SPERLING HANSEN ASSOCIATES

• Landfill Engineering
• Solid Waste Planning
• Environmental Monitoring
• Landfill Fire Risk Control

December 15, 2023 PRJ22018

Jerry Tracey, CWP/CWWP
Public Works Manager
Village of Haines Junction
P.O. Box 5339
Haines Junction, Yukon Y0B 1L0

Re: Haines Junction Solid Waste Management Facility, Solid Waste Management Plan 2023-2033

Dear Mr. Tracey:

Sperling Hansen Associates (SHA) is pleased to present the final Solid Waste Management Plan for the Haines Junction Solid Waste Management Facility.

This report updates the 2013-2023 Solid Waste Management Plan as required by the Yukon Government to renew the Permit for the facility.

Our project team would like to thank you for the opportunity to work with the Village of Haines Junction and we look forward to receiving any revisions you may have. Please contact me if you have any questions regarding the report.

Yours truly,

SPERLING HANSEN ASSOCIATES

PROFESSIONAL ENGINEER
N. C. KOHNERT
2023/12/15

EGBC
Permit to Practice
No. 1003066

Nicole Kohnert, P.Eng., FEC
Senior Environmental Engineer

Haines Junction Solid Waste Management Facility
SOLID WASTE MANAGEMENT PLAN 2023-2033

PREPARED FOR: VILLAGE OF HAINES JUNCTION

VILLAGE OF HAINES JUNCTION
GATEWAY TO KLUANE

PREPARED BY: SPERLING HANSEN ASSOCIATES
Final: December 15, 2023

PRJ22018

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EXECUTIVE SUMMARY

The Haines Junction SWMF is a well located and operated solid waste management facility. Due to the ideal hydrogeologic setting, the risk of environmental impact from this natural control facility is considered low. The facility provides opportunities for solid waste diversion of common recyclables and new programs are being considered to further reduce the amount of waste being landfilled, including a composting program.

To continue the steady improvement of solid waste management services, the following is a summary of the recommendations that have been identified throughout the SWMP including a section on regionalization at the end of this summary:

1. SHA has recommended that an area-based approach be implemented that would make full use of the landfill footprint already covered with trenches (Sperling Hansen Associates, January 2021).

2. SHA recommends that annual volume tracking commence immediately via topographical or aerial survey during snow-less cover months. Alternatively, volumes can be tracked based on set sizing such as quarter, half and full truck box at the gate using a spreadsheet. This method would not take into consideration the amount of soil cover used but could be compared with surveys to determine waste to soil ratios that are useful for operational performance measurements.

3. SHA recommends that the waste streams be comingled utilizing C&D waste strategically to provide structural support for heavy machinery. Waste lifts should not exceed 0.6 m prior to compaction and be consistent with Permit 80-020 requirements with cover occurring every seven days or every 0.5 m lift.

4. SHA recommends that a minimum compaction density of 650 kg/m^3 be applied for this site to minimize annual air space consumption and maximize SWMF longevity. For best practices compaction density ranges should be from 650 kg/m^3 to 850 kg/m^3 (Environment and Climate Change Canada, 2017). Moving forward, it will be imperative for SWMF operations to achieve desired compaction densities and annually maintain a recommended minimum waste to cover ratio of 3:1.

5. SHA recommends that a regional labelling/signage system be implemented for the SWMF and the future service areas.

6. SHA recommends that an updated map of the facility be produced for onsite location enquiries. Signage for hazardous wastes should be upgraded to produce a comprehensive list of all hazardous wastes stored at the SWMF and placed in designated hazardous waste storage sheds.

7. SHA recommends that surface water ditches be upgraded to allow for climate change, ease of maintenance, and certainty in design geometry to convey the required volume of water during a storm event.

8. SHA recommends that pond sizing for this site be revisited during design with additional information on infiltration and snow melt with respect to climate change. Both areas considered for pond placement will allow for further expansion of these preliminary size recommendations. Given the amount of snow cover at the landfill, multiple ponds are recommended to capture spring freshet with the amount of snow melt.

9. The recommended approach to filling is termed the strip method of development. Recommended lifts of 2 m are proposed for the SWMF to a maximum elevation of 653 masl (Phase 3). From the 2020 topography, the ten year design for Phase 1 will combine six 2 m lifts for an approximate vertical fill height of 11 m and 3H:1V side slopes. SHA recommends a lift edge development approach for filling at top of slopes. 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.

10. To further enhance litter control, SHA recommends that Village staff experiment with the containment berm method of cell construction used at Carmacks Landfill. This approach does require additional soil for berms but is expected to result in a marked reduction in the amount of windblown litter. Stumps, mattresses and other bulky wastes can be buried within these berrns.

11. SHA recommends that as the service population grows for the SWMF, the hazardous waste storage area should by upgraded to include secondary containment. A lined surface would mitigate any spills from entering the surrounding environment.

12. SHA recommends that consideration be given to annual geotechnical site inspections during the operation of the landfill conducted by a qualified professional and coinciding with annual survey. The geotechnical inspection should be conducted by a geotechnical engineer, to inspect the active and inactive areas of the landfill footprint, to check the cover for potential problems arising from cracking, erosion especially during snow melt or slumping and to determine the state of any infrastructure that does not receive regular inspection or maintenance. If geotechnical concerns are discovered, then a mitigative action plan should be developed by the QP.

13. The engineering team explored several 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, control stormwater and minimize leachate production.

- Slopes should be effectively re-vegetated during construction of the final cover to assist in evapotranspiration and improve soil stability.
- Gas control is considered desirable beneath the barrier layer to prevent gas pressure build 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.
- The minimum requirement is for a 150 mm thick layer of topsoil. In most final cover designs, SHA typically recommends a thicker 300-600 mm layer 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. With the lower precipitation levels at Haines Junction, making a thicker topsoil layer of 300 mm is acceptable.
- SHA recommends that modelling be completed at the time of closure design to ensure all local conditions are considered when making a decision regarding material types, layer depths and type (e.g. gravel) and barrier layer type. The Hydrologic Evaluation of Landfill Performance (HELP) Model is a useful tool for this purpose.
- The recommended closure strategy for the SWMF is to permanently or temporarily cover the finished side slopes as soon as possible, starting with the south slope of Phase 1 and moving to the east and north side slopes of Phases 1 and 2. Since Phase 3 will be built overtop Phases 1 and 2, final closure of the crest of the landfill would be completed once filling has reached final contours. The timeline for the first closure is estimated to be 2055.
- In their January 2021 report, SHA recommended the Village establish a sinking fund for the progressive closure of the Landfill and post-closure monitoring at a level of $28,569 per year.

The following initiatives are recommended by Village staff:

(a) Since food waste is one of the largest components of refuse going to landfill (25 – 40 percent typically) diverting this ‘low hanging fruit’ will make the largest impact on diversion in most communities if doing so is practical and economically sound for the Village.

(b) Crushing the bottles collected at the site would save shipping costs and provide the Village with a supply of aggregate type material for on-site use, therefore purchase of a glass crusher is recommended.

(c) The Village hopes to avoid burying stumps at the Landfill to conserve air space. The following options are provided:

i. For very dirty stumps embed them in the cell construction berms at the berm core
ii. For stumps that are not dirty, they can be burned with the other brush collected at the site
iii. Break the stump up on site to knock off the dirt and then burn
iv. Disallow land clearing waste at the SWMF
v. To ensure only no dirty stumps are brought to the site, the Village could charge a fee that is high enough to incentivize customers to clean the stumps first before they are brought to the site.

(d) Install a septic field to reduce costs of hauling holding tank waste. It is recommended that the Village use a qualified professional to design the system.

Regionalization

The lifespan calculation for the SWMF included a regionalization approach in that the population from communities outside Haines Junction were included in the waste generation rate for the site. With an annual average estimated airspace consumption of 2,300 m^3, the life of the site is estimated to be to 2131. Since capacity is not the limiting factor for acceptance of out of jurisdiction waste, the Village may want to consider the challenges with respect to tracking the materials from outside the Village boundaries, either from roadside receptacles the roads maintenance company collects or communities that may have to haul longer distances to other facilities. With the Haines Junction SWMF being conveniently located and open convenient hours, the most important consideration is collecting fees for the cost of the service.

Out of jurisdiction agreements are one way to manage fee collection if the agency responsible for the waste is able to collect their costs from residents and businesses outside the Village jurisdiction. Measuring the incoming waste materials will increase the Village's costs as shown in the SWMP, however if these costs can be recouped through the agreements it would be a beneficial change of operation for all parties.

Alternatively, fees could be collected on a per volume basis from each out of jurisdiction vehicle entering the facility (show driver's license). The fee level should be assessed based on the extra costs to attend the gate that is open for specified hours for out of jurisdiction customers.

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APPENDIX SECTION

ACRONYMS AND ABBREVIATIONS

amsl	Above Mean Sea Level
bgs	Below Ground Surface
BOD	Biochemical Oxygen Demand
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
C&D	Construction and Demolition
CAGR	Compound Annual Growth Rate
CSR	Contaminated Sites Regulation
DMR	Designated Materials Regulation
EPH	Extractable Petroleum Hydrocarbons
E-Waste	Electronic Waste
ha	Hectare
HHW	Household Hazardous Waste
ICI	Industrial, Commercial and Institutional
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
LFG	Landfill Gas
LTF	Land Treatment Facility
MSW	Municipal Solid Waste
O&M	Operations and Maintenance
ODS	Ozone Depleting Substance
OH&S	Occupational Health and Safety
PAH	Polycyclic Aromatic Hydrocarbons
SWANA	Solid Waste Association of North America
SWMF	Solid Waste Management Facility
SWMP	Solid Waste Management Plan
VPH	Volatile Petroleum Hydrocarbons
WHMIS	Workplace Hazardous Materials Information System
WKA	Wildlife Key Areas
WRRI	Waste Recovery and Recycling Initiative
YESAB	Yukon Environmental and Socio-Economic Assessment Board

1. INTRODUCTION

The Village of Haines Junction Solid Waste Management Facility (SWMF) operates under Waste Management Permit 80-002 for landfill deposition and recycling of various waste products. The location of the Village of Haines SWMF is shown on Figure 1.

1.1 Solid Waste Management Plan Objectives and Scope

Sperling Hansen Associates (SHA) was retained by the Village of Haines Junction to prepare a Solid Waste Management Plan (SWMP) for the Village of Haines SWMF located in Haines Junction, Yukon. The objective of this SWMP is to satisfy regulatory requirements for an updated plan and to provide a useful and practical guide for solid waste management over the next ten years of facility operation. The scope includes site characterization, a summary of facility design, construction, operation, upgrades, strategies and initiatives, and closure and post-closure plans.

1.2 Facility and Watershed Description

The SWMF is located 2 km north of the Village of Haines Junction Highway 1 and Highway 3 intersection in the Yukon Territory and is encompassed by the Alsek River Basin which drains four subbasins: Aishihik, Dezadeash, Tatshenshina, and Kaskawulsh / Alsek southwest to the Alaskan Gulf. The site is situated on an extensive area of glaciolacustrine sediments comprised primarily of fine-grained silts and clays. The water table is situated more than 30 m below ground, and as such, the hydrogeologic environment is considered ideal for a natural attenuation landfill.

On-site landfilling operations began in the mid to late 1980’s, although a waste management permit was not issued to the Village until 2000 (Tetra Tech EBA, June 2014). The landfill was traditionally developed and operated as a trench facility with one single 6 m lift (3 m below grade and 3 m above grade). Generally, trench landfills are simpler to operate but are considered spatially inefficient and environmentally prone to generating more leachate due to a very large footprint. Inefficiency can lead to increased closure costs on a per tonne basis due to the amortized application of a closure cap over a very thin waste column. SHA has recommended that an area-based approach be implemented that would make full use of the landfill footprint already covered with trenches (Sperling Hansen Associates, January 2021).

The new area based SWMF presented in this plan is designed at industry standard 3H:1V side slopes with a maximum height of 15 m resulting in a total waste column of 18 m. This is 3 times more efficient than the current trenching approach and would provide 635,994 m^3 of gross air space. After accounting for a 1.3 m thick final cover, the net capacity is 551,299 m^3. The cover system will include approximately 1,000 mm clay overtop of the waste followed by Draintube and 300 mm of topsoil. A geomembrane liner system is not envisioned.

This air space will provide >100 years of landfill capacity at anticipated future disposal rates. Clearly, there is no reason to further expand the landfill footprint and incur additional closure and post closure liability. Moving forward, the landfill has sufficient capacity to serve as a regional facility.

The landfill is located within reservation land disposition number 115A13-023 which spans an area of approximately 54 ha. The specific landfill footprint is located within this land and on the western portion with an area of approximately 11 ha. The site plan is shown on Figure 2 and Table 1 lists the landfill legal description.

Table 1: Legal Description

Property	Civic Address	Centre of Site Coordinates
VHJL	No specific site address	N 60° 46’ 20” W 137° 30’ 42”

1.3 Waste Diversion & Disposal

The facility accepts the following waste and hazardous waste products:

Table 2: Waste Diversion & Disposal

Waste Diversion for Recycling (Recycling Centre)	Landfill Onsite Storage for Future Diversion and Recycling	Landfill Disposal or Removed to Off-Site Facilities
• Cardboard • Plastics 1 to 7 • Film Plastics • Glass • Tin • Motor Oil • Anti Freeze • Propane Cylinders • Car Batteries • Household Hazardous Waste • Mixed Paper • Beverage Containers • E-Waste • Free Store for used merchandise	• Brush and Clean Wood (for burning) • Scrap Metal • Automobiles • Tires • Concrete	• Municipal Solid Waste (MSW) • Construction and Demolition (C&D) Waste • Animal Carcasses • Hazardous ("Special) Waste [asbestos on-site; all other Special Waste removed off-site for proper disposal] • Ozone Depleting Substances (ODS) [removed off-site] • Paint [removed off-site] • Autobodies Containing Batteries, Fluids, and Mercury Switches

A substantive recycle centre has been established at the entrance to the facility. The recycle centre is a full-service facility that contains plastic diversion kiosks, a building for cardboard and packaging, and a bottle depot. Recycling Centre diversion products are shown in Table 2 above.

Brush and clean wood, scrap metal, automobiles and tires are diverted to a storage pad on the north side of the landfill. Although tires are shipped out regularly, the scrap metal and automobile hulks are accumulating to large quantities and are in need of a shipping campaign.

A free store exists at the entrance to the facility. Used merchandise including clean working used items for reuse are available.

Historically, incoming solid waste was separated and deposited at two active faces, one for municipal solid waste (MSW) which is essentially normal household waste, and the other for construction & demolition, or C&D waste.

SHA notes that there is no reason to separate C&D and MSW waste. Future comingling these waste streams in one active face would be beneficial to minimize active landfill faces, mitigate the risk for spontaneous landfill fire, and introduce a number of cost saving efficiencies. C&D waste can also be crushed and used as a traffic layer or tipping pad to support heavy traffic on top of MSW loads.

1.4 Background Reports and References

Various reports, maps, and web sites were available for background information purposes. Major technical reports are listed below. All references to background reports, maps, and web sites can be found in Section 13 of this report.

- Current SWMF cost modeling, lifespan analysis, waste generation estimations, and final closure costs were documented in the report *Yukon Municipal Landfill Closure and Post Closure Costs Report – Haines Junction* by SHA on January 27, 2021, (Sperling Hansen Associates, January 2021). Design for the area-based landfill concept for the SWMF was included in this report as was a review of site's current monitoring program and water quality.
- The Site's hydrogeological conceptual model was documented in the report *Hydrogeological Assessment Haines junction Waste Disposal Facility* by Tetra Tech in April 2011 (Tetra Tech EBA, April 2011).
- The previous SWMP was published in June 2014 by Tetra Tech EBA and titled *Haines Junction Solid Waste Management Plan 2013-2-23 Revision Number: 0* (Tetra Tech EBA, June 2014).

1.5 Regulatory Framework

The following Yukon acts, regulations, and guidelines provide the regulatory framework governing development, operations, closure, and post-closure of Yukon SWMFs:

- Environment Act RSY 2002, c.76: defines the requirement for SWMPs and provides legislation for the following SWMF related Regulations:
  - Recycling Fund Regulation O.I.C. 1992/135
  - Beverage Container Regulation O.I.C. 1992/136
  - Special Waste Regulations O.I.C. 1995/047
  - Spills Regulation O.I.C. 1996/193
  - Air Emission Regulations O.I.C. 1998/2007
  - Solid Waste Regulations O.I.C. 2000/11

- Ozone Depleting Substances and Other Halocarbon Regulations O.I.C. 2000/127
- Contaminated Sites Regulation (CSR) O.I.C. 2002/171
- Designated Materials O.I.C. 2003/184.

- Waste Management Permit: Issued for the operation of a SWMF pursuant to the Environment Act, the Solid Waste Regulations, the Air Emissions Regulations, and the Hazardous waste Regulations. Provides specific requirements for SWMPs.
- Yukon Environmental and Socio-economic Assessment Act S.C. 2003, c. 7: Establishes the process to assess the environmental and socio-economic impacts from SWMF activities as part of the Waste Management Permit renewal process.
- Forest Protection Act O.I.C. 2003/57 and the annexed Forest Protection Regulation (2003): Require that burning operations do not threaten forest land.
- Yukon Wildlife Act RSY 2002, c.229: Prohibits SWMF operations from providing waste available to wildlife.
- Occupational Health and Safety Act O.I.C. 2006/178: Provides safety regulations for site operations including mobile equipment, materials and storage, and construction and building safety (trenching and excavating as it relates to cell construction).
- Public Health and Safety Act C.O. 1958/79: Stipulates setback distances from SWMFs to roadways, railways, rights-of-way and cemeteries of 91 and 457 m (100 yards and 500 yards) to buildings, requirements for burial of waste, and limits on personal deposit of waste.
- Highways Act RSY 2002, c.108: Stipulates a 50 m setback distance from SWMFs to highways.
- Territorial Lands (Yukon) Act SY 2003, c.17: Provides regulation for SWMF land-use.
- Yukon Waters Act SY 2003, c.19: Provides regulation limiting depositing waste to surface water and groundwater (refer to the Act for a detailed definition of "waste" as it pertains to this regulation).
- Applicable Guidelines and Fact Sheets accessible from the Environment Yukon website: Asbestos Disposal, Disposal of Animal Carcasses, Used Tire Management Program, Tire Storage, Burning Garbage, Facility Closure

Requirements, Facility Construction Requirements, Facility Monitoring Requirements, and SWMPs.

2. SITE CHARACTERIZATION AND ENVIRONMENTAL DESCRIPTION

2.1 Climate

Haines Junction is located within the Boreal Cordillera Ecozone, Ruby Ranges Ecoregion in the Yukon Territory (Smith, C.A.S., et al., 2004). Representative weather stations are Burwash, Aishihik, and Haines Junction.

The Haines Junction weather station is located approximately 3.8 km northeast from VHJL (Climate ID. 2100630). Climate normals for Haines Junction were available from the Government of Canada web site from 1961 to 1990. Climate normals from Burwash (Climate ID. 2100182) were slightly more current from 1981 to 2010. The Burwash climate station is located approximately 100 km northwest of the SWMF. Climate normals for the Aishihik weather station were unavailable. Available daily temperature and precipitation data is listed in Table 3 below.

Per the Yukon Technical Guidance – Protocol 7 Groundwater Investigation and Characterization, precipitation in the Yukon Territory is generally low with groundwater recharge the greatest in the late spring to early summer due to snowmelt.

Table 3: Climate Normals Stations

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temperature (°C) - Haines Junction	-21.5	-15.3	-9.1	-0.4	5.4	10.3	12.6	10.8	6.2	-0.4	-12.5	-21.1	-2.9
Temperature (°C) - Burwash	-20.5	-16.4	-10.8	-1.2	5.7	11.1	13.1	10.9	5.1	-3.4	-14.6	-17.8	-3.2
Precipitation (mm) - Haines Junction	32.3	18.6	9.2	9	15.7	28.3	35.2	28.5	34.1	35.4	30.5	29	305.7
Precipitation (mm) - Burwash	8.4	7.3	6.9	6.8	24.1	49.2	67.9	41.8	25.2	16.1	10.8	10.2	274.7

Based on the available data, annual precipitation ranges from 274.7 mm to 305.7 mm for the ecoregion.

Although Haines Junction is relatively dry, it is important to implement progressive closure, to channel run-off from the cap away from the landfill site and to prevent run-on of storm water by properly ditching the site.

2.2 Physical and Biological Environment

2.2.1 Topography

The landfill slopes gently from north to south at a grade of approximately 1.35 % from 635 masl to 630 masl. Local topography maintains this slope to the south and the Dezadeash River which is situated below 600 masl. Regionally, Haines Junction is located in a valley that is surrounded by various mountain ranges and plateaus: Ruby Range to the North, the St. Elias Mountains and Kluane Ranges to the west and south, The Yukon-Stikine Highlands further to the South, and the Dezadeash Range to the east.

2.2.2 Permafrost

Permafrost is sporadic in southern parts of the Ruby Range Ecoregion which includes Haines Junction (Smith, C.A.S., et al., 2004) and it has been recorded at Haines Junction to depths of 7.3 m. Generally, permafrost is variably distributed beneath hillsides and more common beneath north facing slopes. Permafrost depth and extent information was not available for VHJL.

2.2.3 Water Drainage and Nearby Waterbodies

Locally, the landfill is located between Pine Creek and Pine Lake to the North and Dezadeash River to the south. The distance from the centre of the site to these water bodies is approximately 2.5 km, 3.4 km, and 2.8 km respectively. A northeast to southwest trending unnamed creek is located approximately 200 m south of the site and discharges finally into Dezadeash River. According to Village staff, the creek flows through a culvert under the Alaska Highway, no fish travel this stream as it is mostly spring run-off, and the creek does not flow in the summer unless there are heavy rains.

Regionally, the Dezadeash River basin drains an area of approximately 4,756 km^2 and flows westward, then southward, at the location south of the landfill. Flow is described as slowly meandering within the wide valley floor with flanked wetlands (Mackay, December

1989). As flow continues south, Dezadeash River confluences with Kuskawulsh River and eventually flows into the Alsek River to the Pacific Ocean.

2.2.4 Vegetation

Locally, the area surrounding the landfill is a forest covered area. Forest cover near the landfill is a mix of mature spruce forest intermixed with willow and poplar. Various grasses and other shrub species are also present (Tetra Tech EBA, June 2014). Regionally, Vegetation in the ecoregion is mainly boreal forest with white spruce dominating the landscape under the tree line of approximately 1200 masl (Smith, C.A.S., et al., 2004).

2.2.5 Wildlife

The Ruby Ranges Ecoregion supports a vast diversity and abundance of wildlife including caribou, Dall sheep, coyotes, wolf, grizzly bears, elk, moose, bison, muskrats, and other rodents. The SWMP falls within the Wildlife Key Area (WKA) 4715 late winter range for moose (Yukon Government, 2022). The late winter range is considered to be a key area where moose gather between January and April that have relatively shallow snow depths and abundant browse.

2.2.6 Fish

According to Fisheries and Oceans Canada, the Dezadeash River is classified as a fish-bearing river. Fish species known to be found in this waterbody include lake whitefish, round whitefish, whitefish, lake trout, longnose sucker, burbot, northern pike, arctic grayling, slimy sculpin, dolly varden, and kokanee salmon (Tetra Tech EBA, June 2014).

2.3 Conceptual Hydrogeology

A hydrogeological assessment was conducted for the SWMF in 2010 (Tetra Tech EBA, April 2011). The three existing wells at the SWMF were installed and developed at that time representing upgradient conditions (HJ-MW01) and downgradient conditions (HJ-MW02 & HJ-MW03). Well completion details are shown in Table 4.

Table 4: VHJL Well Completion Details

Well ID	Drilled Depth (mbgs)	Screened Lithology	Screened Interval (mbgs)	Hydraulic Conductivity (m/s)
HJ-MW01	38.4	Silt with Fine Sand	35.4 - 38.4	$4.1 \times 10^{-7} – 4.7 \times 10^{-7}$

Well ID	Drilled Depth (mbgs)	Screened Lithology	Screened Interval (mbgs)	Hydraulic Conductivity (m/s)
HJ-MW02	41.9	Gravelly Sand (with some silt)	38.9 - 41.9	1.8×10^{-6} – 2.2×10^{-6}
HJ-MW03	47.2	Gravelly Sand (with some silt)	44.2 – 47.2	1.3×10^{-6}

Two units were documented within screened intervals representing a silt with fine sand and a gravelly sand. Calculated hydraulic conductivities ranged from 4.1×10^{-7} m/s to 2.2×10^{-6} m/s.

Groundwater linear velocities were calculated using Darcy's equation (Tetra Tech EBA, April 2011):

V = Ki / n

where: V = groundwater linear groundwater velocity (m/s)
K = hydraulic conductivity determined from site specific testing (m/s)
i = horizontal hydraulic gradient (m/m)
n= porosity of soil assumed to be 0.25.

The estimated maximum linear groundwater velocity utilizing the maximum hydraulic conductivity of 2.2×10^{-6} m/s noted in the gravelly sand, and a horizontal gradient of 0.018 was calculated at 3.1 m/year (Tetra Tech EBA, April 2011). The estimated average linear groundwater velocity was calculated using the average hydraulic conductivity of 1.0×10^{-6} m/s at 1.4 m/year (Tetra Tech EBA, April 2011).

Note that SHA recalculated previous estimates using Darcy's equation and found some discrepancies. Generally, bulk hydraulic conductivity estimates in the Yukon Territory require a minimum of five wells for calculations of the average linear groundwater velocity (Yukon Government, November 2019). Bulk hydraulic conductivity in instances where there are five or fewer wells requires that the maximum K value should be utilized. Current estimates for linear groundwater velocity are provided utilizing groundwater levels from 2020 in Table 5 below.

Table 5: Linear Groundwater Velocity

Hydraulic Conductivity (m/s)	Horizontal Hydraulic Gradient (m/m)	Porosity	Linear Groundwater Velocity (m/year)
Minimum: 4.1×10^{-7}	0.024	0.25	1.2
Maximum: 2.2×10^{-6}	0.024	0.25	6.7

Thus, the minimum and maximum linear groundwater velocities for the site are estimated at 1.2 m/year and 6.7 m/year respectively. Therefore, SHA's conservative groundwater velocity estimate is 6 times faster than that estimated by Tetra Tech EBA.

Given that the Dezadeash River is located about 2.8 km south of the landfill site, the travel time to reach the river is estimated at 400 years. Given the long travel time and large flows in the river, no measurable impact in water quality is anticipated, even in the very long term.

With respect to the unnamed creek 200 m from the landfill site, the travel time to reach this location is estimated to be 30 years.

Four aquifers are considered to exist below the site (Tetra Tech EBA, April 2011). This is summarized in the Table below.

Table 6: Principal Aquifers

Aquifer Name	Unit	Comments
Shallow Quaternary Aquifer	Intergranular Porous Media	Directly below VHJL. Upper most water bearing unit. Monitoring wells HJ-MW01, HJ-MW02, and HJ-MW03 are screened within this unit. The water table is estimated from previous reporting at approximately 30 mbgs with an aquifer depth of approximately 30 m.
Intermediate Quaternary Aquifer	Intergranular Porous Media	Below the Shallow Quaternary Aquifer. Multiple aquifers of varying extents, hydraulic properties, and degrees of confinement.
Deep Quaternary Aquifer	Intergranular Porous Media	Approximately 350 m to 400 m deep. Confined aquifer with artesian conditions and a potentiometric elevation above ground level. Village of Haines water supply well is screened in this unit.

Aquifer Name	Unit	Comments
Shallow Quaternary Aquifer	Intergranular Porous Media	Directly below VHJL. Upper most water bearing unit. Monitoring wells HJ-MW01, HJ-MW02, and HJ-MW03 are screened within this unit. The water table is estimated from previous reporting at approximately 30 mbgs with an aquifer depth of approximately 30 m.
Bedrock Aquifer	Fractured Rock	Potentially a source of lateral and vertical recharge to the Quaternary aquifers.

Recharge to the Quaternary aquifers is considered from rainfall infiltration and alpine surface water flow to alluvial fans and / or deltas from regional mountain ranges. Groundwater flow within the Shallow Quaternary Aquifer is considered to move north to south discharging at the Dezadeash River.

Per the hydrogeological assessment report (Tetra Tech EBA, April 2011), the SWMF is constructed on a thick sequence of clay till below the landfill and above the Shallow Quaternary Aquifer. This layer serves to restrict the movement of leachate and other organic contaminants to the aquifer below. The conceptual contaminant transport mechanism for the landfill involves the percolation of contaminants through the tight underlying soils toward the Shallow Quaternary Aquifer below. If infiltration to the Shallow Quaternary Aquifer does occur, further transport to deeper aquifers could potentially also occur. Contaminant flow would then proceed to downgradient receptors.

The nearest residences to the site are situated over 500 m to the south, on the opposite bank of the unnamed creek. Given that the shallow aquifer is not likely in a hydraulic connection with the creek or landfill run-off, the groundwater wells in the residential areas are protected from any possible contamination impacts. In summary, the landfill is situated in a very protective hydrogeologic setting where impacts to surface and groundwater resources are considered remote.

3. WASTE GENERATION AND CAPACITY ANALYSIS

The SWMF serves the population of Haines Junction and based on capacity, has potential to be used as a regional facility. Future neighboring communities served may include areas northwest of Haines Junction to Beaver Creek, and southern communities including Dezadeash as shown on Figure 2.

Population statistics over the previous 10 years for Haines Junction were used to estimate 2023-2033 population estimates and are shown in the table below, Data was retrieved from the Yukon Socio-Economic Web Portal (Yukon Government, 2022).

Table 7: Population Statistics for Haines Junction

Year	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012
Population	1009	984	964	960	931	904	885	874	866	878
CAGR	2.5	2.1	0.4	3.1	3.0	2.1	1.3	0.9	-1.4	2.6
Average CAGR	**1.6**									

An average Compound Annual Growth Rate (CAGR) of 1.6 % was calculated. Based on the available information, the population is expected to increase from 1,009 in 2021 to approximately 1,042 in 2023. The population at the end of the 2023-2033 time period for Haines Junction is expected to be 1,221.

Population data was available for nearby communities of Beaver Creek, Burwash Landing, and Destruction Bay (Yukon Government, 2022). The total population of these communities in 2021 was 273 people. Based on the available population data, the average CAGR over the previous ten years was calculated at 0.2%. The population at the end of the 2023-2033 time period for these neighboring communities is expected to be 346 people.

An expected service population of approximately 1,600, which includes Haines Junction and neighboring communities, may potentially be expected by 2033. Note that information on seasonal population was unavailable.

3.1 Waste Generation

Data, including annual volumes of waste stored and landfilled at the SWMF, is not being reported due to the absence of scales or volume tracking. SHA recommends that annual volume tracking commence immediately via topographical or aerial survey during snow-less cover months. Alternatively, volumes can be tracked based on set sizing such as quarter, half and full truck box at the gate using a spreadsheet. This method would not take into consideration the amount of soil cover used but could be compared with surveys to determine waste to soil ratios that are useful for operational performance measurements.

Waste generation was estimated using scaled data from the City of Whitehorse. Data was available to SHA from the City of Whitehorse from 2000 to 2019 (Sperling Hansen Associates, January 2021). Waste generation rates were calculated using data from 2015 to 2019 as follows:

- MSW generation rate of 1.6 kg/capita/day
- C&D generation rate of 0.7 kg/capita/day
- Total waste generation of 2.3 kg/capita/day.

Based on the above per capita waste generation estimates for MSW and C&D of 2.3 kg/capita/day, the Haines Junction SWMF is projected to receive between 1,100 tonnes and 1,300 tonnes of combined waste per year during the 2023-2033 time period. This is graphically shown below.

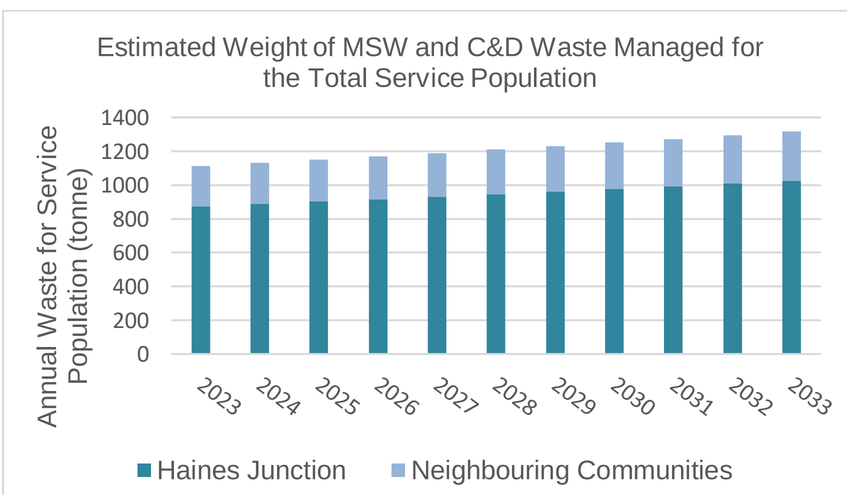

Figure 3-1: Estimated Annual MSW and C&D Quantity

MSW would account for approximately 800 tonnes to 900 tonnes per year while C&D waste is estimated at 300 tonnes to 400 tonnes per year for the period of 2023-2033.

3.2 Waste Diversion

The SWMF is equipped with collection areas for electronic waste, plastics, household hazardous waste, oil & glycol waste, refundable products, and cardboard/boxboard (collection and baling). A transfer bin is also available for the collection of brush and stumps, mattresses, tires, concrete (crushable waste), scrap metal and auto bodies are segregated at the site. Clean wood and brush are placed in a burning pile and burning takes place annually. Photos below show the stockpiles as seen at the site by SHA in October 2020.

Stockpiles: Auto Hulks, Mattresses, Concrete & Scrap Metal

Photo 1: Segregation Stockpiles

Recyclables diversion data for limited items was available for the Haines Junction SWMF from 2016 to 2021 and used with available population data to estimate the average recyclable generation rate for Haines Junction. The data is summarized in the table below.

Table 8: SWMF Recyclables Generation Rates

Recyclable Item	2016	2017	2018	2019	2020	2021
Beverage Cans	6,418	7,685	6,804	6,677	5,845	6,418
Beer Bottles/Cans	13,920	14,400	12,975	10,452	4,510	3,273
Milk Cartons	1,120	385	1,187	833	791	694
Plastic Bottles	2,161	2,244	3,358	2,945	2,420	2,658
Glass Bottles	15,975	19,170	18,145	16,413	12,172	16,901
Tetra Pac Containers	495	585	1,526	1,067	916	879
Tin Cans	28	29	351	15	0	0
Mixed Plastics	10,620	11,570	10,340	6,521	7,441	6,159
Soft Plastic	920	1,380	3,634	4,591	1,655	161
Paper	6,020	5,880	9,661	5,140	10,562	7,794
Boxboard & Cardboard	32,760	28,575	32,223	31,289	23,934	20,017
Styrofoam	756	1,092	827	631	72	0
E-Waste	0	0	990	0	0	0
Textiles	0	1,098	1,267	1,512	420	0
Yearly Total (kg)	**91,193**	**94,093**	**103,288**	**88,086**	**70,738**	**64,954**
Population	904	931	960	964	984	1,009
Recyclables Generation (kg/capita/day)	**0.28**	**0.28**	**0.29**	**0.25**	**0.20**	**0.18**

Based on the available recyclable information, the average recyclable generation for the summarized list was calculated at 0.25 kg/capita/day and assumed to be similar for the neighboring communities. Thus, the SWMF is projected to receive between 120 tonnes to 140 tonnes of these recyclable materials per year during the 2023-2033 time period. This is graphically shown below.

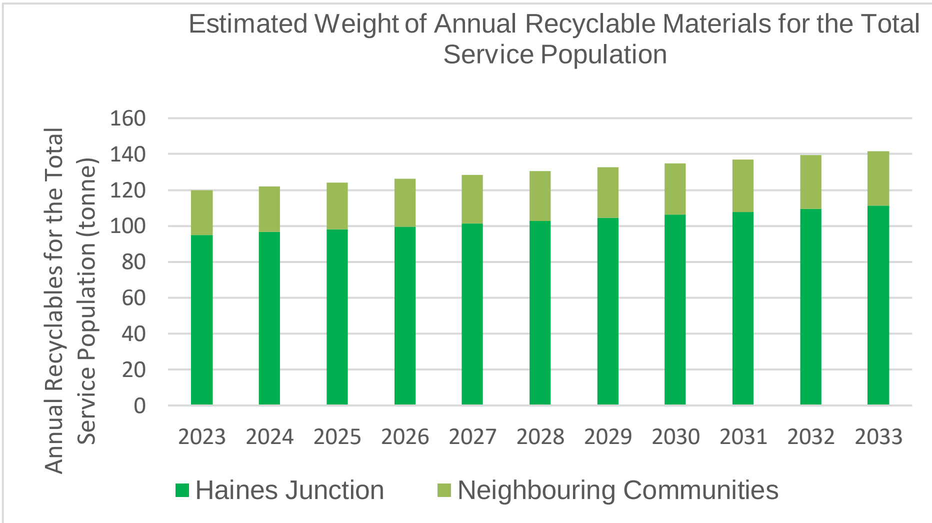

Figure 3-2: Estimated Annual Recycling Weights

Glass is currently diverted and may be a useful commodity if crushed for landfill operations. Crushed glass may be used as a drainage aggregate or for construction in the waste area.

Note that annual estimates for the collection of scrap metal, auto bodies, tires, clean wood & brush, and concrete were unavailable. These items should be accounted for in the future through annual topographic survey or volume tracking at the gate. Household hazardous waste and oil & glycol waste should be tracked upon entry and reported annually as well.

A free store is available onsite for used merchandise and includes clean working used items for reuse. This facility is maintained and monitored by the attendant. Reuse quantity information is not available but could be assessed on a regular basis to show the community's efforts to divert material from disposal.

3.3 Compaction and Cover Material

Incoming solid waste is separated and deposited at two active faces, one for MSW which is essentially normal household waste, and the second for C&D waste using a transfer process. MSW is first collected in a compacting stationary roll off bin at the site entrance and then transferred to the active face so as to keep residential vehicles away from the active face. Commercial vehicles are given access to the face when requested. Transfer bins also exist for C&D waste collection prior to deposition.

Historically, compaction densities for MSW and C&D at the two faces were documented at 150 kg/m^3 and 250 kg/m^3 respectively (Tetra Tech EBA, June 2014). SHA recommends that a minimum compaction density of 650 kg/m^3 be applied for this site to minimize annual air space consumption and maximize SWMF longevity. For best practices compaction density ranges should be from 650 kg/m^3 to 850 kg/m^3 (Environment and Climate Change Canada, 2017). These levels of compaction are generally achieved with the following guidelines:

- Refuse to be compacted should be placed on the active face in layers of no more than 0.6 m (2 ft)
- A slope of 5H:1V should be maintained to achieve optimal compaction
- Evenly spread refuse should be compacted by multiple passes up and down the active face with compaction equipment. Preferable equipment would include a steel wheeled compactor or long narrow tracked dozer.
- Multiple passes should be made over the waste until no further compaction occurs
- A rule of thumb is that five passes are required to achieve good compaction, but this is dependent on size, weight, and wheel track configuration
- Compact the entire active face before applying the next layer of waste.

SHA notes that in our opinion there is no reason to separate C&D and MSW waste and to operate two active faces. Consolidation of both streams at one active face is more efficient and can introduce a number of significant cost saving efficiencies. Comingling of both waste streams at one active face can also lower the risk for spontaneous fire and permit higher compaction rates.

Per Permit 80-002, the permittee is required to cover any exposed waste in a cell that could be moved by animals or wind with soil or other comparable material to a depth of 0.1 metres, or any other depth that an environmental protection officer considers necessary to prevent windblown solid waste and attraction of birds. Per the Permit 80-002, as the population for Haines Junction is between 500 and 5,000 people, this must occur every seven days or after 0.5 m of waste is deposited. To improve operational efficiency and increase the waste to cover ratio which is now estimated at a poor 1 to 1 ratio, SHA recommends that the Village of Haines Junction continue to utilize steel plates as an alternate daily cover system (Sperling Hansen Associates, January 2021) and use only the recommended amount of intermediate cover (0.3 m). This cover system allows the active face to be capped every seven days, even during winter, with a reusable cover that could be removed on subsequent waste deposition. The cost savings related to the steel plates is significant in terms of improved landfill airspace and cover materials.

Annual compaction densities and air space capacity for the SWMF can be calculated via accurate record keeping of waste type and volume upon receipt coupled with an annual topographic survey.

3.4 Capacity

An area-based approach is recommended for the SWMF that would increase the lifespan while maintaining the same footprint. SHA has designed the SWMF to exceed previous lifespan estimates with capacity reached in 2040 to a now >100 years capacity with options to be used as a regional facility (Sperling Hansen Associates, January 2021).

The design includes 635,994 m^3 of gross air space which, after accounting for a 1.3 m thick final cover, will include a net capacity for waste of 551,299 m^3. The area based design is shown in Figures 5 and 6 and L-1 to L-4 in Appendix D. Moving forward, it will be imperative for SWMF operations to achieve desired compaction densities and annually maintain a recommended minimum waste to cover ratio of 3:1.

3.4.1 Municipal Solid Waste Landfill Cell

Based on a waste generation rate of 1.6 kg/capita/day, the SWMF can expect 800 tonnes to 900 tonnes of MSW collection annually in the 2023-2033 time period. To be conservative, this includes MSW waste from neighboring communities that have potential to be included in regional agreements for waste acceptance.

With a compaction rate of 650 kg/m^3, an annual air space consumption of approximately 1,200 m^3 to 1,400 m^3 is expected. Continued use of steel plates alternate daily cover will help keep the waste to cover ratio low and conserve air space.

3.4.2 Construction and Demolition Landfill Cell

Based on a waste generation rate of 0.7 kg/capita/day for C&D, the SWMF can expect 300 tonnes to 400 tonnes of C&D collection annually in the 2023-2033 time period. To be conservative, this includes C&D waste from neighboring communities with potential to be included in regional agreements for waste acceptance.

With a compaction rate of 650 kg/m^3, an annual air space consumption of approximately 500 m^3 to 600 m^3 is expected. As described in section 4.4.1, daily soil cover would be minimal if the Village continued the use of the steel plates alternative cover system. Intermediate cover should be placed on completed cell surfaces, including the top deck and side slopes.

3.5 Lifespan Analysis

A detailed model of airspace consumption was developed for the SWMF using projected operating parameters. The decision around the use of specific parameters for estimating airspace depends on population projections over the life of the SWMF, the expected waste diversion efforts, the amount of soil used for daily and intermediate cover compared to the amount of compacted waste in each lift, the level of effort used for compacting waste in each lift, and the estimated settlement rates. Lifespan calculation parameters for the SWMF are listed in the table below.

Table 9: Lifespan Parameters

Parameter	Lifespan Parameters
Population Growth Rate	1.6 % for the Village of Haines Junction and 0.2% for neighbouring communities estimated to be involved in regionalization
Waste Disposal (MSW + C&D kg/capita/day)	2.3
Waste-to-Cover Ratio (vol/vol)	3:1
Waste Density (kg/m^3)	650
Settlement Rate	5 %

Note that the contributing population growth and waste disposal rate are very important to this calculation and can vary significantly due to external or socio-economic factors as is the waste to cover ratio. Minimizing the amount of daily cover can result in extending the lifespan and deferring capital expenditures for new phases, expansions or locations for many years. This extended lifespan will also provide more time to accumulate tipping fee revenue that can be used to contribute to landfill closure reserves. The closure reserves should be reviewed on an annual basis and the annual funding contribution should be adjusted as necessary to ensure that there will be sufficient funding to implement closure of each phase when required (Environment and Climate Change Canada, 2017).

Considering the expected depth of the waste column, SHA uses a standard settlement rate of 10% based on experience with other similar facilities. However, settlement can be estimated for the SWMF via regular annual survey and diligent record keeping. Based on this information, the lifespan is estimated to 2131.

A summary of information in the 2020 to 2032 timespan is presented in Table 10 below. The full lifespan table is included in Appendix A.

Table 10: Lifespan Analysis

Year	Population VHJ	Population Neighbouring Communities	Estimated Regional Population	Total Disposal of MSW and C&D (tonnes)	Waste Volume (m^3)	Cover Material (m^3)	Settlement Reduction (m^3)	Total Airspace Consumption (m^3)	Cumulative Airspace Consumption (m^3)
2020	984	296	1280	1,075	2,149	716	-143	*2,722	2,722
2021	1009	273	1282	1,076	2,152	717	-143	*2,726	5,449
2022	1025	274	1299	1,090	2,181	727	-145	*2,762	8,211
2023	1042	274	1316	1,105	1,700	567	-113	2,153	10,364
2024	1059	275	1333	1,119	1,722	574	-115	2,181	12,545
2025	1076	275	1351	1,134	1,745	582	-116	2,210	14,755
2026	1093	276	1369	1,149	1,768	589	-118	2,239	16,994
2027	1110	276	1387	1,164	1,791	597	-119	2,268	19,262
2028	1128	277	1405	1,179	1,815	605	-121	2,298	21,560
2029	1146	277	1424	1,195	1,839	613	-123	2,329	23,889
2030	1164	278	1442	1,211	1,863	621	-124	2,360	26,249
2031	1183	279	1462	1,227	1,888	629	-126	2,391	28,640
2032	1202	279	1481	1,243	1,913	638	-128	2,423	31,063
2131	**5786**	**340**	**6126**	**5,143**	**7,912**	**2,637**	**-527**	**10,022**	**557,300**

"*" A lower compaction rate of 500 kg/m^3 is estimated from 2020 to 2022. The target compaction rate is 650 kg/m^3 included from 2023 to 2131.

In the 10 year timespan of 2023 to 2032, average air space consumption is estimated at approximately 2,285 m^3. A fill and phasing strategy is included in Section 4.2.

4. FACILITY DESIGN

4.1 Layout and Infrastructure

The SWMF layout and infrastructure plan is shown on Figure 3. The layout consists of the following three service regimes:

1. Refundable service area (accessible five days/week) – users are able to receive refunds on pre-sorted and pre-counted refundable items.
2. MSW (household waste) drop-off, recyclables drop-off, transfer station for C&D waste, metals, and brush service area (accessible seven days/week) – users can drop of MSW (household waste) into the compactor. Bins exist for limited C&D materials, brush, and lumber.
3. Specific MSW and C&D area (accessible five days/week) – users are able to access gated areas of the landfill to deposit various MSW including scrap metal, tires, mattresses, concrete, auto bodies, appliances, yard waste, certain hazardous waste and regulated wastes. C&D waste from construction, renovation, repair and demolition of houses, large building structures can be deposited including wood, steel, concrete, gypsum, masonry, plaster, and metal. All items must be segregated and deposited at specified locations.

Services are facilitated by one attendant each for the recycling and landfill service areas. Scheduling includes five days/week for the recyclable attendant and four days/week for the landfill attendant. The recycling attendant provides refundable oversight and provides segregation and baling of recyclables including preparation for transport. The landfill attendant provides landfill oversight/operation, segregation of materials, and maintenance of waste roll-off bins and the compactor.

Equipment and machinery utilized in processes are shown in the table below.

Table 11: Equipment and Machinery

Equipment	Description
CAT 953K	Tracked Waste Handler Loader with Dirt Bucket, GP Bucket, Grapple, Pallet Forks, V-Plow
2 X Harmony M42HD	Recyclable Baling Machines (Bale Size: 559 mm x 1,067 mm x up to 762 mm)
Other	Pallet Jack for Bale Staging, Propane Warehouse Forklift

4.1.1 Groundwater Monitoring Wells

The SWMF contains three monitoring wells, HJ-MW01 (background), HJ-MW02, and HJ-MW-03. Well completion details are provided in Section 2.3. Monitoring well locations are shown on Figure 2 and Figure 3.

4.1.2 Signage

Signage appears at the front entrance for the SWMF with information on service hours. Emergency phone numbers are shown at the site including phone numbers to report spills and poachers. Conservation officer contact information is shown as is the Village of Haines Junction Office number and police & ambulance.

Collection areas are clearly labelled for recyclables, hazardous waste, domestic waste, metal, construction, and brush. The free store and mixed paper & cardboard area are also labelled. SHA recommends that a regional labelling system be implemented for the SWMF and the future service areas.

Hours and a map of the gated landfill area are shown on the SWMF web site (Village of Haines Junction, 2022) and also included onsite. Inside the landfill, areas are clearly marked for grubbing, household waste, tires, propane cylinders, and metal.

Signage requirements comply with Permit 80-002. SHA recommends that an updated map of the facility be produced for onsite location enquiries. Signage for hazardous wastes should be upgraded to produce a comprehensive list of all hazardous wastes stored at the SWMF and placed in designated hazardous waste storage sheds.

4.1.3 MSW and C&D Waste

The previous approach for MSW included continuous burial progressively over a series of fifteen cells. C&D waste was deposited in another active area. SHA recommends that these waste streams be comingled with operations utilizing C&D waste strategically to provide structural support for heavy machinery. It is recommended that compaction to 650 kg/m^3 be attained via multiple passes of a tracked loader. Waste lifts should not exceed 0.6 m prior to compaction and be consistent with Permit 80-020 requirements with soil cover being placed on the active face once every 7 days of advance, and the Revelstoke Iron Grizzly ADC being deployed daily in between soil cover applications.

4.2 Fill And Phasing Strategy

Multiple phases are envisioned over the landfill lifespan. SHA recommends that an area-based approach be utilized for waste deposition. This approach would require slight modification of current operations; however, landfilling would continue over the existing landfill with the existing surface serving as a base.

Preliminary phasing is shown on Figures L-1 to L-4 in Appendix D. SHA envisions that Phase One be built to a crest of approximately 30 m width. Phase Two should be built adjacent to Phase One to the north, and both to an elevation of 644 masl. Phase Three can be constructed on top of Phases One and Two to an elevation of 653 masl as shown in Figure 5 (Cut/Fill in Figure 6).

The filling strategy for Phase One includes the landfilling of approximately 95,000 m^3 of waste and is shown on Figures L-1 to L-4 in a series of four lifts (not including last two lifts of the same design). Lifespan modelling indicates that this fill plan (lifts 1 to 4) should continue to 2043 when the capacity with be reached and subsequent lifts can continue to achieve an overall crest width of approximately 30 m and 644 masl. The filling strategy for the landfill should be updated during the subsequent SWMP in 2033. Over the 10-year time period from 2023 to 2032, approximately 23,000 m^3 is expected to be deposited.

The comingling of C&D waste with MSW will provide structural support for heavy machinery, reduce fire risk and produce landfill efficiencies.

Lifts are designed to achieve an operating deck grade of 2 % to facilitate leachate drainage. Thus, lifts one and two begin by filling in space on the landfill floor to achieve this grade. Lifts three and four will continue spanning the full length of Phase One from east to west. Each lift is composed of a series of cells which vary in geometry but generally maintain a width of 32 m to 35 m to achieve required compaction and manage the tipping face to the length and width of the ADC (steel plate length and width are 32’ x 8’).

Lift one will begin to the north with subsequent cells moving to the south. Waste will be pushed down into the lower elevation from west to east. The estimated waste volume to complete lift one is 5,300 m^3.

Lift two will begin from the south with subsequent cells moving to the north. Waste will be pushed up from the east. The estimated waste volume to complete lift two is 10,900 m^3.

Lifts three and four will begin in cells to the south and move north. The estimated waste volumes to complete lift three and four are 16,450 m^3 and 25,900 m^3 respectively.

The landfill base should be sloped at 2 % towards the southwest where runoff can be collected in a pond and allowed to infiltrate. This sequence of filling will continue for all subsequent lifts in Phase One (approximately two more lifts to 644 masl and a volume of 101,750 m^3).

A 2 m lift height shall be maintained for all filling operations. The active face shall be sloped at 5H:1V, resulting in an active face length of 10.2 m. 4 RIG plates will be required to fully cap the active face that should be maintained 10 m wide. As shown in the fill plan drawings, each cell is about 30 m wide. SHA recommends that each cell be constructed in 3 strips, 10 m wide. These strips should be advanced concurrently, and rotated on a weekly basis, with the active strip being covered with ADC, and the other two inactive strips covered with gravel.

4.3 Surface Water Management

Currently clean surface water, flowing outside of the landfill footprint, is managed on site via a network of ditches and culverts running along the site access roads which connect and discharge to a common point at the location of the cattle guard at the site's entrance. At this location, water is conveyed via a culvert system to the surrounding environment. Flow is overland and south to an unnamed creek located on a meandering path of approximately 200 m downgradient. The run-off is considered to be non-impacted by landfill leachate as it originates only from the entrance road and the recycling area parking lot. Village staff has confirmed that runoff from the landfill footprint tends to flow northeast and not south, therefore the unnamed creek is not considered to be in the direct flow path of potentially contaminated run-off.

Per general facility construction requirements of the Yukon Solid Waste Regulation (Yukon Government, November 2019), ditches are required to be designed to accommodate a 1 in 25 year storm or snowmelt event. SHA conducted a review of surface water ditches based on the 2020 topographic survey. Generally, ditches are overgrown with vegetation and are of varied geometry with potential to produce varied results in conveyance of the required design storm event. SHA recommends that surface water ditches be upgraded to allow for climate change, ease of maintenance, and certainty in design geometry to convey the required storm event.

The Rational Method was conducted for the SWMF and is shown in Appendix B. SHA utilized a time of concentration of 20 min for a 1 in 25 year storm event plus a 20% contingency to account for climate change. Results provide design for a 2.00 m^3/s peak flow that would ultimately be accommodated by a v-notch ditch system with 2.5H:1V side slopes, and a height of 1 m. Ditches should be lined with a nominal 300 mm thickness of gravel that generally meets the following criteria:

- A D_{84} particle size of 204 mm was determined by SHA to withstand entrainment during peak flows.

While the overall footprint of this design is in line with the existing infrastructure, existing dimensions should be upgraded to follow this design closely with appropriate bedding material applied. Currently, there is no maintenance conducted on the ditch system. Maintenance of the ditch works should be scheduled and conducted annually.

4.4 Leachate Management

Landfill leachate is generated by precipitation filtering through the soil cover into the underlying refuse layers and from moisture contained in the waste being squeezed out by compaction from the weight of overlying solid waste. The volume of leachate depends on several factors: the most relevant are climate, the surface area of the cells and the type of cover incorporated in and on the refuse.

Leachate is not being collected at the SWMF at this time. The landfill is being operated as a natural attenuation landfill. As such, an important objective for leachate management is to minimize leachate production by surface water diversion including progressive closure of filling areas.

Leachate generation should be prevented as much as possible by:

- Stormwater control – clean surface water should be diverted from the waste filling and stockpiling areas
- Snow clearing – snow should be removed out of the waste area before it melts
- Leachate collection – best practices include grading of the landfill surface to a collection point. Note that ponding generally occurs after snowmelt in the upper northeast portion of the SWMF. Planning should include construction of ditch works to convey flow to a centralized location. A leachate and stormwater runoff collection pond is envisioned in the southwest corner of the landfill and shown on Figure 5. The pond should be unlined to allow infiltration and will serve as a collection point for landfill runoff through the SWMP lifespan. A second collection pond/ wetland is envisioned in the northeast corner.

Runoff ditch works are shown on Figures L-1 to L-4 and should be constructed to coincide with the area based landfill design. The leachate ditches should be constructed similarly to the clean surface water ditches i.e., a v-notch ditch system with 2.5H:1V side slopes, height of 1 m, and lined with a nominal 300 mm gravel with specifications as outlined in Section 4.2.

4.5 Surface Water Ponds

Surface water ponds should be constructed inside the landfill footprint in the areas shown on Figure 5. Surface water ponds serve as leachate and stormwater collection points to mitigate overland leachate flow during pre-closure landfilling activities. During closure, the surface water ponds will subsequently be used to capture clean snowmelt and precipitation from the closed area to promote slow release to the surrounding environment. Based on the available 2020 topographical data and consultation with the Publics Works Manager of Haines Junction and landfill operations personnel, natural site drainage within the landfill trends to southwest and northeast directions roughly splitting the catchment into two drainage directions. Two ponds are envisioned for the landfill: one at the southwestern corner of the landfill, and another at the northeastern corner of the landfill.

SHA has included a pond of approximately 1,700 m^2 in the southwest corner of the landfill at a location that will allow for easy access. The pond should allow infiltration to the surrounding environment and be constructed with 2.5H:1V side slopes and a depth of approximately 3 m. Note that this pond is sized using the Rational Method based on a 1:25 year 24hr design storm with consideration to average annual snow depth over a closed landfill catchment area. Preliminary results indicate that this size of pond would retain a design storm plus snow melt volume of 3,500 m^3 for one day.

A second pond or engineered wetland is included in the northeast corner of the landfill with an area of approximately 4,000 m^2. This structure is also sized using the Rational Method based on a 1:25 year 24hr design storm with consideration to average annual snow depth over a closed landfill catchment area. Preliminary results indicate that this size of pond would retain a design storm plus snow melt volume of 3,500 m^3 for approximately two days. An infiltration pond as described above can be placed in this area, however, SHA proposes that this area be developed as a constructed wetland to provide initial leachate treatment. Wetlands can remove nutrients and provide a polishing effect by further removing pollutants attached to suspended solids in leachate.

SHA recommends that pond sizing for this site be revisited during design with additional information on infiltration and snow melt with respect to climate change. Both areas considered for pond placement will allow for further expansion of these preliminary size recommendations. Given the amount of snow cover at the landfill, multiple ponds are recommended to capture spring freshet with the amount of snow melt.

4.6 Landfill Gas Management

Landfill gas (LFG) emissions are a concern due to potential health issues, nuisance odours, and because LFG contributes to global climate change. Combustible gases, such as methane, are a concern in relation to LFG migration issues.

If LFG is not vented, gas pressures can build up beneath a final 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.

Landfill gas consists primarily of equal parts CH_4 and CO_2. Methane is a potent greenhouse gas (GHG) with global warming potential (GWP) of 28 to 36 times higher than CO_2 in a 100-year timeframe.

Generally, biodegradation of solid waste is considered negligible in permafrost areas and LFG generation is expected to be low (Environment and Climate Change Canada, 2017). Monitoring of LFG can be a requirement for Class 1 landfills with larger footprints and higher quantities of total waste generated (Yukon Government, November 2019). The SWMF should incorporate the following best practices for LFG management:

- Infiltration of water in the waste mass should be reduced. Snow and water should be diverted from the waste
- Organics such as food waste should be diverted. Leaf, paper products, and yard waste should continue to be diverted
- Accidental landfilling of hazardous and hazardous waste should be prevented
- The active face where waste is actively received for disposal should be minimized
- Waste should be adequately compacted and covered
- Seek opportunities for progressive closure.

5. GENERAL OPERATING PROCEDURES

5.1 Site Management

Service regimes are discussed in detail in Section 3 with serviceable hours summarized below. The site is separated into two main sections for access:

1. Refundable service area – Wednesday to Sunday 1:00 pm to 5:30 pm
2. MSW (household waste) drop-off, recyclable drop-off, transfer station for construction C&D, metals, and brush service area – Wednesday to Sunday 9:00 am to 6:00 pm.

Two attendants manage onsite services and are onsite from Wednesday to Sunday 9:00 am to 6:00 pm.

5.2 Landfill Operations

5.2.1 Segregation

Per Permit 80-002, separate areas for the collection of each type of solid waste, hazardous waste, and designated materials that are accepted at the SWMF are established and maintained. Further segregation of materials is also provided by landfill attendants respectively for the recycle centre and the landfill.

5.2.2 Active Face Activities

The active face is the portion of the landfill footprint where MSW is actively accepted, compacted, and buried. SHA recommends that MSW and C&D waste be comingled to produce one active face for the SWMF. The active face should be built from the south and move to the north and east on the existing MSW waste footprint and be built against an outside berm. A compaction goal of 650 kg/m^3 should be pursued. Recommendations on how to achieve the desired compaction are listed in Section 4.3.

The recommended approach to filling is termed the strip method of development. The basic concept of constructing a strip from a series of cells is shown below on Figure 5-1. 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. Lift thickness and width will vary at the Landfill given that the northeast corner of Phase 1 (recommended filling start) is several meters below the surrounding ground level and

Haines Junction uses steel plates for daily cover, thereby maintaining a very specific width for each cell. Generally, each filling cell is broken down into a series of lifts, and each lift is constructed in several parallel strips. Recommended lifts of 2 m are proposed for the SWMF to a maximum elevation of 653 masl (Phase 3). From the 2020 topography, the design for Phase 1 will combine six 2 m lifts for an approximate vertical fill height of 11 m and 3H:1V side slopes.

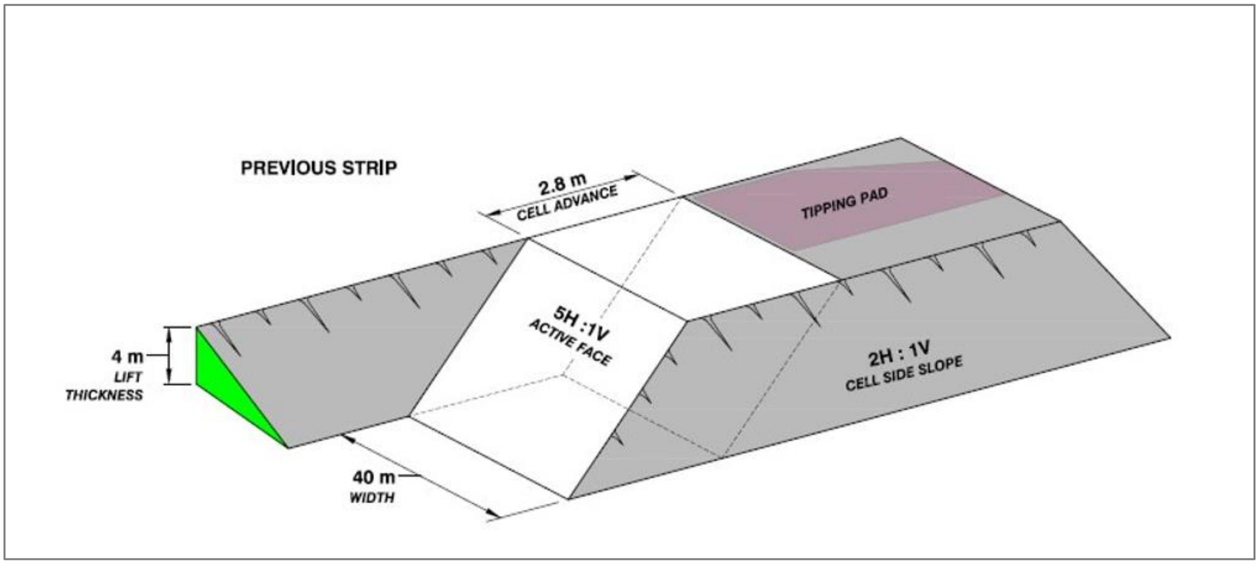

Figure 5-1: Lift Construction Concept Using Strip Method

Constructing the outside edge of each lift can be difficult to achieve. Waste should be spread across the active face by either using a push-up method or a push-down method. The push-up method will occur when waste is placed at the toe of the active face. This is the preferable method since it results in better compaction, gives the contractor better control over the tipping face, and results in less cover soil being pushed into the waste mass. However, at times it may be necessary to dump waste on top of the active lift and use the push-down method where the cell geometry dictates its necessity.

SHA recommends an approach for lift edge construction as illustrated below in Figure 5-2 (note lift height may 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 MSW sloped at about 3H:1V. The operator can then push the remaining soil over the refuse as shown in Figure 5-2, cutting the peak off the soil stockpiles and spreading the excess soil up the slope as operational cover. The key is to fill the cell in such a way that refuse does not cascade down the landfill side slopes.

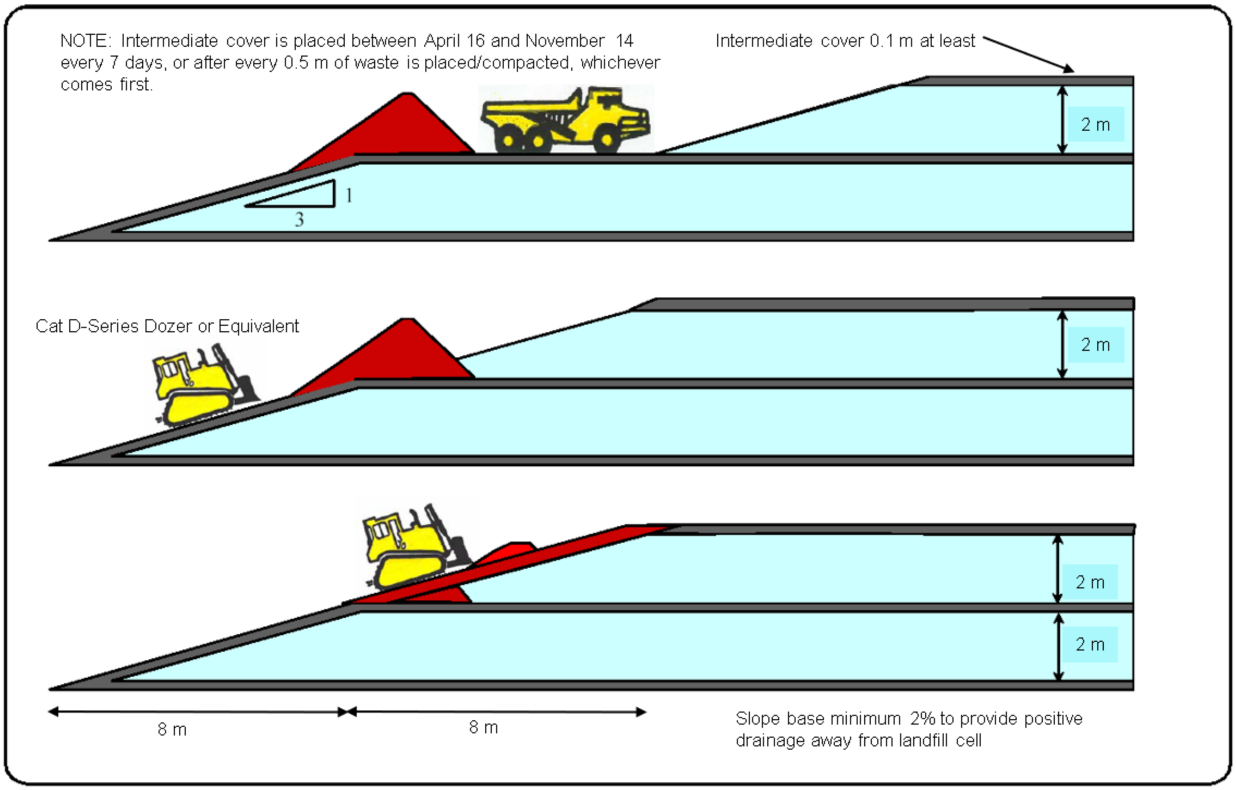

Figure 5-2: Lift Edge Development

To contain litter and provide clear filling direction, the Village of Haines Junction may give consideration to pre-constructing guidance berms for each operational 10 m wide strip before waste placement. This approach, pictured in Photo 2 taken at the Carmacks Landfill limits windblown litter and provides better confinement of MSW. The approach does use more cover soil which consumes air space, so the decision to adopt berms should be made based on an assessment of litter constraint requirements.

Photo 2: Litter Containment Berms used to contain refuse at Carmacks

5.2.3 Burning

Public waste disposal facilities are not allowed to open burn solid waste (Commisioner of the Yukon, 2014). However, burning of untreated brush and wood products, which are not considered solid waste under the Solid Waste Regulations, is allowed. Untreated brush and wood products include natural brush from land clearing activities (e.g., brush, branches) and clean wood. Clean wood is defined as wood that does not contain paint, stain, chemicals or glue, such as felled trees, lumber and pallets. Clean wood does not include engineered wood products such as plywood, particle board, oriented strand board, and cardboard.

Untreated brush and wood products are burned at the SWMF. The procedure is as follows:

- Brush is piled and packed together using a grapple loader throughout the year;
- Generally, in November, when there is adequate snow cover, the pile is measured and burned;
- Public works staff monitor the fire for the first day of burning.

5.2.4 Cover Placement

Permit 80-002 requires that waste be covered with cover soil or other comparable material to a depth of 0.1 m every seven days or after 0.5 m of solid waste is deposited. Note that this does not apply between November 15 and April 15 each year if soil or any other comparable cover material can not be obtained within the service area. An alternate cover option includes using rigid steel plate systems to cover the waste temporarily, such as overnight (Yukon Government, November 2019). The Village has been using steel plates for a number of years.

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. Placing cover soil on improperly finished waste cells is the greatest waste of airspace at a landfill. Essentially, if the active face is not prepared properly, soil will disappear into the voids in the waste and may be spread in layers that may vary in depth. 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 include a) re-grading the active face and side slopes 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. SHA has observed that the use of a vibrational smooth drum roller can dramatically improve the surface.

Soil cover material is currently sourced from local construction projects and stockpiled south of the existing MSW cell 13.

5.3 Recycling and Transfer Operations

The Yukon Government as well as private contractors play an active role in transfer of recyclable goods from the SWMF. A summary is presented in the table below.

Table 12: Recyclable Goods Transfer

Equipment	Description
Recyclables	The Yukon Government contracts the hauling of recyclable goods from the SWMF depot to Raven Recycling in Whitehorse, YT. The contract consists of a pickup frequency of 2 times/month from April to October (if required) and 1 time/month for the remainder of the year
Tires	The Yukon Government contracts the removal of tires up to 32" with rims removed once or twice per calendar year

Equipment	Description
Scrap Metal, Autobodies, White Goods	The Village of Haines Junction is responsible for the removal costs for these materials. There is no specific contractor for this removal.
Hazardous Waste	The Yukon Government pays for removal of some of the hazardous waste once per year while hosting Household Hazardous Waste Day. The Village of Haines Junction contracts KBL Environmental to remove hazardous waste as needed.

5.4 Re-Use Operations

A free store is available onsite for used merchandise and includes clean working used items for reuse.

5.5 Organics Management

A roll off bin for brush is available for storage of this material prior to deposition. Clean wood, brush, and clearing and grubbing materials are burned in the western area of the landfill adjacent to current MSW and C&D faces. Compostable food waste is accepted currently but not separated at the SWMF. All compostable food waste is discarded to the MSW stream by the service population unless individuals practice composting on their own property. Currently there is no end-use designated for compost.

5.6 Hazardous waste Management

The SWMF is permitted to operate a hazardous waste management facility under Permit 80-002 for the collection and storage of all hazardous wastes, excluding those in Class 1 (explosives) and Class 7 (radioactive materials) as defined in the Transportation of Dangerous Goods Act (Canada) (Government of Canada, 1992). Accepted hazardous waste materials typically include lead-acid batteries, glycols, ozone-depleting substances, paint, propane cylinders, residue fuel tanks/drums, used oil, and auto bodies with associated batteries, fluids, and mercury switches.

Hazardous waste is stored in two side by side fenced, unlined, wooden sheds at the SWMF. Sheds house paint cans with shelving for various items such as fluorescent tubes, empty propane cylinder (camping size), and other miscellaneous (unknown) hazardous wastes. Hazardous wastes that require containment are stored in 20 L pails within the enclosures. Batteries, glycol (barrels), and used oil (1000L Tote) are placed on containment pallets. White goods, auto bodies, and large propane tanks are stored in a designated area of the landfill.

Storage and handling of hazardous waste must comply with item 9 requirements from Permit 80-002. SHA recommends that as the service population grows for the SWMF, the hazardous waste storage area should by upgraded to include secondary containment. A lined surface would mitigate any spills from entering the surrounding environment.

5.6.1 Lead-Acid Batteries

Lead-acid batteries are stored in the designated fenced hazardous waste sheds and placed on containment pallets.

5.6.2 Used Oil

Used oil is dropped off in small containers at the hazardous waste collection shed. The landfill attendant transfers waste oil to a 1000 L tote that is located on a containment pallet.

5.6.3 Ozone-Depleting Substances

Ozone-depleting substances from white goods are drained by a qualified technician prior to deposition at the landfill designated area.

5.6.4 Autobody

Auto bodies are stockpiled adjacent to the scrap metals stockpile for removal of any hazardous liquids and mercury containing switches before being salvaged with the scrap metals. Fluids are removed from auto bodies by a contractor prior to compacting and removal from the site.

5.6.5 Paint

Paint cans are accepted at the hazardous waste collection shelter. Oil and water-based paints are typically dried out and then disposed with C&D waste.

5.6.6 Unknown Hazardous waste

Unknown hazardous wastes are stored in the designated hazardous waste enclosures. Handling unknown hazardous waste significantly increases disposal cost and can put the site operator, the public, and the site infrastructure at risk. As recommended in Section 3.1.2, signage for hazardous wastes should be upgraded to produce a comprehensive list of all hazardous wastes accepted and stored at the SWMF. Alternatively, the attendant should require that all materials are inspected before acceptance.

5.7 Environmental Controls

5.7.1 Electric Fencing

An electric exclusion fence and electrified cattle guard (Texas gate) encompasses the entire site. As per the Permit, the fence is activated continuously from April 1 to November 30 each year (and from December 1 to March 31 each year when tracks or signs of dangerous wildlife are noted around the facility).

5.7.2 Wind/Litter Fencing

A modular wind fence approximately 3 m high surrounds the active MSW cell and short plastic wind fence approximately 1 m high surrounds the C&D area. The fence will be moved as required to surround the active face.

5.7.3 Fire Management

Landfill fires pose a potential environmental hazard with costly repercussions. Once a fire penetrates deep into the refuse, it becomes extremely difficult and expensive to extinguish. The key factor in controlling landfill fires is prevention, and one of the best ways to prevent a fire is to encapsulate waste cells in soil.

The following is a general list of preventative measures that can be taken to reduce the risk of fires:

1. Thoroughly compact all refuse.
2. Construct the landfill in cells fully encapsulated in soil.
3. Apply soil cover (a minimum 0.1 m thickness).
4. Promptly apply final cover on all completed landfill surfaces.
5. Investigate all gas vents, steamers and smoke holes.
6. Do not build steep, final landfill slopes that cannot be accessed by equipment.
7. Have a comprehensive Fire Control and Response Plan in place, including equipment and PPE, personnel, responsibilities, logistics and financing.

The measures that should be taken to deal with small fires on the active face are outlined below:

1. The equipment operator at the active face should have a cellular phone or radio phone for emergency calling.
2. Any time a fire is detected, including visible flame, smoke or burning odour, the incident should be reported immediately to the Village of Haines Junction staff

responsible for the landfill. If it appears the fire may not be controlled with on-site equipment, the Fire Department should be notified immediately by calling 911.

3. The burning material should be doused with available water, excavated out and placed on top of the intermediate soil cover. Additional water should be added to the refuse until it is cold to the touch.
4. If sufficient water is not available, soil should be used to smother the fire. A stockpile of at least 100 m3 of mineral soil cover should be maintained near the active face for fire suppression purposes.
5. Again, the refuse should be dug up and placed on top of the intermediate soil cover after the fire is extinguished to prevent a future flare-up.

5.7.4 Spill Management

Spills should be management following the requirements outlined in item 11 of Permit 80-002.

1. The permittee shall contact either an environmental protection officer, or the 24-hour Yukon Spill Report Centre (867-667–7244) as soon as possible under the circumstances in the event of a release, spill, unauthorized emission, discharge, or escape of any substance listed in the Spills Regulations, O.I.C. 1996/193, or any hazardous wastes.
2. The permittee shall ensure that clean-up equipment appropriate for the amount and type of hazardous waste stored on site (such as sorbent, shovel, broom, bucket, gloves, boots, etc.) is readily accessible at all locations where hazardous wastes are handled or stored.
3. The permittee shall ensure that spill procedures are developed, maintained, and posted at all locations where hazardous wastes are handled or stored, and that all associated personnel are familiar with those procedures. The spill procedures must meet the requirements for that type of plan as established by the Branch in writing.
4. In the event that an inspection or other information leads the permittee to believe that ODS are being released into the environment from an appliance or other container deposited at the site, the permittee shall ensure that the ODS are removed from the appliance or other container in accordance with the Ozone-Depleting Substances and Other Halocarbons Regulation, O.I.C. 2000/127.
5. The permittee shall ensure that contaminated material resulting from a release, spill, unauthorized emission, discharge, or escape of any substance listed in the Spills Regulations, O.I.C. 1996/193, or any hazardous wastes is properly handled in accordance with the Contaminated Sites Regulation, O.I.C. 2002/171.

5.8 Inspection and Maintenance

Regular inspections of the site can help to identify dust, litter, odour or vector control issues. Regular inspections should also be carried out to ensure roads and ditch works are being maintained. Continued visual inspection for landfill fire initiation should be conducted by operational staff on site that would include the following:

- Open flame
- Smoke
- Steam venting
- Rapid settlement and cracking
- Elevated surface temperatures
- Unusual odours.

Inspections should also include regular inspections and updates of first aid supplies on site including vehicle kits and first aid station supplies. Spill kits should be regularly inspected. Hazardous waste inspection must comply with item 9-6 of Permit 80-002.

SHA recommends that consideration be given to annual geotechnical site inspections during the operation of the landfill conducted by a qualified professional and coinciding with annual survey. The geotechnical inspection should be conducted by a geotechnical engineer, to inspect the active and inactive areas of the landfill footprint, to check the cover for potential problems arising from cracking, erosion especially during snow melt or slumping and to determine the state of any infrastructure that does not receive regular inspection or maintenance. If geotechnical concerns are discovered, then a mitigative action plan should be developed by the QP.

5.9 Recommended Operational Activities

The following table is included and referenced from the Solid Waste Management for Northern and Remote Communities report published in March 2017 (Environment and Climate Change Canada, 2017).

Table 13: Recommended Operational Activities

Activity	Daily	Weekly	Monthly	Yearly
Waste screening	X			
Segregate and process waste	X			

Activity	Daily	Weekly	Monthly	Yearly
Waste screening	X			
Verify that wastes are managed in the designated areas	X			
Compact waste in the landfill	X			
Cover compacted waste in the landfill		X		
Clean up any spills	X			
Clear roads and working areas	X			
Record wildlife incidents	X			
Pick up windblown litter		X		
Test and pump standing water			if required	
Grade and maintain roads and ditch works			as needed	
Complete spring clean up of SWMF, compact waste, and place intermediate cover (spring and fall)				X
Review operations and maintenance records to assist in planning for the upcoming year				X
Construct a new landfill cell or waste management areas during the summer months if required for the upcoming year				X
Perform sampling in accordance with SWMF permit				X (twice a year per permit)
Complete annual report of operations				X

5.10 Site Safety and Training

The health and safety of workers and the public at the SWMF must always be considered (Environment and Climate Change Canada, 2017). Employers should ensure that their employees are trained in safe work practices for the SWMF. Employers should also provide employees with the necessary personal protective equipment (PPE) to carry out their jobs in a safe manner, such as CSA approved safety boots (steel or composite-toe and chemical resistant), eye goggles, gloves, hard hat, respiratory gear with proper situational filters (dust, volatile organic compounds or VOCs, etc.), safety vest, and work coveralls.

Employees should also be provided access to an eye wash station, a first aid kit, and a fire extinguisher approved by the fire marshal.

The following safety procedures should be implemented in order to minimize health risks to personnel working in and around the MSW facility:

- Equipment should be kept clean.
- Protective clothing and equipment such as gloves, eye goggles, and safety boots should be worn at all times.
- Work clothes should be kept in a designated change room and employees should change into them when they arrive for work. Work clothes should not be worn home. The community maintenance garage should be equipped with laundry facilities to wash work coveralls off-site.
- Hands should be washed frequently and, at a minimum, before eating and after work.
- Personnel should receive appropriate vaccinations that comply with workers' safety guidelines and should ensure they are kept up-to-date.

Public safety should also be taken into consideration when operating a MSW facility. All hazardous materials should be stored in a secure location away from public access. At the completion of each working day, the SWMF should be locked to prevent public access, and facility hours should be clearly posted.

Scavenging of waste from the active face of the landfill should be prohibited. A no-smoking policy should be implemented on-site to prevent explosions and fires. Smoldering material of any kind should not be accepted due to the risk of fire.

6. ENVIRONMENTAL MONITORING

Requirements for monitoring are outlined in item 8 of Permit 80-002. Active groundwater monitoring locations HJ-MW01, HJ-MW02, and HJ-MW03 are required to be sampled twice each year while the permit is in effect, once in the spring and once in late summer, or as otherwise directed in writing by an environmental protection analyst. There are no requirements to monitor LFG and surface water at this time. As indicated in Section 4.3, no landfill impacted surface water is considered to be running off-site or impacting the ephemeral unnamed creek south of the SWMF, therefore additional sampling is not recommended at this time.

6.1 Groundwater Monitoring

All groundwater samples must be analyzed for the parameters listed in the table below.

Table 14. Sampling Parameters

Parameter	Description
Field Parameters	Temperature, Specific Conductance, Oxidation-Reduction Potential, Dissolved Oxygen, pH
Laboratory Parameters	Major Ions (Ca, Mg, Na, K, Cl, SO_4, NO_3, NO_2, PO_4) Dissolved Metals pH, Ammonia, Hardness, Alkalinity, Carbonate, Bicarbonate, Specific Conductance, Total Dissolved Solids Dissolved Organic Carbon, Volatile Organic Compounds, Chemical Oxygen Demand, Total Kjeldahl Nitrogen $LEPH_w$, EPH_{w10-19}, VH_{w6-10}, VPH_w, BTEX, PAH Fecal Coliforms (for those sites at which biosolids or bioliquids are deposited)

Water levels for each well must be recorded at every sampling event.

As indicated in the Tetra Tech EBA 2011 Hydrogeological Assessment for the SWMF, the water uses and applicable water quality standards specified in Schedule 3 of the Yukon Contaminated Sites Regulation, OIC 2002/171 (CSR) are as follows:

Water Use	Radius (km)	Applicability
Aquatic Life (AL)	1	Not Applicable[1]
Drinking Water (DW)	1.5	Applicable
Irrigation (IR)	1.5	Applicable
Livestock (L)	1.5	Applicable

Due to the presence of the unnamed creek 200 m south of the SWMF (1), SHA recommends that the Village continues to analyze groundwater well samples with respect to the Aquatic Life water quality standard. As recommended by Tetra Tech EBA, SHA also recommends that samples be analyzed for the other applicable uses listed above due to the presence of domestic wells and agricultural land uses within 1.5 km of the SWMF.

7. ENVIRONMENTAL IMPACTS

7.1 Groundwater Quality

Groundwater quality data was available from June 2012 to September 2021. Landfill Well Monitoring Reports produced by J. Gibson Environmental Consulting were available to SHA for review from 2018 to 2021. Only Aquatic Life water quality standards have been assessed since biannual sampling began. As indicated in Section 6, other uses should be assessed.

Per the Yukon Protocol 6 Application of Water Quality Standards (Yukon Government, 2020), all applicable water quality standards of the CSR Schedule 3 should be applied with respect to the following:

- The closest surface water body with potential to contain aquatic life is located within a 1 km radius of the site (ephemeral unnamed creek).
- The closest private domestic well appears to be about 790 m downgradient of the site screened in the same aquifer as the SWMF groundwater monitoring wells.
- There are agricultural land uses within 1.5 km of the SWMF.

Recent data indicates that all parameters tested were below applicable Yukon CSR Aquatic Life standards with the exception of sulphate.

Elevated sulphate has been detected in all wells during all sampling events with available data in the 2012 to 2021 time period. A summary of concentrations is shown below:

- HJ-MW01 - Nineteen consecutive events with sulphate concentrations greater than 2200 mg/L. (September 2012 to September 2021, biannual events)
- HJ-MW02 – Nineteen consecutive events with sulphate concentrations greater than 3100 mg/L. (September 2012 to September 2021, biannual events)
- HJ-MW03 – Nine consecutive events with sulphate concentrations greater than 1500 mg/L. (September 2017 to September 2021).

Generally, maximum sulphate concentrations for the SWMF are detected at HJ-MW-02 with a maximum of 4,250 mg/L in 2018 vs the standard of 1,000 mg/L.

Although elevated sulphate concentrations can be associated with landfill leachate, they can also be associated with other processes such as mineral dissolution, mine drainage i.e., the oxidation of sulphur containing minerals, and atmospheric deposition. Reporting by J. Gibson Environmental Consulting indicates that elevated sulphate concentrations at the SWMF are considered representative of background conditions as elevated concentrations exist in upgradient and downgradient wells.

All other parameters were detected below Aquatic Life standards.

During initial hydrogeological investigations in 2010/2011, including installation and sampling of the three groundwater monitoring wells, Tetra Tech EBA listed the groundwater results exceeding the most stringent CSR Schedule 3 criteria. Exceedances were noted for Antimony (DW), Boron (IR), Manganese (DW), Magnesium (DW), Molybdenum (IR), Sodium (DW) and Sulphate (DW). Their interpretation of this preliminary review of groundwater monitoring results indicated that *"while groundwater at all monitoring wells reported concentrations of analytes associated with impact from landfill leachate, these analytes are considered to be representative of background concentrations. Infiltration of leachate to the SQA is expected to be restricted due to the thick sequence of silt underlying the site and the confinement of the SQA."* (Tetra Tech EBA, 2011)

8. LANDFILL CLOSURE

There are two phases to consider at the end of the design life of a landfill cell or SWMF:

- Closure: where the area is decommissioned in a manner that promotes revegetation, minimizes leachate, and ensures that any buried residual waste does not pose a physical hazard to people or animals that may use the site.
- Post-Closure: where the area is monitored over the long term for evidence of releases to the surrounding environment and maintained to ensure the integrity of the various engineered systems.

8.1 Closure Plan

A key goal of a site-specific Closure Plan for the landfill is to identify the most effective type of final cover system. Generally, four basic types of cover systems are used:

- Compacted soil cover
- Geosynthetic cover
- Composite cover
- Evapotranspirative cover.

Interim or temporary cover systems can also be used for areas of the landfill where permeability must be minimized and where filling will not resume for at least one year. This section provides the recommended final cover system, a progressive closure strategy and recommendations for post-closure maintenance and monitoring for the landfill.

8.1.1 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 of 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 management by preventing upward venting of LFG and downward intrusion of oxygen from the atmosphere
- Minimize oxygen infiltration and fire risk
- 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.

The closure plan for the 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, control stormwater and minimize leachate production.
- Slopes should be effectively re-vegetated during construction of the final cover to assist in evapotranspiration and improve soil stability.

8.1.2 Recommended Design Guidelines

Best practice design guidelines for final cover systems are documented in the Solid Waste Management for Northern and Remote Communities Planning and Technical Guidance Document (Environment and Climate Change Canada, 2017). Best practices are summarized below:

- Landfill slope should not exceed 3H:1V
- Final cover slopes should be graded to facilitate stormwater runoff away from the landfill
- An example of final cover design can include the following elements:

- At least a 0.6 m barrier layer with a hydraulic conductivity of 1 x 10^{-7} (semi-arid regions) with a topsoil layer of 0.15 m seeded with native plants and grasses
- Alternative final cover designs may be suitable in arid and/or semi-arid regions, in permafrost regions where biodegradation of solid waste is considered negligible, or in communities with very low waste generation rates and small landfill footprints

- For Class 2 landfills such as the Haines Junction SWMF, modeling for the complete landfill design (base liner, final cover, etc.) should be conducted to demonstrate that leachate will attenuate to the extent that all contaminants will be below the applicable standards at the points of contact with all relevant receptors.

8.1.3 Elements of the Final Cover System

Haines Junction reportedly receives approximately 306 mm of precipitation per year. As such, leachate production is not as major a concern as it would be in wet areas exceeding 1000 mm/ year. Landfill operations and closure costing developed in 2020 by SHA (Sperling Hansen Associates, January 2021) estimated the cost of a clay cap at $57.86 per square metre of closure area based on the following closure system elements:

- 1,000 mm of clay barrier
- Draintube drainage layer
- 300 mm of topsoil seeded with native plants.

The cost estimate included unit rates for earth moving, supply and installation of the system layers, leachate, stormwater and LFG management, engineering, and contingency.

The following sub-sections further describe the elements of a closure system.

Gas/Leachate Collection Layer

Gas control is considered desirable beneath the barrier layer to prevent gas pressure build 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.

The purpose of a gas / leachate collection layer is to provide a high permeability pathway for leachate generated from break-outs 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 $1x10^{-2}$ cm/s or higher.

Barrier Layer

A low permeability soil or geosynthetic layer forms the backbone of an effective cover system. The main advantages and disadvantages of the four different types of barrier layers are summarized in the table below.

Table 15: Advantages and Disadvantages of Different Barrier Layers

	Compacted Soil	Geomembrane	Composite	Evapotranspirative
Typical Material	• Low permeability soil • Significant percentage of clay-sized particles	• LLDPE • HDPE • PVC	• Two barrier layers in intimate contact such as geosynthetic membrane on top of compacted clay liner	• Fine-grained soil placed over coarse-grained soil • Combination of clay, silt, sand and /or loam
Advantages	• Low overall cost • Utilize locally available materials • Minimal post-closure maintenance • Self-healing properties • Long term performance (>100 years)	• Low susceptibility to settlement induced stress cracking • No susceptibility to desiccation • High containment of LFG • Low consumption of airspace • Low leachate generation	• High level of leak protection • Long term performance (>100 years)	• Low overall cost • High performance in arid or semi-arid regions • Utilize locally available materials • Low risk of cracking and desiccation
Disadvantages	• Prone to cracking and desiccation • May not adequately control LFG emissions	• Skilled labour required for installation • Unknown reliability in long term performance (>100 years) • Prone to damage • High capital costs	• Skilled labour required for installation • High capital costs	• Only applicable in areas that have arid or semi-arid climates • May not adequately control LFG emissions

	Compacted Soil	Geomembrane	Composite	Evapotranspirative
		• Susceptible to degradation from UV rays		

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 $1x10^{-1}$ cm/s or better in most instances.

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 typically recommends a thicker 300-600 mm layer 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. With the lower precipitation levels at Haines Junction, making a thicker topsoil layer of 300 mm is acceptable.

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 uses including composting and waste transfer stations.

A 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.

For planning purposes, SHA recommends that the Haines Junction landfill be capped with the following cover system.

- 300 mm top soil
- Non Woven Geotextile Erosion Control Layer
- 1,000 mm compacted clay
- 300 mm intermediate cover – select gravel for leachate and gas venting.

SHA recommends that modelling be completed at the time of closure design to ensure all local conditions are considered when making a decision regarding material types, layer depths and type (e.g. gravel) and barrier layer type. The Hydrologic Evaluation of Landfill Performance (HELP) Model is a useful tool for this purpose.

8.1.4 Progressive Closure Plan

The primary objective of progressive closure is to reduce the landfill area available for infiltration of precipitation by shedding run-off from completed landfill surfaces; thereby meeting the design objective of keeping clean water clean. A secondary objective is to reclaim the ground to a well vegetated landform as quickly as possible. Additional advantages of progressive closure are avoidance of a large closure liability and reducing the risk of spontaneous combustion leading to a landfill fire.

The recommended closure strategy for the SWMF is to permanently or temporarily cover the finished side slopes as soon as possible, starting with the south slope of Phase 1 and moving to the east and north side slopes of Phases 1 and 2. Since Phase 3 will be built overtop Phases 1 and 2, final closure of the crest of the landfill would be completed once filling has reached final contours. The timeline for the first closure is estimated to be 2056. In their January 2021 report, SHA recommended the Village establish a sinking fund for the progressive closure of the landfill and post-closure monitoring at a level of $28,569 per year.

8.2 Post-Closure Monitoring

At the end of the operational life of the landfill which is estimated to be 2131, a post-closure monitoring program should be implemented. All monitoring data collected up to that point will form an essential part of the data set needed to demonstrate closure conditions. Over the post-closure period, selective indicator parameters will continue to be monitored at a reduced frequency to ensure that there is no environmental risk. After the post-closure monitoring period, 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. The costs associated with post-closure monitoring are estimated to be the same as current costs ($7,000) and increase with inflation until the monitoring frequency can be reduced when parameters indicate.

9. RECORD KEEPING AND REPORTING

Record keeping for solid waste management facilities is necessary to both satisfy regulations and permit requirements and to assist with operating the facility and planning for capital works and upgrades to the facility. Haines Junction is required to keep records at the site including information on the following:

- Type and amount of the waste placed in the waste cells
- Intermediate cover placement
- Open burning and incineration
- Construction
- Maintenance and repair of any landfill component
- Electric fencing
- Waste cell closure.

Additionally, and in accordance with the Permit, the following records are required to be kept at the Haines Junction office:

1. an updated site plan showing the location of all active and closed cells and solid and hazardous waste segregation areas at the facility
2. a copy of each plan submitted under this permit, and any amendments to and approvals of each plan
3. summaries of all inspections carried out by the permittee under this permit (including the name of the person conducting the inspection, the date of each inspection, any observations recorded during the inspection, actions taken as a result of those observations, and the date each action was taken)
4. results of surface water and groundwater testing conducted at the site, including any interpretations of monitoring results to determine trends in contaminant levels over time
5. reports on hydrogeological assessments undertaken at the site
6. notes concerning any release, spill, unauthorized emission, discharge or escape that occurred at the facility, including the substance involved and estimated quantity, the date of observation, any spill reports made, and clean-up procedures implemented

7. any deficiencies remedied in accordance with paragraph 2.6, and how and when they were remedied
8. a copy of any waste manifests used to transport hazardous wastes to or from the facility
9. before and after photographs and a detailed description of any activities undertaken to construct a new cell
10. before and after photographs and a detailed description of any activities undertaken to close a cell.

The records shall be kept for a minimum of three years and must be made available to the Ministry upon request.

10. STRATEGIES AND INITIATIVES

SHA reviewed the 2013-2023 Solid Waste Management Plan initiatives and strategies and determined with the help of Village staff the status of each. Appendix C contains a table showing each initiative along with notes for each on status and an indication of whether or not the item should be carried forward into this SWMP for implementation over the next ten years.

The items listed as CARRY FORWARD or ONGOING in Tetra Tech EBA's report include the following (modified slightly for grammar and repetition):

1. Complete financial analysis to determine appropriate tipping fees.
2. Provide community education regarding tipping fees.
3. Consider regionalization of transferred Recycled Materials to reduce operations and maintenance costs associated with trucking.
4. Potentially install a weigh scale system to better track material quantities entering the facility.
5. Consider provision of a site operator for all landfill areas to ensure better waste screening and segregation.
6. Stop accepting auto bodies and start collaborating with local salvaging companies to reduce environmental liabilities associated with autobody stockpiles.
7. In order to limit potential environmental and economic impacts, implement the following:
    - upgrade hazardous waste collection system including signage and containment to meet Yukon regulations and guidelines
    - retain detailed landfill records
    - implement recommended surface water management practices
    - provide funding for a full-time site operator for all areas of the facility to limit uncontrolled dumping practices
    - cap historical operations and progressively closed cells.
8. Phase in a diversion target of 50% using education, incentive programs, enforcement, improved site operations, and record keeping.

9. If possible, no longer accept auto bodies and direct the public to the nearest auto wrecker.
10. Consider sampling the unnamed stream near the landfill and identify the sampling location with a handheld GPS.
11. Analyze groundwater monitoring samples for all applicable water quality standards including Aquatic Life, Drinking Water, Irrigation and Livestock uses.
12. Ensure all landfill operators and managers have specialized professional training in courses such as SWANA Manager of Landfill Operations course, Qualified Landfill Operator course, or similar, and spill response. Additional local training can also be provided by Raven Recycling in Whitehorse to better inform site operators of the recycling stream and how to handle recyclables.
13. Continue working with local municipalities to cooperate on as many initiatives, discussed herein.

The following initiatives have been added for the 2023-2033 SWMP at the request of Village staff.

Composting (13)

Since food waste is one of the largest components of refuse going to landfill (25 – 40 percent typically) diverting this 'low hanging fruit' will make the largest impact on diversion in most communities. There are many reasons to keep organic waste out of landfills including reducing Greenhouse Gases (GHG) and slowing down climate change, using or converting a beneficial material for soil improvement and conserving airspace in the landfills so they last longer than expected. The first step is to encourage food waste reduction, meaning educate the public about how to buy food in a way that does not result in waste. The National Zero Waste Council's Love Food Hate Waste campaign materials are available to local governments including display panels and brochures. It is common to set up display booths at public events and farmer's markets to help educate the general public. The Village's website can also be updated to include these materials.

Backyard composting is also a common initiative that local government implements involving distribution of subsidized composters and providing workshops and educational materials to accompany the distribution. Having readily available compost to improve soils and garden beds at one's home can reduce costs for fertilizer and keep this valuable material out of landfills. The volume of organics in a home composter must be greater than one cubic meter in cold climates to generate enough heat to break down the materials effectively. Bin types must be considered in order to not attract animals to the backyard. Odours should not be generated and therefore attract animals if the composting is carried out properly (i.e. kept aerated). Backyard composters range in price for sturdy bins from $100 to $200. Environment Canada's 2017 report on *Solid Waste Management for Northern and Remote Communities, Planning and Technical Guidance Document* states the following with respect to composting in small northern communities:

> *For smaller communities, the most practical approach will likely be to divert organic waste through household waste diversion measures such as backyard composting and vermicomposting. For communities considering this approach, please consult the City of Yellowknife's Composting North of 60: A Guide to Home Composting in the Northwest Territories7. It is recommended that meat products be excluded from backyard composting to reduce the potential for wildlife-attracting odours.*

Processing capacity for organic waste is usually the limiting factor for implementing collection of organics, especially if local government waits for private investment. However, this can be pushed somewhat by banning organics from the local landfills with sufficient notice. Once infrastructure is available residential programs can be implemented. For example, the City of Vernon, BC, will be implementing a weekly curbside collection program for food scraps starting in May 2022. The garbage will be collected bi-weekly which keeps the extra costs manageable at $4/home/month. They received a grant for purchasing the carts and kitchen catchers. Prior to this program they set out large front load bins for drop off to assess the interest in organics diversion. The bins are tipped twice weekly and will remain in place for use by the ICI sector. The City's primary message is that this program supports their Climate Action Plan. This and other programs in the north Okanagan would not have been possible without the investment by a local farmer in an in-vessel composting facility to co-manage their chicken farm waste. This is one of two recent initiatives in the north Okanagan to co-compost MSW and agricultural waste.

A comprehensive food waste reduction strategy can start simply with education (e.g. Love Food Hate Waste and Food Security initiatives) and then move into collection as funding and processing capacity becomes available.

With respect to yard and garden waste, many landfill owners have found it efficient to collect leaves, grass, brush and other clean wood waste in a stockpile and grind it on a regular basis to construct windrows or static piles. The size and moisture content of the static pile or windrow will dictate the rate of decomposition. Piles can be turned with an excavator or loader and potentially watered with a water tanker truck at the same time if moisture is limiting the required rise in temperature (to kill pathogens and weed seeds). Water could be sourced from an on-site storage pond (leachate and stormwater). Chipping of yard waste using a horizontal or tub grinder will reduce the volume and speed up the process substantially. Depending on the amount of work done to the piles (turning and screening) a compost product can be made available for the public or for use on site within 12 months. Contaminants The location on site to compost this material should be within the landfill footprint in order to utilize the available and approved landfill environmental controls. Costs related to producing a windrow composting product with grinding, turning with an excavator and screening are approximately $17.50 per m^3.

Glass Crushing (15)

The Village would like to purchase a single phase glass crushing machine similar to the one pictured in the photo below. This 1.5 HP, H-100V weighs about 625 lbs. and can crush 300-500 lbs. per hour. Crushing the bottles collected at the site would save shipping costs and provide the Village with a supply of aggregate type material for on-site use.

Photo 3: Glass Crusher

The cost of a small crushing machine is approximately $1,000 not including shipping.

Land Clearing Waste Management (16)

The Village hopes to avoid burying stumps at the Landfill to conserve air space. The following options are used at other landfill sites and could be considered for the SWMF:

1. For very dirty stumps embed them in the cell construction berms at the berm core

2. For stumps that are not dirty, they can be burned with the other brush collected at the site
3. Break the stump up on site to knock off the dirt and then burn
4. Disallow land clearing waste at the SWMF
5. To ensure only non dirty stumps are brought to the site, the Village could charge a fee that is high enough to incentivize customers to clean the stumps first before they are brought to the site.

Option 5 above could also feasibly be accomplished through education and communication.

Septic System (17)

The Village would like to install a septic field at the site to reduce the cost of operating the holding tank. Before installing any septic system, the Village will be required to first obtain a valid permit. Septic systems must be carefully installed in strict accordance with the approved design, in order to avoid later complications with the system. The septic tank must be installed and suitably bedded, with strict adherence to design grade regulations for building sewers. One must also ensure that absorption bed components are installed according to the approved design.

Before designing and installing a septic system, a complete and accurate site investigation must be performed. The site investigation report should include the following details:

- System location and setback distances
- Soil conditions, including the soil type and percolation rate
- Surface features, such as the ground slope, rock outcrops, and traffic areas
- Provision specifics for the expansion or replacement of the septic system
- The depth to groundwater and bedrock must have a minimum vertical clearance from the bottom of the absorption system to groundwater of 1.2 m or 4 ft.

The cost to install the septic field will depend on the location and design. It is recommended that the Village use a qualified professional to design the system.

Litter Control (18)

The Village would like to better control wind blown litter at the Landfill as shown in Photo 10-3 below. As per item 7 above, this was considered in the last SWMP development and has been carried forward for the next ten-year period. Item 5 above also mentions provision of a site operator to assist with controlling waste screening and segregation. This additional staff or contractor could provide a number of services at the site including litter picking and record keeping. At the Haines Junction union labourer rate and a four day/8 hours/day work week, or the equivalent, the cost to the Village would be approximately $42,260 per year including 4% in lieu of benefits. Facility open hours could be adjusted to allow for gate attending and to reduce operating costs.

Besides picking litter on a regular basis, it is usually recommended that landfill operators cover waste during windy days on the sloped tipping face as well as the top of the advancing cell with available soil or other materials that do not generate windblown litter such as wood chips, grubbing materials and C&D waste. This material can be set aside temporarily for this use. Litter fencing is available at the site and should be moved regularly to surround the tipping face.

Photo 4: Litter at Face

Also, as outlined in Section 5.2.2, cell containment berms would help contain windblown litter during operations. As a further littler control measure, snow fencing could be deployed around the top of each berm, creating a “U” shape that would be very effective in containing litter.

11. CLOSURE

This report has been prepared by Sperling Hansen Associates (SHA) on behalf of the Village of Haines Junction 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 the Yukon Territory, 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 the Village of Haines Junction. 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 Village of Haines Junction on this project. Please do not hesitate to contact the undersigned if you have any questions.

Sincerely,

SPERLING HANSEN ASSOCIATES

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APPENDICES

APPENDIX A
Lifespan Analysis

Year	Population VHJ	Population Neighbouring Communities	Estimated Regional Population	Total Disposal of MSW and C&D (tonnes)	Waste Volume (m^3)	Cover Material (m^3)	Settlement Reduction (m^3)	Total Airspace Consumption (m^3)	Cumulative Airspace Consumption (m^3)
2020	984	296	1280	1,075	2,149	716	- 143	2,722	2,722
2021	1009	273	1282	1,076	2,152	717	- 143	2,726	5,449
2022	1025	274	1299	1,090	2,181	727	- 145	2,762	8,211
2023	1042	274	1316	1,105	1,700	567	- 113	2,153	10,364
2024	1059	275	1333	1,119	1,722	574	- 115	2,181	12,545
2025	1076	275	1351	1,134	1,745	582	- 116	2,210	14,755
2026	1093	276	1369	1,149	1,768	589	- 118	2,239	16,994
2027	1110	276	1387	1,164	1,791	597	- 119	2,268	19,262
2028	1128	277	1405	1,179	1,815	605	- 121	2,298	21,560
2029	1146	277	1424	1,195	1,839	613	- 123	2,329	23,889
2030	1164	278	1442	1,211	1,863	621	- 124	2,360	26,249
2031	1183	279	1462	1,227	1,888	629	- 126	2,391	28,640
2032	1202	279	1481	1,243	1,913	638	- 128	2,423	31,063
2033	1221	280	1501	1,260	1,938	646	- 129	2,455	33,518
2034	1241	280	1521	1,277	1,964	655	- 131	2,488	36,007
2035	1261	281	1541	1,294	1,991	664	- 133	2,522	38,528
2036	1281	281	1562	1,311	2,018	673	- 135	2,556	41,084
2037	1301	282	1583	1,329	2,045	682	- 136	2,590	43,674
2038	1322	282	1605	1,347	2,072	691	- 138	2,625	46,299
2039	1343	283	1626	1,365	2,100	700	- 140	2,661	48,959
2040	1365	284	1648	1,384	2,129	710	- 142	2,697	51,656
2041	1387	284	1671	1,403	2,158	719	- 144	2,733	54,389
2042	1409	285	1693	1,422	2,187	729	- 146	2,770	57,160
2043	1431	285	1717	1,441	2,217	739	- 148	2,808	59,968
2044	1454	286	1740	1,461	2,247	749	- 150	2,847	62,815
2045	1478	286	1764	1,481	2,278	759	- 152	2,886	65,700
2046	1501	287	1788	1,501	2,309	770	- 154	2,925	68,626
2047	1525	288	1813	1,522	2,341	780	- 156	2,966	71,591
2048	1550	288	1838	1,543	2,373	791	- 158	3,006	74,597
2049	1574	289	1863	1,564	2,406	802	- 160	3,048	77,645
2050	1600	289	1889	1,586	2,440	813	- 163	3,090	80,735
2051	1625	290	1915	1,608	2,473	824	- 165	3,133	83,868
2052	1651	290	1942	1,630	2,508	836	- 167	3,176	87,045
2053	1678	291	1969	1,653	2,543	848	- 170	3,221	90,265
2054	1704	292	1996	1,676	2,578	859	- 172	3,265	93,530
2055	1732	292	2024	1,699	2,614	871	- 174	3,311	96,841
2056	1759	293	2052	1,723	2,650	883	- 177	3,357	100,199
2057	1788	293	2081	1,747	2,688	896	- 179	3,404	103,603
2058	1816	294	2110	1,771	2,725	908	- 182	3,452	107,055
2059	1845	295	2140	1,796	2,764	921	- 184	3,500	110,555
2060	1875	295	2170	1,822	2,802	934	- 187	3,550	114,105
2061	1905	296	2200	1,847	2,842	947	- 189	3,600	117,705
2062	1935	296	2231	1,873	2,882	961	- 192	3,651	121,355
2063	1966	297	2263	1,900	2,923	974	- 195	3,702	125,058
2064	1998	297	2295	1,927	2,964	988	- 198	3,755	128,812
2065	2030	298	2328	1,954	3,006	1,002	- 200	3,808	132,620
2066	2062	299	2361	1,982	3,049	1,016	- 203	3,862	136,482
2067	2095	299	2394	2,010	3,092	1,031	- 206	3,917	140,399
2068	2129	300	2428	2,039	3,136	1,045	- 209	3,973	144,372
2069	2163	300	2463	2,068	3,181	1,060	- 212	4,029	148,401
2070	2197	301	2498	2,097	3,227	1,076	- 215	4,087	152,489

Year	Population VHJ	Population Neighbouring Communities	Estimated Regional Population	Total Disposal of MSW and C&D (tonnes)	Waste Volume (m^3)	Cover Material (m^3)	Settlement Reduction (m^3)	Total Airspace Consumption (m^3)	Cumulative Airspace Consumption (m^3)
2071	2232	302	2534	2,127	3,273	1,091	- 218	4,146	156,634
2072	2268	302	2570	2,158	3,320	1,107	- 221	4,205	160,839
2073	2304	303	2607	2,189	3,367	1,122	- 224	4,265	165,104
2074	2341	303	2645	2,220	3,416	1,139	- 228	4,327	169,431
2075	2379	304	2683	2,252	3,465	1,155	- 231	4,389	173,820
2076	2417	305	2721	2,285	3,515	1,172	- 234	4,452	178,272
2077	2455	305	2761	2,318	3,566	1,189	- 238	4,516	182,789
2078	2495	306	2801	2,351	3,617	1,206	- 241	4,582	187,370
2079	2535	307	2841	2,385	3,669	1,223	- 245	4,648	192,018
2080	2575	307	2882	2,420	3,723	1,241	- 248	4,715	196,734
2081	2616	308	2924	2,455	3,777	1,259	- 252	4,784	201,518
2082	2658	308	2967	2,490	3,832	1,277	- 255	4,853	206,371
2083	2701	309	3010	2,527	3,887	1,296	- 259	4,924	211,295
2084	2744	310	3054	2,564	3,944	1,315	- 263	4,996	216,290
2085	2788	310	3098	2,601	4,001	1,334	- 267	5,068	221,359
2086	2833	311	3143	2,639	4,060	1,353	- 271	5,142	226,501
2087	2878	311	3189	2,677	4,119	1,373	- 275	5,218	231,719
2088	2924	312	3236	2,717	4,179	1,393	- 279	5,294	237,013
2089	2971	313	3283	2,756	4,241	1,414	- 283	5,371	242,384
2090	3018	313	3332	2,797	4,303	1,434	- 287	5,450	247,834
2091	3066	314	3380	2,838	4,366	1,455	- 291	5,530	253,364
2092	3116	315	3430	2,880	4,430	1,477	- 295	5,612	258,976
2093	3165	315	3481	2,922	4,495	1,498	- 300	5,694	264,670
2094	3216	316	3532	2,965	4,562	1,521	- 304	5,778	270,448
2095	3267	317	3584	3,009	4,629	1,543	- 309	5,863	276,311
2096	3320	317	3637	3,053	4,697	1,566	- 313	5,950	282,261
2097	3373	318	3691	3,098	4,767	1,589	- 318	6,038	288,299
2098	3427	318	3745	3,144	4,837	1,612	- 322	6,127	294,426
2099	3482	319	3801	3,191	4,909	1,636	- 327	6,218	300,644
2100	3537	320	3857	3,238	4,982	1,661	- 332	6,310	306,954
2101	3594	320	3914	3,286	5,055	1,685	- 337	6,404	313,357
2102	3651	321	3972	3,335	5,131	1,710	- 342	6,499	319,856
2103	3710	322	4032	3,384	5,207	1,736	- 347	6,595	326,451
2104	3769	322	4092	3,435	5,284	1,761	- 352	6,694	333,145
2105	3830	323	4152	3,486	5,363	1,788	- 358	6,793	339,938
2106	3891	324	4214	3,538	5,443	1,814	- 363	6,895	346,833
2107	3953	324	4277	3,591	5,524	1,841	- 368	6,997	353,830
2108	4016	325	4341	3,644	5,607	1,869	- 374	7,102	360,932
2109	4081	325	4406	3,699	5,691	1,897	- 379	7,208	368,140
2110	4146	326	4472	3,754	5,776	1,925	- 385	7,316	375,456
2111	4212	327	4539	3,811	5,862	1,954	- 391	7,426	382,882
2112	4280	327	4607	3,868	5,950	1,983	- 397	7,537	390,419
2113	4348	328	4676	3,926	6,040	2,013	- 403	7,650	398,069
2114	4418	329	4746	3,985	6,130	2,043	- 409	7,765	405,834
2115	4488	329	4818	4,045	6,222	2,074	- 415	7,882	413,715
2116	4560	330	4890	4,105	6,316	2,105	- 421	8,000	421,716
2117	4633	331	4964	4,167	6,411	2,137	- 427	8,121	429,836
2118	4707	331	5039	4,230	6,508	2,169	- 434	8,243	438,079
2119	4783	332	5115	4,294	6,606	2,202	- 440	8,367	446,447
2120	4859	333	5192	4,359	6,705	2,235	- 447	8,494	454,940
2121	4937	333	5270	4,424	6,807	2,269	- 454	8,622	463,562
2122	5016	334	5350	4,491	6,910	2,303	- 461	8,752	472,314
2123	5096	335	5431	4,559	7,014	2,338	- 468	8,885	481,199
2124	5178	335	5513	4,628	7,120	2,373	- 475	9,019	490,218
2125	5260	336	5597	4,698	7,228	2,409	- 482	9,156	499,373
2126	5345	337	5681	4,770	7,338	2,446	- 489	9,294	508,668
2127	5430	337	5768	4,842	7,449	2,483	- 497	9,435	518,103
2128	5517	338	5855	4,915	7,562	2,521	- 504	9,579	527,682
2129	5605	339	5944	4,990	7,677	2,559	- 512	9,724	537,406
2130	5695	339	6034	5,066	7,794	2,598	- 520	9,872	547,278
2131	**5786**	**340**	**6126**	**5,143**	**7,912**	**2,637**	- 527	**10,022**	**557,300**

APPENDIX B
Rational Method

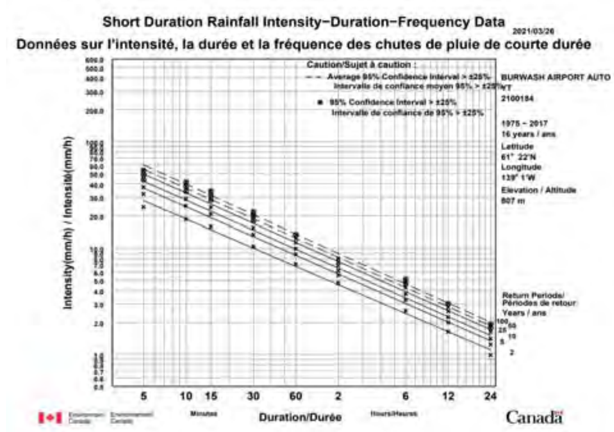
HAINES JUNCTION SWMF
Rational Method

Storm Flows - Rational Method (BC Agricultural Drainage Manual - 1997)

$Q = 0.0028CiA$
Q = peak runoff rate (m^3/s)
i = rainfall intensity (mm/hr) for design period and for time of concentration
A = watershed area (m^2)

$T_c = 0.0195L^{0.77}S^{-0.385}$
T_c = time of concentration (min)
L = maximum length of flow (m)
S = drainage area grade (m/m)

$$C = \frac{Sum(C_1A_1 + C_2A_2\ldots)}{Sum(A_1 + A_2\ldots)}$$

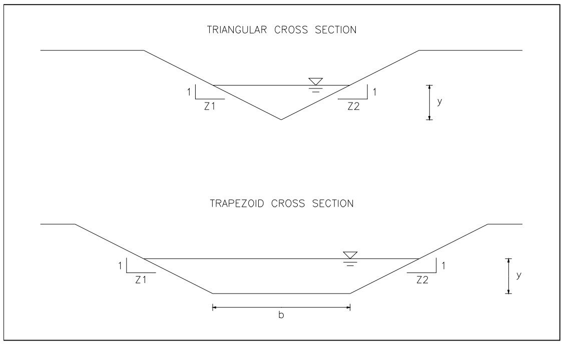


Typical Catchment Area	CLEAN SURFACE WATER CATCHMENT - OUTER DITCHES	LANDFILL LEACHATE CATCHMENT - INNER DITCHES	CLOSED LANDFILL CATCHMENT - POND
Catchment Area (A, m^2) =	**541,531**	**102,113**	**102,113**
Catchment Area (A, ha) =	54	10	10
Runoff Coefficient - C =	0.5	0.5	0.85
Time of concentration - T_c			
Typical slope (S, m/m) =	0.014	0.020	0.333
Length of flow (L, m) =	1000	380	380
T_c (min) =	**20.886**	**8.523**	**2.886**
T_c (hrs) =	0.348	0.142	0.048
If T_c <5mins, use 5mins	**20 mins**	**8.52259**	**5 mins**
Peak Storm Intensity 1 in 25 year Tc min (i, mm/hr) =	**22**	**38**	
Peak Flow (Q, m^3/s) =	**1.67**	**0.54**	
Peak Flow (Q, L/s) =	**1668**	**543**	
Volume for T_c minute Flow (m^3) =	**2090**	**278**	
1:25 yr storm plus 20% Peak Flow (Q, m3/s) =	**2.00**	**0.65**	
Peak Storm Intensity 1 in 25 year 24 hr (i, mm/hr) =			**2**
Peak Flow (Q, m^3/s) =			**0.04**
Peak Flow (Q, L/s) =			**41**
Volume for T_c minute Flow (m^3) =			**3500**
Snowmelt Climate Normals 1981 to 2010 (700 mm) (m3)/year)		**35,740**	**60,757**
Snowmelt (m3/day/20days)		**1,787**	**3,038**

OUTER DITCH Village of Haines Junction

Type A Rip Rap Ditch

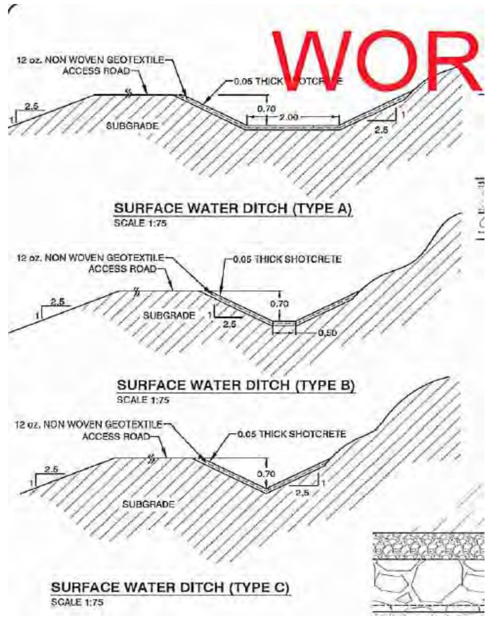
Rational Method



Z_1 =	2.5	RIP RAP CLASS	<10 kg
Z_2 =	2.5	Rip Rap Nominal Thickness	0.3 m
Ditch Hight	1 m	Free Board	0.15 m
Flow Depth (y) =	0.55 m		
Bottom Width (b) =	0 m	(Trapezoid Sections Only)	
Area (A) =	0.76 m^2		
Wetted Perimeter (P) =	2.96 m		
Hydraulic Radius (R) =	0.2553 m		
Longitudinal Ditch Slope (S) =	**0.085 m/m**		
Manning's n =	**0.033 Rip Rap Lined**		

$$Q = \frac{AR^{2/3}S^{1/2}}{n}$$

$Q_{required}$ =	2.00 m^3/s
$Q_{available}$ =	**2.69** m^3/s
Maximum Potential Velocity =	3.56 m/s



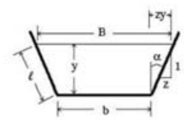


Figure 6. Trapezoidal Open Channel Cross-section

$D84 = 3.54S^{0.747}(1.25qc)^{2/3}/g^{1/3}$

S=	0.085 m/m
Wbankfull	3.5 m
Q=	2.00 m3/s
qc=	0.571857 m2/s
g	9.81 m/s2
D84=	0.204332 m
D84=	204.3322 mm

Equation 6.14

$D_{84} = 3.54S^{0.747}(1.25q_c)^{2/3}/g^{1/3}$

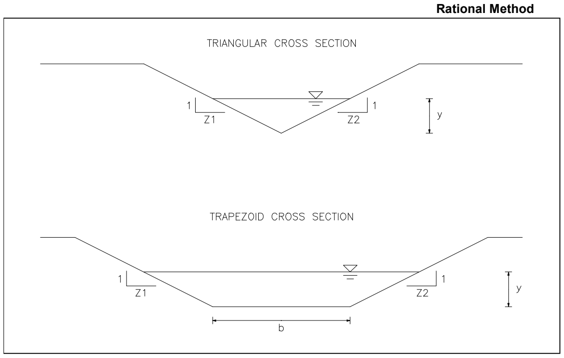
where:

D_{84} = intermediate axis of the 84th percentile particle in the sediment distribution, m (ft)
S = energy slope of the proposed channel
q_c = the critical unit discharge (total design discharge divided by the width of the bankfull channel) at which incipient motion of D_{84} occurs, m^2/s (ft^2/s)
g = the acceleration due to gravity, m/s^2 (ft/s^2)

INNER DITCH - Village of Haines Junction

Type A Rip Rap Ditch

Rational Method



Z_1 =	2.5	**RIP RAP CLASS**	**10 kg**
Z_2 =	2.5	Rip Rap Nominal Thickness	0.3 m
Ditch Hight	1 m	Free Board	0.15 m
Flow Depth (y) =	0.55 m		
Bottom Width (b) =	0 m	(Trapezoid Sections Only)	
Area (A) =	0.76 m^2		
Wetted Perimeter (P) =	2.96 m		
Hydraulic Radius (R) =	0.2553 m		
Longitudinal Ditch Slope (S) =	**0.005 m/m**		
Manning's n =	**0.033 Rip Rap Lined**		

$$Q = \frac{AR^{2/3}S^{1/2}}{n}$$

$Q_{required}$ =	0.65 m^3/s
$Q_{available}$ =	**0.65** m^3/s
Maximum Potential Velocity =	0.86 m/s

$D84 = 3.54S^{0.747}(1.25qc)^{2/3}/g^{1/3}$

S=	0.005 m/m
Wbankfull	3.5 m
Q=	0.65 m3/s
qc=	0.18625 m2/s
g	9.81 m/s2
D84=	0.01165 m
D84=	11.6521 mm

Equation 6.14

$D_{84} = 3.54S^{0.747}(1.25q_c)^{2/3}/g^{1/3}$

where:

D_{84} = intermediate axis of the 84th percentile particle in the sediment distribution, m (ft)
S = energy slope of the proposed channel
q_c = the critical unit discharge (total design discharge divided by the width of the bankfull channel) at which incipient motion of D_{84} occurs, m^2/s (ft^2/s)
g = the acceleration due to gravity, m/s^2 (ft/s^2)

Village of Haines Junction

LEACHATE POND SOUTHWEST

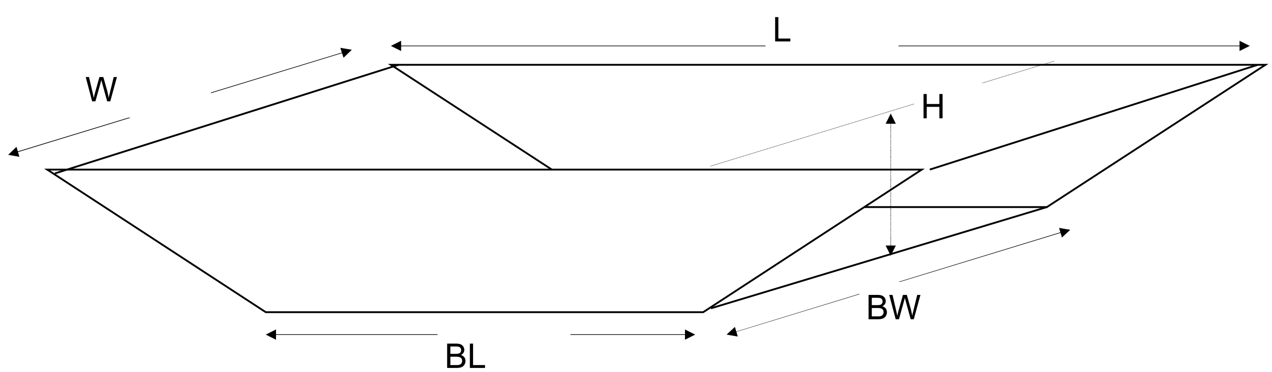
Estimated Annual Snowmelt (m3)	**30,379**
Estimated Snowmelt production per day over a 20 day melt period (m3)	**1,519**
Required 1:25 year 24 hr Capacity (m3)	**1,750**
Factor Safety=	**1.1**
Storage (m3) =	**3,536**

Equalization Pond Volume

$$V = HLW - SH^2L - SH^2W + 2S^2H^3$$

H =	3	m	**BL =**	26 m
L =	41	m	**BW =**	26 m
W =	41	m		
S =	2.5	:1		

SA =	1,681	m^2
V =	3,536	m^3



Village of Haines Junction

LEACHATE POND NORTHEAST

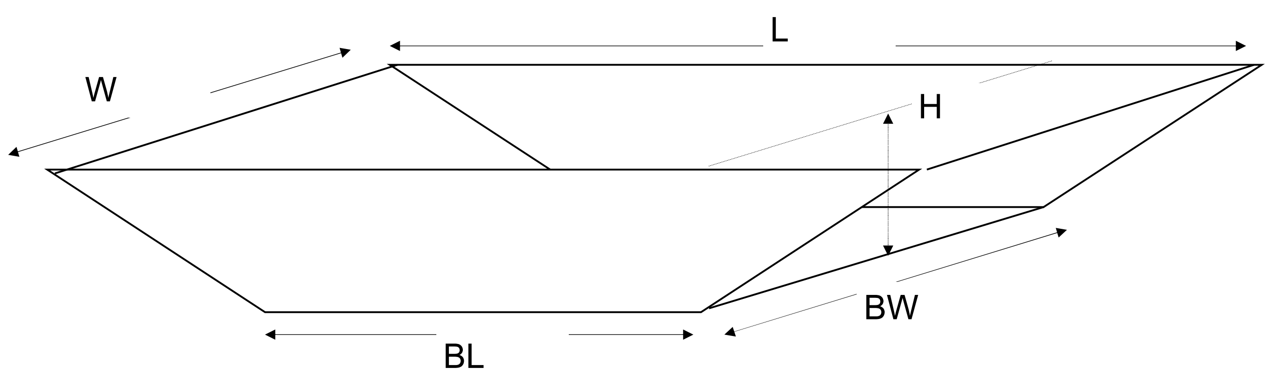
Estimated Annual Snowmelt (m3)	**30,379**
Estimated Snowmelt production per day over a 20 day melt period (m3)	**1,519**
Required 1:25 year 24 hr Capacity (m3)	**1,750**
Factor Safety=	**2.0**
Storage (m3) =	**6,700**

Equalization Pond Volume

$$V = HLW - SH^2L - SH^2W + 2S^2H^3$$

H =	2	m	**BL =**	90	m
L =	100	m	**BW =**	30	m
W =	40	m			
S =	2.5	:1			

SA =	4,000	m^2
V =	6,700	m^3



APPENDIX C
2013-2023 SWMP Initiatives Status

2013-2023 SWMP Recommendations, Strategies and Initatives		
#	Item	Status and Recommended Actions
1	Tipping Fees Provide community eductation regarding tipping fees Complete financial analysis to determine appropriate tipping fees	CARRY FORWARD: To date no tipping fees have been implemented. With the advent of regionalization I feel this is important data to have.
2	Regionalization of transferred/Recycled Materials to reduce operations and maintenance costs associated with trucking	CARRY FORWAD: To date no official regionalization has materialized beyond the immediate local area
3	Achieving waste diversion targets- community education, improved record keeping	CARRY FORWARD: Education will always be required in regards to diversion. Record keeping has improved but suggestions would be welcome as well as, the need to address a way to quantify diversion.
4	Establish an extended producer responsibility system in the Yukon that can assist with funding mechanisms for household hazardous waste and e-waste. The goal would be to put the handling costs up-front to the consumer to ultimately help dispose or recycle these products properly. This would require amendment to the Designated Material Regulation or creation of a similar framework that could be more easily updated.	SENIOR GOVERNMENT INITIATIVE: Currently the Yukon Government hosts a Household hazardous Waste Day in the community each year. Essentially they pay the cost of removal of household hazerdous waste from the site. The Yukon Government has supplied a seacan to store e-waste and normally covers the cost of transporting the e-waste to Whitehorse.
5	Creation of standardized signage throughout the Yukon to provide consistency to the user.	SENIOR GOVERNMENT INITIATIVE: This is an initative which is beyond the scope of the Village.
6	Potentially install a weigh scale system to better track material quantities entering the facility.	CARRY FORWARD: The Village had looked into the scale idea and felt the accuracy and upkeep made it a poor choice. Is there another way to quantify the waste received at the facility?
7	Provision for a site operator for all landfill areas to ensure better waste screening/segregation (introduction of tipping fees would help fund a site operator). A site operator is likely required to collect tipping fees on site.	CARRY FORWARD
8	Require local contractors to have SWMPs to ensure their wastes are being sorted properly as part of their contract (i.e., separation of any segregated materials accepted on site to increase diversion).	DO NOT CARRY FORWARD: This seems difficult to enact as local contractors don't currently have a relationship with the facility and we have noone monitoring what is disposed of on a contant basis.
9	Stop accepting autobodies and start collaborating with local salvaging companies to reduce environmental liabilities associated with autobody stockpiles.	CARRY FORWARD: The idea of not accepting autobodies is great, however, the Village questions where the refused auto bodies will end up, and if that may be a worse problem than dealing with them.
10	Signage for hazardous waste requires upgrading, including a list of materials accepted and banned and warnings against improper handling and storage such as stockpiling oxidizers adjacent to flammable liquids.Tetra Tech EBA recommends that Yukon-wide HHW signage be adopted for all SWMFs.	CARRY FORWARD: Signage needs updating
11	Based on Tetra Tech EBA's field observations, many of the on-site culverts were full of sediment and many ditches were beginning to fill with sediment and vegetation. Tetra Tech EBA recommends that more regular maintenance of surface water management infrastructure be conducted to minimize ponded area during freshet and heavy rainfall events. It should be noted that there is a swale running from the hazardous waste collection shelter to the main ditch system. The hazardous waste collection shelter does not have spill containment and there is potential for offsite migration of spills, should they occur. Tetra Tech EBA recommends that a proper hazardous waste collection shelter be constructed, with spill containment, and that no swales be connected to any potential runoff from this shelter.	ONGOING: Some work has been done here with containment but there is room for improvement
12	In order to limit potential impacts from leachate derived contaminants of concern, Tetra Tech EBA recommends that the following leachate management practices be implemented: improved hazardous waste collection system, retain detailed landfill records, implement recommended surface water management practices, provide funding for a full-time site operator for all areas of the facility to limit uncontrolled dumping practices, all previous closed cells from historical operations and progressively closed cells should be capped with a cover system meeting Environment Yukon's final cover requirements.	ONGOING: There is a lack of detailed landfill records, due in part to not having any means to quantify the waste received. A full time operator to limit uncontrolled dumping has not been implemented. We have an attendant on site but he operates the compaction equipment and empties the transfer bins so is unable to fully interact with each visitor to the site. Capping of the cells is happening however final regulatory cap hasn't been performed due to a layering of cells strategy adopted by the site. We have the equipment to place and compact the cell but would require outside consultation to confirm compaction results.
13	Tetra Tech EBA recommends that a diversion target of 50% be established in a phased approach by 2023.Community education, incentive programs, enforcement, improved site operations, and record keeping will assist in achieving this goal.	ONGOING: it's great to set a target but how do we achieve it without a way to quantify the waste.
14	Based on the size of the current cleared area, there is estimated MSW and C&D landfilling capacity until 2040. Additional capacity is available within the treed area of the reserve boundary.	CARRY FORWARD: SHA Area Based Design Should be implimented
15	The Haines Junction SWMF currently uses a front-end loader to spread, compact and cover waste. The thickness of waste being compacted may vary and Tetra Tech EBA recommends not to exceed 0.5 m. If possible, Tetra Tech EBA recommends that a CAT D-Series bulldozer or equivalent be used to spread, compact, and cover waste in lieu of a front-end loader to obtain reasonable levels of compaction and to minimize potential issues with slope stability and differential settlement.	COMPLETED: A CAT 953K Tracked Loader was purchased this year
16	Based on discussions with Government of Yukon and the Village of Haines Junction, Haines Junction SWMF may become a regional facility. As such, there is a potential to receive transferred materials as a staging ground. There is a potential for recyclable items to be shipped out of Haines Alaska, which may significantly reduce future transfer fees associated with these items.	DO NOT CARRY FORWARD: staff were all asked and there is no recollection of such a plan or possibility
17	Compostable materials are accepted in a separate roll-off bin adjacent to the recycling and MSW drop off depot, which is then transferred to a stockpile southwest of the MSW cell. Currently there is no end-use designated for compost; however, it could be stockpiled for site reclamation and be used for progressive closure activities. The compost stockpile is not covered or lined with a low permeability material and contained in a berm and can potentially produce a leachate with elevated nitrogen that could enter the groundwater regime and be detected in down-gradient monitoring wells. Tetra Tech EBA recommends that a shelter or a low permeability liner and berm be constructed for the compost area.	CARRY FORWARD: Compost is no longer stockpiled or accepted as compost material. It was tried in the past and there were issues with getting enough of the material and also with people depositing the right kinds of material. There is a renewed interest in composting from the community but we would need some clear plan of how it would be achieveable here.

2013-2023 SWMP Recommendations, Strategies and Initatives		
#	Item	Status and Recommended Actions
18	Storage of hazardous waste does not meet recommended storage procedures identified in the Yukon Special Waste Regulations. Refer to the recommendations listed in the report under Section 5.6 - Hazardous (Special) Waste Management. i.e. secondary containment, wooden pallets, plastic wrap on batteries, spill containment for oil, paint should be dried out, paint cans to be deposited in scrap metal pile once paint has been removed, unknown hazardous wate educational material.	ONGOING: Spill containment for oil and glycol have been put in place, drying of paint has been tried but with very limited success.
19	If possible, it is also recommended that autobodies no longer be accepted at the Haines Junction SWMF and the public be re-directed to the nearest auto wrecker.	CARRY FORWARD: The idea of not accepting autobodies is great, however, the Village questions where the refused bodies will end up, and if that may be a worse problem than dealing with them.
20	Previous environmental sampling only included groundwater sampling, as the unnamed creek approximately 115 m south of the site reserve boundary was not previously identified. Tetra Tech EBA recommends that future environmental sampling include surface water samples from this area and identifying, with a hand held GPS, a permanent sample location.	CARRY FORWARD: this was never implemented.
21	Tetra Tech EBA recommends that all landfill operators and managers have specialized professional training in courses such as SWANA Manager of Landfill Operations course, Qualified Landfill Operator course, or similar. Additional local training can also be provided by Raven Recycling in Whitehorse to better inform site operators of the recycling stream and how to handle recyclables.	ONGOING: Currently the existing staff involved with waste management have had training except for recently hired manager.
22	Tetra Tech EBA recommends that the Village of Haines Junction ensures all personnel who are responsible for responding to spills receive the appropriate specialized professional training to do so in advance of a spill. In addition, it is the responsibility of the Government of Yukon to review the attached Spill Contingency Plan and update, if necessary.	Currently staff don't hold valid certificates for Spill response training but the Village will see that we add it to our list of safety courses we offer our employees.
23	Tetra Tech EBA recommends that Village of Haines Junction continue working with local municipalities to realize as many initiatives, discussed herein, as possible during the planning period of this report (2013-2023).	ONGOING:
24	It is further recommended that this report be updated every two years with new or revised strategies and initiatives.	DO NOT CARRY FORWARD

APPENDIX D
Figures

X:\PRJ\PRJ22\PRJ22018 - HAINES JUNCTION SWMP\06_AUTOCAD DRAWINGS\01_DRAWINGS\FIG 1.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:

CLIENT: VILLAGE OF HAINES JUNCTION

PROJECT: HAINES JUNCTION 2023-2033 SOLID WASTE MANAGEMENT PLAN

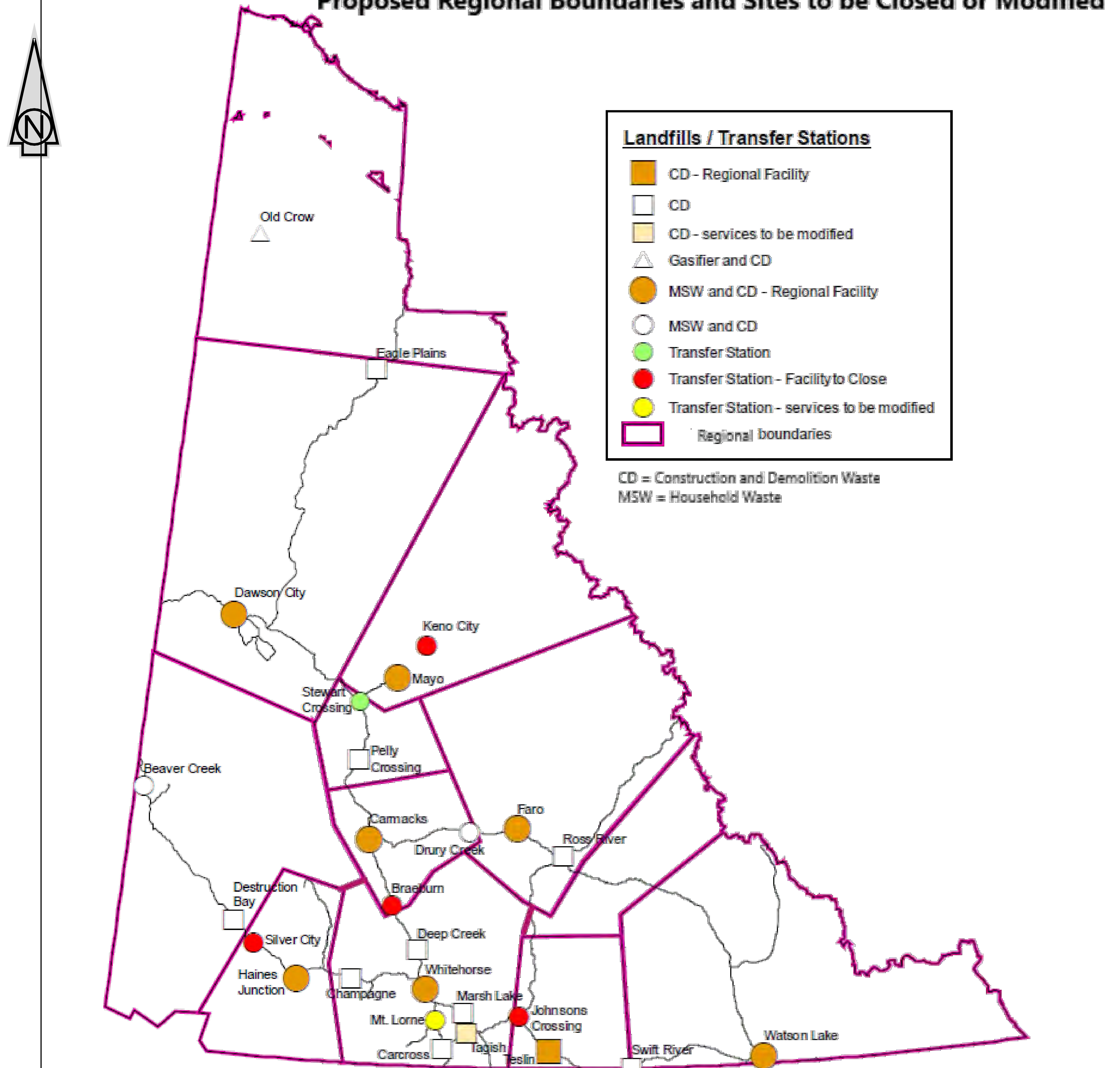
TITLE: **SOLID WASTE MANAGEMENT FACILITY LOCATION**

SCALE:	DATE:	PROJECT NO:
Custom	2022/04/26 (yyyy/mm/dd)	PRJ 22018

DESIGNED	RG	DRAWING NO:
DRAWN	NL	**FIGURE 1**
CHECKED	TS	

Yukon After Regionalization:

Proposed Regional Boundaries and Sites to be Closed or Modified



X:\PRJ\PRJ22\PRJ22018 - HAINES JUNCTION SWMP\06_AUTOCAD DRAWINGS\01_DRAWINGS\FIG 2.DWG

SPERLING HANSEN ASSOCIATES

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- Design & Operations Plans
- Landfill Closure
- Environmental Monitoring

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

LEGEND:

CLIENT: VILLAGE OF HAINES JUNCTION

PROJECT: HAINES JUNCTION 2023-2033 SOLID WASTE MANAGEMENT PLAN

TITLE: **REGIONALIZATION MAP**

SCALE:	DATE:	PROJECT NO:
######	2022/04/26 yyyy/mm/dd	PRJ 22018

DESIGNED	RG	DRAWING NO:
DRAWN	NL	**FIGURE 2**
CHECKED	TS	

X:\PRJ\PRJ22\PRJ22018 - HAINES JUNCTION SWMP\06_AUTOCAD DRAWINGS\01_DRAWINGS\FIG 3.DWG 5/25/2022 4:49 PM

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:

- 5m EXISTING CONTOUR
- 1m EXISTING CONTOUR
- EXISTING FENCE
- PROPERTY BOUNDARY
- ROAD
- MONITORING WELL

NOTE: GROUNDWATER ELEVATIONS ARE SHOWN FROM SEPTEMBER 2020 IN METRES ABOVE SEA LEVEL (masl)

EXISTING TOPO SURVEYED OCTOBER 8, 2020
UTM 8N / CGVD2013
[CGVD2013 =~0.594m>CGVD1928]
IMAGE @ DRONEX SURVEY INC.

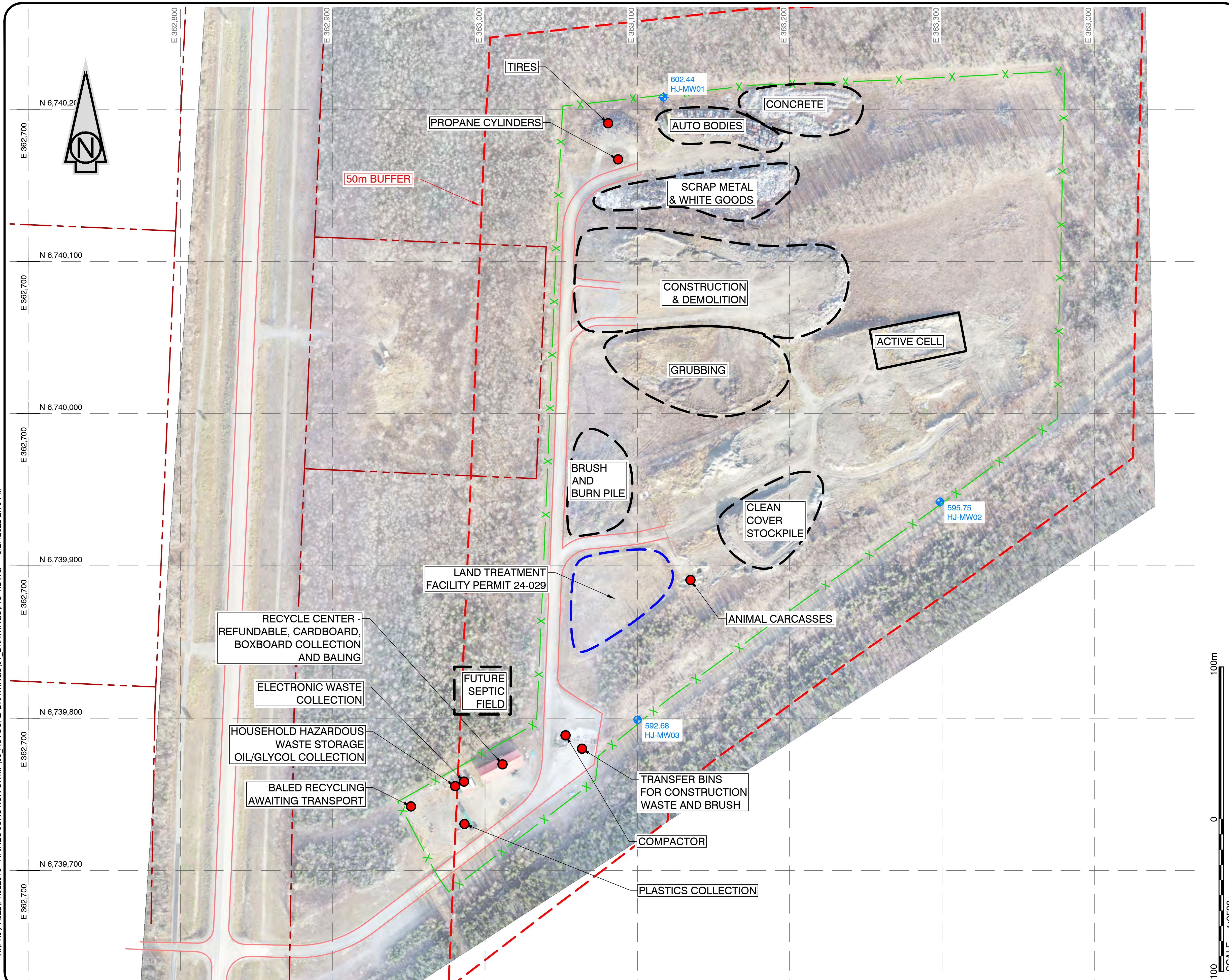
CLIENT: VILLAGE OF HAINES JUNCTION

PROJECT: HAINES JUNCTION 2023-2033 SOLID WASTE MANAGEMENT PLAN

TITLE: **SWMF SITE PLAN (2020 TOPOGRAPHY)**

SCALE:	DATE:	PROJECT NO:
1:2500	2022/04/26 (yyyy/mm/dd)	PRJ 22018

DESIGNED	RG	DRAWING NO:
DRAWN	NL	**FIGURE 3**
CHECKED	TS	



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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:

- 5m EXISTING CONTOUR
- 1m EXISTING CONTOUR
- EXISTING FENCE
- PROPERTY BOUNDARY
- ROAD
- MONITORING WELL

NOTE: GROUNDWATER ELEVATIONS ARE SHOWN FROM SEPTEMBER 2020 IN METRES ABOVE SEA LEVEL (masl)

- 50m BUFFER ZONE

EXISTING TOPO SURVEYED OCTOBER 8, 2020
UTM 8N / CGVD2013
[CGVD2013 = ~0.594m>CGVD1928]
IMAGE @ DRONEX SURVEY INC.

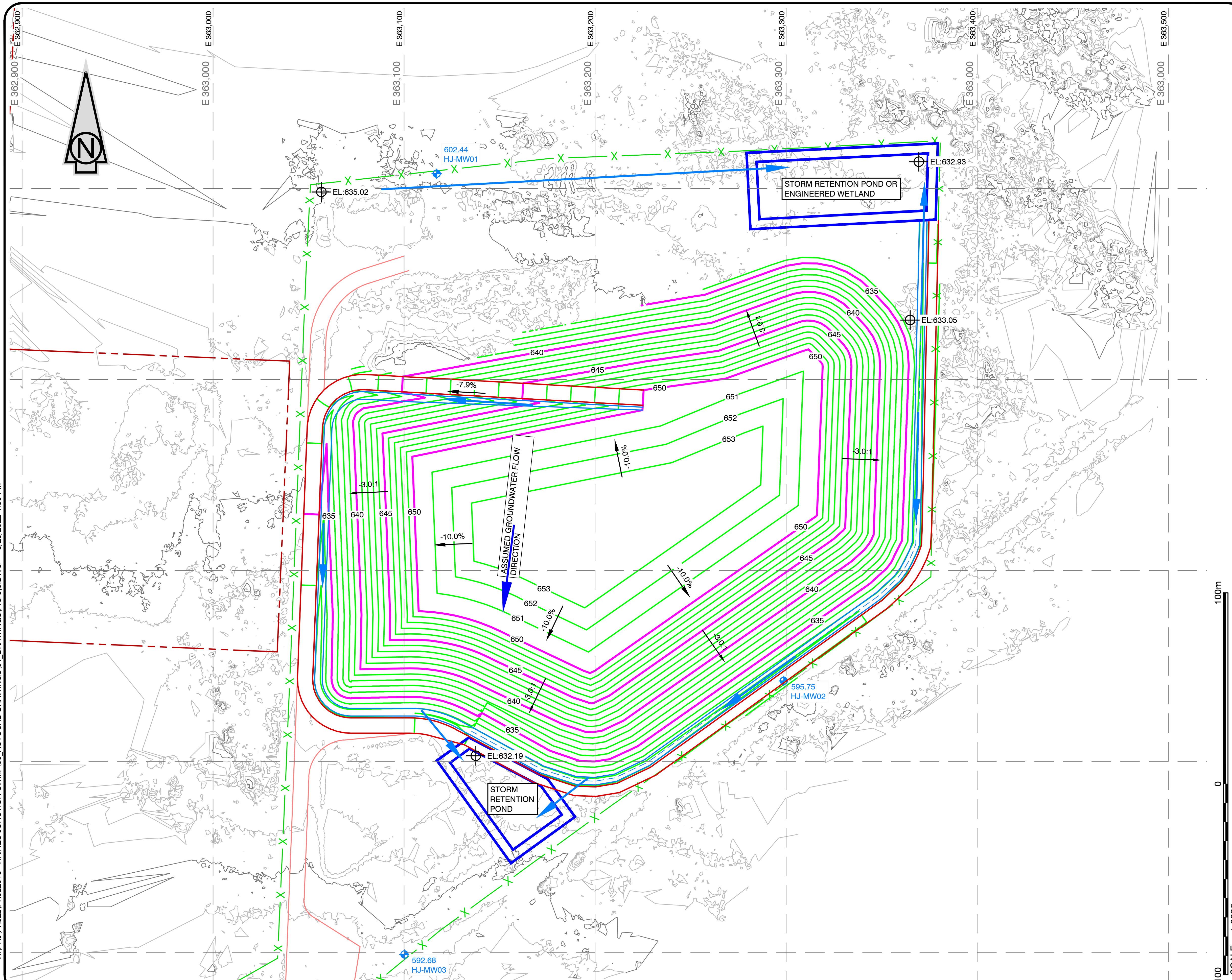
CLIENT: VILLAGE OF HAINES JUNCTION

PROJECT: HAINES JUNCTION 2023-2033 SOLID WASTE MANAGEMENT PLAN

TITLE: **SWMF SITE LAYOUT AND INFRASTRUCTURE**

SCALE:	DATE:	PROJECT NO:
1:2500	2022/04/26 (yyyy/mm/dd)	PRJ 22018

DESIGNED	RG	DRAWING NO:
DRAWN	NL	**FIGURE 4**
CHECKED	TS	



X:\PRJ\PRJ22\PRJ22018 - HAINES JUNCTION SWMP\06_AUTOCAD DRAWINGS\01_DRAWINGS\FIG 5.6.DWG 5/25/2022 4:50 PM

SPERLING HANSEN ASSOCIATES

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

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

LEGEND:

- 5m EXISTING CONTOUR
- 1m EXISTING CONTOUR
- 5m DESIGN CONTOUR
- 1m DESIGN CONTOUR
- EXISTING FENCE
- PROPERTY BOUNDARY
- ROAD
- MONITORING WELL

DESIGN AREA IS APPROXIMATELY 7.5 ha

EXISTING TOPO SURVEYED OCTOBER 8, 2020
UTM 8N / CGVD2013
[CGVD2013 =~0.594m>CGVD1928]
IMAGE @ DRONEX SURVEY INC.

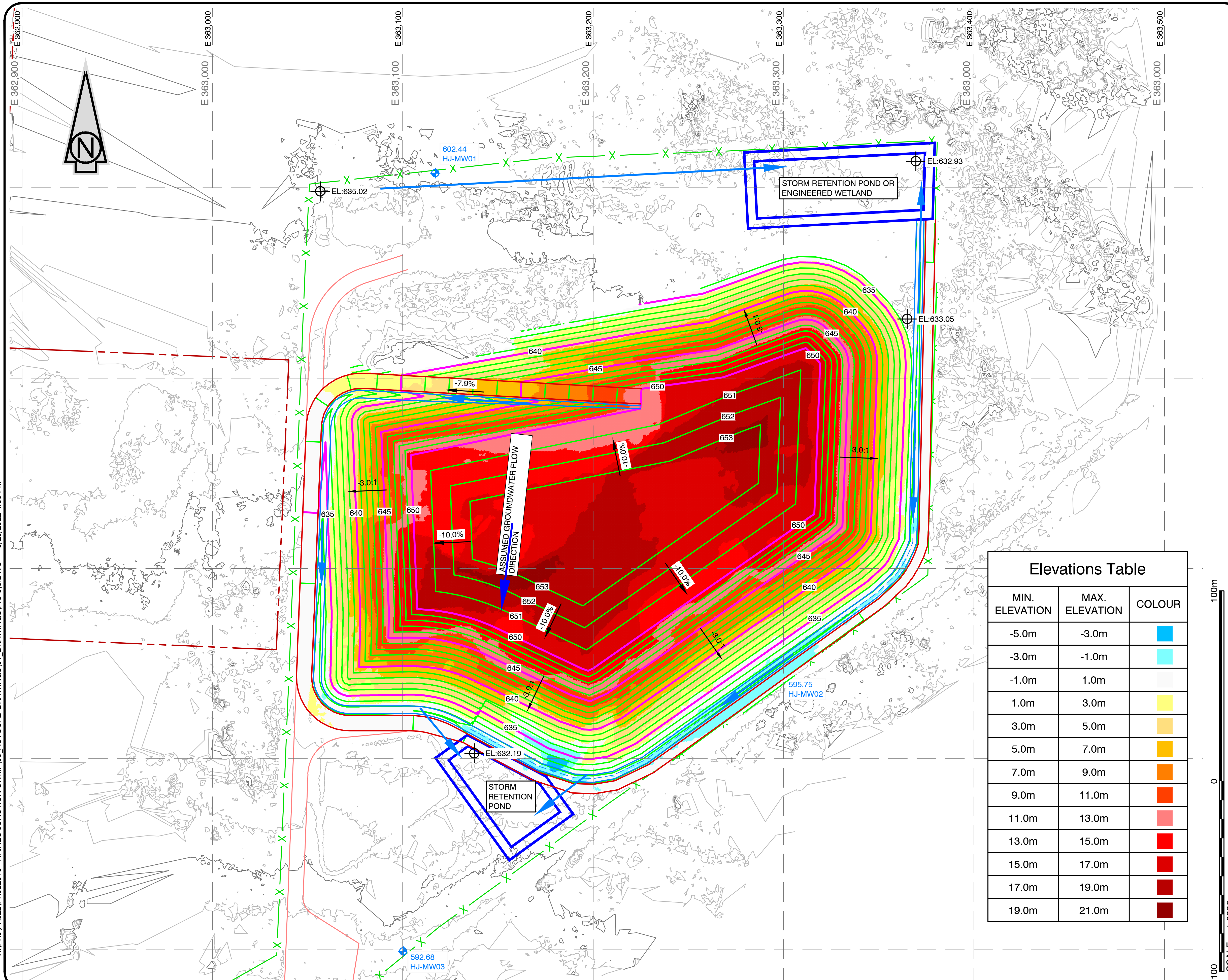
CLIENT: VILLAGE OF HAINES JUNCTION

PROJECT: HAINES JUNCTION 2023-2033 SOLID WASTE MANAGEMENT PLAN

TITLE: **SWMF AREA BASED DESIGN**

SCALE:	DATE:	PROJECT NO:
1:2000	2022/04/26 (yyyy/mm/dd)	PRJ 22018

DESIGNED	RG	DRAWING NO:
DRAWN	NL	**FIGURE 5**
CHECKED	TS	



Elevations Table

MIN. ELEVATION	MAX. ELEVATION	COLOUR
-5.0m	-3.0m	
-3.0m	-1.0m	
-1.0m	1.0m	
1.0m	3.0m	
3.0m	5.0m	
5.0m	7.0m	
7.0m	9.0m	
9.0m	11.0m	
11.0m	13.0m	
13.0m	15.0m	
15.0m	17.0m	
17.0m	19.0m	
19.0m	21.0m	

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LEGEND:

- 5m EXISTING CONTOUR
- 1m EXISTING CONTOUR
- 5m DESIGN CONTOUR
- 1m DESIGN CONTOUR
- EXISTING FENCE
- PROPERTY BOUNDARY
- ROAD
- MONITORING WELL

CUT:	4,580 m³
FILL:	640,574 m³
NET:	635,994 m³ (FILL)

DESIGN AREA IS APPROXIMATELY 7.5 ha

EXISTING TOPO SURVEYED OCTOBER 8, 2020
UTM 8N / CGVD2013
[CGVD2013 = ~0.594m>CGVD1928]
IMAGE @ DRONEX SURVEY INC.

CLIENT: VILLAGE OF HAINES JUNCTION

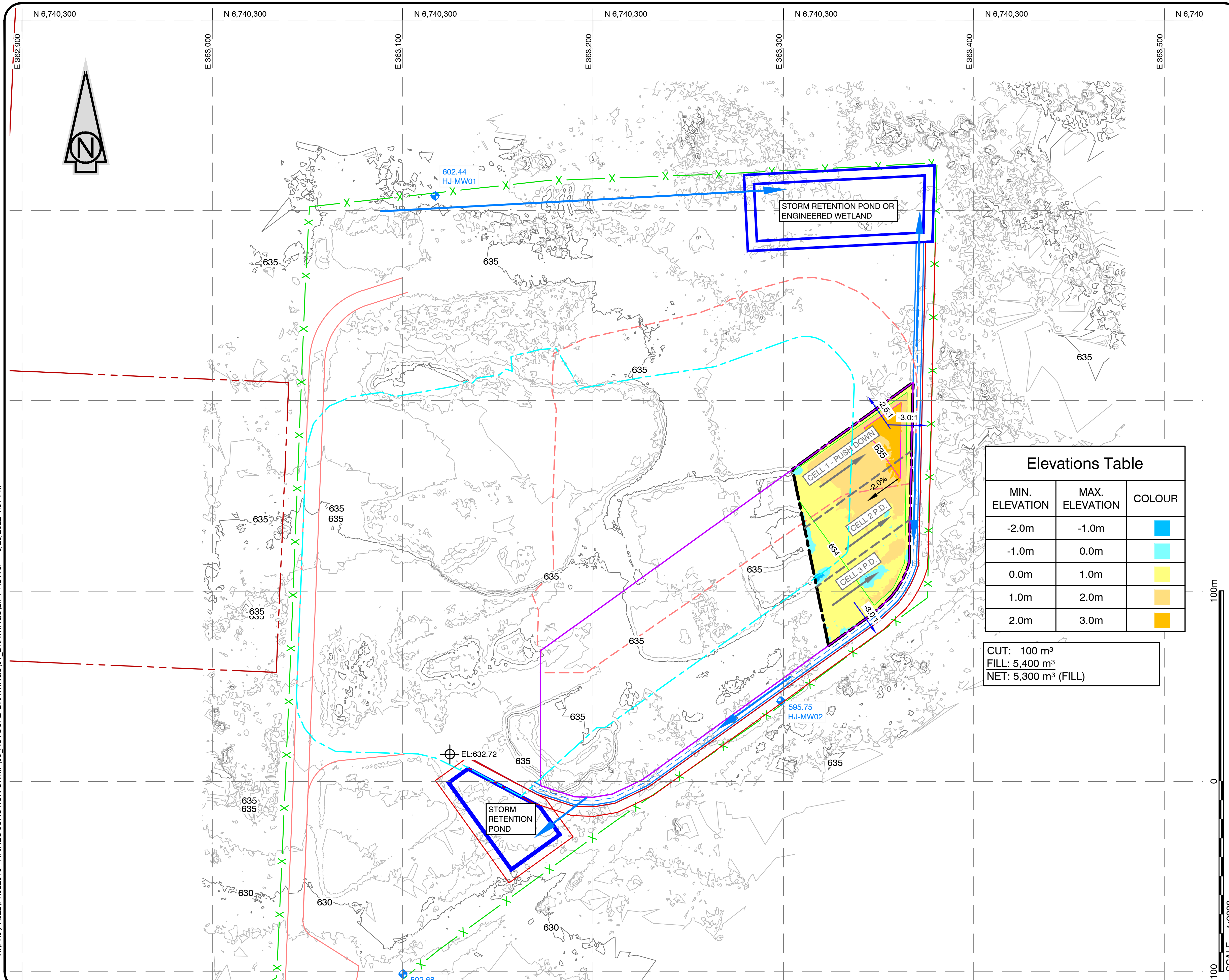
PROJECT: HAINES JUNCTION 2023-2033 SOLID WASTE MANAGEMENT PLAN

TITLE: **SWMF CAPACITY**

SCALE:	DATE:	PROJECT NO:
1:2000	2022/04/26 (yyyy/mm/dd)	PRJ 22018

DESIGNED	RG	DRAWING NO:
DRAWN	NL	**FIGURE 6**
CHECKED	TS	

X:\PRJ\PRJ22\PRJ22018 - HAINES JUNCTION SWMP\06_AUTOCAD DRAWINGS\01_DRAWINGS\FIG 5.6.DWG 5/25/2022 4:50 PM



Elevations Table

MIN. ELEVATION	MAX. ELEVATION	COLOUR
-2.0m	-1.0m	
-1.0m	0.0m	
0.0m	1.0m	
1.0m	2.0m	
2.0m	3.0m	

CUT: 100 m^3
FILL: 5,400 m^3
NET: 5,300 m^3 (FILL)

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LEGEND:

- 5m EXISTING CONTOUR
- 1m EXISTING CONTOUR
- 5m DESIGN CONTOUR
- 1m DESIGN CONTOUR
- EXISTING FENCE
- PROPERTY BOUNDARY
- ROAD
- MONITORING WELL
- PHASE 1 BOUNDARY
- PHASE 2 BOUNDARY
- PHASE 3 BOUNDARY

EXISTING TOPO SURVEYED OCTOBER 8, 2020
UTM 8N / CGVD2013
[CGVD2013 = ~0.594m>CGVD1928]
IMAGE @ DRONEX SURVEY INC.

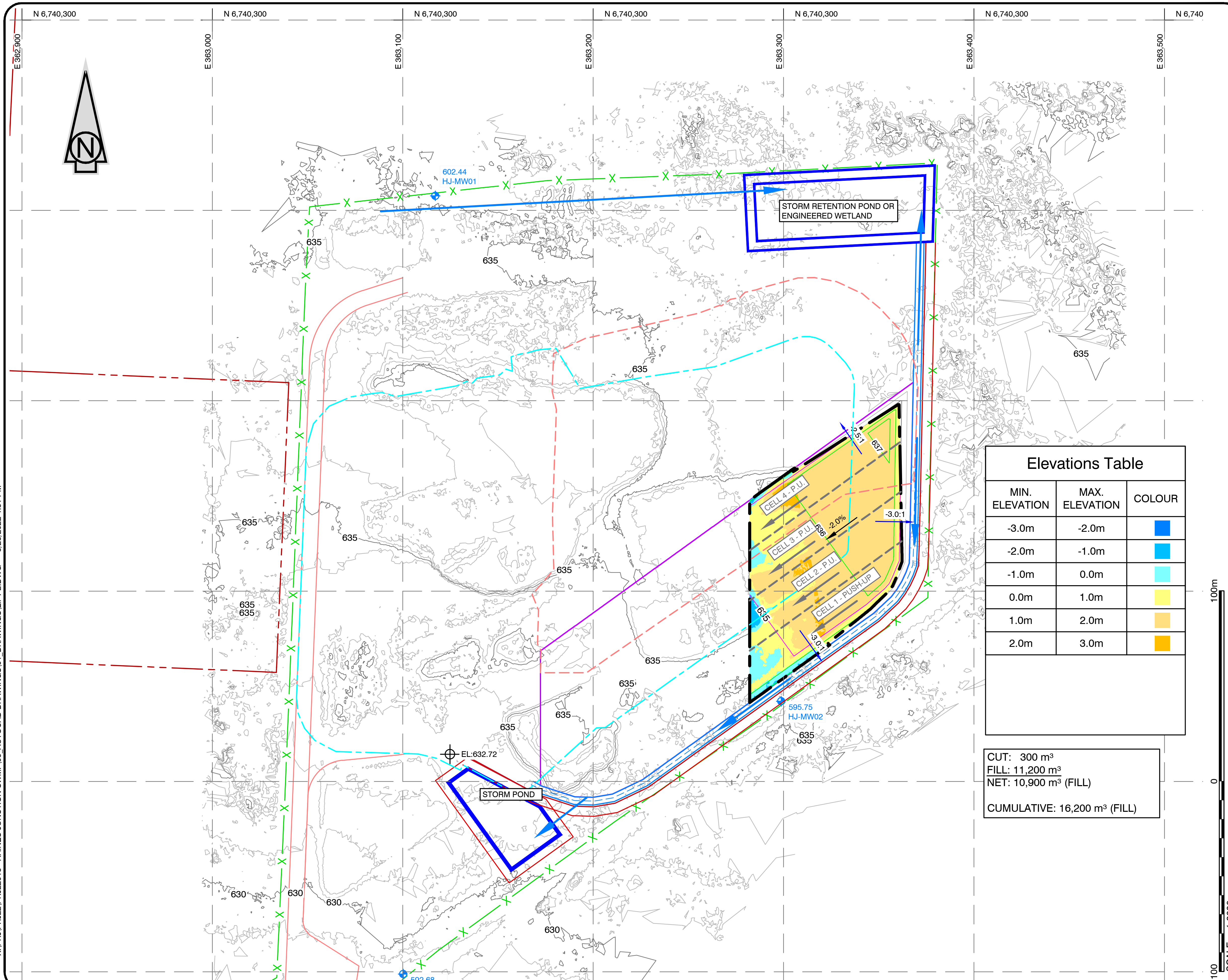
CLIENT: VILLAGE OF HAINES JUNCTION

PROJECT: HAINES JUNCTION 2023-2033 SOLID WASTE MANAGEMENT PLAN

TITLE: **FILL PLAN LIFT 1**

SCALE:	DATE:	PROJECT NO:
1:2000	2022/04/26 (yyyy/mm/dd)	PRJ 22018

DESIGNED	RG	DRAWING NO:
DRAWN	NL	**FIGURE L-1**
CHECKED	TS	



Elevations Table

MIN. ELEVATION	MAX. ELEVATION	COLOUR
-3.0m	-2.0m	
-2.0m	-1.0m	
-1.0m	0.0m	
0.0m	1.0m	
1.0m	2.0m	
2.0m	3.0m	

CUT: 300 m³
FILL: 11,200 m³
NET: 10,900 m³ (FILL)

CUMULATIVE: 16,200 m³ (FILL)

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LEGEND:
- 5m EXISTING CONTOUR
- 1m EXISTING CONTOUR
- 5m DESIGN CONTOUR
- 1m DESIGN CONTOUR
- EXISTING FENCE
- PROPERTY BOUNDARY
- ROAD
- MONITORING WELL
- PHASE 1 BOUNDARY
- PHASE 2 BOUNDARY
- PHASE 3 BOUNDARY

EXISTING TOPO SURVEYED OCTOBER 8, 2020
UTM 8N / CGVD2013
[CGVD2013 =~0.594m>CGVD1928]
IMAGE @ DRONEX SURVEY INC.

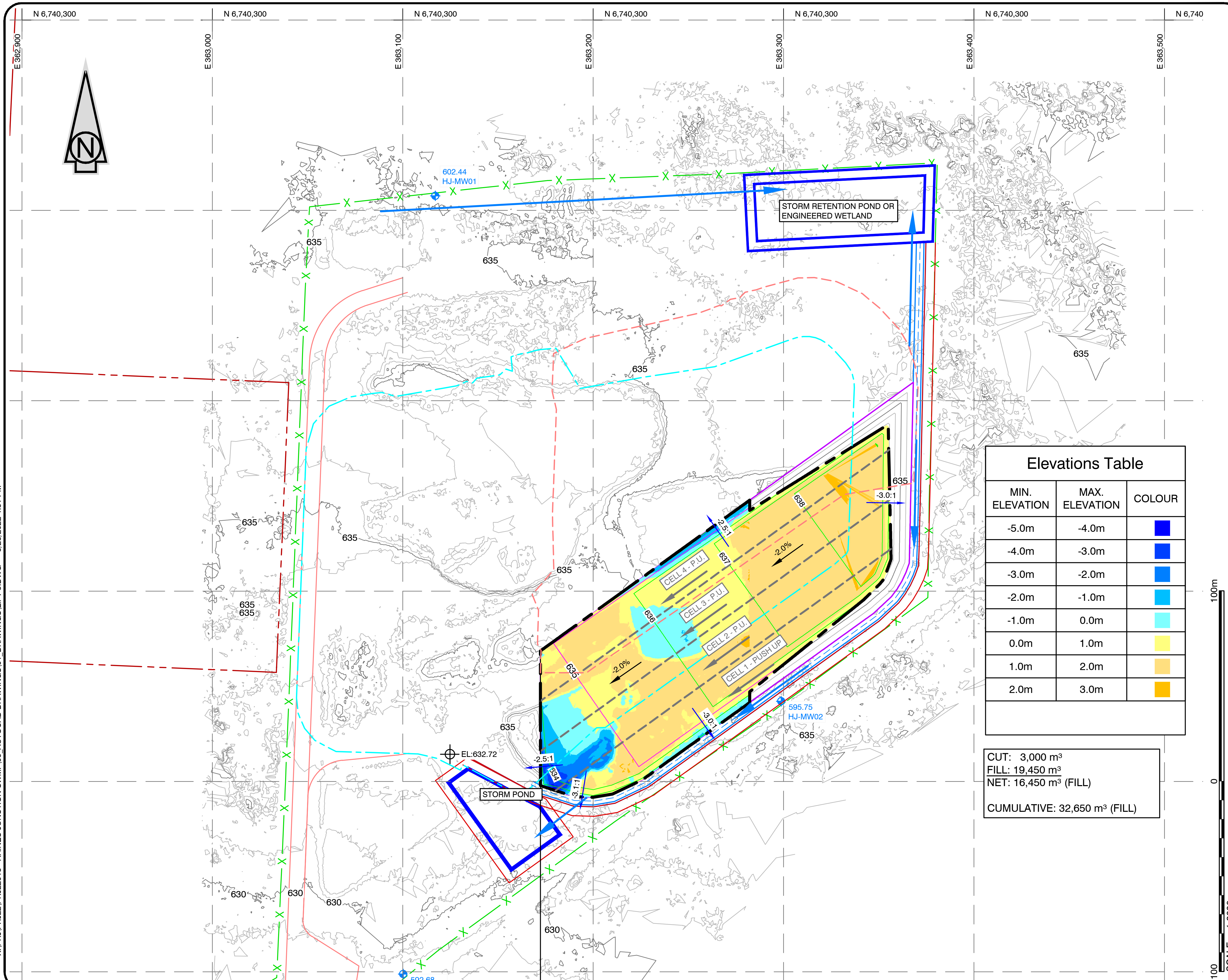
CLIENT: VILLAGE OF HAINES JUNCTION

PROJECT: HAINES JUNCTION 2023-2033 SOLID WASTE MANAGEMENT PLAN

TITLE: **FILL PLAN LIFT 2**

SCALE:	DATE:	PROJECT NO:
1:2000	2022/04/26 (yyyy/mm/dd)	PRJ 22018

DESIGNED	RG	DRAWING NO:
DRAWN	NL	**FIGURE L-2**
CHECKED	TS	



Elevations Table

MIN. ELEVATION	MAX. ELEVATION	COLOUR
-5.0m	-4.0m	
-4.0m	-3.0m	
-3.0m	-2.0m	
-2.0m	-1.0m	
-1.0m	0.0m	
0.0m	1.0m	
1.0m	2.0m	
2.0m	3.0m	

CUT: 3,000 m^3
FILL: 19,450 m^3
NET: 16,450 m^3 (FILL)

CUMULATIVE: 32,650 m^3 (FILL)

SPERLING HANSEN ASSOCIATES

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Phone: (604) 986-7723

LEGEND:

- 5m EXISTING CONTOUR
- 1m EXISTING CONTOUR
- 5m DESIGN CONTOUR
- 1m DESIGN CONTOUR
- EXISTING FENCE
- PROPERTY BOUNDARY
- ROAD
- MONITORING WELL
- PHASE 1 BOUNDARY
- PHASE 2 BOUNDARY
- PHASE 3 BOUNDARY

EXISTING TOPO SURVEYED OCTOBER 8, 2020
UTM 8N / CGVD2013
[CGVD2013 = ~0.594m > CGVD1928]
IMAGE @ DRONEX SURVEY INC.

CLIENT: VILLAGE OF HAINES JUNCTION

PROJECT: HAINES JUNCTION 2023-2033 SOLID WASTE MANAGEMENT PLAN

TITLE: **FILL PLAN LIFT 3**

SCALE:	DATE:	PROJECT NO:
1:2000	2022/04/26 (yyyy/mm/dd)	PRJ 22018

DESIGNED	RG	DRAWING NO:
DRAWN	NL	**FIGURE L-3**
CHECKED	TS	

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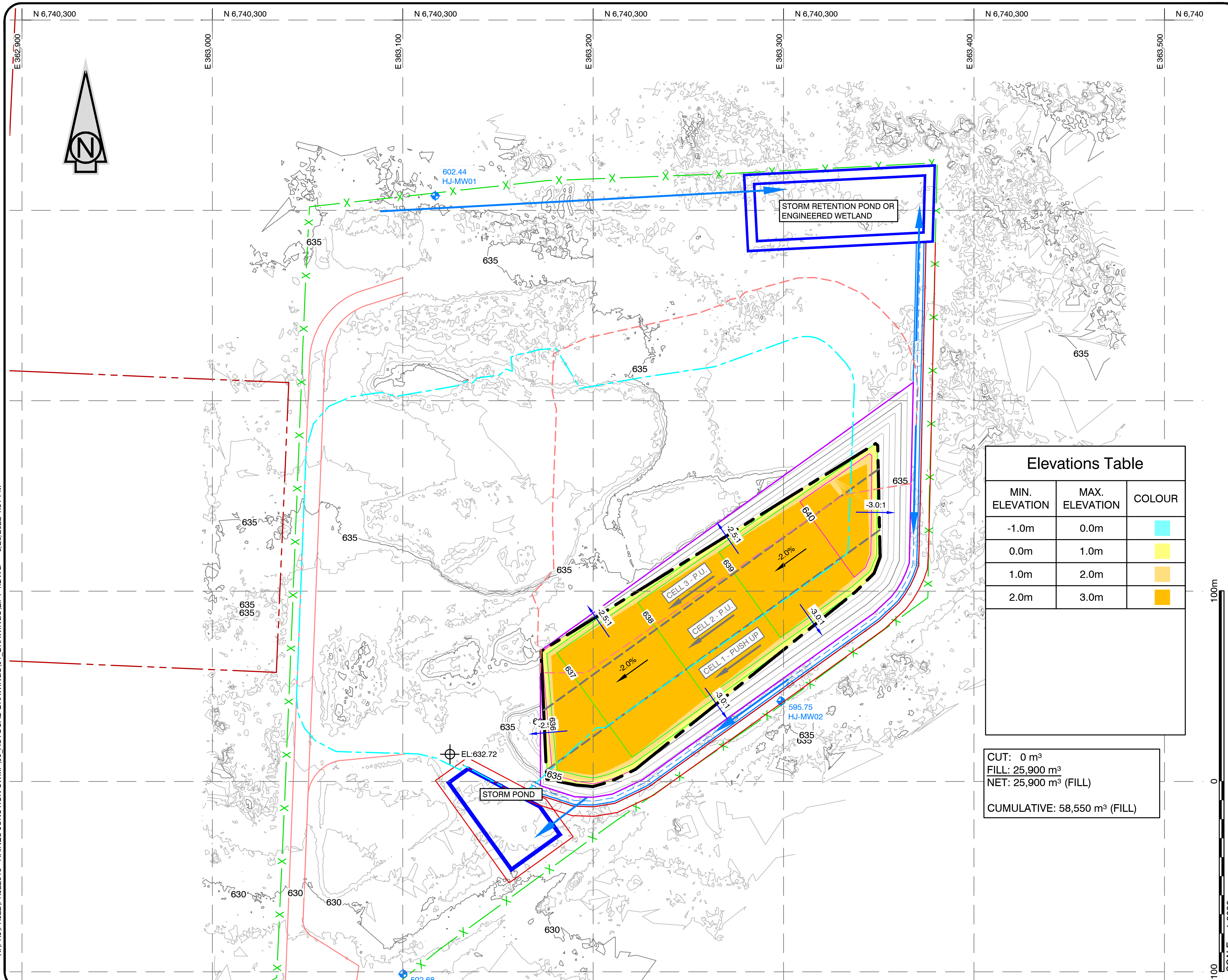

Elevations Table

MIN. ELEVATION	MAX. ELEVATION	COLOUR
-1.0m	0.0m	(light blue)
0.0m	1.0m	(yellow)
1.0m	2.0m	(light orange)
2.0m	3.0m	(orange)

CUT: 0 m³
FILL: 25,900 m³
NET: 25,900 m³ (FILL)

CUMULATIVE: 58,550 m³ (FILL)

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LEGEND:

- 5m EXISTING CONTOUR
- 1m EXISTING CONTOUR
- 5m DESIGN CONTOUR
- 1m DESIGN CONTOUR
- EXISTING FENCE
- PROPERTY BOUNDARY
- ROAD
- MONITORING WELL
- PHASE 1 BOUNDARY
- PHASE 2 BOUNDARY
- PHASE 3 BOUNDARY

EXISTING TOPO SURVEYED OCTOBER 8, 2020
UTM 8N / CGVD2013
[CGVD2013 =~0.594m>CGVD1928]
IMAGE @ DRONEX SURVEY INC.

CLIENT: VILLAGE OF HAINES JUNCTION

PROJECT: HAINES JUNCTION 2023-2033 SOLID WASTE MANAGEMENT PLAN

TITLE: **FILL PLAN LIFT 4**

SCALE:	DATE:	PROJECT NO:
1:2000	2022/04/26 (yyyy/mm/dd)	PRJ 22018

DESIGNED	RG	DRAWING NO:
DRAWN	NL	**FIGURE L-4**
CHECKED	TS	