using the rates shown in Table 3.1.

All values are presented in 2021 Canadian dollars, unless otherwise specified.

*Amount FS Required for the Original Landfill will no longer be required once the Plan to Remove All Waste from Original Landfill is carried out (Section 2.9(a) of OC) and completion report is submitted by a Qualified Professional (Section 2.9(d)).



about GHD

GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

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APPENDIX G:
ANNUAL STATUS COMPLIANCE FORM

Annual Compliance Status Form

AUTHORIZATION NUMBER: 107689
AUTHORIZATION TYPE: Operational Certificate
LEGAL AUTHORIZATION HOLDER NAME: Upland Excavation Ltd.
PERIOD OF COMPLIANCE STATUS ASSESSMENT: **2024-01-01 to 2024-12-31**

AUTHORIZED PERSON NAME: Terry Stuart
AUTHORIZED PERSON SIGNATURE:
SIGNATURE DATE: March 31, 2025

I understand that it is an offense to mislead a government official, and I declare that all of the information presented is accurate and true.
I have been given the authority by the authorization holder to sign this form.

AUTHORIZATION CLAUSE NUMBER	AUTHORIZATION CLAUSE DESCRIPTION	COMPLIANT? (Yes/No/ND)	RATIONALE FOR YOUR COMPLIANCE DETERMINATION	LOCATION OF SUPPORTING INFORMATION IN ANNUAL REPORT
1.1.1	The maximum rate of waste discharge to the Original Lined Cell is 45,000 tonnes per calendar year.	Yes	N/A - waste was not discharged to the Original Landfill in 2024. Operations ceased at the Original Landfill in September 2022 and waste was removed and placed into the New Landfill from April to June 2023. Decomissioning activities were completed in June 2023.	Refer to Section 7.2 of the annual report.
1.1.2	The characteristics of the waste discharge to the Original Lined Cell must be: (a) demolition waste, (b) construction waste, (c) land clearing waste, (d) soil in which the concentrations of all substances are less than the lowest applicable industrial land use standard specified for those substances in (i) the generic numerical soil standards, (ii) the matrix numerical soil standards, or (iii) a director's interim standard for soil, referred to in section 41(1)(a) of the Contaminated Sites Regulation, B.C. Reg. 375/96, (e) sludge from the Original Leachate Management Works, or, (f) other waste as authorized in writing by the director, but does not include: (g) hazardous waste except as authorized pursuant to the Hazardous Waste Regulation, controlled waste, Attractants, and, (h) waste and/or recyclable material prohibited in writing by the director.	Yes	N/A - waste was not discharged to the Original Landfill in 2024. Operations ceased at the Original Landfill in September 2022 and waste was removed and placed into the New Landfill from April to June 2023. Decomissioning activities were completed in June 2023.	Refer to Section 7.2 of the annual report.
1.1.3	The waste discharge is authorized to the Original Lined Cell approximately located as shown on Site Plan A. Waste discharge to the Original Un- lined Cell is not authorized.	Yes	N/A - waste was not discharged to the Original Landfill in 2024. Operations ceased at the Original Landfill in September 2022 and waste was removed and placed into the New Landfill from April to June 2023. Decomissioning activities were completed in June 2023.	Refer to Section 7.2 of the annual report.
1.1.4	Authorization to discharge waste to the Original Lined Cell ceases on the earlier of: (i) the date the Original Lined Cell is filled to capacity with grades not steeper than 3H:1V (33%), (ii) the date of commencement of waste discharge to the New Landfill.	Yes	N/A - waste was not discharged to the Original Landfill in 2024. Operations ceased at the Original Landfill in September 2022 and waste was removed and placed into the New Landfill from April to June 2023. Decomissioning activities were completed in June 2023.	Refer to Section 7.2 of the annual report.
1.1.5	The authorized works are: (i) a lined landfill footprint with a maximum area of 0.72 ha (85 m x 85 m) including from bottom to top a base with perimeter berm, 0.3 m sand cushion layer, 0.5 mm thick coated woven polyethylene liner, 0.3 m granular leak detection layer, leak detection riser pipe, 0.5 mm thick coated woven polyethylene liner, 0.3 m sand protection layer, leachate extraction chamber, final cover, and,	Yes	N/A-Orginal Landfill decommissioned.	Refer to Section 7.2 of the annual report.
1.1.5	(ii) an un-lined landfill footprint with an approximate area of 0.7 ha, final cover, and related appurtenances, approximately located as shown on Site Plan A.	Yes	N/A-Orginal Landfill decommissioned.	Refer to Section 7.2 of the annual report.
1.1.6	The operational certificate holder must ensure the Original Landfill, excluding final cover, is complete and fully operational on or before the date of issuance of this operational certificate, and at all times thereafter, until the Original Landfill is decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.	Yes	N/A - Waste was not discharged to the Original Landfill in 2024. Operations ceased at the Original Landfill in September 2022 and waste was removed and placed into the New Landfill from April to June 2023. Decomissioning activities were completed in June 2023.	Refer to Section 7.2 of the annual report.
1.2.1	The operational certificate holder must convey the leachate from the Original Lined Cell, that is to be discharged on the Facility site, to the Original Leachate Management Works.	Yes	N/A-Orginal Leachate Management Works decommissioned.	Refer to Section 7.2 of the annual report.
1.2.2	The maximum rate of treated leachate effluent discharge to the treated leachate infiltration pond is 7,139 m3 per calendar year.	Yes	N/A-Orginal Leachate Management Works decommissioned.	Refer to Section 7.2 of the annual report.
1.2.3	The concentration of any substance in the treated leachate effluent discharge to the treated leachate infiltration pond must not be greater than the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance.	Yes	N/A-Orginal Leachate Management Works decommissioned.	Refer to Section 7.2 of the annual report.
1.2.4	The treated leachate effluent is authorized to be discharged to the treated leachate infiltration pond and infiltrated into the ground. This authorization ceases on the date the Original Leachate Management Works are decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.	Yes	N/A-Orginal Leachate Management Works decommissioned.	Refer to Section 7.2 of the annual report.
1.2.5	The authorized works are leachate conveyance, storage, treatment and discharge works including pumps, pipes, leachate storage and treatment tanks, treated leachate infiltration pond, flow monitoring works, and related appurtenances approximately located as shown on Site Plan A.		N/A-Orginal Leachate Management Works decommissioned.	Refer to Section 7.2 of the annual report.
1.2.6	Minimum Freeboard must be maintained at all times as follows: treated leachate infiltration pond: 0.6 m.	Yes	N/A-Orginal Leachate Management Works decommissioned.	Refer to Section 7.2 of the annual report.
1.2.7	The operational certificate holder must ensure the Original Leachate Management Works are complete and fully operational on or before the date of commencement of discharge to the treated leachate infiltration pond, and at all times thereafter, until the Original Leachate Management Works are decommissioned in compliance with the plan referred to in section 2.9(a) (plan to remove all waste from the Original Landfill) of this operational certificate.	Yes	N/A - waste was not discharged to the Original Landfill in 2024. Operations ceased at the Original Landfill in September 2022 and waste was removed and placed into the New Landfill from April to June 2023. Decomissioning activities were completed in June 2023.	Refer to Section 7.2 of the annual report.
1.3.1	The maximum rate of waste discharge to the New Landfill is 45,000 tonnes per calendar year.	Yes	N/A - New Landfill accepted approximately 26,285 tonnes in 2024.	Refer to Section 8.6 of the annual report.
1.3.2	The characteristics of the waste discharge to the New Landfill must be: (a) demolition waste, (b) construction waste, (c) land clearing waste, (d) soil in which the concentrations of all substances are less than the lowest applicable industrial land use standard specified for those substances in (i) the generic numerical soil standards, (ii) the matrix numerical soil standards, or (iii) a director's interim standard for soil, referred to in section 41(1)(a) of the Contaminated Sites Regulation, B.C. Reg. 375/96, (e) sludge from the New Leachate Management Works or the New Stormwater Management Works, or, (f) other waste as authorized in writing by the director, but does not include: (g) hazardous waste except as authorized pursuant to the Hazardous Waste Regulation, controlled waste, Attractants, and, (h) waste and/or recyclable material prohibited in writing by the director.	Yes	N/A	Refer to Section 8.6 of the annual report.
1.3.3	The waste discharge is authorized to the New Landfill approximately located as shown on Site Plan A.	Yes	N/A	Refer to Section 8.6 of the annual report
1.3.4	The authorized works are a lined landfill footprint with a maximum area of 3.60 ha including from bottom to top a base with perimeter berm, secondary base liner, leak detection drainage layer and leak collection pipes and sump, primary base liner, leachate collection drainage layer and leachate collection pipes and sump, pumps, pipes, final cover, and related appurtenances, approximately located as shown on Site Plan A.	Yes	Cell 1 constructed as outlined in the construction report	Refer to Appendix C of the annual report
1.3.5	The secondary base liner and the primary base liner must each include an upper high density polyethylene double sided textured geomembrane of minimum 1.5 mm thickness and a lower geosynthetic clay liner of hydraulic conductivity less than or equal to 1 x 10-7 cm/s. However, on the south slope of the base more than 1 m above the primary base liner, the geosynthetic clay liners are not required.	Yes	Cell 1 constructed as outlined in the construction report	Refer to Appendix C of the annual report
1.3.6	The operational certificate holder must ensure the New Landfill, excluding final cover, is complete and fully operational on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.	Yes	N/A	Refer to Section 8.1 of the annual report.
1.4.1	The operational certificate holder must convey the leachate from the New Landfill, that is to be discharged on the Facility site, to the New Leachate Management Works.	Yes	N/A - Leachate is collected within Cell 1 in a series of perforated pipes installed at the base of the cell and discharges to a sump. Leachate is stored temporarily in the landfill and pumped from the sump to the leachate treatment pond for batch treatment.	Refer to Section 8.2 of the annual report.
1.4.2	The maximum rate of treated leachate effluent discharge to the treated leachate infiltration pond is 24,633 m3 per calendar year.	Yes	A total of 4,500 m3 was treated and discharged in 2024	Refer to Section 5.1.2 of the annual report.
1.4.3	The concentration of any substance in the treated leachate effluent discharge to the treated leachate infiltration pond must not be greater than the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance.	No	N/A - Leachate exceedances were due to above normal leachate volumes to be treated.	Refer to Sections 5.1.2 and 9.2 of the annual report.
1.4.4	The treated leachate effluent is authorized to be discharged to the treated leachate infiltration pond and infiltrated into the ground.	Yes	N/A	Refer to Section 5.1.2 of the annual report.
1.4.5	The authorized works are leachate conveyance, treatment and discharge works including pumps, pipes, leachate treatment pond(s), treated leachate infiltration pond, flow monitoring works, and related appurtenances approximately located as shown on Site Plan A.	Yes	N/A - The new leachate management works include leachate collection, extraction, storage, treatment, and infiltration. A process schematic of the new leachate management works is provided in Section 8.8 of the annual report.	Refer to Section 8.8 of the annual report.
1.4.6	The leachate treatment pond(s) must include from bottom to top a secondary base liner, leak detection drainage layer and leak collection pipe(s), and a primary base liner. The secondary base liner and the primary base liner must each include an upper high density polyethylene double sided textured geomembrane of minimum 1.5 mm thickness and a lower geosynthetic clay liner of hydraulic conductivity less than or equal to 1 x 10-7 cm/s.	Yes	N/A	Refer to Appendix C of the annual report.
1.4.7	Minimum Freeboard must be maintained at all times as follows: leachate treatment pond(s): 0.6 m treated leachate infiltration pond: 0.6 m	Yes	N/A - Discharge to leachate ponds controlled by level sensors to ensure minimum freebord of 0.6 m.	Refer to Appendix F of the annual report.

AUTHORIZATION CLAUSE NUMBER	AUTHORIZATION CLAUSE DESCRIPTION	COMPLIANT? (Yes/No/ND)	RATIONALE FOR YOUR COMPLIANCE DETERMINATION	LOCATION OF SUPPORTING INFORMATION IN ANNUAL REPORT
1.4.8	The operational certificate holder must ensure the New Leachate Management Works are complete and fully operational on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter	Yes	N/A	Refer to Appendix C of the annual report.
1.5.1	The operational certificate holder must manage stormwater from the New Landfill such that stormwater is infiltrated into the ground with the authorized works.	Yes	N/A	Refer to Section 5.4 of the annual report.
1.5.2	The stormwater must not include leachate and the concentration of any substance in the stormwater must not be greater than the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance	Yes	N/A	Refer to Section 5.4 of the annual report.
1.5.3	The authorized works are diversion berm, perimeter berm, mid slope swales, drop down channels, ditches, energy dissipation and sediment traps, stormwater infiltration area, and related appurtenances approximately located as shown on Site Plan A.	Yes	N/A	Refer to Appendix C of the annual report.
1.5.4	Minimum Freeboard must be maintained at all times as follows: stormwater infiltration area: 0.6 m all other authorized works: 0.3 m	Yes	N/A - Stormwater retention pond is not required at this time.	
1.5.5	The operational certificate holder must ensure that adequate authorized works to manage stormwater, such that stormwater is infiltrated into the ground with the authorized works, are complete and fully operational on or before the date of commencement of waste discharge to the New Landfill, and at all times thereafter.	Yes	N/A	Refer to Section 5.4 of the annual report.
1.6.1	The authorized works are sign(s), gate, fence, weigh scale, and related appurtenances approximately located as shown on Site Plan A.	Yes	N/A	Refer to Section 1.5 of the annual report.
1.6.2	The operational certificate holder must ensure the authorized works are complete and fully operational on or before the date of issuance of this operational certificate and at all times thereafter.	Yes	N/A	Refer to Appendix F of the annual report.
1.7.1	The location of the Facility is PID 001-223-321, LOT A, DISTRICT LOT 85, SAYWARD DISTRICT, PLAN 30709 EXCEPT PART IN PLAN EPP15087, approximately located as shown on Site Plan A.	Yes	N/A	Refer to Section 1.4 and Appendix F of the annual report.
2.2	The operational certificate holder must cause a Qualified Professional to: (a) Design and inspect the construction of the Facility, and, (b) Certify documents related to the Facility including plans, specifications, drawings, construction reports, assessments, reviews, investigations, studies, surveys, programs, reports and as-built record drawings. (d) Submit a completed Declaration of Competency and a Conflict of Interest Disclosure Statement with each document.	Yes	N/A - Sperling Hansen Associates (SHA) was engaged by Upland Excavating / Northwin Environmental Ltd. as the qualified professional as of December 6th, 2024.	
2.5	Design, Operations and Closure Plan (DOCP) (d) The operational certificate holder must carry out the most recent DOCP and design, construct, operate, inspect, maintain, monitor, and close the Facility, in compliance with most recent DOCP and this operational certificate.	Yes	N/A - Northwin Environmental Ltd. will present a revised DOCP in 2026 which is in accordance the OC (every 5 years).	Refer to Appendix F of the annual report.
2.7	Before a specific quantity of soil is accepted at the Facility, the operational certificate holder must cause a Qualified Professional to certify and submit to the operational certificate holder, a document pertaining to the specific quantity of soil that includes: (i) the soil tonnage(s) and soil quality class(es) as described in the most recent version of Technical Guidance 1 on Contaminated Sites Site Characterization and Confirmation Testing, (ii) the soil origin including applicable civic address, site identification number, parcel identifier, parcel identification number, legal description, and, (iii) characterization of the soil in accordance with ministry procedures and applicable Contaminated Sites Regulation Guidance, Protocols and Procedures.	Yes	N/A	GHD
2.11	(a) The operational certificate holder must cause a Qualified Professional to carry out inspections before and during the construction or modification of Significant Works, and, after the completion of construction or modification of Significant Works, to certify and submit construction report(s) to the director: (i) for construction of the New Landfill and the New Leachate Management Works, on or before 30 days before the date of commencement of waste discharge to those new Significant Works, and, (ii) for all Significant Works, on or before 60 days after the completion of construction or modification of the Significant Works. (b) The construction report(s) must demonstrate that the Significant Works have been constructed in accordance with this operational certificate and the applicable most recent OCP or DOCP, describe any technical concerns that arose from the inspections and testing and how they were addressed, and include as-built record drawings of the constructed Significant Works, all the inspection and testing reports and results including geologic inspection report, quality control and quality assurance testing, soil test data including field and laboratory data, as described in the Landfill Criteria section 10.2 Construction Report(s).	Yes	N/A - Sperling Hansen Associates (SHA) was engaged by Upland Excavating / Northwin Environmental Ltd. as the qualified professional as of December 6th, 2024.	
2.12	The operational certificate holder must notify the director of: the date of commencement of waste discharge to the New Landfill, on that date.	Yes	N/A	Refer to Appendix C of the annual report.
2.14	The operational certificate holder must ensure that the New Landfill secondary base liner, and the New Leachate Management Works leachate treatment pond(s) secondary base liner, are a minimum of 1.5 m above groundwater at all times.	Yes	N/A	See Figure 5 in annaul report and asbuilt drawing CI0002 in Appendix C of annual report
3.1	The operational certificate holder must provide and install multiple and/or spare works and auxiliary power facilities to ensure the Original Lined Cell, Original Leachate Management Works, New Landfill, New Leachate Management Works, and New Storm water Management Works, are complete and fully operational as specified in this operational certificate, including during maintenance, breakdowns and electrical power outages.	Yes	N/A	
3.2	The operational certificate holder must cause persons that are qualified and trained to operate, regularly inspect, and maintain the Facility, in good working order. If components of the Facility have a manufacturer's recommended maintenance schedule, then those components must, at a minimum, be maintained in accordance with that schedule.	Yes	N/A	Northwin Environmental Ltd.
3.2	The operational certificate holder must prepare documents of the qualification and training of the persons operating, inspecting and maintaining the Facility, and of Facility inspections, operation and maintenance.	Yes	N/A	Northwin Environmental Ltd.
3.3	The operational certificate holder must ensure that at least one person responsible for the management of the Facility is certified, and maintains certification, by The Solid Waste Association of North America (SWANA) as a Manager of Landfill Operations, and at least one person responsible for the operation of the Facility has, within the preceding five years, successfully completed the SWANA Landfill Operations Basics course, on or before the earlier of: (i) the date of commencement of waste discharge to the Original Lined Cell, (ii) the date of commencement of waste discharge to the New Landfill, and at all times thereafter	Yes	N/A	Northwin Environmental Ltd.
3.3	The operational certificate holder must prepare documents of the SWANA certification and training of the person(s) responsible for the management and operation of the Facility.	Yes	N/A	Northwin Environmental Ltd.
3.5	The operational certificate holder must ensure that the Facility does not cause the concentration of any substance in groundwater flowing from the Facility site boundary to be greater than: (i) the Contaminated Sites Regulation Generic Numerical Water Standards for Drinking Water (DW), for that substance, or (ii) if the local background concentration of any substance is greater than (i), the local background concentration of that substance.	Yes	N/A	Refer to Section 5.3 of the annual report.
3.6	The operational certificate holder must ensure that: (a) The Facility does not cause: (i) combustible gas concentrations to exceed the lower explosive limit of methane (5 percent by volume), or a lower concentration specified by the director, in soil at the Facility site boundary; (ii) combustible gas concentrations to exceed 20 percent of the lower explosive limit of methane (1 percent by volume) in any building; and (iii) federal, provincial, or local ambient air quality objectives and standards to be exceeded in air at the Facility site boundary. (b) Landfill gas is managed in accordance with all migration and health and safety requirements.	Yes	N/A	Refer to Section 5.6 of the annual report.
3.7	The operational certificate holder must ensure that the Facility does not cause a nuisance including with regard to birds, rodents, insects, odour, noise, dust, litter, vector and wildlife attraction.	Yes	N/A	
3.8	The operational certificate holder must prepare documents of complaints with regard to matters relevant to this operational certificate, including environmental and nuisance complaints. These documents must include the source and nature of the complaint, actions, responses, and corresponding dates and times.	Yes	N/A	Refer to Section 8.10 of the annual report.
4.1	The operational certificate holder must carry out required sampling in accordance with the procedures described in the "British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples, 2013 Edition (Permittee)" or most recent edition, or by alternative procedures as authorized by the director.	Yes	N/A	Refer to Section 3.9 of the annual report.
4.2	The operational certificate holder must carry out required analyses in accordance with procedures described in the "British Columbia Laboratory Manual (2015 Permittee Edition)", or the most recent edition or by alternative procedures as authorized by the director.	Yes	N/A	Refer to Sections 3.9 of the annual report.
4.3	The operational certificate holder must obtain from the analytical laboratory(ies) their precision, accuracy and blank data for each sample set submitted by the operational certificate holder and an evaluation of the data acceptability, based on criteria set by such laboratory.	Yes	N/A	Refer to Section 3.11 of the annual report.
4.3	The operational certificate holder must submit samples to analytical laboratory(ies) that meet the definition of a qualified laboratory under the Environmental Data Quality Assurance Regulation.	Yes	N/A - Analytical services were provided by Bureau Veritas Laboratories (BV) of Burnaby, BC.	Refer to Section 3.11 of the annual report.

Authorized Person Initial: TS

Date: 31/03/2025

AUTHORIZATION CLAUSE NUMBER	AUTHORIZATION CLAUSE DESCRIPTION	COMPLIANT? (Yes/No/ND)	RATIONALE FOR YOUR COMPLIANCE DETERMINATION	LOCATION OF SUPPORTING INFORMATION IN ANNUAL REPORT
4.3	The operational certificate holder must collect, prepare and submit for analysis by the analytical laboratory(ies) quality control (QC) samples for each parameter. As a minimum, the number of QC samples should be 20% of all samples collected (environmental + QC samples) within 48 hours of each other, and include duplicate, field and trip blank samples for each parameter.	Yes	N/A -A qualified EnviroChem chemist completed data verification to assess laboratory and field QA/QC measures.	Refer to Appendix E of the annual report.
5.2	The operational certificate holder must immediately notify the director or designate by email at EnvironmentalCompliance@gov.bc.ca, or as otherwise instructed by the director of any non-compliance with the requirements of this authorization by the operational certificate holder and must take remedial action to remedy any effects of such non-compliance.	Yes	N/A - Non-compliance letter was submitted on February 5th, 2025, to Ministry of Environments and Parks titled "Notification of Oversight in 2024 Q4 Groundwater Monitoring Event".	
5.2	The operational certificate holder must provide the director with written confirmation of all non-compliance events, including available test results within 24 hours of the original notification by email at EnvironmentalCompliance@gov.bc.ca, or as otherwise instructed by the director.	Yes	N/A - Non-compliance letter was submitted on February 5th, 2025, to Ministry of Environments and Parks titled "Notification of Oversight in 2024 Q4 Groundwater Monitoring Event".	
5.3	If the operational certificate holder fails to comply with any of the requirements of this authorization, the operational certificate holder must, within 30 days of such non-compliance, submit to the director a written report that is satisfactory to the director and includes, but is not necessarily limited to, the following: (i) all relevant test results obtained by the operational certificate holder related to the non-compliance, ii) an explanation of the most probable cause(s) of the non-compliance, and (iii) a description of remedial action planned and/or taken by the operational certificate holder to prevent similar non-compliance(s) in the future.	Yes	N/A - Non-compliance letter was submitted on February 5th, 2025, to Ministry of Environments and Parks titled "Notification of Oversight in 2024 Q4 Groundwater Monitoring Event".	
5.3	The operational certificate holder must submit all non-compliance reporting required to be submitted under this section by email to the Ministry's Compliance Reporting Submission Mailbox at EnvironmentalCompliance@gov.bc.ca or as otherwise instructed by the director.	Yes	N/A - Non-compliance letter was submitted on February 5th, 2025, to Ministry of Environments and Parks titled "Notification of Oversight in 2024 Q4 Groundwater Monitoring Event".	
5.4	The operational certificate holder must cause a Qualified Professional to certify and submit an Annual Operations and Monitoring Report in a format suitable for public release, for the preceding calendar year, to the director on or before March 31 of each year. On or before March 31 of each year, the operational certificate holder must post a copy of the Annual Operations and Monitoring Report online, on a website accessible to the public and in accordance with any requirements of the director	Yes	N/A	
5.4	The Annual Operations and Monitoring Report must include a summary of OCP implementation that addresses the information in section 2.3(b), and summary of DOCP implementation that addresses the information in 2.5(b), of this operational certificate.	Yes	N/A	Refer to Section 8.3 of the annual report.
5.4	The Annual Operations and Monitoring Report must include a summary of construction reports.	Yes	N/A	Refer to Section 8.5 of the annual report.
5.4	The Annual Operations and Monitoring Report must include annual and cumulative tonnages and categories of waste including soil tonnage(s) and soil quality class(es) discharged to the Original Lined Cell and to the New Landfill.	Yes	N/A	Refer to Section 8.6 of the annual report.
5.4	The Annual Operations and Monitoring Report must include remaining volume and life of the Original Lined Cell and of the New Landfill.	Yes	N/A - Original Landfill decommissioned	Refer to Section 8.7 of the annual report.
5.4	The Annual Operations and Monitoring Report must include a summary of treated leachate effluent quantity and quality discharged to the treated leachate infiltration pond.	Yes	N/A	Refer to Section 5.1.2 of the annual report.
5.4	The Annual Operations and Monitoring Report must include a summary of complaints and nuisances and description of remedial action planned and/or taken by the operational certificate holder to prevent similar complaints and nuisances in the future.	Yes	N/A	Refer to section 8.10 the annual report.
5.4	The Annual Operations and Monitoring Report must include a summary of non-compliance notifications and non-compliance reporting and description of remedial action planned and/or taken by the operational certificate holder to prevent similar non-compliance(s) in the future.	Yes	N/A - Non-compliance letter was submitted on February 5th, 2025, to Ministry of Environments and Parks titled "Notification of Oversight in 2024 Q4 Groundwater Monitoring Event".	
5.4	The Annual Operations and Monitoring Report must include an annual status form in accordance with the instructions and template at the ministry website https://www2.gov.bc.ca/gov/content/environment/waste-management/waste-discharge-authorization/data-and-report-submissions/annual-status-form	Yes	N/A - Refer to this form.	Refer to Appendix F of the annual report.
5.4	The Annual Operations and Monitoring Report must include a summary of OCP and DOCP implementation, and construction of Significant Works, planned for the next calendar year.	Yes	N/A	Refer to Sections 9.2 and 8.5.3 of the annual report.
5.4	The Environmental Monitoring Plan Report must include site plan(s), sampling locations, storm water flow paths, groundwater elevations,gradients and flow directions.	Yes	N/A	Refer to Secion 5 of the annual report.
5.4	The Environmental Monitoring Plan Report must include data including laboratory analysis and quality assurance and quality control results.	Yes	N/A	Refer to Appendix E of the annual report.
5.4	The Environmental Monitoring Plan Report must include data tabulation, trend analysis, graphs, diagrams, and interpretation.	Yes	N/A	Refer to Appendix E of the annual report.
5.4	The Environmental Monitoring Plan Report must include trigger level assessment plan monitoring, data, results and interpretation.	Yes	N/A - the New Landfill EMP includes a trigger level response plan.	Refer to Appendix F of the annual report.
5.4	The Environmental Monitoring Plan Report must include any determination(s) of the local background concentration of substance(s) in accordance with section 3.5 of this operational certificate.	Yes	N/A - Local determination(s) on local background concentration of substances was not needed.	
5.4	The Environmental Monitoring Plan Report must include comparison of the data with the standards for treated leachate effluent discharge, storm water quality, groundwater quality, and landfill gas management, specified in sections 1.2, 1.4, 1.5, 3.5 and 3.6 of this operational certificate, and identification of any non-compliance and predicted future non-compliance.	Yes	N/A	Refer to Appendix E of the annual report.
5.4	The Environmental Monitoring Plan Report must include results, conclusions, recommendations and changes to the environmental monitoring plan.	Yes	N/A	Refer to sections 5 and Appendix E of the annual report.
5.4	The operational certificate holder must upload monitoring data associated with this operational certificate to the Ministry's Environmental Monitoring System (EMS) database, within 45 days of the end of the 3 month period in which the data is collected.	Yes	N/A - Data has been uploaded to the EMS by the laboratory.	

Authorized Person Initial: TS

Date: 31/03/2025