

NORTHWIN LANDFILL

2026 DESIGN, OPERATIONS & CLOSURE PLAN



Prepared for:

Northwin Environmental Limited

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September 30th, 2026

PRJ24074

Attention: Terry Stuart
Operations Project Manager
Northwin Environmental Ltd.
Suite 315, 1432 Ironwood Street
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Re: Northwin Landfill 2026 Design, Operations & Closure Plan – FINAL

Dear Mr. Stuart,

Sperling Hansen Associates (SHA) is pleased to submit the final report for the *Northwin Landfill 2026 Design, Operations and Closure Plan Update*.

As outlined in our proposal, we have provided analysis and reporting on the Regulatory Context and Design Objectives, Site Conditions and History, Site Development and Landfill Design, Lifespan Analysis, Environmental Controls, Environmental Monitoring Program, Filling Plan and Material Management, Landfill Operations, Closure and Post Closure Plan, Health & Safety and Emergency Management Plan, and Financial Security Plan.

Please contact the undersigned should you have any queries or comments. It has been a pleasure working for the Northwin Environmental Ltd. on this project and we look forward to working with you and your staff during the detailed design phase.

Yours truly,

SPERLING HANSEN ASSOCIATES

Dr. Tony Sperling, P.Eng.
President

EXECUTIVE SUMMARY

Sperling Hansen Associates (SHA) was retained by Northwin Environmental Ltd. (NWE) to prepare the 2026 Design, Operations and Closure Plan (DOCP) for the Northwin Landfill, located within the Upland Excavating Ltd. gravel pit and rock quarry property in Campbell River, British Columbia. The DOCP provides an updated and comprehensive framework for continued design, operations, environmental management, phased development, progressive closure, and post-closure care of the facility. The update addresses regulatory requirements, current site conditions, landfill capacity and lifespan, environmental control systems, monitoring, filling and operating practices, closure and post-closure planning, health and safety, emergency management, and financial security. The final report is intended to consolidate these elements into an updated operating and planning document for Northwin Environmental Ltd.

The Northwin Landfill operates within an approximately 48 ha sand, gravel, and rock quarry property and is authorized under Operational Certificate (OC)-107689. The facility is authorized to receive demolition waste, construction waste, land-clearing debris, contaminated soil that is not hazardous waste, and sludge generated from landfill leachate or water management works, to a maximum permitted disposal rate of 45,000 tonnes per year. The OC-107689 was originally issued on August 1, 2019, and was amended on April 26, 2022, including provisions related to acceptance of non-hazardous contaminated soil and leachate-management infrastructure.

The 2026 DOCP represents the required updates to the previous 2021 DOCP prepared by GHD Ltd. (GHD). Its principal objectives are to update the landfill lifespan estimate, establish detailed filling and phased-development plans, recommend improvements to leachate, stormwater, groundwater and landfill-gas management systems, update the environmental monitoring program, provide guidance for landfill operations and nuisance controls, establish progressive and conceptual closure strategies, and update financial-security requirements. The DOCP is also intended to demonstrate how the landfill's design, operations and closure program address the applicable requirements of the OC and BC Landfill Criteria for Municipal Solid Waste -2nd Edition.

Landfill Development and Capacity

The landfill development plan establishes a four-phase development sequence incorporating the existing landfill footprint and future development areas. The design seeks to maximize available airspace while maintaining appropriate regulatory setbacks, stable slopes, positive surface drainage, environmental controls, access requirements and progressive closure opportunities.

Based on the September 11, 2025 survey, the gross design capacity relative to that survey is approximately 581,561 m³. Approximately 33,655 m³ of this airspace is anticipated to be occupied by liner and leachate-collection infrastructure, leaving approximately 547,906 m³ available for waste disposal, operational cover and road construction. The final contours represent the subgrade elevation.

Lifespan

The lifespan assessment assumes an annual incoming waste tonnage of 45,000 tonnes, a waste density of 1.80 tonnes/m³, a waste-to-cover ratio of 2:1 by volume and a 10% settlement allowance. Under these assumptions, the current design provides an estimated 16 years of remaining landfill life from 2026, with Phase 1 projected to reach completion in 2028, Phase 2 in 2033, Phase 3 in 2038 and

Phase 4 in approximately 2041. The DOCP also identifies the potential for a future eastward lateral expansion after aggregate extraction, which may be assessed as part of the next DOCP update.

Environmental Controls

Environmental protection is a central component of the DOCP. The design follows the general principle of “keep clean water clean”, with systems intended to minimize the contact of clean stormwater with waste, reduce leachate generation, protect groundwater and surface-water quality, control landfill gas and provide contingency measures for potential environmental-control failures.

Leachate generated within the lined landfill footprint is collected, treated and sampled prior to discharge. The treatment process includes biological treatment, chemical treatment where required, filtration, retention in an effluent holding pond and granular activated carbon polishing as necessary. Treated effluent is discharged into the infiltration system only after laboratory results demonstrate compliance with the applicable CSR Generic Numerical Water Standards for Drinking Water; otherwise, recirculation, treatment and resampling continue until the applicable criteria are achieved.

The DOCP also incorporates proposed upgrades to the treated-leachate infiltration system. These include conversion of the existing infiltration pond into a lined settling/flow-equalization pond and construction of two approximately 50 m long and 2 m wide subsurface infiltration trenches, providing approximately 250 m² combined infiltration area. The infiltration system upgrades are intended to increase retention time, improve hydraulic distribution, enhance treatment performance and provide additional operational flexibility.

Stormwater controls are designed to prevent run-on to active landfill areas, divert clean water away from waste, minimize erosion and sediment transport, and maintain flows generally consistent with pre-development conditions. The stormwater-management system incorporates ditches, downchutes, retention and infiltration features and allowances for climate change, snowmelt and multi-day precipitation events.

Landfill gas generation is presently below the threshold requiring an active gas-collection system. Monitoring therefore focuses primarily on detecting lateral migration and protecting occupied structures onsite. Methane concentrations at the property boundary are to remain below the lower explosive limit of 5% methane by volume, while concentrations in onsite buildings are to remain below 20% of the lower explosive limit, equivalent to 1% methane by volume. Contingency measures, including venting trenches, localized vents, gas wells or biocover systems, may be implemented if future monitoring identifies unacceptable methane concentrations.

Environmental Monitoring

The updated environmental monitoring program addresses leachate, groundwater, surface water and landfill gas, together with QA/QC, annual inspections and post-closure monitoring. Groundwater results are evaluated against applicable BC Contaminated Sites Regulation standards, including drinking-water standards, while the monitoring framework also incorporates applicable Hazardous Waste Regulation and provincial water-quality requirements. The hydrogeological assessment indicates that groundwater from the landfill does not discharge to a surface-water body within 500 m of the Site, and no known groundwater extraction points for irrigation or livestock watering occur within that distance.

Raw leachate monitoring is recommended quarterly, while treated leachate is sampled on a batch-by-batch basis before discharge. Surface-water monitoring consists of quarterly water-level monitoring and annual sampling at McIvor and Rico Lakes. Landfill-gas probes are monitored annually. The monitoring program incorporates formal QA/QC procedures covering field sampling, instrument calibration, chain of custody, blanks, reference samples, duplicates and laboratory quality-control requirements.

Annual operating and monitoring reports are required to document waste tonnage, remaining landfill capacity and lifespan, leachate-management performance, monitoring results, operational changes, regulatory compliance and proposed actions or modifications.

Landfill Operations and Material Management

The operational plan addresses active-face management, waste compaction, daily and intermediate cover, authorized and controlled wastes, soil acceptance, construction and demolition waste, access, nuisance controls, security, traffic, record keeping, operator training, waste diversion, fire management and equipment requirements. Personnel are required to be familiar with the Operational Certificate, current DOCP, inspection records, health and safety requirements and annual reporting obligations. The plan also establishes operator-training expectations, including appropriate SWANA landfill-operation qualifications and certification requirements for operation of wastewater-related systems.

Waste diversion remains an important component of landfill operations because it conserves airspace and reduces potential environmental impacts. Reusable and recyclable materials such as yard waste, clean wood, concrete and asphalt are targeted for recovery, while clean wood may be reused, recycled, composted or processed for other beneficial applications where appropriate.

Closure and Post-Closure

The DOCP recommends progressive closure as landfill phases are completed, rather than deferring closure activities until the end of the landfill's operating life. Progressive closure reduces long-term closure liability, limits percolation and leachate generation, improves slope stability and enables earlier establishment of vegetation. Completed phases are to be capped and revegetated in accordance with applicable design requirements and the recommended final-cover strategy.

Post-closure management will include continued maintenance of the final cover, leachate-management system, stormwater controls and landfill-gas systems, together with environmental monitoring, inspection and record keeping. SHA recommends a minimum 30-year post-closure care and monitoring period, subject to continued effective implementation of the post-closure maintenance program and reassessment using future monitoring data. Post-closure monitoring will continue to address groundwater, surface water, landfill gas migration, erosion, cover-system performance and geotechnical conditions.

Health, Safety, Emergency Management

A site-specific health and safety program is required to maintain compliance with WorkSafeBC requirements. NWE has also developed an Emergency Management Plan integrated with Upland Contracting's quarry operations, providing a coordinated response framework across the overall Site. A separate Fire Management Plan addresses landfill fire prevention, response resources, alert levels, firefighting procedures and post-fire actions.

Financial Security

Financial security is required to ensure sufficient resources remain available for future infrastructure, environmental controls, progressive closure, final closure, post-closure maintenance and long-term environmental monitoring. The liabilities are to be evaluated by phase in accordance with Section 8.0 of the BC Landfill Criteria. A separate 2026 Northwin Landfill Financial Security Plan has been prepared to address these requirements.

Conclusions

Overall, the 2026 Northwin Landfill Design, Operations and Closure Plan establishes an integrated framework for development of the remaining approved landfill airspace through approximately 2041 under the stated design assumptions. The plan combines phased development, engineered containment, upgraded leachate and stormwater controls, environmental monitoring, structured operational practices, progressive closure and long-term post-closure care to support continued operation of the Northwin Landfill in accordance with OC 107689 and the applicable provincial regulatory framework.

NORTHWIN LANDFILL DESIGN, OPERATIONS AND CLOSURE PLAN

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1 INTRODUCTION

Sperling Hansen Associates (SHA), as the Qualified Professional, was retained by Northwin Environmental Ltd. (NWE) to prepare the 2026 Design, Operations and Closure Plan (DOCP) for the Northwin Landfill (Landfill), located within the Upland Excavating Ltd. Gravel Pit. This DOCP provides a comprehensive and current reference for the design, operations, environmental management, and closure planning of the Northwin Landfill.

The Site operates as both a sand, gravel, and rock quarry and a waste management facility. Aggregate and rock extraction activities have been ongoing within the Upland Gravel Pit and Rock Quarry since 1976, and the property contains significant reserves of sand, gravel, and basalt. The Northwin Environmental Landfill is a modern engineered landfill facility developed within the Site to provide long-term waste management capacity in accordance with applicable regulatory requirements and best engineering practice.

The Site is owned by Upland Excavating Ltd., which is part of the Upland Group, one of the largest and most diversified construction companies on Vancouver Island. Northwin Environmental is responsible for landfill operations while mining operations within the Site are carried out by Upland Contracting Ltd.

The Northwin Environmental Landfill is authorized under Operational Certificate (OC) 107689 to accept demolition waste, construction waste, land clearing debris, contaminated soil, and sludge generated from landfill leachate or water management works, at a maximum rate of 45,000 tonnes per year. The Operational Certificate was most recently amended on April 26, 2022, to authorize the acceptance of contaminated soil that is not hazardous waste.

This 2026 DOCP has been prepared to support the continued operation, development, and future closure of the Northwin Landfill in accordance with the requirements of Operational Certificate 107689, originally issued on August 1, 2019, as well as applicable provincial guidelines, including the British Columbia Landfill Criteria for Municipal Solid Waste, Second Edition (June 2016).

This updated DOCP reflects current site conditions, operational practices, environmental monitoring programs, and planned development sequencing for the Landfill. It has been prepared to document the design and operational framework for the ongoing development of the engineered landfill footprint, optimize available airspace within the approved site boundary, and support regulatory compliance. Where applicable, this DOCP also incorporates updated procedures and infrastructure associated with leachate management, environmental protection, and progressive landfill development.

1.1 Definitions

The Northwin Landfill, referred to as the *New Landfill* in Operational Certificate (OC) 107689, is located at 7295 and 7311 Gold River Highway, Campbell River, British Columbia. The Landfill is situated within the Upland Excavating Ltd. gravel pit and rock quarry property.

For the purposes of this DOCP, the term *Landfill* refers to the Northwin Landfill footprint, including the liner systems, leak detection system, leachate collection and treatment system, and associated appurtenances.

For the purposes of this DOCP, the term *Site* refers to the approximately 48 ha Upland Excavating Ltd. gravel pit and rock quarry property, which supports both Landfill operations and sand, gravel, and rock quarry activities authorized under Mine Act Permit G-8-114, issued December 27, 1989.

1.2 Objective

As per the OC, an update to the DOCP is required at least once every five years after the date of commencement of waste discharge to New Landfill. The previous DOCP was developed by GHD in July 2021 addressing the requirements for removal of waste from the Old Landfill and its decommissioning as per the OC and another update is due now. The key objectives for this update to the Northwin Landfill DOCP are:

- Update the lifespan estimate for the proposed expansion
- Develop a detailed fill plan
- Prepare a phased development plan
- Provide recommendations on the environmental control system (surface water, groundwater, landfill gas (LFG), and leachate) and monitoring plan as well as leachate, groundwater, surface water, and landfill gas management strategies
- Provide guidance on operational strategies such as landfill methodology, road systems, nuisance controls, security requirements, and buffering requirements
- Develop a progressive and conceptual closure plan
- Update financial security requirements based on the latest phasing plan and closure plan presented in this report. As per the Landfill Criteria requirements outlined in Section 8, costs are to be estimated for landfill closure, post closure care and contingency measures.
- Demonstrate that the Landfill design, operations, and closure will meet the requirements of the Landfill Criteria and the Interim Considerations.

1.3 Purpose

In order to incorporate the aforementioned information seamlessly into the existing DOCP, the report was organized with the following topic specific chapters.

- Chapter 1: Introduction
- Chapter 2: Regulatory Context and Design Objectives
- Chapter 3: Site Background and History
- Chapter 4: Site Development and Design
- Chapter 5: Lifespan Analysis
- Chapter 6: Environmental Controls
- Chapter 7: Environmental Monitoring Program
- Chapter 8: Filling Plan and Material Management
- Chapter 9: Landfill Operations
- Chapter 10: Closure and Post-Closure Plan
- Chapter 11: Health, Safety, and Emergency Management Plan

Chapter 12:	Financial Security Plan
Chapter 13:	References
Chapter 14:	Limitations

Project Start-Up: At the onset of the project, SHA and Northwin Environmental (NWE) management and operations met to discuss the scope of work required. An internal project start-up meeting was held between SHA staff working on the project to review the project and co-ordinate our efforts efficiently.

Regulatory Context & Design Objectives: Chapter 2 presents the regulatory context and design objectives for the Northwin Landfill DOCP, outlining the regulatory, environmental, operational, and closure objectives that guide the design, operation, monitoring, and closure of the facility. The section identifies the key applicable requirements, including Operational Certificate 107689 and its amendment, the BC Landfill Criteria, BC Contaminated Sites Regulation (CSR), Hazardous Waste Regulations (HWR), environmental monitoring guidelines, water quality guidelines, the Mines Act, contaminated soil guidance, and riparian area considerations. It also summarizes major DOCP-related requirements such as leachate and stormwater management, landfill gas control, nuisance prevention, financial security, annual reporting, and areas requiring updates or upgrades to bring the New Landfill into conformance with applicable criteria.

Site Conditions and History: Chapter 3 presents the site background, history, and physical setting of the Northwin Environmental Landfill, including its location within the Upland Gravel Pit and Rock Quarry (the Site) Property, shared landfill and quarry land use, zoning, adjacent land uses, site buffers, infrastructure, security, monitoring amenities, and operational history. The section also summarizes waste acceptance and diversion activities, hydrogeological investigations, climate and climate change considerations, water budget analysis, topography, drainage, geology, aquifer conditions, nearby water bodies, and the site's potential for leachate generation, providing the basis for understanding the landfill's environmental and operational setting.

Site Development and Landfill Design: Chapter 4 presents the site development and landfill design strategy for the Northwin Landfill, including the phased development of the current footprint and proposed expansion area, borrow planning, final contour design, landfill capacity, liner and leachate management upgrades, stormwater and landfill gas management considerations, access road requirements, buffers, slopes, and erosion control measures. The section also outlines the planned four-phase development approach, lift-by-lift filling sequence, progressive closure considerations, and design features intended to maximize airspace while maintaining regulatory setbacks, stable slopes, positive drainage, and environmental protection.

Lifespan Analysis: Chapter 5 presents the landfill lifespan analysis based on available capacity, assumed disposal rates, diversion activities, waste density, waste-to-cover ratio, settlement allowance, and phased airspace volumes. The section summarizes the available landfill volume by phase, accounts for airspace consumed by liner and leachate collection systems, applies key lifespan parameters and estimates the projected lifespan and completion timing for each landfill phase under the current design.

Environmental Controls: Chapter 6 outlines the environmental protection and controls at the site, including leachate, groundwater and surface water management. SHA uses the philosophy of “keep clean water clean”, and based on this concept, upgrades to the leachate treatment system, a design for run-off ditches and stormwater retention ponds for the landfill site are provided.

Environmental Monitoring Program: Chapter 7 presents an environmental monitoring program which is essential for determining if the facility is having an impact on the surrounding environment. The main

components of an environmental monitoring program include groundwater, surface water, LFG and odor emissions monitoring. Provided in this section are recommendations for future monitoring of groundwater, surface water and gas emissions. The plan identifies sampling locations, protocols, sampling frequency, and parameters for testing and analysis.

Filling Plan and Material Management: Chapter 8 presents an analysis to determine the optimum cell dimensions for filling based on current and expected future practices at the landfill. From this analysis, cell dimensions are recommended to achieve the optimal waste to cover ratio. Recommendations are developed specifically to the Northwin Landfill lift-by-lift phase development, and a detailed filling plan is provided for the remaining airspace for Phase 1, Phase 2, and Phase 3.

Landfill Operations: Chapter 9 includes updated Operations Plan to reflect the current operations at the site and to accommodate future design plans. The Operations Plan includes active face operations, cover usage, nuisance management, signage, supervision and recycling facilities, amongst others.

As part of the proposed lined expansion, leachate will be collected and conveyed to a proposed upgraded Leachate Treatment System. SHA has modeled the leachate projection volumes and provided a conceptual design for the leachate collection system. Contingency plans for environmental controls are discussed at the end of this section.

Closure and Post Closure Plan: Chapter 10 presents a detailed conceptual closure plan that addresses final cover design, final topography, visual impacts, re-vegetation, leachate and landfill gas control, post closure monitoring and site access control. The U.S. EPA Hydrologic Evaluation of Landfill Performance (HELP) Model was used to determine the most effective final cover design. The HELP model is a very powerful tool that allows our landfill designers to estimate the amount of leachate that will be produced at a landfill site for any particular cover system. A Contaminating Lifespan Assessment, which was previously performed, is discussed at the end of this Chapter.

Health, Safety, and Emergency Management Plan: Chapter 11 section presents the landfill's health, safety, emergency management, and operational control measures for the Northwin Environmental Landfill. The section outlines key procedures for active face operations, waste compaction, daily/intermediate cover, authorized waste, controlled waste disposal, soil acceptance, access roads, signage, site security, litter, dust, odour, noise, vector control, record keeping, supervision, operator training, waste diversion, and emergency/fire response planning. It also confirms that the landfill operates within an active quarry setting and includes security, leachate management, and operational controls to support safe and compliant landfill operations.

Financial Security Plan: Chapter 12 includes a financial security plan that identifies the required tasks, estimated costs, contingency allowances, financial security calculations, and associated time periods for the phased development of the New Landfill. The plan also establishes the required financial security amounts for each corresponding phase and time period, in accordance with Section 8.0 of the Landfill Criteria.

1.4 Summary of Updates

Since August 2024, when SHA was retained by Northwin Environmental Ltd. as Qualified Professional, we have been providing services for Northwin Landfill. As per Section 2.2 of the OC, SHA services have included the following:

- a) Design and inspect the construction of the Facility

- b) Certify documents related to the Facility including plans, specifications, drawings, construction reports, assessments, reviews, studies, surveys, programs, reports and as-built record drawings.
- c) Submit a complete Declaration of Competency and a Conflict-of-Interest Disclosure Statement with each document.

Since August 2024, SHA has prepared the Northwin Annual Reports. Our annual reports include volumetric updates, a summary of leachate treatment system monitoring and LFG monitoring results and a synopsis of planned environmental control upgrades including upgrades of the leachate treatment system involve an expansion of the infiltration gallery, reconfiguration of the infiltration pond to a fully lined flow equalization and leachate polishing lagoon. The SHA Annual Reports also summarize results of the water quality report that Envirochem Services (ESI) prepares for NWE. Also, in 2025 we completed the Landfill Criteria Conformance Review for Northwin Landfill. A summary of the report is provided in this DOCP update.

2 REGULATORY CONTEXT AND DESIGN OBJECTIVES

This Chapter describes the goals and objectives of the DOCP for the Northwin Landfill. Design objectives and goals for closure are based on the OC, the Landfill Criteria, and on SHA's experience with landfill closures throughout British Columbia.

2.1 Design Objectives

SHA considered several regulatory and design objectives in preparing this DOCP and applied these objectives to the assessment and design of the Site. The following objectives are based on the 2016 *Landfill Criteria for Municipal Solid Waste* and reflect SHA's application of those criteria to the Northwin Environmental Landfill and informed by its experience preparing DOCPs for other landfill facilities throughout British Columbia.

Regulatory Objectives

- To Protect Human Health and The Environment
- To ensure that landfill development complies with the OC and follows the general principles of *The Landfill Criteria for Municipal Solid Waste, Second Edition* (Landfill Criteria)

Environmental Objectives

- To provide a waste disposal facility where waste can be safely deposited and contained without adverse impact on the environment
- To minimize the potential impacts on adjacent landowners through consideration of site aesthetics and compatible land use
- To minimize the volumes of leachate generated at the site and to prevent detrimental impact on ground water and surface water resources downgradient of the site
- To minimize the opportunity for landfill gas (LFG) migration beyond the property boundary, and to reduce the overall greenhouse gas (GHG) and nonmethane organic compounds (NMOC) emissions to the atmosphere
- To ensure continued compliance at the site boundary water and leachate monitoring
- To work with our Environmental Monitoring Plan to ensure protection of the environment pre and post closure

Operational Objectives

- To maximize landfill capacity to ensure that the facility will serve the Vancouver Island and the province for the longest possible time and continues a very important role in the regional solid waste management plan
- To construct landfill capital improvements to maximize efficiencies
- To ensure optimum waste compaction for efficient use of space and to minimize landfill settlement and fire risk
- To ensure access roads will be able to accommodate commercial vehicles
- To provide effective fire, litter, dust, security, wildlife and vector control

Closure Objectives

- To provide a final contour design of the closed landfill
- To identify an effective final cover system that will minimize leachate generation
- To use locally derived cover material wherever possible
- To provide a plan for revegetation and reduction of erosion
- To plan for closure and post-closure monitoring

2.2 Regulatory Requirements

The landfill will be operated in compliance with the OC and the following applicable Provincial legislation and guidelines will be followed in designing and monitoring of the landfill site:

- Operational Certificate 107689 (2019)
- Operational Certificate 107689 Amendment Letter (2022)
- Contaminated Sites Regulation
- Hazardous Waste Regulation
- Comox Strathcona Waste Management 2012 Solid Waste Management Plan (2026 Update is ongoing)
- BC Landfill Criteria for Municipal Solid Waste (BC ENV, 2016) (Landfill Criteria)
- Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills, January 1996
- Approved and Working Water Quality Guidelines for British Columbia
- BC Mines Act
- Interim Considerations for Landfill accepting Contaminated Soils Factsheet (March 2021)
- Riparian Areas Protection Regulation

This legislation includes a comprehensive framework for environmental investigation.

2.2.1 Operational Certificate 107689 (2019)

Key requirements of the OC pertaining to the DOCP update include the following:

- To keep the DOCP up to date, it needs to be updated once every five years;
- The most recent DOCP should be followed in design, construction, operations, inspections, maintenance, monitoring, and closure of the facility;
- 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 (CSR) Generic Numerical Water Standards for Drinking Water (DW), for that substance;
- Stormwater must be managed such that stormwater is infiltrated into ground with the authorized works and must not include any substance with concentrations higher than the CSR Generic Numerical Water Standards for DW, for the substance;

- The New Leachate Management Works should be maintained and operated by person (s) certified by the Environmental Operators Certification Program (EOCP);
- Concentration of any substance in groundwater flowing from the facility site boundary should not be greater than the CSR Generic Numerical Water Standards for DW, for the substance;
- Landfill gas is to be managed in accordance with all migration and health and safety requirements including LEL at the property boundary and 20% LEL in any building at the site;
- The facility should not cause any nuisance regarding birds, rodents, insects, odour, noise, dust, litter, vector and wildlife attractions;
- The calculations of the amounts of financial security and time periods for each phase of development for New Landfill should be performed in accordance with the Landfill Criteria Section 8.0 Financial Security and at the time site closure, the financial security shall be adequate to offset final closure and post-closure care costs; and
- An annual monitoring and operating report must be prepared and submitted.

The requirements in the OC were addressed in the 2021 DOCP as they were required to be addressed prior to the commencement of waste discharge to New Landfill. This DOCP focuses on the Northwin Environmental Landfill and the related requirements only.

2.2.2 Operational Certificate 107689 Amendment Letter (2022)

April 26th, 2022, Amendment Letter to the OC authorized Northwin Landfill to receive contaminated soil that is not hazardous waste, stipulated that the treated leachate holding pond must have a double liner and that the Site Plan defining the approved landfill footprint has been amended.

2.2.3 Contaminated Sites Regulation

In the Province of British Columbia, contaminated sites are regulated under the Environmental Management Act (EMA) and its associated Contaminated Sites Regulation (CSR), which came into force in 1997. The CSR is periodically updated, with the most recent amendments enacted on October 27, 2025.

Landfilling is one of the CSR Schedule 2 activities and the Northwin Landfill is permitted to accept soil that is not hazardous waste according to the OC Amendment in April 2022. Furthermore, in the water quality assessment, CSR standards for appropriate uses are to be considered.

2.2.4 Hazardous Waste Regulation

In 1988, the *Hazardous Waste Regulation* (HWR) pursuant to the EMA came into force and was last amended on March 30, 2022. The HWR identifies certain waste as being particularly hazardous. If asbestos is accepted at the landfill, the discharge must follow the requirements of Section 40 of HWR where requirements for handling, storage containment and transportation are specified.

2.2.5 Solid Waste Management Plan

Northwin Landfill is owned by Upland Excavating Ltd. and is included in the Comox Strathcona Waste Management (CSWM) 2012 Solid Waste Management Plan (SWMP), along with three other active private demolition, land-clearing, and construction waste landfills. Currently, the 2026 SWMP is being updated and finalized by the CSWM Board.

2.2.6 Landfill Criteria for Municipal Solid Waste

The Provincial Government issued the Landfill Criteria for Municipal Solid Waste in June 1993. The Criteria provides guidance for the development, operation, and closure of landfills in British Columbia. The Landfill Criteria are not regulations; rather, they are guidelines used by Regional Waste Managers to establish standards in permits, waste management plans, and operational certificates issued under the Waste Management Act. The Landfill Criteria were updated in June 2016 and are now referred to as the Landfill Criteria for Municipal Solid Waste, Second Edition.

The most important criteria, which are applicable to the development, operations and closure of the Northwin Landfill are summarized below:

Service Life and Contaminating Lifespan. The landfill site is to be designed such that the service life of the facility exceeds the contaminating lifespan.

Site Layout. A buffer zone of 50 m is to be maintained between the landfill footprint and the property boundary of which the 30 m closest to the landfill site boundary shall be reserved for landscape screening and 20 m closest to the landfill footprint should be used for access roads, firebreaks, leachate and LFG management and monitoring works, as required.

Landfill Base Design. The landfill base shall be placed in stable soil or rock, with a minimum distance of 1.5 m above groundwater always. The landfill base that provides the foundation for construction of the landfill base liner and leachate collection system is to be graded to provide a minimum 2% grade for the leachate collection piping and minimum 0.5% for the drainage blanket.

Landfill Base Liner. The landfill base liner shall be a composite liner system with leak detection layer in accordance with OC sections 1.3.4 and 1.3.5.

Surface Water Management Works. All components of the surface water management system shall be designed to direct surface water runoff away from the active operating area within the landfill footprint and discharge it as clean water, where appropriate. The system shall also be designed to minimize the potential for on-site erosion, sediment transport, and sediment loading of downstream watercourses.

Surface water ditches and retention ponds shall be designed to control and retain runoff from a 1-in-100-year, 24-hour storm event. The design shall also account for additional flows that may result from snowmelt and prolonged multi-day precipitation events.

All ditches shall be designed with a minimum grade of 1% and shall be armoured or stabilized, as appropriate, based on expected flow velocities. Suitable erosion protection may include riprap, erosion control matting, vegetative cover, or other approved stabilization measures to prevent erosion of ditch bottoms and side slopes.

According to section 1.5 of the OC, the surface water management work system ensures 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 (DW), for that substance.

LFG Management Works. The British Columbia Landfill Gas (BC LFG) Management Regulation applies to landfills that have accepted Municipal Solid Waste (MSW) on or after January 1st, 2009. The regulation requires that if the quantity of waste in place is equal to or greater than 100,000 tonnes or if the annual quantity of waste received exceeds 10,000 tonnes/year before January 1, 2009, a LFG generation

assessment report had to be submitted to the Ministry of Environment and Climate Change Strategy (ENV) by January 1st, 2011. Landfills that are determined to produce more than 1,000 tonnes of methane per year in the assessment are required to develop a LFG facilities design plan (LFG Design Plan) within one year of submitting the initial LFG assessment. As per the LFG Management Regulation the LFG management facilities are to be designed, constructed, and operated in accordance with the BC LFG Management Facilities Design Guideline. Currently, Northwin Landfill generates less than 1,000 tonnes of methane per year, the site is not mandated to collect and thermally oxidize generated methane.

Final Cover Design. The minimum final cover is to consist of a 0.6 m thick compacted barrier layer, providing a maximum hydraulic conductivity of 1×10^{-5} cm/sec and a minimum 0.15 m thick topsoil layer capable of establishing and sustaining growth of the vegetative cover. A lower permeability barrier layer or the addition of a geomembrane may be required to control leachate generation rates to be consistent with those identified in the Leachate Management Plan recommended to be completed by a Qualified Professional as soon as possible.

Final Contours. Final contours of the landfill are to be constructed at grades not steeper than 3H:1V (33 %). The recommended design criteria for the top plateau of the landfill is a slope not less than 10H:1V (10 %) for cover systems using a soil barrier layer. The grade for the top plateau can be reduced up to 25H:1V (4%) for cover systems using a durable geomembrane or composite barrier layer with an overlying drainage layer above the final landfill side slope.

Site Security Fencing. Fencing is required around the perimeter of the landfill. Security fencing should be established around the entire perimeter of the operational footprint of the landfill. The minimum size fence is to be a 1.2 m post and wire fence. Along the landfill site boundary where vehicle access can be achieved from the outside a minimum 2 m chain link fence is recommended. All access points should have gates that can lock.

A separate security fence will not be installed around the Northwin Landfill. Existing fencing is located along the property boundaries and encompasses the landfill footprint. The fencing is approximately 2 m high and topped with barbed wire. Security cameras and lighting are installed on poles at the Highway 28 entrance and throughout the Site.

Access Roads. An appropriately constructed and maintained access road to the landfill site and a road system within the landfill site capable of supporting all vehicles hauling waste are required during the operating life of the landfill. The following design criteria should be adopted in designing an access road:

- Access road traffic surface is to be a minimum 4 m wide for one lane and 7 m for two lanes.
- Roads for public and commercial traffic should not exceed 8 percent grade.
- Roads for construction / internal off-road equipment traffic should not exceed 15 percent grade.
- All roads sloped steeper than 2 percent should have armored ditches.

Vector and Wildlife Management. Landfills are to be operated to minimize the attraction of vectors and wildlife, such as bears and birds, by applying cover at required frequencies and instituting a good housekeeping program. Further control measures, such as bear control fences, and bird control programs, may be required on a site-specific basis.

Contaminating Lifespan. As per the Landfill Criteria, as a minimum, the Contaminating Lifespan of a landfill shall not be assumed to be less than 30 years when determining the requirements for post-closure operation and maintenance and the amount of financial security required for the landfill site.

It has been made clear in the updated Landfill Criteria that the Criteria are not mandatory requirements but are recommended practices and they may become legally enforceable if incorporated into solid waste management plans, operational certificates and permits issued under the EMA.

2.2.7 Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills

Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills (1996) were established to assist landfill owners and operators to design and implement an environmental monitoring program as required the Landfill Criteria for Municipal Solid Waste. Effective monitoring programs enable landfill operators to demonstrate that they meet the performance criteria contained in Section 4 of the Landfill Criteria for Municipal Solid Waste, and most importantly, help prevent unacceptable environmental impacts throughout the lifespan of the landfill.

2.2.8 Approved and Working Water Quality Guidelines for British Columbia

British Columbia maintains a comprehensive set of approved water quality guidelines for protecting aquatic life, wildlife, agriculture, and human recreation, which are regularly updated, most recently in February 2026. When an approved guideline is unavailable, the Ministry utilizes a "Working Water Quality Guideline" (WWQG), which is adopted from other jurisdictions, including the Canadian Council of Ministers of the Environment (CCME).

2.2.9 Mines Act

Landfilling in British Columbia that involves mining sites or waste is primarily governed by a combination of the Mines and the Environmental Management Act (EMA). The Mines Act regulates the excavation of onsite materials, operational safety and reclamation of the mine site itself, while the EMA regulates the discharge of waste, including landfilling activities, to protect the environment.

Health, Safety and Reclamation Code for Mines in BC protects employees and all other people from undue risks to their health and safety arising out of or in connection with activities at mines.

The Northwin Environmental Landfill has been approved under the Reclamation Plan for the Upland Gravel Pit and Rock Quarry to return the site to pre-development contours.

2.2.10 Interim Considerations for Landfill accepting Contaminated Soils Factsheet (March 2021)

The Interim Considerations for Landfills Accepting Contaminated Soil factsheet, published by the British Columbia Ministry of Environment and Climate Change Strategy in March 2021, provides guidance for the management of contaminated soil in municipal solid waste (MSW) landfills. Soil that has contamination that exceeds the industrial quality standards is waste and can only be received at a site that is authorized under the Environment Management Act to receive this type of soil.

The 2022 amendment to the Operational Certificate expanded the authorized waste types to include "soil that is not hazardous waste," as specified in Sub-section 1.3.2(d). The Northwin Landfill was constructed with a composite double liner system and leak detection system in accordance with the requirements of the OC. These design features also satisfy the applicable requirements of the *Interim Considerations for Landfills Accepting Contaminated Soil* (Interim Guidelines).

2.2.11 Riparian Areas Protection Regulation

The Riparian Areas Regulation may apply to residential, commercial, or industrial activity within 30 metres of a watercourse that removes or alters plants; disturbs soils; constructs roads, buildings or structures; develops drainage systems etc. Under the Riparian Areas Regulation, local governments may allow development within 30 m of the highwater mark of a stream or top of a ravine bank, provided the prescribed riparian assessment methods have been followed. The purpose of the Riparian Areas Regulation assessment report is to assess the potential impact of a proposed development in a riparian area. If there is an unnamed stream around the landfill footprint, the need for an assessment should be determined during detailed design of works that may encroach on the riparian area.

Current Environmental conducted a Riparian Areas Assessment for the Northwin Environmental Landfill. The assessment concluded that there were no riparian areas on the subject property.

2.2.12 Previous Waste Discharge Permit (Superseded)

Acceptance and discharge of certain waste materials at the Landfill Site were previously authorized under Waste Discharge Permit No. PR-10807, issued under the Environmental Management Act on June 1, 1992. Under the Permit, the Site accepted clean wood waste for burning and DLC waste. The Permit PR-10807 has been superseded by OC 107689 issued in August 2019.

2.3 Landfill Criteria Conformance Review

GHD completed a Landfill Criteria Conformance Review for the Northwin Landfill in January 2017 (See Appendix A). As mentioned in the compliance checklist in Appendix A, GHD addressed some of the identified areas in 2019 DOCP (GHD, 2019) that was developed focusing on the original landfill. The 2021 DOCP (GHD, 2021) was developed for the design, operations and closure of the new engineered landfill. Northwin submits an Annual Compliance Status Form with the annual report every year that reflects the compliance status of the landfill with the OC. The OC for the Northwin Landfill was issued on August 1st, 2019, and was last amended on April 26th, 2022. Hence the OC reflects the requirements of the Landfill Criteria for Municipal Solid Waste. SHA completed the Annual Compliance Status Form with the 2025 Annual Report (SHA, 2025). However, SHA reviewed the conformance status of the New Landfill and identified the areas for upgrades. The areas that are addressed in this DOCP update and where upgrades are required to bring the Landfill into conformance with the Criteria are as follows:

- Leachate Infiltration System Upgrade
- Landfill liner and leak detection system expansion
- Protection of groundwater
- Surface Water Management Plan update to include strategy for peak flow control
- Conservation of existing landfill footprint through operational efficiencies
- Closure Plan update
- Progressive Closure Plan Update.

3. SITE BACKGROUND AND HISTORY

3.1 Location and Use

Northwin Environmental Landfill, referred to as the New Landfill in Operational Certificate (OC) 107689, is located on the Upland Gravel Pit and Rock Quarry property in Campbell River, British Columbia at 7295 and 7311 Gold River Highway and shares the site with Upland Contracting. As shown on Figure 3-0 & Figure 3-1, the Site is situated approximately 7 km west of Campbell River, and is accessed directly from Highway 28 (Gold River Highway) via internal access roads. The Site occupies an approximate area of 48 hectares and supports both landfill operations and aggregate extraction activities.

For the purposes of this DOCP, the term Landfill refers to the Northwin Environmental Landfill footprint, including the engineered landfill cells, liner systems, leak detection system, leachate collection system, leachate treatment system, and related appurtenances. The term the Site refers to the broader Upland Gravel Pit and Rock Quarry Property that supports landfill and quarry-related operations. Northwin Landfill currently includes Phase 1 Stage 1 (Cell 1 East and West), both constructed with engineered double-liner systems and leak detection infrastructure.

The Site operates as a combined waste management facility and a commercial aggregate / rock quarry. Aggregate extraction activities have been ongoing at the Upland Gravel Pit and Rock Quarry since 1976, while the current landfill operations commenced in 1992. Landfilling operations are carried out by Northwin Environmental Ltd. while mining and quarry-related activities continue to be undertaken by Upland Contracting Ltd. as part of the broader industrial use of the property. Aggregate and rock quarry operations continue concurrently with landfill operations that are being undertaken as part of the gravel pit reclamation plan.

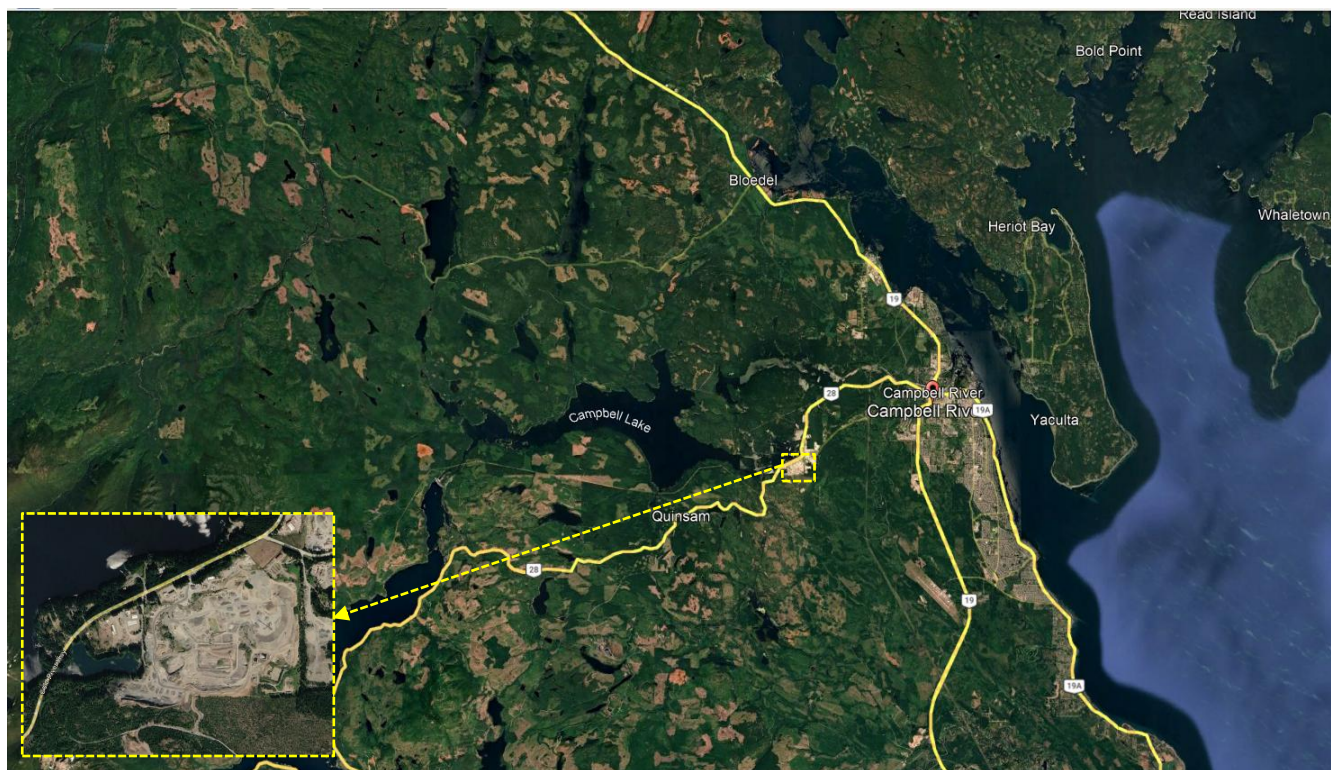


Figure 3-0: Northwin Landfill Site Location Map

3.1.1 Zoning

The Site is zoned I-3 in accordance with the City of Campbell River Zoning Bylaw No. 3250 (2006), as last amended June 9, 2015. The I-3 zoning designation is consistent with the long-standing industrial and resource-extraction use of the property. The aggregate and quarry operations are authorized under Mine Act Permit G-8-114. The landfill operations are authorized under Operational Certificate 107689. The landfill is recognized as an approved reclamation activity under the Mine Permit.

Northwin Environmental Landfill is located within the Upland Gravel Pit and Rock Quarry Property and operates as part of this broader industrial site. Accordingly, the current use of the property as a landfill and quarry site is consistent with its industrial zoning and permitted operational function.

For the purposes of this DOCP, the zoning context confirms that the Site is situated within an area designated for industrial-type land uses rather than residential, commercial, or institutional development. This zoning framework is compatible with the continued operation, monitoring, and phased development of Northwin Environmental Landfill within the Site.

3.1.2 Adjacent Land Use and Site Buffers

As shown in Figure 3-2, surrounding land uses are predominantly industrial, resource extraction, and undeveloped rural lands, which are generally compatible with continued landfill operations. The Site boundaries are described as follows: to the north is Gold River Highway (Highway 28); to the east are forested and industrial lands; to the west are Rico Lake, a construction storage yard, and an undeveloped industrial lot; and to the south are lands within the Strathcona Regional District, including forestry related lands. The Comox Strathcona Waste Management Centre, including the now closed Campbell River Landfill, the Municipal Transfer Station and the Composting Facility are located 850 m northeast of the Site.

Natural and operational buffers are present around the Landfill footprint. These include the broader Upland Gravel Pit and Rock Quarry, internal haul roads, quarry working areas, and undeveloped portions of the Site. In addition, nearby water features such as Rico Lake to the west and McIvor Lake to the north, together with local topography and the engineered landfill containment systems, form part of the broader environmental setting considered in site development and monitoring. The landfill is also located on a terrace with no direct overland drainage to the Quinsam River, and no natural surface watercourses occur on the Site itself.

3.1.3 Site Amenities

Site infrastructure and amenities supporting landfill operations include the engineered landfill cells, internal access roads, perimeter berms, leachate collection and treatment works, infiltration works, monitoring infrastructure, fencing, controlled access gates, signage, and site security measures. The New Leachate Management System includes collection, extraction, storage, treatment, and discharge components that support environmental compliance.

Security amenities currently include a fence and locking gate along Gold River Highway, posted signs indicating “Industrial Site – No Trespassing” and “Property Under Video Surveillance,” 24-hour camera surveillance, restricted access for authorized personnel and waste haulers, and nighttime illumination. These features help maintain site security, regulatory compliance, and control of public access.

Environmental monitoring amenities include groundwater monitoring wells, surface water monitoring stations, landfill gas monitoring locations, leak detection monitoring points, and leachate monitoring locations used to support the annual operations and monitoring program.

3.1.4 Property Acquisitions

No recent property acquisitions specifically associated with the development of Northwin Landfill have been identified.

3.2 Historical Context and Site Operations

The Site has supported aggregate and rock quarry operations since 1976 and has long functioned as an industrial resource site. Northwin Environmental Landfill was developed starting in November 2021 as a modern engineered landfill within this broader property and is authorized under Operational Certificate 107689. At present Northwin Environmental Landfill consists of Phase 1 Stage 1 and Phase 1 Stage 2, both designed with double-liner systems, leak detection, and leachate management works.

The Landfill is authorized to accept construction waste, demolition waste, land clearing waste, soil that is not hazardous waste, and sludge from new leachate or stormwater management works, together with other wastes specifically authorized by the Ministry including asbestos. By September 11, 2025, approximately 160,435 m³ of waste had been placed in the constructed Phase 1 cells, leaving approximately 47,349 m³ of remaining capacity in those cells.

Leachate collection and treatment systems have been commissioned, and leachate from the landfill cells continue to be treated in batches and discharged only when treatment criteria are met.

Site infrastructure continues to be refined and upgraded through ongoing environmental monitoring, leachate treatment optimization, and phased landfill development planning. The current DOCP is being revised to optimize development sequencing within the approved footprint and extend landfill life.



Photo 3-1: Leachate Treatment Ponds – Photo taken June 2025

3.2.1 Waste Diversion Activities

Northwin Environmental Landfill is operated primarily as an engineered disposal facility for residual waste streams and is authorized under Operational Certificate 107689. Authorized wastes include construction waste, demolition waste, land clearing waste, soil that is not hazardous, and sludge from leachate or stormwater management works. Waste diversion at the Site is focused on screening incoming loads, identifying materials with potential for reuse or recovery, and preventing unauthorized or unsuitable materials from being landfilled.

Material Recovery is a part of the Site operations framework and recovery of items from incoming waste with potential reuse value may occur, while unauthorized scavenging from the active face or elsewhere on the Site is prohibited for health and safety reasons. This approach supports controlled recovery where practical, while maintaining safe and orderly landfill operations.

Waste diversion is also supported through the Site's waste acceptance procedures. Incoming waste is subject to inspection and acceptance controls to confirm that only authorized materials are received, and that hazardous waste, controlled waste, attractants, and other prohibited materials are excluded unless specifically authorized in writing by the Director. In this way, waste diversion at Northwin Landfill includes both material screening and the redirection of non-conforming materials away from disposal at the Site.

Overall, Northwin Environmental Landfill's waste diversion approach remains appropriate as it primarily receives residual construction, demolition, land clearing, and soil-related waste streams.

3.2.2 Hydrogeological Investigation

The Hydrogeology and Hydrology Characterization Report was prepared May 2016 and amended August 2020 by Northwin Environmental Ltd. for the Northwin Environmental Landfill to support the landfill approval and satisfy the requirements of Operational Certificate 107689 and Section 10.1 of the BC Landfill Criteria. The investigation included desktop review, borehole advancement, test pitting, monitoring well installation, hydraulic monitoring, single-well response testing, pumping tests, surface water assessment, groundwater/surface water sampling, and development of a conceptual hydrogeologic model. Field investigations were completed between 2015 and 2019, with supplemental work added to refine the understanding of groundwater flow, bedrock topography, and potential receptors.

The regional setting consists of granular overburden deposits, primarily sand and gravel, overlying basaltic bedrock. Bedrock elevation is highly variable, particularly along the western and southwestern portions of the Site, where shallow or exposed bedrock forms a ridge extending from the small mountain near the southwest boundary toward McIvor Lake. This bedrock high is interpreted as a hydraulic barrier between the pit area and lands west of the groundwater divide.

Three main hydrogeologic units were identified beneath the Site: the sand and gravel aquifer, the shallow aquifer, and the bedrock aquifer. The sand and gravel aquifer is considered the principal groundwater flow system at the Site and is the main receptor for infiltrated stormwater and treated effluent. Groundwater elevations measured between 2015 and 2019 indicate seasonal variation, with groundwater generally highest during wetter periods and lowest during dry-season monitoring events.

Surface water flow is strongly influenced by the pit topography and the local watershed divide. Precipitation falling within and near the gravel pit generally drains toward the base of the pit, where it infiltrates and recharges the sand and gravel aquifer. Groundwater in the principal sand and gravel

aquifer generally flows toward the southeast, in the direction of the Quinsam River watershed. Surface water bodies near the Site include Rico Lake, Mclvor Lake, and two small watercourses south of the Site; however, these features are interpreted to be upgradient or cross-gradient of the landfill and are not considered downgradient groundwater receptors for the landfill.

The investigation concluded that Mclvor Lake and Rico Lake do not receive groundwater from the sand and gravel aquifer beneath the Site. Hydraulic gradients indicate groundwater flow is directed from the lakes toward the Site, rather than from the Site toward the lakes. The two small watercourses identified within 500 m south of the Site are also not considered receptors of groundwater from the Site because they are cross-gradient, flow away from the Site, and are located well above the groundwater elevation near the southeast Site boundary.

Baseline water quality sampling was completed to characterize pre-landfill groundwater and surface water conditions. Samples were collected from monitoring wells, Rico Lake, Mclvor Lake, the wash plant, and a nearby residential water supply well. Parameters included field parameters, general chemistry, nutrients, metals, sulphide, PAHs, petroleum hydrocarbons, VOCs, and oil and grease. The baseline program was intended to support future comparison of water quality during landfill operation and post-closure monitoring.

Applicable groundwater standards were based primarily on the Contaminated Sites Regulation (CSR) Generic Numerical Water Standards for Drinking Water (DW) because future potable groundwater use may be possible near the Site. Aquatic life standards were not considered applicable to groundwater because no known aquatic receiving environments are located within 10 m of the downgradient Site boundary. Surface water quality in Rico Lake and Mclvor Lake was generally good, with some noted exceedances such as temperature, dissolved oxygen, sulphide, calcium, phenolics, and phosphorus that should be considered during future monitoring.

3.3 Physical Summary and Site Characteristics

3.3.1 Climate

The temperature and precipitation data was found on the Environment Canada website from the nearest weather station at the Cambell River Station. This data was also used in the water budget analysis discussed in Section 3.3.3.

The average annual precipitation (as rain) is approximately 1,481.8 mm based on the years on record (1991 to 2020), with most falling in the months of October to April. The average annual temperature is about 9.2°C with an average peak of 17.7°C occurring in July and the minimum average of 2.6°C occurring in January. Snowfall does occur at the landfill, with the maximum average snowfall of 24.3 cm occurring in January. Typically, the snow melts shortly after falling on the ground.

Table 3-1: Climate Data for Campbell River Climate Station, 1991 to 2020

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	194.1	120.9	115.3	88.4	60.1	61.0	33.1	44.1	68.5	177.7	213.1	217.1	1393.3
Snowfall (cm)	24.3	18.9	14.0	0.4	0.0	0.0	0.0	0.0	0.0	0.1	8.6	22.4	88.6
Precipitation (mm)	218.0	139.4	129.2	88.9	60.1	61.0	33.1	44.1	68.5	177.7	221.0	240.8	1481.8
Daily Av. (°C)	2.6	3.2	5.2	8.0	12.2	14.9	17.7	17.6	14.0	8.7	4.6	2.3	9.3

Source: Environment Canada, 2025

3.3.2 Climate Change Predictions

A study was done for the Hartland Landfill Site in the Capital Regional District at the south end of Vancouver Island by the Canadian Institute for Climate Studies in 1999 to determine the effects of extreme precipitation on the leachate collection system over the lifetime of the landfill. Included in the analysis were predictions for climate change and precipitation increases over the West Coast of Canada and by extension to the Northwin Landfill.

Recent updates of climate models that generate specific climate projections for coastal British Columbia and Vancouver Island include:

- **Shifts in Average Rainfall:** Annual Increase: Regional climate models predict an increase in total precipitation of about 6% to 20%, primarily falling as rain rather than snow during the wetter winter and fall months.
- **Seasonal Changes:** Winter and fall can expect up to a 12% to 15% increase in precipitation, while summer months may experience a decline in rainfall of up to 13%, which will elevate seasonal drought risks.
- **Extreme Rainfall and Storm Intensity:** Because a warmer atmosphere holds more moisture, extreme weather events are becoming more frequent and intense: 24-Hour Maxima: Projections estimate roughly a 10% increase in 24-hour extreme rainfall events by 2050, potentially reaching 15% to 20% by 2100. Short-Duration Deluges: Extreme short-duration rainfall (e.g., intense, sudden downpours lasting a few hours) will see even more dramatic increases of 15% to 25%.

Several general circulation models (GCMs) were compared to estimate changes in Pacific Coast winter temperatures and precipitation during the second half of the 21st century (approximately 2050–2100), including the Canadian Climate Centre General Circulation Model II (CCC GCM II), the Geophysical Fluid Dynamics Laboratory General Circulation Model (GFDL GCM), and the National Aeronautics and Space Administration Goddard Institute for Space Studies General Circulation Model (NASA GISS GCM)., were compared that estimated the change in seasonal temperatures and precipitation for the second half of the 21st century (approximately 2050 to 2100), were compared that estimated the change in seasonal temperatures and precipitation for the second half of the 21st century (approximately 2050 to 2100). All projections indicated a warmer and wetter winter, meaning a larger impact on the leachate collection system at Northwin Environmental Landfill. The average increase in temperature over the second half of the 21st century was estimated to be 2.5 degrees and the increased precipitation to be about 15%. More intense precipitation events were expected as a result but were not quantified. Estimates for 2000 to 2050 indicate a modest increase in precipitation.

By extending this estimation to the Northwin Landfill, the following can be assumed for a weather condition after 2050 (based on current statistics, as summarized in Table 3-2):

- Annual precipitation will increase from about 1482 mm to 1,549 mm
- Winter rainfall (between October to March) will be about 1,194 mm
- The annual temperature would rise from 9.2°C to 10.1°C.

The 15% increase in seasonal precipitation and the 2.5 degree increase in temperature were applied to the winter months (October to March) only. A 25% increase in storm intensity characteristics based on the intensity duration frequency (IDF) curve has been adopted for hydraulic design.

As the climate change models encompass all the Pacific Coast, there is uncertainty in how an increase in temperature will affect the precipitation at Northwin Landfill. There are substantial differences between the models used in the Canadian Institute for Climate Studies Report, and caution must be used when applying these values. The increased precipitation values discussed above present preliminary estimates only.

3.3.3 Water Budget Analysis

A water budget analysis was performed using the Thornthwaite method (Thornthwaite and Mather, 1957). A representative soil moisture retention capacity for the site of 25 mm was chosen. This soil moisture retention capacity was chosen to represent the soil conditions expected at the site during landfill development, when much of the refuse will be capped by a bare intermediate cover layer of silty sand/sandy loam.

The water balance examines the relationship between precipitation and evapotranspiration, the process involving the return of water to the atmosphere through evaporation and transpiration through vegetation. During the winter months, precipitation will typically exceed evapotranspiration resulting in a moisture surplus. During the summer months, precipitation rates will be less than evapotranspiration rates thereby resulting in a moisture deficit. A moisture surplus will result in water flowing over the landfill surface as runoff, being retained in storage (i.e. snow or soil moisture) or infiltrating and generating leachate. During a moisture deficit, water is drawn out of surface soils thereby decreasing the soil moisture content.

Table 3-2 presents the water balance calculations. The water budget analysis suggests that between the months of May and September, there will be a water deficit and no percolation into the landfill due to lower precipitation rates. Most of the precipitation will either run off the landfill or be drawn from the soil as evapotranspiration. Over the year, the analysis revealed that approximately 354 mm of water will be drawn from surface soils as evapotranspiration and a total of 370 mm of the yearly precipitation will be converted to runoff.

The annual water balance indicates there is high potential for water infiltration into the refuse at the Northwin Landfill. Total percolation (PERC) was calculated at 756 mm for the year, occurring between the months of October to April. No percolation is anticipated during summer months. Based on this analysis, Northwin Landfill is expected to have a high potential for leachate generation. These results emphasize that there is significant precipitation at the site that will produce leachate.

Table 3-2: Waste Budget Analysis Results

Component		Jan 31	Feb 28	Mar 31	Apr 30	May 31	Jun 30	Jul 31	Aug 31	Sep 30	Oct 31	Nov 30	Dec 31	Annual
Precipitation														
Rainfall (mm)		194.1	120.9	115.3	88.4	60.1	61.0	33.1	44.1	68.5	177.7	213.1	217.1	1393.4
Snowfall (cm)		24.3	18.9	14.0	0.4	0.0	0.0	0.0	0.0	0.0	0.1	8.6	22.4	88.70
Total Precipitation (mm)	P	218.0	139.4	129.2	88.9	60.1	61.0	33.1	44.1	68.5	177.7	221.0	240.8	1481.8
Standard Deviation (mm)		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Avg. Temperature (°C)	T	2.6	3.2	5.2	8.0	12.2	14.9	17.7	17.6	14.0	8.7	4.6	2.3	9.3
Snow Storage and Melt														
Month End Snow Cover (cm)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0
Change in Snow Cover (cm)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	-1.0	
Snow Melt (cm)		24.3	18.9	14.0	0.4	0.0	0.0	0.0	0.0	0.0	0.1	7.6	23.4	
Available Precipitation (mm)	AP	218.3	139.7	129.3	88.8	60.1	61.0	33.1	44.1	68.5	177.8	220.7	240.4	1481.8
Evapotranspiration														
Heat Index	"I"	0.37	0.51	1.06	2.04	3.86	5.22	6.78	6.72	4.75	2.31	0.88	0.53	35.0
Unadjusted Potential ET (mm)	UPET	0.4	0.5	0.8	1.3	1.8	2.5	3.0	3.0	2.3	1.4	0.7	0.4	
Monthly Duration Corr.	r	22.2	23.4	30.6	34.5	39.9	40.8	41.1	37.5	31.8	27.6	22.8	21.0	
Adjusted Potential ET (mm)	PET	8.9	11.7	24.5	44.9	71.8	102.0	123.3	110.6	73.1	38.6	16.0	7.4	633
Runoff														
Co-efficient of run-off*	Cro	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
Run-off	RO	54.6	34.9	32.3	22.2	15.0	15.3	8.3	11.0	17.1	44.4	55.2	60.1	370
Water Shortage														
Infiltration (mm)	INF	163.7	104.8	96.9	66.6	45.1	45.8	24.8	33.1	51.4	133.3	165.5	180.3	
Water Available for Storage (mm)	INF-PET	154.9	93.1	72.5	21.7	-26.7	-56.3	-98.5	-77.6	-21.8	94.7	149.5	173.0	479
Cumulative Water Shortage (mm)	ACCWL			0.0	0.0	-26.7	-83.0	-181.5	-259.0					
Storage														
Soil Storage (mm)	ST	16.1	15.0	8.0	3.0	1.2	1.0	1.0	1.0	1.0	4.4	12.0	17.6	
Change in Soil Storage (mm)	DeltaST	0.0	-1.1	-7.0	-5.0	-1.8	-0.2	0.0	0.0	0.0	3.4	7.6	5.6	
Actual ET (mm)	AET	8.9	11.7	24.5	44.9	46.9	46.0	24.8	33.1	51.4	38.6	16.0	7.4	354
Percolation														
Percolation	PERC	154.9	94.2	79.5	26.7	0.0	0.0	0.0	0.0	0.0	91.3	141.9	167.4	756

3.4 Topography and Geology

3.4.1 Topography and Drainage

The Northwin Environmental 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 (GHD O&M Report, 2023).

There are no natural surface watercourses on the site. Surface drainage is controlled through a stormwater management plan described in the Design, Operations, and Closure Plan (DOCP). Perimeter berms have been built around the landfill cells so that precipitation falling within the landfill footprint is captured and managed as leachate, while rainfall outside the landfill area is allowed to infiltrate naturally into the underlying sand and gravel aquifer.

Two significant water bodies are located near the site:

- Rico Lake is a manmade former borrow pit associated with the construction of Highway 28 and is situated to the west within a natural depression. Rico Lake has no fish and drains through subsurface groundwater pathways toward Mclvor Lake and into the Upland rock quarry. Its elevation ranges between 179 m and 180 m above mean sea level (AMSL).
- Mclvor 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 (GHD DOCP, 2021).

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 northwestern portion of the site (GHD DOCP, 2021).

3.4.2 Site Geology

The regional geology of the Northwin Landfill site has been influenced by multiple glaciation events during the Pleistocene Epoch. At that time 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 primarily underlain by interbedded sand and gravel, with occasional silty sand layers. These deposits extend to depths greater than 40 m beneath the landfill footprint.

3.4.2.1. Bedrock Geology

The site is underlain by the Karmutsen Formation of the Wrangellia Terrane, which is composed predominantly of submarine flood basalts and may reach thicknesses of up to 6 km. Site investigations indicate that the landfill is founded above competent igneous basalt bedrock, with the bedrock surface occurring at a depth of at least 50 m below original ground level.

A significant bedrock ridge exists between Rico Lake and the Upland gravel pit and rock quarry, forming a surface water and groundwater flow divide. This geological feature influences local drainage and hydrogeologic conditions (GHD O&M Report, 2023).

3.4.3 Hydrogeologic Setting

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 downward 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 Sand and Gravel 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.
- There are no downgradient surface water bodies located within 500 m of the landfill; therefore, aquatic life standards are not considered necessary for groundwater assessment.

Ongoing hydrogeologic monitoring is conducted to assess potential impacts from landfill operations, particularly concerning groundwater quality and managing potential exceedances beyond Contaminated Sites Regulation (CSR) Generic Numerical Water Standards for Drinking Water (DW).

3.5 Groundwater Conditions

3.5.1 Groundwater Levels

Groundwater elevations are monitored as part of the annual monitoring program. The groundwater levels observed during 2025 for monitoring events Q1 through Q4 are presented below in Table 3-3.

Table 3-3: Groundwater Levels

Monitoring Location	Reference Elevation TOR (m AMSL)	Depth to Water (m BTOR)				Depth to Bottom (m BTOR)				Water Elevation (m AMSL)			
		March 10-12, 2025	June 3-4, 2025	September 2-3, 2025	November 24-26, 2025	March 10-12, 2025	June 3-4, 2025	September 2-3, 2025	November 24-26, 2025	March 10-12, 2025	June 3-4, 2025	September 2-3, 2025	November 24-26, 2025
MW1-14	172.9	10.400	8.304	10.356	8.962	12.103	12.050	12.051	12.052	162.5	164.6	162.5	163.9
MW2-14	173.8	16.792	17.509	18.652	17.809	22.185	22.200	22.211	22.212	157.0	156.3	155.1	156.0
MW2A-16	173.9	16.635	17.411	18.543	18.781	41.665	41.619	41.621	41.623	157.3	156.5	155.4	155.1
MW3-14	168.6	14.771	14.881	15.805	14.102	17.771	17.765	16.765	16.772	153.8	153.7	152.8	154.5
MW4A-15	169.3	8.952	8.963	9.669	8.481	23.444	23.315	23.330	23.315	160.3	160.3	159.6	160.8
MW4B-15	169.3	9.105	8.135	9.805	8.629	19.253	19.834	19.820	19.901	160.2	161.2	159.5	160.7
MW5A-15	191.9	6.861	8.129	8.332	8.215	8.760	8.780	8.782	8.782	185.0	183.8	183.6	183.7
MW5B-15	192.0	8.188	8.480	7.591	7.243	11.257	11.265	11.261	11.262	183.8	183.5	184.4	184.8
MW6-17	185.4	7.785	9.056	9.552	8.385	11.999	11.825	11.830	11.010	177.6	176.3	175.8	177.0
MW7-17	187.5	3.132	3.711	4.201	3.069	4.659	4.520	4.521	4.522	184.4	183.8	183.3	184.4
MW8-17	192.5	Dry	Dry	Dry	Dry	18.831	18.830	18.832	18.832	-	-	-	-
MW9-17	191.7	26.894	24.301	26.475	24.446	54.550	34.360	34.358	34.340	164.8	167.4	165.2	167.3
MW10-17	189.1	42.431	41.270	41.739	42.145	47.193	45.145	44.659	44.652	146.7	147.8	147.4	147.0
MW11-19	194.8	48.425	46.988	47.554	47.561	53.055	53.012	52.665	52.664	146.4	147.8	147.2	147.2
MW12-22	-	41.265	39.610	40.910	41.112	44.781	43.035	43.100	43.172	-	-	-	-
MW13-25	189.9	-	-	39.019	38.882	-	-	45.651	45.264	-	-	150.9	151.0
MW15A-18	183.1	4.474	5.469	4.862	6.645	6.035	6.030	6.030	6.031	178.6	177.6	178.2	176.5
MW15B-18	183.2	4.569	5.583	4.936	6.709	9.460	9.430	9.431	9.433	178.6	177.6	178.3	176.5
PZ1-19	192.1	19.681	19.961	18.532	Destroyed	21.055	21.050	21.053	Destroyed	172.4	172.1	173.6	-
SW15-01 [McIvor Lake]*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	177.03	177.55	176.5	
SW15-02 [Rico Lake]**	180.33	0.32	-0.52	-1.94	-1.62	N/A	N/A	N/A	N/A	180.65	179.81	182.3	182.0

Notes:

191.88	Surveys completed by McEhannay 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.
N/A	not applicable.
MW	monitoring well.
-	Data not available or not recorded.

3.5.2 Groundwater Flow

Figures 3-3A and 3-3B show the groundwater contours and the inferred flow direction observed during the Q1 and the Q3 2025 monitoring events. As can be seen in Figures 3-3A & 3-3B, the groundwater gradient across the site is relatively steep at approximately 4%, with an inferred flow direction towards the southeast. Only minor differences are noted in the groundwater flow directions over the year.

Along the southern property boundary, the hydraulic gradient is steeper, about 20%. This is on account of bedrock present at shallower depth, reducing the hydraulic conductivity in that area. Flow lines converge in the southeast corner of the site suggesting a higher permeability and flow velocities in that area.

3.6 Water Quality

Analytical results for groundwater and surface water at the Northwin Landfill are compared to the following provincial regulations and guidelines:

- Contaminated Sites Regulation (CSR, BC Reg. 375/96, including amendments effective October 27, 2025, by B.C. Reg. 171/2025).
- Hazardous Waste Regulation (HWR, BC Reg. 63/88, O.C. 268/88 including amendments up to BC Reg. 243/2016, updated March 29, 2022).

Groundwater and surface water analytical results are evaluated with the following standards due to proximity of drinking water receptors:

- BC Contaminated Site Regulation (CSR) Numerical Water Standard for Drinking Water use (BC CSR-DW), Schedule 3.2

Currently, surface water results are compared to the British Columbia Approved Water Quality Guidelines.

3.6.1 Background Groundwater and Surface Water Quality

Background water quality for the Site is inferred from upgradient monitoring wells that are monitored which include MW6-17, MW9-17, MW1-14, MW4A-15, and MW4B-15. Surface water background conditions are represented by annual sampling of McIvor Lake (SW15-01) and Rico Lake (SW15-02). Concentrations of parameters at upgradient groundwater wells are generally below applicable Contaminated Sites Regulation (CSR) Generic Numerical Water Standards for Drinking Water (DW). This indicates that background groundwater quality upgradient of the landfill remains generally stable and continues to provide a reasonable baseline against which downgradient conditions can be assessed.

Background surface water quality continued to be assessed through annual sampling of McIvor Lake and Rico Lake under the monitoring program. This location remains appropriate reference point for evaluating regional surface water conditions in the vicinity of the Site.

3.6.2 Effluent Water Quality

Effluent water quality at Northwin Landfill is represented by the treated leachate discharged following batch treatment and compliance verification. Under the current treatment process, untreated leachate is conveyed to the aeration equalization pond, treated through chemical addition, pH adjustment, coagulation/flocculation, filtration, and recirculation through granular activated carbon as needed, then sampled prior to discharge. Treated leachate is only discharged once analytical results confirm compliance with the applicable Contaminated Sites Regulation (CSR) Generic Numerical Water Standards for Drinking Water (DW) in accordance with Section 1.4.3 of the OC.

The treated leachate should be sampled and tested for general chemistry parameters, anions, nutrients, total metals, LEPH, HEPH, and PAHs, consistent with the parameters analyzed for the raw untreated leachate.

3.6.3 Downgradient Groundwater and Surface Water Quality

Downgradient groundwater is currently evaluated from wells MW3-14, MW10-17, MW11-19, MW12-22 and MW13-25 which are located downgradient of the landfill.

There are no downgradient surface water bodies to establish downgradient surface water quality.

3.6.4 Electrical Conductivity Survey

One of the key parameters that is often used as a leachate indicator is electrical conductivity (EC) as leachate impacted water invariably has elevated EC values. The EC values can also be naturally elevated due to elevated levels of dissolved minerals such as calcium and magnesium.

3.7 Environmental Assessment

The environmental assessment for the Upland Gravel Pit and Quarry was completed by Current Environmental to identify potential aquatic receptors within the Upland Pit area and a 500 m buffer to the south, southeast, and east of the pit boundary. The assessment was completed in support of an application under the BC Contaminated Sites Regulation and included both desktop review and ground-level field surveys. The desktop review considered available fisheries, habitat, mapping, conservation, and aerial imagery resources, while field surveys were completed on April 5 and 6, 2017, with an updated assessment completed on March 15, 2018.

The assessment found that the Upland Gravel Pit and Quarry and surrounding area are highly disturbed and generally do not provide high quality aquatic habitat. The site is dominated by coarse sand and gravel deposits with high infiltration rates, resulting in most precipitation and overland flow dissipating into the permeable ground. The surrounding topography indicates that surface water and groundwater generally flow toward the southeast and away from the Site.

Two primary watercourse systems were identified within the area of interest. Watercourse System 1 originates from an off-site wetland and flows approximately 800 m within the area of interest before dissipating within the channel or at its terminus in a gravel pit. Watercourse System 2 also originates from the same off-site wetland and flows approximately 450 m southeast through the area of interest, with one section containing mature riparian vegetation within a ravine near the boundary of the assessment area.

Overall, Current Environmental concluded that there is limited aquatic habitat value within the Upland Pit and surrounding area of interest. The site has been highly modified, with much of the area disturbed within the past 10 years, and the two identified watercourse systems do not provide high-quality aquatic habitat. The detailed report is presented in Appendix B.

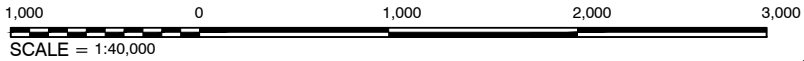
FIGURES



SPERLING
HANSEN
ASSOCIATES



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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:



PROJECT:

NORTHWIN LANDFILL DESIGN OPERATION
AND CLOSURE PLAN UPDATE

TITLE:

SITE LOCATION MAP

SCALE:

1:40,000

DATE:

2026/09/11
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

-

DRAWING NO:

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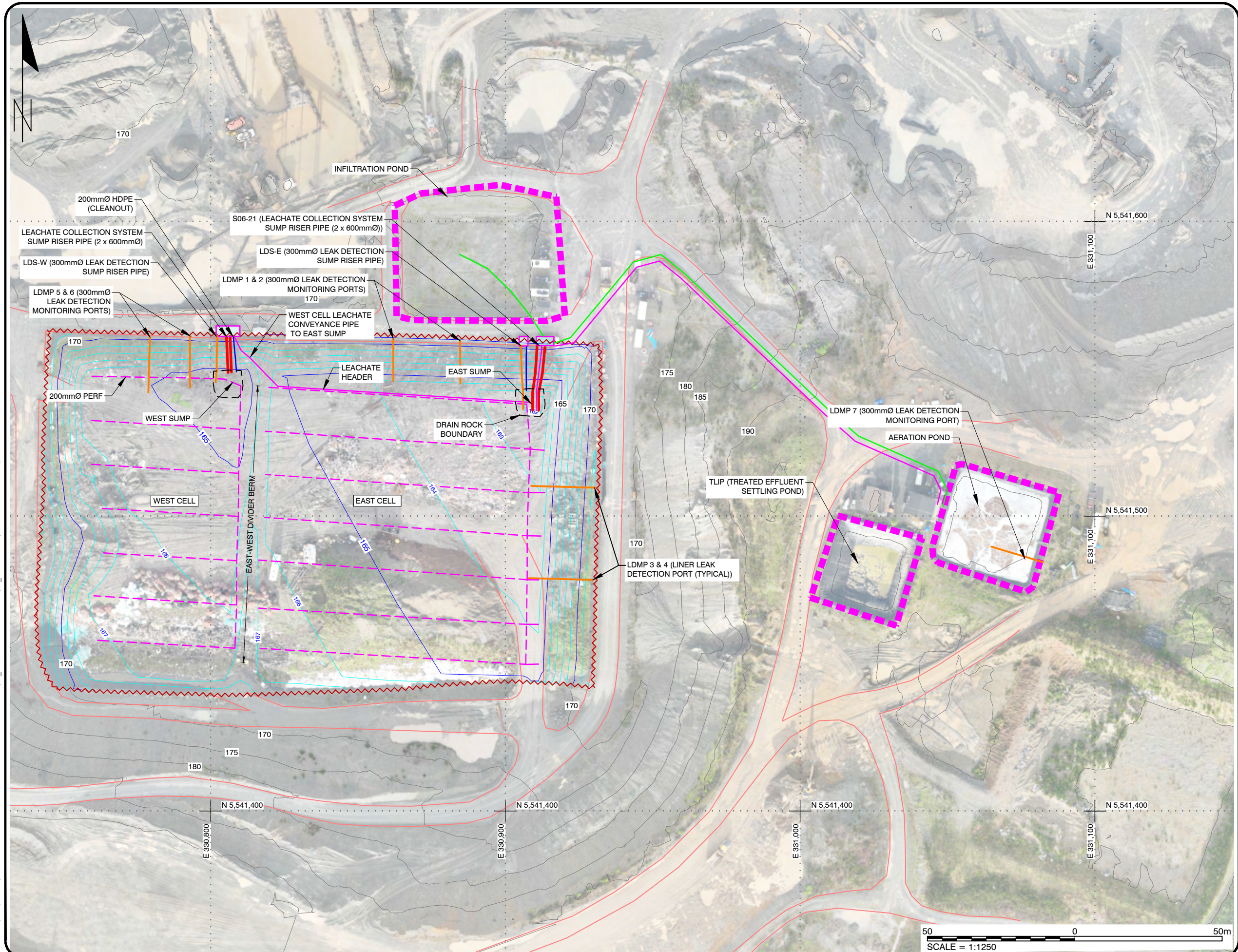
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FIGURE 3-1

CHECKED

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- Environmental Monitoring

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Phone: (604) 986-7723

LEGEND:

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

TOPO SURFACE SURVEYED SEPTEMBER 11, 2025
BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

SITE ORTHO IMAGE BY NORTHWIN - DEC 15, 2025
OTHER IMAGE BY BING MAPS

CLIENT:



PROJECT:

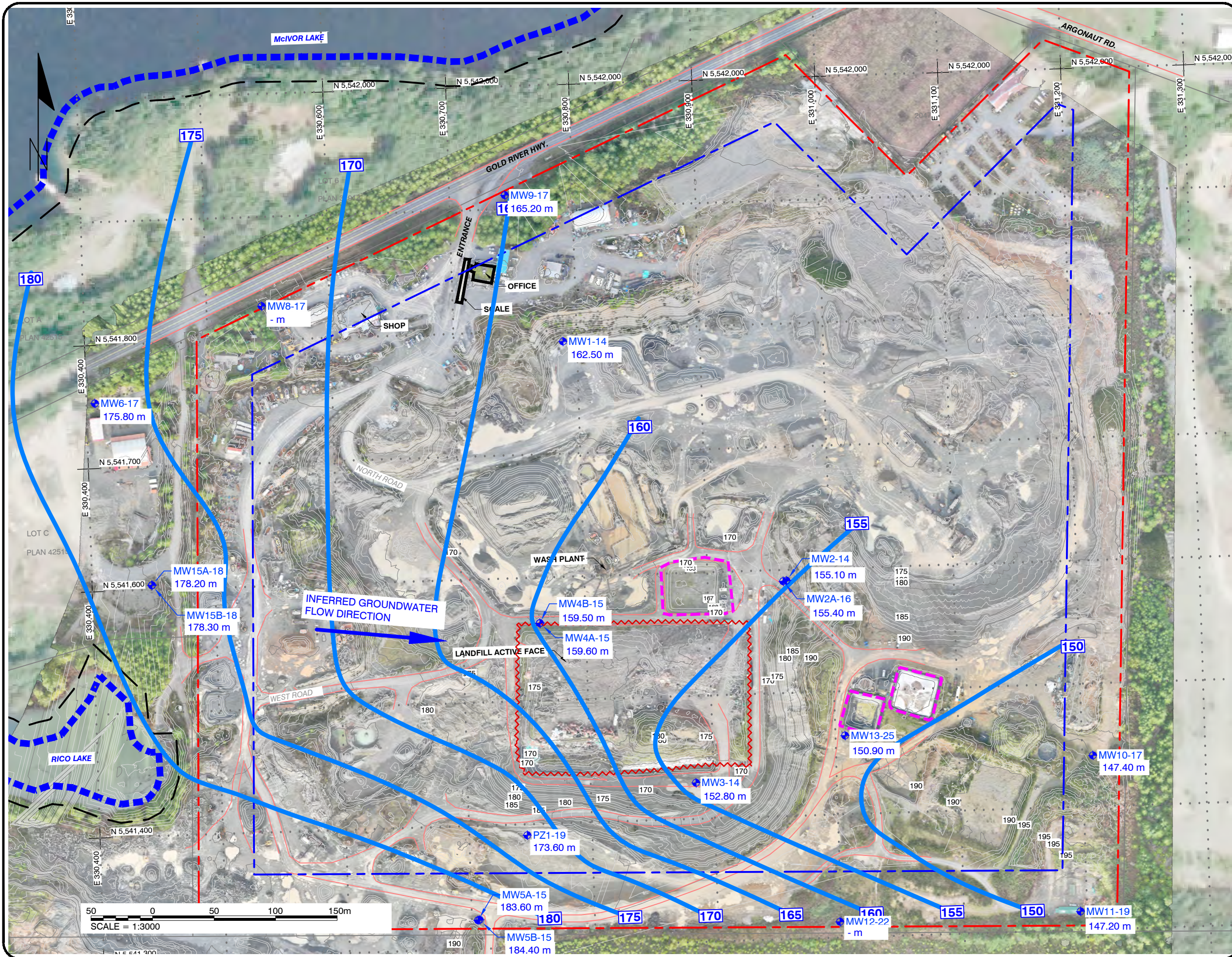
NORTHWIN LANDFILL DESIGN OPERATION
AND CLOSURE PLAN UPDATE

TITLE:

EXISTING LEACHATE COLLECTION
SYSTEM

SCALE:	DATE:	PROJECT NO:
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DESIGNED	-	DRAWING NO: FIGURE 3-2
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CHECKED	TS	

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Phone: (604) 986-7723

LEGEND:

- UTM GRID LINE
- CONTOUR - EXISTING (5m)
- PROPERTY BOUNDARY
- LEACHATE TREATMENT SYSTEM
- 5m OFFSET FROM PROPERTY
- 50m OFFSET FROM PROPERTY
- EXISTING LAKE
- 20m OFFSET FROM EXISTING LAKE
- LANDFILL BASE LINER EXTENTS
- MONITORING WELL
- GROUNDWATER LEVEL CONTOURS (5m)

TOPO SURFACE SURVEYED SEPTEMBER 11, 2025
BY NORTHWIN. UTM83-10N / GEOID UNKNOWN
SITE ORTHO IMAGE BY NORTHWIN - DEC 15, 2025
OTHER IMAGE BY BING MAPS

CLIENT:



PROJECT:

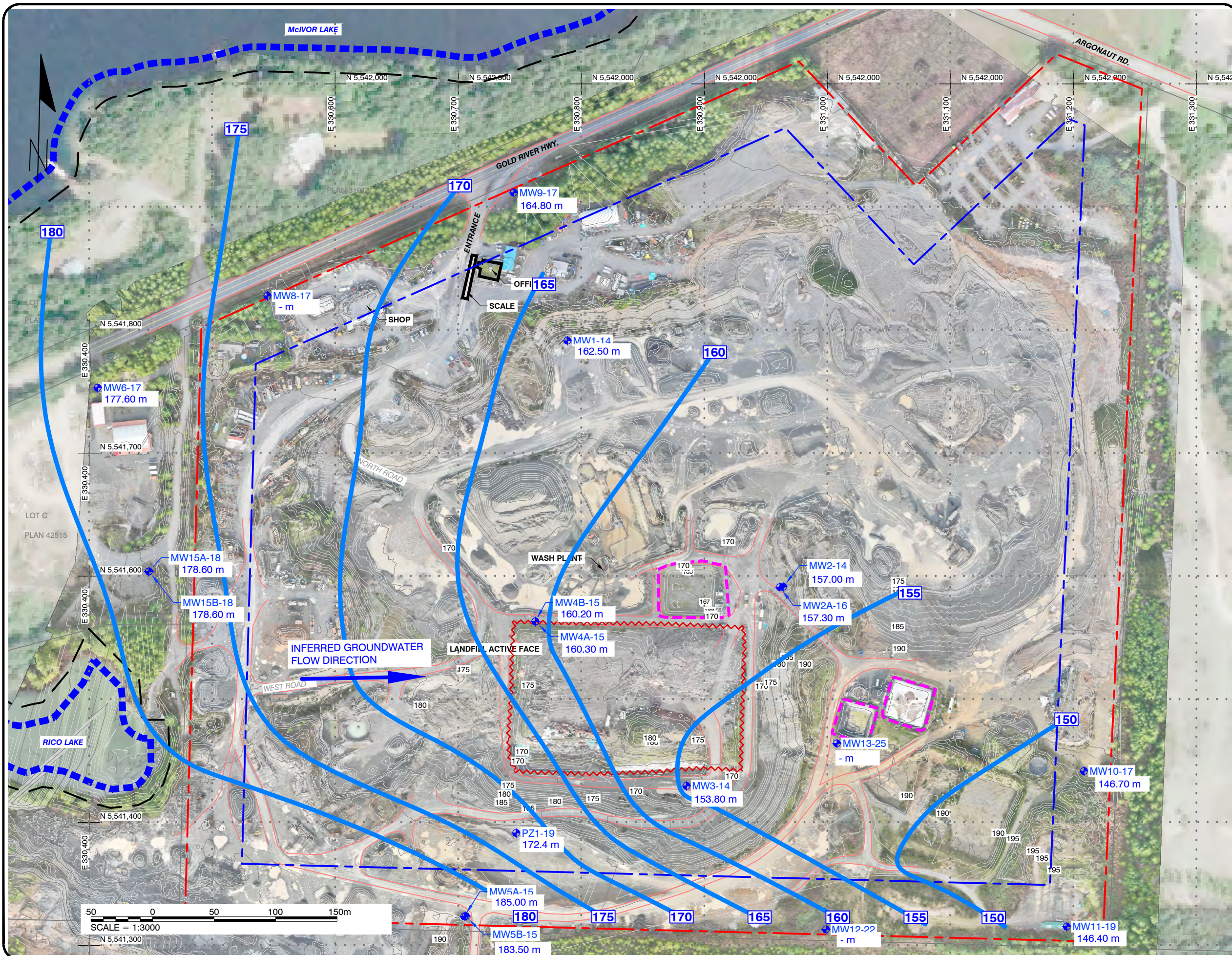
NORTHWIN LANDFILL DESIGN OPERATION
AND CLOSURE PLAN UPDATE

TITLE:

GROUNDWATER ELEVATION
CONTOURS SEPTEMBER 2025
(SEASONAL LOW)

SCALE:	DATE:	PROJECT NO:
1:3000	2026/09/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO: FIGURE 3-3 (A)
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CHECKED	TS	

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LEGEND:

- UTM GRID LINE
- CONTOUR - EXISTING (5m)
- PROPERTY BOUNDARY
- 5m OFFSET FROM PROPERTY
- 50m OFFSET FROM PROPERTY
- LEACHATE TREATMENT SYSTEM
- EXISTING LAKE
- 20m OFFSET FROM EXISTING LAKE
- LANDFILL BASE LINER EXTENTS
- MONITORING WELL
- GROUNDWATER LEVEL CONTOURS (5m)

TOPO SURFACE SURVEYED SEPTEMBER 11, 2025
BY NORTHWIN. UTM83-10N / GEOID UNKNOWN
SITE ORTHO IMAGE BY NORTHWIN - DEC 15, 2025
OTHER IMAGE BY BING MAPS

CLIENT:



PROJECT:

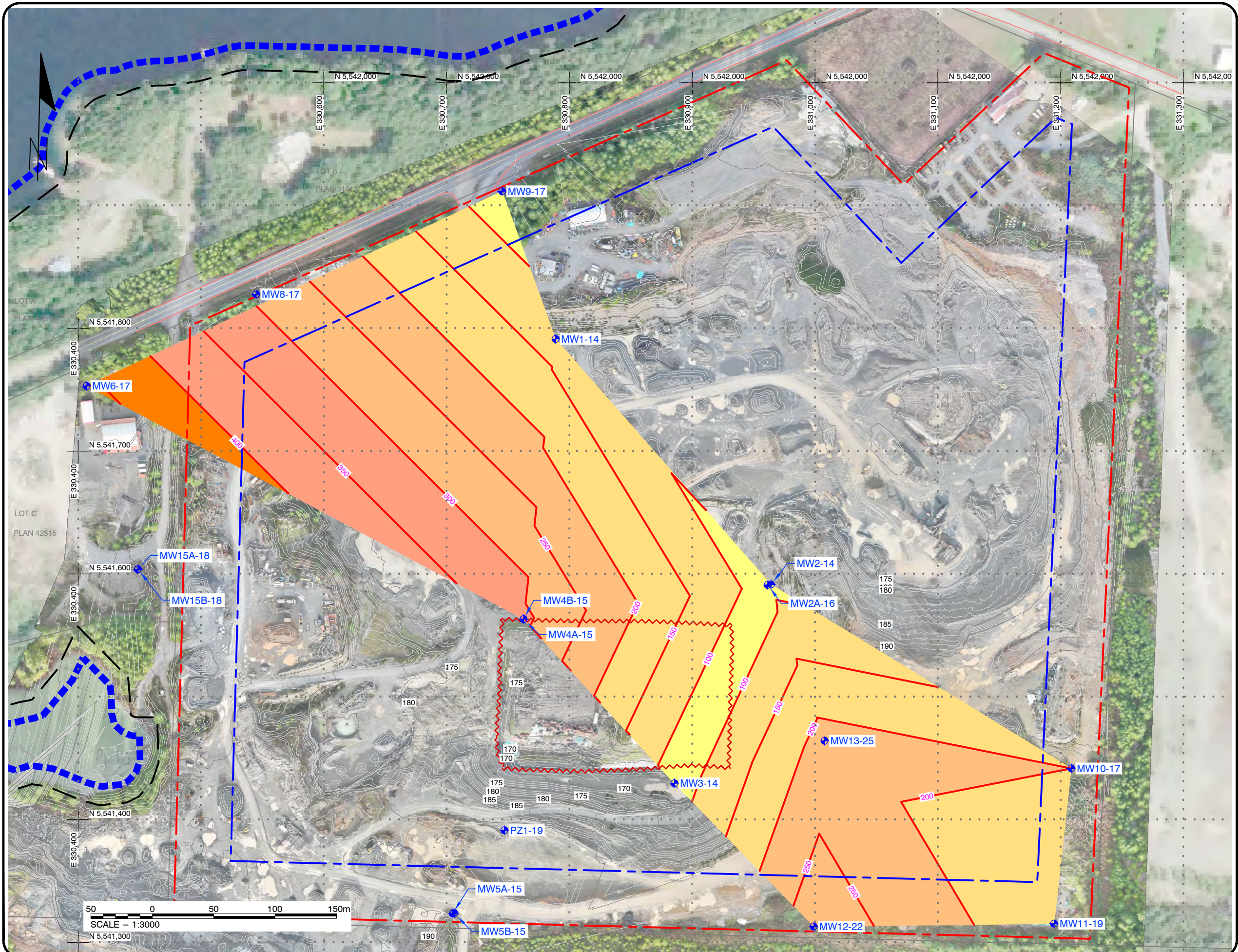
NORTHWIN LANDFILL DESIGN OPERATION
AND CLOSURE PLAN UPDATE

TITLE:

GROUNDWATER ELEVATION
CONTOURS MARCH 2025
(SEASONAL HIGH)

SCALE:	DATE:	PROJECT NO:
1:3000	2026/09/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO: FIGURE 3-3 (B)
DRAWN	EP	
CHECKED	TS	

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LEGEND:

- UTM GRID LINE
- ~~~~~ CONTOUR - EXISTING (5m)
- PROPERTY BOUNDARY
- 5m OFFSET FROM PROPERTY
- 50m OFFSET FROM PROPERTY
- LEACHATE TREATMENT SYSTEM
- EXISTING LAKE
- 20m OFFSET FROM EXISTING LAKE
- 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	
500.0 uS/cm	1500 uS/cm	

TOPO SURFACE SURVEYED SEPTEMBER 11, 2025
BY NORTHWIN. UTM83-10N / GEOID UNKNOWN.
SITE ORTHO IMAGE BY NORTHWIN - DEC 15, 2025
OTHER IMAGE BY BING MAPS

CLIENT:



PROJECT:

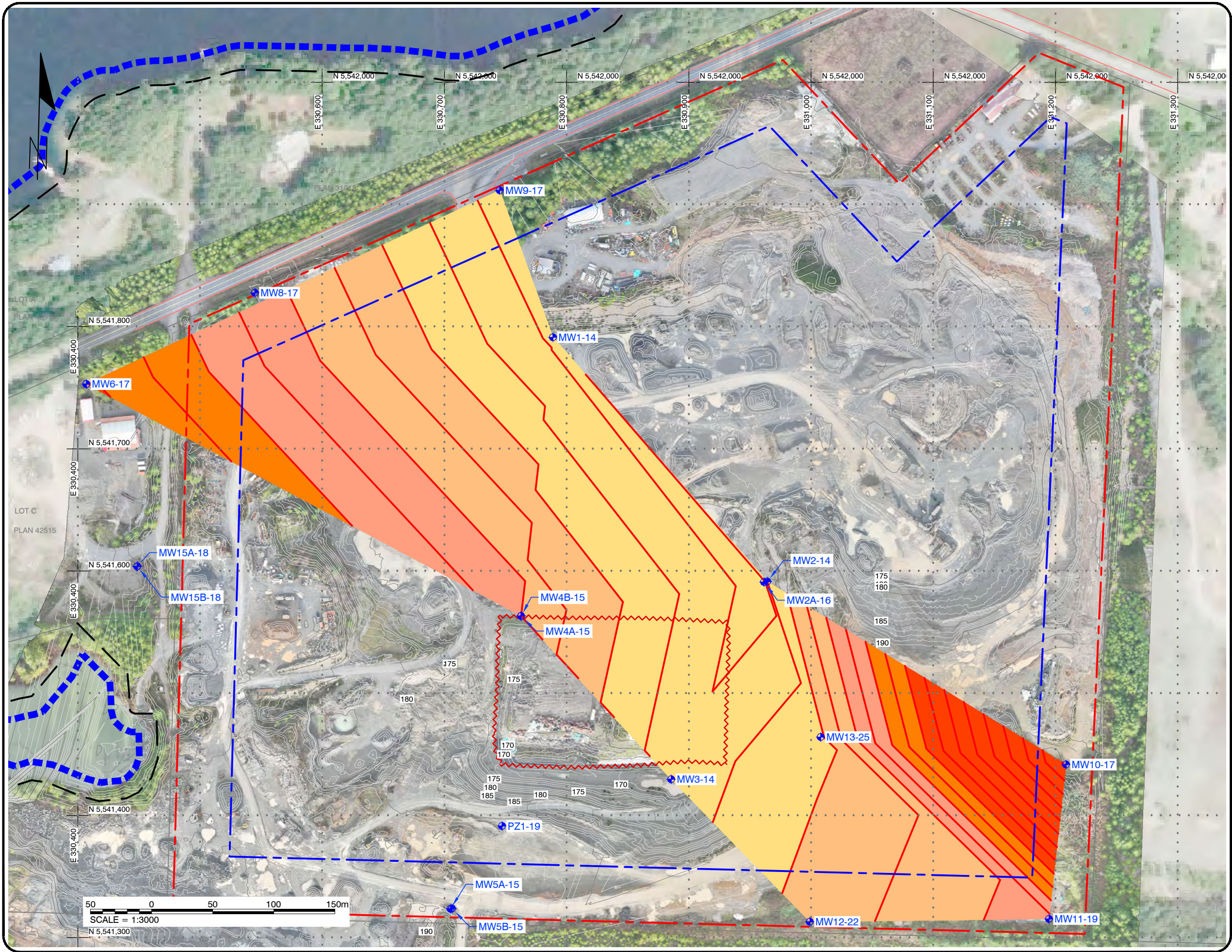
NORTHWIN LANDFILL DESIGN OPERATION
AND CLOSURE PLAN UPDATE

TITLE:

ELECTRICAL CONDUCTIVITY MAP
(MARCH 2025)

SCALE:	DATE:	PROJECT NO:
1:3000	2026/09/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO: FIGURE 3-4 (A)
DRAWN	EP	
CHECKED	TS	

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Phone: (604) 986-7723

LEGEND:

..... UTM GRID LINE

CONTOUR - EXISTING (5m)

--- PROPERTY BOUNDARY

--- 5m OFFSET FROM PROPERTY

--- 50m OFFSET FROM PROPERTY

--- LEACHATE TREATMENT SYSTEM

EXISTING LAKE

--- 20m OFFSET FROM EXISTING LAKE

LANDFILL BASE LINER EXTENTS

MONITORING WELL

Conductivity Table

MIN. CONDUCTIVITY	MAX. CONDUCTIVITY	COLOUR
0.0 uS/cm	100 uS/cm	
77.0 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	
500.0 uS/cm	910 uS/cm	

TOPO SURFACE SURVEYED SEPTEMBER 11, 2025
BY NORTHWIN. UTM83-10N / GEOID UNKNOWN.
SITE ORTHO IMAGE BY NORTHWIN - DEC 15, 2025
OTHER IMAGE BY BING MAPS

CLIENT:



PROJECT:

NORTHWIN LANDFILL DESIGN OPERATION
AND CLOSURE PLAN UPDATE

TITLE:

ELECTRICAL CONDUCTIVITY MAP
(SEPTEMBER2025)

SCALE:

1:3000

DATE:

2026/09/11
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

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DRAWING NO:

DRAWN

EP

FIGURE 3-4

CHECKED

TS

(B)

4 SITE DEVELOPMENT AND DESIGN

This chapter presents the Northwin Landfill development strategy including the overall phased design of the current footprint and the proposed expansion area. The design is presented in a sequence of contour drawings that show the development of the landfill, cut and fill contours and volumetric quantities for each of the Phases.

In updating the final contour design for the Landfill in this DOCP, SHA has considered the following objectives for site development:

- Design the landfill within the existing footprint and provide capacity for future.
- Source material on site, where possible, and provide estimates for daily, intermediate, final cover and construction requirements over the next five years.
- Divide the development into phases for organized filling and progressive closure.
- Provide a lift-by-lift filling plan for Phase 2.
- Maintain a 50 m buffer from the property boundary, as required by Landfill Criteria.
- Maintain outside final slopes no steeper than 3H:1V, as required by the Landfill Criteria.
- Design the landfill crest with minimum 4% grade, as required by the Landfill Criteria.
- Upgrade access roads as required.
- Develop a leachate management system including phased liner construction, leachate collection and extraction and leachate treatment upgrades to manage expected leachate quantities.
- Develop a stormwater management system that will divert run-on as well as clean run-off from areas that are progressively closed with final cover.
- Plan a landfill gas monitoring strategy to ensure that methane levels remain below regulatory limits.
- Ensure the site is secure and nuisances are kept to a minimum (wildlife, vectors, dust, and odour).
- Design roads for commercial traffic to be 8% or flatter to support safer travel in winter conditions.
- Design stormwater ditching every 15 vertical meters to better control run-off and prevent erosion.
- Design stormwater ditching adjacent to the access roads for erosion control and surface water management.
- Design downchutes for surface water drainage from the crest and midslope ditches of closed areas.
- Design Borrow Area and excavations a minimum 1.5 m above high groundwater levels.

4.1 Borrow Plan

Figure 4-1 shows the existing tomography. The borrow plan for the build out of the site, including the expansion area, is shown in Figure 4-2 to 4-7. The bedrock surface contours are presented in Figure 4-2 while gravel extraction surface contours are presented in Figure 4-3. From the cut and fill in Figure 4-4, the total borrow volume i.e. extracted gravel volume is estimated to be 320,763 m³.

Figure 4-5 shows the liner surface grading plan, where Figure 4-6 shows the liner surface cut and fill. Figure 4-6 shows that net 13,276 m³ of fill will be required to achieve subgrade/bottom of liner surface design elevation.

Filling the borrow area with soil that meets land use standards will be completed sequentially as the landfill development progresses. Further details have been presented in Figure 4-7 and discussed in Chapter 6.

4.2 Final Contour Design and Capacity

GHD developed the original final contour design for the Northwin Environmental Landfill. The plan called for building the landfill as a pyramid like fill against the south side of the Upland Gravel Pit and Rock Quarry, with the landfill floor established at the 170 m level on the north, east and west sides and rising at 3H:1V contours to a top of slope elevation of 190 m, and a maximum crown elevation of 195 m. This concept was projected to have an air space capacity of 532,365 m³. Actual air space would have been somewhat less because the GHD design did not make any provisions for haul ramps that will be required for trucks to access fill areas.

The final design was developed on existing site topography as presented in Figure 4-1. This mapping is a composite of a Northwin Environmental Ltd. topographic survey of the landfill operating areas undertaken in September 2025. To maximize available air space within the landfill, this DOCP presents an updated design that adds a structural berm and vertical liner on the west side of the landfill. This strategy raises the landfill toe limit elevation on the west side of the landfill from 170 - 174 m to 170 – 195 m.

As the Northwin Landfill is being developed in areas where the available sand and gravel resource is first extracted, the depth to bedrock was first characterized as shown in Figure 4-2. The design goal was to maintain the liner above the bedrock surface and at least 1.5 m above the seasonally high-water table surface as defined in Figure 3-3B.

The planned sand and gravel extraction design surface is presented in Figure 4-3. The southern gravel pit cut is established 19 m from the property boundary, maintaining the 5 m offset required under the Mines Act Permit and a buffer for a long-term haul road and ditch to support ongoing aggregate extraction operations. The design side slopes of the gravel extraction will be 2H:1V

To the west, sand and gravel will be mined down to the bedrock surface, exposing the bedrock in the black dashed polygon shown in Figure 4-3. The bottom of the Phase 2 excavation will slope to the northeast at 10% grade, from a starting elevation of 185 m on the west side of the expansion area to a sump elevation of 163 m on the east side.

The design cut heat map is shown on Figure 4-4. The total sand and gravel production cut will be 320,763 m³, with the maximum depth cut being up to 28.9 m.

Once all accessible sand and gravel is extracted, Northwin will place soil that meets land use standards to establish the desired liner base surface shown in Figure 4-5. To ensure stability of the double liner system and drainage layer subgrade slopes will be constructed at 2.5H:1V. A new ramp will be constructed on the west side of the landfill to provide long term access for haul trucks bringing waste to the landfill. The ramp will be designed to meet the Landfill Criteria for Municipal Solid Waste. The grading soil volume required to achieve design grades for the liner subbase and haul ramp is 13,276 m³. The fill heat map presented on Figure 4-6.

To comply with section 1.3.4 and 1.3.5 of the Operational Certificate and section 2.2.10 of the regulatory requirements for landfills receiving contaminated soil, Phase 2 will be constructed with a composite liner system comprised of two 60 mil HDPE and GCL composite liners with a leak detection layer. Design detail A/4-7 shows the placement sequence of the liner materials on the flat portions of Phase 2 while detail D/4-7 presents the placement sequence for the 2.5H:1V side slopes.

As an additional environmental safeguard, Northwin will extend a single liner beneath the planned soil wedge area, as defined by the purple polygon on Figure 4-6. The grading wedge liner area is 13,780 m².

The extents of the composite double liner system for Phase 2 are defined by the red polyline in Figure 4-6. The composite double liner system will be extended 10 m beyond the approved limit of waste to an anchor trench at elevation 180 m. The composite double liner system area will be 18,750 m².

A vertical chimney drain and tertiary liner will be progressively constructed at the approved limits of waste to contain waste within the approved liner polygon. To the south, the vertical liner will be supported by the wedge of grading fill that will be vertically extended in 2.5 m lifts concurrently with waste placement. The vertical chimney drain detail is shown on detail B/4-7.

A run-on collector drain will be constructed on the up-slope side of the tertiary GCL liner to intercept any seepage captured on top of the liner. The seepage will be directed to the lined treated leachate pond for release to the infiltration gallery. It is expected that this seepage will be clean but will be periodically tested to ensure that it meets CSR Generic Numerical Water Standards for Drinking Water (DW).

The updated final design contours for the Northwin Environmental Landfill are presented in Figure 4-8. To the north and east the landfill design is the same as originally proposed by GHD. To the south and west the design has been modified to increase airspace capacity within the approved limits of waste with the vertical chimney drain and tertiary lining system.

As shown in Figures 4-8 and 4-9, the top elevation of the developed landfill will be 199 m with a crest slope at 4% and side slopes at 3H:1V. The surface of the final elevation represents the design elevation of the top of the intermediate cover and the underside elevation (below liner) of the final cover system. As shown in Figure 4-9, the remaining landfill capacity for waste and operational cover relative to the September 2025 survey is projected at 581,561 m³. The total design capacity relative to the base liner surface shown in Figure 4-9A is 740,372 m³ within the approved waste footprint. 105,934 m³ of air space within the soil grading wedge backfill, as reported in Figure 4-9B.

4.3 Phase Development

The landfill development is to be split into 4 phases to facilitate progressive closure. The following section presents a detailed description of how Phases 1 through 4 are to be developed at the Landfill. The overall objective of the fill plan is to build each phase vertically in 2.5 m thick lifts, keeping the waste footprint as small as possible while providing access roads sloped at 8% on adverse grades and 10% on down grades. The flat working deck on each lift will need to provide positive drainage at a minimum of 2% grade to prevent ponding water. All final outside slopes will be constructed at 3H:1V and all internal slopes, where slopes tie into the next phase, will be built at 2.5H:1V.

Figure 4-18 illustrates how the four phases will be developed on N-S and E-W cross sections with locations of those sections shown on Figure 4-8.

Phase 1 (North): (Figure 4-10 and Figure 4-11)

At present, NWE has completed filling of Phase 1 West to 175 and is progressing on filling Phase 1 East to 175 m as well. Once both sub-phases are brought up to a common grade, two more 2.5 m lifts will be developed across Phase 1, bringing Phase 1 to the final design elevation of 180 m.

Figure 4-10 presents the design contours for Phase 1 completion. Note the down ramp into Phase 2 that must be constructed as part of Phase 1 filling operations. Figure 4-11 presents the fill heat map that indicates Phase 1 will provide 94,496 m³ of air space relative to the Sept. 2025 baseline surface.

Phase 2 (South): (Figure 4-12 and Figure 4-13)

Once Phase 1 is completed to 180 m elevation, landfiling will move into Phase 2, the freshly excavated area south of Phase 1. Landfiling will then continue in the Phase 2 expansion area, advancing in 2.5 m high lifts from 163 to 180 m elevation. Access into Phase 2 will be via an existing down ramp in the southeast corner of Phase 1. This phase will also be filled to 180 m elevation. Completion contours for Phase 2 are shown on Figure 4-12 while Figure 4-13 presents the fill heat map that indicates a volumetric capacity of 178,491 m³ for Phase 2.

Phase 3 (South): (Figure 4-14 and Figure 4-15)

Once Phase 2 is completed, the 180 m landfill plateau will be divided roughly in half. Phase 3 will be developed on the southern portion of the 180 m plateau. It will be progressively filled to a design elevation of 198 m, with access provided by an internal up ramp on the north face of Phase 3, accessed from the 180 level on the west side of the landfill. Design contours for Phase 3 completion are shown on Figure 4-14 while the fill heat map for Phase 3 is shown on Figure 4-15. The volumetric capacity of Phase 3 is 156,266 m³.

Phase 4 (North): (Figure 4-16 and Figure 4-17)

Once Phase 3 is completed to design elevation, the same internal ramp will now be used as a down ramp into Phase 4. Phase 4 will be progressively filled in 2.5 m lifts from 180 up to a final design elevation of 201 m completing filling of the Northwin Environmental Landfill Phases 1 to 4. The completion contours for Phase 4 are shown on Figure 4-16 while the Phase 4 fill heat map is shown on Figure 4-17. The design capacity of Phase 4 is 152,308 m³.

On completion of Phase 4, NWE may consider a further lateral expansion to the east at the 170 m level once all aggregate from that area is mined out. As that lateral expansion would occur outside the currently approved landfill footprint, a major amendment to Operational Certificate 107689 would be required. NWE may advance this expansion concept in the next 5-year update to the DOCP.

The phasing, basal liner area (where applicable), airspace capacity for each phase is shown in Table 4-1 below.

Table 4-1: Summary of Phase Development

Phase	Gross Volume (m³)	Base Liner Area/Active Area (m²)	0.45 m Thick Base Liner Volume (m³)	Total Phase Capacity for Waste and Daily Cover (m³)
Phase 1 North	94,496	22,600	10,170	84,326
Phase 2 South	178,491	18,750	8,438	170,054
Phase 3 South	156,266	15,750	7,088	149,179
Phase 4 North	152,308	17,688	7,960	144,348
Total	581,561	74,788	33,655	547,906

The final contour geometry will consist of 3H:1V outside slopes with stormwater collection benches established at 15 m (vertical) spacings on the slopes. Access to the crest will be realized with an up-ramp on the south side of the landfill graded at 8%.

Access to active lifts in each phase will be achieved via internal ramps that will progressively be buried as the landfill is developed, allowing for maximum air space capacity to be realized. The crest will be designed with the high point in the middle and with grades of 4% to facilitate shedding of surface water to the crest ditches and downchutes. Progressive and final closure are more fully described in Chapter 10.

4.4 Seismic Assessment

4.4.1 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 most 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 m AMSL at the small mountain to the south and 170 m AMSL 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.
- The adjacent property located Northwest of the Upland Gravel Pit and Rock Quarry (the Site) bedrock is orientated around a bedrock outcrop. This localized highpoint is present at elevations 183.5 to 182.1 m AMSL.
- Underlying the Site, bedrock generally dips steeply from west to east from 183.0 m AMSL (outcrop) to at least 145 m AMSL.

4.4.2 Underlying Stratigraphy

Based on the results of the site investigations, and review of past well logs, the area west and south of the current landfill is comprised of three major stratigraphic units beneath the Site comprised of sand and gravel, sandy silt and Karmutsen basalt bedrock.

4.4.3 Slope Stability Analysis

The purpose of this section is to prove that the proposed final design for the Northwin Landfill is within acceptable factor of safety for failure and that the slope stability is improved to acceptable levels as a result of the design.

4.4.3.1 Slope Stability Model

Stability of the site was modeled using the program SLIDE 4.0, designed for 2D slope stability analysis on soil and rock slopes. The slope stability models discussed below have been developed largely from strength parameters used by GHD in the Northwin Environmental Ltd. 2016 Geotechnical Investigation Report (GHD, 2016).

Two critical cross-sections were selected through representative planned sloped areas of the site. The locations of the sections analyzed are presented on plan view in Figure 4-8, while Figure 4-18 provides the cross-section profiles.

The analysis was performed using the limit equilibrium technique and Bishop Simplified method of analysis. Materials are modeled using a Mohr-Coulomb strength envelope. Failure scenarios were modeled for both static and seismic (earthquake) conditions for the proposed and existing profiles. The following Factor of Safety (FOS) for slope failure have been adopted as minimum standards:

- | | |
|---|-----|
| • Static Conditions adjacent to Developed Land and Infrastructure | 1.5 |
| • Static Conditions adjacent to Undeveloped Land | 1.3 |
| • Seismic Loading | 1.0 |

A pseudo-static analysis was performed to determine if the slopes would be stable during an earthquake when subjected to peak ground acceleration expected for the area. The peak horizontal ground acceleration (PGA) of 0.339 g was used for the Northwin Landfill from the 2025-2020 National Building Code of Canada Seismic Hard value Tools (see Appendix C). The primary return period for the PGA values is 2,475 years which corresponds to a 2% probability of exceedance in 50 years.

The following assumptions were made in the process of simplifying complex situations in the field to a computer model:

- Strength characteristics of the ground materials were generalized; and
- Stabilizing effects of vegetative cover on the side slopes were not included.

4.4.3.2 Groundwater Conditions

Groundwater conditions of the site have been discussed in Section 3.5.1. The groundwater levels have been estimated for the model based on the available data with the inferred flow direction towards the southeast.

4.4.3.3 Strength Parameters

Table 4-2 outlines the geotechnical parameters used for the modeled materials. Types of materials selected to represent the site conditions are waste (DLC), sand/gravel, fill (Silt) and bedrock.

The published literature on DLC waste is limited. Golder Associates (2003) had measured in-situ density of demolition land clearing construction landfill (DLC) waste to be 10.6 to 12.8 KN/m³ at a DLC landfill in the Vancouver and Fraser Valley Area of British Columbia. The friction angle of DLC waste was reported to be as high as 35 degrees with a cohesion value of 0 degrees (Golder Associates, 2003). Based on our experience, we assumed the friction angle of DLC waste to be 30 degrees with a cohesion (C') value of 2 KN/m² for the Northwin Landfill. Unit weight for the compacted waste (existing) was assumed to be 12 KN/m³, while for the uncompacted waste (new), it was assumed to be 8 KN/m³ (GHD, 2016).

Table 4-2: Geotechnical Parameters for SLIDE

Material	Unit Weight, γ (kN/m ³)	Cohesion, c' (kN/m ²)	Internal Friction Angle, ϕ' (degrees)
Un-compacted Waste	8	2	30
Compacted Waste	12	2	30
IL Minus Fill (Silt)	18	0	30
Sand/Gravel	20	0	38
Bedrock	20	0	40

4.4.3.4 Stability Results

The proposed landfill design is stable for all static loading conditions with FOS values exceeding 1.50. For the seismic loading conditions, FOS values far greater than 1.0 are obtained on both cross sections. Hence, the landfill with the proposed design will be very stable. Results are presented in Appendix C, Figures C-1 to C-4.

Table 4-3: Results from Slope Stability Analysis

Section	FOS Static Deep-seated	FOS Seismic Deep-seated
Section N-S	2.08	1.02
Section W-E	2.02	1.00

4.4.4 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.

4.4.4.1 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.

4.4.4.2 Long-term Settlement

Long Term settlements, or primary consolidation settlements, occur due to the expulsion of pore water from the waste material. Depending on the loading, saturation degree, and the drainage path within 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 2% to 5% of total waste column thickness, resulting in total settlement of 0.6 to 1.5 m at the landfill crest.

4.4.4.3 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 in the range of 1% to 5% of total waste column thickness, about 0.3 to 1.5 m at the landfill crest.

4.4.5 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 Northwin Environmental 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.

4.5 Site Access and Haul Road Development

Site access to Gold River Highway is 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 Upland Sand Gravel Pit and Quarry, which is currently excavated to a depth of approximately 20 m below the surrounding topography. An aggregate wash plant is located near the centre of the Pit.

On site access roads will be constructed to a width of 10 m including 3.5 m traffic lanes and 1.5 m shoulders. Ditching may be established on the up-slope side of all roads. Roads will generally be crowned on the pit perimeter and in-sloped within the landfill footprint. Cross slopes for the roads will be at 2%. Roads will be sloped at 8% for adverse grade segments and 10% for downhill grades.

4.6 Perimeter Containment Berms

A perimeter containment berm will initially be constructed on the west side of the Landfill, as shown in Figure 4-6. Smaller perimeter berms will be established on the east perimeter of Phase 2. The purpose of the perimeter containment berms are 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 contaminated 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 extraction and production area and the upper portion of the Site above the landfill. The southern perimeter containment berm will extend on top of the Landfill and will direct surface water run-off from south of the Site to the east. This surface water berm will extend beyond the limit of waste in the east and west direction, as shown in Figure 6-4.
4. Provide support for the toe of slope of the waste mass.

4.6.1 Interim Containment Berms and Temporary Cover

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. Temporary covers will reduce the infiltration area by temporarily covering the inactive portion of a constructed phase with HDPE geomembrane. Surface water diversion swales will also be constructed to promote clean surface water diversion.

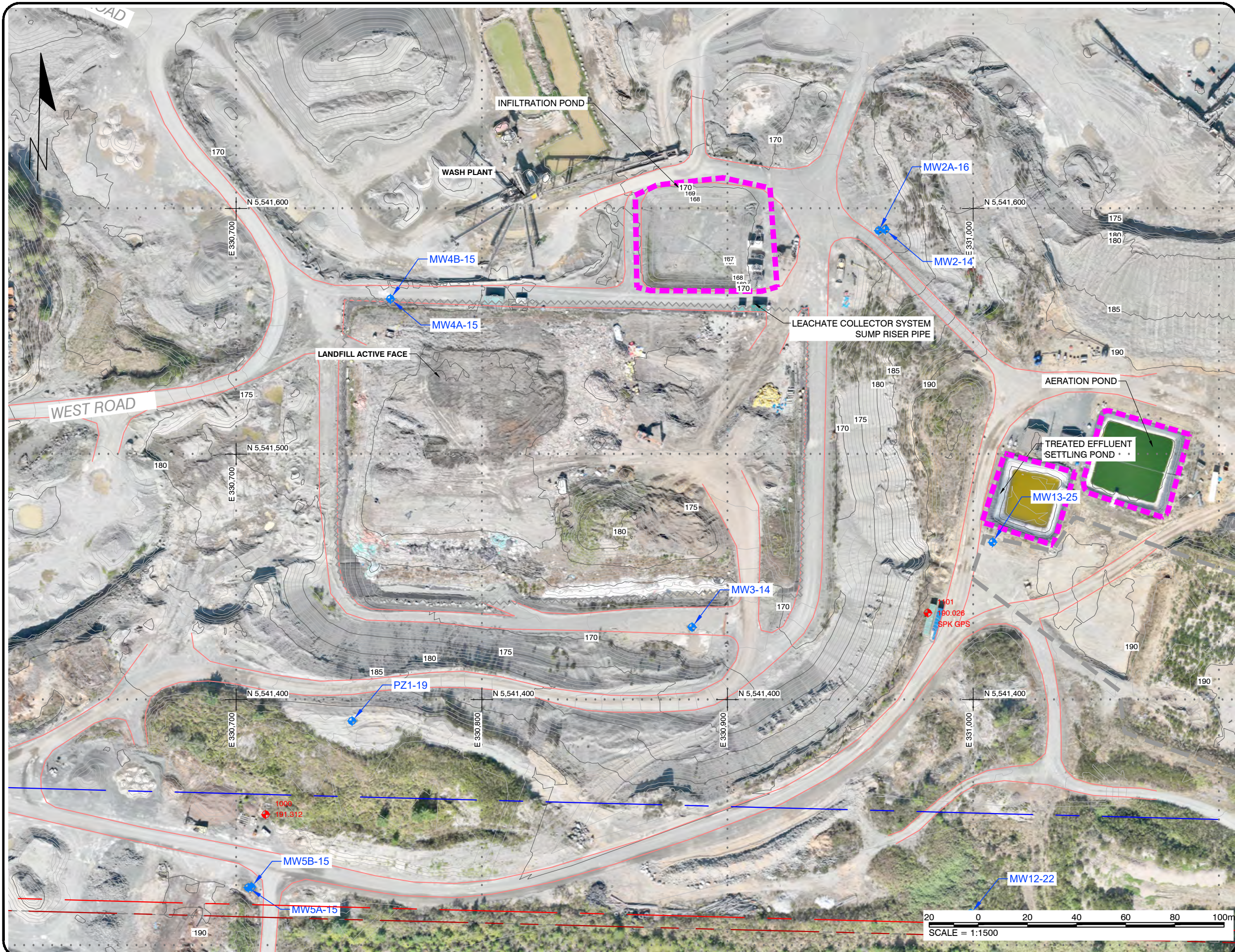
FIGURES



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Landfill Services Group
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• Design & Operations Plans
• Landfill Closure
• Environmental Monitoring
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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 SEPTEMBER 11, 2025
BY NORTHWIN. UTM83-10N / GEOID UNKNOWN
SITE ORTHO IMAGE BY NORTHWIN - SEP 11, 2025
OTHER IMAGE BY BING MAPS

CLIENT:



PROJECT:

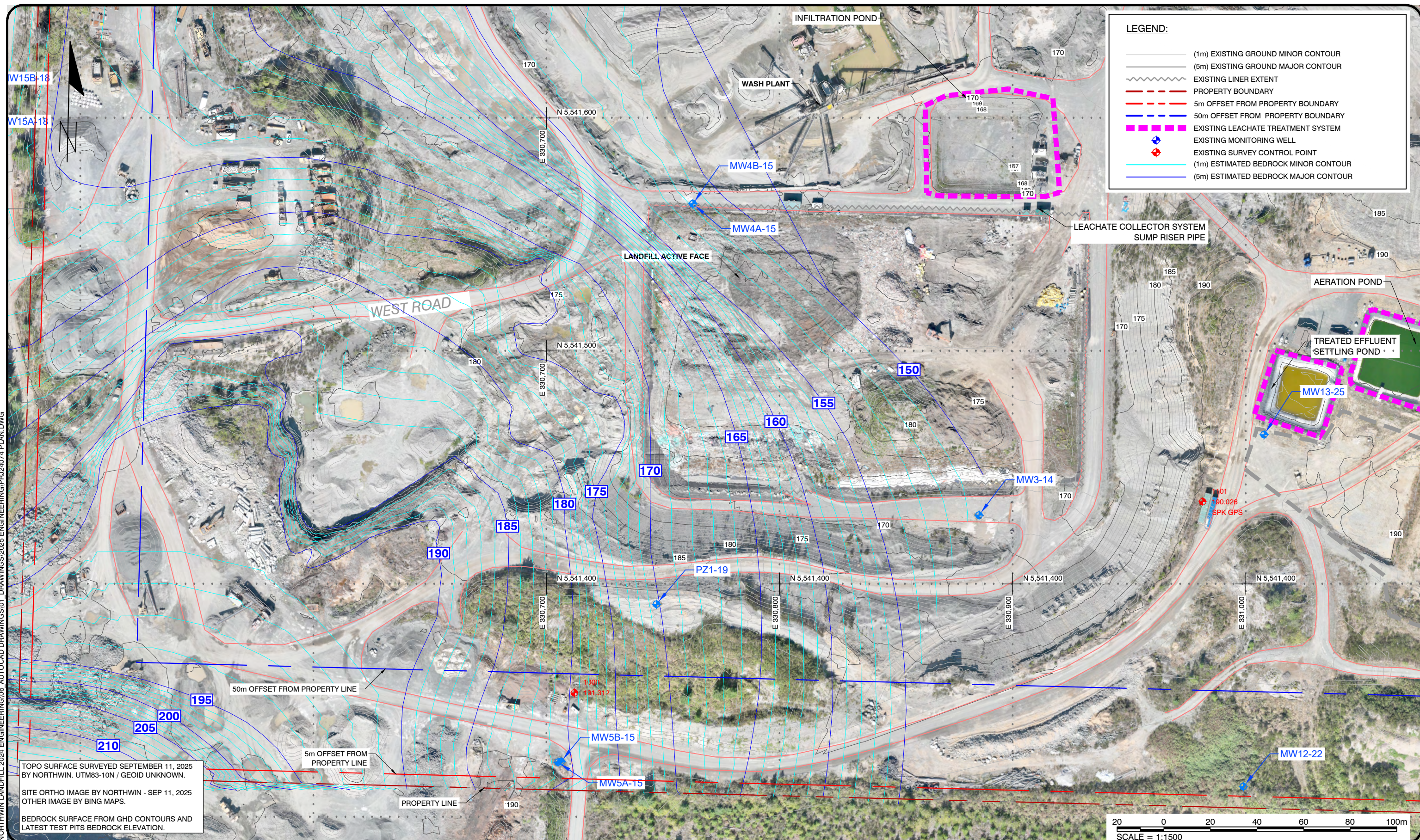
NORTHWIN LANDFILL DESIGN OPERATION
AND CLOSURE PLAN UPDATE

TITLE:

EXISTING TOPOGRAPHY

SCALE:	DATE:	PROJECT NO:
1:1500	2026/09/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO: FIGURE 4-1
DRAWN	EP	
CHECKED	TS	

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TOPO SURFACE SURVEYED SEPTEMBER 11, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN.

SITE ORTHO IMAGE BY NORTHWIN - SEP 11, 2025 OTHER IMAGE BY BING MAPS.

BEDROCK SURFACE FROM GHD CONTOURS AND LATEST TEST PITS BEDROCK ELEVATION.



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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

--- CONTOUR - BEDROCK (5m)

CLIENT:



**NORTHWIN
ENVIRONMENTAL LTD**

PROJECT:

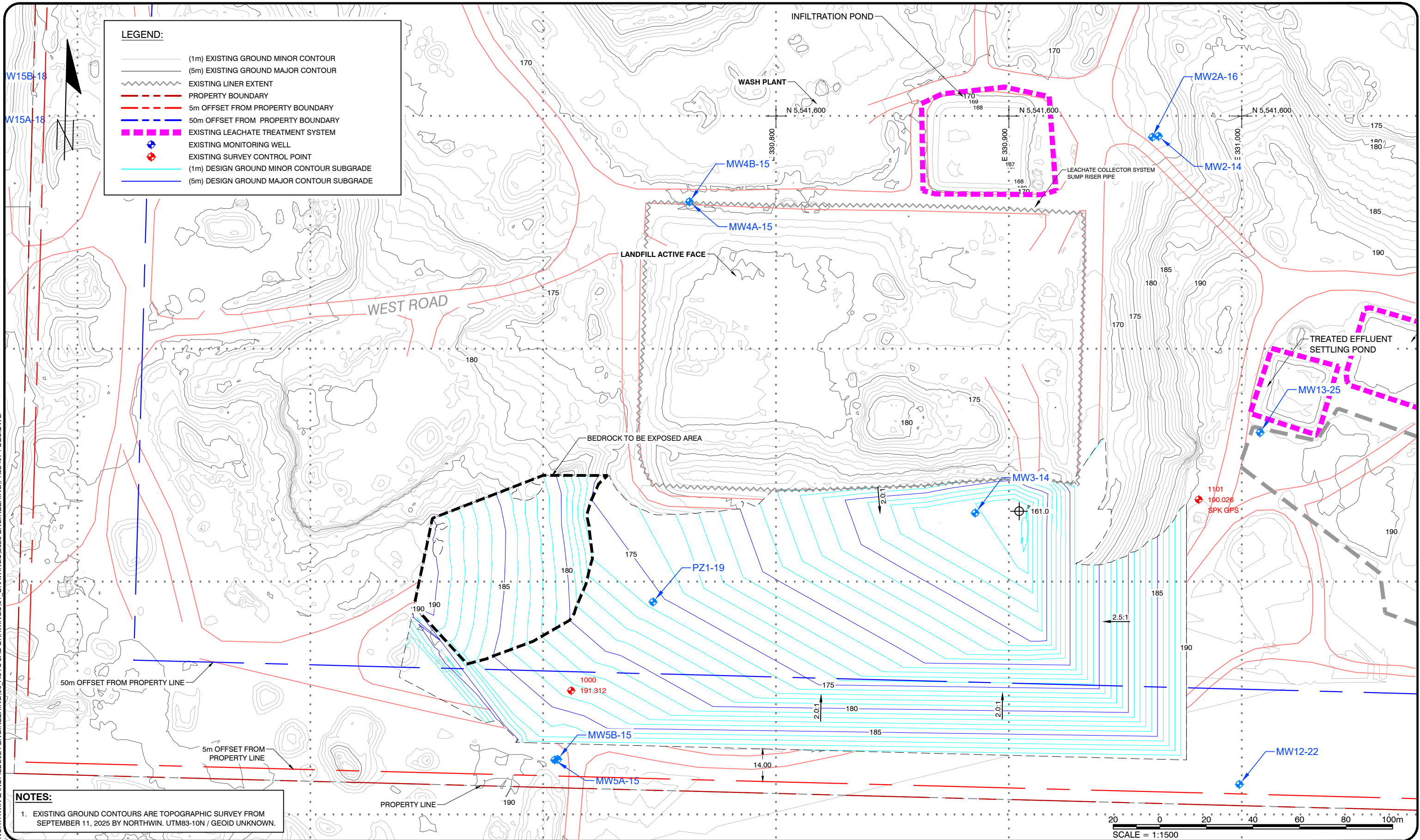
**NORTHWIN LANDFILL DESIGN
OPERATION AND CLOSURE PLAN
UPDATE**

TITLE:

BEDROCK SURFACE CONTOURS

SCALE: 1:1500	DATE: 2026/09/11 yyyy/mm/dd	PROJECT NO: PRJ 24074
DESIGNED	DRAWING NO:	
DRAWN	EP	FIGURE 4-2
CHECKED	TS	

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PROJECT:

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TITLE:

GRAVEL EXTRACTION SURFACE
CONTOURS

SCALE:

1:1500

DATE:

2026/09/11
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

DRAWN

CHECKED

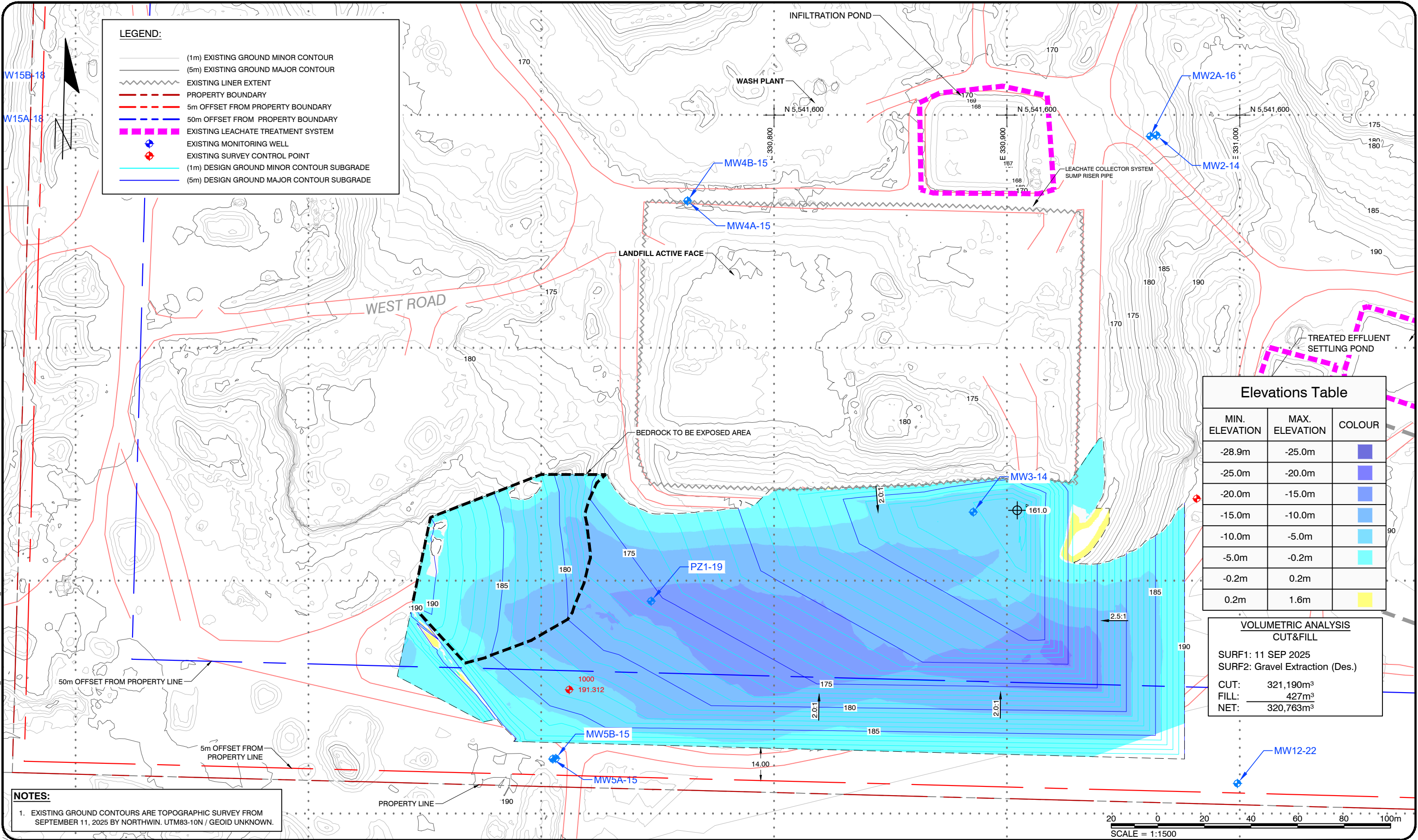
DRAWING NO:

FIGURE 4-3

EP

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LEGEND:

- (1m) EXISTING GROUND MINOR CONTOUR
- (5m) EXISTING GROUND MAJOR CONTOUR
- EXISTING LINER EXTENT
- PROPERTY BOUNDARY
- 5m OFFSET FROM PROPERTY BOUNDARY
- 50m OFFSET FROM PROPERTY BOUNDARY
- EXISTING LEACHATE TREATMENT SYSTEM
- EXISTING MONITORING WELL
- EXISTING SURVEY CONTROL POINT
- (1m) DESIGN GROUND MINOR CONTOUR SUBGRADE
- (5m) DESIGN GROUND MAJOR CONTOUR SUBGRADE

Elevations Table

MIN. ELEVATION	MAX. ELEVATION	COLOUR
-28.9m	-25.0m	
-25.0m	-20.0m	
-20.0m	-15.0m	
-15.0m	-10.0m	
-10.0m	-5.0m	
-5.0m	-0.2m	
-0.2m	0.2m	
0.2m	1.6m	

VOLUMETRIC ANALYSIS
CUT&FILL

SURF1: 11 SEP 2025
SURF2: Gravel Extraction (Des.)
CUT: 321,190m³
FILL: 427m³
NET: 320,763m³

NOTES:

- EXISTING GROUND CONTOURS ARE TOPOGRAPHIC SURVEY FROM SEPTEMBER 11, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN.

SCALE = 1:1500



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LEGEND:

CLIENT:



PROJECT:

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OPERATION AND CLOSURE PLAN
UPDATE

TITLE:

GRAVEL EXTRACTION SURFACE
CUT AND FILL

SCALE:

1:1500

DATE:

2026/09/11
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

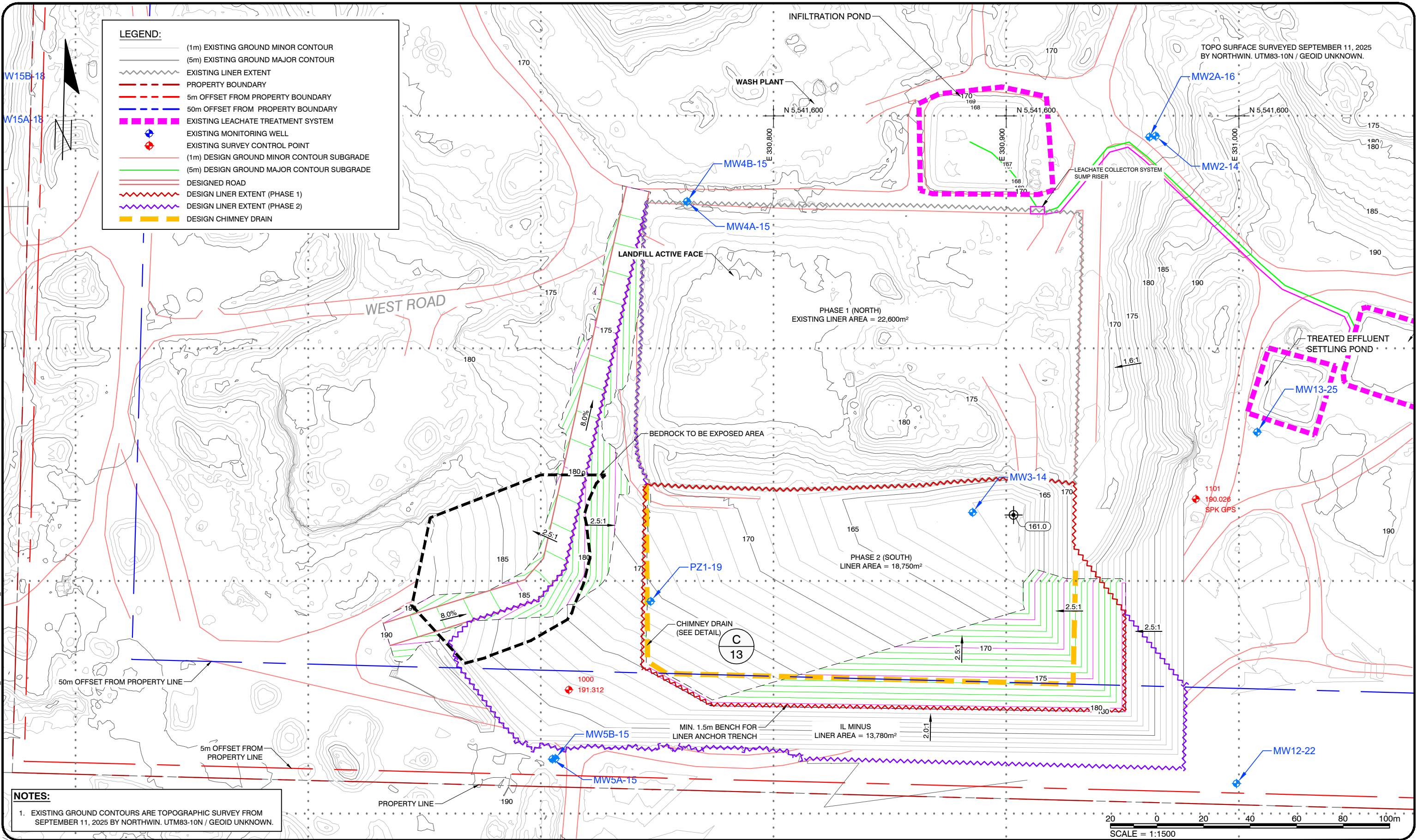
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FIGURE 4-4

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LEGEND:

CLIENT:



PROJECT:

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OPERATION AND CLOSURE PLAN
UPDATE**

TITLE:

**LINER SURFACE GRADING PLAN
CONTOURS**

SCALE:

1:1500

DATE:

**2026/09/11
yyyy/mm/dd**

PROJECT NO:

PRJ 24074

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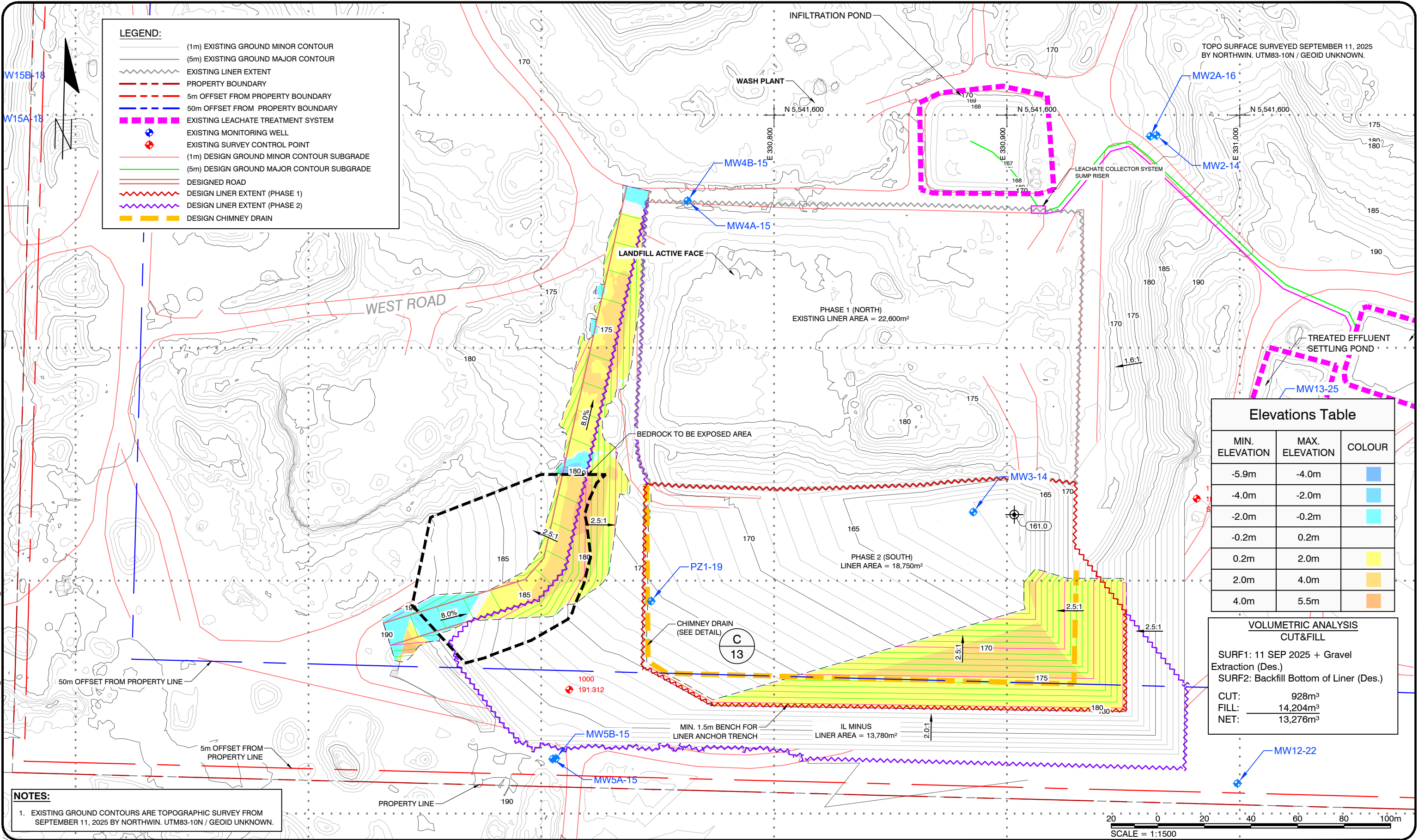
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FIGURE 4-5

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LEGEND:

- (1m) EXISTING GROUND MINOR CONTOUR
- (5m) EXISTING GROUND MAJOR CONTOUR
- EXISTING LINER EXTENT
- PROPERTY BOUNDARY
- 5m OFFSET FROM PROPERTY BOUNDARY
- 50m OFFSET FROM PROPERTY BOUNDARY
- EXISTING LEACHATE TREATMENT SYSTEM
- EXISTING MONITORING WELL
- EXISTING SURVEY CONTROL POINT
- (1m) DESIGN GROUND MINOR CONTOUR SUBGRADE
- (5m) DESIGN GROUND MAJOR CONTOUR SUBGRADE
- DESIGNED ROAD
- DESIGN LINER EXTENT (PHASE 1)
- DESIGN LINER EXTENT (PHASE 2)
- DESIGN CHIMNEY DRAIN

NOTES:

- EXISTING GROUND CONTOURS ARE TOPOGRAPHIC SURVEY FROM SEPTEMBER 11, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN.

Elevations Table

MIN. ELEVATION	MAX. ELEVATION	COLOUR
-5.9m	-4.0m	
-4.0m	-2.0m	
-2.0m	-0.2m	
-0.2m	0.2m	
0.2m	2.0m	
2.0m	4.0m	
4.0m	5.5m	

VOLUMETRIC ANALYSIS

CUT&FILL

SURF1: 11 SEP 2025 + Gravel
Extraction (Des.)
SURF2: Backfill Bottom of Liner (Des.)
CUT: 928m³
FILL: 14,204m³
NET: 13,276m³

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LEGEND:

CLIENT:

PROJECT:

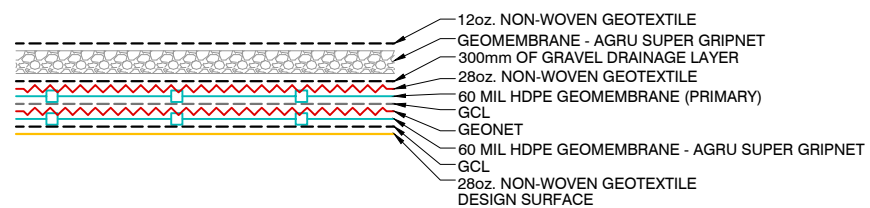
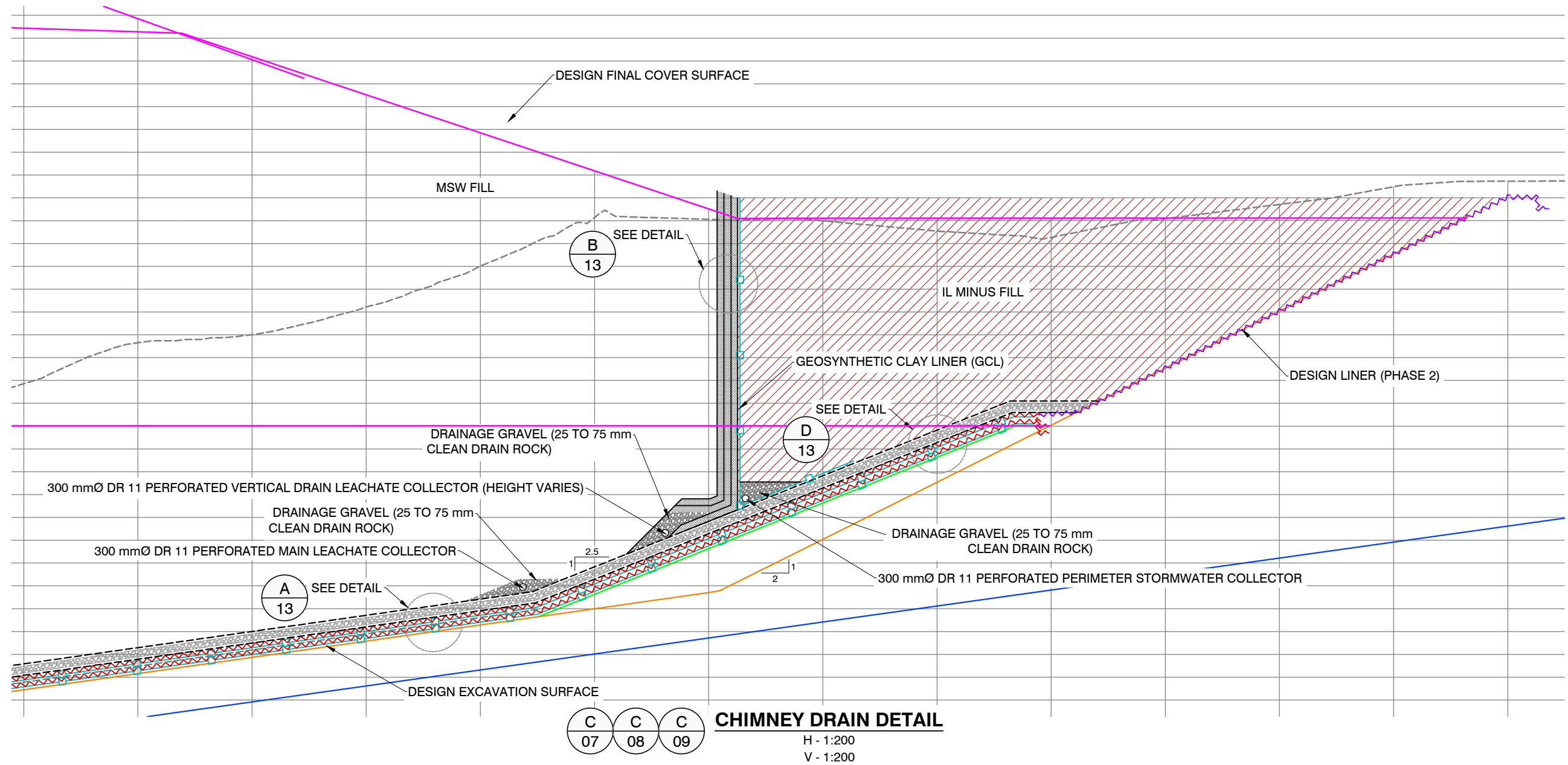
NORTHWIN LANDFILL DESIGN
OPERATION AND CLOSURE PLAN
UPDATE

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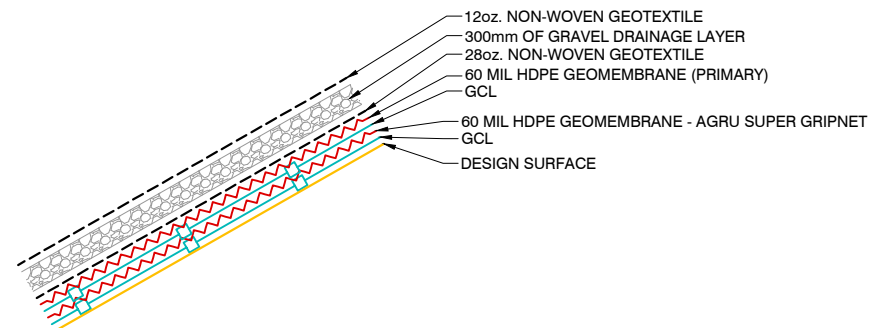
LINER SURFACE CUT AND FILL

SCALE: 1:1500	DATE: 2026/09/11 yyyy/mm/dd	PROJECT NO: PRJ 24074
DESIGNED	-	DRAWING NO:
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CHECKED	TS	

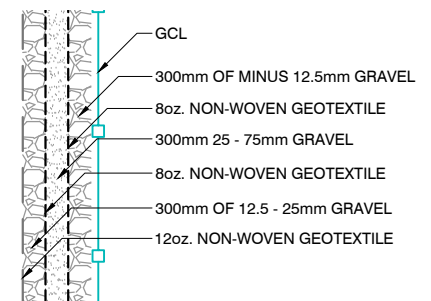
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A
13
BOTTOM LAYER BASE DETAIL
SCALE 1:100



D
13
BOTTOM LAYER SLOPED DETAIL
SCALE 1:100



B
13
CHIMNEY DRAIN DETAIL
SCALE 1:100



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LEGEND:

CLIENT:



PROJECT:

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OPERATION AND CLOSURE PLAN
UPDATE**

TITLE:

**CHIMNEY DRAIN AND LINER
DETAILS**

SCALE:

1:200

DATE:

2026/09/11
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

DRAWN

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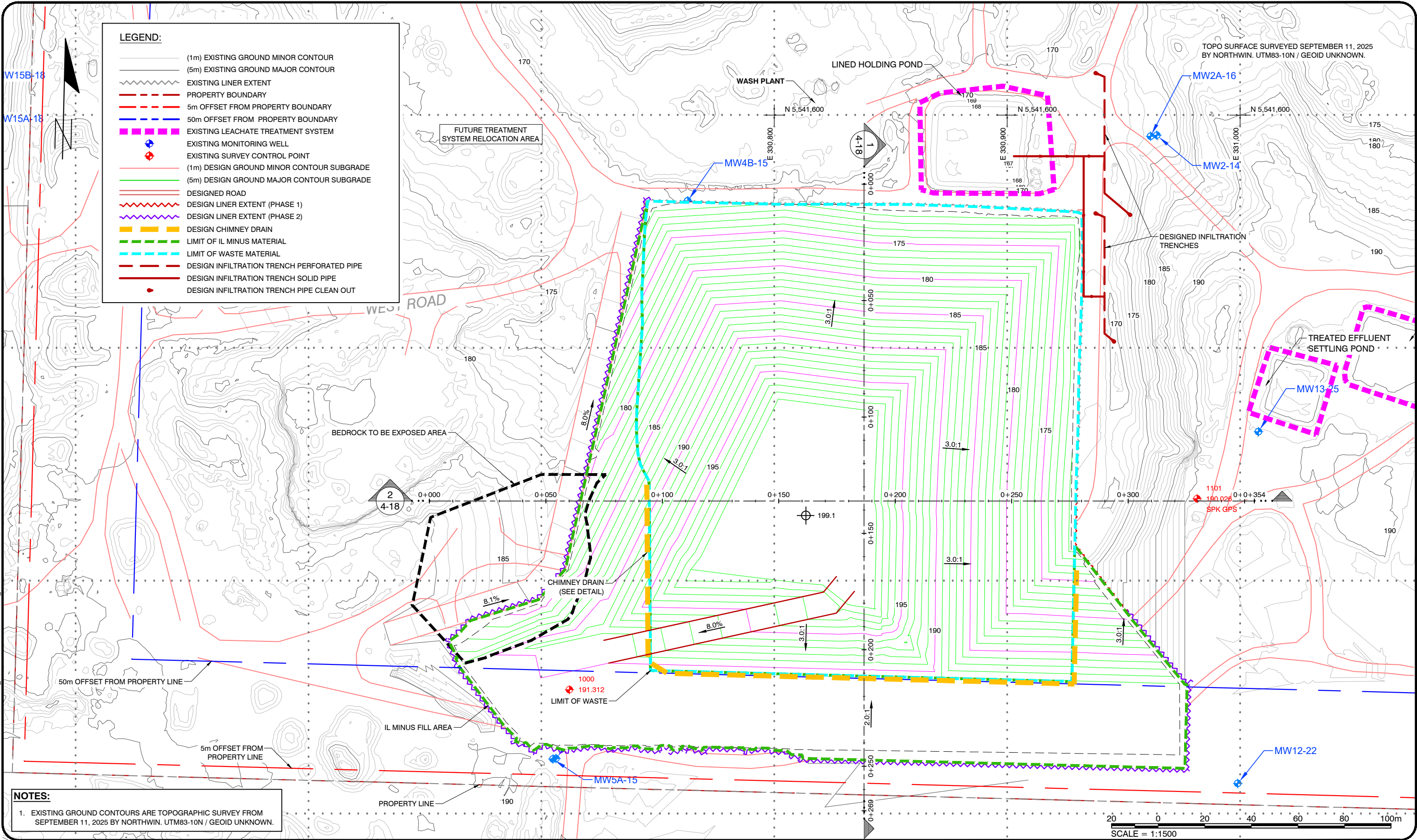
DRAWING NO:

EP

TS

FIGURE 4-7

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LEGEND:

CLIENT:



PROJECT:

NORTHWIN LANDFILL DESIGN
OPERATION AND CLOSURE PLAN
UPDATE

TITLE:

FINAL LANDFILL CONTOURS
PLAN VIEW

SCALE:

1:1500

DATE:

2026/09/11
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

DRAWN

CHECKED

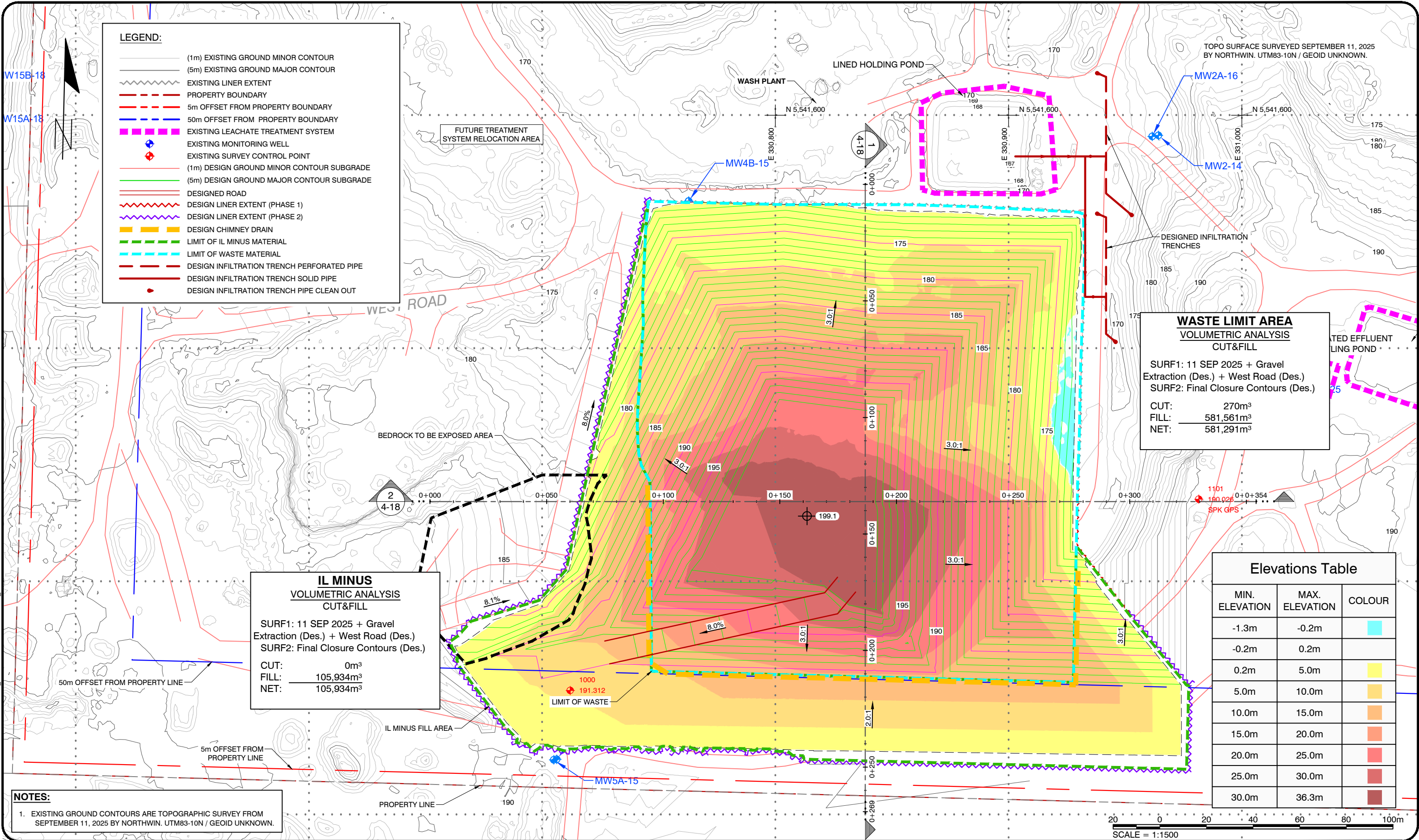
DRAWING NO:

EP

TS

FIGURE 4-8

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LEGEND:

CLIENT:



PROJECT:

NORTHWIN LANDFILL DESIGN
OPERATION AND CLOSURE PLAN
UPDATE

TITLE:

FINAL LANDFILL CONTOURS CUT
AND FILL

SCALE:

1:1500

DATE:

2026/09/11
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

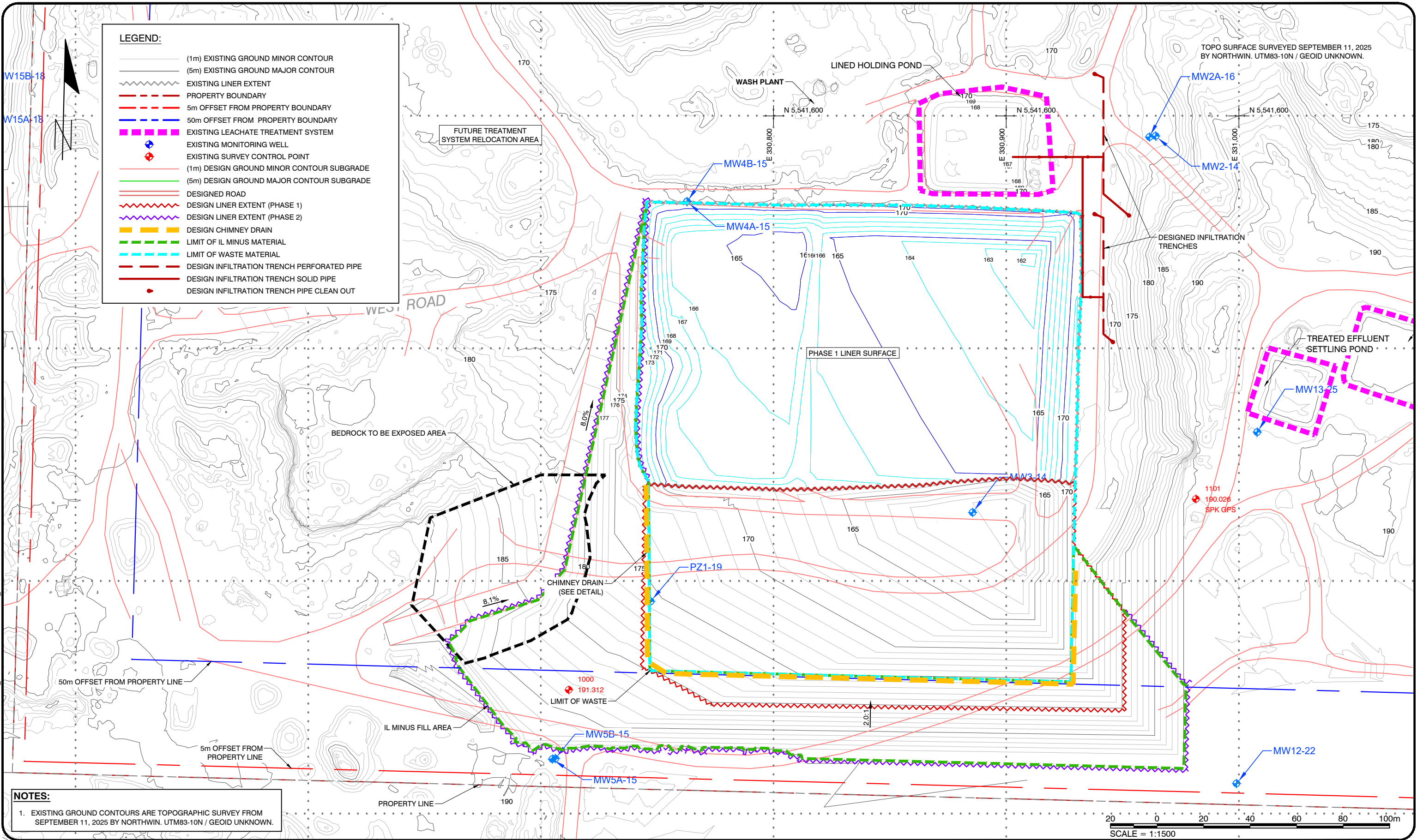
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DRAWING NO:

FIGURE 4-9

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NOTES:
1. EXISTING GROUND CONTOURS ARE TOPOGRAPHIC SURVEY FROM SEPTEMBER 11, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN.



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LEGEND:

CLIENT:



PROJECT:

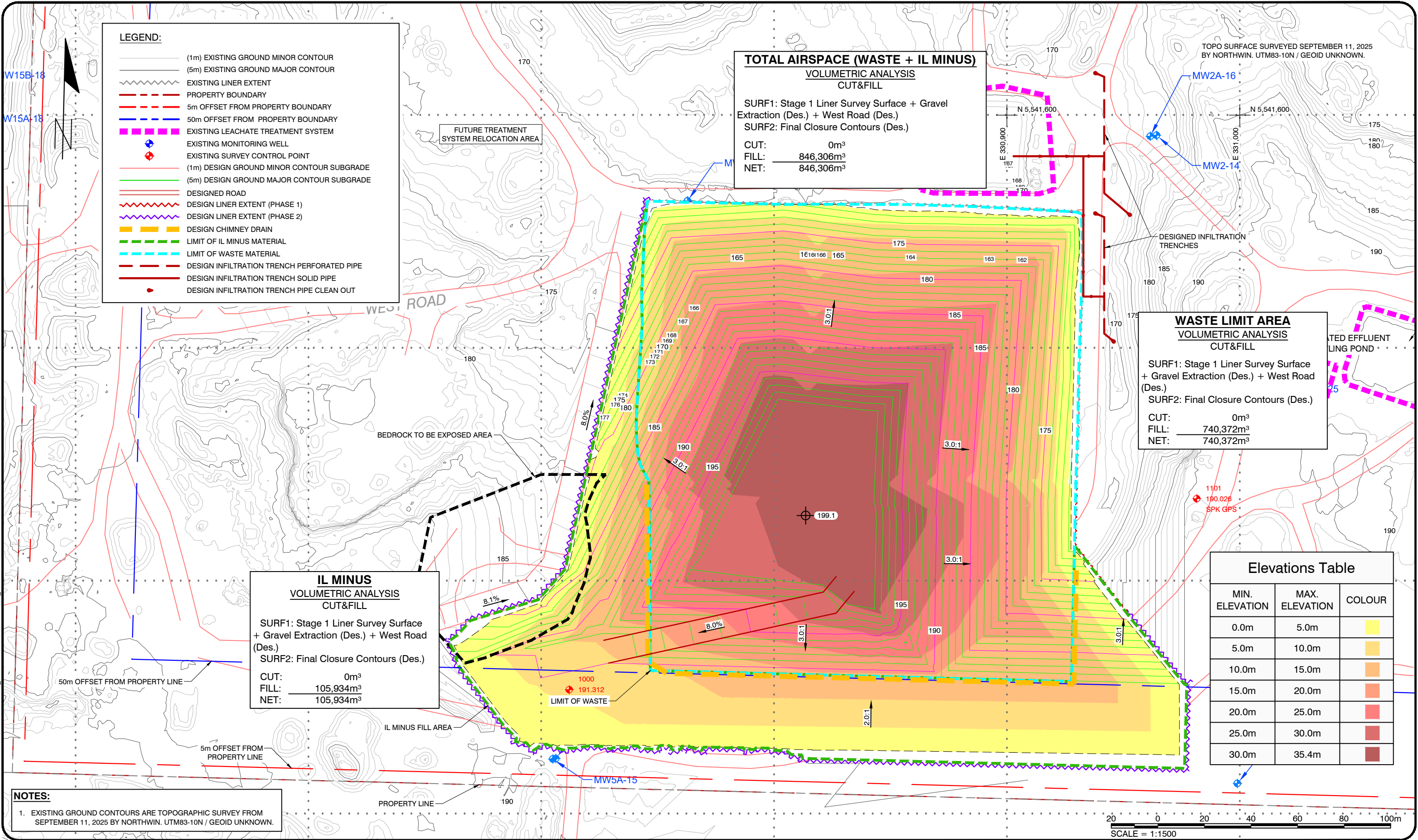
NORTHWIN LANDFILL DESIGN
OPERATION AND CLOSURE PLAN
UPDATE

TITLE:

BOTTOM OF STAGE 1 AND 2
SURFACE CONTOURS

SCALE: 1:1500	DATE: 2026/09/11 yyyy/mm/dd	PROJECT NO: PRJ 24074
DESIGNED	DRAWING NO:	
DRAWN EP	FIGURE 4-9A	
CHECKED	TS	

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LEGEND:

CLIENT:



PROJECT:

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OPERATION AND CLOSURE PLAN
UPDATE

TITLE:

TOTAL LANDFILL AIRSPACE CUT
AND FILL

SCALE:

1:1500

DATE:

2026/09/11
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

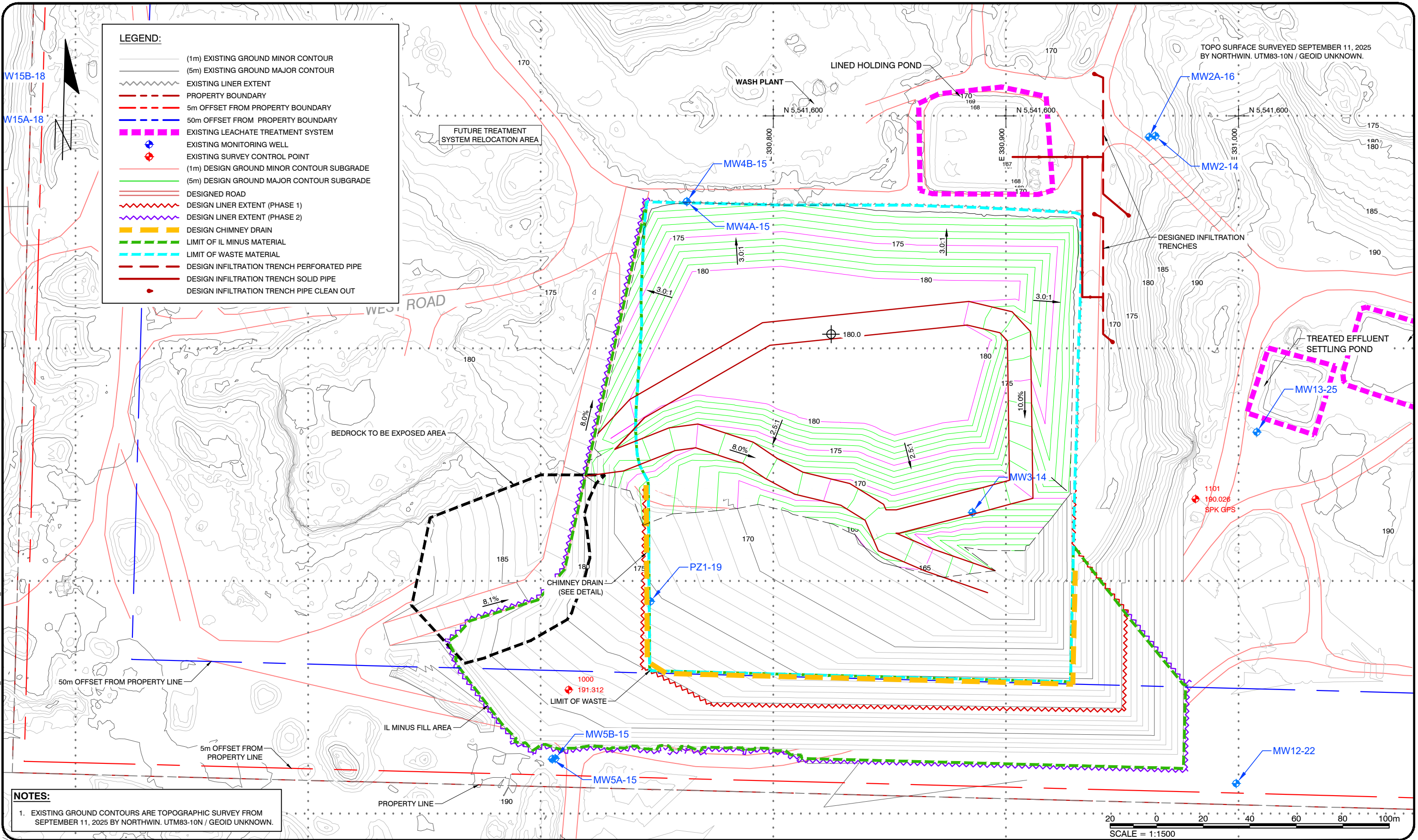
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FIGURE 4-9B

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LEGEND:

CLIENT:



PROJECT:

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OPERATION AND CLOSURE PLAN
UPDATE

TITLE:

PHASE 1 DESIGN CONTOURS

SCALE:

1:1500

DATE:

2026/09/11

yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

DRAWN

CHECKED

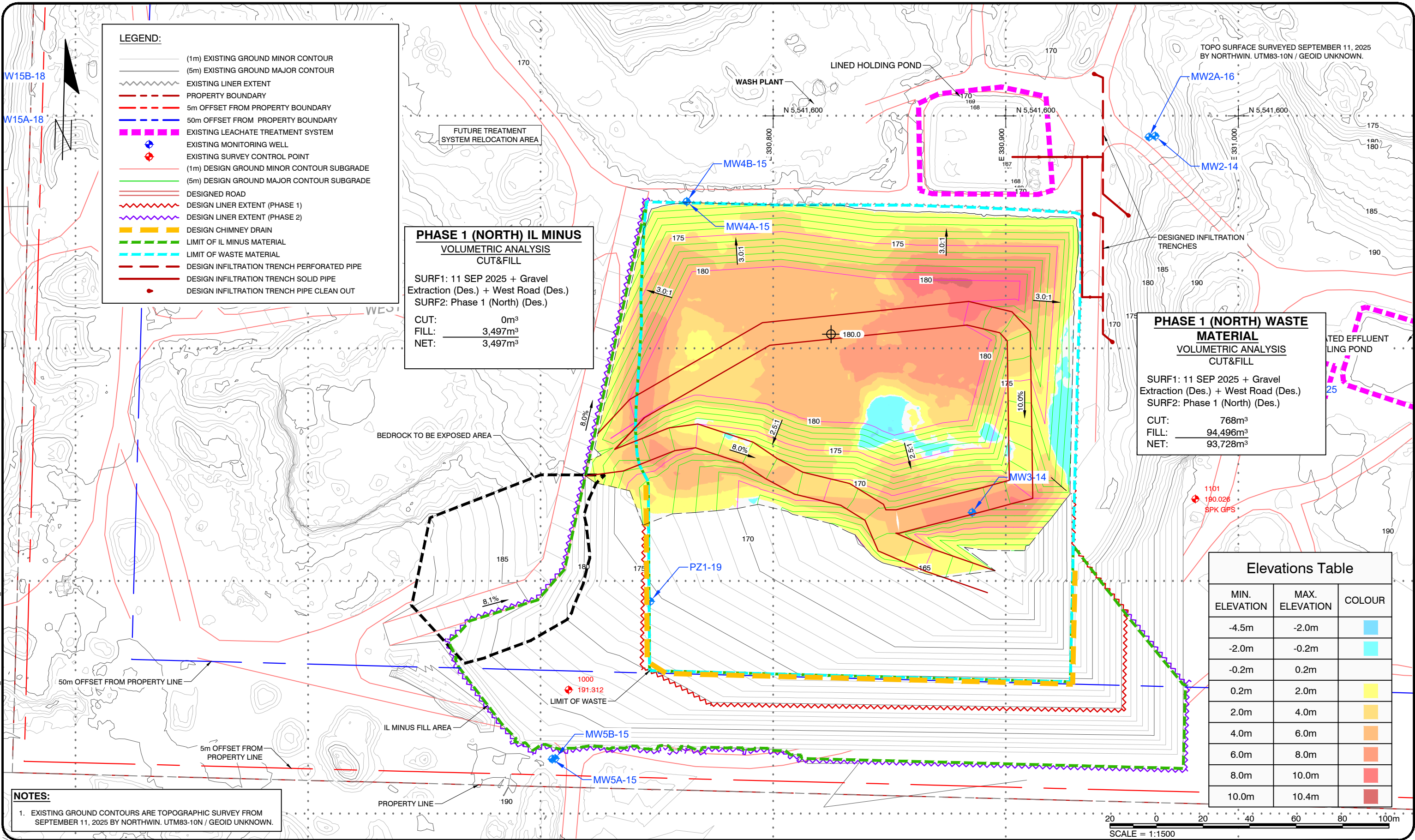
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FIGURE 4-10

EP

TS

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LEGEND:

CLIENT:



PROJECT:

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OPERATION AND CLOSURE PLAN
UPDATE

TITLE:

PHASE 1 CUT AND FILL

SCALE:

1:1500

DATE:

2026/09/11
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

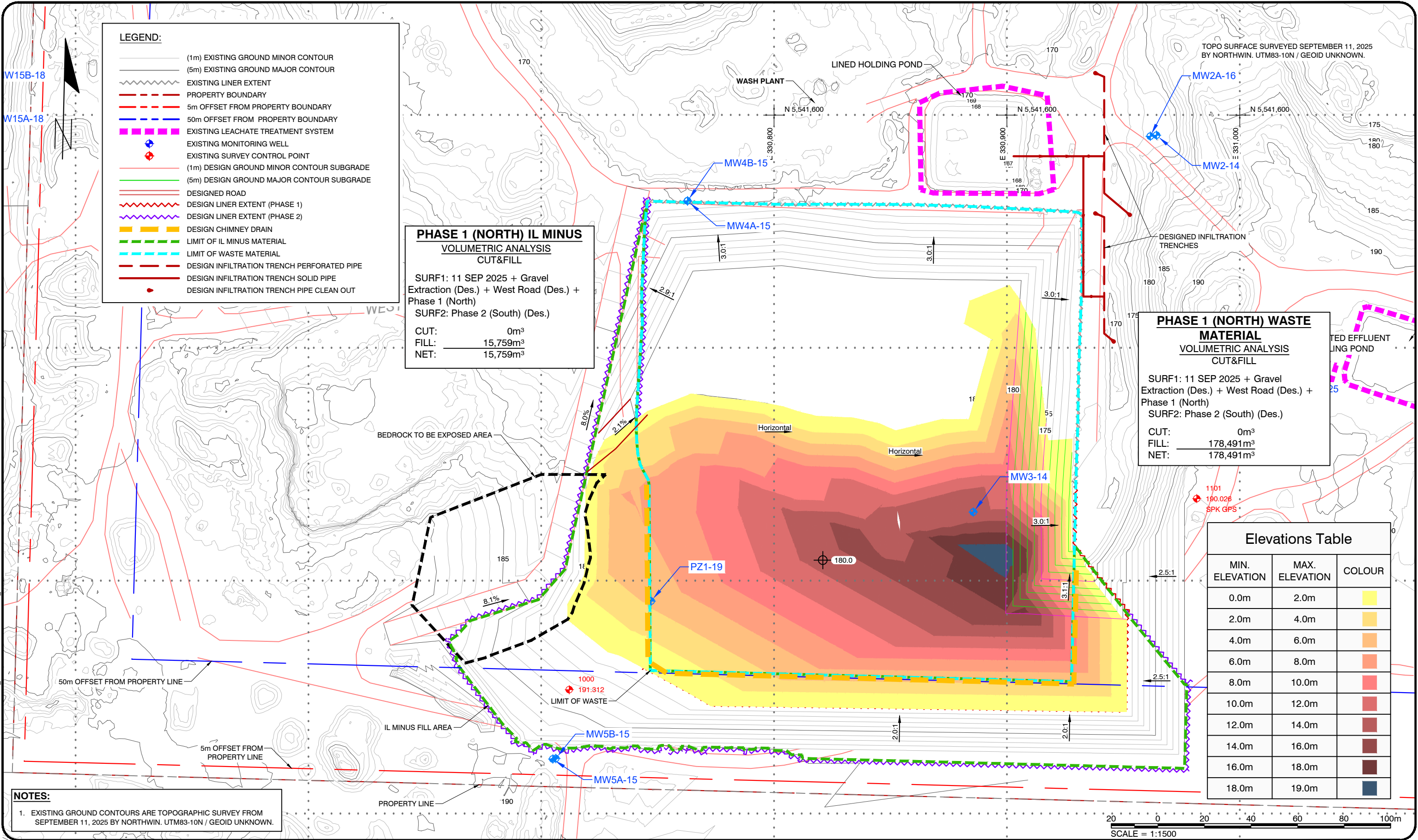
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FIGURE 4-11

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LEGEND:

- (1m) EXISTING GROUND MINOR CONTOUR
- (5m) EXISTING GROUND MAJOR CONTOUR
- EXISTING LINER EXTENT
- PROPERTY BOUNDARY
- 5m OFFSET FROM PROPERTY BOUNDARY
- 50m OFFSET FROM PROPERTY BOUNDARY
- EXISTING LEACHATE TREATMENT SYSTEM
- EXISTING MONITORING WELL
- EXISTING SURVEY CONTROL POINT
- (1m) DESIGN GROUND MINOR CONTOUR SUBGRADE
- (5m) DESIGN GROUND MAJOR CONTOUR SUBGRADE
- DESIGNED ROAD
- DESIGN LINER EXTENT (PHASE 1)
- DESIGN LINER EXTENT (PHASE 2)
- DESIGN CHIMNEY DRAIN
- LIMIT OF IL MINUS MATERIAL
- LIMIT OF WASTE MATERIAL
- DESIGN INFILTRATION TRENCH PERFORATED PIPE
- DESIGN INFILTRATION TRENCH SOLID PIPE
- DESIGN INFILTRATION TRENCH PIPE CLEAN OUT

PHASE 1 (NORTH) IL MINUS
VOLUMETRIC ANALYSIS
CUT&FILL

SURF1: 11 SEP 2025 + Gravel
Extraction (Des.) + West Road (Des.) +
Phase 1 (North)
SURF2: Phase 2 (South) (Des.)
CUT: 0m³
FILL: 15,759m³
NET: 15,759m³

PHASE 1 (NORTH) WASTE
MATERIAL
VOLUMETRIC ANALYSIS
CUT&FILL

SURF1: 11 SEP 2025 + Gravel
Extraction (Des.) + West Road (Des.) +
Phase 1 (North)
SURF2: Phase 2 (South) (Des.)
CUT: 0m³
FILL: 178,491m³
NET: 178,491m³

Elevations Table

MIN. ELEVATION	MAX. ELEVATION	COLOUR
0.0m	2.0m	
2.0m	4.0m	
4.0m	6.0m	
6.0m	8.0m	
8.0m	10.0m	
10.0m	12.0m	
12.0m	14.0m	
14.0m	16.0m	
16.0m	18.0m	
18.0m	19.0m	

NOTES:

- EXISTING GROUND CONTOURS ARE TOPOGRAPHIC SURVEY FROM SEPTEMBER 11, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN.



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- Landfill Closure
- Environmental Monitoring

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Phone: (604) 986-7723

LEGEND:

CLIENT:



PROJECT:

NORTHWIN LANDFILL DESIGN
OPERATION AND CLOSURE PLAN
UPDATE

TITLE:

PHASE 2 CUT AND FILL

SCALE:

1:1500

DATE:

2026/09/11
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

DRAWN

CHECKED

-

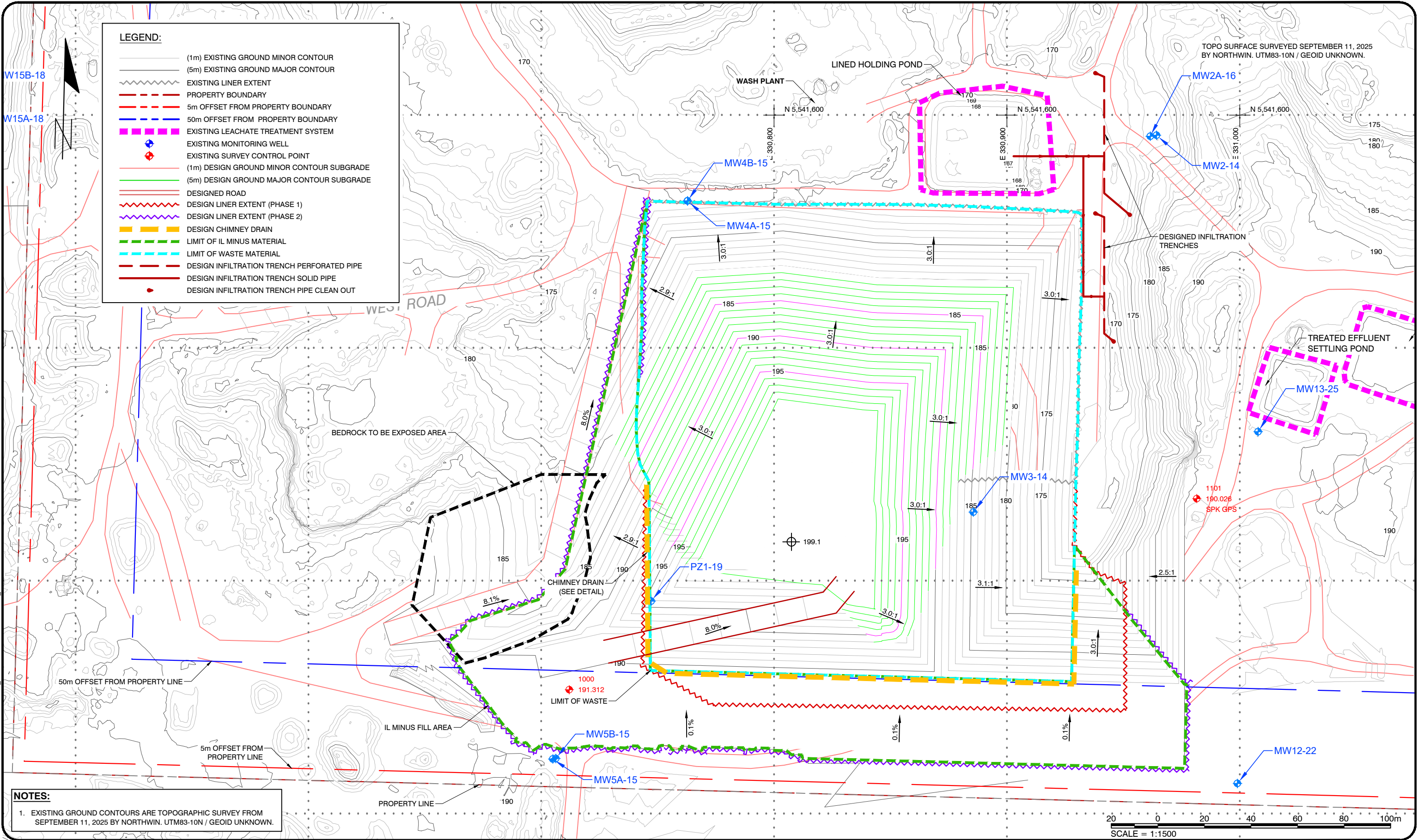
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TS

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FIGURE 4-13

PDF GENERATED by: Eduardo Kugler Pamplona 19/11/2026 5:27 PM X:\PRJ\PRJ24\PRJ24074 - NORTHWIN LANDFILL 2024 ENGINEERING\06 AUTOCAD DRAWINGS\01 DRAWINGS\2025 ENGINEERING\PRJ24074 PHASE 4 DES.DWG



NOTES:
1. EXISTING GROUND CONTOURS ARE TOPOGRAPHIC SURVEY FROM SEPTEMBER 11, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN.



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Phone: (604) 986-7723

LEGEND:

CLIENT:



PROJECT:

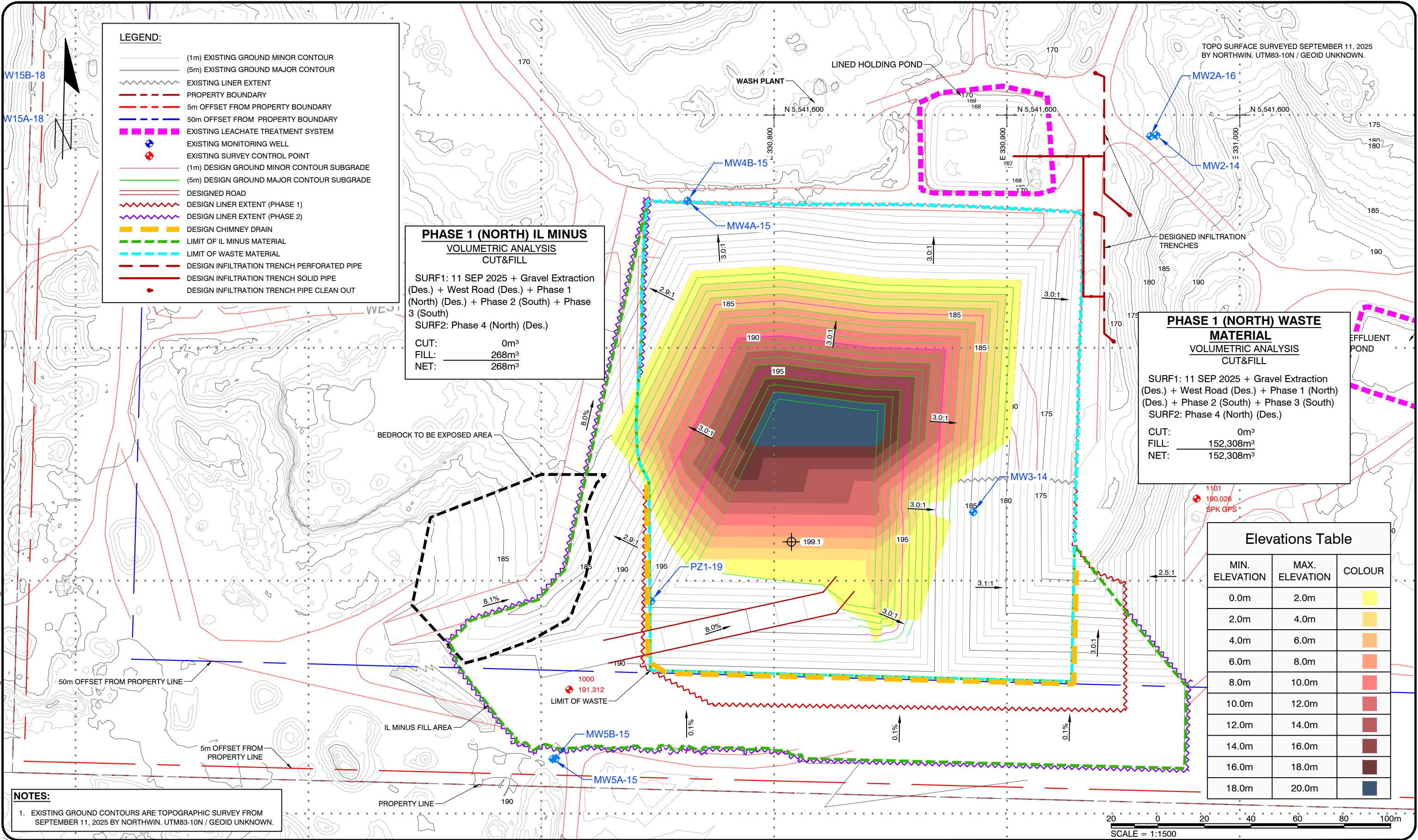
NORTHWIN LANDFILL DESIGN
OPERATION AND CLOSURE PLAN
UPDATE

TITLE:

PHASE 4 DESIGN CONTOURS

SCALE: 1:1500	DATE: 2026/09/11 yyyy/mm/dd	PROJECT NO: PRJ 24074
DESIGNED	-	DRAWING NO:
DRAWN	EP	FIGURE 4-16
CHECKED	TS	

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LEGEND:

- (1m) EXISTING GROUND MINOR CONTOUR
- (5m) EXISTING GROUND MAJOR CONTOUR
- EXISTING LINER EXTENT
- PROPERTY BOUNDARY
- 5m OFFSET FROM PROPERTY BOUNDARY
- 50m OFFSET FROM PROPERTY BOUNDARY
- EXISTING LEACHATE TREATMENT SYSTEM
- EXISTING MONITORING WELL
- EXISTING SURVEY CONTROL POINT
- (1m) DESIGN GROUND MINOR CONTOUR SUBGRADE
- (5m) DESIGN GROUND MAJOR CONTOUR SUBGRADE
- DESIGNED ROAD
- DESIGN LINER EXTENT (PHASE 1)
- DESIGN LINER EXTENT (PHASE 2)
- DESIGN CHIMNEY DRAIN
- LIMIT OF IL MINUS MATERIAL
- LIMIT OF WASTE MATERIAL
- DESIGN INFILTRATION TRENCH PERFORATED PIPE
- DESIGN INFILTRATION TRENCH SOLID PIPE
- DESIGN INFILTRATION TRENCH PIPE CLEAN OUT

PHASE 1 (NORTH) IL MINUS

VOLUMETRIC ANALYSIS
CUT&FILL

SURF1: 11 SEP 2025 + Gravel Extraction
(Des.) + West Road (Des.) + Phase 1
(North) (Des.) + Phase 2 (South) + Phase
3 (South)
SURF2: Phase 4 (North) (Des.)

CUT: 0m³
FILL: 268m³
NET: 268m³

PHASE 1 (NORTH) WASTE

MATERIAL
VOLUMETRIC ANALYSIS
CUT&FILL

SURF1: 11 SEP 2025 + Gravel Extraction
(Des.) + West Road (Des.) + Phase 1 (North)
(Des.) + Phase 2 (South) + Phase 3 (South)
SURF2: Phase 4 (North) (Des.)

CUT: 0m³
FILL: 152,308m³
NET: 152,308m³

Elevations Table

MIN. ELEVATION	MAX. ELEVATION	COLOUR
0.0m	2.0m	
2.0m	4.0m	
4.0m	6.0m	
6.0m	8.0m	
8.0m	10.0m	
10.0m	12.0m	
12.0m	14.0m	
14.0m	16.0m	
16.0m	18.0m	
18.0m	20.0m	

NOTES:

- EXISTING GROUND CONTOURS ARE TOPOGRAPHIC SURVEY FROM SEPTEMBER 11, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN.



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LEGEND:

CLIENT:



PROJECT:

NORTHWIN LANDFILL DESIGN
OPERATION AND CLOSURE PLAN
UPDATE

TITLE:

PHASE 4 CUT AND FILL

SCALE:

1:1500

DATE:

2026/09/11

yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

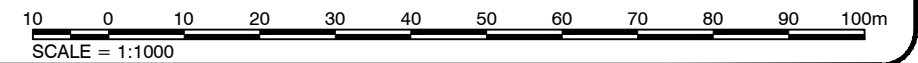
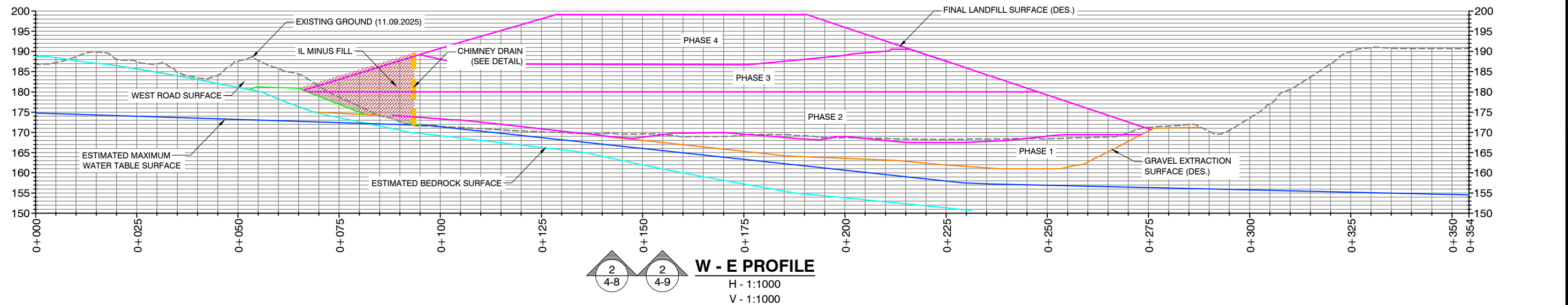
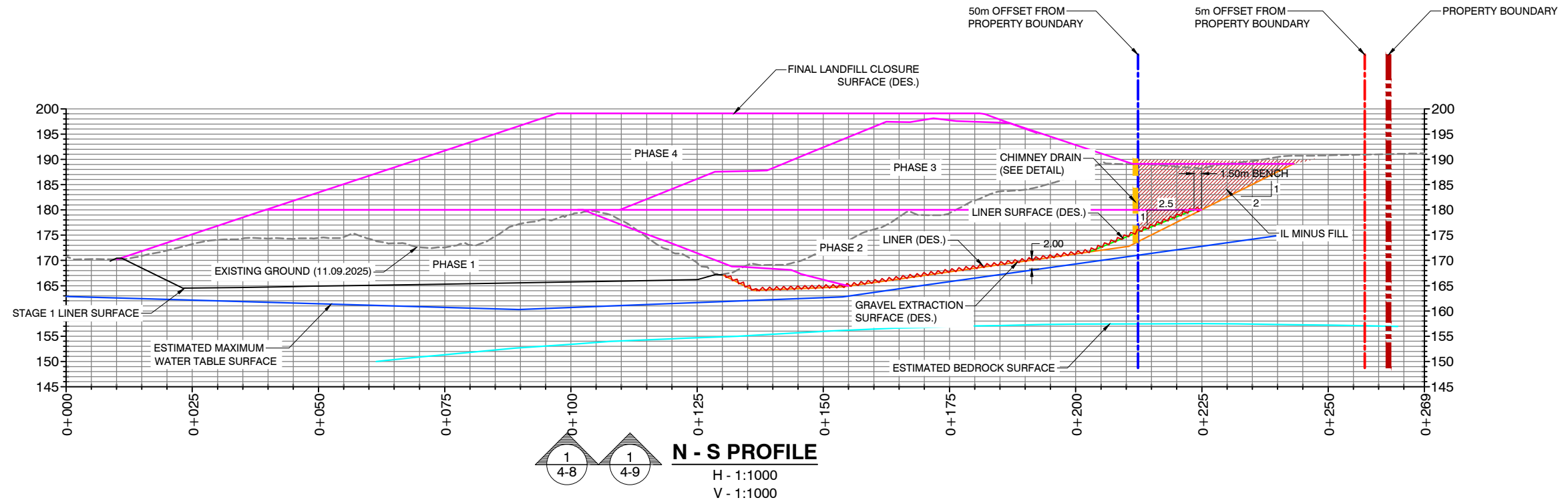
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DRAWING NO:

FIGURE 4-17

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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

CLIENT:



PROJECT:

NORTHWIN LANDFILL DESIGN
OPERATION AND CLOSURE PLAN
UPDATE

TITLE:

PROFILES

SCALE:

1:1000

DATE:

2026/09/11
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

DRAWN

CHECKED

DRAWING NO:

FIGURE 4-18

5 LIFESPAN ANALYSIS

This chapter describes estimated lifespan of the landfill based on the available information and assumed lifespan parameters.

5.1 Landfill Allowable Criteria

The maximum allowable annual discharge volume of the Northwin Landfill is 45,000 tonnes per year, and the maximum design capacity relative to the September 11th, 2025, survey is 581,561 m³. The approved landfill footprint defines the limits of waste. The area of the limit of waste is 3.77 Ha, (approximately 185 m E-W by 200 m N-S).

5.2 Volume Analysis

The available volume in each phase of the landfill was determined using Autodesk Civil 3D 2025, which determines the volume between digital topographic surfaces. Table 4-1 presents a summary of the volume analysis for each of the phases, taking into consideration the air space that will be consumed by the leachate collection system in Phase 2 (discussed in Chapter 6). The air space that will be consumed by the final cover does not impact on the volume analysis as the surface on which the volumetric calculations are based is the liner surface (Figure 4-5) vs. final design contours for top of intermediate cover (Figure 4-8).

The base liner and leachate collection system is comprised of GCL, 1.5 mm HDPE geomembrane, leak detection layer, GCL, 1.5 mm HDPE geomembrane, 28oz non-woven geotextile, 300mm of gravel drainage layer and woven geotextile. In total, the leachate collection system is 320 mm thick. The contour elevations shown on the borrow plans are base of liner elevations. As such, the volume of liner for a thickness of 0.32 m to the top of the leachate collection system has been deducted to estimate the airspace capacity for waste and operational cover.

Table 4-1 reports the capacity of each phase including base liner volumes, and the remaining phase capacity for waste and operational cover. Once again, the phase capacity for waste and operational cover was calculated by subtracting the liner and leachate collection system volume requirements from the total phase capacity. All the lifespan and volume analysis results in the following sections are based on final contour and phasing plans; see Figures 4-8 to 4-18.

In total, 33,655 m³ of the total available airspace (gross) will be consumed by the leachate collection systems that will be constructed on top of the liner surface shown in Figure 4-5, leaving 547,906 m³ of airspace for waste landfilling, operational cover placement and road construction, as detailed in Table 4-1.

5.3 Lifespan Parameters

The amount of time required to completely fill the available airspace of the landfill was determined based on the following input parameters:

5.3.1 Waste Density

Waste compaction at the Northwin Landfill involves using heavy equipment to crush and compress waste during disposal. This process not only conserves airspace but also helps to reduce issues associated with litter, odours and vectors. Northwin Landfill utilizes medium sized excavators to manage the active filling area as well as compact the waste. It is estimated, based on the yearly survey data presented in

the 2025 Annual Report that a waste density of 1.7 tonnes/m³ was historically achieved since commencement of waste acceptance after material was diverted at the active face by Northwin. This degree of compaction is considered very good for a small sized landfill and reflects the operator's knowledge of the site, as well as their experience in landfill operations. Based on total air space consumption since commencement of waste acceptance as per survey, the total volume of waste and operational cover landfilled to September 2025 was 160,439 m³, as determined from a cut and fill analysis presented in Figures 5-1 and 5-2. It is estimated that to the end of the year, the total volume consumed was 167,871 m³, as tabulated below. The total tonnage received to the end of 2025 is 290,979 tonnes. This translates to an airspace utilization density of 1.7 tonnes/m³. This density is utilized for all air space consumption and lifespan projections in this DOCP.

Table 5-1 below presents waste density and waste to cover ratios at the site over the past 7 years.

Table 5-1: Summary of Operations at the Northwin Landfill since 2019

Year	Annual Landfilled Tonnage (tonnes)	Annual Cover Soil Usage (m³)	Total Airspace Consumed Per Year for Waste Filling Activities (m³)	Waste Density (tonnes/m³)	Waste to Cover Ratio (vol/vol)
2019	6,548	1,889	3,778	1.7	2
2020	13,636	3,933	7,867	1.7	2
2021	50,990	14,709	29,417	1.7	2
2022	44,814	12,927	25,854	1.7	2
2023	124,078	35,792	71,583	1.7	2
2024	26,285	7,582	15,164	1.7	2
2025	24,628	7,104	14,208	1.7	2
TOTAL	290,979	83,936	167,871	1.7	
AVERAGE	41,998	12,680	25,436	1.7	2

5.3.2 Waste to Cover Ratio

Waste to cover ratio is defined as the volume of waste to the volume of cover material used. It is ideal to have a waste to cover ratio of 3:1 or greater, which reflects efficient use of cover material, but this is often difficult at smaller landfills. As presented in Table 5-1, a waste to cover ratio of 2:1 was achieved at the Northwin Landfill in 2025 and an average ratio of 2:1 was achieved from 2019 to 2025. For the lifespan Analysis, we assumed a waste to cover ratio of 2:1.

5.3.3 Settlement

Based on experience at numerous sites, landfills settle over time creating additional air space. To account for the additional air space that will be created because of this settlement, our analysis factors in a 10% settlement rate.

A summary of the lifespan parameters used in the analysis is presented below:

- Waste to cover ratio of 2:1 (vol/vol)
- Waste density of 1.80 tonnes/m³
- Settlement Rate: 10% of the Waste Volume
- Annual incoming waste tonnage: 45,000 tonnes/year

Please note that the annual waste disposal quantity for the year 2025 was estimated to be 24,628 tonnes (see Table 5-1). For future years the lifespan projection assumes that the landfill will receive the maximum annual permitted tonnage of 45,000 tonnes/year.

5.4 Landfill Capacity by Phase and Lifespan Analysis

A summary of the air space available for landfilling as well as air space that will be consumed by the leachate collection system was presented in Table 4-1. Based on the available airspace, the estimated lifespan for each phase was calculated and is summarized in Table 5-3 below. A detailed lifespan analysis is presented in Table 5-2.

Table 5-3: Lifespan Analysis Results Summary

Phase	Completion Year	Span
Phase 1 (North)	2028	3
Phase 2 (South)	2033	5
Phase 3 (South)	2038	5
Phase 4 (North)	2041	3
Total		16

5.4.1 Lifespan Analysis Results

Based on the analysis and the summary presented in Table 5-3, the landfill will have a lifespan of 16 years from 2026 based on the current design. As the landfill is well inside property boundaries, NWE may choose to apply for an eastward lateral expansion of the facility once aggregate is removed from that area. In that case, the expansion concept would be developed in the next DOCP update, scheduled for July 2031.

TABLES



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Table 5-2
Lifespan Analysis: Existing Operating Conditions

Year	Landfilled Waste		Cumulative Waste	Cover Soil	Cumulative Cover	Settlement	Materials Used	Net Airspace	Cumulative Airspace	Phase	Cumulative Phase	Cover Soil Used in Phase	Phase End/Begin
	tonnes	m ³	m ³	m ³	m ³	m ³	In Landfill	Consumed	Consumed	Capacity	Capacity	m ³	
2019	6,548												
2020	13,636												
2021	50,909												22,167 m3 came from original lined cell in 2021
2022	44,814												
2023	124,078												57,167 m3 came from original lined cell in 2023
2024	26,285												
2025	24,628	10,262	10,262	5,131	5,131	1,539	5,131	13,853	13,853				
2026	45,000	25,000	35,262	12,500	17,631	3,750	12,500	33,750	47,603				
2027	45,000	25,000	60,262	12,500	30,131	3,750	12,500	33,750	81,353				
2028	45,000	25,000	85,262	12,500	42,631	3,750	12,500	33,750	115,103	94,496	94,496	42,631	Ph 1 Remaining Ends
2029	45,000	25,000	110,262	12,500	55,131	3,750	12,500	33,750	148,853				
2030	45,000	25,000	135,262	12,500	67,631	3,750	12,500	33,750	182,603				
2031	45,000	25,000	160,262	12,500	80,131	3,750	12,500	33,750	216,353				
2032	45,000	25,000	185,262	12,500	92,631	3,750	12,500	33,750	250,103				
2033	45,000	25,000	210,262	12,500	105,131	3,750	12,500	33,750	283,853	178,491	272,987	62,500	Ph 2 Ends
2034	45,000	25,000	235,262	12,500	117,631	3,750	12,500	33,750	317,603				
2035	45,000	25,000	260,262	12,500	130,131	3,750	12,500	33,750	351,353				
2036	45,000	25,000	285,262	12,500	142,631	3,750	12,500	33,750	385,103				
2037	45,000	25,000	310,262	12,500	155,131	3,750	12,500	33,750	418,853				
2038	45,000	25,000	335,262	12,500	167,631	3,750	12,500	33,750	452,603	156,266	429,253	62,500	Ph 3 Ends
2039	45,000	25,000	360,262	12,500	180,131	3,750	12,500	33,750	486,353				
2040	45,000	25,000	385,262	12,500	192,631	3,750	12,500	33,750	520,103				
2041	45,000	25,000	410,262	12,500	205,131	3,750	12,500	27,803	547,906	118,653	547,906	37,500	Ph 4 Ends
TOTAL	744,628	385,262		192,631		57,789	192,631	547,906					

10%
2
1.8

per year
vol/vol
tonnes/m³

Total Lifespan 16 Years

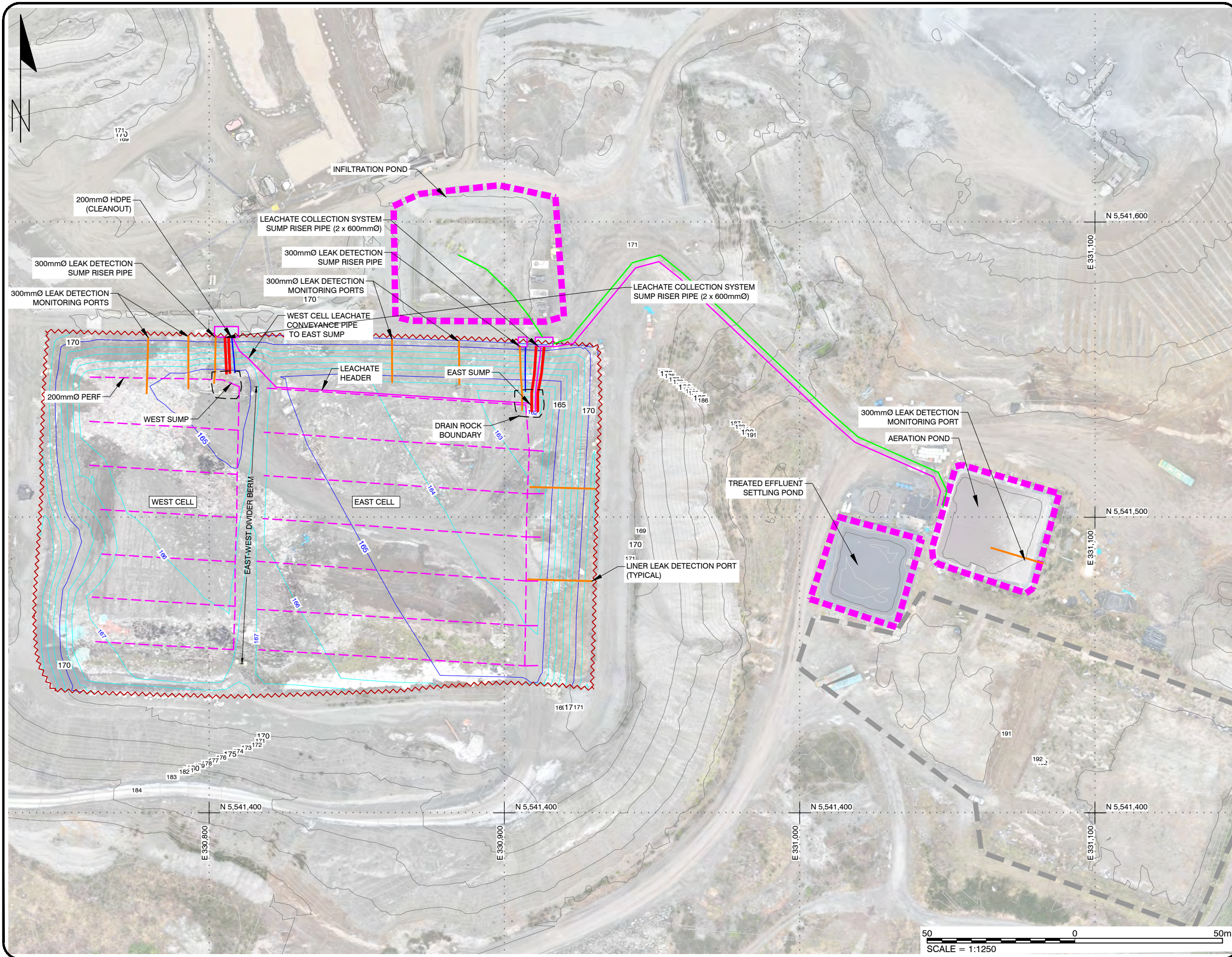
FIGURES



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HANSEN
ASSOCIATES



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Landfill Services Group

- Landfill Siting
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- 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)
- 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 SEPTEMBER 11, 2025
BY NORTHWIN. UTM83-10N / GEOID UNKNOWN
SITE ORTHO IMAGE BY NORTHWIN - SEP 11, 2025

CLIENT:



PROJECT:

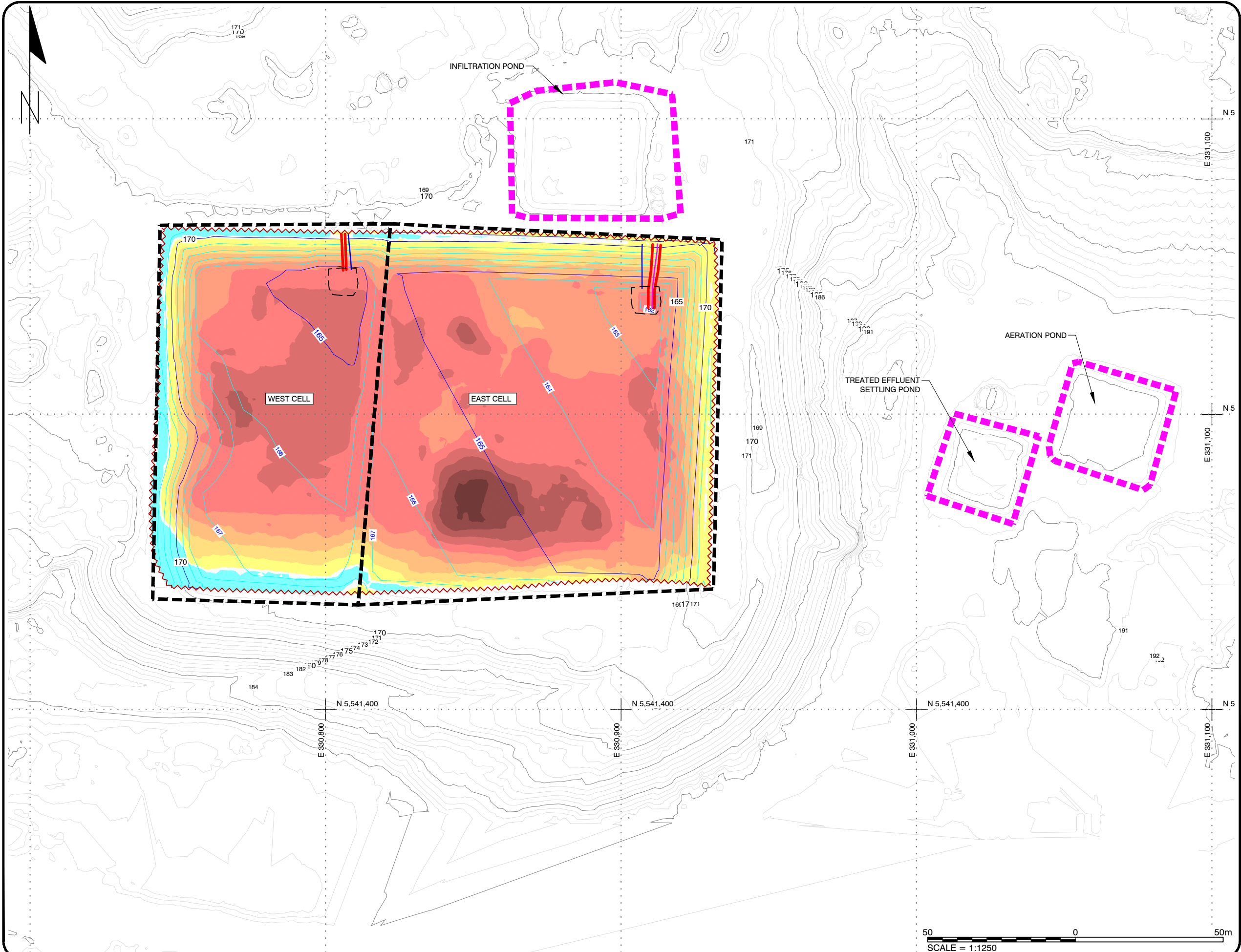
NORTHWIN LANDFILL DESIGN OPERATION
AND CLOSURE PLAN UPDATE

TITLE:

BOTTOM OF PHASE 1 SURFACE
CONTOURS

SCALE:	DATE:	PROJECT NO:
1:1250	2026/09/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO: FIGURE 5-1
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CHECKED	TS	

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- Environmental Monitoring

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North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723

LEGEND:

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

Elevations Table		
MIN. ELEVATION	MAX. ELEVATION	COLOUR
-1.5m	-0.2m	
-0.2m	0.2m	
0.2m	2.0m	
2.0m	4.0m	
4.0m	6.0m	
6.0m	8.0m	
8.0m	10.0m	
10.0m	12.0m	
12.0m	14.0m	
14.0m	16.0m	
16.0m	17.0m	

STAGE 1 EAST & WEST
NET FILL (WASTE IN PLACE): 160,439 m³
CAPACITY: 207,784 m³
REMAINING: 47,345 m³
EXPECTED FILL VOLUME/YEAR: 34,615 m³
LIFESPAN REMAINING = 1.37 YEARS

BASE SURFACE: STAGE 1 LINER
COMPARISON SURFACE: EXISTING TOPOGRAPHY
SEPTEMBER 11, 2025

TOPO SURFACE SURVEYED SEPTEMBER 11, 2025
BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

CLIENT:



PROJECT:

NORTHWIN LANDFILL DESIGN OPERATION
AND CLOSURE PLAN UPDATE

TITLE:

PHASE 1 WASTE IN PLACE CUT
AND FILL

SCALE:	DATE:	PROJECT NO:
1:1250	2026/09/11 yyyy/mm/dd	PRJ 24074
DESIGNED	-	DRAWING NO: FIGURE 5-2
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CHECKED	TS	

FIGURE 5-2

6 ENVIRONMENTAL CONTROLS

As required in the Landfill Criteria for Municipal Solid Waste (Landfill Criteria), this section outlines the environmental controls for the Landfill. Changes and additions to environmental control infrastructure at the site are generally reported to ENV through the Landfill Annual Report and DOCP updates.

The Criteria recommends that landfill leachate, groundwater, stormwater and landfill gas be managed in accordance with management plans that can be regularly updated to ensure their effectiveness in meeting regulatory requirements such as those listed in the Landfill OC. This chapter provides description of the infrastructure installed to mitigate and prevent environmental impacts attributable to the Landfill.

6.1 Leachate Management Plan

As specifically outlined in the Landfill Criteria, an engineered liner system, leachate collection, and Leachate Management Plan (LMP) are required for all new landfill phases built on existing ground. Section 1.4 of the OC specifically describes the requirements for the Leachate Management Works at the site.

6.1.1 Leachate Generation Potential

Northwin Environmental Landfill receives about 1481.8 mm of precipitation annually. Thus, the leachate generation potential at the site is considered to be high.

6.1.2 Leachate Generation Estimate

To estimate the amount of leachate being generated currently and the future projections, SHA conducted a water balance analysis for the site using the Hydrological Evaluation of Landfill Performance (HELP) model.

The water balance examines the relationship between precipitation and evapotranspiration, the process involving the return of water to the atmosphere through evaporation and transpiration through vegetation. A 50-year simulation of leachate production at the site was run using the HELP model. The results are summarized in Chapter 10. The average annual precipitation created by the HELP model is 1,366.59 mm, while the actual average recorded on site is higher at 1,481.8 mm/yr. Based on the model generated average precipitation of 1,366.59 mm/yr, the HELP Model predicts that 896.2 mm/yr of leachate will be generated based on the average climate data and predicted evapotranspiration. Thus, HELP predicts that under average conditions 65.6% of precipitation falling on the landfill footprint will be converted to leachate, with the balance being lost through evapotranspiration and runoff.

SHA also ran the model using extreme weather data, based on historic data (1965-2007) from Campbell River Climate Station. If extreme weather conditions are considered, the model generated 1,816.04 mm/yr of precipitation and predicts 1,230 mm/year of leachate will be generated for the present conditions. Thus, under extreme conditions, HELP predicts that 67.7% of precipitation will be converted to leachate.

In practical terms, any water that falls on active portions of the landfill, including contact water that runs off unclosed areas of the landfill is managed as leachate. Therefore, leachate flows will include infiltration, run-off from the active face and areas capped with intermediate cover as well as moisture that is released from waste during the decomposition process. Based on the phasing plan as presented in Figures 4-8 through 4-17, SHA conducted a phase-by-phase estimation of leachate generation and contaminated runoff from the active face for both average and extreme weather conditions. The results

are summarized in Table 6-1a and 6-1b for Geomembrane cover system and 6-2a and 6-2b for Clay cover system.

Table 6-1a: Summary of Phase-by-Phase Leachate Generation for Average Climate Conditions – Geomembrane Cover

Phase	Leachate Only (m ³ /yr)	Contaminated Run-off (m ³ /yr)	Total (m ³ /yr)
Phase 1 (North)	20,254	1,871	22,125
Phase 2 (South)	16,866	1,553	18,419
Phase 3 (South)	14,204	1,304	14,204
Phase 4 (North)	16,130	1,465	16,130
All Phases closed with Final Cover	449	0	449

Table 6-1b: Summary of Phase-by-Phase Leachate Generation for Extreme Climate Conditions – Geomembrane Cover

Phase	Leachate Only (m ³ /yr)	Contaminated Run-off (m ³ /yr)	Total (m ³ /yr)
Phase 1 (North)	27,798	4,873	32,671
Phase 2 (South)	23,149	4,043	27,192
Phase 3 (South)	19,496	3,396	19,496
Phase 4 (North)	22,141	3,814	22,141
All Phases closed with Final Cover	622	0	622

Table 6-2a: Summary of Phase-by-Phase Leachate Generation for Average Climate Conditions – Clay Cover

Phase	Leachate Only (m ³ /yr)	Contaminated Run-off (m ³ /yr)	Total (m ³ /yr)
Phase 1 (North)	20,254	1,871	22,125
Phase 2 (South)	16,990	1,553	18,543
Phase 3 (South)	14,380	1,304	14,380
Phase 4 (North)	16,679	1,465	16,679
All Phases closed with Final Cover	1,336	0	1,336

Table 6-2b: Summary of Phase-by-Phase Leachate Generation for Extreme Climate Conditions – Clay Cover

Phase	Leachate Only (m ³ /yr)	Contaminated Run-off (m ³ /yr)	Total (m ³ /yr)
Phase 1 (North)	27,798	4,873	32,671
Phase 2 (South)	23,282	4,043	27,324
Phase 3 (South)	19,684	3,396	19,684
Phase 4 (North)	22,727	3,814	22,727
All Phases closed with Final Cover	1,569	0	1,569

Leachate generation will be at its maximum when Phase 4 (North) will be operational. Under average climate conditions, the maximum leachate generation with a geomembrane cover system is estimated to be 16,130 m³/year (0.51 L/s), while under the extreme climate condition it is 22,141 m³/year (0.7 L/s). With a Clay cover system, under average climate conditions, the maximum leachate generation is estimated to be 16,679 m³/year (0.53 L/s), while under the extreme climate condition it is 22,727 m³/year (0.72 L/s).

6.1.3 Leachate Management Strategy

Leachate management at the site is conducted to remain in compliance with Section 1.4 of OC 10769 (2019) and Amendment Letter of April 26th, 2022. Leachate is currently collected from the landfill cells via a series of perforated leachate collector pipes installed at the base liner system of the Engineered Landfill cells and conveyed to two sumps: Cell 1 (Phase 1) East Sump and Cell 1 (Phase 1) West Sump.

Leachate from the west sump is pumped into the east sump. Leachate collected in the east sump is then pumped up to the New Leachate Treatment Facility.

Section 1.4 of the OC and the 2022 amendment specify requirements for the New Leachate Management Works. Section 1.4.5 specifies that “the authorized works are leachate conveyance, treatment and discharge work including pumps, pipes, leachate treatment pond(s), treated leachate infiltration pond, flow monitoring works, and related appurtenances.”

The amendment to the permit dated April 26, 2022, added “treated leachate holding pond or tank” after “leachate treatment pond(s)” in the above section (Section 1.4.5).

Section 1.4.6 of the OC issued on August 1, 2019, specifies that, “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 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.”

The April 26th, 2022, amendment also added “the treated leachate holding pond must include from bottom to top a secondary 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.” after 1×10^{-7} cm/s in Section 1.4.6.

6.1.3.1 Leachate Collection System

As per the Cell 1 East and Ponds Construction Report, the leachate collection system includes perforated leachate collection pipes within a stone drainage blanket sloped towards the leachate sump. The leachate collection is composed of:

- 300 mm thick, 50 mm diameter, clear, stone drainage blanket (with minimal fines);
- Perforated leachate collection pipes with minimum diameter of 200 mm;
- Maximum 15 m lateral spacing (as per the Landfill Criteria) between leachate collectors;
- Maximum 50 m drainage path (as per the Landfill Criteria) for leachate to travel before it is intercepted by the leachate collectors;
- Clean-outs at each end of the leachate collectors;
- Leachate collection header pipe at the east end of the Landfill running towards the leachate collection sump at a minimum slope of 2%; and
- Leachate sump at elevation 161.1 m AMSL with two leachate sump riser pipes with minimum diameters of 600 mm.

Appendix D shows the record drawings of the leachate collection system.

Existing Phase 1 and planned Phase 2 expansion area leachate collectors are shown in Figures 3-2 and 6-1, respectively. Leachate generated in Phase 2 will be collected in a sump on the east side of Phase 2 and will be pumped to the East Sump of Phase 1. From there all collected leachate will be pumped to the leachate treatment pond. The leachate collection system for the Phase 2 Expansion area is also shown on Figure 6-1.

6.1.4 Leachate Treatment

The leachate treatment system was commissioned as per the 2021 DOCP (GHD, 2021). As per the leachate treatment concept outlined in the commissioning report (GHD, 2023), below is a summary of the existing leachate treatment system:

The Engineered Landfill leachate management system and treatment process includes the following:

1. Conveyance of untreated leachate from landfill to the treatment pond with inline chemical addition prior to entering pond.
2. pH adjustment in the treatment pond
3. Chemical treatment if required
4. Filtration to effluent holding pond for sampling
5. While in effluent holding pond, recirculation through Granular Activated Carbon (GAC) for polishing, when required.
6. Sampling
7. If the sample meets the applicable criteria, the treated water is discharged to the infiltration pond. If not, treatment and resampling continue until all parameters meet discharge criteria. The treated leachate is then discharged to the infiltration pond.

The effluent batch is held in the effluent holding pond and recirculated through the GAC, as required, until sampling and laboratory analysis confirm that the effluent quality meets the discharge criteria for all parameters. Once the discharge criteria are met, the treated effluent is discharged to the infiltration pond. The discharge criteria from the Effluent Holding Pond is the Contaminated Sites Regulation (CSR) Generic Numerical Water Standards for Drinking Water (DW) Figure 6-2 below depicts the leachate treatment process:

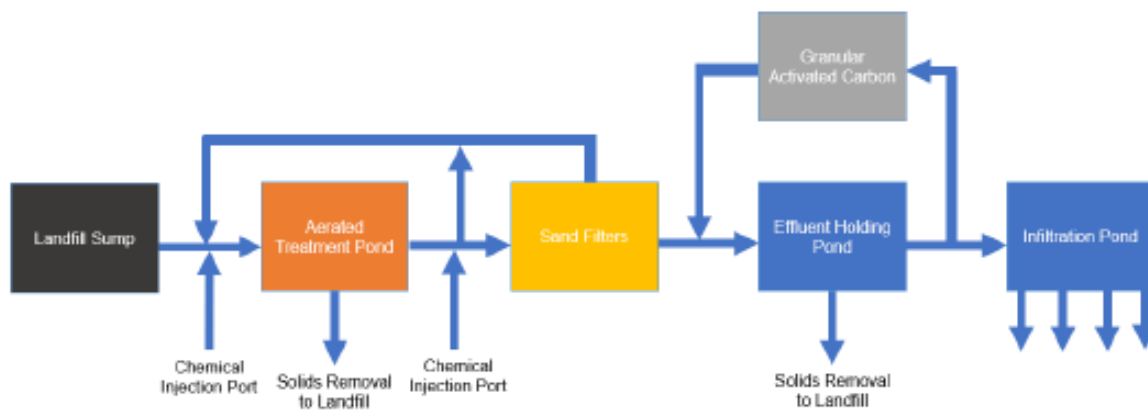


Figure 6-2: Leachate Treatment Process Diagram (Source: GHD West & Ponds Commissioning Report, 2024)

6.1.5 Treated Leachate Infiltration System Upgrade

NWE retained SHA to design an upgrade to the Leachate Infiltration System. These upgrades are part of ongoing site development and stewardship efforts to ensure continued compliance with OC requirements. SHA submitted a notification with a request for the approval of the upgrade through the letter dated July 8th, 2025. The Ministry of Environment and Parks (ENV) required NWE to go through an amendment of the OC reflecting the proposed upgrades. SHA is currently working to address ENV's requirements for the OC amendment.

SHA prepared a set of strategic enhancements aimed at improving the effectiveness of the leachate infiltration system. The proposed upgrades are intended to improve treatment performance, increase retention time, and enhance the site's capacity to manage leachate flows efficiently.

Key Proposed Upgrades:

- **Conversion of Existing Infiltration Pond:** The current unlined infiltration pond will be upgraded to a fully lined pond. According to Section 1.4.6 of the OC issued on August 1, 2019, and the April 26th, 2022, amendment “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 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. 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.”
- **Implementation of New Infiltration Trench Design:** To increase retention time in the treatment system, the existing unlined sand and gravel-based infiltration pond will be converted to double lined settling/discharge flow equalization pond. From the newly lined infiltration holding pond, two new 50 m long subsurface infiltration trenches will be added to broadly distribute treated leachate to the water table. Discharge will be alternated between the two trenches on each batch cycle to broadly distribute the hydraulic loading. The infiltration trenches will maintain an approximate combined length of 100 m with a minimum width of 2 metres. The final dimensions will remain flexible to accommodate site-specific conditions.
- **Enhanced Treatment Performance:** The settling/flow equalization pond will increase settling and retention time, helping ensure that leachate is treated to meet applicable discharge criteria. The additional pond will also allow the main treatment pond to be emptied at a much faster rate, transferring the discharge equalization function from the treatment pond to the new lined settling pond.
- **Inclusion in DOCP:** These design modifications are documented in this DOCP in Appendix E – Leachate Infiltration System Upgrades.

6.1.6 Liner System

As per Section 1.3.5 of the OC, within the approved waste footprint “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. As an additional safeguard, NWE has elected to also deploy a single geomembrane liner in areas where soil that meets land use standard will be placed for the slope grading wedge after extraction of aggregate resources.

As per Cell 1 East and Pond Construction Report (GHD, 2021) and Cell 1 West Construction Reports (GHD, 2024), the liner system installed to date is a composite double liner system comprised of a primary and a 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. The secondary base liner refers to the composite liner system comprised of an HDPE geomembrane liner and GCL which underlies the leak detection system. The Phase 1 liner system is shown on Photo 6-1.



Photo 6-1: Leachate Sump Installation with Secondary HDPE Geomembrane and Leak Detection Geocomposite in Cell 1 East

Appendix D - Record drawings show the liner system at the Northwin Landfill Site.

Bedrock surface contours, gravel extraction surface contours, gravel extraction surface cut and fill, liner surface grading plan contours and liner surface cut and fill drawings are presented in Figures 4-2 through 4-6 respectively. Leachate collectors for Phase 2 are presented in Figure 6-1.

The liner system for the Phase 2 Expansion Area will comprise of the same elements. For installation efficiency and cost reduction, the drainage geocomposite leak detection layer and the secondary geomembrane liner may be combined into one product, Agru Drain Liner. On the 2.5H:1V side slopes, the drain liner will utilize Agru Super Gripnet sheet or equivalent with aggressive texture on both sides of the liner.

Figure 6-3 presents the recommended liner system for both low slope and 2.5H:1V areas within Phase 2.

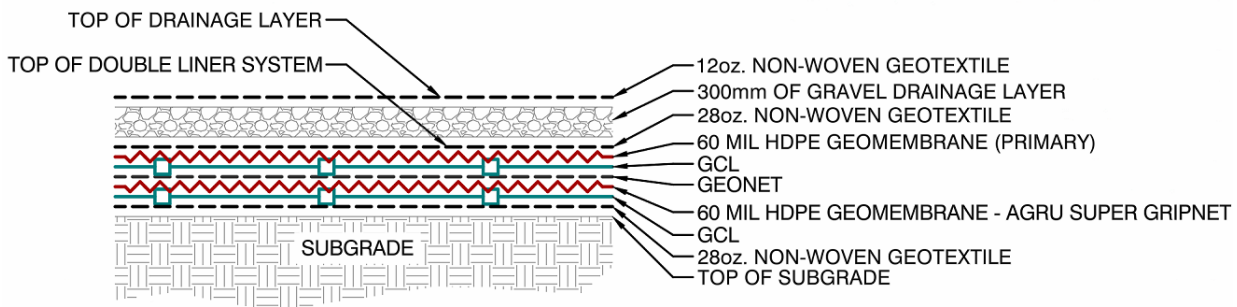


Figure 6-1: Liner System for Phase 2 Base and Side Slopes

Liner for the slope grading area outside the approved landfill footprint where soil that meets land use standard will be backfilled to create the necessary slope geometry will be comprised of a single 1.5 mm double textured HDPE liner.

A chimney drain and vertical liner will contain leachate within the approved landfill footprint and convey it downward to the leachate collection piping. The vertical liner will prevent lateral leachate breakouts from seeping into the soil grading wedge. The collected leachate will drain to the Phase 2 East Sump. Figure 6-1 presents the leachate management system layout in plan view. The location of the vertical chimney drain is shown on Figure 6-1 while the vertical Chimney drain details are presented in Figure 4-7. Photo 6-2 shows the construction of a lift of the Chimney Drain System at the Howe Sound Pulp and Paper Landfill.

To promote rapid drainage of leachate into the leachate collection system, all liner surfaces will be graded at a minimum of 2%. A detailed liner grading plan has been shown on Figure 4-5.

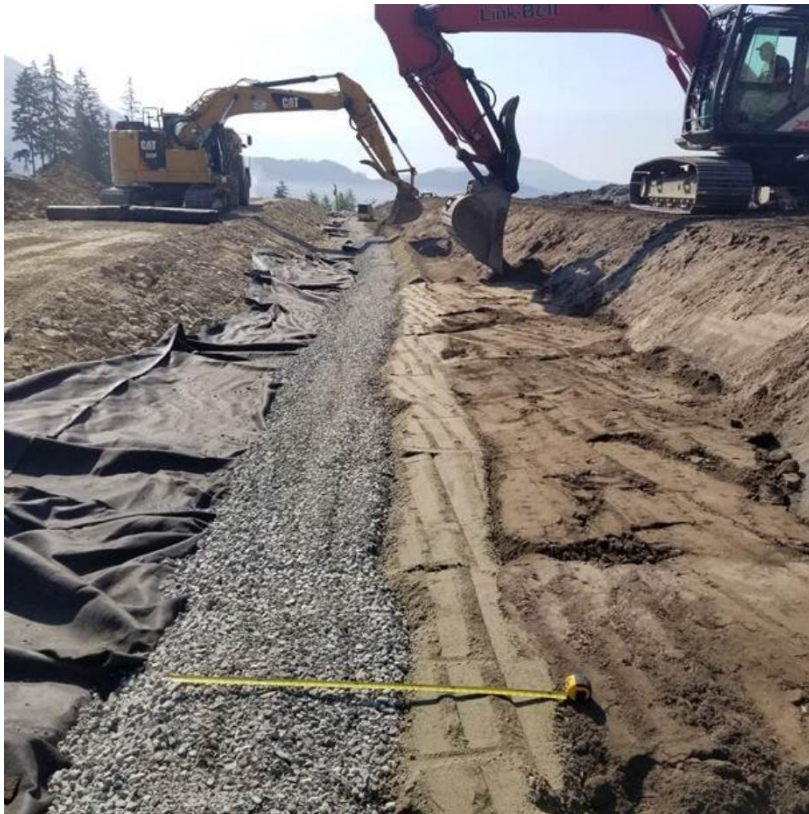


Photo 6-2: Chimney Drain System Construction at Howe Sound Pulp and Paper Landfill

6.1.7 Leak Detection System

As per the OC, a leak detection drainage layer, leak collection pipes and sump were installed at the site in Phase 1 East and Phase 1 West following GHD's design (GHD, 2021). The leak detection, underlying the primary base liner, system comprises of:

- Geocomposite drainage layer
- Minimum 2.75% slope along the primary flow path and minimum 2% slope along the secondary flow path

- A 300 mm diameter riser pipe bedded in a sand drainage layer for monitoring potential leakage through six monitoring ports around the landfill perimeter.

The details of the leak detection sumps and risers are presented in Appendix D – Record Drawings.

Using the latest advances in liner technology, an approach that is easier to construct will be adopted for the Phase 2 leak detection system. Agru Drain Liner (or equivalent) will be adopted to achieve the functionality of a geocomposite leak detection layer and a secondary HDPE geomembrane in a single product. On the landfill base drain liner with micro-spike texturing on the bottom will be utilized (Agru Mirco Drain). This product incorporates a geomembrane sheet with upward-facing drainage studs and downward facing spiked asperities. On side slopes, Agru Super Grip Net sheet with aggressive texturing on the base will be adopted.

Leachate collection pipes will be 300 mm HDPE DR-11 perforated pipes. This DR rating can withstand the large surcharge when properly bedded. The proposed pipe network, including the perforated lateral runs and clean outs is shown on Figure 6-1.

6.2 Stormwater Management Plan

The Landfill Criteria requires that a Stormwater (Surface Water) Management Plan (SMP) be prepared for the Landfill site. Section 1.5 of the OC species is the New Stormwater Management Works and requires that the stormwater at the site be managed in such a way that stormwater is infiltrated into the ground as part of the authorized works.

The surface management work designed and constructed at the Northwin Landfill site will meet the following criteria:

- Promote diversion of clean water to minimize leachate production and maintain natural groundwater recharge patterns;
- Protect the surface water quality in the off-site surface water bodies receiving drainage from the landfill site;
- Provide a design for surface water control works that will ensure drainage coming onto and leaving the landfill site does not result in interruptions to the site operations;
- Maintain run-off from the site with minimal sediment release and at rates that are consistent with pre-development flows;
- Prevent surface water run-on onto the active Landfill footprint area;
- Minimize the potential for erosion of cover soil from the area with intermediate cover;
- Design storm water ditch network for conveying 1:200 year, 24-hour storm event
- Include allowances for additional precipitation due to climate change, snow melt, and multi-day precipitation events.

The SMP must also address the management of surface water flows generated on site throughout the operating and post-closure period of the landfill.

One of the primary objectives of an SMP is to minimize leachate production by diverting stormwater away from the refuse. This will be achieved by diverting clean run-on and run-off from closed areas, minimizing percolation through the top surface of the landfill and enhancing run-off from the landfill. Secondary objectives are to prevent erosion of the operational and final cover systems, prevent ponding

of surface water on the cover system, control flooding of active landfill areas and control surface water in a manner compatible with the proposed end-uses.

In order to manage the stormwater from the Landfill site as the phases are built to their final contours and to protect slopes from erosion, ditches lined with an erosion control blanket shall be installed along the toe of the landfill footprint, inside the perimeter berm and access roads and on mid-slope benches as part of progressive landfill closure. Run-off from the finally closed areas shall be directed to a stormwater pond to be built in the northwest corner of the site as shown in Figure 6-4. The storm water retention pond is to be constructed concurrently with progressive closure of Phase 1. This pond is to be constructed as an unlined infiltration pond as run-off from well vegetated progressive closure areas is expected to have minimal sediment load.

6.2.1 Storm Water Modeling

To determine the appropriate sizing of the swales/ditches, peak flows were determined using the Rational Method, which is commonly used in determining the peak flow runoff rates in small watersheds. The rationale for the method is that steady uniform rainfall intensity will cause runoff to reach its maximum rate when all parts of a watershed are contributing to the point of outflow. This is dependent on the time of concentration, which is taken as the time for water to flow to the discharge point from the most remote point of the watershed. Along with the rainfall intensity and drainage area, which are relatively straightforward to determine, the peak flow is dependent on the runoff coefficient. The runoff coefficient is dependent on the final cover design. It is primarily influenced by topography, vegetation, the seasons and the subsurface material type. The method and coefficients for the analysis were obtained from the BC Agricultural Drainage Manual (1997). This method allows variations of the material types, the vegetation types and the topography (slope) conditions. The Intensity-Duration-Frequency (IDF) curve for Campbell River Airport was used to predict storm intensities. The IDF curve is provided in Figure 6-5.

6.2.1.1 Estimation for 200 Year Return Period

To satisfy the requirements outlined in the Interim Considerations for Landfills Accepting Contaminated Soils (ENV, 2021) stormwater works were modelled using a 1 in 200-year design storm event with allowances for snowmelt and multi-day precipitation.

As presented in Table 6-3, the 200-year 24-hour intensity was estimated to be 4.27 mm/hr and rainfall amount to fall in a 24-hour period is estimated to be 102.59 mm, based on an extrapolation from the IDF curve as reported in Table 6-3.

A.I. reports that rainfall intensities of the 24-hour storm event in the Campbell River area are expected to increase roughly 10 to 20% by 2050 and as much as 40% by 2100. Therefore, for retention pond calculations, a design storm event of 123.1 mm/day has been used.

2014/12/21

Short Duration Rainfall Intensity–Duration–Frequency Data
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée

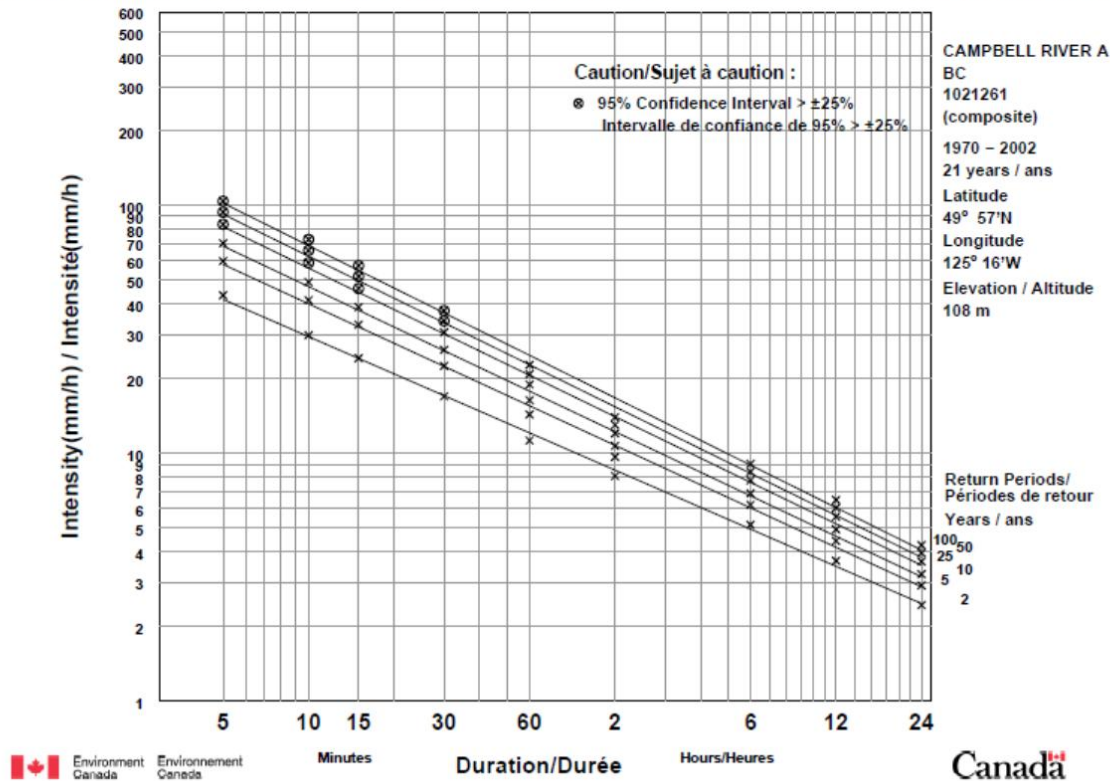


Figure 6-5: IDF Curve for Campbell River Airport

Table 6-3: Campbell River A Rainfall Projection

Campbell River IDF (mm/hr)					
Return period	10	25	50	100	200
2 Hour	12.00	14.00	15.00	17.00	10.98
6 Hour	7.00	7.80	8.50	9.00	9.65
24 Hour	3.30	3.70	3.90	4.00	4.27
Campbell River Rainfall Amount (mm)					
Return period	10	25	50	100	200
2 Hour	24.00	28.00	30.00	34.00	21.97
6 Hour	42.00	46.80	51.00	54.00	57.92
24 Hour	79.20	88.80	93.60	96.00	102.59

Rational Method calculations were completed for stormwater ditches for the 1 in 200-year 5 min storm event to ensure that the planned ditch geometry will be sufficient for expected flows. Additional allowances for snowmelt and multiday precipitation with 1 in 200-year 24 hr event were made for the stormwater retention pond. According to the B.C. Manual of Operational Hydrology, multi-day precipitation amounts are important for hydrologic analysis in coastal regions, where storms that produce high flows typically last several days.

Snowmelt from a snow event can introduce significant additional run-off to the stormwater system. According to the B.C. Manual of Operational Hydrology (Ministry, 1991) during a melt event with snow on the ground, melt rates can exceed 50 mm of water equivalent per day during periods of rapid melt. During the melt period, the total melted water produced is dependent on energy sources such as absorbed solar radiation, convective heat transfer, conduction of heat from the ground, and heat content from rainwater. The influence of heat from the ground is estimated to be minimal, at 0.5 mm/day. Similarly, rain induced snowmelt generally contributes a small amount of melt into the system, but it can be significant in coastal regions. SHA has used the equation provided in the BC Manual of Operational Hydrology (1991) to estimate the influence of rain on snow melting at the Northwin Landfill:

$$M_t = T_a (1.33 + 0.86V + 0.0126P_r) + 2.3 \text{ mm/day}$$

Where M_t = total melt in mm/day; T_a = daily mean air temperature (Deg C); P_r = daily precipitation (mm); and V = wind speed 15 m above snow surface (m/s). With a value of $T_a = 3.39^\circ\text{C}$, as found from the historical data, the total melt is estimated to be 4.32 mm/hr, or 103.68 mm in a 24-hour period. In the absence of rain, solar radiation becomes an important melt factor with melt rates that can exceed 50 mm per day.

Because the rain-free period melt rate (50 mm per day) is less than the rain-induced snowmelt (4.32 mm/hr or 103.68 mm/day), SHA has used 103.68 mm per day snowmelt amounts in our analysis to be conservative.

All infrastructure will be sized accordingly during detailed design.

6.2.2 Toe/Road Ditches

To determine the sizing of the toe/road swales/ditches, peak flows were determined using the Rational Method as described above and shown in Appendix F.

SHA recommends ditches with a triangular cross section, 0.75m depth and 2.5H:1V side slopes lined with an appropriately sized riprap. In some areas it may be possible to replace the rip rap with a less expensive erosion control mat. This should be assessed during detailed design.

Analysis of ditches can be revisited during detailed design. Figure 6-4 shows the location of the ditches for the final landfill configuration, while Figure 6-6 shows a Midslope surface water ditch for the Landfill.

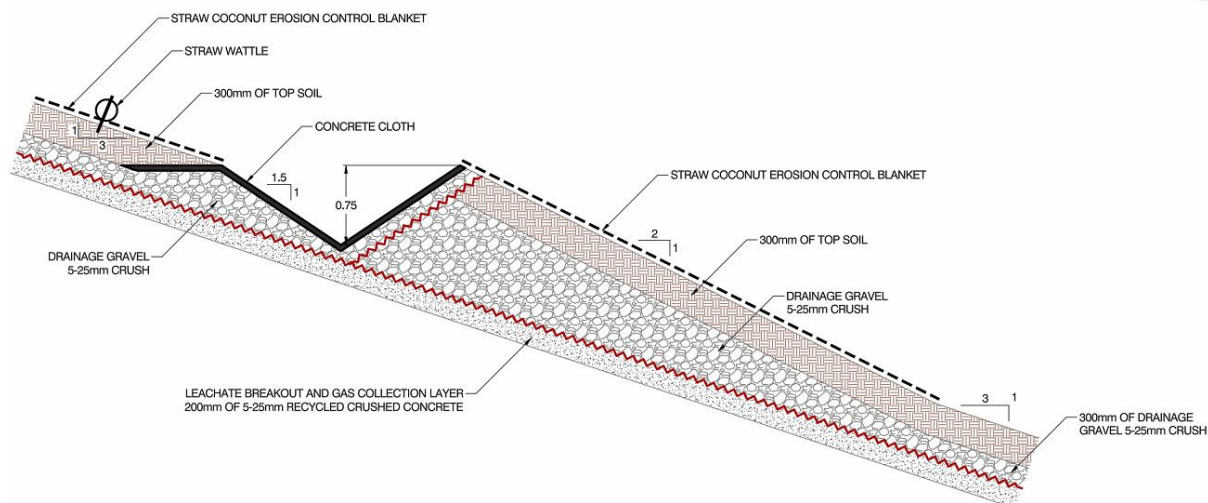


Figure 6-6: Mid Slope Run-Off Interception Ditch

6.2.3 Mid-slope Berm

In order to ensure stability of the landfill as well as to facilitate smooth drainage of stormwater SHA usually provides mid-slope berms at every 15 m interval depending on the location. Figure 6-4 shows the recommended mid slope ditch and downchute locations for the landfill. Normally, SHA uses the permanent access roads for this important storm water control function. To provide sufficient room for a one way 7 m wide road and ditch, mid slope benches must be constructed 12 m wide. Primary ramps with two way traffic shall be constructed with a 10 m wide travel surface and an initial bench width of 15 m. However; because Northwin Environmental Landfill has been designed with internal haul roads to maximize available air space there will not be any external ramps along which ditches can be constructed.

6.2.4 Midslope Ditches

As the height of the landfill will be approximately 30 m, one mid slope interception ditch will be required to prevent excessive erosion of the final cover system. The ditch, to be designed with a depth of 0.75 m will be supported with a small berm formed of 5x25 mm drainage gravel, as shown on Figure 6-4. To achieve a 100% rate of run-off capture, a geomembrane flap will be installed on the upslope side of the berm, as shown in Figure 6-4.

The mid-slope ditches will collect runoff falling on the closure areas above and direct it through down chutes to the toe ditches. Based on the run-off analysis using the Rational Method, the ditches will need to be triangular in shape and have a total depth of 0.75 m, with side slopes at 1.5H:1V. A geomembrane flap will be welded to the main geomembrane panel along the full length of the ditch. The intent of this flap is to capture 100% of run-off collected within the upper drainage layer on the upper slopes of the closed area to enter the ditch rather than percolate beneath the berm to the lower level. The flap will enhance the stability of the slopes below.

Control of erosion in the ditch is a key consideration. To avoid risk of liner damage and facilitate construction, concrete cloth shall be used to armour the ditch. The entire ditch will be covered with an Erosion Control Blanket and on the upslope side of the ditch straw wattle will be installed.

6.2.5 Down Chute

Armoured down chutes will be constructed to convey run-off collected in the mid-slope ditches to the surface water ditches at the toe of the landfill. Photo 6-3 shows a downchute at the recently completed Delta Shake and Shingle Landfill implemented by SHA. Based on the run-off analysis and Rational Method calculations, the downchutes will be trapezoidal in shape and have a total depth of 0.50 m, bottom width of 1.0 m and side slopes at 3H:1V. The ditches will be lined with medium weight geotextile, with a 300 mm thick 250 to 450 mm Rip Rap Layer on top for the full ditch depth.

The rip rap layer will ensure that there is no erosion due to the high velocities that will be experienced within these downchutes. More detailed specification for the rip rap armouring will be developed during detailed design. Also, it will be important to provide some form of energy dissipation at the bottom of each chute to protect the lower ditch works from scour.



Photo 6-3: Delta Shake and Shingle Landfill Downchute

6.2.6 Stormwater Retention Ponds

Currently, there is no separate stormwater pond at the site. Once progressive closure is implemented, stormwater will be kept clean and is expected to flow either directly to the environment (if meets discharge quality) or to be directed to the future stormwater pond as shown on Figure 6-4. With a run-off coefficient of 0.35 for Meadows and Pasture Land (Govt. of BC, 1997), the estimated retention volume for the stormwater pond required to store runoff during an extreme event is around 2,500 m³. The sizing of the pond will be confirmed during detailed design. Construction of the stormwater pond shall be undertaken before stormwater starts to be discharged from the site, concurrently, or in advance of construction of a permanent landfill cap on any of the phases.

6.2.7 Stormwater Infiltration

Stormwater will be gradually infiltrated to environment from the unlined stormwater infiltration pond. In the unlikely event that monitoring shows that water being infiltrated does not meet water quality, then the infiltration approach will be re-evaluated.

6.3 Landfill Gas Management Plan

Landfill gas (LFG) emissions can be a concern at sites that generate a large amount of LFG. C&D waste typically generates much less LFG than MSW landfills. Northwin Landfill is a low production site with very low levels of LFG produced so a LFG collection system is not warranted. Notwithstanding; LFG is fully reviewed in this chapter due to safety awareness, potential health issues, potential nuisance odours and because LFG releases contribute to global climate change. If LFG is not vented, gas pressures can build up beneath a final cover system or in encapsulated pockets if fine soils are used for daily and intermediate cover, ultimately leading to uplift of the cover system. Additionally, gas can migrate from the site to nearby properties and structures if it is prevented from venting directly to the atmosphere and / or if there is a preferential pathway for the gas to travel easily off the site.

LFG is a by-product of the natural decomposition of organic materials in landfills. The most common form of LFG, which is created when biological anaerobic decomposition occurs, consists primarily of equal parts methane (CH₄) and carbon dioxide (CO₂). Other trace constituents include more than 166 different Non-Methane Organic Compounds (NMOC), nitrogen (N₂) and oxygen (O₂); the concentrations of these constituents are subject to the amount and composition of contributing waste material within the landfill, the decomposition rate of the specific contributing material, and the level of atmospheric air intrusion into the landfill.

Methane is a potent greenhouse gas (GHG) with global warming potential (GWP) of 28 to 36 times higher than CO₂ in a 100-year timeframe. Methane, at concentrations between 5 to 15% by volume in air, will cause an explosion if it encounters an ignition source. The lower end of the range (5%) is referred to as the lower explosive limit (LEL). Combustible gases are a concern in relation to LFG migration, for example in utility trenches leading off site.

Carbon dioxide, another major component of LFG, is found at low concentrations in atmospheric air. The main danger posed by CO₂ is that it can displace atmospheric air in confined structures such as manholes and culverts. This could cause asphyxiation for someone entering such a structure without properly checking the conditions.

LFG may also contain Hydrogen Sulphide (H₂S), which originates from biological degradation of gypsum drywall, sulfur-containing industrial wastes, and biosolids from municipal wastewater treatment plants. Hydrogen Sulphide emissions may be problematic at a landfill as they can cause odour, impact surrounding communities, cause wear or damage to LFG collection and energy utilization components and contribute to the formation of explosive conditions. Normally, H₂S can be detected by humans at concentrations as low as 0.05 parts per million (ppm) (or Microliter/liter µl/l), and by 3 ppm, a distinctive odour of rotten eggs is noted. At concentrations between 10 and 50 ppm, most people experience headaches and nausea. This gas is highly toxic in concentrations above 50 ppm. A concern with H₂S is that the ability to smell the gas is gradually decreases during exposure.

Besides the obvious benefits of LFG control reducing climate change and increasing site safety, there are several other factors about LFG which signify the importance of having a proper LFG Management System at landfills that generate a large amount of LFG. The most important of these factors are:

- Methane is a flammable gas and explosive in a specific range of concentration.
- LFG contains trace amounts of Hazardous Air Pollutants (HAPs), Volatile Organic Compounds (VOCs) and other odorous compounds which can be easily destroyed by capturing and combusting the gas.
- Excessive concentrations of LFG in work areas can pose serious dangerous conditions for the workers' health and safety.
- Producing renewable energy and/ or green fuel (substituting fossil fuel) from the captured LFG provides an additional potential revenue stream for the landfill project as well as local and global environmental benefits.

6.3.1 Applicable Regulations and Guidelines

BC Ministry of Environment and Climate Change Strategy's (ENV) LFG regulations and guidelines as well as the BC Landfill Criteria for Municipal Solid Waste are the regulations and guidelines that apply to LFG management in BC landfills. Environment and Climate Change Canada (ECCC) also developed a new Federal LFG regulation that came into effect in December 2025.

6.3.1.1 BC Landfill Gas Regulation

The ENV Landfill Gas Management Regulation (LFG Regulation) applies to landfill sites in BC that (i) accepted MSW for disposal on or after January 1st, 2009, and (ii) have 100,000 tonnes or more of MSW in place or receive more than 10,000 tonnes/year of MSW in any calendar year. Regulated landfills are mandated to complete a LFG generation assessment. Landfills that are determined to generate 1,000 tonnes or more of methane per year are required to install an active LFG management system. This system, if required, is to collect LFG actively and reduce methane emissions by flaring such as thermal combustion or other methods that would result in the same amount of emission reduction as flaring. The active LFG management facility shall continuously operate until the methane generation rate at the facility falls below 500 tonnes/year.

6.3.1.2 BC Landfill Criteria for Municipal Solid Waste

This document outlines specific requirements that must be satisfied during design, operations and closure of MSW landfills in BC. According to the Criteria:

- Soil gas concentrations at the landfill site boundary must not exceed 100% LEL (i.e. 5% methane by volume) at any time
- Combustible gas concentrations measured in on-site buildings must not exceed 20% LEL (i.e. 1% methane by volume) at any time
- LFG must also be managed in accordance with all migration and health and safety requirements. Resources include WorkSafe BC and the Landfill Gas Management Facilities Design Guidelines (Section 8.0 LFG Migration Assessment and Control; Section 9.0 Health and Safety)
- LFG emissions must be managed such that all federal, provincial, and local ambient air quality objectives and standards are not exceeded.

6.3.1.3 ECCC Regulatory Framework on Landfill Methane Emissions

The Federal Regulations Respecting the Reduction in the Release of Methane and Certain Volatile Organic Compounds (Landfills), enacted by Environment and Climate Change Canada (ECCC) came into force on December 12, 2025 (the “ECCC Regulations”). Under the Federal LFG Regulations issued by ECCC, Canadian landfills are obligated to conduct LFG generation modeling and report their applicability status to ECCC. The Regulations apply to landfills that meet either of the following criteria:

- Disposed of waste after January 1, 2010, and contain more than 450,000 tonnes of MSW in place; or
- Disposed of more than 20,000 tonnes of MSW in 2025 (or any subsequent year) and contain more than 200,000 tonnes of MSW in place.

Certain types and portions of landfills are exempt from the Regulations including the following:

- Landfills that are under final cover and ceased to accept waste before January 1, 2010, or
- Landfills that have received only the following types of waste:
 - a. hazardous waste
 - b. non-biodegradable waste
 - c. waste produced from forest products operations
 - d. construction and demolition waste

Since Northwin Environmental Landfill receives predominantly construction and demolition waste, inert waste and contaminated soil it is exempted from the ECCC regulations under exemption.

6.3.2 Landfill Gas Generation Estimate

There are several LFG generation models which assist landfill designers, operators and regulating authorities to estimate the amount of methane generated in landfills. Among these models, the first order decay reaction model has been the most widely used. The first order decay reaction model assumes that degradable materials in the waste are decomposed at a constant rate over a period. First order decay models also assume that the total amount of carbon decreases gradually as consumed by bacteria and therefore the rate of gas generation also decreases every year after the deposition of organics in the landfill ceases. The LFG generation assessment for the Northwin Landfill has been performed, as described below, using ENV Model (MOE Tools).

6.3.2.1 ENV Model

In order to complete ENV Model using MOE Tools, we followed the procedures described in the Landfill Gas Generation Assessment Procedure Guidance Report, prepared for the British Columbia Ministry of Environment (MOE) by Conestoga-Rovers & Associates (CRA), dated March 2009 and the steps recommended in the MOE Tools instructions as described below.

Historical Waste Tonnage

For the purpose of MOE guidelines, the historical data on annual waste tonnage should cover the period from the first year of landfill operations or thirty years before the year in which the assessment takes place, whichever is more recent, to the year immediately preceding the year in which the assessment is conducted. SHA reviewed previous reports and used the available tonnage from the previous reports (2025 Annual Report) as presented in Table 6-4.

Table 6-4: Historical Disposal Tonnages at Northwin Landfill

Year	Disposal at Landfill (Tonnage)
2019	6,548
2020	13,636
2021	33,939
2022	44,814
2023	38,327
2024	26,285
2025	24,628
2026	45,500

It was assumed that the future projected annual tonnage would be the maximum permitted tonnage at the site. It was assumed that waste relocated from the old, lined landfill in 2021 and 2023 would not contribute significant quantities of LFG.

Waste Tonnage in Place

Waste tonnage in place was estimated to be 290,897 tonnes at the end of 2025, including 79,334 tonnes of relocated waste and 211,563 new waste received between 2019 and 2025.

Waste Characterization

For the LFG generation assessment, waste landfilled at the site was segregated into the following three categories: Relatively inert, moderately decomposable and decomposable. The percentages of each of the categories are 75%, 25% and 0% respectively (DOCP, 2021).

Climate

As presented in Section 3.3.1, The average annual precipitation (as rain) is approximately 1,481.8 mm based on the years on record (1991 to 2020), with most falling in the months of October to April.

6.3.2.2 Model Input Parameters

Methane Generation Potential, L_0

The methane generation potential, L_0 , represents the total potential yield of methane from unit mass of waste. This outcome depends on the waste composition, and more specifically the fraction of organic matter present. The recommended L_0 values in the MOE Guidelines for different waste categories were assigned as presented in Table 6-5.

Table 6-5: MOE Recommended L_0 Values for Northwin Landfill

Waste Category	Methane Generation Potential, L_0 (m^3 methane/tonne of waste)
Relatively Inert	20
Moderately Decomposable	120
Decomposable	160

Methane Generation Rate, k

The methane generation rate, k , is influenced by moisture content of the waste, the availability of nutrients, pH, and temperature. In determining the value of k from Table 5.2 of the MOE Guidance Report, average annual precipitation of 1481.8 mm was used. Since the value of average annual precipitation lies within the range >1,000 mm to <2,000 mm the following values (Table 6-6), of k were selected for three different categories of waste.

Table 6-6: MOE Recommended k Values for Northwin Landfill

Annual Average Precipitation	k (yr ⁻¹)		
	Relatively Inert	Moderately Decomposable	Decomposable
1482 mm	0.02	0.06	0.11

Water Addition Factor

The moisture content within the landfill is influenced primarily by the infiltration of precipitation through the landfill cover and active area. Other factors that may affect the moisture content in the waste that in turn will affect the rate of LFG generation, include the initial moisture content of the incoming waste, the amount and type of daily cover used at the site, the permeability and time of placement of final cover systems, the type of base liner, the leachate collection system and the depth of the waste in the landfill

site. Currently, there is no leachate recirculation or storm water injection system in place. Based on SHA's knowledge, NWE has no plans for moisture addition or leachate recirculation in the future.

The water addition factor was determined from Table 5.3 of the MOE Guidance Report based on the information described above. As the landfill condition is such that partial infiltration is taking place, a factor of 1.0 was selected.

6.3.2.3 Landfill Gas Generation Model Results

The gas generation estimates show that the annual methane generation at the Landfill is currently about 343 tonnes/year. Methane generation from the Northwin Landfill in 2025 was estimated to be 327 tonnes of methane/year. Figure 6-7 shows the methane generation estimate at the Northwin Landfill from 2019 to 2030. The output summary of the results from the model is presented in Table 6-7. This Table represents the information required in Sections 4(2)d, 4(2)(e) and 4(3)(a) of the Regulation. T1 and T2 summaries, as per the MOE Tools, are presented in Appendix G.

Table 6-7: Output Summary of the Results

Item	Year of Estimate	Mass of Methane
		(tonnes/year)
Estimated Quantity of Methane Produced in the Year Preceding the Assessment	2025	327.1
Estimated Quantity of Methane Produced in the Year of Assessment	2026	343.1
Estimated Quantity of Methane Produced one Year after the Assessment	2027	386.3
Estimated Quantity of Methane Produced two Years after the Assessment	2028	427.3
Estimated Quantity of Methane Produced three Years after the Assessment	2029	466.3
Estimated Quantity of Methane Produced four Years after the Assessment	2030	503.2

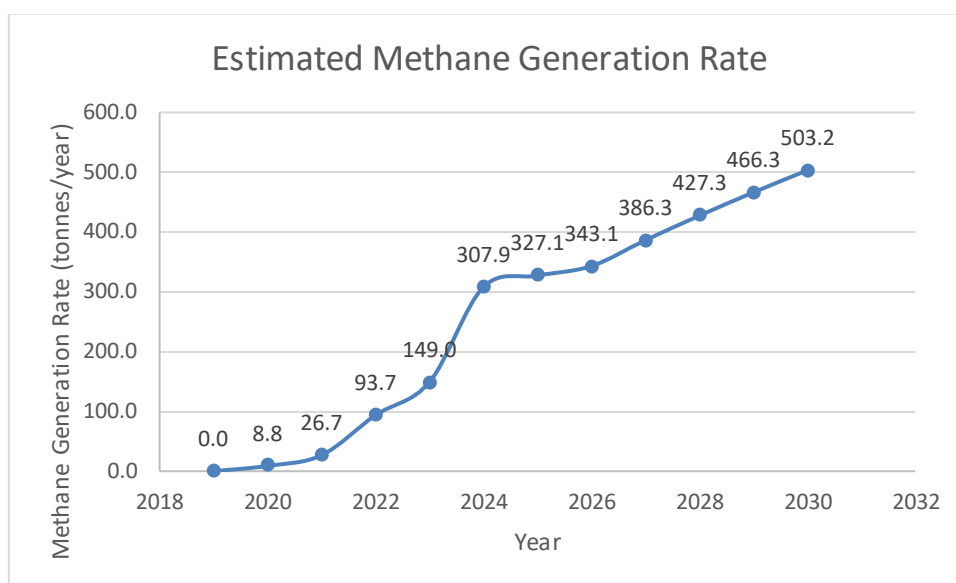


Figure 6-7: Methane Generation Estimates for Northwin Landfill (ENV Model)

6.3.3 LFG Management Requirements

Since the estimated methane generation rate at Northwin Landfill is well below the 1,000 tonnes of methane per year threshold, the site is not mandated to collect and thermally oxidize generated methane. However, Northwin is required to complete the supplementary LFG generation assessment and submit a standalone LFG generation assessment report to the ENV.

6.3.4 LFG Management System Options

Landfill Gas consists primarily of equal parts CH₄ and CO₂. Methane is a potent greenhouse gas (GHG) with global warming potential (GWP) of 28 to 36 times higher than CO₂ in a 100-year timeframe and that's why management of LFG is regulated in many jurisdictions.

By regulation, the Northwin Landfill is not currently mandated to install and operate an active LFG management facility as the quantity of generated methane at this site is assessed to be below the provincial regulation threshold of 1,000 tonnes of CH₄ per year. Nevertheless, some steps can be considered by NWE to beneficially minimize the amount of GHG's released into the atmosphere.

Biofiltration

Biofiltration is a process in which gases are treated by passing the gas stream through a bed of porous solid medium enriched with microorganisms. Biofiltration includes three types of systems; (i) BioFilters, (ii) BioCovers, and (iii) BioWindows. BioFilters require the collection and piping of the gas into the biofilter and BioWindows have a small footprint and very low CH₄ uptake capacity. Therefore, for the specific situation at the Northwin Landfill, BioCover is the most cost-effective method to control CH₄ emissions without needing to collect the generated gas from the landfill.

BioCover is a porous medium in which biological activity is significant enough to reduce CH₄ concentrations appreciably before LFG reaches the atmosphere. In a BioCover system, a landfill cover is designed to maximize the oxidation of CH₄ by promoting the growth of methanotrophic bacteria or methanotrophs. Methanotrophs are capable of utilizing CH₄ as their energy and carbon source and

converting it to carbon dioxide (CO₂) and water without producing secondary by-products that are toxic. At this landfill, deployment on intermediate cover surfaces prior to final closure could reduce GHG emissions and could potentially generate revenue from GHG credits as the site is not a regulated site. SHA recommends that this opportunity be explored prior to the next DOCP update.

6.4 Contingency Plan

As per the Criteria, the DOCP should provide a Contingency Plan that includes possible failure and non-compliance scenarios of the leachate, surface water, and LFG management facilities. Practical and implementable contingency measures to address any failure or non-compliance with the performance criteria should also be developed.

Leachate

Leachate is currently managed at the Site using the existing treatment system. With the expansion of Phase 2 and future development of Phases 3 and 4, leachate generation is expected to increase. Accordingly, the leachate treatment system is planned to be upgraded and relocated to the northwest corner of the Site to accommodate future leachate management requirements. The infiltration system is currently being upgraded to add holding capacity and to expand the infiltration area.

Surface Water

Circumstances that may cause failure and/or non-compliance of the surface water works include extreme weather events, increased snowmelt, clogging or blockage of infrastructure and erosion. SHA has designed surface water management works (ditches and downchutes) with flow capacity and ditch geometry that is able to handle flows in excess of a 1 in 200-year, 5-minute storm event, which exceeds the Criteria requirement for control and a retention pond size that will contain a 1 in 100-year, 24-hour storm event. As a precaution, regular maintenance at the landfill should include all the surface water infrastructure to prevent erosion and clogging.

In the event the ditching or stormwater retention pond overflows due to excess stormwater flow, perimeter berms and or ditching should be constructed in appropriate areas to prevent run-off flows from flooding operational areas and/or leaving the site. Care should be taken to avoid excess water flowing into sensitive receiving environments. Through use of diversion berms and/or sand bagging, stormwater should be re-directed to the appropriate ditches or retention area(s). Nortwin should engage a Qualified Professional (QP) as soon as they need help developing a response and mitigation plan.

In the unlikely event that environmental monitoring indicates the surface water downstream of the landfill is being impacted by landfill operations, NWE should inspect the landfill for signs of leachate breakout or uncontrolled stormwater discharge. If leachate breakouts are identified, diversion berms should be constructed to contain the leachate within the landfill area. If uncontrolled stormwater discharge is identified, stormwater ditching and/or diversion berms should be constructed to route the stormwater to the proposed stormwater retention pond.

Landfill Gas

Landfill gas emergencies can result from off-site migration of LFG and risk to life and/or the environment. Landfill gas may or may not be detected by strong odours and is best identified using gas detection units scanning for methane LEL. If excessive landfill gas is detected on site, landfill operations should cease in that area and landfill staff, and the public should evacuate the area by moving to an up-wind location. The source of the LFG should be investigated by a QP with appropriate gas detection and safety

equipment. Once the source of the LFG is identified, remedial measures should be implemented as recommended by the QP.

Northwin Landfill does not currently have an LFG collection system because LFG generation is well below the regulatory limit. Contingency measures to manage LFG would be implemented in the event that excessive LFG concentrations exceeding limits are detected in on-site structures or at the property boundary. Such measures could potentially include venting trenches, localized vents, localized gas wells, biocover, amongst other gas management strategies. If a LFG exceedance is detected NWE should immediately determine the cause of the issue and then retain a QP to promptly address it. while complying with WorkSafe BC regulations.

Landfill Fire

Landfill fire poses a significant risk at C&D landfills, both at the active face due to batteries and other reactive wastes and due to spontaneous combustion. In the event a fire develops NWE shall respond following the Fire Safety Plan documented in Section 9.31 of this report.

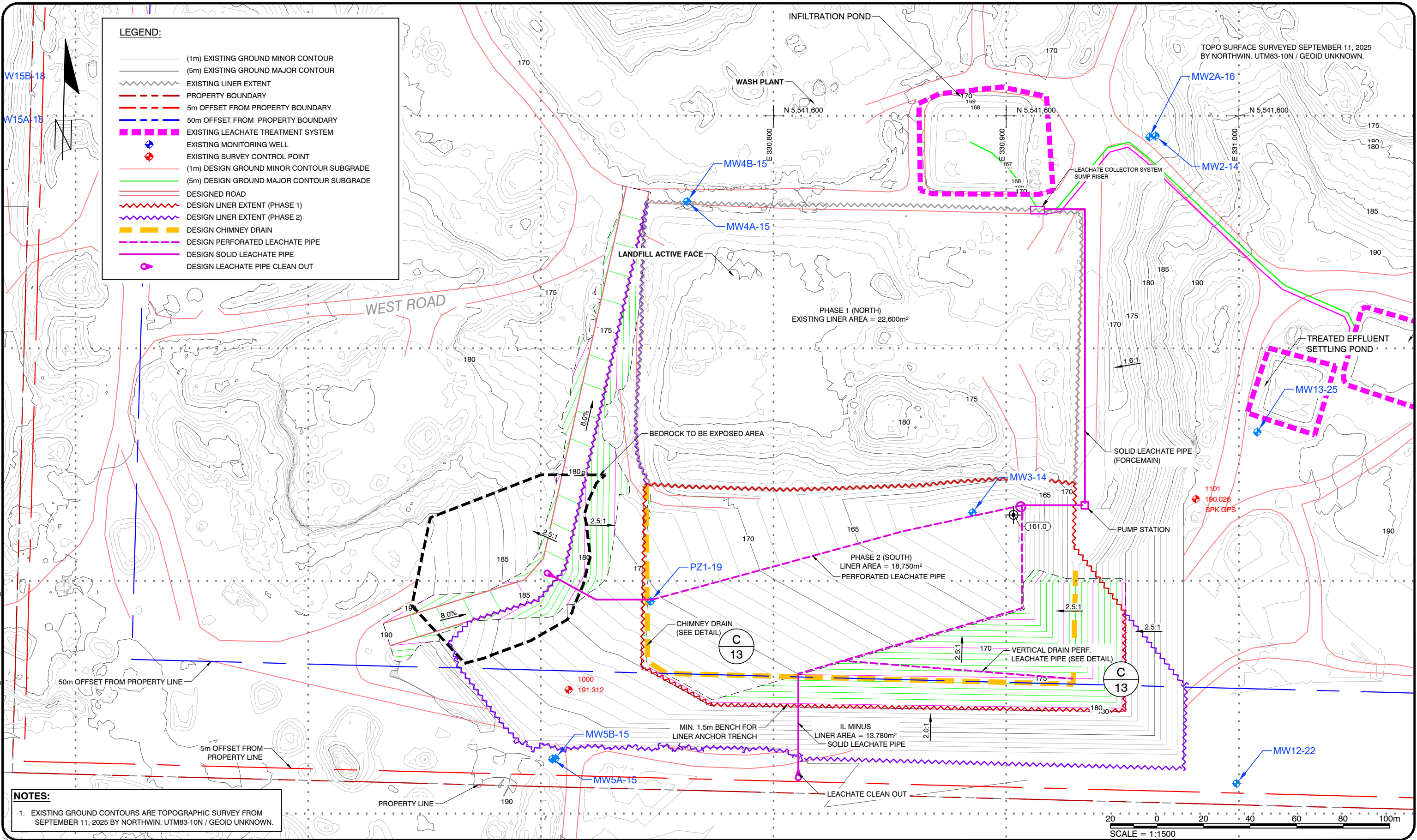
FIGURES



SPERLING
HANSEN
ASSOCIATES



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**SPERLING
HANSEN
ASSOCIATES**

- 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:

CLIENT:



PROJECT:

**NORTHWIN LANDFILL DESIGN
OPERATION AND CLOSURE PLAN
UPDATE**

TITLE:

**LEACHATE MANAGEMENT
SYSTEM**

SCALE:

1:1500

DATE:

2026/09/11
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

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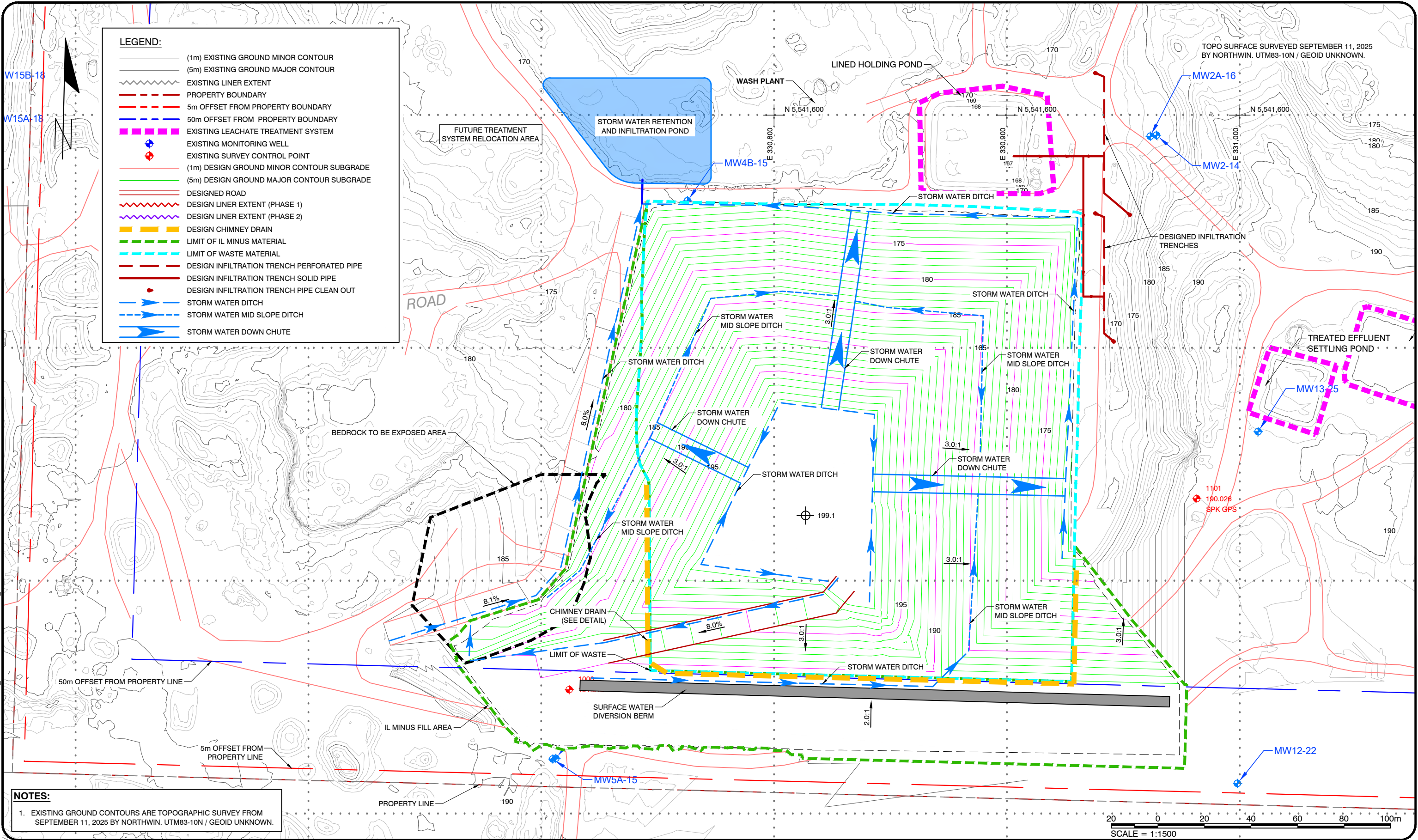
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FIGURE 6-1

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**SPERLING
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- Landfill Siting
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LEGEND:

CLIENT:



PROJECT:

NORTHWIN LANDFILL DESIGN
OPERATION AND CLOSURE PLAN
UPDATE

TITLE:

**SURFACE WATER
MANAGEMENT SYSTEM**

SCALE:

1:1500

DATE:

2026/09/11
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

DRAWN

CHECKED

DRAWING NO:

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FIGURE 6-4

7 ENVIRONMENTAL MONITORING PROGRAM

The environmental monitoring requirements for the Northwin Landfill are stipulated in OC 107689 issued August 1, 2019. The characteristics of leachate, surface water, and groundwater at the property boundary must not exceed concentrations set in the *British Columbia Approved Water Quality Guidelines* and *A Compendium of Working Water Quality Guidelines for British Columbia*. Where natural background water quality concentrations exceed these guidelines, the characteristics of leachate, surface water, and groundwater at the property boundary must not exceed background concentrations. Monitoring and reporting requirements must address, but not be limited to subsections 4.1, 4.2, and 7.15 of the Landfill Criteria and the *Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills* (Guidelines).

Evaluation of laboratory analytical results for groundwater and surface water are recommended to be completed as follows:

1. Groundwater samples are recommended to be compared to the BC Contaminated Sites Regulation (CSR) B.C. Reg. 375/96 including amendments effective October 27, 2025, by B.C. Reg. 171/2025).
2. Hazardous Waste Regulation (HWR, BC Reg. 63/88, O.C. 268/88 including amendments up to BC Reg. 243/2016, updated March 29, 2022).
3. BC Contaminated Site Regulation (CSR) Numerical Water Standard for Drinking Water use (BC CSR-DW), Schedule 3.2.
4. According to the Hydrogeology and Hydrology Characterization Report (HHCR) dated May 27, 2016, and amended May 4, 2021, 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.
5. There are no known agricultural activities (i.e., no groundwater extraction points for irrigation / livestock watering) occurring within 500 m of the Site.

The recommended monitoring plan and summary of laboratory parameter collection for the Northwin Landfill is detailed in the sections below.

7.1 Environmental Monitoring Plan

The monitoring plans for leachate, surface water, groundwater, and landfill gas are summarized in the sections below, including sampling locations, frequencies, and parameters.

7.1.1 Leachate Monitoring

As per the OC Section 1.4.5, the New Landfill leachate management system process includes the following:

1. Conveyance of untreated leachate from landfill to treatment pond with inline chemical addition prior to entering pond.
2. pH adjustment in treatment pond

3. Coagulant and floc addition
4. Filtration to effluent holding pond for sampling
5. While in effluent holding pond, recirculation through Granular Activated Carbon (GAC) for polishing as required
6. Sampling
7. If sample passes, then discharged into infiltration pond. If not, then targeted treatment. Again, sampled for failed parameters. Process repeated until all parameters pass prior to discharge.

Conversion of the infiltration pond to a lined infiltration holding pond increases retention time and achieves greater flexibility in leachate management.

Raw Leachate is currently monitored quarterly. Monitoring is recommended to continue at that frequency. Monitoring locations include S06-21 (east leachate sump). The TLIP (treated leachate settling pond), referred to as “effluent holding pond” in this report is sampled on a batch by batch bases before entering the infiltration pond. Leachate monitoring parameters and frequency are summarized in the table below.

Table7-1: Leachate Parameters and Sample Frequency

Monitoring Location	Sampling Frequency	Field Parameters	Laboratory Parameters
S06-21 (East Leachate Sump)	Quarterly	Conductivity, Dissolved oxygen, Oxidation reduction potential, pH, Temperature, Total dissolved solids and Turbidity	General Chemistry, Nutrients, Metals, Petroleum Hydrocarbons/ VOCs, and Phenols
TLIP (Treated leachate settling pond)	Batch by Batch (before entering infiltration pond)	Conductivity, pH, and temperature	General Chemistry, Dissolved Metals, VOCs, PAHs, and PHCs

Leachate flow data has been recorded continuously since 2015. The flow of leachate should be calculated from recorded measurements of total leachate volumes divided by the time between measurements. It is recommended that data be graphed as m³/d. Monthly totals (m³) and peak flows (L/sec) should also be reported.

7.1.2 Surface Water Monitoring

The surface water monitoring program currently consists of quarterly water level monitoring and annual sampling. Monitoring is recommended to be continued at that frequency. Surface water locations are specific to the Mclvor and Rico Lakes located upgradient and cross-gradient of the landfill. The background SW 15-01 (Mclvor Lake) sampling location is located to the north of Site. The Mclvor Lake level will be obtained from the BC Hydro reservoir level records. A second background sampling location, SW 15-02 (Rico Lake), sampling location is located west of the Site. The Rico lake level will be recorded using the existing Rico Lake gauge.

The surface water monitoring parameters and frequency are summarized in the table below.

Table7-2: Surface Water Parameters and Sample Frequency

Monitoring Location	Sampling Frequency	Field Parameters	Laboratory Parameters
SW 15-01 (McIvor Lake)	Annually	pH, conductivity, temperature, dissolved oxygen, oxidation reduction potential, total dissolved solids, and turbidity	General Chemistry, Nutrients, and Total metals
SW 15-02 (Rico Lake)			

7.1.3 Groundwater Monitoring

In 2025, there was one additional downgradient monitoring well installed at the Site (MW 13-25). Two previously existing wells will be decommissioned during the proposed landfill upgrades (PZ1-19 and MW3-14). Subsequent to the above changes, there are currently seventeen groundwater monitoring wells included in the monitoring program. Of the seventeen existing wells, seven are located upgradient of the landfill and represent background groundwater quality, six are located downgradient of the lined landfill and four wells are located cross-gradient of the landfill.

Groundwater is currently monitored on a quarterly basis for laboratory parameters, field parameters, and water levels. It is recommended that the quarterly monitoring frequency be adjusted for selected upgradient wells (MW8-17, MW9-17, and MW1-14) located away from the landfill and along the Campbell River Highway. Specifically, laboratory and field parameter monitoring may be reduced to one selected well per quarter in these areas, while water levels should continue to be measured quarterly in all wells.

Groundwater monitoring parameters and frequency are summarized in the table below.

Table7-3: Groundwater Parameters and Sample Frequency

Monitoring Location	Location	Sampling Frequency	Field Parameters	Laboratory Parameters
MW 8-17	Upgradient Well	Annually	pH, conductivity, temperature, dissolved oxygen, oxidation reduction potential, total dissolved solids, and turbidity	General Chemistry, Nutrients, Dissolved metals, PAHs, and PHCs.
MW 9-17	Upgradient Well	Annually		
MW 1-14	Upgradient Well	Annually		
MW 4A-15	Upgradient Well	Quarterly		
MW 4B-15	Upgradient Well	Quarterly		
MW 2-14	Cross-gradient Well	Quarterly		

MW 2A-16	Cross-gradient Well	Quarterly		
MW 10-17	Downgradient Well	Quarterly		
MW 11-19	Downgradient Well	Quarterly		
MW 12-22	Downgradient Well	Quarterly		
MW 13-25	Downgradient Well	Quarterly		
MW 7-17	Upgradient Well	Water Level Only		
MW 8-17	Upgradient Well	Water Level Only		
MW 5A-15	Cross-gradient Well	Water Level Only		
MW 5B-15	Cross-gradient Well	Water Level Only		
MW 15A-18	Cross-gradient Well	Water Level Only		
MW 15B-18	Cross-gradient Well	Water Level Only		
MW 3-14	Downgradient Well	Decommissioned Due to Proposed Expansion	The wells must be abandoned and properly decommissioned prior to proposed landfill expansion	
PZ-19	Cross-gradient Well	Decommissioned Due to Proposed Expansion		

7.1.4 Landfill Gas Monitoring

Landfill Gas (LFG) is a by-product of the natural decomposition of organic materials in landfills. The most common form of LFG, which is created when biological anaerobic decomposition occurs, consists primarily of equal parts methane (CH₄) and carbon dioxide (CO₂). Other trace constituents include more than 166 different Non-Methane Organic Compounds (NMOC), nitrogen (N₂) and oxygen (O₂); the concentrations of these constituents are subject to the amount and composition of contributing waste material within the landfill, the decomposition rate of the specific contributing material, and the level of atmospheric air intrusion into the landfill.

Previous LFG generation assessments have been completed in 2021. Results indicate that the landfill was generating less than 1,000 tonnes of methane per year and below ENV's LFG Management Regulation. Therefore, it was concluded that installing an active gas collection system at this landfill site was not mandatory. Because the quantity of waste in place at Northwin Landfill has exceeded 100,000 tonnes, Northwin Environmental Ltd. is required to prepare and submit to the ENV a gas generation assessment report for Northwin Landfill every five years.

Although Northwin Environmental Ltd. is not currently required to collect and oxidize generated methane, discussions are ongoing regarding the potential implementation of a methane emission reduction initiative at the Site. This may include the use of a biocover system, if and when deemed necessary, to support methane oxidation and reduce landfill gas emissions. Use of engineered biocover systems for reduction of fugitive methane emissions from landfills is an emerging GHG mitigation technology.

Biocover systems, fabricated using organic residuals such as biosolids and compost, can have ideal physicochemical properties that stimulate the growth of methanotrophic bacteria that consume methane and produce carbon dioxide, a less potent GHG.

The objective for the landfill gas (LFG) monitoring program is to detect lateral migration of LFG at the site. Currently, LFG is being monitored at the perimeter of the Site, as well as monitoring 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. Soil vapour monitoring probes are installed at the Site and monitored annually. Two probes were installed in 2022. Then the other probe was installed in 2025 to replace a 2022 installed probe that was decommissioned due to it being placed in a high traffic area.

Landfill Gas monitoring parameters and frequency are summarized in the table below.

Table 7-4: Landfill Gas Parameters and Sample Frequency

Monitoring Location	Location	Sampling Frequency	Comments
LFG1-22	Near Wash Plant	Annually	Decommissioned due to it being placed in a traffic area
LFG2-22	Southern Property Boundary (South of Landfill)	Annually	
LFG3-25	Near Wash Plant (North of Landfill)	Annually	Replaced decommissioned LFG1-22

7.2 Annual Report

Per the OC, an annual operating and monitoring report must be submitted to the Regional Manager, Environmental Protection by March 31 of each year and encompass the preceding 12-month period from January 1 to December 31. The annual report must include:

1. An executive summary
2. Tonnage of each type of waste discharged to the landfill for the year
3. Remaining site life span and capacity
4. Leachate management including leachate quantities and qualities
5. A review of the preceding year of operation, plans for the next year, and any new information or proposed changes relating to the facilities and plans
6. In the event of any non-compliance with the conditions of the OC, an action plan and schedule to achieve compliance
7. Comparison of the monitoring data with the performance criteria in section 4 of the *Landfill Criteria for Municipal Solid Waste* 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.

SHA recommends the following be included in the annual reporting as listed in the Criteria:

8. An account of any closure works completed
9. Any changes from approved reports, plans and specifications

7.3 Quality Assurance/Quality Control

SHA recommends that the Northwin Environmental Ltd. continue to incorporate a quality assurance/quality control (QA/QC) program as part of the Environmental Monitoring Plan. A QA/QC program is a system of procedures, checks, audits, and corrective actions that will assist in ensuring that the data collected in the field and generated at the laboratory is accurate and of high quality. This is of prime importance, as the monitoring data will form the basis for all of the conclusions regarding the impact of the landfill on the surrounding environment. The primary purpose of the QA/QC program is not to check up on the environmental laboratory conducting the analyses, but to demonstrate the reproducibility of the analytical data. Reproducibility demonstrates that the data is of high quality and that, in turn, the conclusions drawn from the data have an associated high level of confidence.

QA/QC recommendations are as follows:

1. Use of a CALA (Canadian Association for Laboratory Accreditation Inc.) accredited laboratory
2. Use of electronically transferred data into tables to minimize manual entry
3. Use of unique sample identification for each sample
4. Recording of the date and time of sample collection
5. Recording the source of sample (including name, location, and sample type)
6. Use of preservative as required
7. Accurate completion of chain of custody forms
8. Submission of samples within recommended holding times
9. Analysis of duplicate sample results and laboratory internal QA/QC.

There are two main types of laboratory QA/QC samples – internal and external. Internal QA/QC refers to the routine procedures that laboratories perform, on a daily or a “batch” basis, in order to ensure that nothing inside the laboratory is influencing the analytical results. External QA/QC refers to blind QC samples submitted to the laboratory to determine whether the sampling methodology contaminated the samples, to determine the laboratory analytical precision and accuracy and to assess sampling variability.

Internal laboratory QA/QC must be supplemented with external QA/QC evaluation in the form of field duplicates, trip blanks, and field blanks in accordance with the most recent edition of the British Columbia (BC) Field Sampling Manual (2013) to monitor precision. In general, the level of external QC that is recommended is approximately 10%-30% of sample batch size. For example, a sampling regime that consists of 10 sample locations should include 1 to 3 additional QA/QC samples for a total of 11 to 13 samples submitted for analysis. Duplicate samples should be collected from a different, randomly chosen location during each monitoring event.

7.3.1 Internal QA/QC

As discussed, internal QA/QC consists of routine checks and procedures that are undertaken by the laboratory on a daily or batch basis. Typically, laboratories have their own internal QC program, which may include (but is not limited to):

- Standard methods for cleaning sample bottles, utensils, and analytical equipment

- Standard procedures for method blanks, spike samples, lab duplicates, reference samples, surrogate recoveries, etc.
- Storage, handling and quality of internal QC sample
- Sample storage procedures
- Sample documentation (e.g. analytical technician, analytical technique, control charts and other information)
- Storage, handling and quality of cleaning agents, reagents, acids, distilled or deionized water
- QA/QC training for and certification of staff.

Laboratory control samples, method blanks, reference materials, and reference spikes are used by the laboratory to determine the internal analytical accuracy of a laboratory.

7.3.2 External QA/QC

In accordance with Section 4.3 of the OC, quality assurance (QA) involves submitting blind QC samples as part of a sampling suite. The blind samples usually consist of a combination of trip blank, field blank, and duplicate samples. Each type of external QC sample is discussed below as per the BC Field Sampling Manual.

7.3.2.1 Field Blank Samples

Field blank samples are used to determine whether any systematic sampling contamination is affecting the samples. Field blanks typically consist of commercially available de-ionized or distilled water that is taken with the field staff during a sampling event. The blanks are treated identically to all other samples, by being poured into a sample bottle, by undergoing any routine filtration or acidification in the field and by being submitted to the laboratory as a discrete sample. Field blanks should be used for environmental samples and for monitoring effluent parameters having low permit limits.

7.3.2.2 Equipment Blank Samples

Equipment blank samples are used to determine whether any equipment contamination is affecting the samples. Equipment blanks typically consist of using commercially available de-ionized or distilled water that is processed in the same manner as all other samples once all equipment has been decontaminated and properly cleaned. The blanks are treated identically to all other samples.

7.3.2.3 Field Duplicates

Duplicate samples are used to determine the analytical precision of the laboratory and to assess sample variability. Field duplicates, as their name implies, are two samples collected from the same sampling point. The sample is duplicated by either collecting the samples sequentially, or by collecting one large sample, which is subsequently split into two sub-samples. The samples are submitted separately. Field duplicates are optional for effluents known to be highly stable and homogeneous. Field duplicates are mandatory for unstable or heterogeneous effluents, and for all environmental samples.

7.3.3 Data Acceptance Criteria

As part of the QA/QC program, data acceptance criteria are used to assess whether the analytical results being generated by the laboratory are within acceptable bounds. Data that falls outside the acceptable bounds will require further assessment in order to determine the reasons behind the data variability. The recommended data quality objectives for duplicates per the BC Environmental Laboratory Manual (BCELM) should include Relative Percent Difference (RPD) analysis. Generally, for concentrations below 5 times the method detection limit (MDL), the difference between the two duplicate values shall

not exceed twice the reported detection limit (DL) value. For concentrations at or greater than 5 times reported DL, the Relative Percent Difference shall not exceed 20-50% for specific parameters.

Table 7-5 BCELM Recommended RPDs

Parameter Category	Recommended RPD at Concentrations Exceeding 5X MDL
Organics in solids - PAHs - Volatile Organics (including VPH) - EPH	50% 40% 40%
Organics in Water (Volatile Organics (including BTEX and VH)	30%
Metals in Solids	30%
Metals in Water	20%
General Inorganics in Solids	30%
General Inorganics in Water	20%

7.4 QA/QC-Protocols

A rigorous QA/QC protocol has been developed by Northwin Environmental Ltd. and by the QP conducting the sampling based on the British Columbia Field Sampling Manual. The protocol was reviewed by the QP that will prepare the annual report before commencing the monitoring program. The QA/QC protocol includes the procedures for: sampling, calibration of field instruments, chain of custody reports and the use of blank, reference and duplicate samples. The protocol will also specify the QA/QC procedures that the selected laboratory will use.

7.5 Post-Closure Monitoring

During post-closure periods, monitoring requirements will continue for all parameters such as groundwater, surface water, lateral gas migration, erosion, cover system and geotechnical monitoring. Post-closure groundwater monitoring will continue using the existing monitoring well network, which includes locations upgradient to the north, downgradient to the south, and cross-gradient to the east and west of the landfill footprint, as shown on Figures 3-3A and 3-3B. Note that landfill expansion will proceed to the south and west until final closure. Any wells that must be abandoned (PZ-19 and MW 3-14) for the landfill expansion should be decommissioned properly prior to construction of the liner system. Landfill Operators and Northwin Environmental Ltd. staff should ensure that all monitoring locations are secure and are not compromised during site upgrades, daily operations or closure works. The post-closure monitoring program should extend 30 years post-closure as mentioned in Chapter 10 (See Figure 7-1). SHA recommends that 30 years of appropriate post-closure monitoring be completed following final closure at Northwin Landfill.

7.6 Annual Inspection

SHA recommends that, during operations, an annual inspection be conducted. The annual inspection should include a geotechnical inspection conducted shortly after the snow has melted for the year. A geotechnical inspection and landfill settlement monitoring will also be required annually during the post-closure care period as per the Criteria. A post-closure (including progressive closure) annual grid-walk at the same time of year, preferably not with snow on the ground, is a common program at closed landfills that helps observe any changes in cover quality and determine the need for repairs.

7.6.1 Erosion Monitoring

An annual site inspection comprising a geotechnical inspection and a landfill survey are required at all sites by ENV. Geotechnical inspections should be conducted by Northwin Environmental Ltd. staff on a minimum yearly basis to inspect active and inactive areas within the landfill footprint, to check the cover for potential problems arising from slumping, cracking or erosion, and to determine the state of other infrastructure that does not receive regular inspection. If significant geotechnical issues are identified, a qualified geotechnical engineer should be retained to assess the situation.

Additional inspections should be conducted on an as needed basis after intense storm events to detect cover erosion, ditch clogging and blow-outs, sediment accumulation, leachate breakouts and seeps.

7.6.2 Site Survey

An annual survey of the active area is recommended. Accurate surveys are useful in data collection of important landfill parameters required to assess lifespan estimates and schedule capital costs. Survey data is used to gather information on deposition volumes, excavation volumes, settlement monitoring, infrastructure layout, cell size determinations, compaction density tracking, and waste to cover ratio on an annual basis.

The results of the surveys should be included in the annual reports submitted to the ENV. All monitoring data should be compiled annually into a comprehensive monitoring report as required by the OC and the landfill Criteria. Annual reporting is a useful way to ensure that all necessary monitoring is being completed.

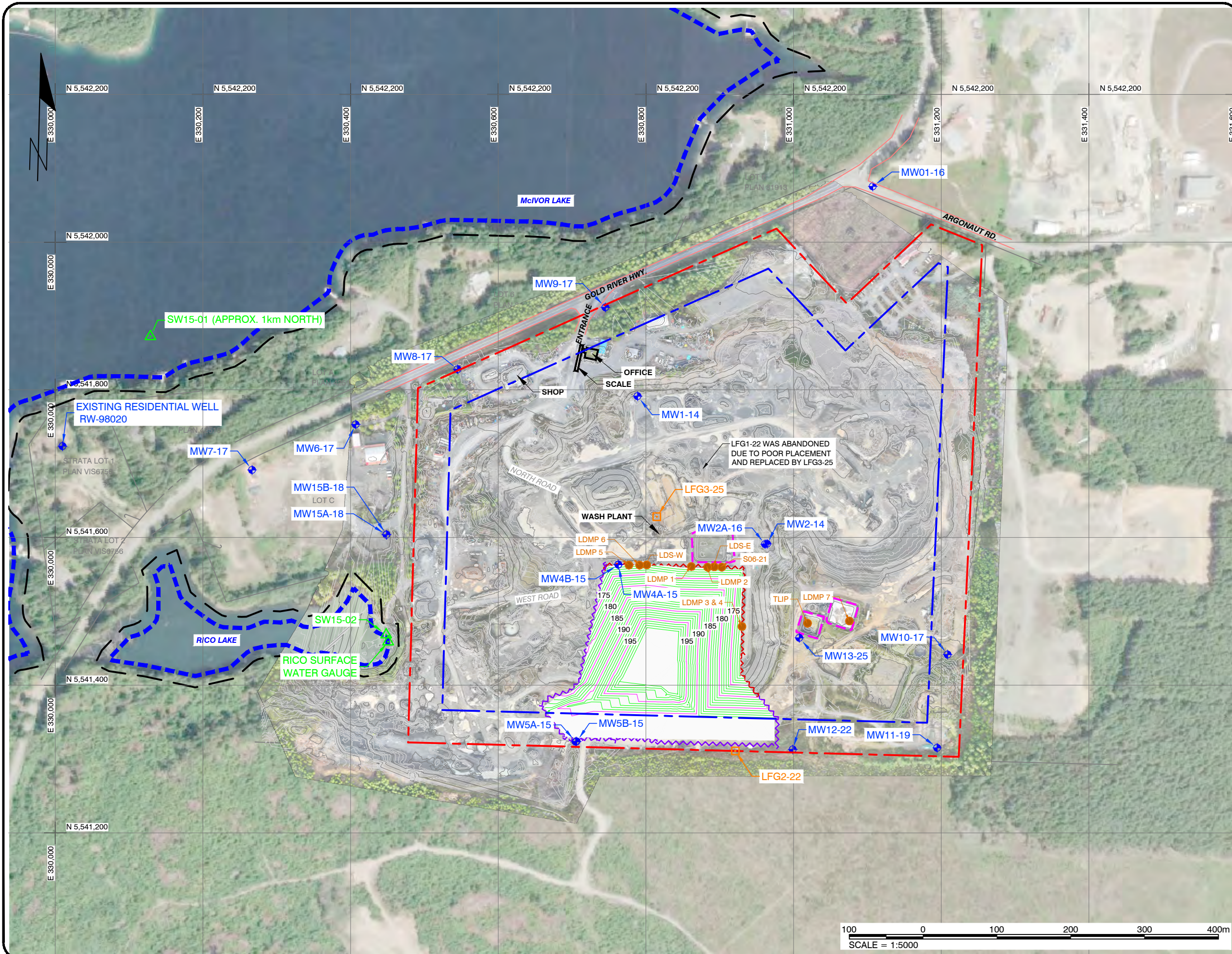
FIGURES



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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
- 5m OFFSET FROM PROPERTY
- 50m OFFSET FROM PROPERTY
- LEACHATE TREATMENT SYSTEM
- EXISTING LAKE
- 20m OFFSET FROM EXISTING LAKE
- LANDFILL BASE LINER EXTENTS
- EXISTING MONITORING WELL
- EXISTING SURFACE WATER MONITORING LOCATION
- SOIL VAPOUR PROBE
- LEACHATE MONITORING LOCATION

TOPO SURFACE SURVEYED SEPTEMBER 11, 2025
BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

SITE ORTHO IMAGE BY NORTHWIN - DEC 15, 2025
OTHER IMAGE BY BING MAPS

CLIENT:



PROJECT:

NORTHWIN LANDFILL DESIGN OPERATION
AND CLOSURE PLAN UPDATE

TITLE:

POST CLOSURE MONITORING
LOCATIONS

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8 FILLING PLAN AND MATERIAL MANAGEMENT

This Chapter presents SHA's recommendations for the systematic filling operations required to execute the landfill phases to design grade prior to the active filling area being completed at Phase 1 North and waste filling commencing within the Phase 2 South, Phase 3 South, and Phase 4 North area. The filling plan includes strategies for constructing individual landfill cells, for constructing strips within each 2.5 m thick lift (as per the current practice) and for proper management of outside edges of each lift so that available airspace is not wasted. This chapter discusses the filling plan for Phase 2 (South), as presented in Figures 8-1 to 8-21.

8.1 Landfill Method and Sloping

Phases 2 through 4 shall be constructed in multiple 2.5 m lifts, the first a variable thickness lift from the north toe at 170 m elevation up to 180 m, and the second and all successive lifts from 180 m up to the crest elevation of 200 m at 2.5 m lift thickness. The strip method of filling is to be used to construct each lift. The basic concept of constructing a strip from a series of cells is shown below in Figure 8-22. The figure shows the concept visually, however variations to this approach are required based on the landfill and the size of the area in which filling is taking place.

Waste is placed using either the push-up or push-down method of cell construction. The push-up method is the preferable method and the push-down is used where the Cell geometry dictates its necessity.

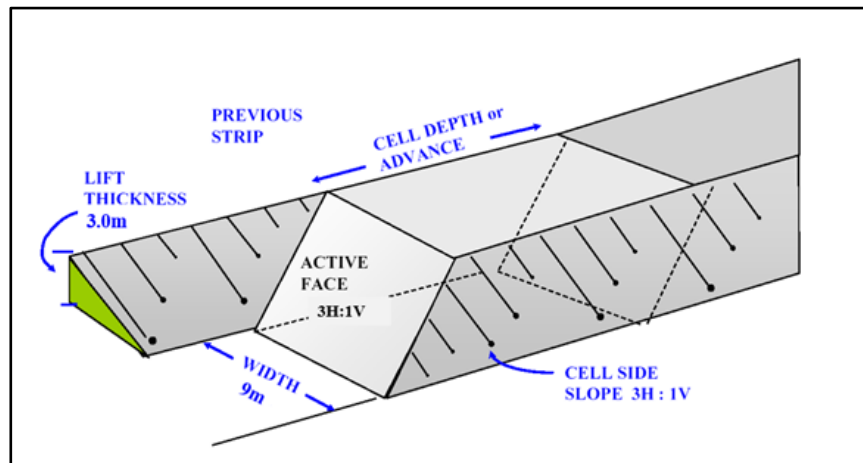


Figure 8-22 Lift Construction Concept Using Strip Method

Phase 1 North has approximately two more 2.5 m lifts of filling from El. 175 m to 180 m before completion.

Phase 2 South is to be constructed in strips advancing from west to east, in this instance adopting a push down method of fill placement of eight lifts between around 160 and 180 m. Subsequent phases 3 and 4 (south and north, respectively) should raise the landfill in eight lifts by 2.5 m intervals from elevation 180 m until the design final elevation of 200 m is achieved. Note that the final lift will involve placing a crown lift on Phase 3 south and Phase 4 north to achieve final design elevation to EL. 199 m and to recover air space lost due to settlement.

8.2 Cell Optimization and Geometry

The actual volume of air space that is consumed daily at Northwin Landfill depends on the amount of incoming refuse and the amount of daily and intermediate soil cover placed. Soil cover is necessary to isolate the waste from the environment, and to control odors and vectors, such as birds and flies. In addition, if placed properly, soil cover provides an effective firebreak that minimizes the risk of fire spreading throughout the entire landfill site, as well as prevents the spontaneous combustion of the waste. In the place of daily soil cover, use of an ADC can help to extend the life of the landfill. Currently, Northwin Environmental Ltd. uses incoming mineral soil and onsite soil for operational cover that is deployed with an excavator.

The amount of cover soil utilized on a daily and weekly basis is evaluated in terms of the waste to cover ratio, defined as the volume of compacted waste for each volume of soil cover utilized. Recognizing that air space is valuable, today many landfill operators attempt to optimize their soil cover in order to use as little as possible while ensuring that all the functional objectives of soil cover continue to be realized. This is achieved by compartmentalizing the refuse in cells whose dimensions are carefully optimized to match the incoming tonnage.

The 2025 Annual Report concluded that during the 2025 reporting period, a total of 11,549 m³ of waste was placed in the landfill, together with 8,638 m³ of operational cover. As a result, the waste to cover ratio was approximately 1.34 to 1 (vol/vol).

A waste cell is a unit of waste fully encapsulated by soil. The optimum cell dimensions vary depending on the amount of waste entering the landfill. Typically, unless the landfill's geometry creates other constraints, a landfill manager will want to optimize the ratio of waste to soil cover material. The optimum cell dimensions for the Landfill were calculated using SHA's Landfill Wizard Cell Geometry Spreadsheet (see Table 8-1).

Table 8-1: Landfill Wizard Cell Geometry Spreadsheet

The results indicate that by continually placing daily cover every three weeks, the "optimum" waste to cover ratio is 4.58 to 1. This ratio can be achieved with a 2.5 m thick lift and a 9 m wide active face. However, SHA's experience is that medium tonnage landfills do not operate well with lift heights above 3.0 m due to constraints with constructing side berms and the overall area of the active face requiring maintenance. Currently, the Northwin Landfill maintains 2.5 m lift and 30 m width. Therefore, SHA recommends that a lift thickness be 2.5 m and the active face width be maintained at 15.0 m. This configuration results in a potentially achievable waste to cover ratio of approximately 5.31:1.

As Northwin Engineered Landfill receives a significant volume of contaminated soil for disposal annually, the amount of soil available for operational cover is not an operational constraint. Therefore, operations applies ample soil cover on the completion of each cell, typically achieving a waste to cover ratio of 2:1. It is recommended that this practice continue in the future to minimize waste exposure and risk of fire.

In order to achieve a waste to cover ratio of 2:1 that SHA assumed in the lifespan analysis, SHA has provided the following operational recommendations:

- Provide good compaction to active face, including grading, to prevent the use of excessive soil that could slip between the spaces in the MSW;
- Operate the active face at a slope of 3-5H:1V to aid in compaction efficiency;

- Stockpile incoming soil away from the active face to prevent the use of excessive soil due to ease of access;
- Recover excess cover soil from previous cells / lifts if it exists;
- Make use of diverted waste products such as asphalt shingles, crushed concrete or chipped wood waste mixed with local soil for operational cover soil;
- Minimize the usage of large soil berms on the outside edge of slopes and roads; and
- Quarterly cover soil usage tracking via contractor recorded cover soil volumes and GPS survey.

8.3 Lift Operations

Constructing the outside edge of each lift can be difficult to achieve. The key is to fill the cell in such a way that refuse does not cascade down the landfill side slopes. SHA recommends the approach for lift edge construction illustrated below in Figure 8-23 (note lift height will vary). During the construction of each lift, the process involves first dumping a line of soil stockpiles along the crest of the landfill slope to a height of 1.3 m to 1.5 m to contain the refuse and to prevent spill-over. The refuse should be pushed in only to the toe of the soil berm, with the outside face of waste sloped at about 3H:1V. The operator can then push the remaining soil over the refuse as shown in Figure 8-23, cutting the peak off the soil stockpiles and spreading the excess soil up the slope as operational cover.

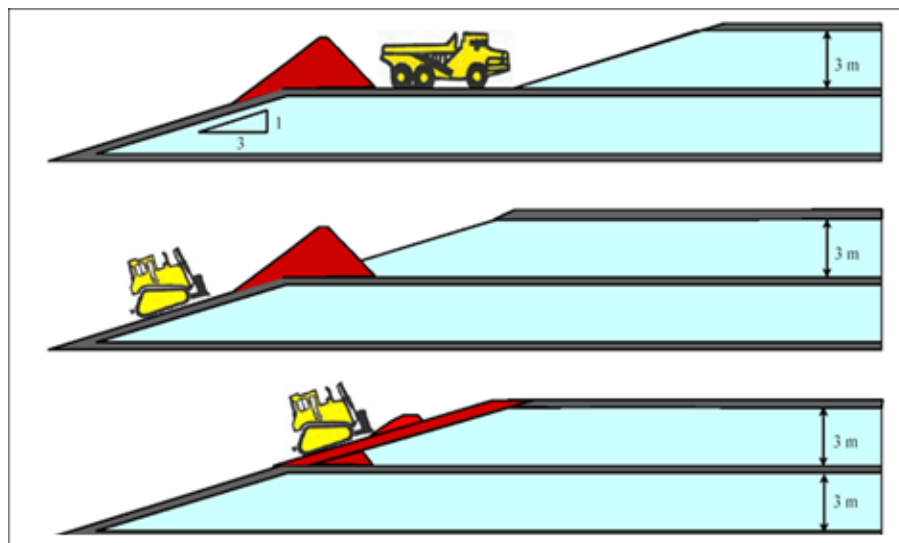


Figure 8-23 Lift Edge Development

8.4 Operational Cover

When using soil as a cover material there are some practical methods that should be employed to ensure that soil is not lost during cover placement. The Handbook of Landfill Operations (Bolton, 1995) suggests that placing cover soil on improperly finished waste cells is the greatest waste of airspace at a landfill. The Handbook suggests that, if, after the waste is compacted, proper measures are taken to manicure the waste cell before cover is placed, significant savings in material can be realized. Essentially, if the active face is not prepared properly, soil will disappear into the voids in the waste face and may be spread in layers that may significantly vary in depth. An example used in the Handbook suggests that an investigation was undertaken at a landfill where cover soil varied in depth from 5" to 3.5'. The basic idea for eliminating these potential problems is to ensure that the waste face is as smooth and even as possible before cover soil is placed. Recommendations in the Handbook include a) regrading the active face prior to placing cover to create a smooth surface and b) to track-walk the face with a dozer to "knit"

the surface of the garbage together to avoid loss of soil in the dimples created by the compactor. The principle of ensuring an even, smooth active face, with few voids, should be attempted with the available equipment.

8.5 Lift-by-Lift Filling Plan

The following presents a lift-by-lift description of how SHA foresees Phase 2 being developed over the next 5 years at the Northwin Landfill site. Alterations to the orientation of cells may become apparent during construction but this will provide a basis for access road construction and phase development / completion. The overall objective of the fill plan is to build vertically and keep as small a waste footprint as possible while providing reliable access. The flat working deck of each lift should be sloped to provide drainage at a minimum 2% grade to avoid ponding water. All final outside slopes will be constructed at 3H:1V and all internal slopes (slopes where the next phase or future phases will tie-into) will be built at 2.5H:1V. Main access roads are to be completed at no greater than 8% with temporary access roads no greater than 8%. Roads utilized for construction and internal off-road equipment shall not exceed 10% grade.

Completed Phase 1:

Based on topography captured of Northwin Landfill in September 2025, and discussions with Northwin Environmental Ltd., SHA has projected that Phase 1 will be completed to a crest elevation of 180 m by 2028, as shown in Figure 4-10.

Phase 2 Lift-1:

Lift 1, as shown on Figure 8-1, is constructed south of the previously completed Phase 1 area, beginning in the eastern portion of Phase 2, Lift 1. Filling is completed using a push-up approach, progressing from east to west. Lift 1 will provide capacity of 969 m³, as shown on Figure 8-2. Filling within Lift 1 raises the working deck in 2.5 m intervals to an approximate elevation of 163.5 m. Lift 1 is constructed in two push-up cells Figure 8-3.

Phase 2 Lift-2:

Lift 2, as shown on Figure 8-4, is built off the previously completed Lift 1, beginning in the eastern portion of Phase 2, Lift 2. Filling is completed using a push-up approach, progressing from east to west. Filling within Lift 2 raises the working deck in 2.5 m intervals to an approximate elevation of 166.0 m. As shown on Figure 8-5, a total net fill volume of approximately 4,038 m³ is planned for Lift 2. Lift 2 is constructed in five push-up cells Figure 8-6.

Phase 2 Lift-3:

Lift 3, as shown on Figure 8-7, is built off the previously completed Lift 2, beginning in the eastern portion of Phase 2, Lift 3. Filling is completed using a push-up approach, progressing from east to west. Filling within Lift 3 raises the working deck in 2.5 m intervals to an approximate elevation of 168.5 m. As shown on Figure 8-8, a total net fill volume of approximately 10,475 m³ is planned for Lift 3. Lift 3 is constructed in ten push-up cells Figure 8-9.

Phase 2 Lift-4:

Lift 4, as shown on Figure 8-10, is built off the previously completed Lift 3, beginning in the eastern portion of Phase 2, Lift 4. Filling is completed using a push-up approach, progressing from east to west. Filling within Lift 4 raises the working deck in 2.5 m intervals to an approximate elevation of 171.0 m. As shown on Figure 8-11, a total net fill volume of approximately 19,797 m³ is planned for Lift 4. Lift 4 is constructed in fourteen push-up cells Figure 8-12.

Phase 2 Lift-5:

Lift 5, as shown on Figure 8-13, is built off the previously completed Lift 4, beginning in the eastern portion of Phase 2, Lift 5. Filling is completed using a combination of push-down and push-up approaches, progressing from east to west. Filling within Lift 5 raises the working deck in 2.5 m intervals to an approximate elevation of 173.5 m. As shown on Figure 8-14, a total net fill volume of approximately 29,995 m³ is planned for Lift 5. Lift 5 is constructed in seven push-down and remaining push-up cells Figure 8-15.

Phase 2 Lift-6:

Lift 6, as shown on Figure 8-16, is built off the previously completed Lift 5, beginning in the eastern portion of Phase 2, Lift 6. Filling is completed using a combination of push-down and push-up approaches, progressing from east to west. Filling within Lift 6 raises the working deck in 2.5 m intervals to an approximate elevation of 176.0 m. As shown on Figure 8-17, a total net fill volume of approximately 39,924 m³ is planned for Lift 6. Lift 6 is constructed in eight push-down and remaining push-up cells Figure 8-18.

Phase 2 Lift-7:

Lift 7, as shown on Figure 8-19, is built off the previously completed Lift 6, beginning in the western portion of Phase 2, Lift 7. Filling is completed using a combination of push-down and push-up approaches, progressing from west to east. Filling within Lift 7 raises the working deck in 2.0 m intervals to an approximate elevation of 178.5 m. As shown on Figure 8-20, a total net fill volume of approximately 45,200 m³ is planned for Lift 7. Lift 7 is constructed in eight push-down and remaining push-up cells Figure 8-21.

8.6 Material Management

Landfills require a very large amount of construction material during their lifespan. Typically, 25% to 50% of air space in most landfills is consumed by mineral soil and drainage aggregates. These materials are used for daily and intermediate (operational) cover, roads, basal liners and leachate collection systems, gas collection systems and drainage, barrier and topsoil layers within the final cover system. Efficient operation of a landfill requires that the material acquisition be well planned so that construction materials are available when required. The following sections present the materials management plan for the landfill, including the material requirements for each phase of the landfill development.

8.6.1 On Site Borrow Pit

The borrow area will be located to the south side of the landfill for primarily sourcing construction materials (Figure 4-4). The operational cover requirement was projected for the landfill to build out at 205,131 m³. Though a total of 320,763 m³ in-situ volume is available from the borrow area, a significant portion of the borrow material is gravel that will be sold. Northwin has adequate volumes of soil stockpiled that can be used as cover, as well as incoming soil that meets regulatory acceptance levels (not hazardous waste). This material will be utilized for operational cover, with a total estimated cover requirement of 205,131 m³. Table 8-2 below presents the borrow, waste and soil that meets land use standards volumes of borrow and fill areas:

Table 8-2: Summary of Cut and Fill Borrow Areas

Phase	Identifier	Borrow (m³)	Waste & Cover (m³)	Operational Cover Soil (m³)
Phase 1	North – Up to EL 180	0	94,496	42,631
Phase 2	South – Up to EL 180	320,763	178,491	62,500
Phase 3	South – Up to EL 200	0	156,266	62,500
Phase 4	North – Up to EL 200	0	118,653	37,500
Totals		320,763	547,906	205,131

TABLES



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TABLE 8-1: LANDFILL WIZARD CELL GEOMETRY SPREADSHEET
Northwin Landfill - Using Alternate Daily Cover System

Input Data:

Incoming Annual Tonnage:	45000 tonne/yr	Daily Cover Soil Thickness:	0.15 m
Compacted Density:	1.81 tonne/m ³	Intermediate Cover Soil Thickness on Top:	0.3 m
No. of days open per week:	5 days	Intermediate Cover Soil Thickness on Sides:	0.3
Operating days between soil daily cover:	21 days	Slope Angle Ratio on Active Face:	5
		Slope Angle Ratio on Side Slopes:	2.5

Calculations:

Daily Volume of Incoming Refuse:	95.36 m ³
Refuse Volume in Cell:	2002.57 m ³
Active Face Multiplier:	5.099019514
Side Slope Multiplier:	2.692582404

Cell Length Calculation:

Lift Thickness (m)	Active Face Width (m)							
	6	9	12	15	18	21	24	50
0.5	667.52	445.02	333.76	267.01	222.51	190.72	166.88	80.10
1.0	333.76	222.51	166.88	133.50	111.25	95.36	83.44	40.05
1.5	222.51	148.34	111.25	89.00	74.17	63.57	55.63	26.70
2.0	166.88	111.25	83.44	66.75	55.63	47.68	41.72	20.03
2.5	133.50	89.00	66.75	53.40	44.50	38.14	33.38	16.02
3.0	111.25	74.17	55.63	44.50	37.08	31.79	27.81	13.35
5.0	66.75	44.50	33.38	26.70	22.25	19.07	16.69	8.01
7.5	44.50	29.67	22.25	17.80	14.83	12.71	11.13	5.34
10.0	33.38	22.25	16.69	13.35	11.13	9.54	8.34	4.01

Waste to Soil Ratio on Volume Basis

Lift Thickness (m)	Active Face Width (m)							
	6	9	12	15	18	21	24	50
0.5	1.36	1.45	1.49	1.52	1.54	1.56	1.57	1.60
1.0	2.29	2.54	2.69	2.78	2.84	2.89	2.92	2.98
1.5	2.96	3.39	3.65	3.81	3.92	3.99	4.04	4.08
2.0	3.46	4.05	4.42	4.64	4.79	4.89	4.95	4.89
2.5	3.84	4.58	5.03	5.31	5.49	5.60	5.66	5.44
3.0	4.14	5.00	5.52	5.85	6.04	6.15	6.21	5.77
5.0	4.85	5.99	6.66	7.02	7.18	7.22	7.17	5.83
7.5	5.21	6.43	7.06	7.31	7.33	7.21	7.02	5.02
10.0	5.33	6.49	6.99	7.09	6.96	6.73	6.44	4.22

	Designates Recommended Cell Dimensions
	Identifies Optimum Cell Dimensions

Spreadsheet developed by Sperling Hansen Associates
#8 1225 East Keith Road
North Vancouver, B.C., Canada
V7J 1J3

Contact: Dr. Tony Sperling, P.Eng.
sperling@sperlinghansen.com

Spreadsheet provided for educational purposes only:
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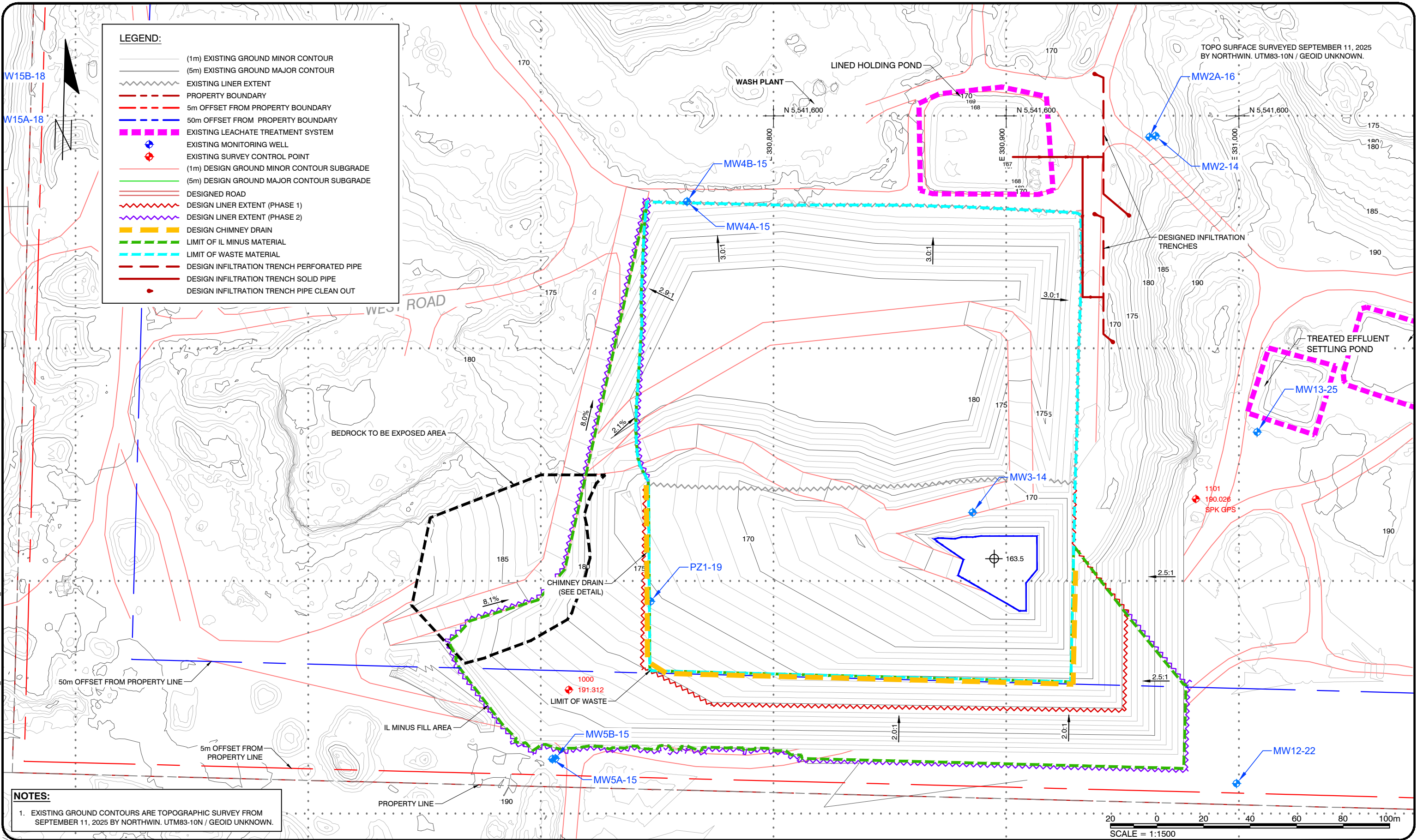
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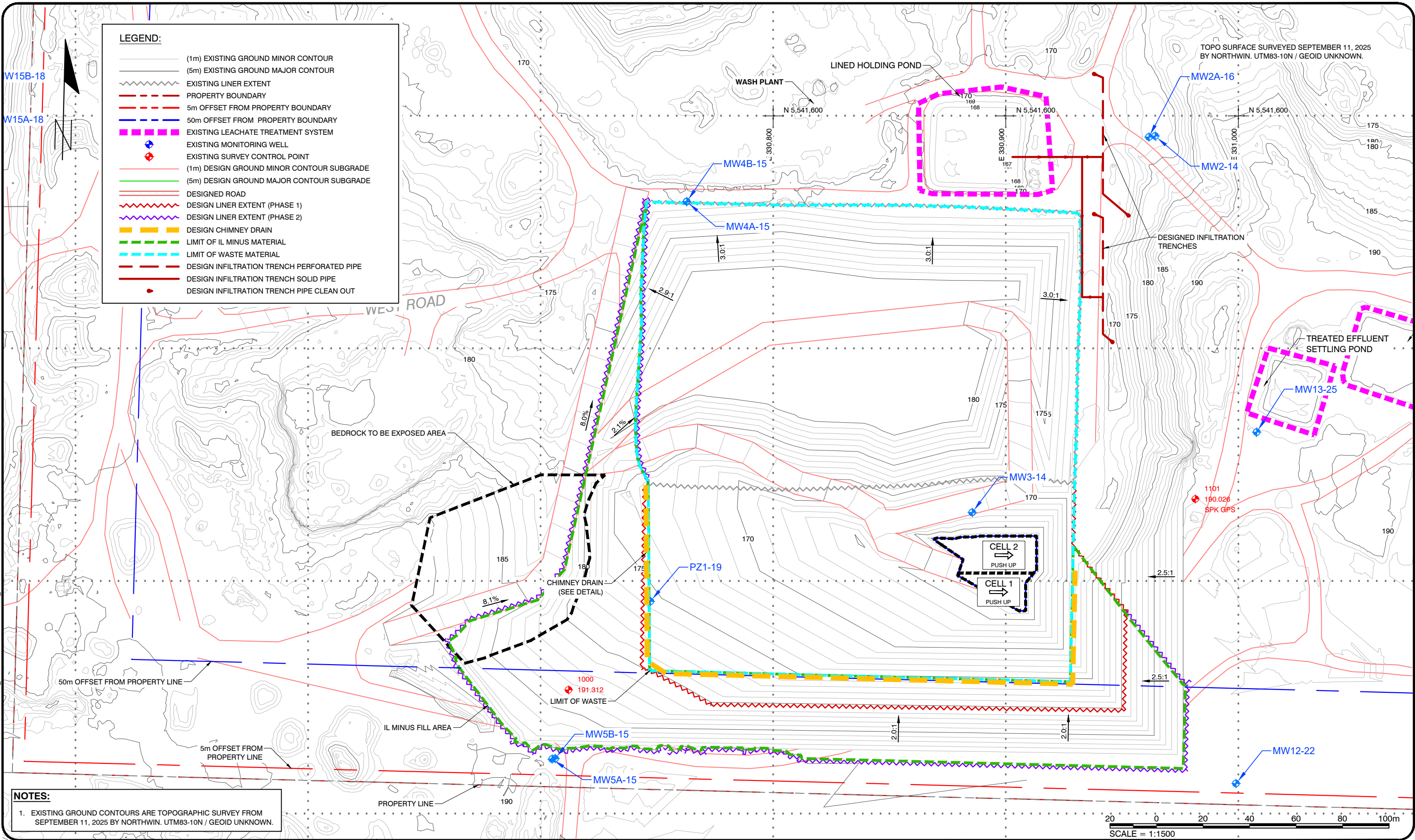
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FIGURE 8-1

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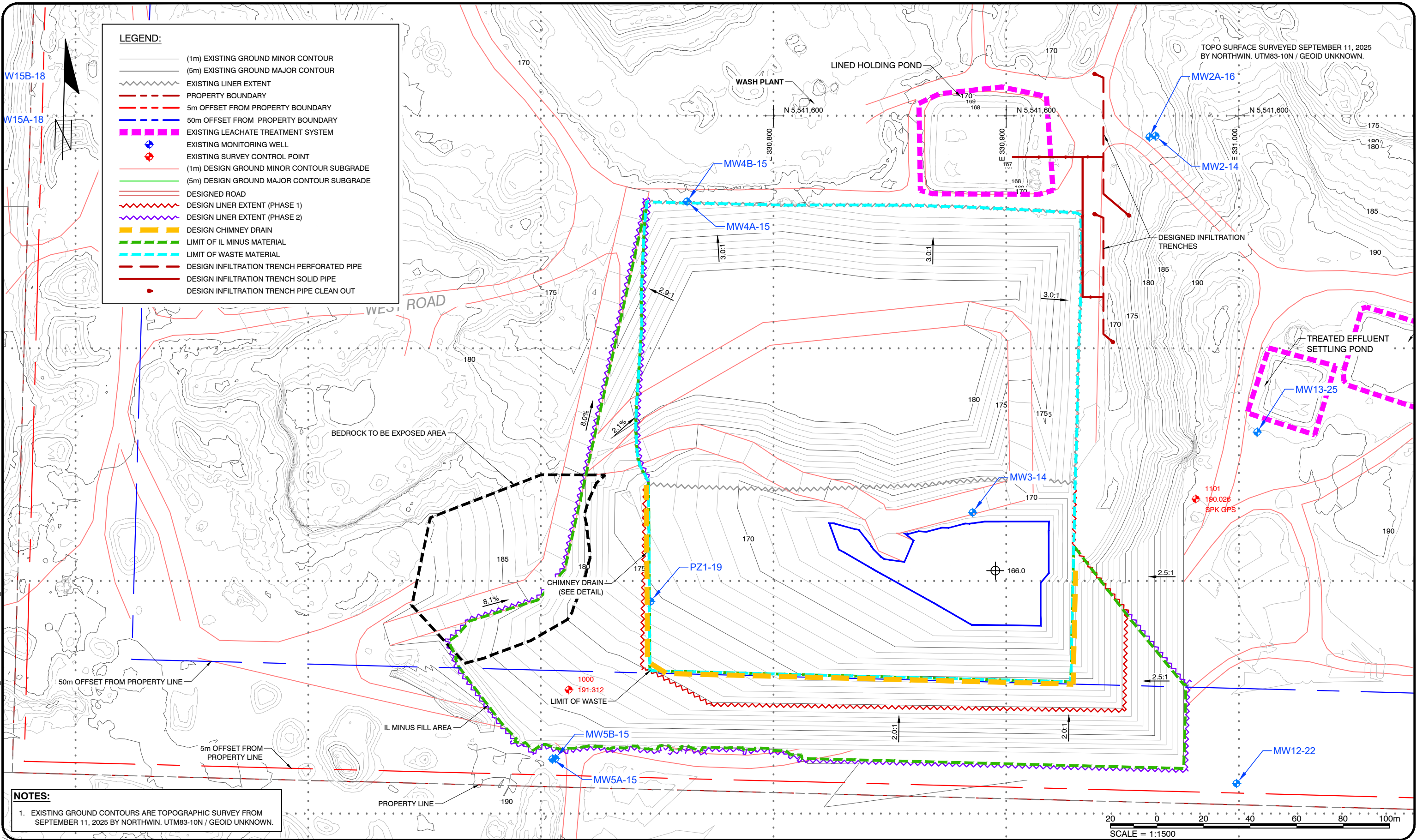
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PHASE 2 LIFT 2 DESIGN
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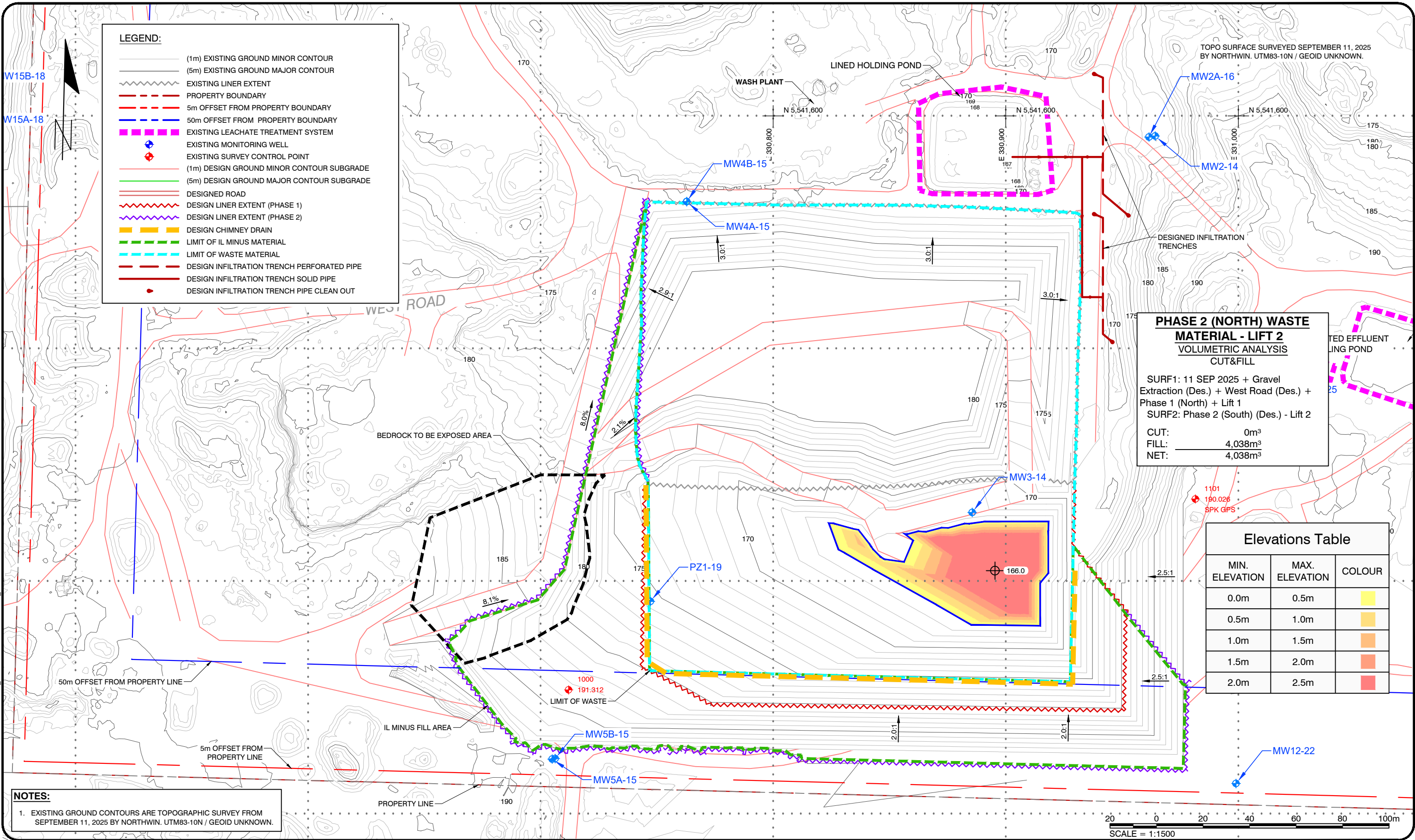
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FIGURE 8-4

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LEGEND:

- (1m) EXISTING GROUND MINOR CONTOUR
- (5m) EXISTING GROUND MAJOR CONTOUR
- EXISTING LINER EXTENT
- PROPERTY BOUNDARY
- 5m OFFSET FROM PROPERTY BOUNDARY
- 50m OFFSET FROM PROPERTY BOUNDARY
- EXISTING LEACHATE TREATMENT SYSTEM
- EXISTING MONITORING WELL
- EXISTING SURVEY CONTROL POINT
- (1m) DESIGN GROUND MINOR CONTOUR SUBGRADE
- (5m) DESIGN GROUND MAJOR CONTOUR SUBGRADE
- DESIGNED ROAD
- DESIGN LINER EXTENT (PHASE 1)
- DESIGN LINER EXTENT (PHASE 2)
- DESIGN CHIMNEY DRAIN
- LIMIT OF IL MINUS MATERIAL
- LIMIT OF WASTE MATERIAL
- DESIGN INFILTRATION TRENCH PERFORATED PIPE
- DESIGN INFILTRATION TRENCH SOLID PIPE
- DESIGN INFILTRATION TRENCH PIPE CLEAN OUT

PHASE 2 (NORTH) WASTE MATERIAL - LIFT 2
VOLUMETRIC ANALYSIS
CUT&FILL

SURF1: 11 SEP 2025 + Gravel
Extraction (Des.) + West Road (Des.) +
Phase 1 (North) + Lift 1
SURF2: Phase 2 (South) (Des.) - Lift 2

CUT: 0m³
FILL: 4,038m³
NET: 4,038m³

Elevations Table

MIN. ELEVATION	MAX. ELEVATION	COLOUR
0.0m	0.5m	
0.5m	1.0m	
1.0m	1.5m	
1.5m	2.0m	
2.0m	2.5m	

NOTES:

- EXISTING GROUND CONTOURS ARE TOPOGRAPHIC SURVEY FROM SEPTEMBER 11, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN.



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- Design & Operations Plans
- Landfill Closure
- Environmental Monitoring

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CLIENT:



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PHASE 2 LIFT 2 CUT & FILL

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2026/09/11

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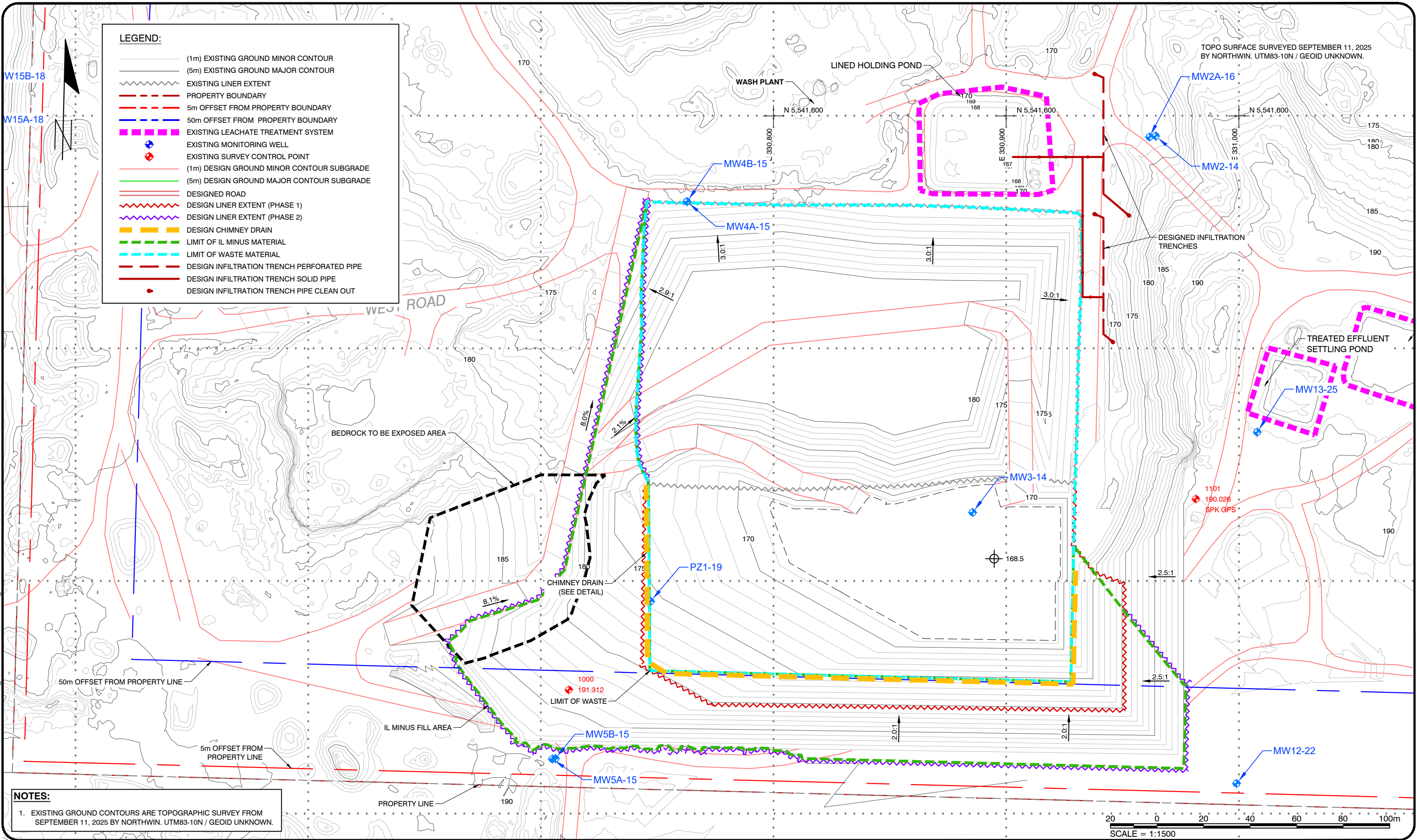
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FIGURE 8-5

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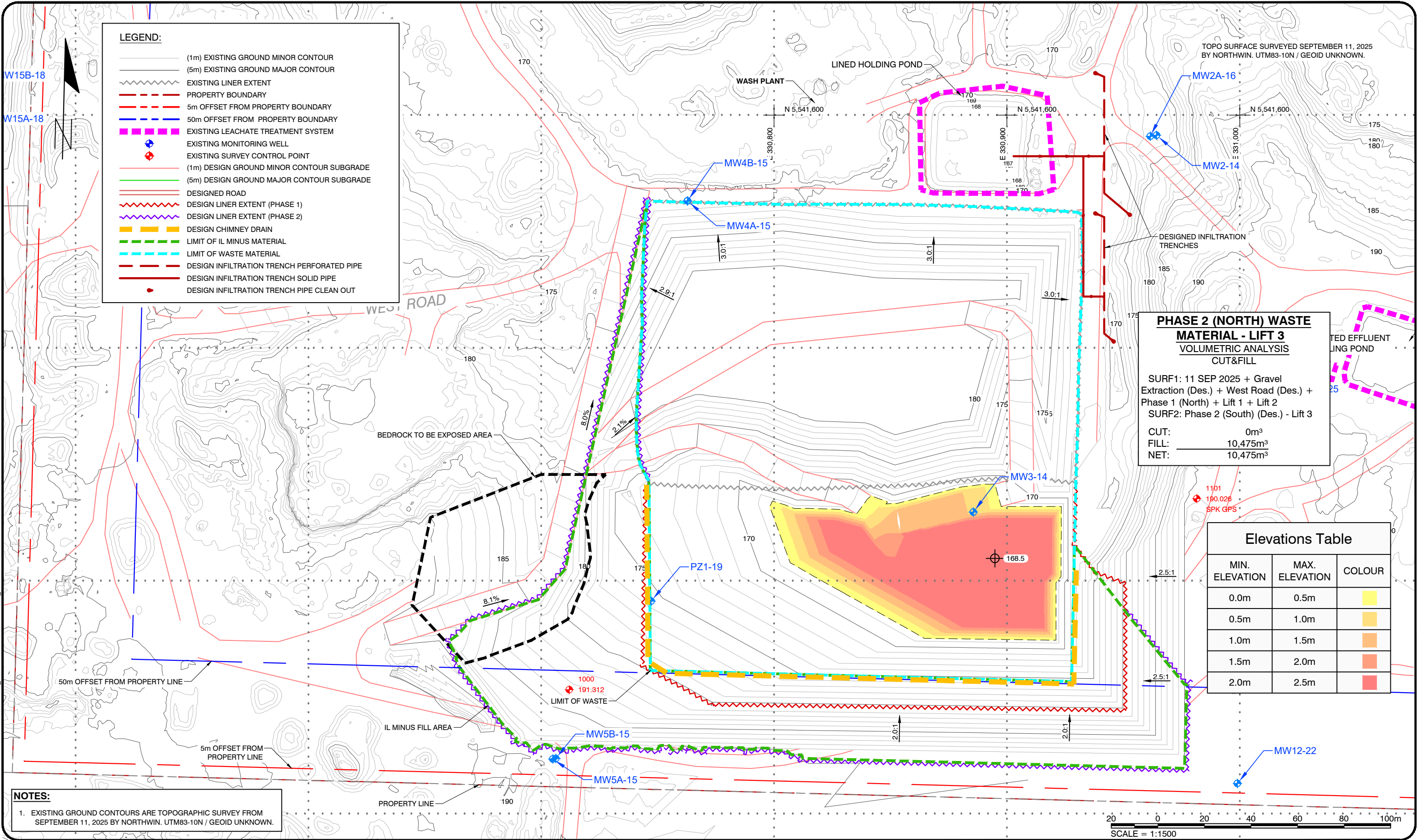
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FIGURE 8-7

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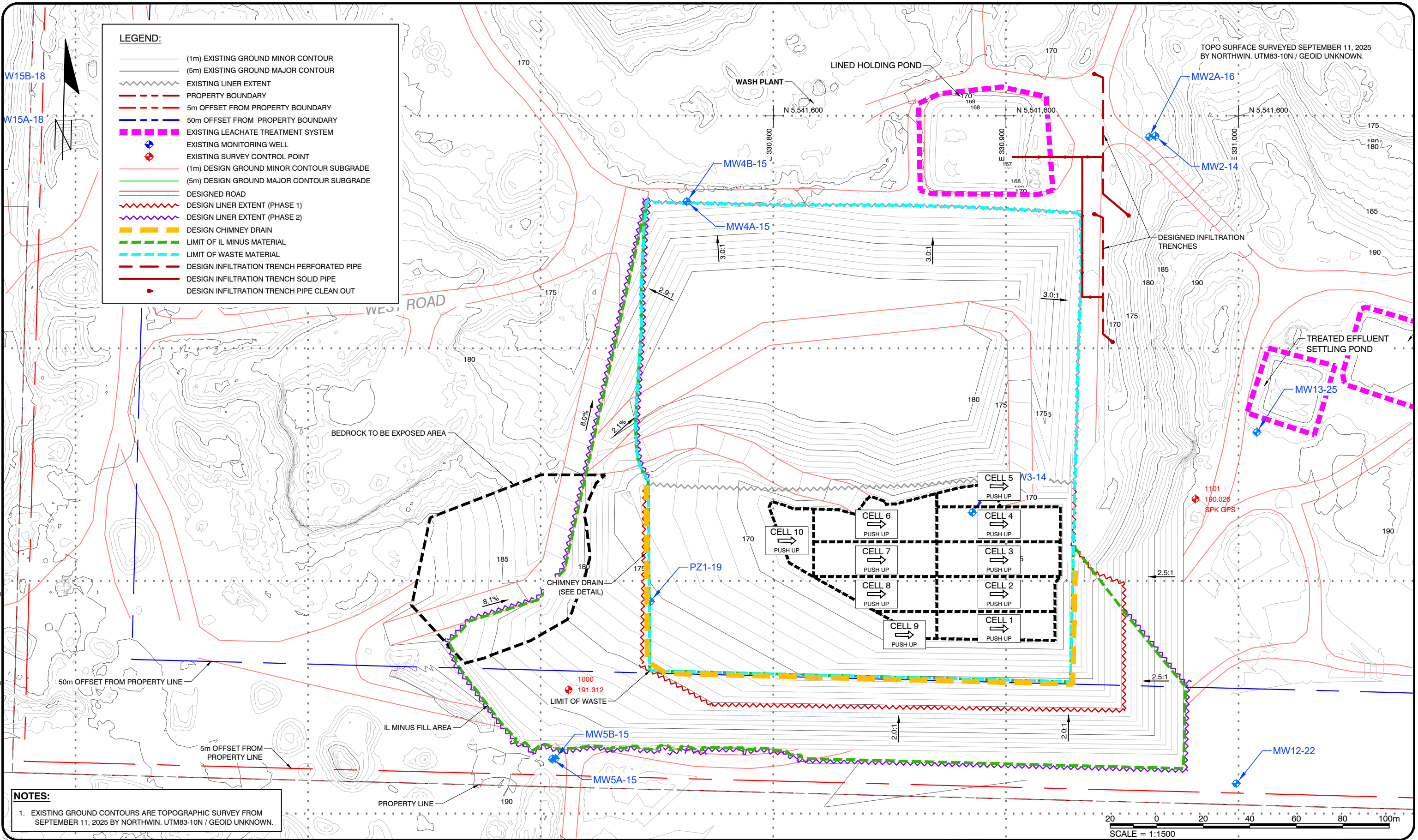
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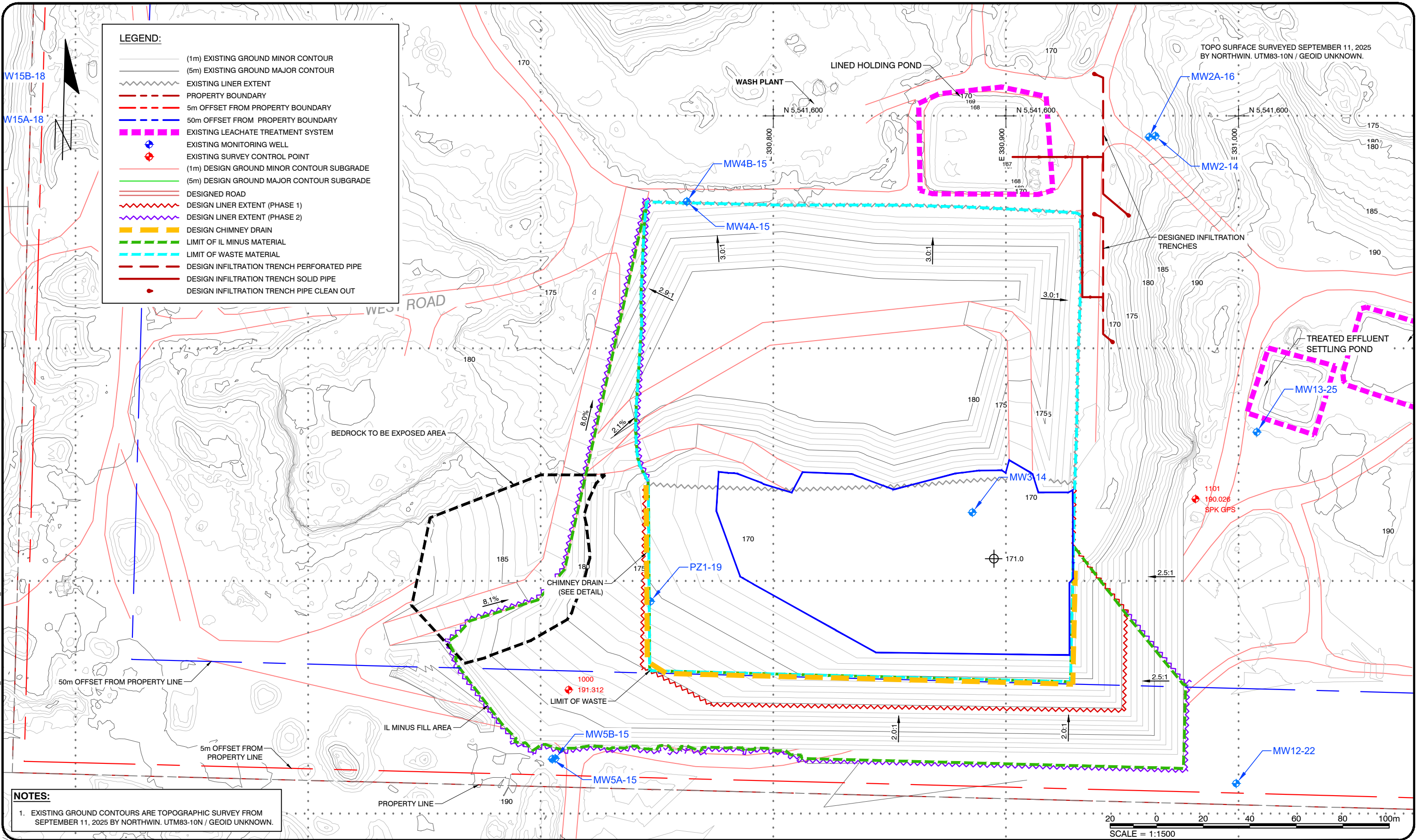
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FIGURE 8-9

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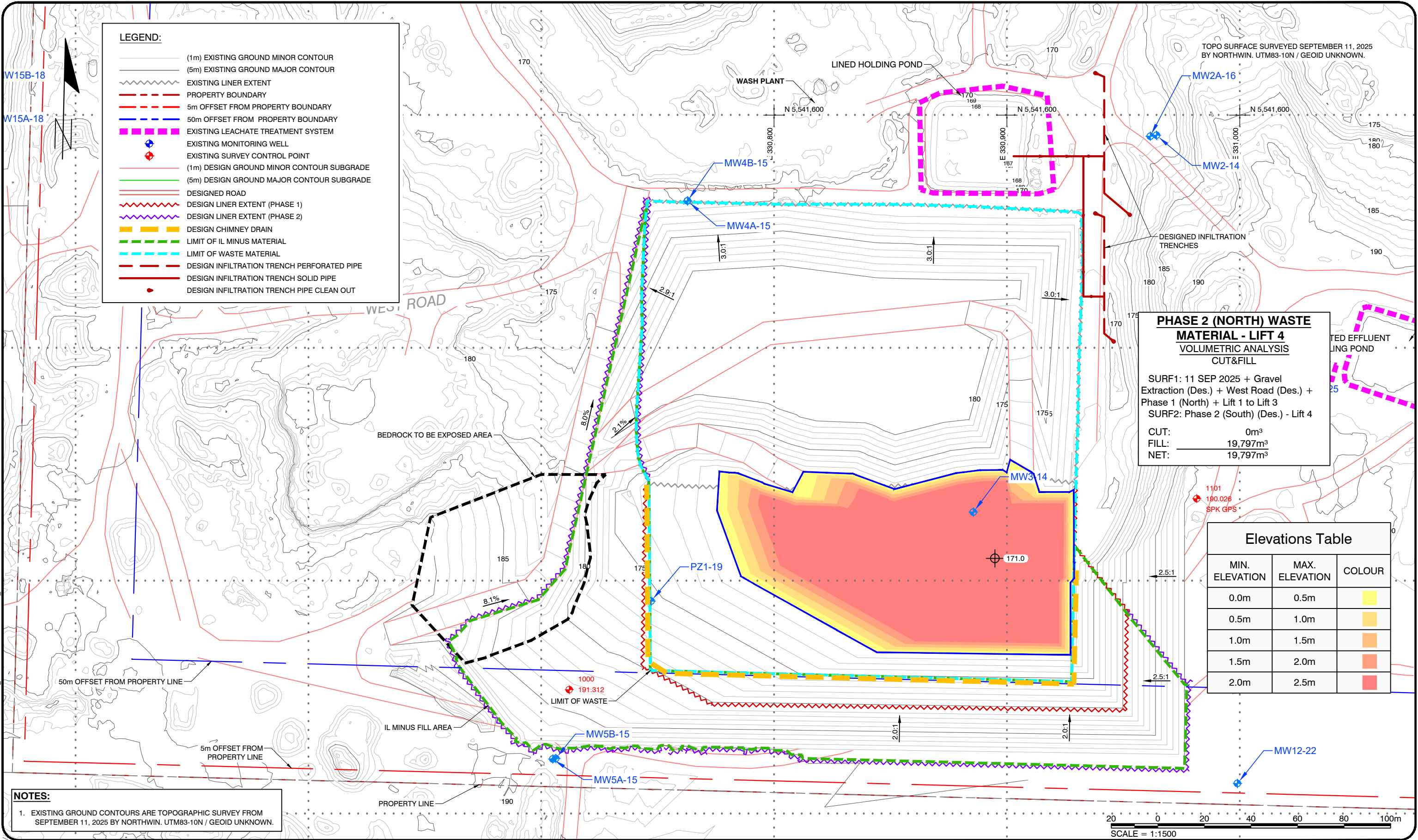
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FIGURE 8-10

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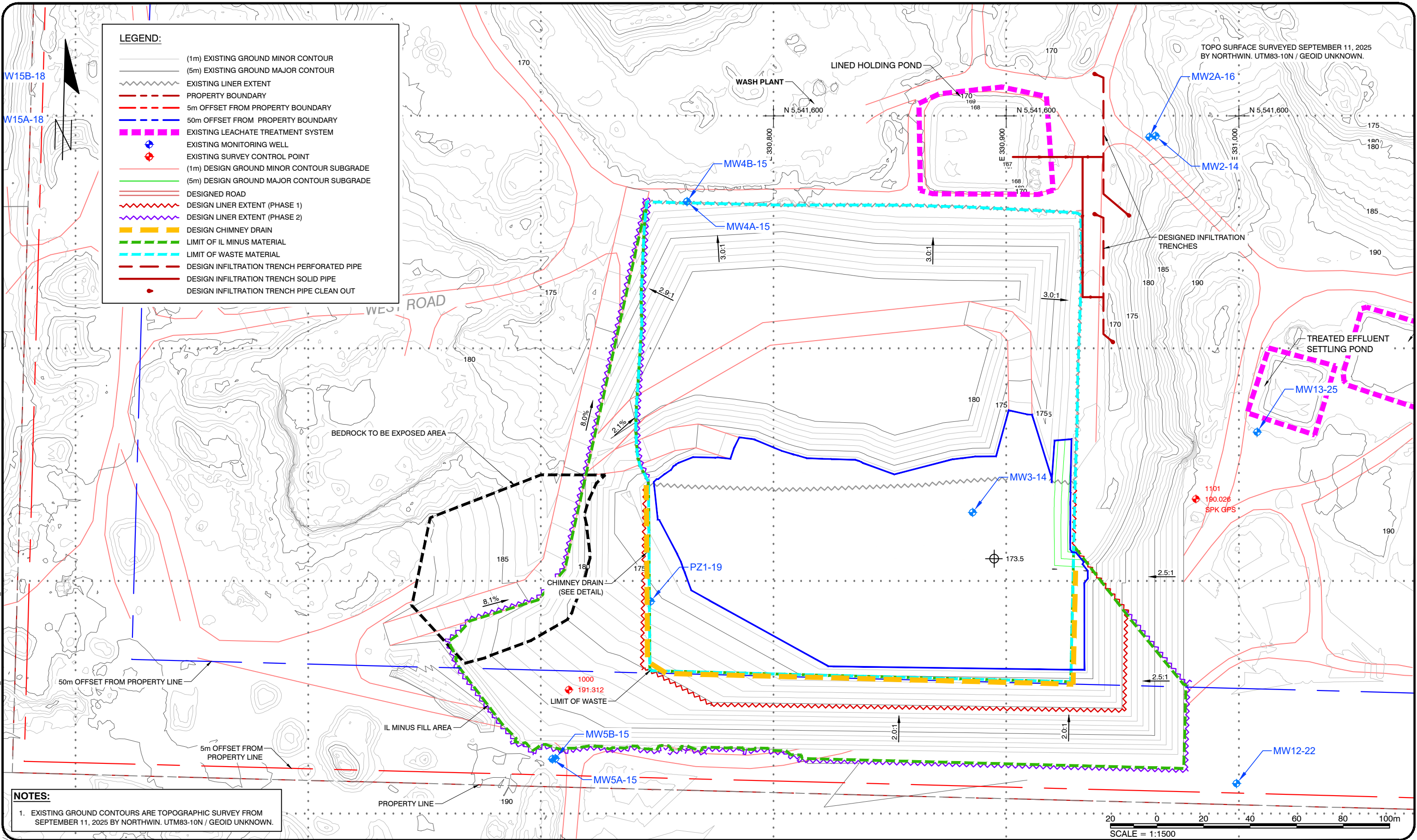
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FIGURE 8-11

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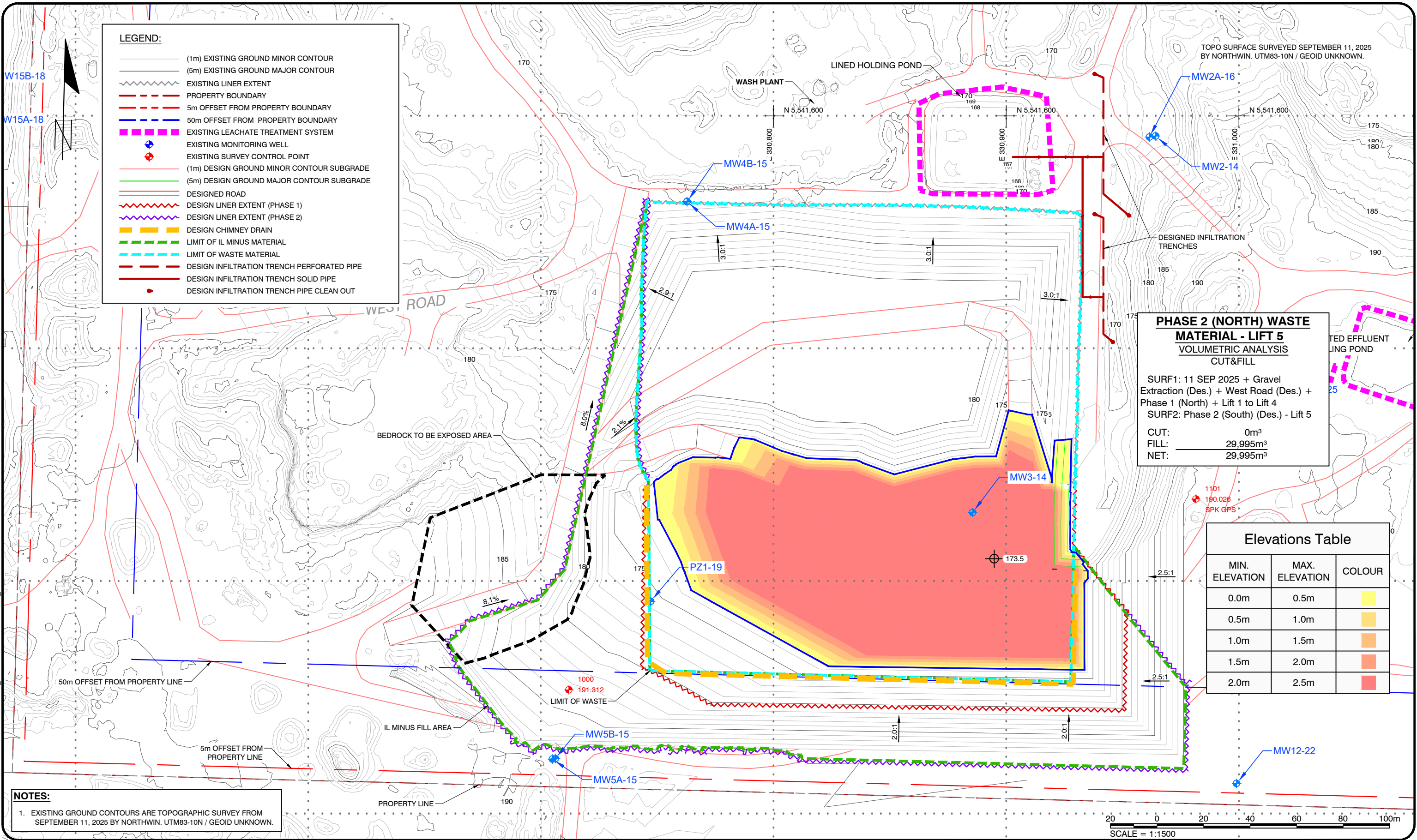
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FIGURE 8-13

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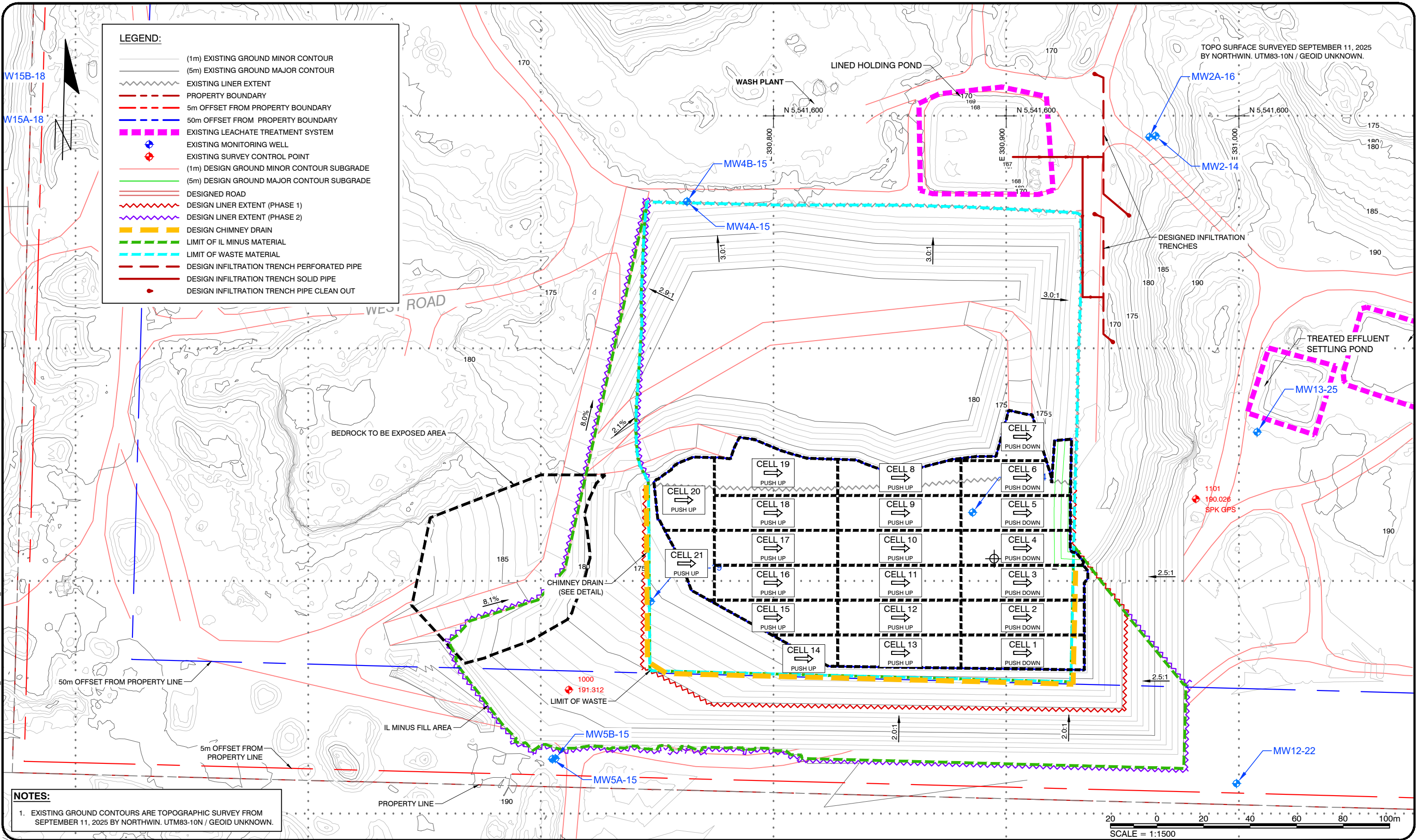
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FIGURE 8-14

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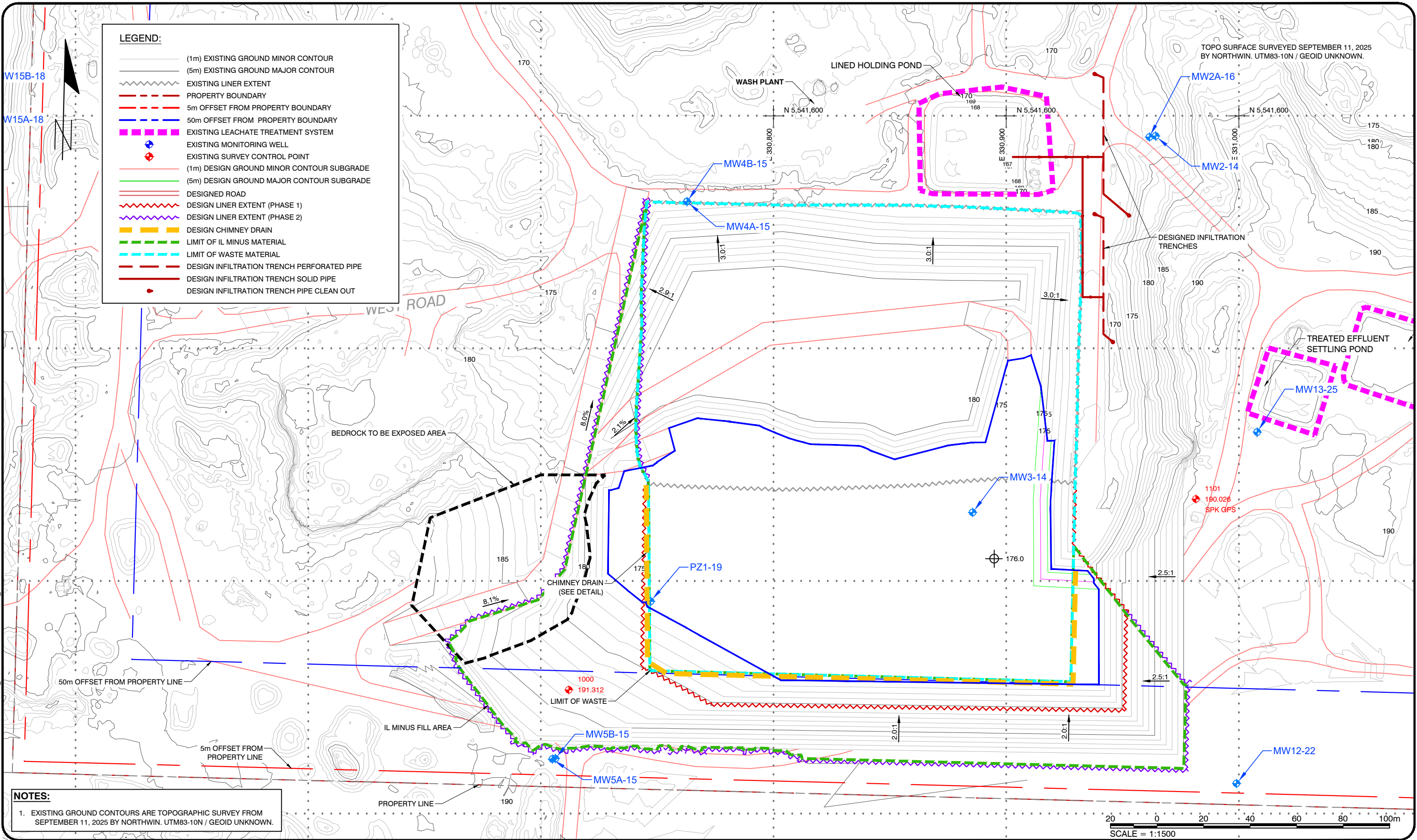
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FIGURE 8-15

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SCALE:

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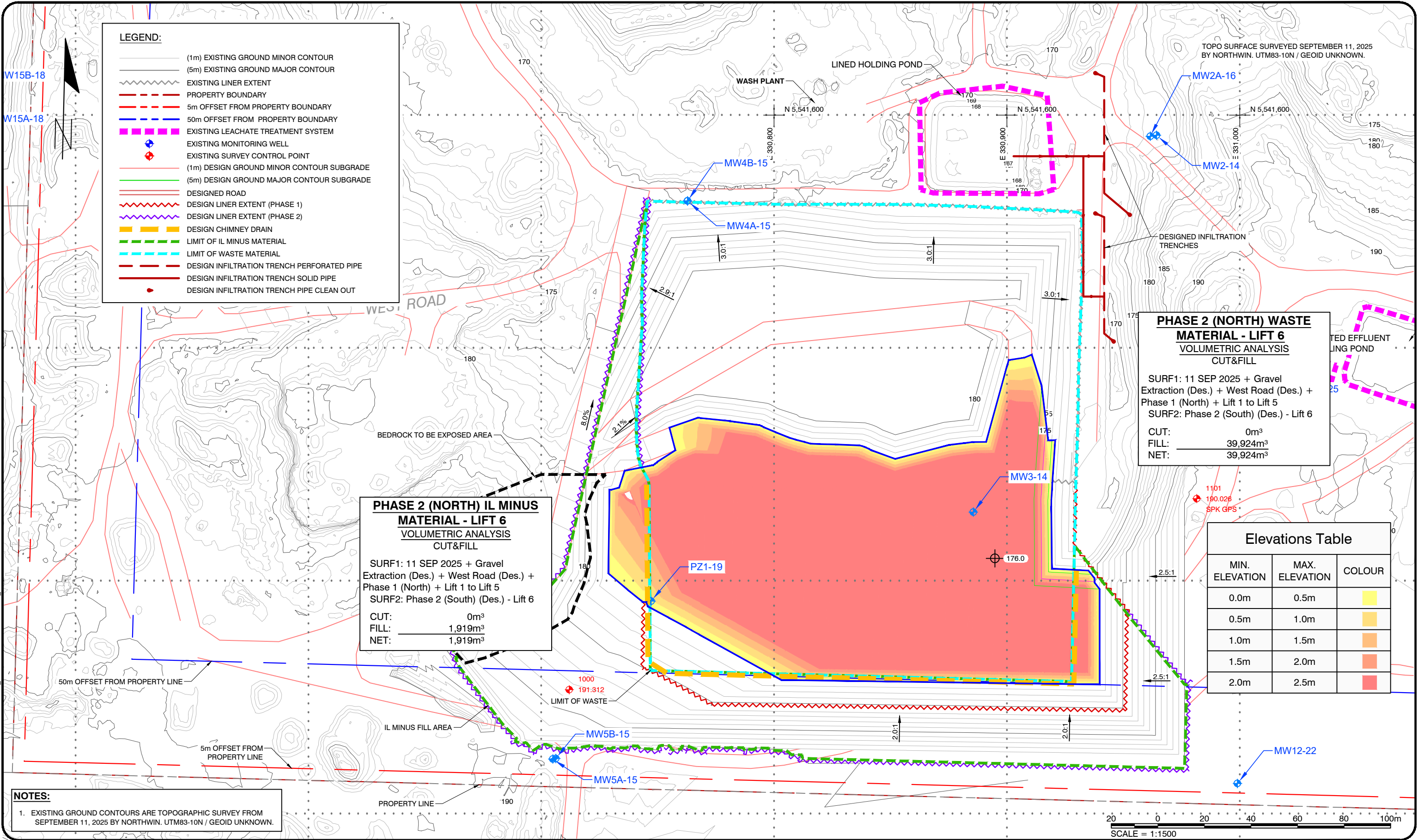
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FIGURE 8-16

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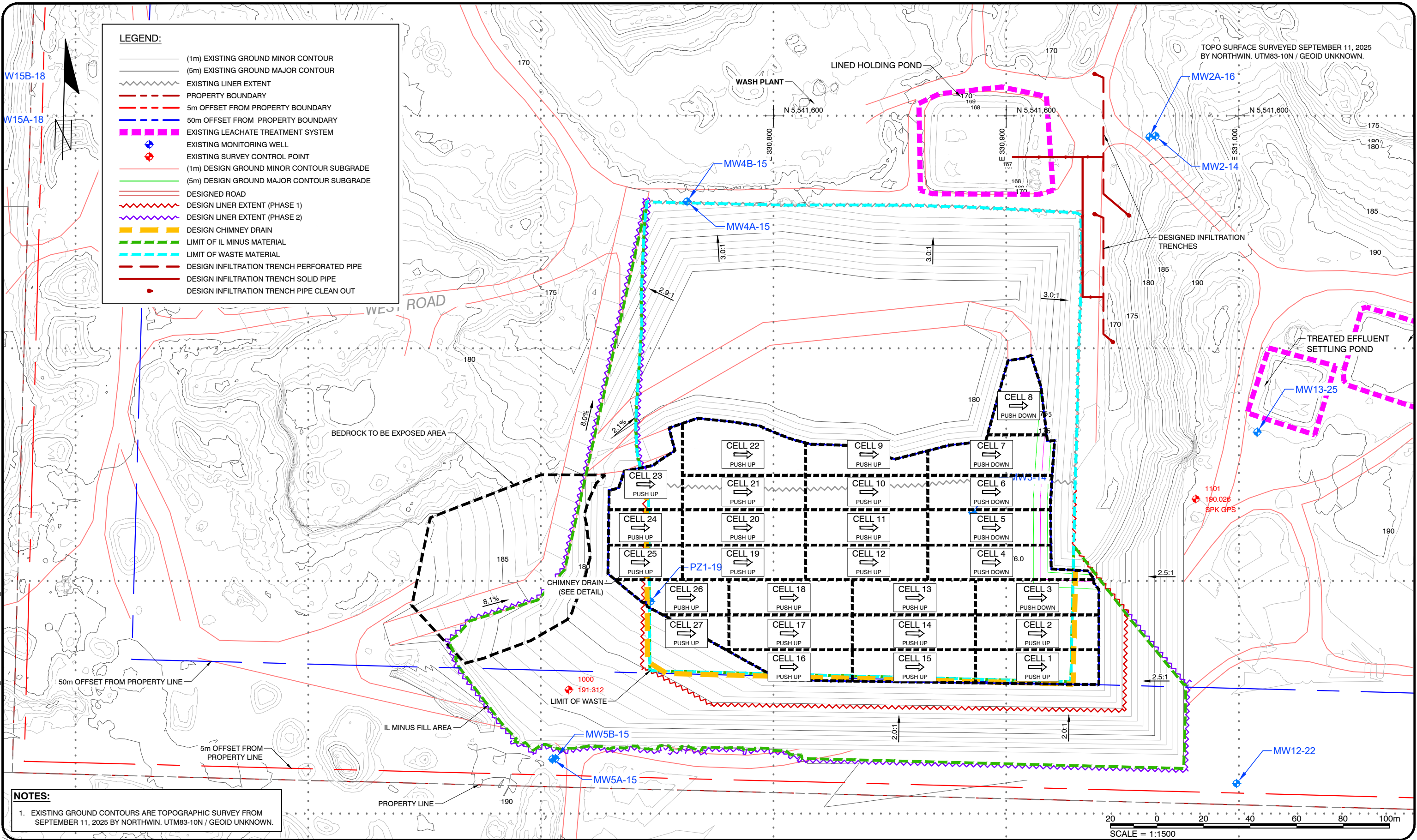
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FIGURE 8-17

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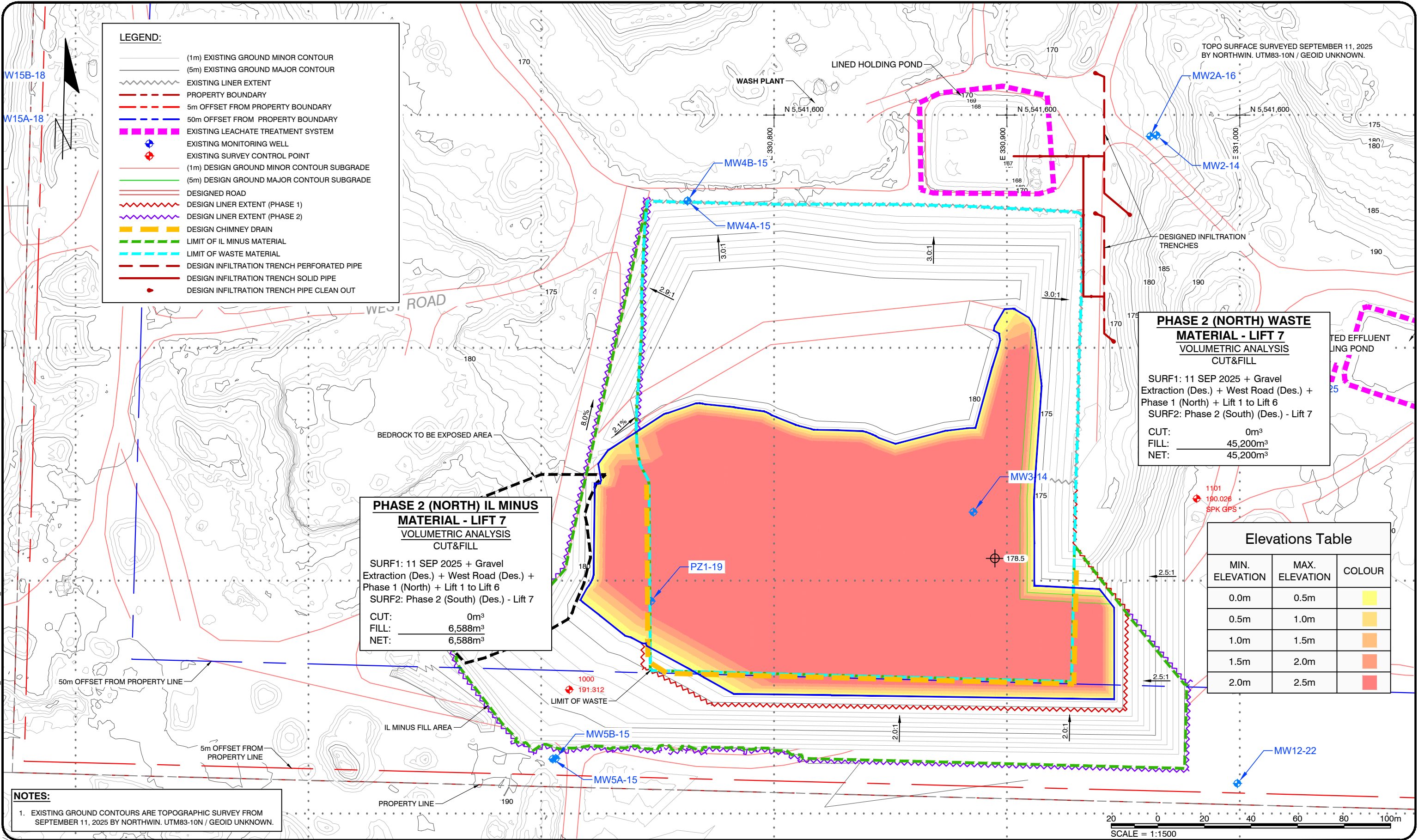
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FIGURE 8-18

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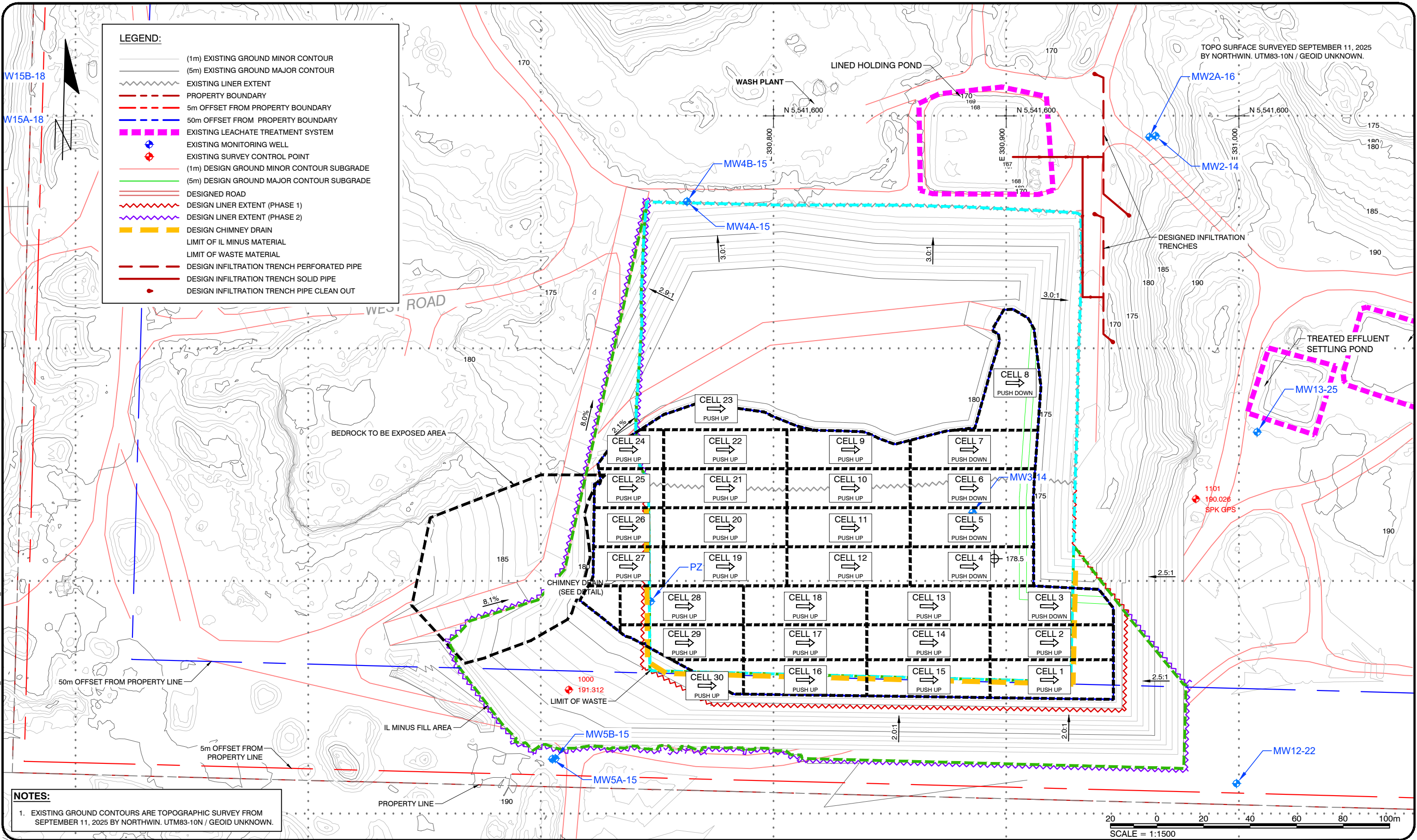
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FIGURE 8-20

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NOTES:
1. EXISTING GROUND CONTOURS ARE TOPOGRAPHIC SURVEY FROM SEPTEMBER 11, 2025 BY NORTHWIN. UTM83-10N / GEOID UNKNOWN.



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LEGEND:

- (1m) EXISTING GROUND MINOR CONTOUR
- (5m) EXISTING GROUND MAJOR CONTOUR
- EXISTING LINER EXTENT
- PROPERTY BOUNDARY
- 5m OFFSET FROM PROPERTY BOUNDARY
- 50m OFFSET FROM PROPERTY BOUNDARY
- EXISTING LEACHATE TREATMENT SYSTEM
- EXISTING MONITORING WELL
- EXISTING SURVEY CONTROL POINT
- (1m) DESIGN GROUND MINOR CONTOUR SUBGRADE
- (5m) DESIGN GROUND MAJOR CONTOUR SUBGRADE
- DESIGNED ROAD
- DESIGN LINER EXTENT (PHASE 1)
- DESIGN LINER EXTENT (PHASE 2)
- DESIGN CHIMNEY DRAIN
- LIMIT OF IL MINUS MATERIAL
- LIMIT OF WASTE MATERIAL
- DESIGN INFILTRATION TRENCH PERFORATED PIPE
- DESIGN INFILTRATION TRENCH SOLID PIPE
- DESIGN INFILTRATION TRENCH PIPE CLEAN OUT

CLIENT:



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9 LANDFILL OPERATIONS

The Northwin Environmental Landfill is not a standalone operation; rather, it operates within an active sand, gravel, and rock quarry in Campbell River, British Columbia. The New Landfill is authorized under Operational Certificate (OC) 107689, including the 2022 Amendment, and operates in accordance with the *ENV BC Landfill Criteria for Municipal Solid Waste, Second Edition* (June 2016) (Landfill Criteria). The Northwin Environmental Landfill is designed to serve surrounding and nearby businesses and communities in the Campbell River area.

Under OC 107689, the New Landfill is authorized to accept demolition waste, construction waste, land clearing waste, asbestos containing waste, soil that is not Hazardous Waste, and sludge generated from landfill leachate or water management works, at a maximum annual disposal rate of 45,000 tonnes. Landfill operations include maintaining a small, controlled active face and the regular operation, maintenance, and monitoring of the site's leachate management works.

Site signage at the entrance and scale provides the information required under the OC, including the site name, owner, emergency contact phone number, hours of operation, restricted public access, user fees, and prohibited materials. The Landfill site also includes perimeter security fencing with cameras and lighting, a secured front entrance gate, and treatment, effluent holding, and infiltration ponds associated with leachate management. The primary Landfill facilities are shown on Figure 4-1. Northwin Environmental Ltd. management, staff, and/or contractor personnel are present during operations to operate, maintain, and manage the facility.

9.1 Active Face Operation

The active face is the portion of the landfill footprint where all waste is actively accepted, compacted, and buried. 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 - 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.

The location of the active face is generally dictated by the filling plan as outlined in Chapter 8. However, the filling operations may deviate from the fill plan from time to time for operational reasons such as too much rain, temporary construction, etc.

At the time of this DOCP, active landfilling is taking place in Phase 1 North, where a liner was installed in 2021. As shown in Figure 4-1, the active face is in the northwest corner of Phase 1 North, at an elevation of approximately 175 m above sea level.

9.2 Waste Compaction

Waste compaction involves using specialized heavy equipment to crush and compress waste during disposal. This process conserves airspace allows for easy placement of the alternate daily cover (ADC), and reduces soil cover, windblown litter, odors, risk of fires, and vectors.

At the active face, waste should be spread in layers no greater than 0.6 m thick, to optimize waste compaction with minimal equipment effort. As layers become thicker than 0.6 m, the maximum compaction that can be achieved efficiently drops off sharply and additional equipment time is required, or airspace is wasted. SHA recommends that the landfill operator make the first crushing pass over the waste driving forward, so that the equipment bucket should protect the driver in the event of an explosive container hidden in the waste, such as a propane bottle or fire extinguisher. The Solid Waste Association of North America (SWANA) recommends that waste be compacted by making three to five passes over each waste layer (one pass means a single pass in one direction). SHA's experience from other operations indicates that more than five passes are required to achieve adequate densities in the range of 0.85 - 0.9 tonnes/m³. Since waste compaction is dependent on so many factors, it should inevitably fall upon the experience of the landfill operator to judge when adequate compaction has been achieved. However, the general principles that should be followed include making sure that waste layers are not too thick prior to compaction (no greater than 0.6 m) and that the slope of the active face is maintained between 4H:1V to 5H:1V.

The Landfill currently utilizes specialized heavy equipment (Case 250D excavator) to sort and compact waste during disposal which weighs 26-29 tonnes. It was reported in the 2025 Annual Report, (SHA, 2026) that a waste compaction density of around 1.22 tonnes/m³ is being achieved at the site.

SHA has conducted a review of actual waste densities being achieved and based on a total air space volume consumed from start-up of 167,871 and total tonnage placed since start-up of 290,979 tonnes. Based on these figures, the air space utilization density (ASUD) is 1.73 tonnes/m³, resulting in an air space utilization factor of 0.58 m³/tonne. The observed ASUD is very high as typically C&D waste has an ASUD of 0.65 tonnes/m³. The primary reason that the ASUD is so high at Northwin is that contaminated soil forms a significant percentage of incoming waste at the facility.

Topographic surveys of the site are completed at least once per year, to confirm the compaction level being achieved and to assess the volumetric filling rate for the Landfill. Updating the consumed airspace regularly is critical to ensure efficient operational habits are maintained, and air space utilization is maximized. It is also critical for measuring planned development timelines to ensure reserve funds remain sustainable for subsequent phases and required capital.

9.3 Daily/Intermediate Cover

As waste is received intermittently by appointment and consists primarily of C&D material and soil, application of cover on a daily basis is not required. As such, daily cover shall continue to be applied over placed waste as a means of landfill nuisance control on an as-needed basis, as determined by landfill staff.

The Landfill Criteria recommends that a 0.15 m soil layer or functional equivalent material must be placed over all exposed solid waste at the end of each working day, and that 0.3 m of soil or functional equivalent material must be placed over all areas that should not receive waste for 30

days or more. 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.

The purposes of the daily and intermediate cover are as follows:

- Reduce wind-blown litter
- Promote surface water drainage
- Reduce release of odors from landfill
- Minimize presence of disease vectors, including flies, mosquitoes, rodents
- Prevent larger animals such as birds and bears from scavenging
- Act as a firebreak between landfill cells
- Reduce fire ignition risk and spread
- Cover hazardous materials
- Improve site aesthetics.

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 6.

9.4 Alternate Daily Cover

In the place of daily soil cover, an alternate daily cover (ADC) can help to extend the life of the landfill by achieving the functional objectives of daily cover without consuming a large amount of airspace. Polyethylene tarps and grizzly metal plates may be used as temporary and re-useable daily cover. These ADC panels are deployed at the end of each day to comply with cover requirements such as reducing litter and vectors. The grizzly plates also reduce the landfill's use of soil, which can be used for other operations.

9.5 Authorized Waste

The waste authorized by the OC 107689 to be accepted at the Site and discharged into the Landfill are:

- Demolition waste
- Construction waste
- Land clearing waste
- Soil that is not hazardous waste
- Sludge from New Leachate Management Works or New Stormwater Works

Other wastes as authorized in writing by the director. The waste not authorized to be accepted at the Site and discharged into the Landfill are:

- Attractants (such as domestic waste)
- Controlled wastes as defined by the Landfill Criteria
- Waste or recyclables prohibited in writing by the director

9.6 Controlled Waste Disposal

Friable asbestos and materials that have been identified by WorkSafe B.C. as potentially containing asbestos including Vermiculite insulation, blown-in insulation, drywall, and acoustic ceiling tiles, are considered as Hazardous Waste under the B.C. Hazardous Waste Regulation (HWR). These materials must be transported in compliance with the Transportation of Dangerous Goods Act and Regulations and disposed of following regulation guidance in the HWR, Part 6, Section 40 and any landfill specific Asbestos policies. The following provides a brief synopsis of requirements.

Northwin Landfill presently accepts asbestos waste for burial within the landfill. An asbestos burial site is utilized to entomb the asbestos underground, significantly reducing its risk to human health and preventing asbestos particles from becoming suspended in the air by keeping it in a wet environment. Asbestos creates very little leachate and will be buried under the Municipal Waste Landfill Criteria. Based on the above justifications, Northwin Landfill has received authorization by the MOE under RS112161 to accept controlled disposal of waste asbestos containing materials (ACM) managed according to Section 40 of the HWR. Continued burial of the asbestos in a dedicated location to avoid co-disposal with incoming C&D should be considered by NWE to reduce the risk of future human contact with the asbestos in case drilling or excavation activities need to occur in the future.

Northwin Environmental Ltd. require a hazardous materials survey to provide a minimum of 48hrs in advance before disposal of controlled waste takes place. The report must meet OH&S guidelines including sampling by qualified personnel (Level S) and testing other hazards such as lead. Only exceptions are vermiculate and asbestos concrete pipe which are assumed to be ACM containing.

Disposal and handling of hazardous waste must comply with the requirements of the HWR.

The landfill accepts asbestos only 2 days per week. Commercial and public loads are required to comply with section 46 of the HWR. Asbestos must be completely contained during handling, storage, and transport. Asbestos should be brought to the Landfill as per the HWR and the protocols and requirements under the Northwin Environmental Ltd. Demolishing, Renovating or Altering Structure approval process, which includes strict hauling rules to safeguard the public and landfill staff against hazardous materials.

Asbestos loads should be deposited into either a dedicated “Asbestos” trench typically excavated in landfilled areas or in a controlled waste trench excavated within the final landfill footprint where no further excavation for cover soil or leachate collection works is to take place. The trench should be excavated between 2,000 and 4,000 mm deep. Asbestos materials should be immediately covered with a minimum of 500 mm of cover soil.

For cases where dedicated disposal of controlled waste is authorized, the specific on-site locations where the controlled wastes are deposited shall be recorded to 1 m accuracy using a hand-held GPS. It is important to maintain records, so the materials can be avoided during future work such as installing landfill gas collection wells, horizontal LFG collectors and excavations during potential landfill fires.

Asbestos is accepted at the Landfill and is buried in a specific location that is away from the public and should not be disturbed; the procedures in place include the following:

- The carrier must present a properly filled out manifest for completion by scale-house staff
- The carrier is directed to the Hazardous Waste Cell
- The landfill contractor staff screen the incoming load to ensure it is properly contained
- The load, if accepted, is tipped, and covered with 500 mm of soil cover.

9.7 Specified Risk Material

No Specified risk material (SRM) is accepted.

9.8 Soil Acceptance

The Soil Acceptance Plan outlines the procedures to be followed before soil is accepted for discharge at the Landfill. These procedures include soil screening and review of supporting data and reports required. Related documents are provided in Appendix H.

Operational Certificate 107689 Amendment letter (2022) authorizes Northwin Environmental Landfill to accept soil that is not hazardous waste as defined in the Hazardous Waste Regulation (HWR)

Prior to delivery to the Northwin Environmental Landfill, a waste movement document is provided to the client and must accompany each load delivered to the Landfill. Upon arrival, the waste movement document is reviewed by Northwin staff to confirm that the information is complete and consistent with the waste characterization data, analytical results, and other supporting documentation previously submitted to Northwin. This review represents the first screening step in the waste acceptance process.

Incoming loads are visually inspected to confirm that the material is consistent with the waste movement document and the supporting data and reports provided to Northwin. Following receipt and during unloading, the equipment operator conducts a further visual inspection of the material for evidence of unacceptable waste or other conditions inconsistent with the approved waste stream.

Loads or materials determined to be unacceptable are rejected or isolated, as appropriate, and managed in accordance with Northwin's Unacceptable Waste Policy

9.9 Construction and Demolition Waste

All Construction and Demolition (C&D) waste proposed for disposal at the Northwin Environmental Ltd. landfill shall be screened prior to acceptance. All incoming loads are subject to inspection to verify that the material is consistent with the approved waste stream and complies with the acceptance requirements of Operational Certificate (OC) 107689 and all associated amendments.

Construction and demolition waste generated from renovations, deconstructed buildings, or demolition activities shall be accompanied by a Hazardous Materials Survey completed in accordance with WorkSafeBC requirements. The Hazardous Materials Survey shall identify all

hazardous materials associated with the proposed work and any materials that may be handled, disturbed, or removed during the project. Where required, additional sampling and analytical testing shall be completed to demonstrate that the material meets the landfill's acceptance criteria and complies with the Hazardous Waste Regulation (HWR), applicable Ministry guidance documents, and Operational Certificate (OC) 107689.

All Hazardous Materials Surveys, analytical data, and supporting documentation shall be prepared and submitted by a Qualified Professional (QP), where applicable. Qualified personnel at Northwin Environmental Ltd. shall review all submitted documentation and analytical data to verify compliance with Operational Certificate (OC) 107689, all associated amendments, and applicable regulatory requirements. Northwin Environmental Ltd. reserves the right to request additional information, clarification, supplemental sampling, or additional analytical testing where necessary to complete the review and determine the material's acceptability.

Once the review has been completed and the material has been determined to meet the facility's acceptance criteria, Northwin Environmental Ltd. will issue a Waste Movement Document authorizing transport of the approved material. No C&D waste requiring pre-approval shall be accepted at the facility unless a valid Waste Movement Document has been issued by Northwin Environmental Ltd.

Only the material identified in the approved Waste Movement Document may be transported to the landfill. Any changes to the source location, waste characteristics, hazardous materials assessment, analytical results, or project scope shall require re-evaluation and written approval prior to transport.

Construction and demolition debris may not require a Hazardous Materials Survey where the waste is generated from new construction or where the materials being removed have not been exposed to, and do not contain, hazardous building materials. Any exemption from the requirement for a Hazardous Materials Survey is subject to review and approval by Northwin Environmental.

9.10 Material Recovery

Materials recovered from the incoming waste streams for re-use/recycling include:

- Yard waste
- Clean wood
- Concrete
- Asphalt

9.11 Access Roads

Access to Northwin Landfill is from Gold River Highway and is controlled with a gate located at the north side of the Landfill. The gate is locked outside normal operating hours to prohibit vehicle entrance and uncontrolled disposal when the Landfill is closed. 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.

Internal access roads are required to maintain access to the working areas of the Landfill and to the active face. As recommended by the Landfill Criteria, access roads for public and commercial traffic should not exceed 8% grade; roads utilized for construction and internal off-road equipment shall not exceed 15% grade.

The access road traffic surface is required under the Landfill Criteria to be 4 m wide for single lane traffic and 7 m wide for two lanes to accommodate the safe travel of vehicles. Surface water ditches are required to be maintained along all main roads so that roads have adequate drainage.

Roads and the active landfilling areas should be maintained to a high standard for landfill users. Surfaces should remain free of mud with the use of well-draining cover materials, and free of potholes and ruts that can damage vehicles. The driving surface should also remain free of materials that can damage tires. Regular inspections should be carried out to ensure roads are being maintained to the established standards. Road maintenance is a reflection on the entire landfill facility and complaints can be significantly reduced with frequent attention.

Additional access roads are planned for the future to facilitate access to landfill expansion and Pit operation areas.

9.12 Signage

Signage should be maintained at the landfill entrance and include the following current information:

- Site name
- Owner and operator
- Contact information for owner and operator
- Emergency phone number(s)
- Hours of operation
- Materials/waste accepted for landfill and recycling

Traffic control signage is recommended under the Landfill Criteria. Signage should delineate landfill site boundaries, drop-off areas for public and commercial waste haulers, material recovery, and disposal areas of the landfill. The signage will be reviewed from time to time by Landfill staff for adequacy and additional signage implemented as required.

9.13 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 Upland Gravel Pit and Rock Quarry (the Site)
- Berms constructed within the Landfill to minimize sightlines to exposed waste, when necessary
- Application of daily and intermediate cover as required
- Application of final cover on the northern edge of the Landfill including vegetative cover as soon as reasonably possible

9.14 Site Security and Fencing

As per the Landfill Criteria, security fencing is required to discourage unauthorized access and to exclude bears and other wildlife from entering the Landfill area. Currently, 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.

Northwin Environmental is planning to extend fencing with cameras and lights along south property boundary.

9.15 Litter Control

Northwin Environmental Ltd. is committed to maintaining effective litter control throughout the landfill to protect adjacent properties, roadways, and the surrounding environment. Operational practices are designed to minimize the generation and migration of wind-blown litter and to maintain a clean and well-managed facility.

Active waste placement areas are kept as small as practicable, and waste is covered in accordance with the requirements of Operational Certificate (OC) 107689 to reduce the potential for litter to become airborne. Litter control measures are implemented throughout landfill operations and are adjusted as necessary to respond to changing operating conditions and weather.

Site personnel conduct regular inspections of the active disposal area, landfill perimeter, access roads, drainage ditches, and property boundaries for wind-blown litter. Any litter identified is collected promptly to maintain site cleanliness and prevent migration beyond the property boundary.

Wind-blown litter is collected on a regular basis throughout the site to prevent contamination of the adjacent aggregate quarry, gravel extraction operation, and asphalt plant. Maintaining effective litter control protects the quality of aggregate materials produced on site, supports efficient operations, and demonstrates Northwin Environmental Ltd.'s commitment to responsible environmental stewardship and good housekeeping.

9.16 Dust Control

Dust is a common problem at most landfill sites as a result of hauling and handling waste and borrow material, and from vehicle traffic over unpaved access roads. Dust control techniques, such as watering down road surfaces, posting, and enforcing reasonable on-site speed limits, and vegetation programs should be implemented as required. When watering road surfaces, application of water should be kept light to avoid slippery or erosive conditions and to minimize the production of leachate. If necessary, dust palliatives, which could reduce dust by absorbing moisture, may be used to control dust within the active landfill area. The commonly used dust palliatives include magnesium chloride, calcium chloride or other similar hydrating chemicals, although chloride containing solutions are discouraged due to chloride being a leachate indicator parameter used in water quality monitoring. The best solution for dust control is to pave or coat all long-term access roads with pavement grindings.

9.17 Odor and Noise Control

Odors associated with the landfill are very negligible, because there is no acceptance of putrescible waste entering the Site. However, waste entering the site should not sit exposed for an extended length of time, and should be placed, compacted, and covered as quickly as possible. The best method for controlling the odors from buried waste is to adequately cover the waste. As the Site is well contained and located away from populated areas, any odors from waste do not seem to be a concern at the Landfill. Measures to reduce odor impacts to neighboring properties include adequate daily and intermediate cover, following the filling plan, controlling litter, and keeping the active face area to a minimum.

Noise is not considered problematic, as the Landfill is located within an industrial area surrounded by similar industrial uses. If any complaints are received, they should be promptly addressed. Noise at landfills tends to originate from operational machinery such as excavators and trucks. As recommended in the Landfill Criteria, the site operations should minimize noise by making use of natural or constructed features such as berms and vegetated buffers; constructing main haul roads to 8% grade or less to minimize engine noise; and, to schedule noisy activities during hours that should minimize impacts in the community.

9.18 Vector and Bird Control

Vectors are defined in the Landfill Criteria as “a carrier that is capable of transmitting a pathogen from one organism to another and includes but is not limited to, flies and other insects, birds, and rodents.” Since the landfill does not accept putrescible waste, birds are the only vectors reported at the Site. Therefore, the Landfill Criteria recommends vectors and wildlife be discouraged from feeding at the landfill.

There are two main concerns regarding the presence of vectors at landfills:

- Ensuring that landfill workers are adequately protected from potential disease transmission.
- Preventing the landfill from acting as a source for vectors to transmit diseases to off-site areas.

Both concerns can be dealt with through the control of vector access and vector numbers. Northwin Landfill will comply with the daily, intermediate cover and final cover requirements stated in Section 9.3., 9.4, 10.3, respectively.

9.19 Open Burning

Although sometimes allowed under the Landfill Criteria, open controlled wood waste burning is a rarely approved practice at landfills. Under the current OC, the permit does not allow controlled burning of clean wood waste.

9.20 Vehicle Scales

The Landfill scale house is currently located at the entrance end of the site. The facility includes one truck scale for in-bound and an out-bound and attendant building that is staffed during hours of landfill operations.

9.21 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 could be expected to increase marginally from the existing traffic volumes to the Site.

9.22 Record Keeping

Northwin Environmental Ltd. keeps records for the ENV's review as per the Landfill Criteria requirements. Complete records must be kept for at least seven (7) years and must be submitted to the Director within fourteen (14) days of request from the ENV. Records kept must include the OC and all amendments, records of inspections, plans and reports, list of complaints, tonnage data, and recyclable material data if available.

9.23 Supervision

A Site Operator, under contract to the Northwin Environmental Ltd., operates the landfill during normal operation hours. It is recommended that the contractor representative in charge of the landfill makes certain that a fulltime, fully trained operator is present at this landfill during operating hours, and the gates are to be locked to prevent unauthorized access during non-operating hours. The Operator will inspect every load of incoming waste to ensure it matches the waste characterization, and complies with the requirements of the OC.

The Site 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.

The operator is to be familiar with the OC, inspection records, the current DOCP, site health and safety requirements and annual reports.

9.24 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 staff working regularly at the Landfill active face will successfully complete SWANA Landfill Operations Basics or the 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, a discharger must not discharge unless the wastewater facility is operated and maintained by persons certified by, and in accordance with, the Environmental Operators Certification Program.

9.25 Scavenging

Scavenging is defined in the Landfill Criteria as the informal and unauthorized recovery and removal of waste. Scavenging at the site is prohibited. To prevent the spread of disease and the risk to personal safety of workers and the public, scavenging of waste is to be prevented. The

salvaging of wastes should continue to be encouraged. Any divertible materials and items should be sorted in the Diversion Area and hauled off site.

9.26 Waste Reduction

Waste diversion prior to disposal is encouraged to conserve valuable airspace and reduce the risk for harmful impacts to the environment. The Landfill has a diversion strategy that aims to recover re-use/recycling material such as yard waste, clean wood, concrete, and asphalt.

9.27 Wood Waste Management

The Landfill currently accepts clean wood waste at the site. The wood is recovered or diverted from the waste stream for beneficial re-use/recycling. The smaller sized material can be composted or used as mulch. Material that is pressure treated, chemically treated, or creosote contaminated cannot be composted and may be shredded and then used as hog in the landfill (i.e., for winter roads or blended for cover soil).

9.28 Organic Waste Management

Organic waste diversion saves significant amount of landfill airspace. It also reduces landfill gas and leachate generation and contributes to addressing climate change. Clean BC Strategy of the Province calls for 90% organic waste diversion from landfills by 2030.

9.29 Fire Management Plan

A Fire Management Plan has been developed for the Site. The plan addresses key areas including fire safety, firefighting resources, landfill fire alert levels, firefighting methods, and post-fire response procedures.

A copy of the draft Fire Management Plan is provided in Appendix I. The plan will be reviewed and updated at least annually, or more frequently if required based on site conditions, operational changes, or regulatory requirements.

9.30 Tipping Fees and Hours of Operation

Northwin Environmental Ltd. from time to time amend the set tipping fees for Northwin Landfill. All fees are programed into the weighbridge software for consistent application.

The Landfill is open to commercial customers during the following days and hours:

- Monday to Friday: 7:00 a.m. to 3:30 p.m.

The site is closed on Saturday, Sundays and all statutory holidays.

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.

9.31 Site Maintenance

The contractor is required to conduct regular site maintenance that includes ditch cleaning, litter picking, cleaning paved roads, grading gravel roads and removing snow.

9.32 Performance Audits

Contractor performance audits are conducted on an ongoing basis to determine compliance with service contracts.

9.33 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
- Excavator

9.34 Winter and Wet Weather Operations

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.

9.35 Neighbour Relations Plan

Northwin Environmental Ltd. 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 Section 9.22.

10 CLOSURE AND POST-CLOSURE PLAN

A key goal of a site-specific Closure Plan for the Northwin Landfill is to identify the most effective type of final cover system. In British Columbia, four basic types of cover systems are used: 1) compacted soil cover, 2) geosynthetic cover, 3) composite cover, and 4) evapotranspirative cover. An evaporative cover is usually considered for landfills located in the arid/semi-arid regions. The Northwin Environmental Landfill is located in an area with relatively high precipitation (about 1394 mm/yr) and hence not considered for evapotranspirative cover. This chapter explores the potential effectiveness of each of these cover systems and identifies the best option for Northwin Landfill.

10.1 Closure Objectives

The purpose of constructing a final closure system at a landfill is to put in place the necessary environmental control systems to effectively manage leachate, LFG and settlement. A well-designed closure system should provide the following benefits:

- Isolation of refuse preventing direct contact with humans and vectors;
- Control the release of odours;
- Minimization of infiltration and leachate production through surface water diversion and run-off;
- Prevention of leachate breakouts at landfill toe and on side slopes;
- Protection of the cover from erosion through maintenance of a sustainable vegetative community;
- Enhancement of LFG collection by preventing upward venting of LFG and downward intrusion of oxygen from the atmosphere;
- Minimize oxygen infiltration and fire risk; and
- Provide habitat for methanotrophic bacteria in the vegetative cover system to enhance oxidation of fugitive methane emissions.

In developing the final cover design to meet the above objectives the local site conditions and end use were considered. The types and thickness of soils and other materials used in the cover were based both on regulatory guidelines as well as site-specific conditions and design objectives. Key elements that were considered in the final cover design are listed below:

- Leachate minimization objectives could be achieved with a low permeability soil barrier layer with hydraulic conductivity (k) less than 1×10^{-7} cm/s for the non-arid region or a geomembrane barrier;
- A topsoil layer of at least 150 mm thickness, should be adopted to protect the underlying barrier layer and to provide a medium that will support vibrant growth of vegetation;
- There is an abundance of soil material on site that may potentially be screened to produce different product types required for the utilization of the closure and expansion system design; and
- Establishing a healthy vegetative community on closed portions of the landfill is a priority of the progressive closure plan.

The closure plan for Northwin Landfill builds on the concepts identified above. In addition, the engineering team explored several other design issues to answer questions in optimizing the cover design concepts. These considerations and recommendations are outlined below.

- SHA recommends that closure occur progressively to avoid accumulation of a large closure liability, and to minimize leachate production. Capping the site in a series of phases, as discussed in Chapter 4 of this report, will minimize the amount of infiltration of water and eventual leachate production; and
- Slopes should be effectively re-vegetated during construction of the final cover to assist in evapotranspiration and improve soil stability.

Based on the results of the engineering investigation, a basic final cover design concept was identified, approximate performance levels were established, and approximate capital construction costs were projected (Chapter 11).

10.2 Recommended Design Guidelines

Regulatory requirements for landfill closure have been specified in the Landfill Criteria. The key requirements that dictate design of the final cover system are summarized below:

- Each completed Phase shall be covered within one year of completing the subject area;
- The final cover barrier layer shall consist of a minimum of 600 mm of low permeability soil with a hydraulic conductivity of $<1 \times 10^{-7}$ cm/s for landfill sites located in non-arid regions;
- The barrier layer shall be protected with a minimum 150 mm thick topsoil layer with suitable vegetation established. Final cover shall be sloped at a minimum of 4%, to promote surface water runoff, to a maximum slope of 33%. The top plateau shall be a minimum of 10% for soil barrier layer covers, and 4% for geomembrane or composite barrier layer covers; and
- Surface water runoff shall be directed into collection systems and disbursed into existing ditches.

10.3 Elements of Final Cover System

To achieve the objectives outlined above, a minimum cover system comprising a top-soil horizon and barrier layer is required. Additional layers, including a drainage layer on top of the barrier system and a gas collection layer under the barrier system may also be required to achieve site-specific objectives.

Figure 10-1 provides a schematic illustration of a geomembrane / composite final cover veneer. As shown in Figure 10-1, depending on the particle size gradation of the various layers, it may be necessary to introduce geotextile separation / cushion layers at key interfaces to prevent migration of topsoil or clay into the various drainage layers or to protect the geomembrane from damage from the drainage layer. Healthy vegetation is also a key element of final closure. As illustrated in Figure 10-1, the layers are presented in a bottom (refuse) to top (topsoil) order.

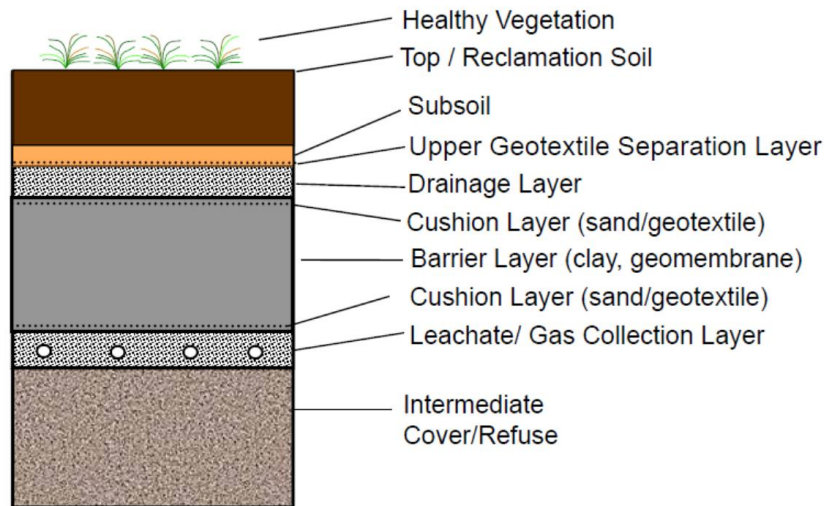


Figure 10-1: Geomembrane / Composite Final Cover Veneer

10.3.1 Gas/Leachate Collection Layer

The purpose of a gas / leachate collection layer is to provide a high permeability pathway for leachate generated from breakouts to migrate to the landfill toe and for LFG to travel laterally beneath the cover system to the closest collection point; otherwise, leachate breakouts may be experienced on the landfill side slopes. To prevent head build-up, the gas / leachate drainage layer must attain a permeability of 1×10^{-2} cm/s or higher.

Gas control is considered desirable beneath the barrier layer to prevent gas pressure from building up and to eliminate the risk of LFG displacing atmospheric air in the root zone of vegetation growing on the cover. For this reason, a network of passive lateral gas vents is usually recommended for cover systems employing a barrier layer if active gas collection is not considered.

10.3.2 Barrier Layer

A low permeability soil or geosynthetic layer forms the backbone of an effective cover system. In British Columbia, a 600 to 1,000 mm layer of low permeability soil has typically been used in constructing a landfill cap. As a second closure option, geosynthetic barrier layers are being introduced at landfill sites where low permeability soil is not readily available. There is also the third option, which is a composite liner, consisting of both low permeability soil and geosynthetic barrier components. In the case of a composite liner, a fine-grained soil layer (e.g. clay or silt) is typically used as a cushion layer, and the primary geomembrane liner is deployed on top.

Compacted Soil Barriers: In British Columbia, the minimum regulatory requirement for a final cover system is a 600 mm thick compacted soil barrier with a hydraulic conductivity of 1×10^{-7} cm/s for the non-arid regions. To achieve this low level of permeability, soils must contain a significant percentage of clay-sized particles.

Natural low permeability soil cover systems have the following advantages over geosynthetic cover systems:

- Low permeability soil covers have been used widely in British Columbia and are accepted by the Ministry as an effective means of landfill closure;

- A natural soil cover system may provide the lowest overall cost solution using inexpensive, locally available materials;
- A natural cover system will allow infiltration of small quantities of water into the refuse, thereby increasing the rate of stabilization of the refuse as well as increasing the production of LFG;
- Use of synthetic materials may increase long term post-closure maintenance costs because it will be important to regularly mow the cover to protect the underlying membrane from root penetration by certain tree and brush species, except in areas protected by a thick subsoil (e.g. tree islands);
- Soil cover systems have self-healing properties, whereby clays swell to reseal penetrations and/or cracks; and
- Soil may provide better performance in the very long term (e.g. >100 years) in the event geomembranes deteriorate over time.

Minimum specifications for a compacted till barrier layer shall be as follows:

- Compacted Hydraulic Conductivity $<1.0 \times 10^{-7}$ cm/s for non-arid regions
- Standard Proctor Density >95%
- Fines passing No. 200 sieve >30%
- Clay content >15%
- Gravel content <25%

The barrier soil should be compacted with a sheepsfoot or grid roller compactor with a mass exceeding 10,000 kg. The final surface should be proof rolled to a smooth finish with a grid roller or smooth drum compactor to eliminate any deep dimples such as those left behind with the sheepsfoot compactor. The barrier soil shall be placed in lifts; the individual loose lifts should not exceed 200 mm in thickness. Moisture of the till should be closely controlled during placement. Moisture contents shall fall between 0 and 10% wet of the Standard Proctor optimum. Since till or other low permeability soil will only achieve the required low permeability if properly compacted. A rigorous independent QA/QC program will be needed to ensure that the construction contractor meets the above specifications.

Geomembrane Barriers: Several geosynthetic membrane products have been used successfully for landfill closure applications, including PVC, HDPE, Very Low-Density Polyethylene (VLDPE), Linear Low-Density Polyethylene (LLDPE), polypropylene and GCL. Of these options, PVC geomembranes have historically been installed in many projects completed in North America prior to the year 2000. However, LLDPE membranes have become popular recently because the textured LLDPE product has a more aggressive texture and higher friction angle compared to PVC. Additionally, LLDPE is much more stable in the long term, as it is not subject to plasticizer loss. Geomembrane caps have become prevalent in the U.S. where Subtitle D regulations require the final cover barrier layer to be less pervious than the bottom liner to prevent development of the bathtub effect. In British Columbia, PVC geomembrane caps have been successfully installed by SHA at Hartland Landfill in Victoria, Cedar Road Landfill in Nanaimo and the Iona Grit Landfill in Richmond. LLDPE caps have been successfully installed by SHA at landfills in Prince George, Nanaimo, Salmon Arm, Fernie, Creston, Chetwynd, Blue River and at the Vancouver Landfill where more than 80 hectares have now been capped with LLDPE.

Advantages of geomembrane barriers include:

- Less susceptibility to settlement induced stress cracking
- No susceptibility to desiccation
- Superior containment of LFG
- Lower consumption of air space and
- Reduced leachate generation.

Disadvantages of geomembranes include:

- Lower interface friction resistance than clay (without texture or sand friction layer);
- Skilled labour and more stringent QA/QC are required to achieve a reliable barrier;
- Reliability of membranes in very long term (>100 years) not clearly defined;
- Membrane needs to be deployed on smooth, well compacted ground;
- Synthetic covers can be more susceptible to damage from inappropriate end uses, potentially limiting end use options;
- Overlying drainage and topsoil layers must be placed with care;
- Reduced infiltration will slow the rate of decomposition of the garbage, thereby increasing the contaminating lifespan of the landfill and potentially reducing the rate of gas production;
- Capital costs are typically higher than those experienced with soil barriers, if soil material is available on site; and
- The geomembrane could potentially be damaged by voles and mice, which could become prevalent in grassy meadows if the landfill is returned to a natural meadow end use.

Composite Barrier Systems: Composite systems are comprised of two barrier layers in intimate contact. The most common composite design is to deploy a geosynthetic membrane on top of a compacted clay liner of reduced thickness (e.g. 300 to 500 mm). The primary advantage of composite lining systems is that they provide a higher level of leak protection and greater security in the very long term. Composite barrier systems are frequently specified for hazardous waste containment facilities. As a fine-grained cushion layer (or geotextile) is required beneath the primary liner in any case, 300 mm thick secondary liners have been adopted in the closure of many B.C. MSW landfills.

10.3.3 Drainage / Cushion Layer

The purpose of a drainage layer on top of the barrier is to quickly convey water passing through the topsoil horizon down slope to the landfill toe or mid-slope groundwater interceptor ditch. Without an effective drainage layer, the topsoil could become saturated during heavy rainfall events. This condition could lead to excessive head build-up on the barrier layer and can lead to erosion and slumping problems on side slopes and increased infiltration over the landfill crest. Use of a high permeability topsoil medium could be considered; however, in our opinion a high permeability topsoil layer would not achieve the same performance as a gravel drainage layer and would likely become saturated and unstable during extreme precipitation events. To meet functionality requirements, the drainage layer should have a hydraulic conductivity of 1×10^{-1} cm/s or better in most instances.

10.3.4 Subsoil Layer

The primary function of a subsoil layer is to provide a deep soil horizon in which roots can establish. This layer is important when considering planting shrubs and trees with deep, penetrating root systems. Without such a protective layer, the roots could penetrate the underlying barrier systems.

A subsoil layer is used on relatively few landfill closure projects. The primary reason is that many landfills have a deficit of suitable soil material. In addition, the placement of a subsoil layer can consume landfill airspace, which is generally considered a valuable asset by landfill owners.

At the Northwin Environmental Landfill a subsoil horizon is not considered essential to implement a basic open meadow type closure which would be compatible with a wildlife/natural park end use. However, should forested end use be envisioned, further investigation into a subsoil layer will be required.

10.3.5 Filter Layer

To prevent migrating fines from the topsoil from clogging the underlying drainage layer, a non-woven geotextile blanket should be placed over the drainage layer. The most important characteristic of the geotextile in this application is the opening size. This should be small enough to ensure that overlying topsoil or subsoil material cannot pass into the drainage layer, a light to medium weight non-woven geotextile should be utilized. Geotextile panels should be sewn or placed with sufficient overlap in the field to ensure that they do not become separated during placement. Detailed specifications for the material should be developed once the exact composition of the topsoil is known. Standard geotextile filter criteria should be referenced during detailed design to ensure that the material will prevent migration of the fine cover soils. Also, a laboratory shear strength test should be conducted to determine shear strength properties at the topsoil geotextile interface in order to ensure that the topsoil will not slip, especially under saturated conditions.

10.3.6 Topsoil Layer

A layer of organic topsoil is essential to ensure a healthy and sustainable vegetative community on top of the final cover system. The minimum requirement is for a 150 mm thick layer of topsoil. In most final cover designs SHA recommends a thicker layer (300-600 mm) of topsoil to provide sufficient moisture retention in the soil during periods of drought, thereby preventing plant mortality, and to reduce the risk of root penetration into the underlying barrier layer.

Once vegetation is established, the topsoil layer improves the overall appearance of the closed site. It can create and diversify animal habitat as well as function as land area for other anthropogenic uses including composting and waste transfer stations.

Fertile soil is an essential part of the closure system. It is the nutrient and organic matter capital required to sustain a vegetative cover and protect the underlying barrier system. The sustainability of this soil system has direct impacts on the long-term site maintenance requirements. A soil that does not have the appropriate properties may not perform well over the long term, which will result in increased costs to the site's owner. A soil that performs poorly may also fail to protect the entire closure system.

Where soil resources are limited, costly or of poor quality, opportunities may exist to fabricate a topsoil for placement over the closure system. Use of fabricated topsoil provides possibilities for using other local organic residuals such as wood waste, green waste and wastewater treatment plant residuals. Fabricated soils composed of traditional "waste" products are enabled under provincial regulation and form the basis of an ecological approach to a sustainable landfill closure. Fabricated soils require a carbon source, a nutrient source and a structural material. The carbon source can be peat, sawdust, wood waste, or primary paper mill solids. The nutrient source can be animal manure, wastewater

treatment plant residuals, secondary paper mill solids or chemical fertilizers. The structural material is sand or sandy soil.

Materials that may be suitable for production of suitable topsoil include:

- Compost produced from the organics composting program
- Ground up wood waste
- On-site organic soils
- Biosolids and sludge from wastewater treatment plants in Comox Valley Regional District and possibly from out of region
- Shredded brush from land clearing operations

10.3.7 Fabricated Soil

In BC, several regional districts have successfully used fabricated soils to satisfy landfill closure requirements. The Thompson-Nicola Regional District has used fabricated soils in the progressive closure of steep slopes at five landfills. Regional District of Okanagan Similkameen is also utilizing fabricated soil as biocover. In addition to achieving closure objectives, the development of fabricated soils promotes regional sustainability by recycling organic and inorganic residuals.

Fabricated soils are typically composed of three base ingredients. These three ingredients are:

- a carbon source (e.g. wood waste, compost)
- structural material (e.g., sand, overburden) and
- a nutrient source (e.g., organic residuals including wastewater treatment plant residuals and compost).

The use of organic residuals in the reclamation of the landfill will assist in achieving the reclamation objectives listed above by providing disturbed soil with the nutrient capital and improved physical and biological properties necessary for vegetation establishment. Organic residuals such as municipal wastewater treatment plant residuals and compost provide slow-release sources of essential plant nutrients including nitrogen, phosphorus, and potassium. The majority of nutrients in organic residuals are generally bound by organic matter and mineralized to plant available inorganic forms as required.

The use of wastewater treatment plant residuals in landfill closure addresses two problems facing municipalities: applying topsoil of adequate thickness to landfills at the time of closure and the safe disposal of residual wastes. Residual waste is produced at every wastewater treatment plant although their quality varies with the type of treatment. There is considerable concern by ranchers and First Nations in the area about the application of wastewater treatment plant residuals introducing contaminants into surface water bodies. For these reasons, incorporation of wastewater treatment plant residuals Northwin, if used, must follow the Organic Matter Recycling Regulation (OMRR).

Soil fabrication involves combining feedstock materials at the correct ratios to create a soil that meets the requirements of the OMRR and the Soil Amendment Code of Practice (SACoP). Feedstock materials are sourced and analyzed for specific chemical, physical and biological properties. The results of these analyses are used in a model to predict final soil quality and to determine the optimum combinations and

proportions to meet the regulatory requirements. The final soil product must have chemical, physical and biological properties that will ensure sustained vegetation growth with minimal maintenance requirements. The feedstock materials are then combined in a lab-scale mixer to confirm the predicted characteristics. Fabricating soil in this manner represents a low-cost option for the topsoil layer that combines optimum soil fertility with the potential to reuse other organic residuals at the site.

10.3.7.1 Fabricated Soil Development

Closer to the time of closure, the source or fabrication of topsoil should be given careful consideration. Candidate soils should be analyzed to determine their suitability, and other amendment materials should be investigated. A final cover test pad program should be initiated to identify the optimum topsoil and revegetation strategy. Test pads should be conducted on two or three different slope aspects, as these will have a considerable effect on moisture retention and growth of various vegetation species.

10.4 HELP Modeling of Final Cover Options

A range of final cover system options were considered in this study to explore the most suitable final cover system at the Northwin Environmental Landfill. To investigate these aspects of cover performance, various model scenarios were constructed and analyzed with HELP (Schroeder, et. al., 1994). Table 10-1 shows the HELP modeling profiles and input details for different scenarios. The results of the modeling are presented in Table 10-2.

All of the scenarios used the same geologic profile representative of average conditions at the site. It was estimated that the refuse thickness at the Northwin site varies from 20 to 30 m. Therefore, an average thickness of 25 m is used in the model. The average hydraulic conductivity, K , for the refuse was estimated to be 5×10^{-4} cm/s based on SHA's previous experience.

The analysis was done separately for the crest of the landfill, and for the side slopes. For this project, all the cover option profiles were assessed using a 50-year simulation based on climate patterns from the Campbell River climate station. These climate values were corrected to reflect the temperature and precipitation experienced at the landfill site and its surrounding areas. The average monthly precipitation rate and temperature based on the Environment Canada Climatic Normal Data (1991 to 2020) were input into the model. The average annual precipitation created by the HELP model was 1366.59 mm; however, the actual average recorded on site is higher at 1,481.8 mm/yr. This difference is due to the artificial parameters that the HELP model uses to simulate the weather. In addition, SHA ran the model using the extreme year precipitation of 1985.8 mm/yr, based on historic data from Campbell River climate station (1999). Based on the input parameters, the model estimates that the extreme precipitation would be 1,816.04 mm/yr.

In the simulation, three different final cover system designs, as described in Table 10-1, were utilized. **Option 1 (Ministry Recommended Clay Barrier)** involves a 150 mm topsoil/biocover horizon ($k = 1 \times 10^{-3}$ cm/s), a 600 mm Clay Barrier Layer ($k = 1 \times 10^{-7}$ cm/s). **Option 2 (Ministry Recommended Geomembrane Barrier)** involves a 150 mm topsoil horizon ($k = 1 \times 10^{-3}$ cm), 450 mm subsoil horizon ($k = 1 \times 10^{-4}$ cm) and a LLDPE geomembrane as barrier ($k = 4 \times 10^{-13}$ cm/s). **Option 3 (Geomembrane Barrier with Drainage Layer)** involves a 300 mm topsoil horizon ($k = 1 \times 10^{-3}$ cm), 300 mm Gravel Drainage Layer ($k = 1 \times 10^{-1}$ cm), a LLDPE geomembrane as barrier ($k = 4 \times 10^{-13}$ cm/s) and Drintubes Leachate/Gas Collection Layer. **Option 4 (Clay Barrier with Drainage Layer)** involves a 300 mm topsoil horizon ($k = 1 \times 10^{-3}$ cm), 300 mm Gravel Drainage Layer ($k = 1 \times 10^{-1}$ cm), a 600 mm thick layer as barrier ($k = 1 \times 10^{-7}$ cm/s) and Drintubes Leachate/Gas Collection Layer. In each case, the cover veneer was constructed on a 300 mm thick intermediate cover layer ($k = 1 \times 10^{-3}$ cm/s). Each option was simulated for both crest and side slopes. The results show that leachate generation was found to be higher on the crest with 4% slope and thus the results for the crest are reported.

As mentioned in Table 10-2, under average conditions runoff, evapotranspiration and change in water storage were found to be 82.8 mm/yr, 368.2 mm/yr and 19.4 mm/yr respectively for the open condition; leachate production prior to closure was found to be 896.2 mm/yr. Under extreme conditions, the runoff, evapotranspiration and change in water storage were found to be 215.6 mm/yr, 348.5 mm/yr, and 22.0 mm/yr respectively; leachate production prior to closure was found to be 1,230.0 mm/year.

Option 1- Ministry Recommended 600 mm Clay Barrier with a 150 mm Topsoil Layer: This option is, in fact, the Ministry recommended option as per the Landfill Criteria. Under average conditions, after closure with the clay barrier, run-off was found to be increased to 914.8 mm/yr, while evapotranspiration was found to increase to 423.7 mm/yr. The change in water storage reduced to -0.1 mm/yr. Leachate production was found to decrease to 28.2 mm/yr. Under extreme conditions, runoff, evapotranspiration, and change in water storage were found to be 1,388.4 mm/yr, 399.7 mm/yr, and -0.1 mm/yr, respectively; leachate production was found to be 28.1 mm/yr under extreme conditions.

Option 2 –Geomembrane with a 150 mm Topsoil Layer and a 450 mm Subsoil Layer: As mentioned in Table 10-2, under average conditions the runoff and evapotranspiration were found to be 802.8 mm/yr and 550.6 mm/yr and change in water storage was found to be -0.1 mm/yr, after closure with this option. Leachate production was found to be 13.3 mm/yr for the closed conditions under this option. Under extreme conditions, runoff, evapotranspiration and change in water storage were found to be 1,279.1 mm/yr, 523.7 mm/yr, and -0.1 mm/yr, respectively; leachate production was found to be 13.3 mm/yr.

Option 3 –Geomembrane with a 300 mm Topsoil Layer and a 300 mm Drainage Layer with Drintubes Gas/Leachate Collection Layer: As mentioned in Table 10-2, under average conditions the runoff and evapotranspiration were found to be 63.0 mm/yr and 406.7 mm/yr and change in water storage was found to be -0.2 mm/yr, after closure with this option. Lateral drainage was found to be 888.8 mm/yr and leachate production was found to be 8.3 mm/yr for the closed conditions under this option. Under extreme conditions, runoff, evapotranspiration and change in water storage were found to be 260.1 mm/yr, 345.2 mm/yr, and 0 mm/yr, respectively. Lateral drainage was found to be 1,199.3 mm/yr and leachate production was found to be 11.5 mm/yr.

Option 4 – 600 mm Clay with a 300 mm Topsoil Layer and a 300 mm Drainage Layer with Drintubes Gas/ Leachate Collection Layer: As mentioned in Table 10-2, under average conditions the runoff and evapotranspiration were found to be 62.9 mm/yr and 406.7 mm/yr and change in water storage was found to be -0.2 mm/yr, after closure with this option. Lateral drainage was found to be 872.4 mm/yr and leachate production was found to be 24.7 mm/yr for the closed condition under this option. Under extreme conditions, runoff, evapotranspiration and change in water storage were found to be 260.4 mm/yr, 345.1 mm/yr, and -0.1 mm/yr, respectively. Lateral drainage was found to be 1,181.6 mm/yr and leachate production was found to be 29.0 mm/yr.

10.5 Recommended Cover System

Alternatively, SHA recommends a clay cover system (Option 4) be implemented at the Northwin Landfill as shown on Figure 10-2a consisting of the following layers from top to bottom, provided competent clay is available:

- 300 mm Topsoil / Fabricated Growing Medium (including biosolids)
- 8 Oz Separation Geotextile
- 300 mm 5-25 mm Clear Crush Drainage Gravel

- 8 Oz Separation Geotextile
- 600 mm of Low K Soil with $K < 1 \times 10^{-7}$ cm/s
- Drain Tubes Gas and Leachate Breakout Collection Layer
- LFG Gas Collection Trenches
- 300 mm Intermediate Soil Cover

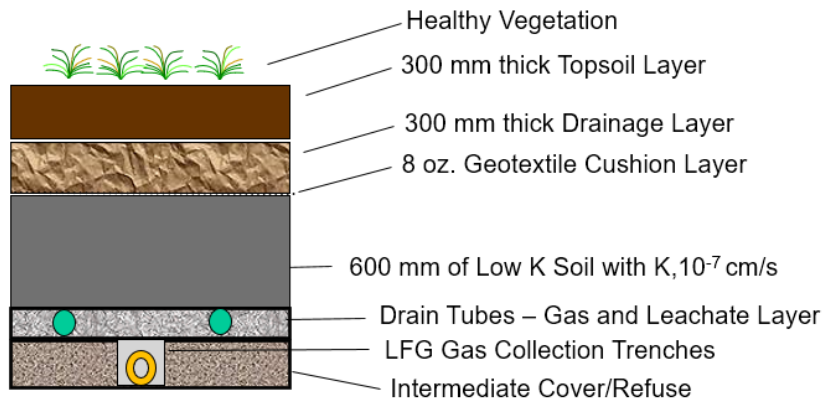


Figure 10-2a: Recommended Clay Cover System

As a alternate option in case sufficient low K clay cannot be secured, SHA would recommend a geomembrane cover system (Option 3) be implemented at the Northwin Landfill as shown on Figure 10-2b consisting of the following layers from top to bottom:

- 300 mm Topsoil / Fabricated Growing Medium (including biosolids)
- 8 Oz Separation Geotextile
- 300 mm 5-25 mm Clear Crush Drainage Gravel
- 12 Oz Cushion Geotextile
- 40 mil LLDPE Geomembrane (textured both sides)
- Drain Tubes Gas and Leachate Breakout Collection Layer
- LFG Gas Collection Trenches
- 300 mm Intermediate Soil Cover

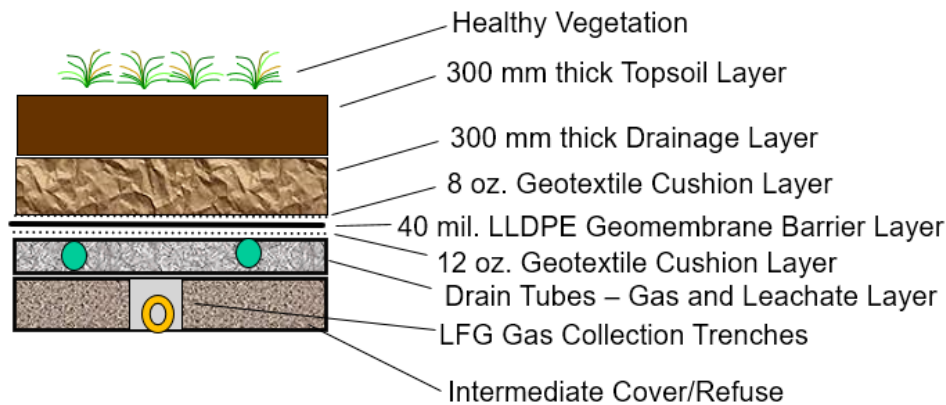


Figure 10-2b: Recommended Geomembrane Cover System

The requirement of a sub-soil layer in the cover system can be revisited based on the end use plan during detail design.

10.6 Progressive Closure Plan

Progressive closure will be necessary to keep leachate generation to a minimum. Essentially, progressive closure involves filling upwards to final grades quickly, rather than spreading waste out horizontally, and then constructing final closure over completed sections of the landfill progressively. This approach has advantages, closure costs can be spread out over the life of the landfill, closed “green” areas can provide screening for operations and most importantly, leachate production will be reduced by capping waste sooner rather than later.

Figure 10-3 provides a progressive closure plan for the site. Included in the plan are the sequential phases to be closed and the base liners to be constructed. Closure of the areas shown should occur within 1 year of the completion of each phase as per the Landfill Criteria.

10.7 Erosion Control & Vegetation

10.7.1 Revegetation

Revegetation activities at the landfill will be protective of human health and the environment, promote environmental stewardship, and will be conducted in compliance with applicable regulatory requirements. As per the revegetation strategy recommended in the Revegetation Management Plan developed by Current Environmental Ltd. (2018), the Upland gravel pit and rock quarry will need to be reclaimed to a self-sustaining state using a combination of methods including site regrading, placement of growing medium, and revegetation using appropriate plant species.

The revegetation should use recommended seed mix and planting specification as per Revegetation Management Plan and 2020 Mine Closure and Rehabilitation Plan (GHD, 2020).

Specifically, revegetation activities will:

- mitigate the erosive forces of precipitation
- utilize feedstock at the landfill in a fabricated soil to promote the establishment of vegetation

- provide a protective layer for the final cover system that minimizes erosion and
- restoring land cover and species types to emulate those of nearby terrestrial ecosystems.

10.8 Post-Closure Maintenance and Monitoring

10.8.1 Contaminating Lifespan Analysis

The contaminating lifespan of a landfill, as defined in the Landfill Criteria, refers to the duration during which landfilled waste has the potential to produce effluent or air contaminants. Kerry Rowe (1991) articulated this concept in his paper *Contaminant Impact Assessment and the Contaminating Lifespan of Landfills* as "the period during which the landfill will produce contaminants at levels that could have unacceptable impact if discharged into the surrounding environment." According to Rowe (1991), key factors influencing the contaminating lifespan include:

Mass of Contaminant per Unit Area (Thickness and Density of Waste): Generally, a thicker waste mass results in a greater mass of any given contaminant, thereby extending the contaminating lifespan.

Infiltration Through the Cover System: Infiltration through waste provides an opportunity for contaminants to be leached and removed, playing a crucial role in contaminant removal from the source.

Characteristics of Leachate Produced: The nature of leachate influences the contaminating lifespan, affecting the time taken to reach allowable concentration levels for each contaminant.

Available Pathway for Contaminant Release: The available release pathway contributes to contaminant lifespan through attenuation.

As per Section 8.3 of the landfill Criteria, the post-closure care duration is determined based on the contaminating lifespan. In the absence of a technical rationale, default values are used: 50 years for landfills with less than 100,000 tons of MSW, 100 years for those with less than 1,000,000 tons, and 200 years for those with more than 1,000,000 tons.

The final cover system, leachate conveyance system, and LFG management system would eliminate potential contaminants if assured by implementing a Post-closure Maintenance Plan. A minimum contaminating lifespan of 30 years post-installation of the final cover can be recommended, subject to the ongoing implementation of following six action items:

1. *Maintenance of the final cover system so that it remains effective. This maintenance should include consideration of the estimated lifespan of LLDPE geomembrane, which is estimated to be on the order of 100 to 200 years.*
2. *Operation and maintenance of the leachate management system. Leachate generation at a phase is expected to be minimal once the phase has received a final cover (geomembrane or clay).*
3. *Maintenance of the surface water drainage control system.*
4. *Operation and maintenance of the landfill gas management system. LFG generation for any given phase is expected to decline with time after the phase has been closed. As a result, the LFG generation rate for each phase is expected to exhibit a significant reduction 30 years after closure and is expected to continue to decline thereafter.*

5. *On-going environmental monitoring including maintenance and replacement of monitoring stations, if required (e.g., ground water monitoring wells, etc.).*
6. *Accurate record keeping on all key elements of post-closure operation and monitoring.*

Section 7.3 of the Landfill Criteria requires that the “Post-closure operation and maintenance shall be done in accordance with the Closure Plan” and Section 7.4 of the Landfill Criteria requires that, “As part of the Closure Plan, the contaminating lifespan of the landfill shall be determined using the latest updated environmental monitoring information.”

SHA suggests that the scope of post-closure undertakings be reassessed annually based on the recent monitoring results. If any of the aforementioned post closure activities are not implemented, a reevaluation of the contaminating lifespan will be required based on the updated monitoring results.

SHA recommends a minimum 30-year post-closure care period, contingent on the effective implementation of the aforementioned recommended Post-closure Maintenance Plan, encompassing detailed post-closure operations, maintenance programs, and specified environmental monitoring outlined in Section 10.3.4 of the Landfill Criteria.

10.8.2 Post-Closure Monitoring

At the end of the operational life of the landfill, a closure monitoring program will be implemented. Consequently, all monitoring data collected up to that point will form an essential part of the data set needed to demonstrate closure conditions. A closure report will need to be prepared to support the application to surrender the permit and to demonstrate that waste stabilization has been achieved. Please see post closure monitoring details in Chapter 7.

10.9 End Use

As per the revegetation strategy recommended in the 2020 Mine Closure and reclamation Plan (GHD, 2020), the end land use objective for the site is to reclaim the land for industrial purposes, consistent with the Permitted Uses of the I-3 zone as defined by the Campbell River Zoning Bylaw 3250 (2006), under Section 5.16.

As part of the reclamation strategy recommended by GHD (2020), the landfill will be closed after its lifespan to meet the post closure requirements as per the Landfill Closure Plan and the Reclamation Plan (GHD, 2020).

The Mine Plan also indicates that portions of the surface lands will be revegetated with local trees, shrub and grass species to promote land productivity.

TABLES



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Table 10-1 HELP MODEL PROFILE AND SCENARIOS

Layers	Vegetation	Open				
		Active-Open	Option 1 - 150 mm Topsoil with 600 mm Clay Barrier - ENV	Option 2 - 150 mm Topsoil and 450 mm Subsoil Layer with Geomembrane Barrier	Option 3 - 300 mm Topsoil with Geomembrane Barrier and 300 mm Drainage Layer	Option 4 - 300 mm Topsoil with 600 mm Clay Barrier and 300 mm Drainage Layer
		Poor Stand of Grass	Good Stand of Grass	Good Stand of Grass	Good Stand of Grass	Good Stand of Grass
		Evaporative Zone Depth = 20cm	Evaporative Zone Depth= 51 cm	Evaporative Zone Depth= 51 cm	Evaporative Zone Depth= 51 cm	Evaporative Zone Depth= 51 cm
Layer 1	Material Function Thickness (mm) K Value (cm/s)	Intermediate Cover Vertical Percolation Layer 300 1x10 ⁻³	Topsoil/Biocover Vertical Percolation Layer 150 1x10 ⁻³	Topsoil/Biocover Vertical Percolation Layer 150 1x10 ⁻³	Topsoil/Biocover Vertical Percolation Layer 300 1x10 ⁻³	Topsoil/Biocover Vertical Percolation Layer 300 1x10 ⁻³
Layer 2	Material Function Thickness (mm) K Value (cm/s)	Refuse Vertical Percolation Layer 25000 5x10 ⁻⁴	Clay Barrier Layer 600 1x10 ⁻⁵	Subsoil Vertical Percolation Layer 450 1x10 ⁻⁴	Gravel Drainage Layer 300 1x10 ⁻¹	Gravel Drainage Layer 300 1x10 ⁻¹
Layer 3	Material Function Thickness (mm) K Value (cm/s)		Intermediate Cover Vertical Percolation Layer 300 1x10 ⁻³	LLDPE Geomembrane Barrier Layer 40 mil 4x10 ⁻¹³	LLDPE Geomembrane Barrier Layer 40 mil 4x10 ⁻¹³	Clay Barrier Layer 600 1x10 ⁻⁷
Layer 4	Material Function Thickness (mm) K Value (cm/s)		Refuse Vertical Percolation Layer 25000 5x10 ⁻⁴	Intermediate Cover Vertical Percolation Layer 300 1x10 ⁻³	Leachate/Gas Collection Layer Draintubes 102 4.2	Leachate/Gas Collection Layer Draintubes 102 4.2
Layer 5	Material Function Thickness (mm) K Value (cm/s)			Refuse Vertical Percolation Layer 25000 5x10 ⁻⁴	Intermediate Cover Vertical Percolation Layer 300 1x10 ⁻³	Intermediate Cover Vertical Percolation Layer 300 1x10 ⁻³
Layer 6	Material Function Thickness (mm) K Value (cm/s)				Refuse Vertical Percolation Layer 25000 5x10 ⁻⁴	Refuse Vertical Percolation Layer 25000 5x10 ⁻⁴
Layer 7	Material Function Thickness (mm) K Value (cm/s)					

Table 10-2 HELP MODEL RESULTS

Scenarios	Scenario Modelled	Evapotranspiration (mm/yr)	Evapotranspiration as % of P	Runoff (mm/yr)	Runoff as % of P	Lateral Drainage (mm/yr)	Lateral Drainage %	Percolation to leachate (mm/yr)	Percolation to Leachate % of P	Lateral Drainage in Leachate Collection Layer (mm/yr)	Lateral Drainage in Leachate Collection Layer %	Change in water storage (mm/yr)	Change in water storage as % of P	Leakage through Bottom Layer	Leakage through Bottom Layer as % of P	Leachate Produced (mm/yr)	Leachate Produced as % of P	Precipitation (mm/yr)
I.D	4% Slope																	
	Average																	
	Open - Active	368.2	26.9%	82.8	6.1%	N/A	N/A	896.2	65.6%	N/A	N/A	19.4	1.4%	896.2	65.6%	896.2	65.6%	1,366.59
Option 1	Closed - 150 mm Topsoil with 600 mm Clay Barrier - ENV	423.7	31.0%	914.8	66.9%	N/A	N/A	28.2	2.1%	N/A	N/A	(0.1)	0.0%	28.2	2.1%	28.2	2.1%	1,366.59
Option 2	Closed- 150 mm Topsoil and 450 mm Subsoil Layer with Geomembrane Barrier - ENV Geomembrane Option	550.6	40.3%	802.8	58.7%	N/A	N/A	13.3	1.0%	N/A	N/A	(0.1)	0.0%	13.3	1.0%	13.3	1.0%	1,366.59
Option 3	Closed- 300 mm Topsoil with Geomembrane Barrier and 300 mm Drainage Layer with Drintube Gas/Leachate Collection Layer	406.7	29.8%	63.0	4.6%	888.8	65.0%	8.4	0.6%	-	0.0%	(0.2)	0.0%	8.3	0.6%	8.3	0.6%	1,366.59
Option 4	Closed- 300 mm Topsoil with 600 mm Clay Barrier and 300 mm Drainage Layer with Drintube Gas/Leachate Collection Layer	406.8	29.8%	62.9	4.6%	872.4	63.8%	24.7	1.8%	-	0.0%	(0.2)	0.0%	24.7	1.8%	24.7	1.8%	1,366.59
	Extreme																	
	Open - Active	348.5	19.2%	215.6	11.9%	N/A	N/A	1,230.0	67.7%	N/A	N/A	22.0	1.2%	1,230.0	67.7%	1,230.0	67.7%	1,816.04
Option 1	Closed - 150 mm Topsoil with 600 mm Clay Barrier - ENV	399.7	22.0%	1,388.4	76.5%	N/A	N/A	28.1	1.5%	N/A	N/A	(0.1)	0.0%	28.1	1.5%	28.1	1.5%	1,816.04
Option 2	Closed- 150 mm Topsoil and 450 mm Subsoil Layer with Geomembrane Barrier - ENV Geomembrane Option	523.7	28.6%	1,279.1	70.4%	N/A	N/A	13.3	0.7%	N/A	N/A	(0.1)	0.0%	13.3	0.7%	13.3	0.7%	1,816.04
Option 3	Closed- 300 mm Topsoil with Geomembrane Barrier and 300 mm Drainage Layer with Drintube Gas/Leachate Collection Layer	345.2	19.0%	260.1	14.3%	1,199.3	66.0%	11.6	0.6%	-	0.0%	(0.0)	0.0%	11.5	0.6%	11.5	0.6%	1,816.04
Option 4	Closed- 300 mm Topsoil with 600 mm Clay Barrier and 300 mm Drainage Layer with Drintube Gas/Leachate Collection Layer	345.1	19.0%	260.4	14.3%	1,181.6	65.1%	29.0	1.6%	-	0.0%	(0.1)	0.0%	29.0	1.6%	29.0	1.6%	1,816.04

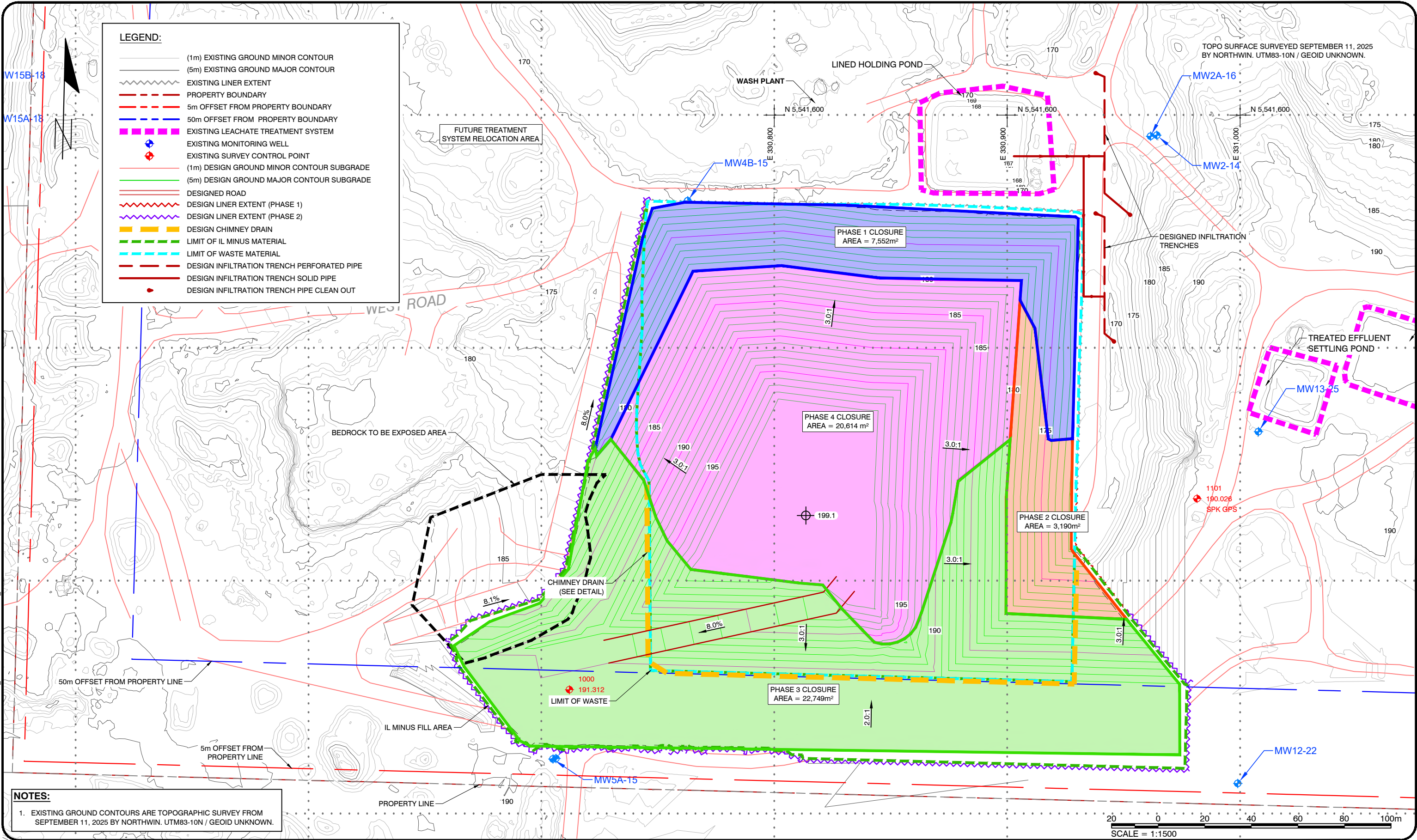
FIGURES



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

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North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723

LEGEND:

CLIENT:



PROJECT:

NORTHWIN LANDFILL DESIGN
OPERATION AND CLOSURE PLAN
UPDATE

TITLE:

PROGRESSIVE CLOSURE
AREAS BY PHASE

SCALE:

1:1500

DATE:

2026/09/11

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PROJECT NO:

PRJ 24074

DESIGNED

DRAWN

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FIGURE 10-3

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11 HEALTH, SAFETY, AND EMERGENCY MANAGEMENT PLAN

11.1 Health and Safety Plan

A site-specific health and safety plan should be in place for the Northwin Environmental Landfill to ensure that operations meet the requirements of Worksafe BC.

11.2 Emergency Management Plan

To ensure personnel are trained and prepared for potential emergencies, Northwin Environmental Ltd. has developed an Emergency Management Plan (EMP) consistent with COR requirements. The EMP is integrated with Upland Contracting, the operator of the Upland Gravel Pit and Rock Quarry, to provide a coordinated approach across the Site. The EMP is posted at designated locations in accordance with WorkSafe BC requirements.

12 FINANCIAL SECURITY PLAN

A comprehensive financial security plan is needed for every private landfill site in accordance with Section 8.0 – Financial Security of the Landfill Criteria. The amount of the financial security should ensure that sufficient capital is available for necessary infrastructure and capital projects, including liner systems, leachate treatment works, landfill gas management, and other operational or environmental control systems. Financial resources must also be set aside to support progressive closure, final closure, post-closure care, long-term environmental monitoring, and maintenance for the estimated contaminated lifespan of the site. The liabilities should be estimated for each phase of development as outlined in Section 8.1 of the Criteria.

The Financial Security Plan update for the Northwin Landfill has been completed in a standalone report (SHA, 2026).

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14 LIMITATIONS

This report has been prepared by Sperling Hansen Associates (SHA) on behalf of the 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 SHA to determine its accuracy and completeness. SHA 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. SHA 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 SHA 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.

We appreciate the opportunity to work with the Northwin Environmental Ltd. on this project. Please do not hesitate to contact the undersigned if you have any questions.

Sincerely,

SPERLING HANSEN ASSOCIATES
EGBC License to Practice #1003066

Report prepared by:

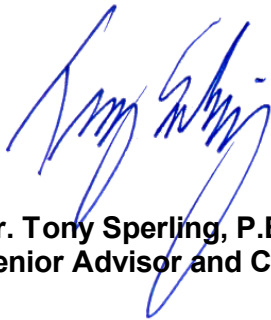


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September 30th, 2026

APPENDICES



SPERLING
HANSEN
ASSOCIATES



APPENDIX A:
LANDFILL CRITERIA CONFORMANCE REVIEW



January 4, 2017

Reference No. 088877

Mr. Allan Leuschen
Senior Environmental Protection Officer
Authorizations – South
Environmental Protection Division
Ministry of Environment

Dear Mr. Leuschen:

**Re: Compliance Checklist
Landfill Criteria for Municipal Solid Waste - Second Edition (June 2016)
Upland Landfill Waste Discharge Application
Upland Excavating, Campbell River, BC**

1. Introduction

GHD Limited (GHD) is submitting this letter to the Ministry of Environment (MOE) on behalf of Upland Excavating Ltd. (Upland) in support of the Waste Discharge Application (Application) for the Upland Landfill (Landfill) submitted on May 27, 2016. The Application is filed under Tacking Number 335965 and Authorization Number 107689.

The following technical reports were submitted in support of the Application:

- Technical Assessment Report
- 2016 Design, Operations, and Closure Plan
- Hydrogeology and Hydrology Characterization Report
- 2016 Geotechnical Investigation

The MOE submitted a letter to GHD, dated October 6, 2016, requesting additional information related to the Application. GHD responded with a proposed approach and timeline in a letter dated December 7, 2016. This letter has been prepared in accordance with GHD's letter, dated December 7, 2016, to address Item 2 of the MOE's additional information request requesting a review of the technical reports based on the Landfill Criteria for Municipal Solid Waste – Second Edition, dated June 2016 (Landfill Criteria).

2. Compliance Checklist Methodology

GHD has completed a compliance review to compare the technical reports submitted May 27, 2016 with the Landfill Criteria which was finalized in June 2016. The technical reports were prepared referencing the draft version of the Landfill Criteria. There were no significant revisions to the Landfill Criteria between the draft and final versions.



GHD developed the compliance checklist, provided in Attachment A, based on the criterion in the Landfill Criteria. The reports were evaluated against the criteria. Five evaluation categories were developed as follows:

- **Compliant** – The criterion is satisfied
- **Not Addressed** – Not addressed in the technical reports submitted, however, the criterion will be addressed in the future (for example: construction reports will be completed after construction).
- **Exempt** – Based on site conditions and/or operations the Landfill is deemed exempt from a criterion based on the Qualified Professionals judgment (for example: the Landfill is exempt from the requirement to install a bear fence as no putrescible waste will be accepted)
- **Non-Compliant** – A criterion is not satisfied, will not be satisfied in the future under current plans, and no technical justification is provided.
- **Not Applicable** – Criterion does not apply to this site or type of landfill (for example: no surface water will be discharged from the Landfill to a surface water body)

3. Compliance Checklist Review Conclusions

The attached compliance checklist presents the results of GHD's review. GHD concludes that the technical reports are substantially compliant with Landfill Criteria. A number of criterion have been identified as not addressed that will be addressed during detailed design, construction, operation, annual reporting, and post-closure of the Landfill. Based on GHD's review, no criterion has been categorized as non-compliant.

We trust this submission will provide the additional information requested regarding the compliance with the Landfill Criteria. Should you have any questions or require further information regarding the submission please do not hesitate to contact the undersigned.

Sincerely,

GHD

Gregory D. Ferraro, P.Eng.
SS/sz/02

Shauna Sturgeon, B.Sc.Eng.

Encl.

cc: Terry Stuart – Upland Excavating Ltd.
Mark Stuart – Upland Excavating Ltd.
Brian Fagan – Upland Excavating Ltd.

Attachment A Compliance Checklist

Compliance Checklist
Landfill Criteria for Municipal Solid Waste - Second Edition (June 2016)
Upland Landfill - Waste Discharge Application
Upland Excavating Ltd, Campbell River, BC

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
3	Siting Criteria						
3.1	>500 m from an existing or planned sensitive land use (schools, residences, hotels, restaurants, cemeteries, food processing facilities, churches and					x	Existing Site. Landfill located in base of existing aggregate pit.
3.2	>100 m from a heritage or archaeological site (see also BC Heritage Conservation Act)					x	Existing Site. Landfill located in base of existing aggregate pit.
3.3	>8.0 kilometers from an airport (may be reduced to 3.2 km with bird control and approval)					x	Existing Site. Landfill will not receive petrucible waste, there birds will not be attracted to waste.
3.4	>50 m from limit of waste (discharged MSW) to the property boundary	x					
	30 m closest to the landfill site boundary shall be reserved for natural or landscaped screening	x					
3.5	>300 m of a regular capacity water intake	x					
	>500 m of a high capacity water intake	x					
3.6	A landfill shall not be located in a depression which acts as a point of water collection during rainfall events (unless acceptable diversion works are provided)	x					Surface water diversion swale will prevent runoff from landfill outside of aggregate pit running onto Landfill
3.7	>100 m from a geologically unstable area	x					
3.8	>100 m of an environmentally sensitive area (park, wildlife management area, critical wildlife area or wildlife sanctuary, BC Wildlife Act Section 3 land, an ecological reserve, bird sanctuary, Federal Wildlife Act wildlife area, a marine sanctuary, a wetland, habitat of rare, threatened or endangered species, etc.)	x					
3.9/11	>100 m from a surface water body, including sea level maximum high tide or seasonal high watermark of an inland lake shoreline.	x					
3.1	Not located in a flood plain	x					Not in a flood plain
3.12	>1.5 m above groundwater at all times	x					
4	Performance Criteria						
4.1	Groundwater and Surface Water Quality						
	Identify current and planned future uses of groundwater and surface water within 1 km of the landfill footprint	x					Identified current uses
	QP must recommend appropriate water quality criteria and compliance locations which must be approved in writing by the director	x					To be provided as part of final EMP
	Ground or surface water quality must not decrease beyond that recommended by a QP for the Landfill at the landfill boundary or 150 m from the landfill	x					The approved ground water quality criteria will be met at the property boundary
	Discharges to surface water considered as fish habitat must comply with the requirements of the federal Fisheries Act					x	No discharge to surface water
4.2	Landfill Gas Management						
	Soil gas concentrations at the landfill site boundary shall not exceed the CH4 LEL	x					
	Combustible gas concentrations in Site buildings <20% of CH4 LEL (1% v/v).	x					
	LFG shall be managed in accordance with the following objectives and standards:						
	migration	x					
	H&S	x					
	LFG emissions shall be meet the following standards:						
	federal	x					
	provincial	x					
	local ambient air quality	x					
	Landfills with >100,000 tonnes of waste in place, or receiving > 10,000 tonnes/yr shall submit a LFG Generation Assessment Report	x					A preliminary Landfill Gas Generation Assessment is included in the DOCP with forecasted waste characteristics to estimate forecasted landfill gas generation rates
	Landfills generating greater than 1,000 tonnes CH4/yr shall:						
	prepare a LFG Management Facilities Design Plan					x	Current LFG generation forecast <1,000 tonnes CH4/yr
	have LFG Management system in place four years after The LFG Facilities Design Plan submission					x	Current LFG generation forecast <1,000 tonnes CH4/yr
	LFG management systems are to be designed to maintain 75% collection efficiency as determined by the MOE Gas Generation Model					x	Current LFG generation forecast <1,000 tonnes CH4/yr
4.3	Nuisance						
	A landfill shall be operated to prevent public nuisances e.g. noise, dust, litter, vectors or wildlife attraction	x					
5	Design Criteria						
5.1	Service Life and Contaminating Lifespan						
	Landfill facilities design service life shall exceed the contaminating lifespan	x					Contaminating lifespan is less than the landfill infrastructure performance life

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
5.2	Site Layout						
	Site layout shall:						
	take into consideration groundwater flow direction and surface water infiltration and discharge points	x					
	minimize potential for leachate and LFG impacts off-site	x					
	provide for site entrance, gatehouse, material recovery/recycling area, structures, access roads, landfill footprint, surface water ditching and management ponds, LFG management infrastructures (if applicable)	x					
5.3	Landfill Base Design						
	A QP geologic inspection shall be completed prior to placement and construction of landfill base liner system		x				Landfill cell construction to be inspected by QP.
	The landfill base shall:						
	serve as an adequate foundation for construction of a landfill base liner and leachate collection system	x					
	be placed on stable soil or rock	x					
	be > 1.5 m above groundwater at all times	x					
	not be subject to consolidation that could result in differential settlement	x					
	provide for >2% primary drainage path slope (leachate collection piping)	x					
	provide for >0.5% secondary drainage path slope (drainage blanket)	x					
	provide for max 50 m drainage blanket drainage path length (to leachate collection pipe)	x					
5.4	Landfill Base Liner						
	Landfill base liner shall consist of:						
	a primary liner HDPE geomembrane liner	x					
	a secondary compacted clay or Geosynthetic Clay liner	x					
	QA/QC on liner install shall be conducted consisting of:						
	continuous inspection by QP		x				To be addressed during construction
	non-destructive leak testing of each seam		x				To be addressed during construction
	post backfill leak detection survey of HDPE geomembrane		x				To be addressed during construction and commissioning
	The HDPE geomembrane shall meet the following minimum requirements						
	>1.5mm thickness	x					
	>100 yr liner service life	x					
	meet or exceed industry standard QA/QC		x				To be addressed during construction
	texture & asperity shall be designed to provide stability in all circumstances including earthquake		x				To be addressed during detailed design
	The secondary clay liner shall:						
	consist of a compacted clay liner or GCL with equivalent performance	x					Design includes GCL with equivalent performance
	be composed of >25% clay and >60% silt and clay by weight	x					Design includes GCL with equivalent performance
	> 750 mm compacted thickness perpendicular to slope (If secondary	x					Design includes GCL with equivalent performance
	<1x10-7cm/sec compacted hydraulic conductivity	x					Design includes GCL with equivalent performance
	>0.1% organic carbon content	x					Design includes GCL with equivalent performance
	remain stable when exposed to leachate (clay structure and permeability)		x				To be addressed during detailed design. Specific GCL will be compatible with expected landfill leachate

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
5.5	Leachate Collection System (LCS)						
	Landfills shall have a LCS above the geomembrane liner	x					
	the LCS shall be:						
	constructed in accordance with approved Leachate Management Plan		x				To be addressed during construction
	installed with QP oversight and continuous QA/QC inspection by QP		x				To be addressed during construction
	managed in accordance with the approved Leachate Management Plan		x				To be addressed during operation
	designed to maintain a leachate head of <0.3 m at any point on the landfill base liner	x					
	Shall be constructed of the following (or alternative with equivalent hydraulic conductivity and mechanical protection):						
	a non-woven geotextile installed on top of geomembrane liner (placed prior to placement of stone to protect against puncture)	x					
	a drainage blanket consisting of continuous 0.3 m thick, 50 mm diameter chemically inert clear stone with minimal fines or equivalent	x					
	an engineered filter layer above stone drainage blanket	x					
	leachate collector pipes consisting of:						
	perforated or slotted HDPE collector pipes placed within drainage blanket at < 15 m lateral spacing between pipes and with < 50 m drain path	x					
	pipes sized to handle leachate flows based on site-specific leachate generation calculations but always >150 mm diameter	x					
	pipes with wall thickness designed based on site specific loading from waste and final cover loads		x				To be addressed in detailed design
	> 2% collector pipe slope along primary leachate flow paths	x					
	cleanouts at each end of leachate collector pipes	x					
	collection header and sump to collect leachate from collector pipes	x					
	Steps shall be taken to prevent entry of air into collector pipes during operation		x				To be addressed during construction
5.6	Surface Water (SW) Management Works						
	Surface water management works shall:						
	be designed and constructed in accordance with SWMP	x					
	be completed prior to commencement of landfill site operations	x					
	direct/convey SW runoff away from the active operation to minimize surface water contact with waste	x					
	prevent surface water run-on onto the landfill footprint	x					
	minimize potential for on-site erosion	x					
	minimize potential for downstream sediment loading	x					
	control peak flow to prevent downstream flooding					x	No surface water flow to downstream locations water bodies
	be designed based on hydrogeologic modeling of 5-, 10- and 100- year design storm events	x					
	include implementation of appropriate erosion control measures to prevent erosion of banks and landfill side slopes (e.g. hydroseeding, erosion control blankets and straw wattle)	x					
	promote settling of sediment	x					
	promote infiltration of retained storm water for groundwater recharge	x					
	have low flow control structures and high flow overflow spillways for all SW ponds					x	Overflow spillway or low flow control structures not required in surface water infiltration areas as they do not outlet to surface water bodies.
	have ditches and retention ponds designed for the control and retention of a 1:100-year, 24-hour storm events	x					
	be designed to account for additional water from snow melt and prolonged multi-day precipitation events		x				Multi-day precipitation events to be included in final surface water model in final DOCP
	treat SW runoff generated from active areas of the landfill as leachate	x					
	include ditches armored with appropriate erosion protection for expected flows	x					
	not have ditches sloped <1%	x					Addressed in Table 8.5
	be designed such that no flow reversals develop in ditches due to localized settlement	x					
	have erosion control measures to prevent active erosion of channel slopes and surfaces that contribute to runoff	x					
	Mid-slope drainage ditches/swales shall be constructed on final cover surfaces as required to prevent erosion of cover soil. Recommended spacing of ditches 15 m vertical	x					

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
5.7	Landfill Gas Management (LFG) Works						
	Works shall be constructed as per the requirements of the LFG Management Regulation	x					
	LFG works shall be constructed and operated in accordance with the BC LFG Management Facilities Design Guideline					x	
	LFG management works shall follow document entitled "Technologies and Best Management Practices for Reducing GHG Emissions from Landfills Guidelines"					x	
5.8	Final Cover Design						
	The final cover design shall:						
	prevent exposure of humans and/or wildlife to MSW	x					
	control infiltration of precipitation	x					
	minimize the uncontrolled release of methane to the atmosphere	x					
	limit erosion and release of sediment to surrounding surface waters	x					
	control the release of odours	x					
	minimize oxygen infiltration and fire risk	x					
	be compatible with the end use planned for the landfill site	x					
	Barrier Layer						
	Final cover design shall meet the following characteristics or be of an alternative final cover (e.g. evapotranspirative cover) which provides equivalent or better performance with respect to reduction of infiltration:						
	consist of a barrier layer with a hydraulic conductivity <1 x 10 ⁻⁵ cm/sec (arid regions) or 1 x 10 ⁻⁷ cm/sec (non-arid regions)	x					Final cover barrier layer will consist of a GCL equivalent to 1x10 ⁻⁷ cm/sec required for non-arid regions
	have minimum compacted thickness of 0.6 m measured perpendicular to the slope	x					
	have a topsoil layer thickness determined by annual precipitation but not less than >0.15 m	x					
	have a topsoil layer capable supporting sustained vegetative cover over barrier layer	x					
	ensure the maximum allowable leachate generation rate is not exceeded	x					
	be designed based on hydrologic modeling demonstrating final cover stability under design storm conditions and consistency with the LMP		x				Slope stability of specific cover material to be addressed in detailed design
	allow for waste stabilization during the post-closure period	x					
	designed in coordination with LFG management facilities including LFG collection/venting facilities	x					
	Topsoil layer shall:						
	have a depth related to the type of vegetation planned	x					
	provide moisture retention and nutrients required to support long term healthy vegetative growth		x				To be addressed in detailed design
	consist of an appropriate mix of soil, a carbon source and a nutrient source (soil or fabricated growing medium)		x				To be addressed in detailed design
	be developed by a QP in compliance with BCs organic matter recycling regulation If biosolids are used					x	
	Vegetation shall:						
	have seed or hydroseed applied at the earliest opportunity (which will allow for germination)		x				Timeline of hydroseed application will be specified in detailed design of final cover
	achieve erosion control, low maintenance and end use objectives	x					
	be periodically reseeded and fertilized until cover is fully established		x				To be addressed post-closure
	sustain vegetal species selected whose root systems will not impact performance of the low permeability layer	x					
5.9	Final Contours						
	Landfill side slopes shall be no steeper than 33%	x					
	Landfill top plateau must have minimum slope of 10 % for soil cover	x					
	Top plateau with durable geomembrane or composite barrier layer with an overlying drainage layer above the final landfill side slopes may have a minimum slope of 4 %					x	Minimum top plateau slope will be 10 %
	Grades may be altered post-closure to accommodate a planned beneficial land use if no differential settlement can be demonstrated for a period of at least 1 year post-closure					x	Post closure end use currently not planned
	Surface water control benches shall be installed at a minimum every 15 m vertical	x					Surface water control benches located half way up sloop at approximately 10 m vertical from base of landfill and top plateau

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
5.10	Site Security and Fencing						
	Landfill security shall discourage unauthorized access	x					
	Minimum 1.2m high fence, post and wire or better, around the entire perimeter of Landfill Site			x			Fenced along road, large site located in remote location
	Minimum 2.0 m high fence is recommended where vehicle access can be achieved from outside	x					Fence located along road
	Site Security shall include vandal proof locking mechanisms at publicly accessible entry points and shall be maintained in a locked position outside of operating hours	x					
5.11	Access Roads						
	Entrance facilities should be placed to minimize queuing along public roads	x					Queueing on roads will not be permitted
	Access roads shall:						
	be all-weather safe	x					
	provide access to on-site facilities for inspection and maintenance during the operating and post-closure periods	x	x				Existing road network will be utilized within the Site, access roads on the landfill active face will be addressed during operations
	provide safe public access to all material drop-off and waste disposal areas					x	Public access is not permitted to the Site
	prevent the tracking of mud or waste from the site onto public roadways		x				Existing road network will be utilized with no issues noted
	meet the traffic load and vehicle type	x					Existing road and vehicle types will be utilized with no issues noted
	>4 m for single lane	x					Existing road network will be utilized
	>7 m for two lanes	x					Existing road network will be utilized
	<8 % grade on public access roads					x	Public access is not permitted to the Site
	<15% grades on construction/internal roads	x					Existing road network will be utilized
	have armored ditches for roads >2% grades			x			The existing road network on the property do not have armored ditches and have functioned effectively. Landfill perimeter ditches will effectively manage leachate from access roads on the final contours of the landfill.
5.12	Vector and Wildlife Management and Nuisance Controls						
	Landfill site shall be designed to satisfy the operation criteria with respect to vector and wildlife management and nuisance controls	x					Vectors are not expected to be an issue due to the nature of the waste
6	Operations Criteria						
6.1	Authorized Wastes						
	The DCOP shall identify:						
	waste to be received including controlled waste	x					
	controls to be implemented for their receipt and disposal of all wastes	x					Waste acceptance policy and landfilling of waste discussed in Section 6.3 and 6.4 of DOCP, respectively
	Hazardous Wastes						
	Approval from the Director shall:						
	be received for disposal of Hazardous Wastes	x					For ACM only
	only be issued for asbestos and/or hydrocarbon contaminated soil	x					For ACM only
	Controlled wastes						
	Controlled wastes shall only be deposited:						
	with approval from the Director					x	Controlled wastes including slaughter, poultry, fish hatchery, farming, animal by-product, and liquid or semi-liquid waste will not be accepted
	where it has been demonstrated that there is no other viable alternative for the waste stream					x	Controlled wastes including slaughter, poultry, fish hatchery, farming, animal by-product, and liquid or semi-liquid waste will not be accepted
	Waste asbestos shall be:						
	transported in compliance with the TDG Act and regulations	x					
	deposited only in compliance with section 40(2) of the HWR	x					References part 6, section 40
	Controlled waste shall be:						
	disposed in a 2-4 m deep trench excavated into MSW at the active face					x	Controlled wastes including slaughter, poultry, fish hatchery, farming, animal by-product, and liquid or semi-liquid waste will not be accepted
	disposed into native soil within the landfill footprint where no further excavation will occur					x	Controlled wastes including slaughter, poultry, fish hatchery, farming, animal by-product, and liquid or semi-liquid waste will not be accepted
	immediately covered with a minimum of 0.5 m of cover or MSW					x	Controlled wastes including slaughter, poultry, fish hatchery, farming, animal by-product, and liquid or semi-liquid waste will not be accepted
	Recovery of recyclable and reusable materials should be encouraged	x					Diversion of suitable materials will be continued

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
6.2	Landfilling of Wastes						
	All waste shall be:						
	placed within the landfill footprint in accordance with the Filling Plan	x					
	spread in thin layers (0.6 m or less) on the active face		x				To be addressed during operation, compaction will be optimized
	The area of active face shall be kept at a minimum	x					
	Recommendation in Appendix A shall be followed for landfilling of waste	x					Area of active face consistent with Appendix A
6.3	Cover Placement						
	Daily cover soil shall:						
	be >150 mm thick	x					
	be placed over the entire surface of the active face at the end of each operating day	x					
	or of equivalent alternate material approved by Director	x					
	Intermediate cover shall:						
	be >300 mm thick soil	x					
	be placed on areas that will not receive waste for >30 days	x					
	or of equivalent alternate material approved by Director					x	Alternate cover not proposed
	Water contacting daily cover shall be managed as leachate in accordance with the LMP (if considered leachate)	x					
	Optional stripping of cover shall:						
	be undertaken only immediately before beginning an active face on top	x					
	not result in unacceptable nuisance odours and/or odour complaints					x	Stripping of cover soil is not currently planned for the Site
	Final Cover soil shall						
	>600 mm thick or equivalent material (as outlined in 5.8 above).	x					
	be placed within 365 days on any part of the landfill footprint at final contours	x					
	Contaminated soil may be used as waste cover under the conditions provided in App B	x					
6.4	Nuisance Controls						
	The landfill shall be designed and operated to:						
	prevent impacts from nuisance factors	x					
	comply with any local government nuisance bylaws	x					
	have a complaint response procedure posted on-site	x					
	Dust						
	Dust releases should be controlled on site	x					
	dust emissions from roads shall:						
	be controlled via watering (or equivalent)	x					
	not be controlled by chloride (if possible)	x					
	not be controlled by waste oil	x					
	Landfill supervisory staff shall:						
	routinely watch out for dust clouds	x					Dust remedial measures will be implemented as required. Specific direction will be provided to operational staff during the operational life of the landfill
	initiate remedial measures whenever excessive dust is observed	x					
	Noise						
	Site operations shall be minimized by:						
	making use of natural and/or constructed features such as vegetation or berms	x					
	<8% slope on main haul roads					x	Haul roads will be consistent with the existing road network used for gravel operation, Noise levels will be consistent with existing operations.
	scheduling operations appropriately	x					
	Litter						
	Litter on the landfill shall:						
	not be left exposed	x					
	be prevented from migrating beyond the landfill site boundary	x					
	be removed at least once per year	x					Litter will be removed periodically as required

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
	Odour						
	Operations shall be conducted in a manner to prevent nuisance from odour	x					No putrescible waste to be received or discharged, therefore little odour will be generated.
	An aeration system shall be installed in leachate storage ponds and other liquid facilities that generate unpleasant odours	x					The leachate management system will include an aeration pond.
	Biosolids and other odorous materials shall be stored, blended, and processed with required odour control measures in place					x	No odorous material will be received or discharged
6.5	Vector and Wildlife Management						
	Landfills shall						
	apply cover to discourage wildlife from feeding at landfills	x					
	have a bird deterrent program if <8km from an airport or are located where birds converge	x					
	implement a rodent control program	x					
	have bear proof electric fences if they are located in bear habitat within 120 days of a bear siting or other dangerous wildlife (cougar, coyote, wolf).			x			No putrescible waste to be received or discharged, therefore no bear risk.
6.6	Burning						
	Landfills shall burn clean wood and/or yard wastes only if:						
	approved in the SWMP, OC or permit	x					Burning under the OC will continue only if approved by the Director
	if it can be demonstrated to the director that there is no viable alternative		x				A technical assessment report in support of the burning operations under the OC may be submitted
	Open burning shall undertaken only if:						
	a technical assessment report satisfactory to the directors is be submitted		x				A technical assessment report in support of the burning operations under the OC may be submitted
	is approved in the SWMP, OC or permit	x					
	is approved by any other applicable fire protection authorities (see Appendix C for further details)	x					Will comply with local fire authorities stated in DOCP
6.7	Landfill Fire Management						
	The risk of landfill fires shall be reduced by:						
	application of daily, intermediate and final cover requirements	x					
	isolating wastes by specified thicknesses of inert daily and intermediate cover	x					
	constructing fire breaks >15 m wide free of combustible materials within the buffer zone, within the 20 m closest to the landfill footprint	x					
	providing year-round, immediate access to >4,000 lpm water or suitable alternative fire suppression equipment specified in the Fire Safety Plan		x				4000lpm supply not specifically referenced. Finalized fire and emergency response plan will identify the fire suppression measures and supplies.
	providing fire suppression equipment to all landfill equipment working at the operating face	x					
	taking all reasonable efforts to immediately extinguish unauthorized fires	x					
	reporting large fires which pose a threat to public health or to neighbouring property to the Provincial Emergency Program	x					
6.8	Scavenging						
	Scavenging shall be prevented	x					
6.9	Site Health And Safety Plan						
	The landfill site operations shall meet the requirements of Work Safe BC	x					
6.1	Signage						
	External signage shall include name of owner/external landfill operator, contact information, hours of operations, emergency contact information, waste and recyclable accepted or prohibited, tipping fees	x					Tipping fees will not be included in signage as Landfill private use.
	Internal signage shall include directions for: for public and commercial waste haulers to drop-off, material recovery, disposal areas		x				Waste haulers will be specifically directed by landfill staff and signage during operations. No public loads will be accepted.
6.11	Weigh Scales						
	Weigh scales shall						
	be installed if site receives >5,000 tonnes of waste per year	x					
	meet requirements of federal Weights and Measures Act	x					

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
6.12	Records						
	Records shall:						
	be kept on-site for inspection and maintained for at least 7 years	x					
	be ready to be submitted to MOE within 14 days if requested	x					
	Records shall include:						
	Permit or the Operational Certificate	x					
	plans and reports	x					
	inspection records conducted by regulatory agencies	x					
	a complaint ledger	x					
	waste tonnages and volumes disposed of in a landfill	x					
	recyclable material data and disposition for each category of waste and recyclable material received and exported from the landfill site (if available)	x					
6.13	Operator Training						
	Landfills shall:						
	be supervised and operated by trained qualified personnel	x					
	have staff trained in appropriate specialized professional training	x					
	have staff which should engage in continuing education		x				Continuing education will be addressed during the operational life of the landfill
7	Closure and Post-Closure Criteria						
7.1	Closure Plan						
	A Closure Plan shall:						
	be included in the DOCP	x					
	be updated within two years of landfill closure or when significant changes that may impact its operational lifespan to the landfill site are planned		x				Applicable to future DOCP updates and Site changes as required
	include proposed post-closure land use for the Site	x					Post closure to be determined, referenced in DOCP
7.2	Progressive Closure						
	Each area of the landfill that has achieved final contours shall be closed within 365 days	x					
	Progressive closure activities shall be completed based on the filling plan	x					
7.3	Post-Closure Operations and Maintenance						
	Post-closure operations shall be conducted in accordance with the Closure Plan	x					
7.4	Contaminating Lifespan						
	The contaminating lifespan shall:						
	be determined using the latest updated environmental monitoring information	x					
	be assumed to be >30 years for post-closure operation and maintenance, and financial security requirements	x					
	address permanent shutdown of LFG facilities					x	No LFG facilities are proposed
7.5	Contaminated Sites Regulation and Landfill Closure						
	Closures shall be completed in compliance with any applicable regulations of the BC CSR.	x					The DOCP states the end use plan will comply with the BC CSR.
	A site profile shall be completed and submitted to the director 10 days prior to final deposit of waste		x				To be addressed prior to closure
	Closure process and the post-closure monitoring and reporting requirements will be regulated under the closure plan	x					
	Additional closure requirements may be required if use will change after closure		x				To be determined post-closure
8	Financial Security						
	Private Landfills shall provide financial security		x				Financial Security will be submitted as a separate document, all financial security criteria below has been deemed not addressed for the purposes of this review (technical documents only)
	Publicly held landfills shall:						
	Follow the Public Sector Accounting Board's financial reporting model for annual financial reporting purposes					x	Not a publicly held landfill
	Establish a dedicated closure fund to ensure that taxpayers are appropriately funding the future liability associated with the landfills including progressive closure and post closure care and monitoring					x	Not a publicly held landfill

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
8.1	Amount of Financial Security						
	Financial security required must be estimated and be sufficient to match liabilities for each phase of development, close the site at any point of operation, and to continue with post-closure maintenance and monitoring		x				To be addressed in Financial Security Plan
	An initial security deposit shall be kept equal to, at a minimum, the liability associated with the site when maximum land disturbance as a result of site development prior to placement of any waste has been conducted		x				To be addressed in Financial Security Plan
	Increasing financial security shall be kept which matches the costs projected and the timeline for each phase of development		x				To be addressed in Financial Security Plan
	At the time of site closure the financial security shall be adequate to offset final closure and post closure care		x				To be addressed in Financial Security Plan
8.2	Calculating Financial Security						
	The amount of financial security shall be calculated as the sum of the Cost of emergency closure or planned closure, whichever is greater		x				To be addressed in Financial Security Plan
	All costs shall:						
	be identified individually and tabulated for each phase of the landfill development		x				To be addressed in Financial Security Plan
	shall include costs associated with administration, engineering assessment and construction oversight		x				To be addressed in Financial Security Plan
	The costs shall not be reduced by the value of any assets		x				To be addressed in Financial Security Plan
	A contingency of 20% shall be added to the total estimated costs		x				To be addressed in Financial Security Plan
	Closure Costs						
	The following activities shall be included in the forecasting of closure costs:						
	compaction grading of the landfill surface area		x				To be addressed in Financial Security Plan
	final cover placement and establishment of vegetation		x				To be addressed in Financial Security Plan
	installation of fences, gates, surface water control works, landfill gas		x				To be addressed in Financial Security Plan
	Post-Closure Costs						
	The following activities shall be included in the forecasting of post-closure costs:						
	management and maintenance of the landfill final cover including fertilizing		x				To be addressed in Financial Security Plan
	operation and maintenance of any on-site or off-site leachate management		x				To be addressed in Financial Security Plan
	operation and maintenance of LFG management facilities		x				To be addressed in Financial Security Plan
	operation and maintenance of site infrastructure including surface water		x				To be addressed in Financial Security Plan
	construction or replacement of any monitoring or control works as required		x				To be addressed in Financial Security Plan
	annual environmental monitoring and reporting		x				To be addressed in Financial Security Plan
	contingency measures cost		x				To be addressed in Financial Security Plan
	activities to be included are the costs of implementing and maintaining the landfill		x				To be addressed in Financial Security Plan
8.3	Post-Closure Period						
	The post-closure period for which post-closure care will be required shall be determined based on the contaminating lifespan of the landfill	x					
	Contaminating lifespan of the landfill shall be no less than 30 years and may either be determined by a QP or no less than: <100,000 tonnes MSW in place : 50 years 100,000-1,000,000 tonnes MSW in place : 100 years >1,000,000 tonnes MSW in place: 200 years	x					Determined by QP to be 28 years, therefore 30 years is used for post-closure period
8.4	Cost to be Presented in Current Dollars						
	All cost estimates shall be presented in net present values		x				To be addressed in Financial Security Plan
	Cost estimates shall be adjusted for inflation and discount rates calculated		x				To be addressed in Financial Security Plan
	Discount rates shall be based on the current Government of Canada Long Term		x				To be addressed in Financial Security Plan
	The rate of return shall be 2% unless otherwise determined by a member of the		x				To be addressed in Financial Security Plan
8.5	Review Period						
	Cost estimates shall be reviewed at least every 5 years or at the commencement of a new landfill phase or where there has been a significant design revision		x				To be addressed in Financial Security Plan
8.6	Types of Financial Security						
	The financial security shall consist of an irrevocable letter of credit or a Surety Bond (recommended for short term issuance only)		x				To be addressed in Financial Security Plan
	The financial institution issuing the irrevocable letter of credit shall meet the following criteria: Is a Canadian Chartered Schedule 1, 2 or 3 Banks or Canadian Credit Union Has a senior unsecured long term credit rating of Standard and Poor's A+, Moody's A1, or Dominion Bond Rating Service A (high) Has an office in Canada		x				To be addressed in Financial Security Plan

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
9	Monitoring Criteria						
	A detailed Environmental Monitoring Plan (EMP) shall:						
	be prepared for leachate, groundwater, surface water, and LFG		x				To be updated in final EMP
	demonstrate compliance with performance criteria consistent with plans/reports	x					
	address the need for monitoring within 1 km of the landfill footprint	x					
	be developed in accordance with the "Guidelines for the Environmental Monitoring at Municipal Solid Waste Landfills" for groundwater, surface water, leachate and soils and vegetation or its approved replacement	x					
	be included in the DOCP	x					
9.1	Leachate Monitoring						
	Monitoring of leachate levels within the landfill shall be conducted to ensure:						
	LFG extraction wells are not flooding					x	LFG extraction wells are not proposed
	waste is not becoming saturated	x					Leachate head will not exceed 0.3 metre.
	pore pressures are maintained at acceptable levels to prevent slope instability		x				Leachate head will not exceed 0.3 metre, monitoring of the leachate level to prevent pore pressure build up will be included in the revised EMP.
	Leachate is monitored to assist in determination of contaminating lifespan	x					
9.2	Groundwater and Surface Water Monitoring						
	Groundwater and surface water monitoring results are to be assessed for compliance with applicable criteria	x					
	The EMP for groundwater shall be developed based on the:						
	Hydrogeology and Hydrology Characterization Report	x					
	Groundwater and Surface Water Impact Assessment	x					
	expected landfill performance	x					
	The EMP for surface water shall be developed:						
	to monitor the performance of the surface water control works	x					Specific monitoring locations will be included in the revised EMP.
9.3	Landfill Gas Monitoring						
	The EMP for landfill gas shall follow the requirements in the BC Landfill Gas Management Facilities Design Guidelines	x					
10	Plans and Reports						
	All reports shall be:						
	be certified by a qualified professional	x					reports certified to date, need for future certification not specifically addressed in DOCP
	kept up to date	x					All reports will be maintained and updated as required.
	maintained on-Site for inspection/submission as required	x					
	The following shall be conducted in accordance with the plans and reports:						
	landfill planning	x					
	landfill design	x					
	landfill construction		x				To be completed during landfill construction/operation.
	landfill operation		x				To be completed during landfill construction/operation.
	landfill monitoring		x				To be completed during landfill construction/operation.
	landfill closure		x				To be completed during landfill construction/operation.
	The following reports shall be prepared for each landfill:						
	Landfill Criteria Conformance Review and Upgrading plan (if applicable)		x				
	Hydrogeology and Hydrology Characterization Report	x					
	Construction Reports(s)		x				To be completed during landfill construction/operation.
	Design, Operation and Closure Plan (DOCP)	x					
	Landfill Gas Generation Assessment (if required),	x					Included in the DOCP.
	Landfill Gas Management Facilities Design Plan (if required)					x	Not required
	Annual Operations and Monitoring Report(s)		x				To be completed during landfill construction/operation.

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
10.1	Hydrogeology and Hydrology Characterization Report (HHC report)						
	The HHC report shall characterize:						
	site geology	x					
	site hydrogeology	x					
	surface hydrology at and near the landfill site	x					
	The HHC report shall include:						
	map and cross-sections	x					
	geologic structure	x					
	hydraulic conductivity	x					
	groundwater flow direction	x					
	groundwater flux	x					
	springs and groundwater discharge locations	x					
	surface hydrology	x					
	water quality	x					
	background groundwater quality	x					
	land and water use: well map and well information	x					
	adjacent land use	x					
	groundwater and surface water uses	x					
10.2	Construction Report(s)						
	Landfills shall prepare construction reports after:						
	construction	x					All reports related to development of the Site will be maintained
	significant modification of landfill facilities	x					All reports related to development of the Site will be maintained
	Construction reports shall:						
	demonstrate that the landfill has been constructed in accordance with the plans,		x				To be addressed during landfill construction
	demonstrate that geologic conditions encountered are as expected and used in groundwater and surface water impact assessment		x				To be addressed during landfill construction
	include inspection quality assurance/quality control testing results		x				To be addressed during landfill construction
	include as-built record drawings including the lines, grades and as- built elevations of the landfill		x				To be addressed during landfill construction
	include results of all soil test data		x				To be addressed during landfill construction
	include geologic inspection report(s)		x				To be addressed during landfill construction
	be kept up to date as landfill development occurs		x				To be addressed during landfill construction
	be retained for inspection and upon request submitted to the MOE		x				To be addressed during landfill construction
	demonstrate QA/QC testing has been conducted during the construction or significant alteration to the landfill		x				To be addressed during landfill construction
	address concerns identified during QA/QC testing		x				To be addressed during landfill construction
10.3	Design, Operations and Closure Plan						
	Landfill owners shall prepare and maintain a DOCP that:						
	is reviewed and updated as needed or at least every five years		x				To be addressed throughout landfill operation
	demonstrates that the facility will be planned, designed, constructed, operated, monitored and closed in accordance with the criteria	x					
	The DOCP shall include the following:						
	Topographical map showing:						
	area at least 1 km from the landfill footprint	x					
	elevation contours	x					
	natural ground slopes	x					
	drainage patterns	x					
	other topographical features	x					
	Site Plan showing:						
	area at least 1 km from the landfill footprint	x					Updated Site Plan will be submitted
	landfill property	x					
	landfill site boundary	x					
	landfill footprint	x					
	buffer zone	x					
	all applicable features in the siting criteria and corresponding distances		x				Updated Site Plan will be submitted
	legal property boundaries, right-of-way and other easements	x					
	topographic contours (10 or 05 m)	x					
	UTM Grid (100 -m spacing), north arrow and scale		x				Updated Site Plan will be submitted
	all existing structures and infrastructure	x					
	tree line areas		x				Updated Site Plan will be submitted

Compliance Checklist
Landfill Criteria for Municipal Solid Waste - Second Edition (June 2016)
Upland Landfill - Waste Discharge Application
Upland Excavating Ltd, Campbell River, BC

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
	Site Layout Plan including:						
	landfill site boundary	x					Presented on Existing Conditions drawing
	landfill footprint	x					Presented on Existing Conditions drawing
	buffer zone	x					Presented on Existing Conditions drawing
	current landfill contours	x					Presented on Existing Conditions drawing
	final landfill contours	x					Presented on Existing Conditions drawing
	waste thickness	x					Presented on Existing Conditions drawing
	design volume	x					Presented in fill plan figures
	Landfill facilities including:						
	site entrance	x					
	fencing		x				Will be included in Updated Site Plan
	roads	x					
	gatehouse					x	Gate house will be Site office as there is no access to Public
	weigh scale	x					
	waste and recyclable drop-off and recycling facilities					x	Drop off area for waste will be direct to landfill, diverted materials (recyclables) will be stockpiled in areas designated in the OC.
	leachate management works	x					
	surface water management works					x	
	landfill gas management works					x	
	Physical Summary including:						
	physical setting	x					
	geology	x					
	hydrogeology	x					
	hydrology	x					
	climatic conditions	x					
	Geotechnical and Seismic Assessment including:						
	bearing capacity					x	Not specifically addressed in the geotechnical report, conclusions based on geotechnical investigation indicate the site is suitable for a Landfill due to the dense nature of the soils that previously held an additional 20 m of overburden prior to excavation.
	differential settlement	x					
	slope stability during construction, operations and post-closure	x					
	seismic and fault activity risk assessment	x					
	effects on the landfill base liner and leachate collection system					x	Because the risk for settlement and liquefaction is low there are no anticipated effects to the landfill base liner and leachate collection system due to settlement or the seismic events discussed in the 2016 Geotechnical Report.
	conclusions and recommendations regarding the suitability of the landfill site	x					
	Groundwater and Surface Water Impact Assessment including:						
	Impact assessment at the nearer of the site boundary or within 150 m of landfill for:						
	Groundwater	x					
	Surface water	x					
	planned and current uses of groundwater and surface water within 1 km of the	x					
	applicable water quality criteria and compliance monitoring locations		x				The EMP will be updated to present the final monitoring locations
	application of the water quality monitoring results to date	x					
	up-gradient and down-gradient surface water and groundwater quality	x					
	identification of landfill parameters of concern	x					
	leachate quality	x					
	contaminant concentrations	x					
	mass loadings	x					
	trends		x				To be completed in future monitoring reports
	assimilative capacity	x					
	cumulative impacts	x					
	Landfill Design						
	Design that demonstrates the landfill will satisfy all sections of the Criteria along with necessary plans specs, drawings, elevations sections etc.	x					

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
	Filling Plan						
	Planned development of individual phases and cover borrow areas	x	x				Daily cover may be contaminated soil imported to the Site, intermediate and final cover will on-site borrow areas, borrow areas are to be determined at the time cover is required and will be material excavated as part of the aggregate excavation
	Progressive Closure Plan						
	Documents that show how progressive closure will be implemented including:						
	Phasing Plan showing areas to be progressively closed	x					
	plan area of each progressive closure	x					
	schedule for each progressive closure		x				Timing to be determined upon approval of the OC
	proposed cover system profile	x					
	stability analysis including under design storm conditions		x				Slope stability analysis of final cover to be completed as part of detailed design based on specific materials soil materials proposed
	analysis of landfill gas production and any required venting	x					
	materials management plan indicating the closure material source and storage	x					
	Lifespan Analysis Table						
	Projection of annual waste tonnage to be:						
	received	x					
	reused					x	Materials to be reused will not be forecasted
	recycled					x	Materials to be recycling will not be forecasted, recycling will be promoted
	burned		x				To be provided in Technical Assessment Report for Burning Operations
	landfilled	x					
	airspace consumed	x					
	Contaminating Lifespan Assessment						
	Lifespan assessment of key contaminants demonstrating validity of design service life and contaminating lifespan	x					
	Surface Water Management Plan (see section 10.3.2)						
	Leachate Management Plan (see section 10.3.3)						
	LFG Management Plan (if required)						
	Demonstrates the LFG management facilities will satisfy the “Criteria”	x					
	May consist of an LFG Facilities Design Plan					x	Current LFG generation forecast <1,000 tonnes CH4/yr therefore no LFG Facilities Design Plan is required
	Environmental Monitoring Plan (see section 9)						
	Facility Operations Plan						
	Demonstrates how the facilities will be operated in compliance with the operation criteria	x					
	The design of the nuisance control measures is to be included in the plan	x					
	Closure Plan (see section 10.3.4)						
	Fire Safety Plan						
	Submitted to the Fire authority that would respond to the fire		x				Will be submitted prior to landfilling under OC
	Describes how fire risks will be minimized	x					
	Includes an emergency response plan to quickly extinguish a fire if one develops	x					
	Identifies a suitable water supply, firefighting and heavy equipment resources	x					
	Emergency Response Plan						
	Shall document strategies for dealing with emergencies at the site including:						
	HAZ-MAT incidents	x					
	spills	x					
	power outages		x				
	extreme climate events	x					
	Demonstrates the landfill meets the requirements of Work Safe BC	x					Discussed in Health and Safety Section of DOCP, will be included in final Emergency Response Plan
	Financial Security Plan (see section 8)						
	Contingency Plan						
	Shall include:						
	possible failure and non-compliance scenarios of the leachate, surface water, and landfill gas management facilities.	x					Discussed in submitted Technical Assessment Report
	Practical and implementable contingency measures to address any failure or non-compliance with the performance criteria.	x					Discussed in submitted Technical Assessment Report

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
	Land Survey						
	Identifies landfill site boundary and the landfill footprint.	x					
	The limits of the landfill footprint and landfill site boundary are to be established and maintained in the field.		x				To be completed issuance of OC
10.3.1	Filling Plan						
	A filling plan shall be developed and include:						
	generation and collection of leachate	x					
	methods to control of storm water	x					
	methods to control of litter during the various seasonal conditions	x					Addressed in the Site Operations Section of the DOCP
	calculation of interim slope stability and safety	x					Addressed in the 2016 Geotechnical Investigation Report
	method of vehicle access to the active waste disposal area		x				Access roads to the active face will be determine during the operational life of the landfill.
	progressive closure of the landfill footprint	x					
	methods to minimize nuisance impacts such as dust, nuisance weeds, etc.	x					Included in the nuisances section of the DOCP
	description of fill method cell by cell	x					
	identification of the development of cells, strips and lifts	x					
	full details on the cell geometry and cell size	x					
	requirements and plans for daily, intermediate and final cover	x					Addressed in Landfill Design and Site Operations section of Landfill
	plans for any proposed stripping and reuse of cover layers and road materials					x	Stripping of cover is not currently planned
	target compaction density	x					Targeted to meet the airspace utilization factor specified
	waste to cover ratio	x					Addressed in fill table
	air space utilization factor	x					Airspace utilization factor of 1.3 tonne/m3
	engineering drawings presenting the progressive closure of the landfill footprint	x					
10.3.2	Surface Water Management Plan						
	A Surface Water Management Plan shall be prepared and include:						
	explanation of how the landfill will satisfy performance criteria	x					
	description of potential for surface water impairment and resulting impacts	x					
	a demonstration of understanding of the local and regional watershed	x					
	demonstration that the natural hydrologic cycle is preserved	x					
	a description of surface water management on Site	x					
	measures to promote diversion of clean water to minimize leachate production and promote groundwater recharge	x					
	measures to protect the surface water quality in the off-site surface water bodies receiving drainage from the landfill site					x	Drainage from the landfill area and base of the aggregate pit will not discharge to an off-site surface water body
	a design for surface water control works	x					
	a design that will maintain run-off from the site sediment free and at rates that are consistent with pre-development flows	x					
	identification the surface water management works required for the control of erosion, sediment transport, flood risk, water quantity and water quality	x					
	meteorological data applicable to the site	x					
	results of the hydrologic modeling	x					
	detailed design of ditches, down-chutes, culverts, retention ponds and other surface water control infrastructure	x					
	discussion addressing management of surface water during operation and post-closure	x					Addressed in post closure plan
	The Surface Water Management Plan shall prepared in a manner consistent with the water management requirement strategies utilized in developing the leachate management plan and the groundwater and surface water impact assessment	x					

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
10.3.3	Leachate management Plan						
	All new and expanding landfills and new landfill phases at existing landfills shall:						
	be designed with engineered liner system	x					
	be designed with engineered leachate collection system	x					
	A Leachate Management Plan shall address the following:						
	leachate generation quantities under average and extreme conditions for the following flows	x					
	demonstrate the performance criteria (Section 4) will be satisfied	x					
	present an assessment of alternatives for off-site or on-site leachate treatment			x			Alternatives have been analyzed independently, only preferred leachate management alternative was carried in the DOCP
	identify the preferred treatment method	x					
	demonstrate that the preferred alternative is practical and implementable	x					
	provide an implementation schedule of the preferred alternative		x				Leachate treatment system will constructed prior to discharge of waste under OC
	identify required approvals for implementation of the Leachate Management Plan if off-site disposal/treatment is proposed.					x	
	A Leachate Management Plan shall include (at a minimum):						
	Leachate generation quantities under average and extreme conditions for the following flows						
	annual	x					
	monthly	x					
	peak	x					
	leachate chemistry profiles (actual and expected) including concentrations of:						
	ammonia	x					
	BOD	x					
	chloride	x					
	iron	x					
	manganese	x					
	TSS	x					
	landfill liner strategy (including leachate compatibility and lifespan).	x					
	leachate collection strategy (including protection from clogging).	x					Cleanouts at both ends and redundant leachate sump
	leachate collection system efficiencies.	x					
	Treatment System Selection and Design Plans including:						
	identification of Management Alternatives including opportunities for moisture reduction, on-site treatment, off-site treatment, and recirculation.			x			Alternatives were analyzed independently, only the preferred leachate management alternative was included in the DOCP.
	evaluation of management alternatives including required level of treatment, availability of infrastructure, economics, sustainability and environmental risks.			x			Alternatives were analyzed independently, only the preferred leachate management alternative was included in the DOCP.
	sludge management	x					
	treatment system performance monitoring and maintenance		x				Specific maintenance requirements will be address in the detailed design and during the completion of an operations and maintenance manual for the leachate management system
	leachate discharge strategy	x					
	leachate management contingency plan	x					
	If discharging to a groundwater infiltrations system:						
	demonstration leachate meets applicable groundwater standards as specified by the director	x					The groundwater impact assessment demonstrated groundwater will meet the compliance criteria at the property boundary
	If discharging to a stream or river:						
	demonstration that the discharge meets applicable surface water quality standards as specified by director					x	No discharges to a stream or river
	demonstration that any leachate discharge to surface water comply with requirements of the federal Fisheries Act					x	No discharges to a stream or river
10.3.4	Closure Plan						
	Landfills shall prepare Closure Plan describing post-closure operations and maintenance of:						
	general site facilities (e.g. roads, fencing &c.)	x					
	overall facility	x					
	final cover	x					
	surface water management works	x					
	leachate collection and on-site leachate treatment facility/leachate haulage program	x					
	LFG management facilities					x	Current LFG generation forecast <1,000 tonnes CH4/yr therefore no LFG management facilities are proposed
	environmental monitoring program throughout entire Contaminating Life Span	x					
	contingency measures for any reasonably foreseeable failure of works	x					Discussed in the submitted Technical Assessment Report

	Second Edition Landfill Criteria for Municipal Solid Waste (June 2016)	Compliant	Not Addressed	Exempt	Non Compliant	Not Applicable	Comments
10.4	Landfill Gas Generation Assessment						
	Landfills with >100,000 tn waste in place or that receive >10,000 tn/yr shall undertake an assessment of landfill gas generation and to submit the results to the MOE	x					
10.5	Landfill Gas Management Facilities Design Plan						
	Sites generating >1,000 tonnes CH4 shall complete a LFG Management Facilities Design Plan and installation of design					x	Current LFG generation forecast <1,000 tonnes CH4/yr
10.6	Annual Operations and Monitoring Report						
	Landfills shall prepare a Annual O&M Report which includes:						The Annual Operations and Monitoring Reports will address the the following criteria, at this time the criteria will be considered not addressed as they relate to the submitted technical reports.
	Annual Environmental Monitoring Report						
	Data tabulation, comparison to performance criteria, interpretation, trends		x				To be addressed in future Annual Operations and Monitoring Reports
	Identification of any non-compliant criteria (present or predicted future)		x				To be addressed in future Annual Operations and Monitoring Reports
	Conclusions, recommendations and proposed changes to the environmental monitoring plan		x				To be addressed in future Annual Operations and Monitoring Reports
	Annual Operations Report						
	Total volume, tonnage, and types of waste discharged into the landfill for the year		x				To be addressed in future Annual Operations and Monitoring Reports
	Types and tonnages of waste that were not directly disposed of into the landfill such as open burned, recycled, composted, etc.		x				To be addressed in future Annual Operations and Monitoring Reports
	Leachate quantities collected, treated and discharged.		x				To be addressed in future Annual Operations and Monitoring Reports
	LFG quantities collected flared and utilized (as required by LFG Management Plan)		x				To be addressed in future Annual Operations and Monitoring Reports
	Operational plan for the following 12 months		x				To be addressed in future Annual Operations and Monitoring Reports
	Remaining site life and capacity		x				To be addressed in future Annual Operations and Monitoring Reports
	Closure works completed to date		x				To be addressed in future Annual Operations and Monitoring Reports
	Results of regular inspection for:						
	cover integrity		x				To be addressed in future Annual Operations and Monitoring Reports
	health of vegetation		x				To be addressed in future Annual Operations and Monitoring Reports
	undesirable plant species		x				To be addressed in future Annual Operations and Monitoring Reports
	burrowing animals		x				To be addressed in future Annual Operations and Monitoring Reports
	erosion		x				To be addressed in future Annual Operations and Monitoring Reports
	settlement		x				To be addressed in future Annual Operations and Monitoring Reports
	any changes from approved reports, plans and specifications		x				To be addressed in future Annual Operations and Monitoring Reports
	any complaints received and the action taken as a result of a complaint		x				To be addressed in future Annual Operations and Monitoring Reports
	Financial Security Plan update		x				To be addressed in future Annual Operations and Monitoring Reports
	identification of any non-compliance with the Solid Waste Management Plan						To be addressed in future Annual Operations and Monitoring Reports
	progress report on efforts to resolve previously determined non-compliance		x				To be addressed in future Annual Operations and Monitoring Reports
	Landfill owners are encourage to track and report the following:						
	compaction, waste to cover ratio, waste to road ratio and airspace utilization		x				To be addressed in future Annual Operations and Monitoring Reports
	operation and maintenance expenditures		x				To be addressed in future Annual Operations and Monitoring Reports

APPENDIX B:
CURRENT ENVIRONMENTAL – SITE ASSESSMENT REPORT

16 March, 2018

GHD
10271 Shellbridge Way
Richmond, BC
V6X 2W8

Attention: Roxy Hasior

Subject: Site Assessment – Potential Aquatic Receptors at the Upland Pit – Campbell River, BC – Updated March 2018

Roxy,

The Upland Group is planning to broaden the spectrum of materials that may be disposed of at their large pit located at 7295 Gold River Hwy, in Campbell River, BC. To meet this objective, an application under the BC Contaminated Site Regulation (CSR)¹ is required. As part of this application, Current Environmental was retained to complete a ground-level assessment for potential aquatic receptors (aquatic life assessment) within an area outside the pit area delineated by GHD. This area lies between the Upland Pit boundary to a distance of 500 m to the east and south (Figures 1 and 2).

METHODS

Generally, field inspection focused on identifying all wetted habitats with the potential to meet the following definition as outlined in the CSR:

"aquatic life water use" means the use of water as habitat for any component of the freshwater or marine aquatic ecosystem, including phytoplankton, zooplankton, benthos, macrophytes and fish.

The area of interest (AOI) included the Upland Pit, and a 500 m buffer to the south, southeast, and east of the pit boundary.

Desktop Review

Prior to completing field surveys, an office-based overview study was completed to inform the assessment work. Resources consulted as part of the office-based study included:

¹ March 18, 2013

1. Ministry of Environment (MoE) *Fisheries Information Database Query* (FIDQ) database²;
2. Fisheries and Oceans Canada (DFO) *Mapster v3*³;
3. BC Geographic Warehouse iMapBC⁴;
4. MoE HabitatWizard⁵;
5. City of Campbell River Interactive Webmap⁶;
6. Sensitive Habitat Inventory and Mapping⁷;
7. BC Conservation Data Center (CDC) *Species and Ecosystem Explorer*⁸;
8. Aerial imagery of the AOI.

Field Surveys

The project area of interest (AOI) was surveyed on foot on April 5th and 6th, 2017. Field surveys were conducted by walking transects spaced approximately 100 m apart throughout the study area to ensure adequate inventory coverage. Initial surveys were timed to coincide with elevated flow conditions during spring months; the weather during these two days was inclement with periods of both rain and sun. An updated assessment was completed on March 15th, 2018, following a period of a few days of intermittent rain. The weather during the 2018 assessment was sun with some cloud cover. The objectives of the secondary assessment were to confirm previous field observations, identify any alterations to drainages on the site, and to ascertain the presence of, if any, aquatic receptors within a 100 m down-gradient direction of the 500 m AOI.

RESULTS

During the field assessment work, two candidate watercourse systems were noted as aquatic receptors within the study area (Figure 2). Likely a result of the prevalence of deep gravel deposits in the area, it appears that the vast majority of precipitation and overland flows dissipate into the gravelly and permeable soils. Furthermore the topography of the surrounding landscape is such that groundwater flows are conveyed away from the Pit. As such, there were no other habitats with the potential to provide aquatic life water use noted within the subject area. General comments on the surrounding landscape and the two watercourse systems are discussed in the following subsections.

² Ministry of Environment (2017). Fisheries Inventory Data Queries (FIDQ). Accessed from <<http://www.env.gov.bc.ca/fish/fidq/>>

³ Fisheries and Oceans Canada (DFO; 2013). Mapster v3 (Archived). Accessed from <<http://www.pac.dfo-mpo.gc.ca/gis-sig/maps-cartes-eng.htm>>

⁴ BC Geographic Warehouse (2018). iMapBC. Accessed from <<http://www2.gov.bc.ca/gov/content/data/geographic-data-services/web-based-mapping/imapbc>>

⁵ Ministry of Environment (2018). HabitatWizard. Accessed from <<http://maps.gov.bc.ca/ess/hm/habwiz/>>

⁶ City of Campbell River (2016). Sustainable Official Community Plan Webmap. Accessed from <http://webmap.campbellriver.ca/Html5Viewer_public/Index.html?viewer=SOCP>

⁷ Sensitive Habitat Inventory and Mapping (SHIM) Atlas (2018). The Community Mapping Network. Accessed from <<http://www.cmnmaps.ca/SHIM/>>

⁸ B.C. Conservation Data Centre. 2017. BC Species and Ecosystems Explorer. Ministry of Environment, Victoria B.C. Accessed from <<http://a100.gov.bc.ca/pub/eswp/>>

General Site Comments

Not surprisingly, soils within the entire study area are dominated by gravel and sand deposits with a high infiltration rate. Furthermore, the site has a history of significant disturbance; the Upland Pit and similar substrate sourcing developments in the surrounding area and intensive, recent, forest harvesting have resulted in over 75% of the site having low ecological function. The southern 40% of the site appears to have been harvested within the past ten years. The lack of riparian reserve areas is reflective of the lack of significant aquatic habitat features in the area.

The site generally drains towards the southeast. In the southwest corner of the AOI, a steep slope borders Watercourse 2, conveying any flows northeast until they reach the watercourse, which would then transport flows southeast. The area to the south of the pit (between the pit and Watercourse 1) is relatively flat (Photo 10). Towards the southeast corner of the AOI, the ground slopes down towards the southeast away from the AOI, and is somewhat terraced near the road that approximately follows the AOI boundary.

Wetland

The wetland where the watercourses affecting the AOI originate was not delineated for the purpose of this assessment as it falls outside of the AOI boundaries. This wetland feature is classified as a treed swamp. Vegetation within the swamp was comprised predominantly of slough sedge, willow species, red-osier dogwood, hardhack, and 12-15 year old western red cedar situated in drier sections (Photo 1). The riparian vegetation immediately surrounding the wetland included a thick layer of salal, deer fern, western red cedar and Douglas-fir trees. The wetland is located at a higher elevation than the Upland Pit and adjacent AOI.

Watercourse System 1

This small system originates from the abovementioned small wetland swamp located approximately 70 m outside of the western AOI boundary. The flows originating from the wetland enter the AOI in a small, somewhat naturalized channel (bankfull width ~ 1.3 m) flowing east/northeast approximately 140 m south of the southwestern-most corner of the Upland Pit. This channel bifurcates into several smaller channels that run downslope (approximately 7° slope), at times under large piles of cut logs. Riparian vegetation on the western portion of Watercourse 1 within the AOI is a young Douglas-fir (10-20 year) forest with western hemlock, alder, and western red cedar. A thick layer of salal, oceanspray, bracken fern, and swordfern make up the understory. The substrates in this portion of Watercourse 1 are typically fine organics and hydrophytic vegetation.

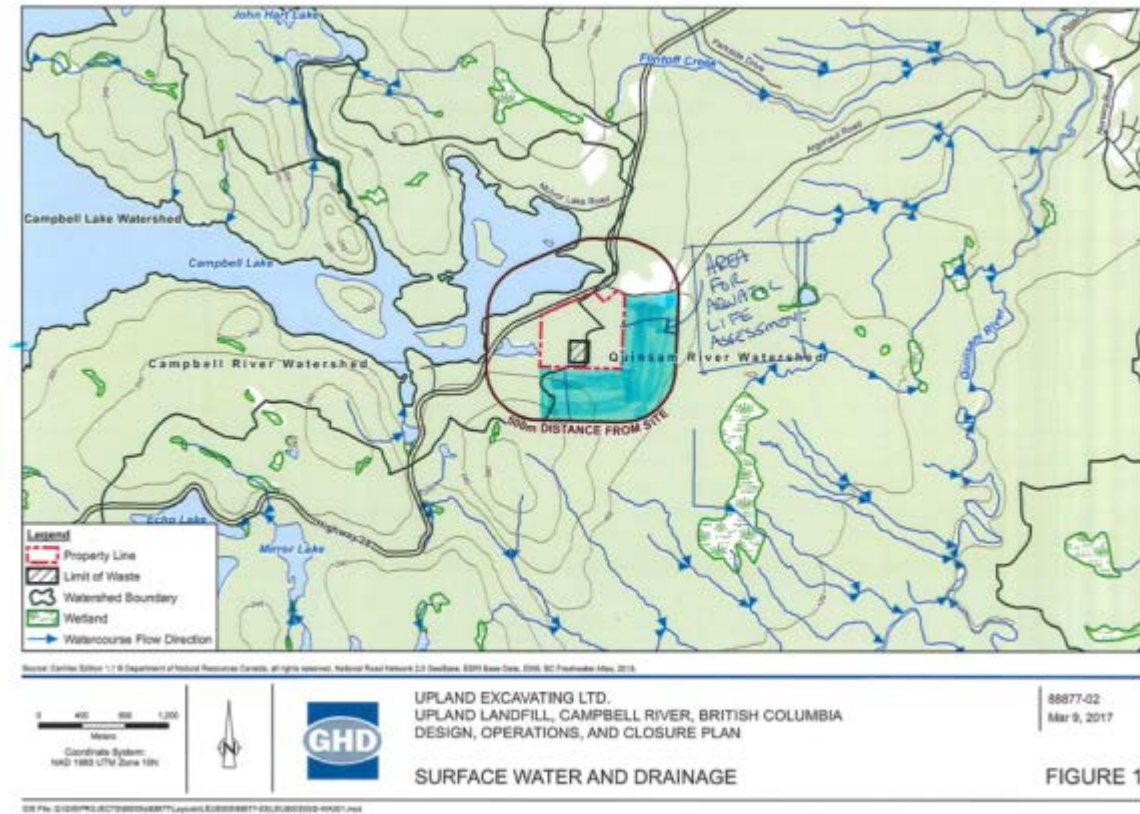


Figure 1. Overview map showing the location of the project area and the AOI. Figure provided by GHD.

The watercourse flows further downslope to the east in skidder trail ruts; substrates in this section are predominately organic fines with short sections of exposed bedrock (Photo 2). The channel slope is approximately 6-7° through this section. At the base of the slope, the watercourse widens in a relatively flat area with fine organic substrates, scattered gravel and angular rock, and then flows into a roadside ditch running north-south (Photo 3). Flows are conveyed through the roadside ditch for approximately 500 m (southeast) until dissipating to ground through coarse substrates in what appears to be a smaller gravel borrow area. Substrates in this ditch vary from fine organics to gravel, cobbles, and angular crush (Photo 4). The substrates along the ditch section of this watercourse are likely a result of the various materials used to surface the road that have been transported to the ditch resulting from road use. During the March 15th assessment, the ditch flowed for a short time at the base of the slope before drying prior to reaching the abovementioned infiltration area (Photo 5). There were no channels conveying flows away from this pit observed. Young Douglas-fir (2-5 years old), dull Oregon-grape, salal, trailing blackberry, cedars, and the occasional shore pine characterize the riparian vegetation along the ditch. Riparian vegetation along the roadside section of this ditch was younger than the upstream end.

Watercourse System 2

Interestingly, this system originates from the same natural wetland area as the Watercourse System 1 mentioned above. However, flows from the wetland feeding this system flow in a southeasterly direction through a natural channel with an average bankfull width of 1.8 m. This channel widens in low gradient areas and is populated with fine organic substrates in most areas. The majority of this channel flows through a 277 m section of young (2-4 years old) Douglas-fir forested area (Photo 6), similar to the riparian vegetation of the roadside ditch portion of Watercourse 1, before entering an more mature forest over a ~90 m length. The mature forest, with a riparian community consisting primarily of Douglas-fir with western hemlock, western red cedar, salal, oceanspray, and swordfern, is confined within a steeply banked ravine (approximately 30° banks; Photo 7). The watercourse crosses a gravel road; upstream of the road-crossing culvert, the channel is lined with rip rap, and flows were subsurface at the time of the March 15th 2018 assessment. Watercourse 2 crosses the southern AOI boundary within the steep ravine. Beyond this point, the watercourse was not assessed. The right (southwestern) bank of Watercourse 2 is a steep, rocky slope that is elevated above the rest of the AOI (Photo 8). Any runoff or flows from this direction would be conveyed into Watercourse 2, which flows in a southeasterly direction out of the AOI.

Site Vegetation

As mentioned, the majority of the AOI appears to have been cleared within the past 5-10 years. The vegetation in most areas is comprised of young Douglas-fir (< 5 year) with some western red cedar and a shrub community dominated almost exclusively by salal, dull Oregon-grape, and red huckleberry⁹. The area between Watercourse 1 and the pit boundary is the most recently cleared. On the eastern portion of the AOI, there is a second growth forest stand that is characterized by Douglas-fir (40-60 years old), western hemlock, western red cedar, red huckleberry, salal, and dull Oregon-grape (Photo 9). North of this forest, another pit has cleared all vegetation and excavated large areas of the AOI.

⁹ This shrub community is reflective or relatively well drained soils.

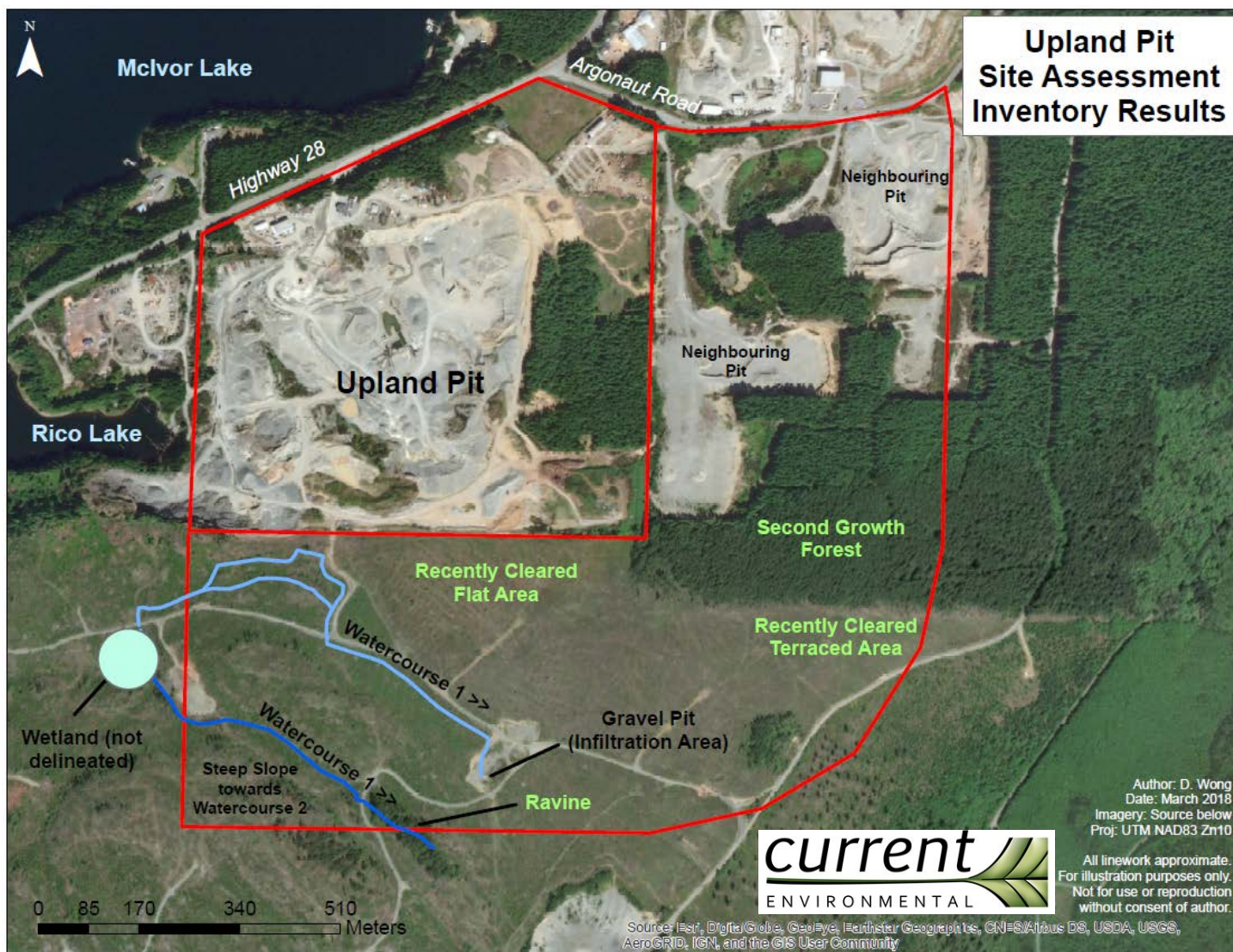


Figure 2. Results of site assessment showing watercourses affecting the AOI, as well as general vegetation types.

SUMMARY

Generally, the Upland Pit and surrounding area do not provide high quality habitat. The following is a summary of key results of the aquatic habitat assessment:

1. The site is highly disturbed, both within the Upland Pit and in the 500 m buffer AOI.
2. Topography indicates surface and groundwater generally flows towards the southeast.
3. Site is largely devoid of significant aquatic habitats as a result of the prevalence of coarse sand and gravel substrates with a high infiltration rate.
4. Two primary watercourses were identified:
 - a. Watercourse System 1: flows for approximately 800 m within the AOI. Flows originate from an off-site wetland, and are conveyed down the gradient towards the southeast, where they dissipate in-stream or at the terminus of the watercourse in a gravel pit. The watercourse lacks functioning riparian vegetation in the downstream end.
 - b. Watercourse System 2: flows for approximately 450 m within the AOI. Flows originate from the same off-site wetland mentioned above and are conveyed southeast at the base of a large, rocky slope. One area of the watercourse has mature, functioning riparian vegetation within a ravine at the boundary of the AOI.

Overall, there is little habitat value within the Upland Pit and surrounding AOI. The site has been highly modified, most of which has been disturbed within the past 10 years. The two identified watercourse systems do not provide high quality aquatic habitat.

Please contact the undersigned with any questions.

Sincerely,

CURRENT ENVIRONMENTAL




WARREN FLEENOR, R.P. BIO. PRINCIPAL

DISCLAIMER

This report was prepared exclusively for GHD and Upland Group by Current Environmental. The quality of information, conclusions and estimates contained herein is consistent with the level of effort expended and is based on: i) information available at the time of preparation; ii) data collected by the authors and/or supplied by outside sources; and iii) the assumptions, conditions and qualifications set forth in this report. This report is intended to be used by GHD and Upland Group only, subject to the terms and conditions of its contract or understanding with Current Environmental. Other use or reliance on this report by any third party is at that party's sole risk.

PHOTOGRAPHS



Photo 1. View of the wetland vegetation (outside of AOI boundary).



Photo 2. View looking downstream along Watercourse 1 as it flows down skidder ruts.



Photo 3. View looking downstream of Watercourse 1 where it meets the road alignment and transitions to roadside ditch.



Photo 4. View of the roadside ditch portion of Watercourse 1 showing lack of flows in some sections.



Photo 5. View of Watercourse 1 where it enters the gravel borrow pit, left, looking upstream at the slope into the pit, and right, looking downstream into the pit.



Photo 6. View of Watercourse 2 showing young riparian vegetation.



Photo 7. View of the forested vegetation within the ravine of Watercourse 2.



Photo 8. View looking southwest from near Watercourse 1 showing steep topography southwest of Watercourse 2.

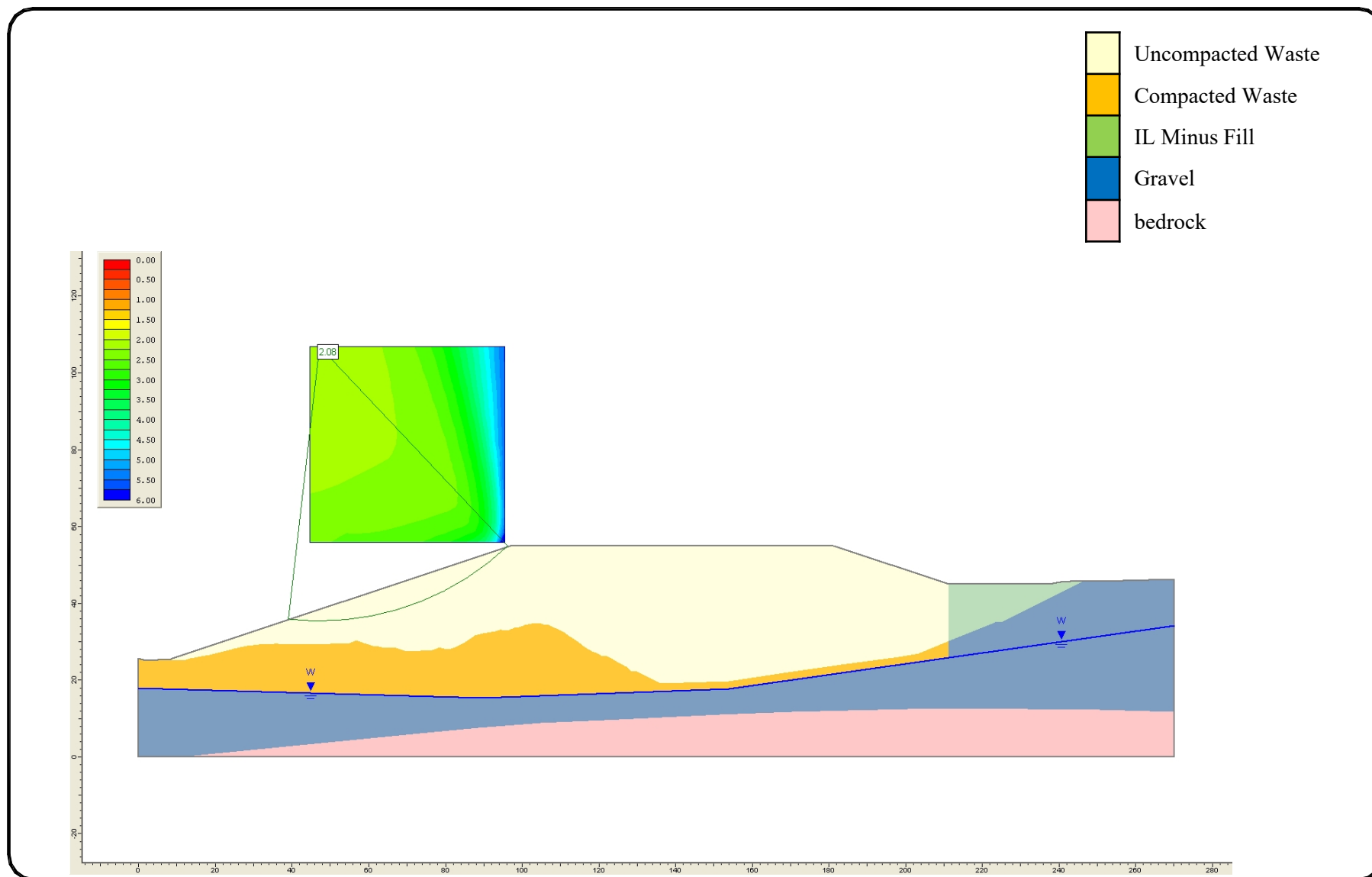


Photo 9. View of the forested area on the east side of the AOI.



Photo 10. View of the flat, recently cleared area to the south of the Upland Pit (from approximate Upland Pit boundary).

APPENDIX C: SLOPE STABILITY



PROJECT:

**NORTHWIN LANDFILL
DESIGN, OPERATIONS AND
CLOSURE PLAN UPDATE**

TITLE:

**SECTION N-S PROPOSED
STATIC**

SCALE:

N/A

DATE:

2026/6/22

PROJECT NO:

24074

DESIGNED

IB

DRAWN

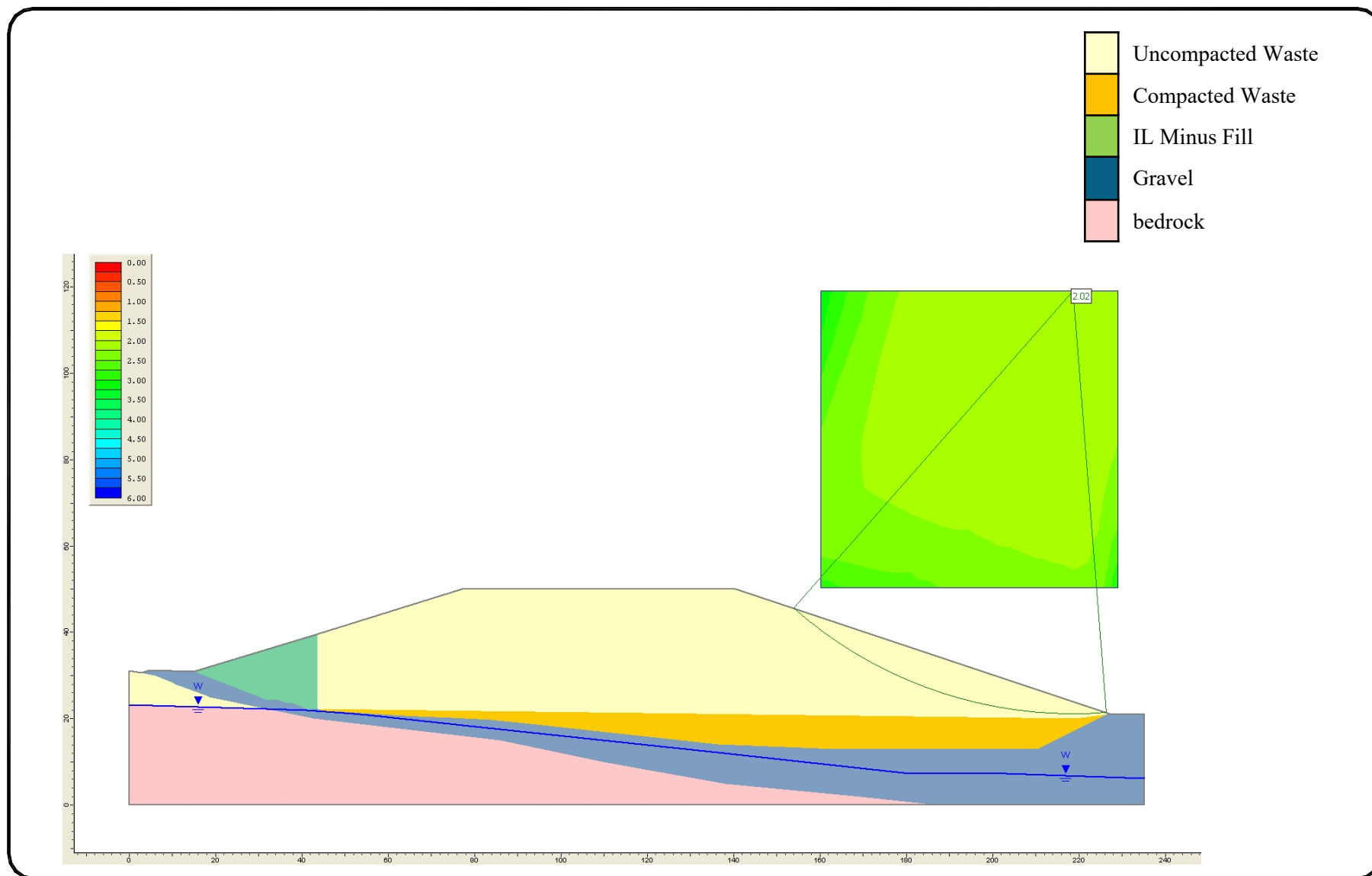
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DRAWING NO:

FIGURE C-1



SPERLING
HANSEN
ASSOCIATES



NORTHWIN
ENVIRONMENTAL LTD.

PROJECT:

**NORTHWIN LANDFILL
DESIGN, OPERATIONS AND
CLOSURE PLAN UPDATE**

TITLE:

**SECTION W-E PROPOSED
STATIC**

SCALE:

N/A

DATE:

2026/6/22

PROJECT NO:

24074

DESIGNED

IB

DRAWN

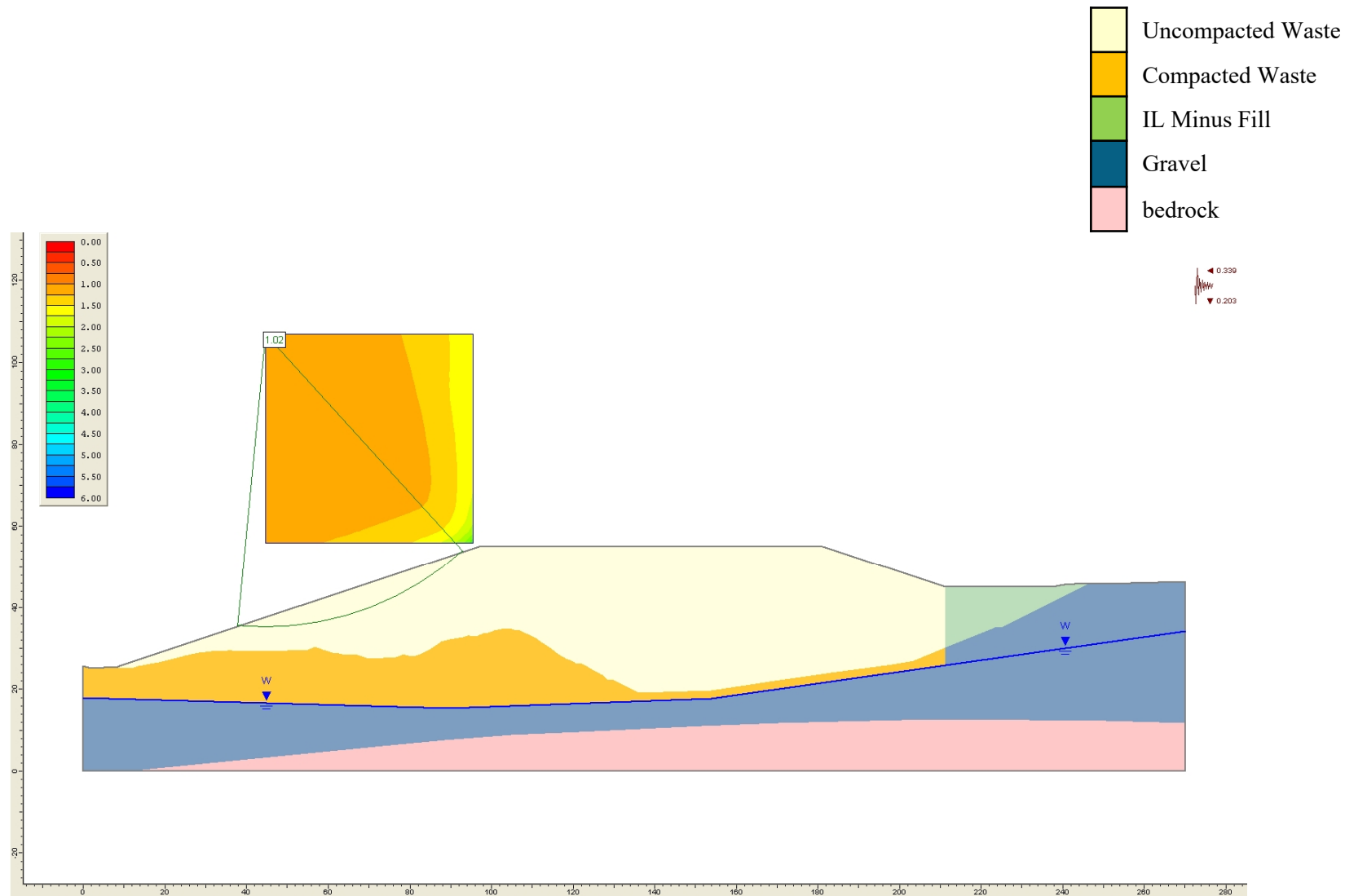
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FIGURE C-2



PROJECT:

**NORTHWIN LANDFILL
DESIGN, OPERATIONS AND
CLOSURE PLAN UPDATE**

TITLE:

**SECTION N-S PROPOSED
SEISMIC**

SCALE:

N/A

DATE:

2026/6/22

PROJECT NO:

24074

DESIGNED

IB

DRAWN

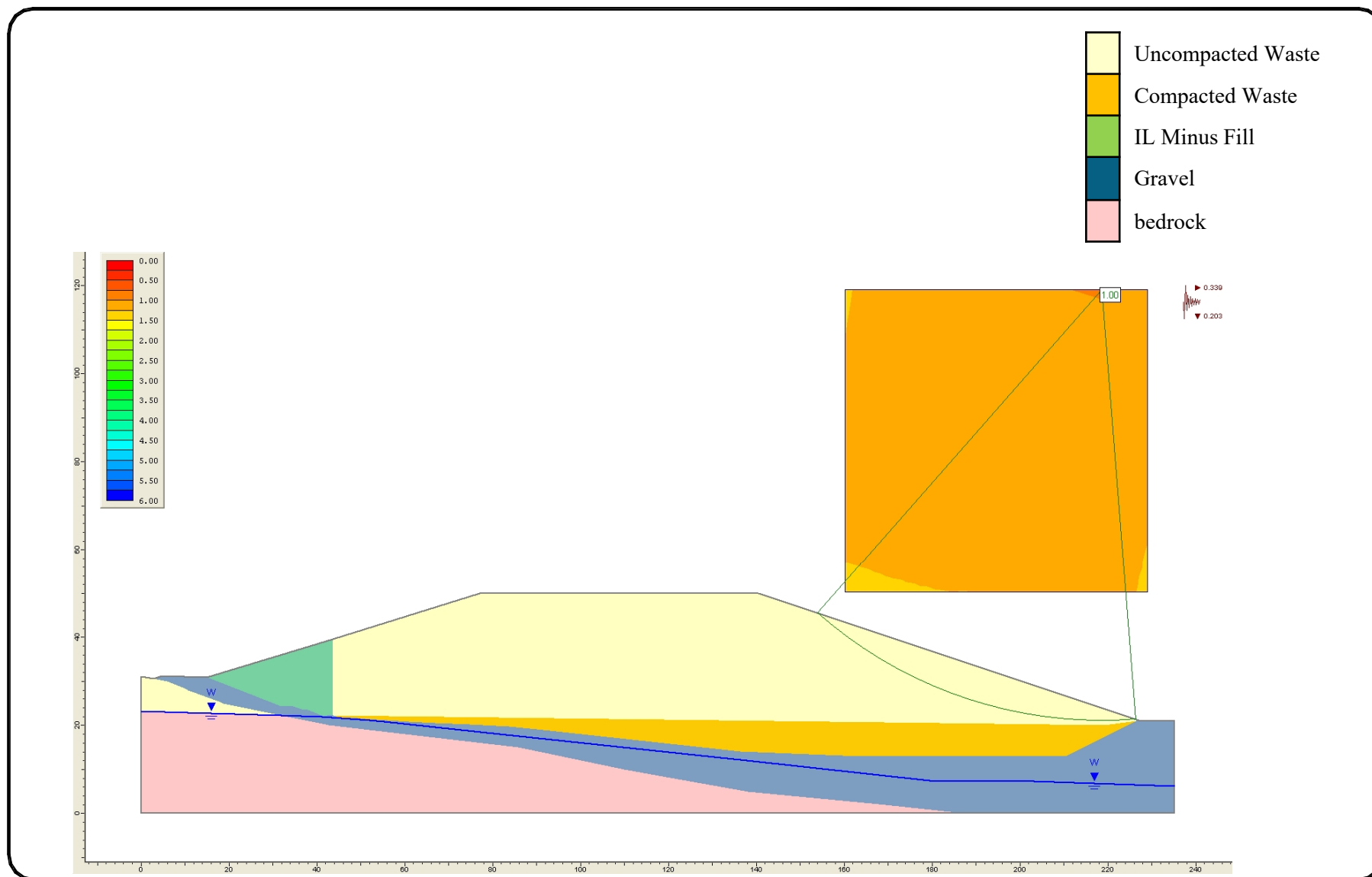
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TS

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FIGURE C-3



SPERLING
HANSEN
ASSOCIATES



NORTHWIN
ENVIRONMENTAL LTD.

PROJECT:

**NORTHWIN LANDFILL
DESIGN, OPERATIONS AND
CLOSURE PLAN UPDATE**

TITLE:

**SECTION W-E PROPOSED
SEISMIC**

SCALE:

N/A

DATE:

2026/6/22

PROJECT NO:

24074

DESIGNED

IB

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TS

DRAWING NO:

FIGURE C-4

2025 -2020 National Building Code of Canada - Seismic Hazard Values

Northwin Landfill

Code edition	NBC 2025
Site designation Xv	X ₄₅₀
Latitude (°)	50.005
Longitude (°)	-125.362

Probability	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	Sa(5.0)	Sa(10.0)	PGA	PGV
2%	0.83	0.72	0.0374	0.305	0.0883	0.0374	0.339	0.479
5%	0.536	0.461	0.0185	0.179	0.0486	0.0185	0.221	0.293
10%	0.359	0.3	0.0106	0.105	0.0283	0.0106	0.149	0.182

Note:

The 5%-damped spectral acceleration (Sa(T), where T is the period, in s and peak ground acceleration (PGA) values are given in units of acceleration due to gravity (g, 9.81 m/s²).

Peak ground velocity (PGV) is given in m/s. Probability is expressed in terms of percent (%) exceedance in 50 years. By default, all probabilities for the user-specified site designation are shown.

Other site designations can be selected from the respective drop-down menu in the table. In low hazard regions, a minimum value of 0.001g for T ≤ 2.0s and of 0.0001g for T > 2.0s is assigned.

Further information on the calculation of seismic hazard is provided in the Background Information tab.

Reference:

**APPENDIX D:
RECORD DRAWINGS**



Cell 1 West Construction Report

Northwin Landfill

Upland Excavating Ltd.

19 March 2024



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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Appendices

Appendix A	Record Drawings
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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

- 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 geocomposite, 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).

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).

3.3 Geosynthetics QA/QC

The Liner Installer performed QA/QC according to the design specifications on all geomembrane installed. QC included performing field shear 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 shear 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.

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

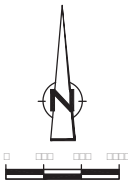
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NEW LANDFILL (NORTHWIN LANDFILL) AS-BUILT RECORD DRAWINGS OCTOBER 2021

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Project
**AS-BUILT
RECORD DRAWINGS**

1	ISSUED FOR RECORD	T.W.	R.H.	10-19-2021
No.	Issue	Drawn	Approved	Date
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Drafting Check	S.KEMP	Design Check	R.HASIOR	
Project Manager	D. LIDDY	Date	Oct 19, 2021	
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Project No. 11222680

Title

COVER

Sheet No.

GN-0001

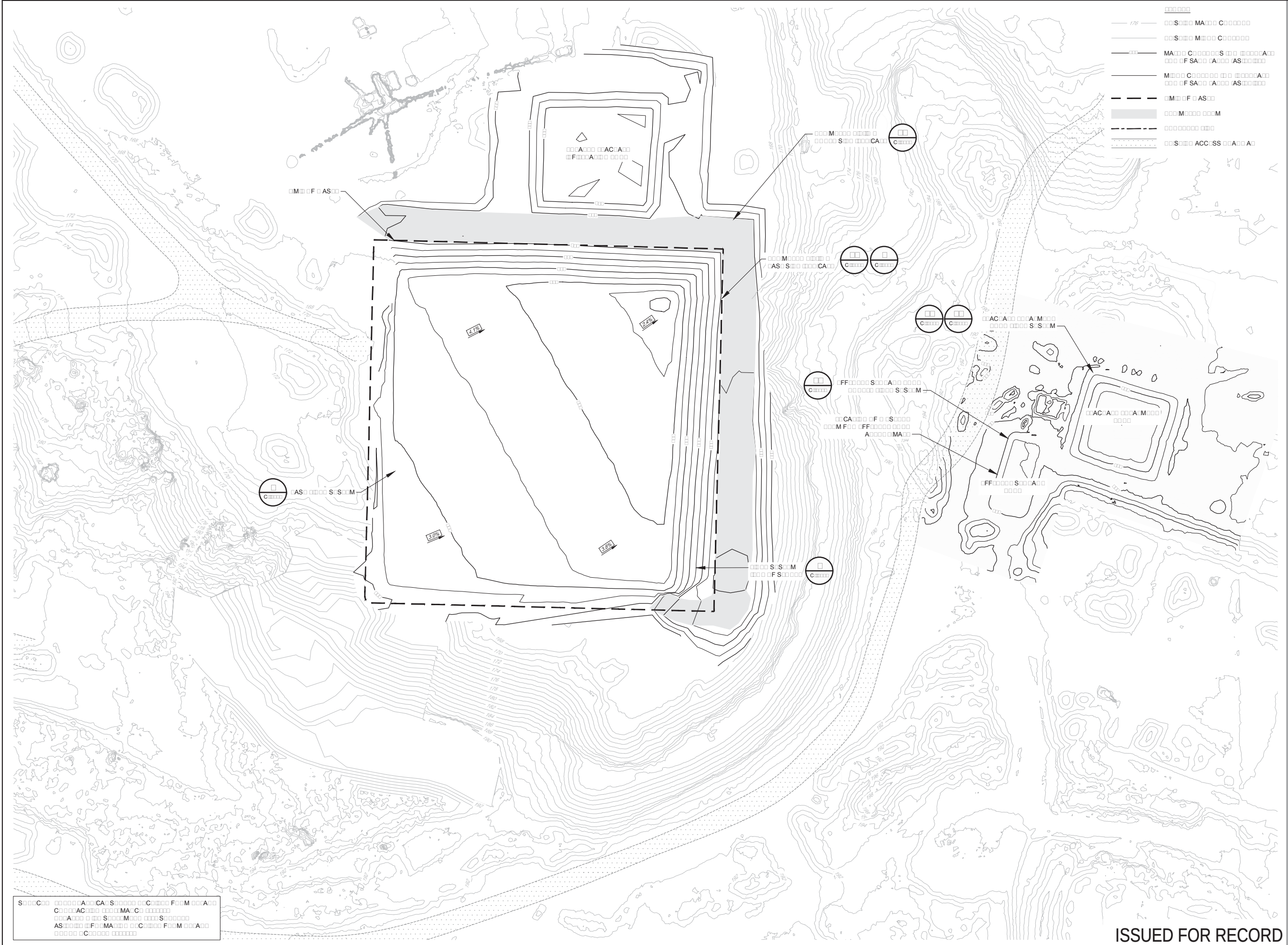
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LOCATION MAP

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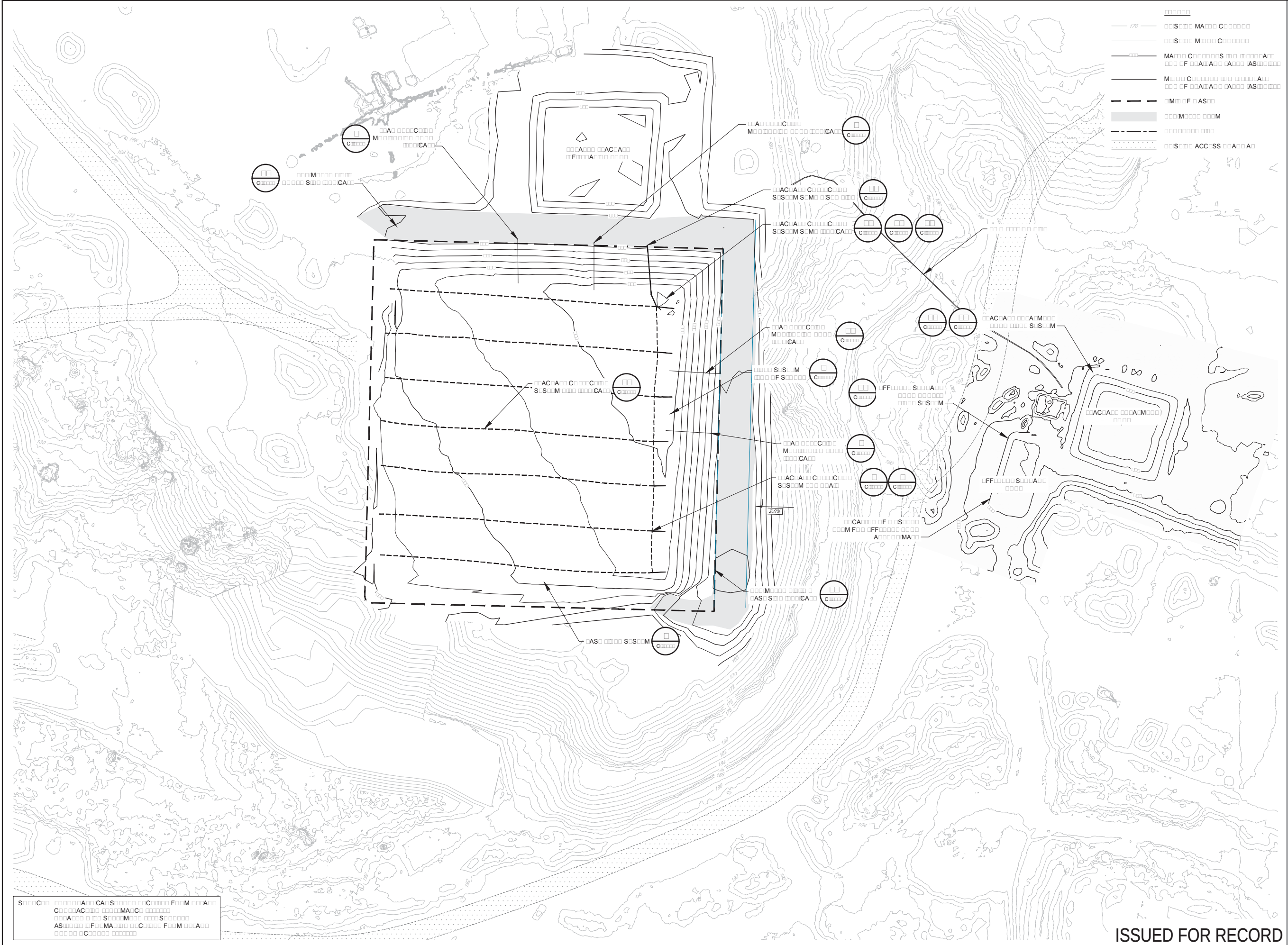
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Title		BASE OF LINER (TOP OF SAND)		
Sheet No.		CI-0002		

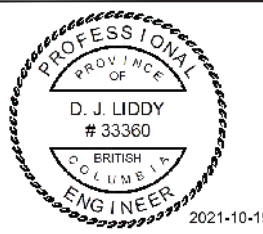
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Sheet 2 of 9





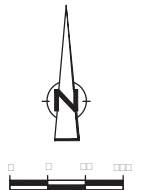
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PROFESSIONAL
ENGINEER
D. J. LIDDY
#33360
BRITISH COLUMBIA
2021-10-19

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North Arrow
Graphic Scale Bar

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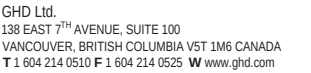
TOP OF DRAINAGE
LAYER

Sheet No.

CI-0003

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Sheet 3 of 9



Project

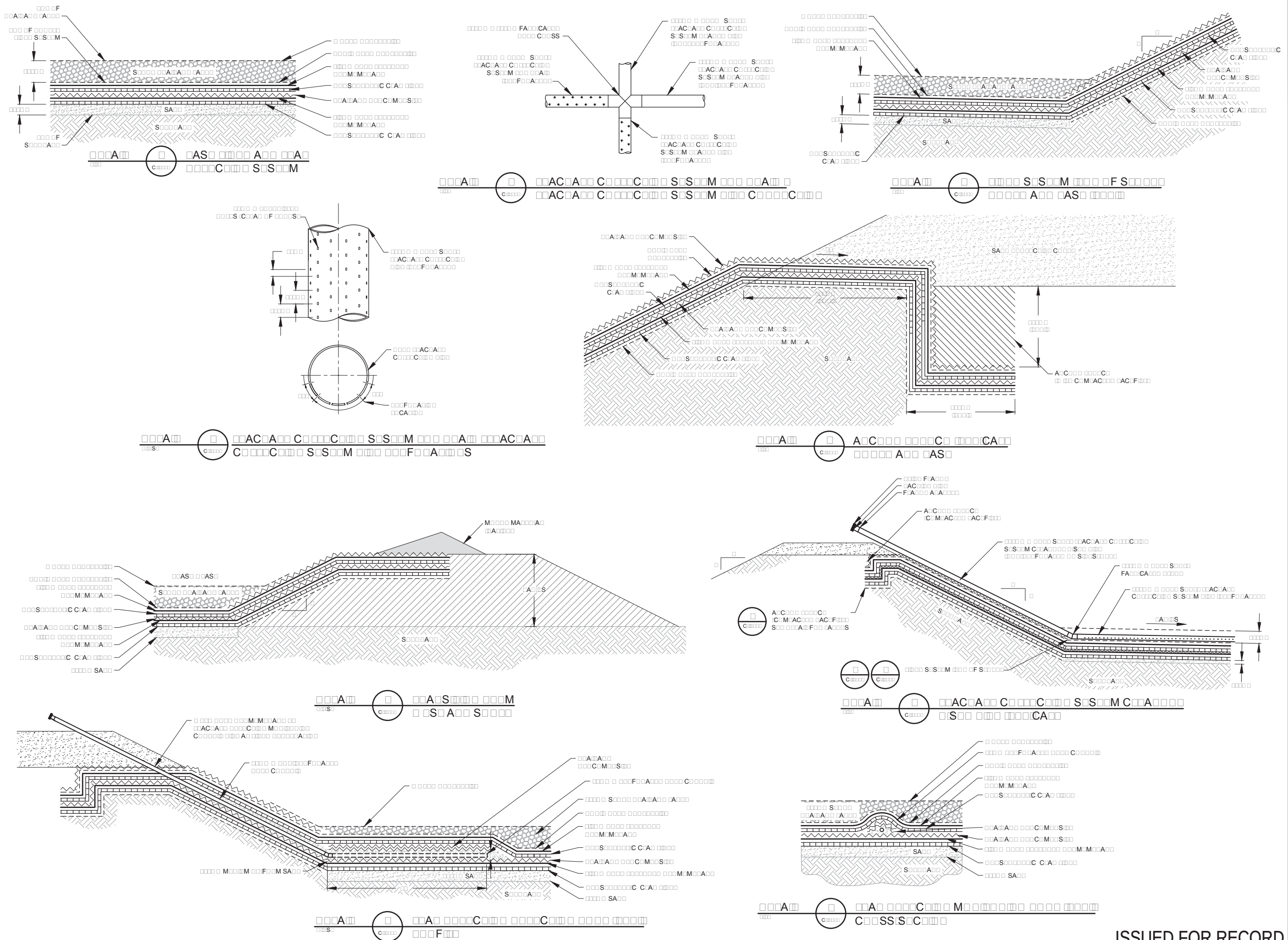
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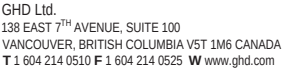
DETAILS
LINER DETAILS

Sheet No.

CI-0004



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Project Manager	D. LIDDY	Date	October 19, 2021
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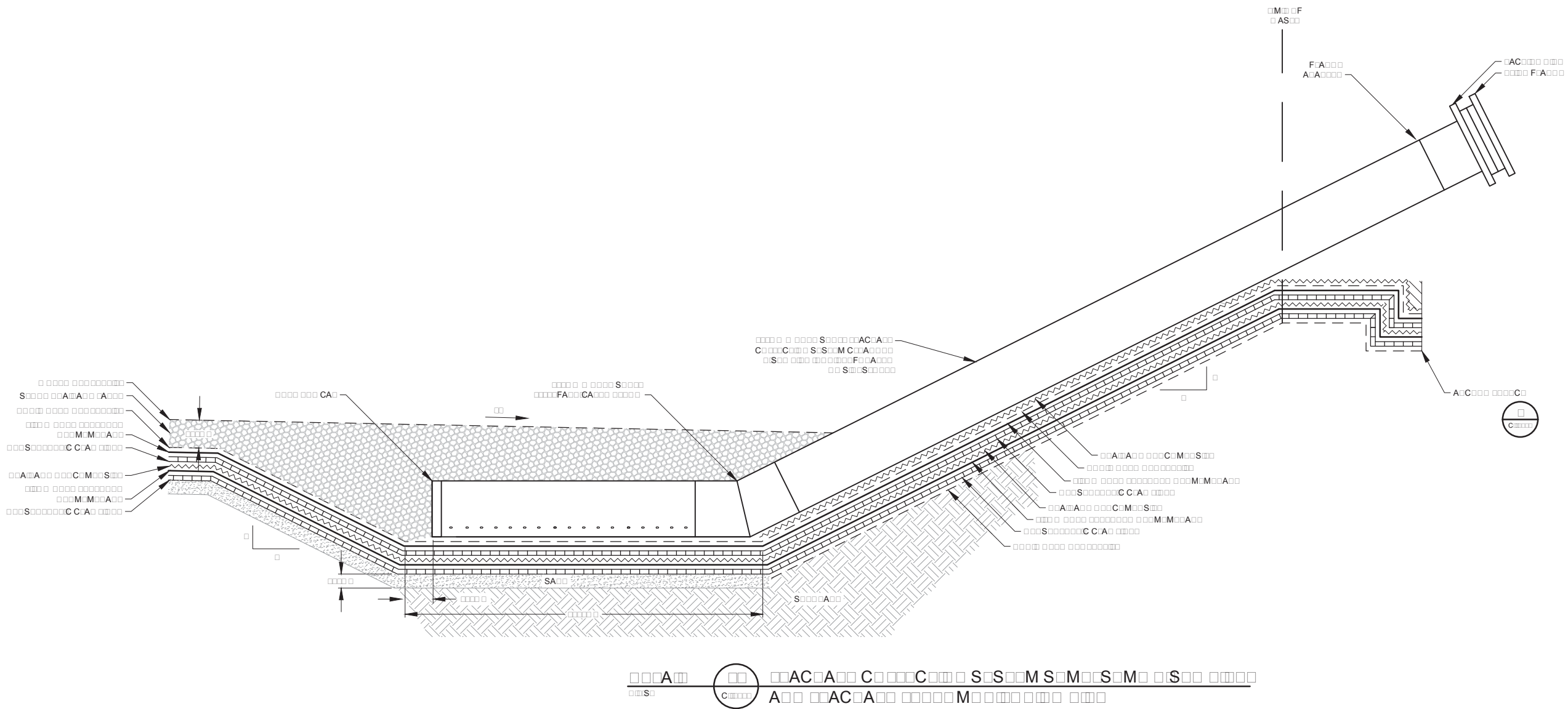
DETAILS
LEACHATE
COLLECTION SUMP

Sheet No.

CI-0005

Sheet 5 of 9

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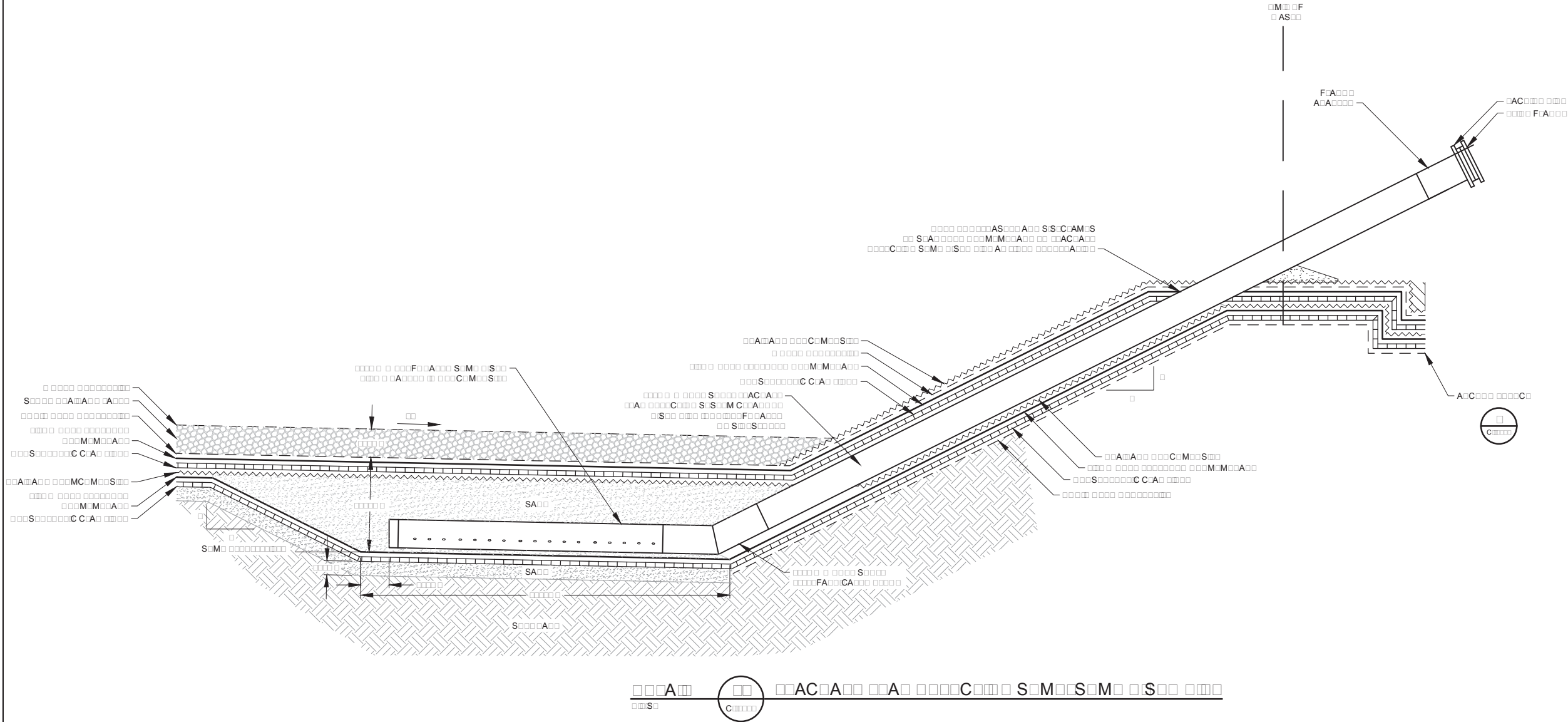
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Title
DETAILS
LEACHATE LEAK
DETECTION SUMP

Sheet No.

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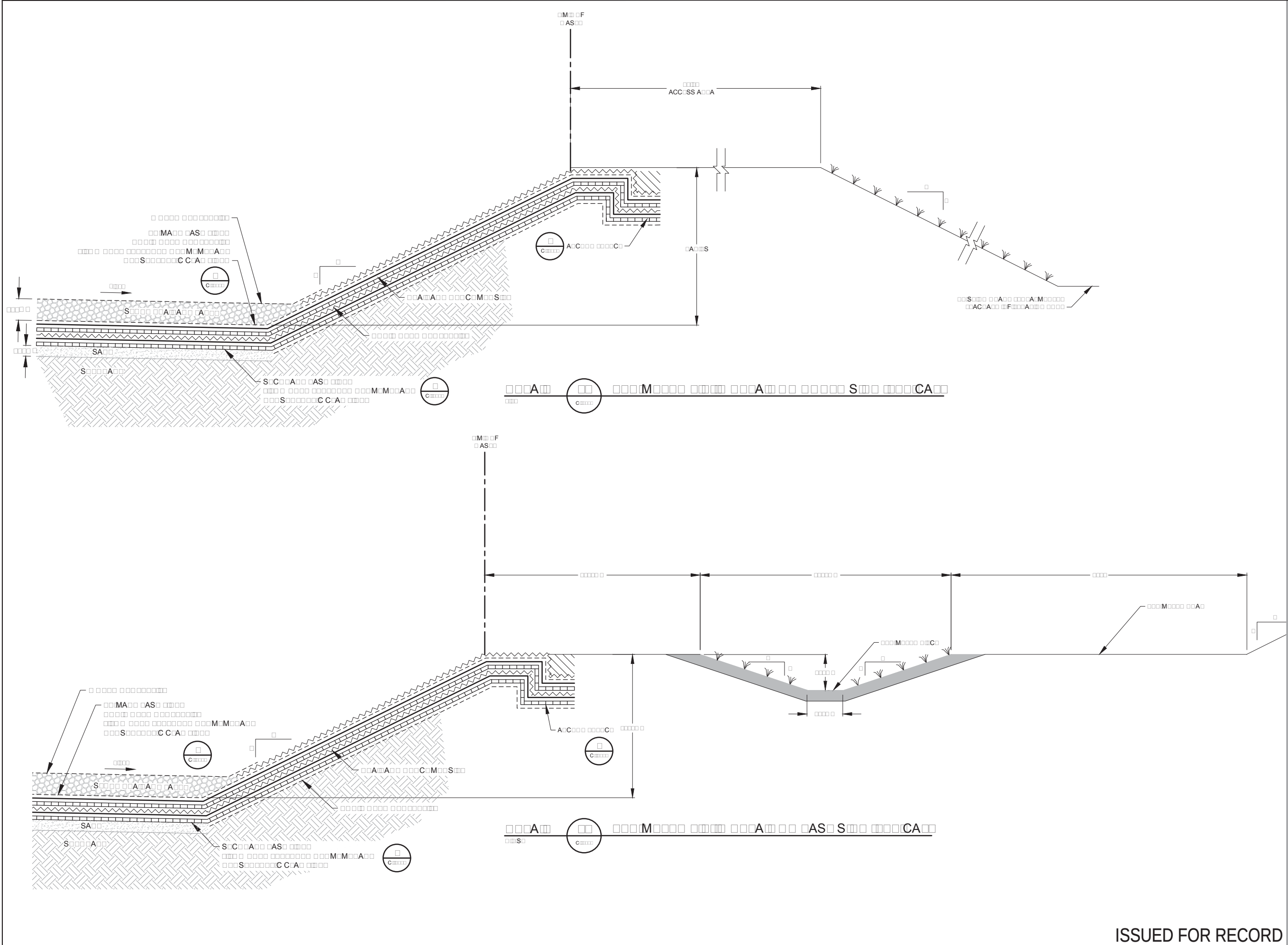
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Title
DETAILS
LEACHATE COLLECTION
SYSTEM

Sheet No.

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Title
DETAILS
PERIMETER TIE-IN DETAILS

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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

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CAMPBELL RIVER, B.C.

NEW LANDFILL (NORTHWIN LANDFILL)

STAGE 1 WEST - DETAILED DESIGN DRAWINGS

MAY 2022



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AREA MAP

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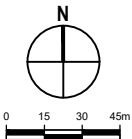
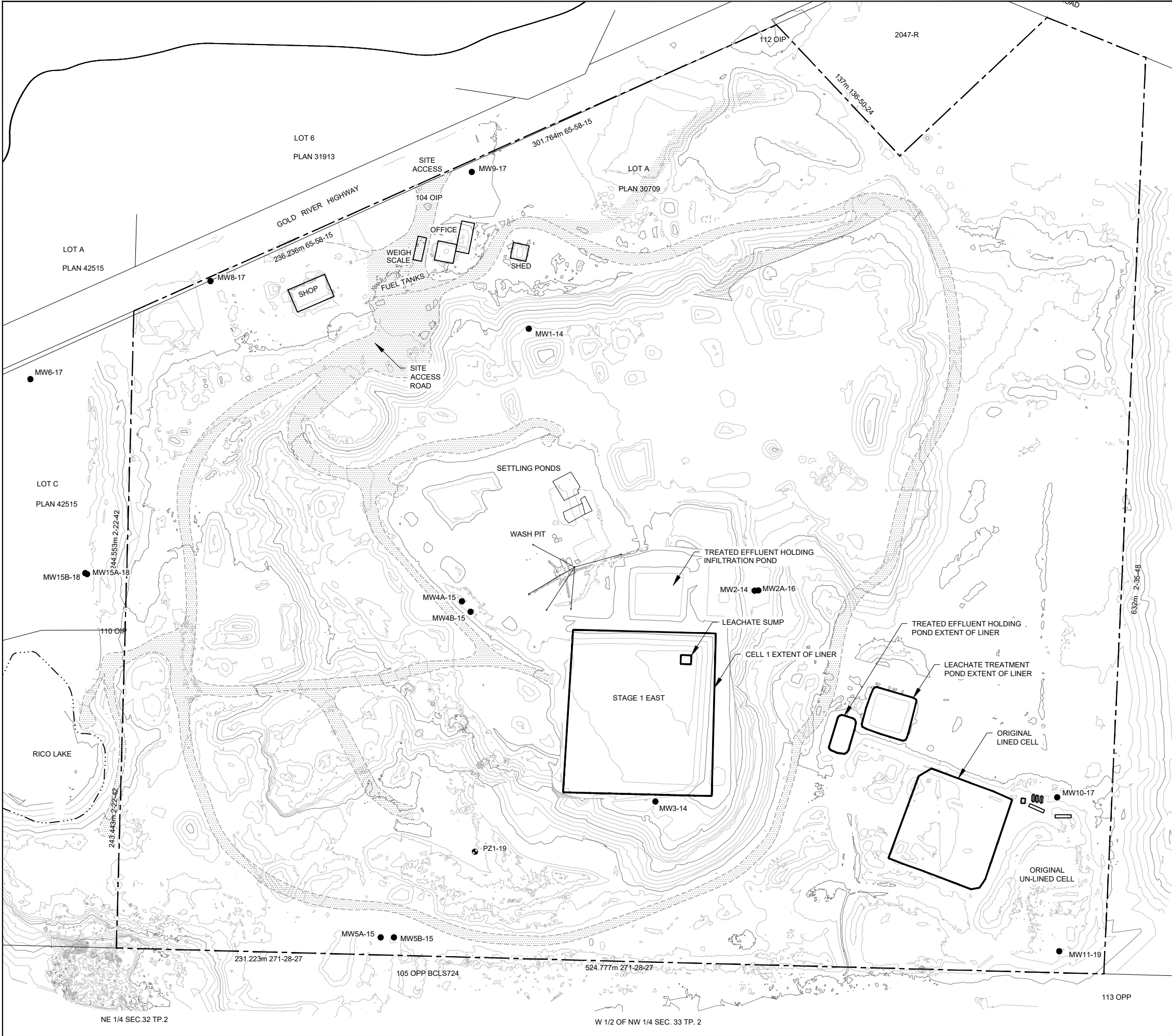


LOCATION MAP

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

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

DRAFT



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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Project Manager		Project Director		

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CAMPBELL RIVER, B.C.**

Project
**STAGE 1 WEST
DETAILED DESIGN**

Date
2022-05-06

Scale
1:1500

Project No.
11222680

Title
EXISTING CONDITIONS

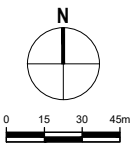
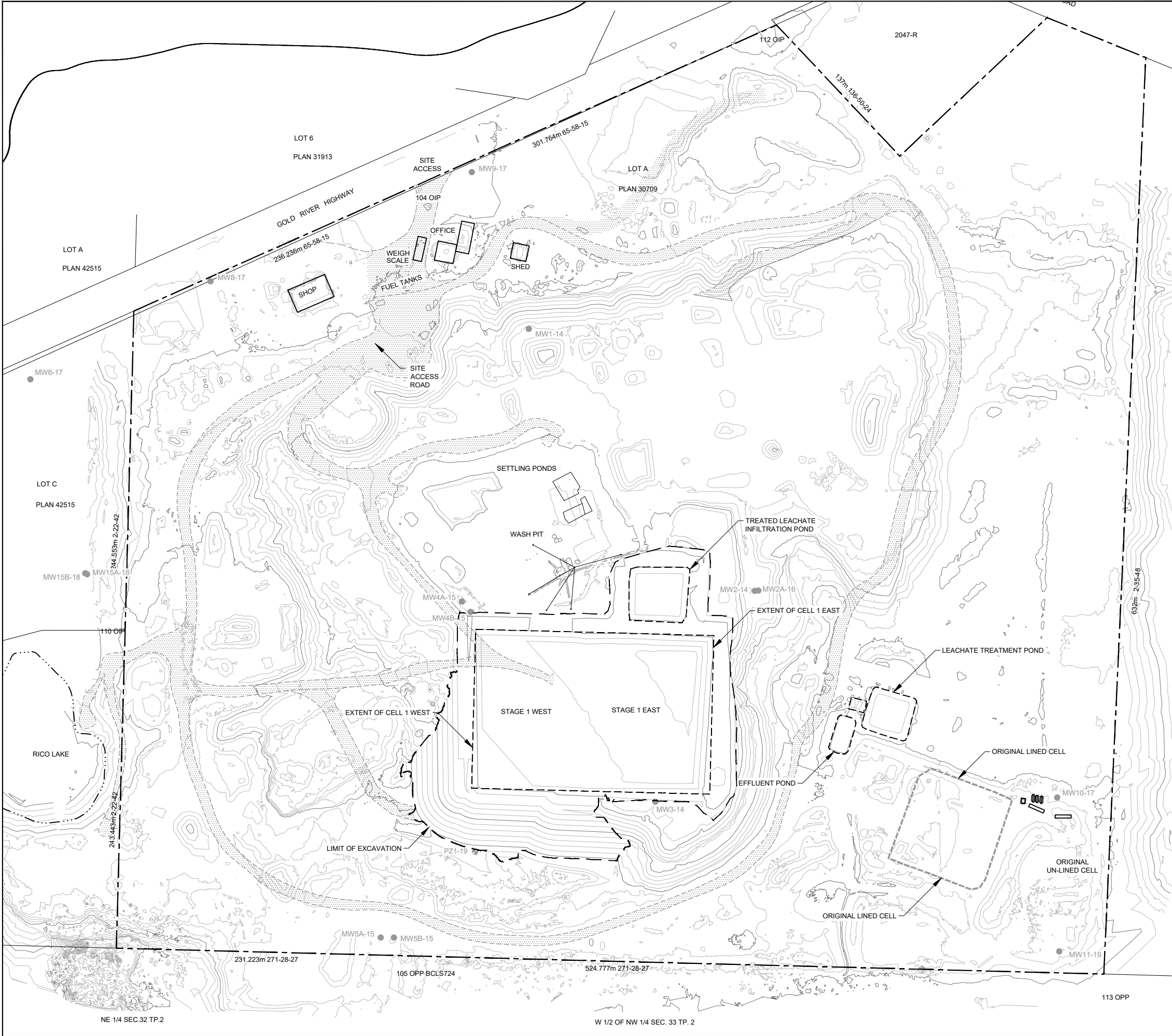
Size
ANSI D

Status Code

DRAFT

Sheet No.
CI-0101

Sheet
1 of 10



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

Bar is 25mm on original size sheet
0 25mm



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Drafting Check			Design Check	
Project Manager			Project Director	

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CAMPBELL RIVER, B.C.**

Project
**STAGE 1 WEST
DETAILED DESIGN**

Date
2022-05-06

Scale
1:1500

Project No.
11222680

Title
FINAL CONDITIONS

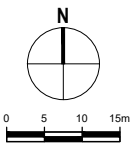
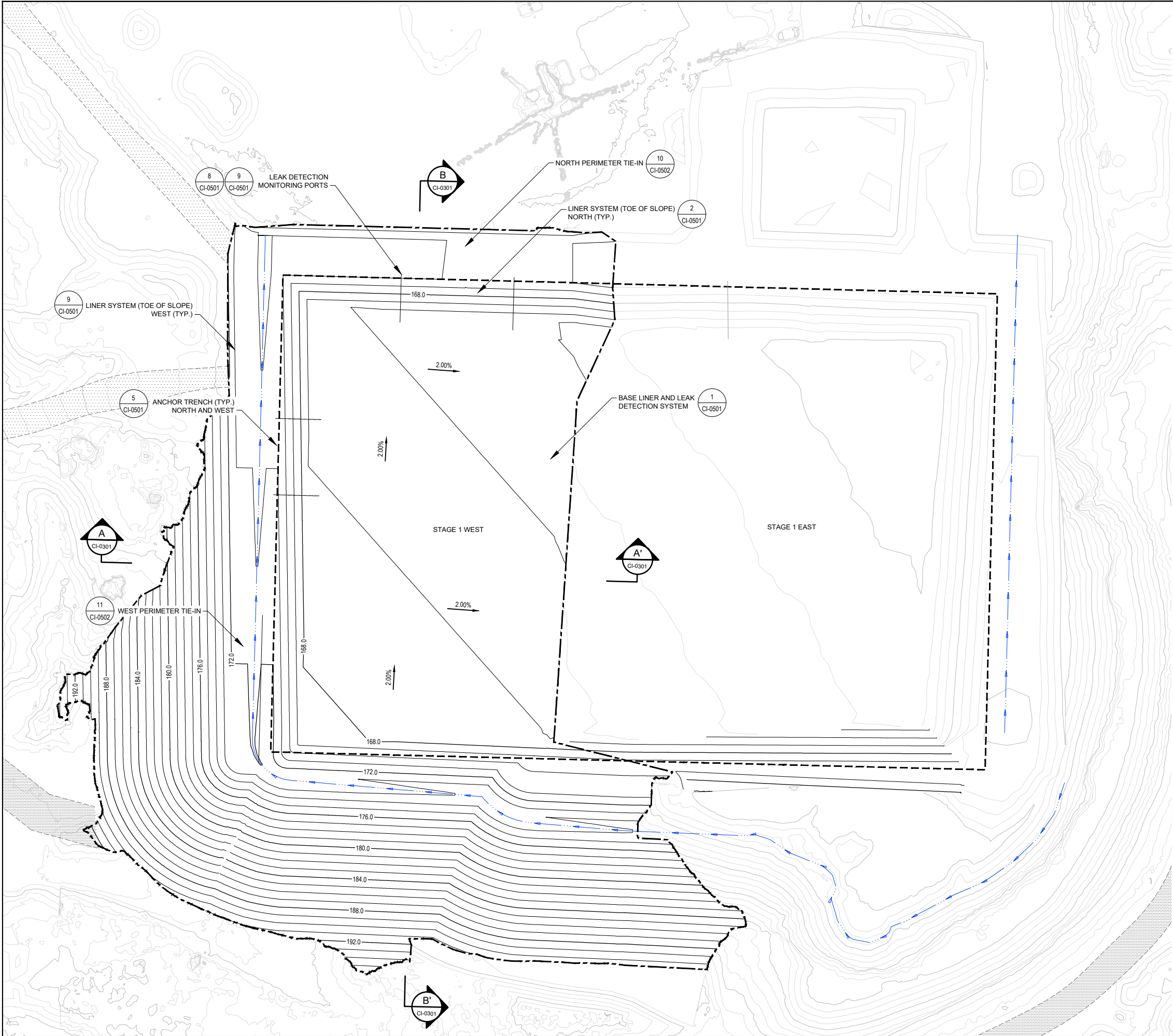
Size
ANSI D

Status Code

DRAFT

Sheet No.
CI-0102

Sheet
1 of 10



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

Bar is 25mm on original size sheet
0 25mm



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Manager		Director		

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Project
STAGE 1 WEST
DETAILED DESIGN

Date
2022-05-06

Scale
1:500

Project No.
11222680

Title
TOP OF SUBGRADE

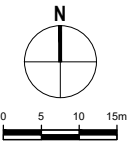
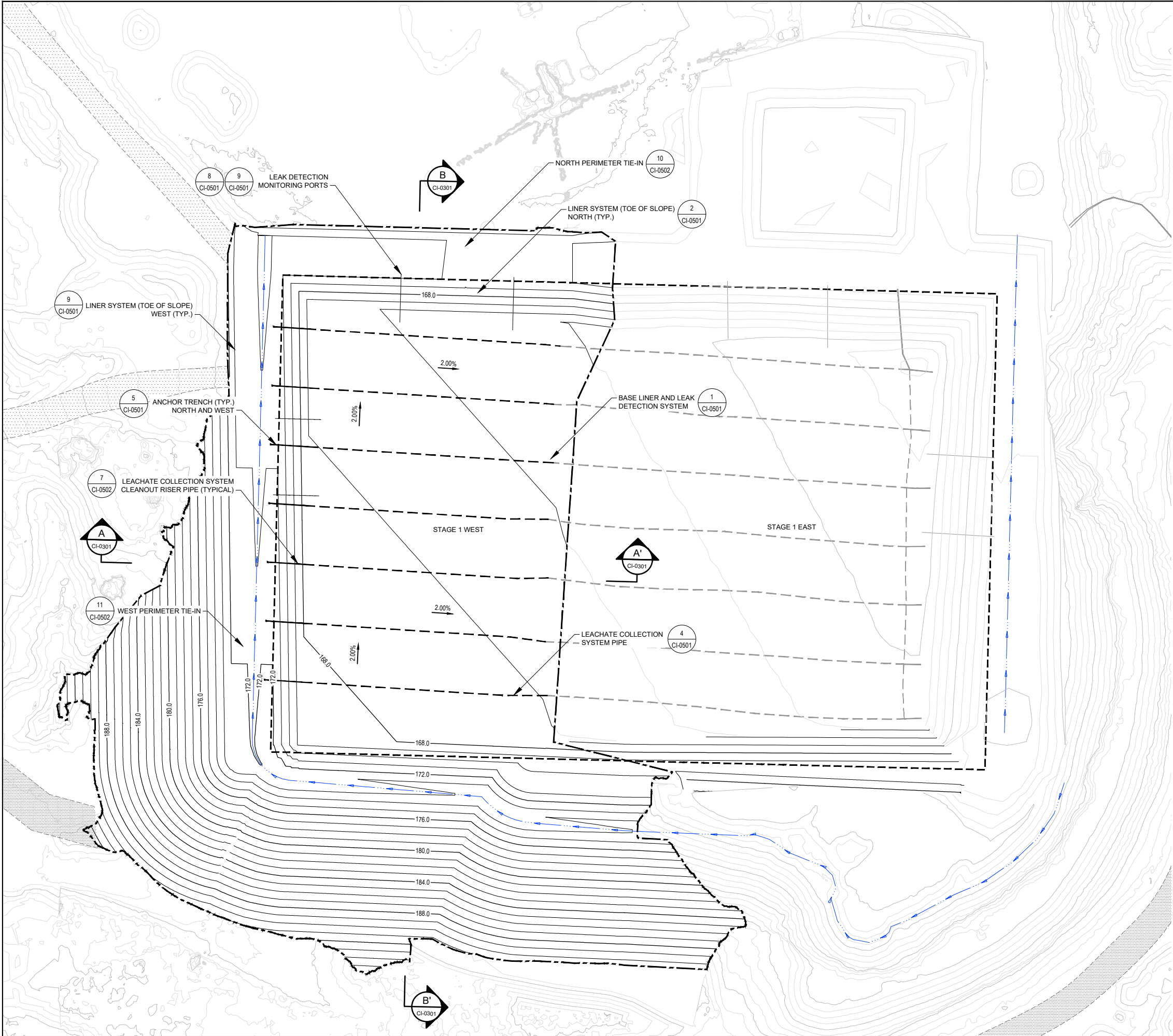
Size
ANSI D

Status Code

DRAFT

Sheet No.
CI-0103

Sheet
1 of 10



LEGEND

- 625 EXISTING CONTOUR (MAJOR) - 4m
- 625 EXISTING CONTOUR (MINOR) - 1m
- 625 BOTTOM OF LINER CONTOUR (MAJOR) - 4m
- 625 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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Project
**STAGE 1 WEST
DETAILED DESIGN**

Date
2022-05-06

Scale
1:500

Project No.
11222680

Title
**TOP OF DOUBLE LINER
SYSTEM**

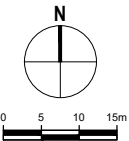
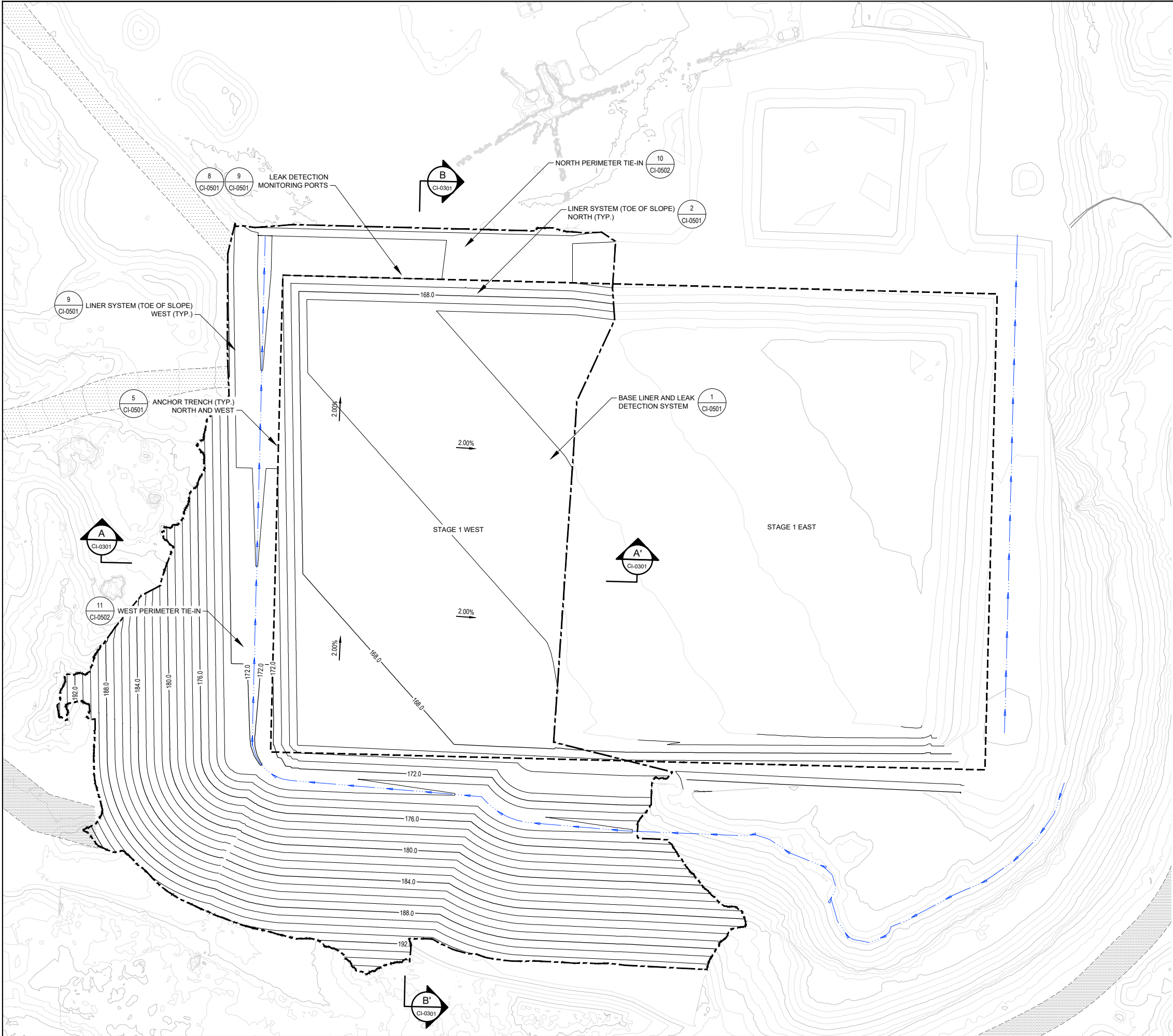
Size
ANSI D

Status Code

Sheet No.
CI-0104

Sheet
1 of 10

DRAFT



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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Project		Project		
Manager		Director		

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Project	STAGE 1 WEST DETAILED DESIGN

Date	2022-05-06	Scale	1:500
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Project No.	11222680
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Title	TOP OF DRAINAGE LAYER	Size	ANSI D
Status Code			

DRAFT

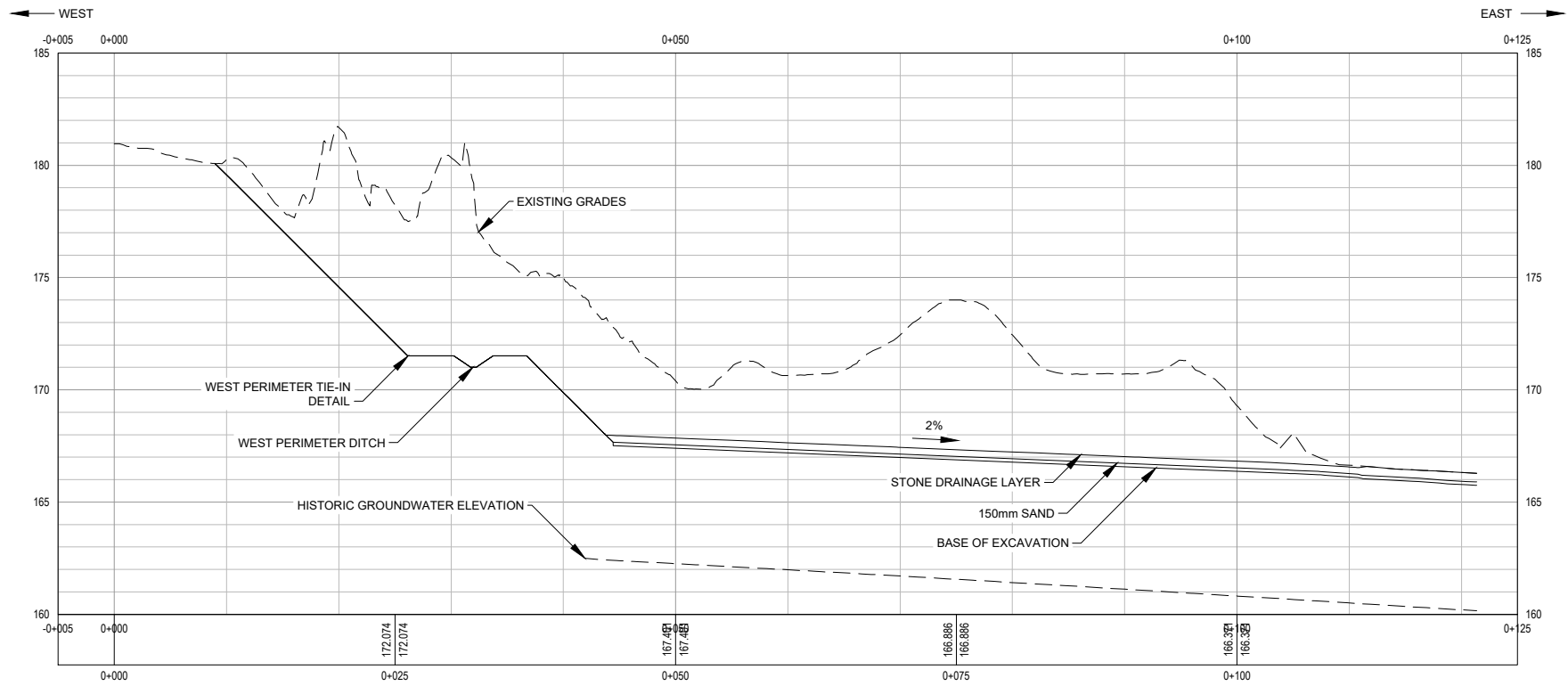
Sheet No.
CI-0105
Sheet
1 of 10



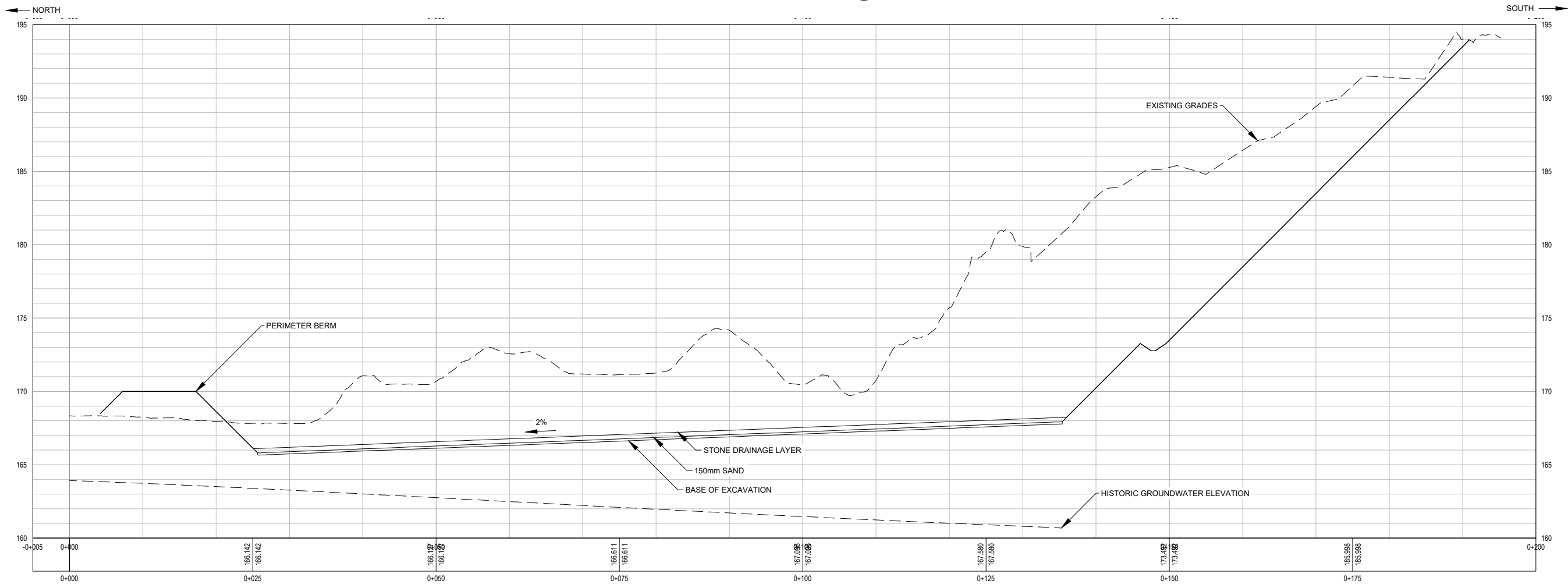
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SECTION A-A'
HORZ: 1:300
VERT: 1:150
CI-0103



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

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Project
**STAGE 1 WEST
DETAILED DESIGN**

Date
2022-05-06

Scale
AS SHOWN

Project No.
11222680

Title
**STAGE 1 WEST
CROSS-SECTIONS**

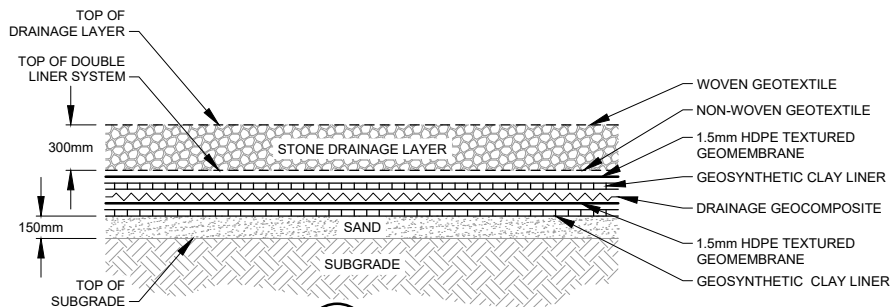
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Status Code

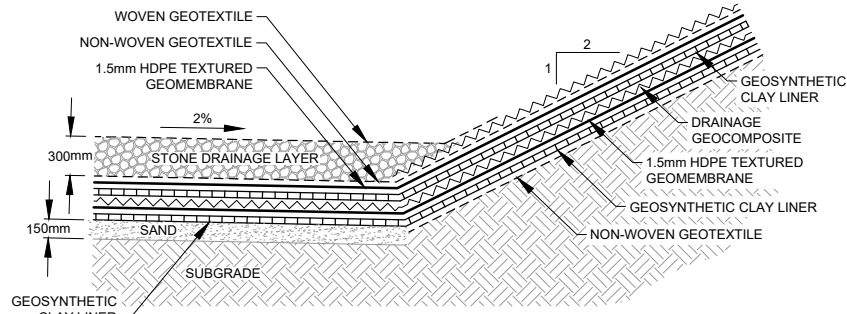
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Sheet No.
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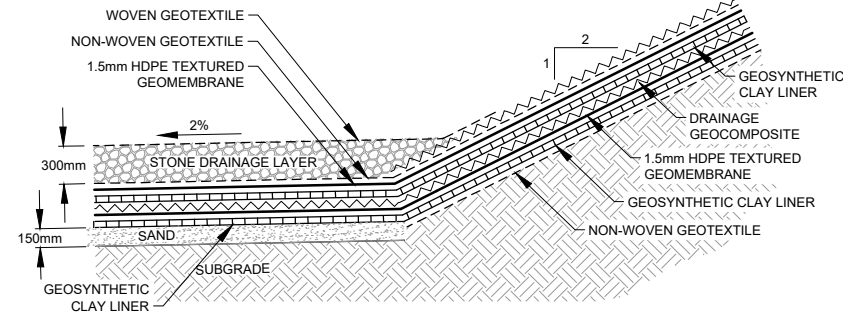
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1 of 10



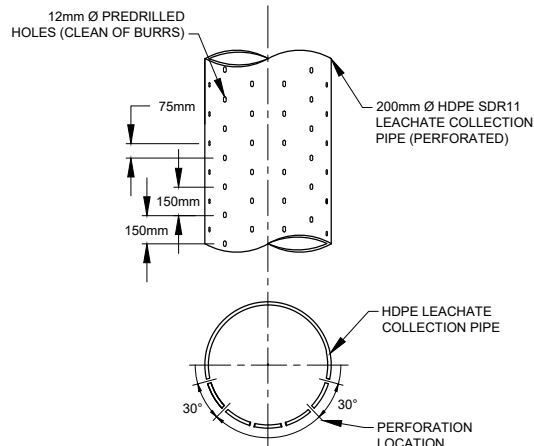
DETAIL 1 BASE LINER AND LEAK DETECTION SYSTEM
1:25



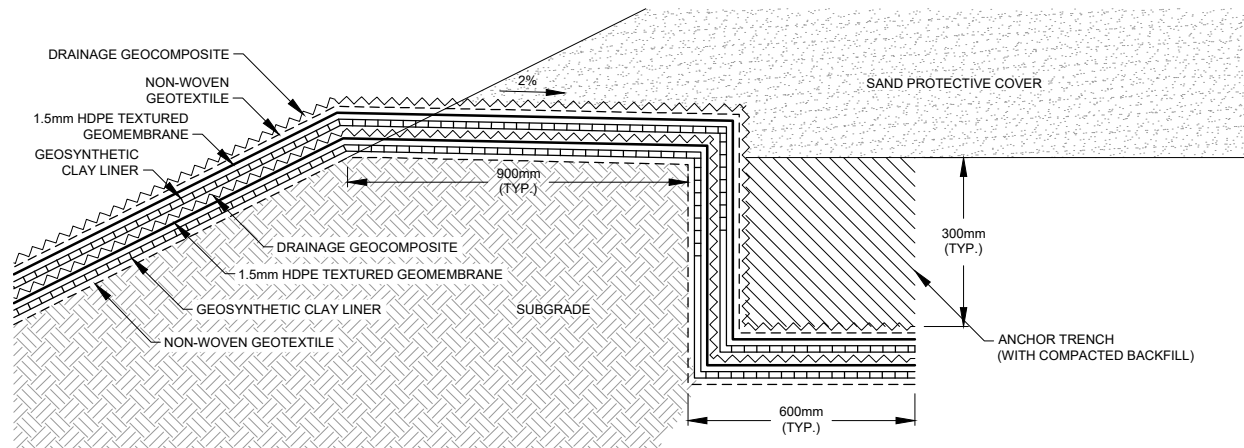
DETAIL 2 LINER SYSTEM (TOE OF SLOPE) NORTH (TYP.)
1:30



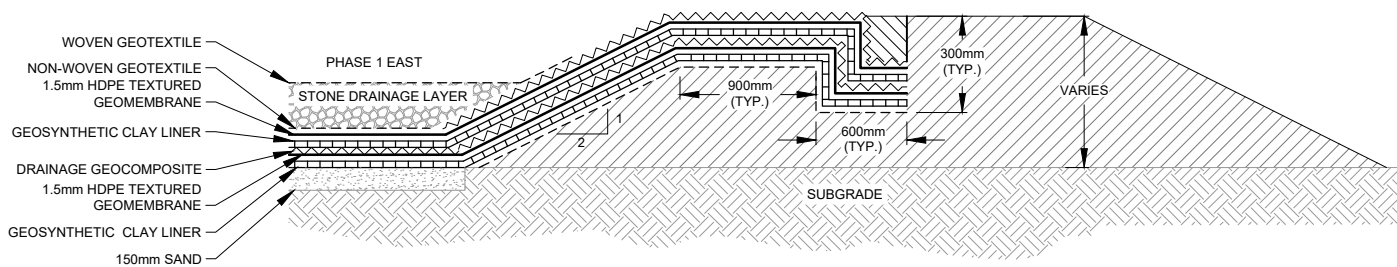
DETAIL 3 LINER SYSTEM (TOE OF SLOPE) WEST (TYP.)
1:30



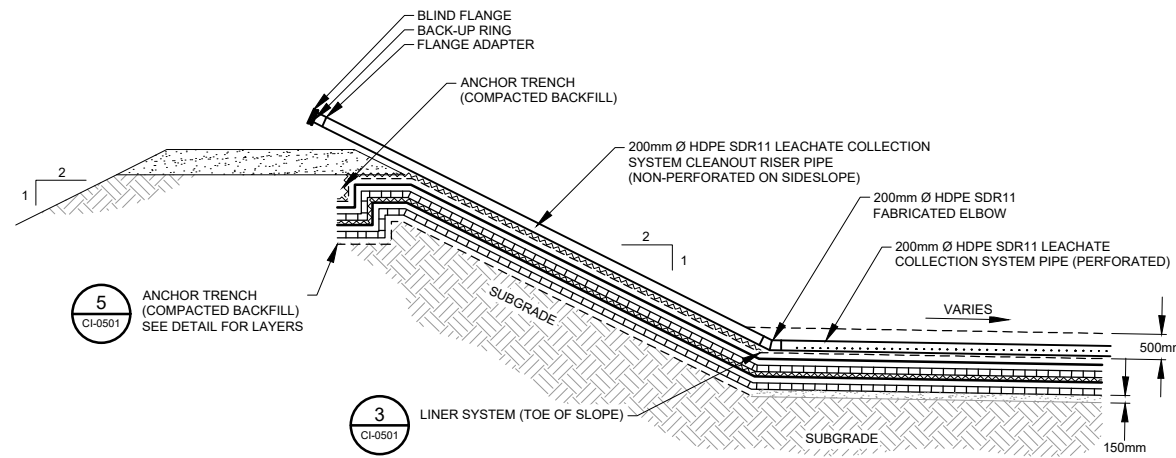
DETAIL 4 LEACHATE COLLECTION SYSTEM TOE DRAIN / LEACHATE COLLECTION SYSTEM PIPE PERFORATIONS
N.T.S.



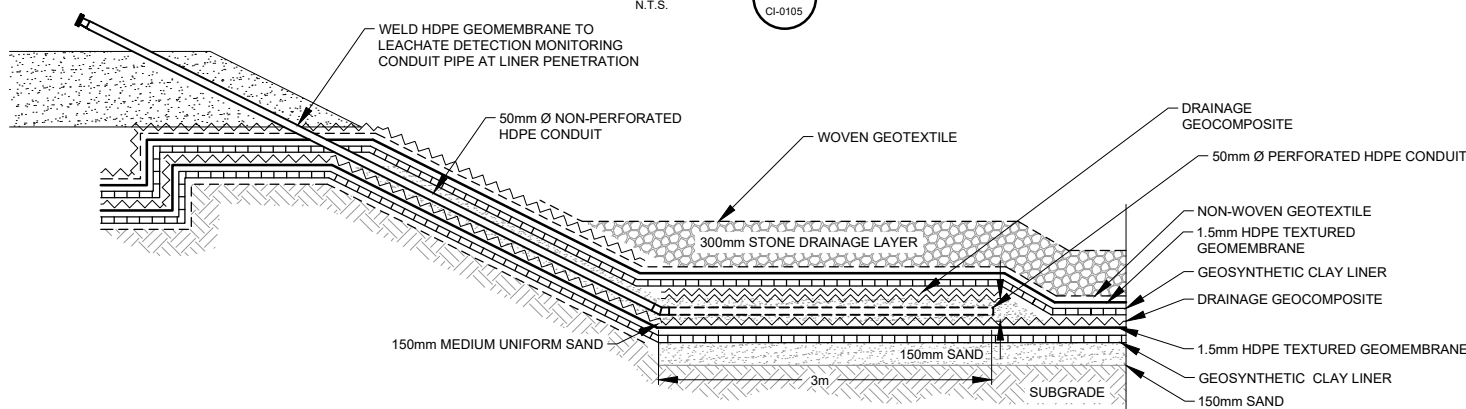
DETAIL 5 ANCHOR TRENCH (TYPICAL) NORTH AND WEST
1:10



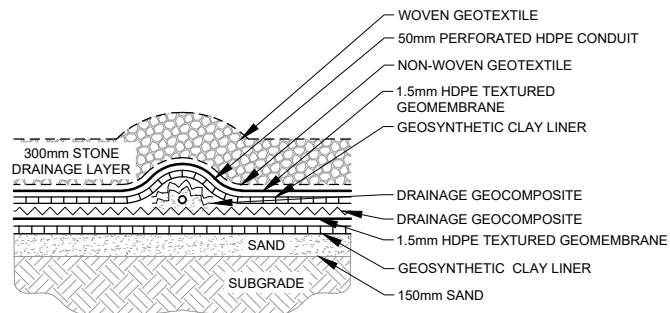
DETAIL 6 SOUTHERN TRANSITION BERM
N.T.S.



DETAIL 7 LEACHATE COLLECTION SYSTEM CLEANOUT RISER PIPE (TYPICAL)
1:75



DETAIL 8 LEAK DETECTION DETECTION PORT (TYP.) PROFILE
N.T.S.



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



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**STAGE 1 WEST
DETAILED DESIGN**

Date
2022-05-06

Scale
AS SHOWN

Project No.
11222680

Title
LINER SYSTEM DETAILS

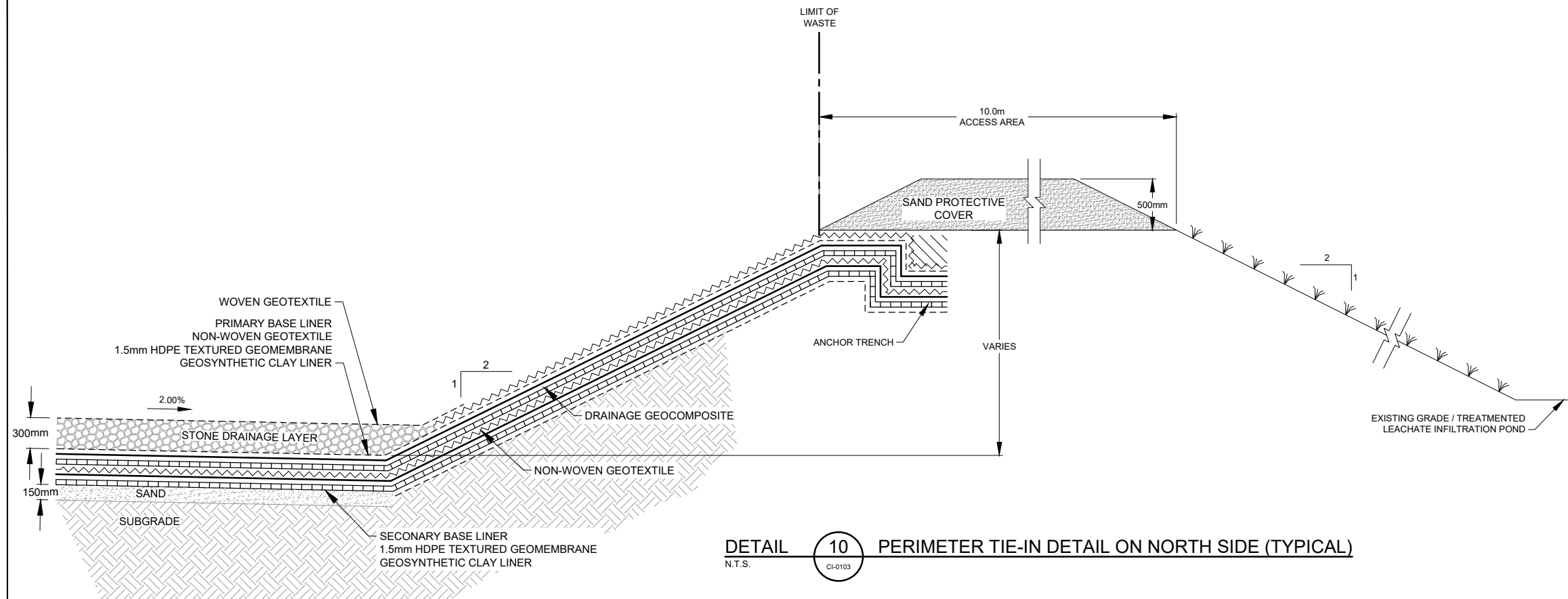
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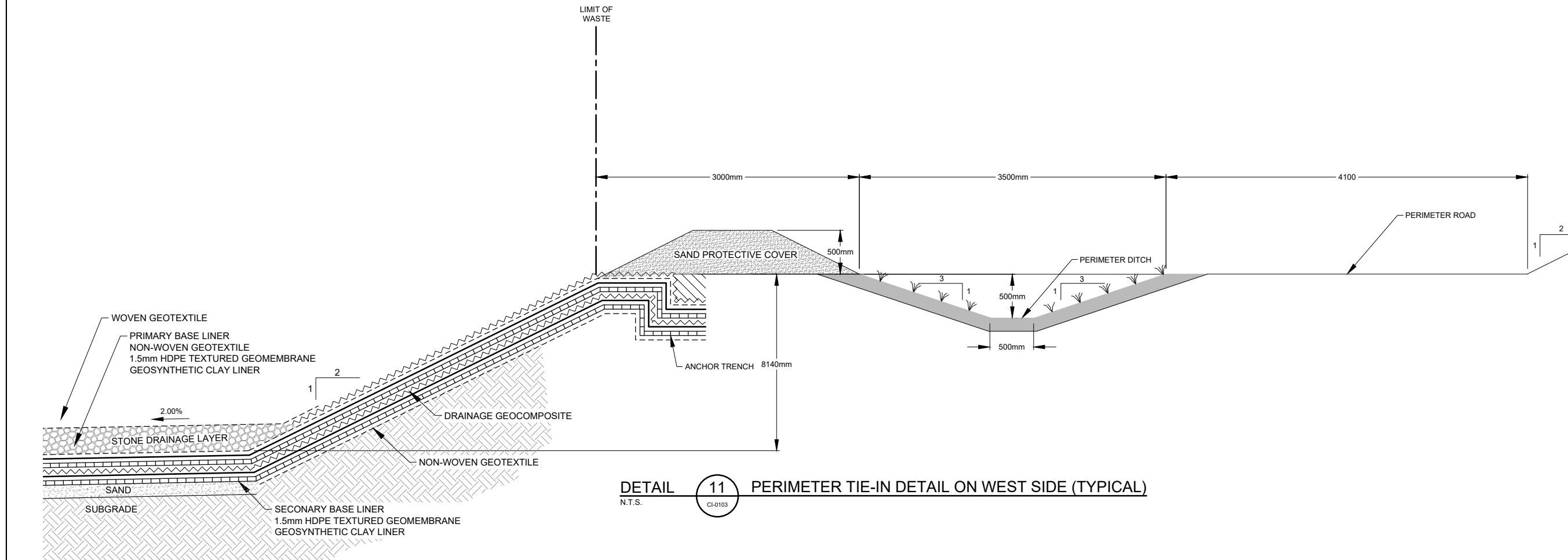
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DETAIL 10 PERIMETER TIE-IN DETAIL ON NORTH SIDE (TYPICAL)
N.T.S.



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

No.	Issue	Checked	Approved	Date
Author	T.WAGSTAFF		Designer	
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Check			Check	
Project			Project	
Manager			Director	

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STAGE 1 WEST
DETAILED DESIGN

Date
2022-05-06

Scale
N.T.S.

Project No.
11222680

Title
PERIMETER TIE-IN
DETAILS

Size
ANSI D

Status Code

DRAFT

Sheet No.
CI-0502

Sheet
1 of 10

APPENDIX E:
LEACHATE INFILTRATION SYSTEM UPGRADES

X:\PRJ\PRJ24074 - NORTHWIN LANDFILL 2024 ENGINEERING\06_AUTOCAD DRAWINGS\01_DRAWINGS\INFILTRATION POND DESIGN\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
- ⊕ SURVEY CONTROL POINT



AUGUST 14, 2026

TOPO SURFACE SURVEYED SEPTEMBER 11, 2025
BY NORTHWIN. UTM83-10N / GEOID UNKNOWN

SITE ORTHO IMAGE BY NORTHWIN - SEP 11, 2025
OTHER IMAGE BY BING MAPS

CLIENT:



PROJECT:

2025 NORTHWIN LANDFILL ENGINEERING

TITLE:

SITE PLAN WITH NEW LEACHATE
INFILTRATION SYSTEM

SCALE:

1:3000

DATE:

2026/08/14
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

-

DRAWING NO:

DRAWN

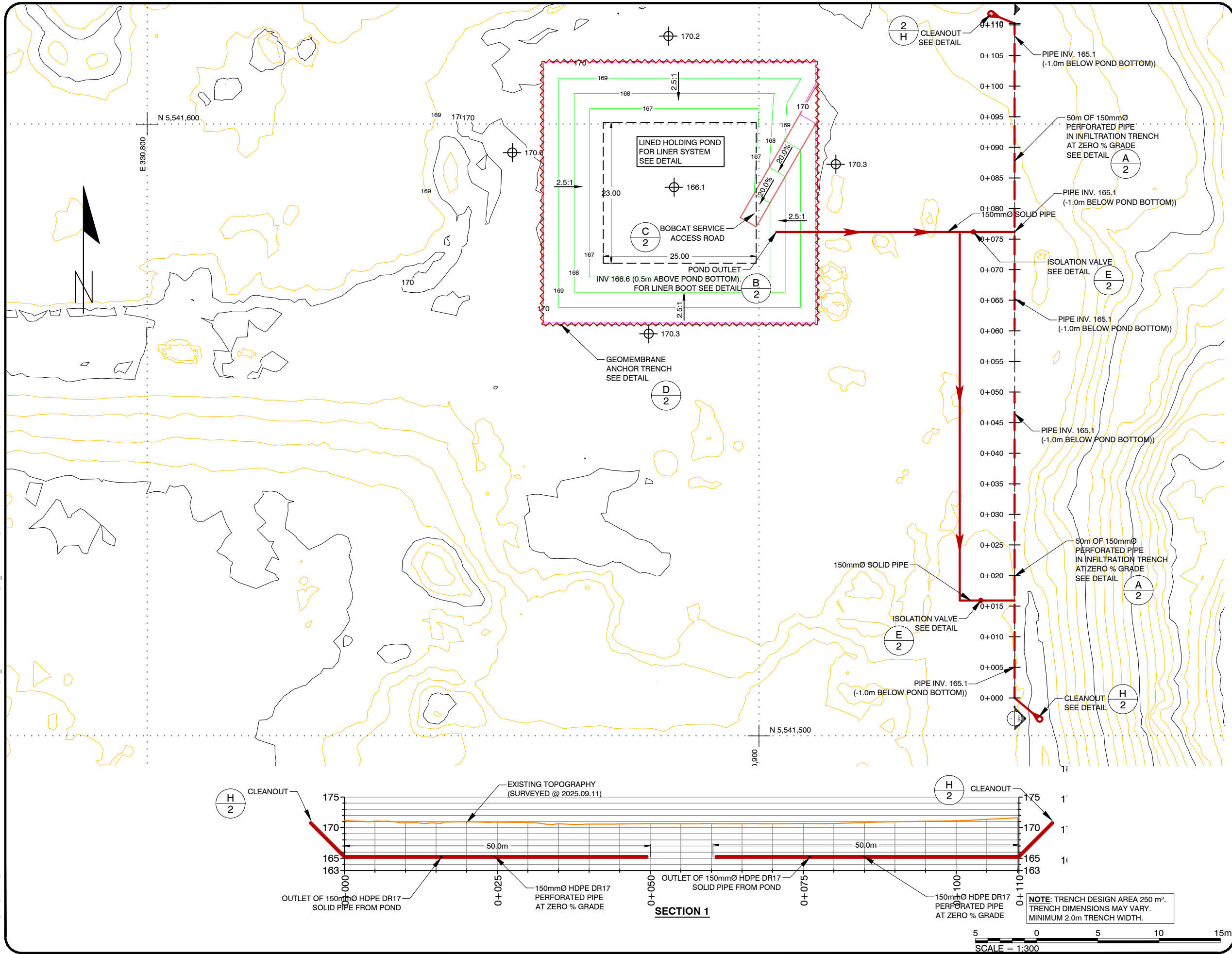
NL

CHECKED

TS

FIGURE 1

X:\PRJ\PRJ24\PRJ24074 - NORTHWIN LANDFILL - 2024 ENGINEERING\06_AUTOCAD DRAWINGS\01_DRAWINGS\INFILTRATION POND DESIGN\INFILTRATION SYSTEM.DWG



SPERLING
HANSEN
ASSOCIATES

Landfill Services Group

- Landfill Siting
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North Vancouver, B.C. V7J 1J3
Phone: (604) 986-7723



TOPO SURFACE SURVEYED SEPTEMBER 11, 2025
BY NORTHWIN. UTM83-10N / GEOID UNKNOWN
SITE ORTHO IMAGE BY NORTHWIN - SEP 11, 2025
OTHER IMAGE BY BING MAPS

CLIENT:



PROJECT:

2025 NORTHWIN LANDFILL ENGINEERING

TITLE:

LINED HOLDING POND
SUBGRADE CONTOURS AND
INFILTRATION TRENCH

SCALE:

1:600

DATE:

2026/08/14
yyyy/mm/dd

PROJECT NO:

PRJ 24074

DESIGNED

TS

DRAWN

NL

CHECKED

TS

DRAWING NO:

FIGURE 2

SCALE:	DATE:	PROJECT NO:
AS SHOWN	2026/08/14 yyyy/mm/dd	PRJ 24074
DESIGNED	TS	DRAWING NO: FIGURE 3
DRAWN	NL	
CHECKED	TS	

**APPENDIX F:
RATIONAL METHOD**

APPENDIX F
Northwin Landfill
Rational Method

Storm Flows - Rational Method (BC Agricultural Drainage Manual - 1997)

Q = 0.0028Ci/A
Q = peak runoff rate (m³/s)
i = rainfall intensity (mm/hr) for design period and for time of concentration
A = watershed area (ha)

$T_c = 0.0195L^{0.77}S^{-0.385}$ 0.002777778
T_c = time of concentration (min)
L = maximum length of flow (m)
S = drainage area grade (m/m)

$$C = \frac{\text{Sum}(C_1A_1 + C_2A_2...)}{\text{Sum}(A_1 + A_2...)}$$

Typical Catchment Area

	Material Vegetation Topography	Area A Topsoil Pasture Hilly	Permanent Closure
Catchment Area (A, m ²) =		25.000	
Catchment Area (A, ha) =		2.50	
Runoff Coefficient - C =		0.35	
Time of concentration - T _c			
Typical slope (S, m/m) =		33%	
Length of flow (L, m) =		400	
T _c (min) =		3.013	
T _c (hrs) =		0.050	
If T _c < 5mins, use		5mins	
Peak Storm Intensity for 200 Yr 5 min Event (i, mm/hr) =		108.41	(for 5 min event)
Peak Flow (Q, m ³ /s) =		0.27	
Peak Flow + 20% for Climate Change (Q, m ³ /s) =		0.32	
Peak Flow + 20% for Climate Change (Q, L/s) =		319	
Volume for T _c minute Flow (m3) =		58	
Peak Storm Intensity for 1 in 200 Yr Rainfall (i, mm/hr) =		4.27	(for 24h hour event)
Peak Flow (Q, m ³ /s) =		0.010	
Peak Flow + 20% for Climate Change (Q, m ³ /s) =		0.013	
Peak Flow + 20% for Climate Change (Q, L/s) =		13	
For 24 hr Volume (m3)=		1086	
Peak Storm Intensity for 1 in 100 Yr Rainfall (i, mm/hr) =		4.00	(for 24h hour event)
Peak Flow (Q, m ³ /s) =		0.010	
Peak Flow + 20% for Climate Change (Q, m ³ /s) =		0.012	
Peak Flow + 20% for Climate Change (Q, L/s) =		12	
For 24 hr Volume (m3)=		1016	
Peak Storm Intensity for 1 in 50 Yr Rainfall (i, mm/hr) =		3.90	(for 24h hour event)
Peak Flow (Q, m ³ /s) =		0.01	
Peak Flow + 20% for Climate Change (Q, m ³ /s) =		0.01	
Peak Flow + 20% for Climate Change (Q, L/s) =		11	
For 24 hr Volume (m3)=		991	
Peak Storm Intensity for 1 in 25 Yr Rainfall (i, mm/hr) =		3.70	(for 24h hour event)
Peak Flow (Q, m ³ /s) =		0.009	
Peak Flow + 20% for Climate Change (Q, m ³ /s) =		0.011	
Peak Flow + 20% for Climate Change (Q, L/s) =		11	
For 24 hr Volume (m3)=		940	
		WAY-2	WAY-1
Average Snow Melt (mm/hr)		1	4.32
Multi-Day Precip (mm/hr)		0.6	0.6
Peak Intensity fo 1 in 200 year 24 hour event + Snowmelt (mm/hr)		6	9
Peak Flow for 1 in 200 year 24 hour event + Snowmelt + Multi-Day Precip (Q, m ³ /s) =		0.014	0.0226
ak Flow for 1 in 200 year 24 hour event + Snowmelt + Multi-Day Precip + 20% for Climate Change (Q, m ³ /s) =		0.016	0.0271
Peak Flow (Q, L/s) =		16	27
		1,407 m3/day	2,345 m3/day

APPENDIX G:
LFG

Year of Assessment	2026	LFG Management Regulation Reference
Annual Tonnage in Preceding Year	26,285 (tonnes/year)	4-2-a
Total waste in Place in the Preceding Year	322,062 (tonnes/year)	4-2-c
Methane generation in the Preceding Year	353 (tonnes CH ₄ /year)	4-2-d

Next Five Years	Waste TonnageMethane Generation		
	(tonnes)	(tonnes CH ₄ /year)	
2026	45,500	370	4-2-b & 4-2-e
2027	45,500	412	4-2-b & 4-2-e
2028	45,500	451	4-2-b & 4-2-e
2029	45,500	489	4-2-b & 4-2-e
2030	45,500	525	4-2-b & 4-2-e

	Relatively Inert	Moderately Decomposable	Decomposable	
Gas Production potential, Lo =	20	120	160	m ³ CH ₄ /tonne
lag time before start of gas production, lag =	1	years		
Historical Data Used (years)	30			
1st Year of Historical Data Used	1996			
4 Years after Reporting Year	2030			
methane (by volume)	50%			
carbon dioxide (by volume)	50%			
methane (density) - 1atm, 25C	0.6557	kg/ m ³	(25C,SP)	
carbon dioxide (density)	1.7988	kg/ m ³	(25C,SP)	

Year	Year Number	Annual Tonnage (tonnes)	Cumulative Waste-in-place (tonnes)	Waste Tonnage			Methane Generation Rate, k			Annual Methane Production (tonnes/yr)
				Relatively Inert (tonnes)	Moderately Decomposable (tonnes)	Decomposable (tonnes)	Relatively Inert (year ⁻¹)	Moderately Decomposable (year ⁻¹)	Decomposable (year ⁻¹)	
1996	1	0	0	0	0	0	0.02	0.06	0.11	0.00
1997	2	0	0	0	0	0	0.02	0.06	0.11	0.00
1998	3	0	0	0	0	0	0.02	0.06	0.11	0.00
1999	4	0	0	0	0	0	0.02	0.06	0.11	0.00
2000	5	0	0	0	0	0	0.02	0.06	0.11	0.00
2001	6	0	0	0	0	0	0.02	0.06	0.11	0.00
2002	7	0	0	0	0	0	0.02	0.06	0.11	0.00
2003	8	0	0	0	0	0	0.02	0.06	0.11	0.00
2004	9	0	0	0	0	0	0.02	0.06	0.11	0.00
2005	10	0	0	0	0	0	0.02	0.06	0.11	0.00
2006	11	0	0	0	0	0	0.02	0.06	0.11	0.00
2007	12	0	0	0	0	0	0.02	0.06	0.11	0.00
2008	13	0	0	0	0	0	0.02	0.06	0.11	0.00
2009	14	0	0	0	0	0	0.02	0.06	0.11	0.00
2010	15	0	0	0	0	0	0.02	0.06	0.11	0.00
2011	16	0	0	0	0	0	0.02	0.06	0.11	0.00
2012	17	0	0	0	0	0	0.02	0.06	0.11	0.00
2013	18	0	0	0	0	0	0.02	0.06	0.11	0.00
2014	19	0	0	0	0	0	0.02	0.06	0.11	0.00
2015	20	0	0	0	0	0	0.02	0.06	0.11	0.00
2016	21	0	0	0	0	0	0.02	0.06	0.11	0.00
2017	22	0	0	0	0	0	0.02	0.06	0.11	0.00
2018	23	0	0	0	0	0	0.02	0.06	0.11	0.00
2019	24	45,500	45,500	34,125	11,375	0	0.02	0.06	0.11	0.00
2020	25	45,500	91,000	34,125	11,375	0	0.02	0.06	0.11	61.15
2021	26	47,320	138,320	35,490	11,830	0	0.02	0.06	0.11	119.08
2022	27	44,814	183,134	33,610	11,203	0	0.02	0.06	0.11	176.41
2023	28	38,327	221,460	28,745	9,582	0	0.02	0.06	0.11	227.38
2024	29	74,317	295,777	55,738	18,579	0	0.02	0.06	0.11	266.98
2025	30	26,285	322,062	19,714	6,571	0	0.02	0.06	0.11	352.91
2026	31	45,500	367,562	34,125	11,375	0	0.02	0.06	0.11	369.80
2027	32	45,500	413,062	34,125	11,375	0	0.02	0.06	0.11	411.68
2028	33	45,500	458,562	34,125	11,375	0	0.02	0.06	0.11	451.43
2029	34	45,500	504,062	34,125	11,375	0	0.02	0.06	0.11	489.15
2030	35	45,500	549,562	34,125	11,375	0	0.02	0.06	0.11	524.95

**APPENDIX H:
SOIL ACCEPTANCE PLAN**

Northwin Landfill
#7295 Gold River Highway
Campbell River, BC
V9H 1P1
Phone 1 (250) 850-7511
Phone 2 (250) 202-8644

Soil Screening Process

Upland staff will complete the following steps prior to the acceptance of soil and during discharge at the Northwin Landfill.

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
#7295 Gold River Highway Campbell
River, BC
V9H 1P1
Phone (250) 850-7511 / (250) 202-8644

Soil Acceptance Agreement

This Agreement must be executed before any soil can be accepted 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 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 I:
FIRE MANAGEMENT PLAN

FIRE MANAGEMENT PLAN

1. Fire Safety Plan

If not controlled, landfill fires can threaten the health of landfill staff, customers, contractors and residents in surrounding neighborhoods, as well as lead to undesirable impacts on the environment in terms of toxic emissions of pollutants to the air and groundwater.

This section presents a Risk Mitigation Plan and Monitoring Program to minimize the risk of a landfill fire during operations and establishes protocols for quick control and extinguishment of any fire that could develop at the Landfill. This plan should be reviewed and updated at least once annually.

1.1. Filling Strategy

The risk of a landfill fire occurring due to spontaneous combustion or surface ignition can be minimized by maintaining the active filling area as small as practical and placing daily cover at the end of each day.

1.2. Rapid Attack Crew and Strategy

The first response crew for a landfill fire should be the operational staff on site. A water supply should always be on site or near the site in order to immediately suppress any fires. The most effective method for immediate fire suppression is to excavate the source of the fire and saturate the area with water or bury it with dirt provided the fire is not electrical, hydrocarbon or chemical in nature.

1.3. On-Site Policies

The on-site policies for fire risk reduction include:

- Coverage of waste, using adequate cover comprised of inert mineral soil
- Maintaining adequate soil resources onsite to fight a fire
- Maintaining sufficient water resources available to fight a fire
- Smoking is forbidden anywhere near the landfill, all staff watch out for customers who may not see the signage indicating this complete ban.
- Supply and keep a maintenance log for an adequate amount of fire extinguishers
- Any onsite alarm systems should be inspected on a monthly basis and tested annually
- Incoming vehicles should be visually inspected for smoke, steam, or heat
- Site exits should remain free of obstructions and unlocked
- Periodic testing of landfill gas monitoring wells for oxygen entry, elevated temperatures and presence of carbon monoxide;
- Good site security to prevent arson
- Training for all operational staff to recognize signs of a landfill fire.

1.4. Continuous Site Inspections

Continued visual inspection for landfill fire initiation should be conducted by operational staff on site. These indicators include:

- Open flame
- Smoke
- Steam venting
- Rapid settlement and cracking
- Elevated surface temperatures
- Unusual odours.

1.5. Action Steps, Reporting and Reclamation in Case of a Fire

During the continuous site inspections, if a landfill fire is suspected, Landfill Fire Control Inc. (LFCI), a subsidiary of SHA, should be contacted to investigate. If monitoring indicates that temperature and Carbon Monoxide (CO) levels are above normal, then a more detailed investigation should be initiated with additional drilling and instrumentation requirements to be determined on a case-by-case basis. If an investigation is initiated, the mitigation steps should be discussed with Northwin Environmental Ltd. and the current onsite operator.

The steps to extinguish a fire, should it occur, are described briefly below and should be determined on a site-specific basis. If a fire occurs, a detailed response action plan needs to be completed including details on extinguishment method, health and safety and ultimate reclamation.

2. Fire Fighting Resources

2.1. Onsite Equipment Resources

In case of a fire emergency during operational hours, the immediate response should be by landfill operational staff. There are numerous pieces of heavy equipment on site to quickly attack a fire. Currently these include:

- Front-end Loader
- Dozer
- Excavator

2.2. Fire Department Resources

The Fire Department that services the area is the Campbell River Fire Department No. 1 Fire Station at 675 13th Avenue, Campbell River, BC. which is approximately 12 km from the site.

2.3. Outside Contractor Resources

Outside contractor resources are generally required on large fires that may require several weeks or more to fully extinguish. On protracted fires, should retain appropriate outside contractors. Outside contractor's resources may be required in the following areas:

- Additional water tank trucks

small amount of water. In most cases, soil is more effective than water

- Don't waste time trying to fight a large fire with a fire extinguisher
- Commence application of water with Class A Foam or F-500 (typically at 0.5%) on the fire in-situ or dig out burning material, and soak or smother once placed on inert soil surface
- Shut down any methane gas extraction wells within 100 meters of the fire zone
- Notify the surrounding landowners if there is a chance that the fire could spread beyond the landfill.

3.2. General Procedures for Medium Landfill Fires

- Follow General Safety Procedures for reporting and evacuation - **call 911**
- Mobilize Unified Command Team
- Initiate Incident Command Structure Protocols
- Assess fire situation
- Develop firefighting strategy (water, oxygen control, overhaul, or combination)
- Assess appropriate level of respiratory protection & health and safety issues, ensure all staff wear required level of personal protection
- Notify regulatory agencies
- Implement fire-fighting strategy
- Establish Command Pos
- Implement security protocols, especially sign-in/sign-out
- Implement financial control protocols
- Install monitoring equipment to assess progress (gases, temperature)
- Review strategy daily, adjust as necessary.

3.3. General Fire Fighting Procedures for Large Landfill Fires

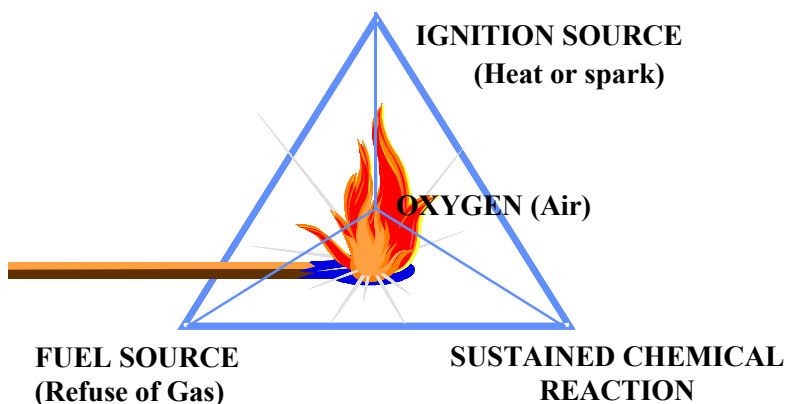
- Follow General Safety Procedures for reporting and evacuation - **call 911**
- Mobilize Incident Command Team
- Initiate Incident Command Structure Protocols
- Assess fire situation
- Establish Command Post
- Implement security protocols, especially sign-in/sign-out
- Notify regulatory agencies
- Initiate public relations program
- Initiate planning for evacuation of on-site staff and potentially affected residents, if there is

potential for air quality hazards

- Develop fire-fighting strategy (water, oxygen control, overhaul, or combination) - review strategy with technical staff from Landfill Fire Control Inc
- Assess appropriate level of respiratory protection & health and safety issues
- ensure all staff wear required level of personal protection
- Implement fire-fighting strategy
- Implement financial control protocols
- Install monitoring equipment to assess progress (gases, temperature)
- Review strategy on a daily basis, adjust as necessary.

4. Fire Fighting Methods

Four basic ingredients are required for a fire to burn: 1) fuel, 2) an ignition source, 3) sustained heat and 4) sustained chemical reaction these form the fire tetrahedron. To prevent a fire from occurring, or to control a fire that is already burning it is necessary to remove at least one of the four fire tetrahedron ingredients.



Fire prevention focuses on elimination of all potential ignition sources from the landfill, including burning cigarettes, hot loads and conditions that increase the risk of spontaneous combustion. Once a fire starts, the ignition source has been introduced. Therefore, to achieve extinguishment one must remove the heat source, cut off the oxygen supply or interrupt the rapid oxidation reaction.

There are three principal methods of fighting landfill fires, specifically the following:

- Water Extinguishment Method
- Oxygen Suppression Method
- Excavate and Overhaul Method.

A fourth method, which involves isolating the fire and allowing it to burn itself out or accelerating combustion, is generally undesirable due to associated air pollution impacts arising from

particulate matter and contaminants contained in the smoke. Open combustion of refuse is also contrary to Ministry of Environment regulations and is not permitted at Northwin Landfill.

- Selection of the preferred method of fire extinguishment is dependent upon many variables, including but not necessarily limited to size and intensity of the fire
- Depth of the fire (surface fire versus deep fire)
- Material fueling the fire (MSW, DLC waste, clean wood waste, etc.)
- Compaction of refuse in place
- Size of cells in which refuse is contained
- Thickness and continuity of intermediate cover fire breaks
- Material used for intermediate cover (clay, sand, inert soil, wood waste)
- Availability of inert cover soil (preferably clay)
- Availability and delivery pressure of water for firefighting purposes
- Population density and sensitivity of people down wind of the fire zone
- Sensitivity of other receptors in the terrestrial and aquatic environment
- Proximity of sensitive infrastructure (e.g., gas pipelines, utilities, fuel tanks, etc.)
- Risk of the fire spreading off-site
- Availability of firefighting resources.

5. Post Fire Procedures

After the fire has been extinguished the following procedures should be followed:

- Replace any fire protection equipment that was used or destroyed during the fire
- Cordon the area affected by the fire until it is safe for re-entry
- Reclaim any equipment that can be salvaged.