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Oct. 6, 2020

Mardy Semmler
Executive Director
Inuvialuit Water Board
PO Box 2531
Inuvik, NT
X0E 0T0

Re: N7L3-1619 – Modifications to Sewage Lagoon

I apologize for the oversight in regards to conditions Part G and Part H of our current water licence; the Hamlet wishes to notify the Board and request approval for the construction of a berm and ditch around the perimeter of our Sewage Lagoon as per the attached construction plan and design report prepared by Dillon Consulting in 2018. Details as to the proposed Berm design are laid out in the attached Sewage Lagoon and Solid Waste Assessment report prepared by Dillon Consulting in 2017, section 7.3.1, page 19.

The Assessment report recommended that a berm be constructed around the perimeter to prevent the inflow of surface water into the lagoon to stop overflow from the lake that has been reported in the past, particularly during spring runoff and periods of heavy precipitation. It is expected that the lagoon collects a large amount of surface runoff that lessens the amount of space available for the storage and treatment of the sewage effluent, a reduction in surface water entering the lagoon would allow for more treatment capacity. As well, the overflow potentially causes effluent to spread overland outside the bounds of the lagoon.

A lack of suitable equipment and material for berm construction prevented the start of the project until this construction season. Although the project will not be completed this year, it is hoped that a good part of the base for the berm will be constructed this year and this will enable it to be completed next year.

Yours truly,

John Holland
Senior Administrative Officer

DILLON
CONSULTING

HAMLET OF PAULATUK

Sewage Lagoon and Solid Waste Assessment

November 2017 – 17-6028

November 29, 2017

Hamlet of Paulatuk
Box 98
Paulatuk, NT X0E 1N0

Attention: John Holland
Senior Administrative Officer

Re: Hamlet of Paulatuk Sewage Lagoon and Solid Waste Assessment

Dear Mr. Holland:

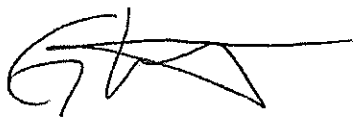
Dillon Consulting Limited (Dillon) is pleased to provide you with the following final report, titled ***Hamlet of Paulatuk Sewage Lagoon and Solid Waste Site Assessment.***

As part of this report, Dillon reviewed background information for the sewage disposal and solid waste disposal facilities, and conducted a site visit July 25 – 28, 2017 to assess the state of current facilities and to meet with Hamlet staff and councillors. This report provides a summary of findings from the site visit.

We welcome your review and comments on this document. Please contact me at 867.920.4555 ext. 4111 or by email at gstrong@dillon.ca.

Sincerely,

DILLON CONSULTING LIMITED



Gary Strong, P.Eng.
Partner

GS:cj
Attachment: *Hamlet of Paulatuk Sewage Lagoon and Solid Waste Assessment*

Our file: 17-6028

DILLON CONSULTING

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References

Acronyms, Abbreviations, Definitions

– C –

CFU, *colony forming unit*

– I –

Inuvialuit Water Board (IWB), *"The IWB holds authority under the Waters Act (S.N.W.T. 2014) to issue water licences in that portion of the Inuvialuit Settlement Region located within the Northwest Territories." (IWB, n.d)*

– S –

Surveillance Network Program (SNP), *"means a monitoring program established to define environmental sampling and analysis requirements, […], to collect Water quality data, and to assess discharge quality, compliance with licence terms and conditions and the potential for Licensee activity impact on the environment" (IWB, 2015)*

Executive Summary

The Hamlet of Paulatuk's sewage and solid waste management needs are serviced by facilities located approximately 2 km south of the Hamlet. Sewage is collected by a vacuum truck six days per week and discharged into a natural lake system known as 'Lake A'. Sewage effluent receives primary treatment in 'Lake A' and then discharges through a wetland area into Darnley Bay. Discharge from the lake into the wetland occurs continuously throughout the summer months. A depth assessment was conducted, and concluded that the total volume of 'Lake A' is approximately 128,000 m^3, and of this volume approximately 15,000 m^3 (12%) is accumulated sludge. Reported issues with overflow from the lake in the past are not believed to be due to a lack of capacity in the lake, but the inflow of surface water into the lagoon due to the lack of freeboard and no berm around 'Lake A'. It is recommended that a berm be constructed around the lagoon perimeter. Water samples were taken at the sewage disposal and solid waste disposal facilities in accordance with the Surveillance Network Program. Stations 1619-3 and 1619-4 exceeded total suspended solids effluent criteria, and Station 1619-2 exceeded pH effluent criteria. It is recommended that manual decanting occur annually in the fall, rather than allowing continuous flow during summer months, to control treatment time and better manage Surveillance Network Program sample results.

Solid waste is collected twice a week and transported to the solid waste management facility. General domestic waste is placed in the active landfill cell while larger waste items are stored and sorted at the bulky waste storage area. Waste from the local Northern Store is collected and landfilled separately, in a designated cell. Based on the site assessment, municipal waste in the active landfill cell is piled above the recommended 2 m maximum. It is recommended that the cell be managed to ensure the waste is piled to a maximum of 2 m. Current disposal practices are expected to result in the municipal cell reaching capacity in approximately 12 months. Properly adhering to the *Solid Waste Disposal Facilities Operation and Maintenance Plan* is recommended to increase the lifespan of the current active cell. The use of the area method is recommended to extend the lifespan of the current facility by up to 20 years. Bulky waste at the facility should be sorted, processed for shipping (ie. hazardous materials removed) and shipped to appropriate recycling/disposal facilities.

1.0 Introduction

Dillon Consulting Limited (Dillon) was retained by the Hamlet of Paulatuk (the Hamlet) to further assess the findings of the May 2017 *Sewage Lagoon and Solid Waste Site Assessment* report prepared by Dillon. This report addresses the concerns and recommended remedial actions of the previous report which are relevant to the engineering services provided by Dillon. Several concerns and remedial action items were noted to be the responsibility of the Hamlet, and are therefore not addressed in detail in this report.

1.1 Scope of Work

The Consulting Services Agreement for this project was signed July 4th, 2017 and the associated work plan was approved on this date. The following scope of work was completed in relation to the preparation of this report:

- Meet with Hamlet staff and administration;
- Site inspection of solid waste management and sewage treatment facilities;
- Conduct site surveys, including sludge and lagoon depth measurements of sewage lagoon;
- Conduct community meeting related to the potential selection of a new solid waste management facility location;
- Collect water samples as per water licence N7L3-1619; and
- Assess the sewage lagoon capacity.

Annual reporting related to the Hamlet of Paulatuk water licence will be prepared in a separate document.

2.0 Background Review

2.1 Solid Waste Disposal Facilities

The solid waste disposal facility is located adjacent to the sewage lagoon, surrounding the north and east sides of the lagoon. Solid waste is collected twice weekly (Monday and Friday) using the Hamlet's 1.5 tonne small compactor truck. The truck has an estimated capacity of 3.5 m^3. Approximately 10 trips per operating day are required for municipal and Northern Store waste collection and disposal. Waste is collected more frequently during peak times of the year, as needed. There are two active landfill cells, one cell for general municipal domestic waste, and one for the Hamlet's Northern Store (to the west of the municipal cell). The northern end of the site is fenced to reduce windblown litter, and is equipped with an entrance gate.

Other waste items including end-of-life vehicles (ELVs), all-terrain vehicles (ATVs), and snowmobiles, white goods, barrels, and other bulky waste is sorted and stored on-site. Hazardous wastes are intended to be stored in the Hamlet maintenance garage, however some items including vehicle batteries, waste oil, and paint are stored at the solid waste disposal site.

2.2 Sewage Disposal Facilities

The current sewage treatment system used by the Hamlet is 'Lake A', a natural lake lagoon located approximately 2 km southwest of the Hamlet. This lagoon has been in use since the early 1990s. Its maximum extremities are approximately 250 m by 340 m, and discharges to a vegetated wetland channel approximately 300 m by 50 m before reaching its final discharge point to Darnley Bay. Primary treatment (sludge settling) occurs in 'Lake A', while secondary treatment occurs in the wetland area. Discharge is continuous during the summer and fall months, however it freezes over in winter months. Overflow from 'Lake A' has been reported in the past, particularly during spring runoff and periods of heavy precipitation. There are no berms constructed around the lagoon, and it has no freeboard. There are no records of historic sludge removal from 'Lake A'. The lagoon is not hydraulically connected to New Water Lake, the fresh water supply source for the Hamlet.

Municipal sewage is collected six days a week with a 550 litre truck, with 5 – 6 truck trips per operating day. The Hamlet has two sewage trucks with this capacity. Sewage is discharged into the lagoon using a steel culvert chute located at the northeast corner of the lagoon.

3.0 Site Inspection

Dillon visited the Hamlet of Paulatuk from July 25th – 28th 2017 to complete the following tasks:

- Perform a site assessment of the sewage treatment system and solid waste facilities;
- Perform a site survey of the sewage disposal and solid waste disposal facilities, including bathymetric measurements of lagoon sludge;
- Collect water samples in accordance with the Water Licence SNP sampling requirements;
- Discuss sewage and solid waste site operations with community staff members and council members; and
- Complete a photographic record of the site.

3.1 Solid Waste Disposal Facilities

In both the municipal waste and Northern Store cells, there is little evidence of compaction, and no evidence of cover material being applied. The Hamlet foreman has indicated that compaction and cover occurs on an as-needed basis, every two to three months. The lack of cover material may contribute to windblown litter on site and to surrounding lands off-site. Three black bears were observed to be scavenging in the active cells upon arrival at the facility.

To the east of the municipal cell, running parallel lengthwise to the road is an additional cell with minor amount of hazardous materials. Two rolls of geotextile material approximately 5 m in length are also located in this cell (see Photo 5).

The only signage observed at the landfill was the name sign adjacent to the gate (see Photo 6). Fencing was observed to be falling over and in general disrepair (see Photo 7). Significant windblown litter was noted outside of the solid waste facility to the north, down to Old Water Lake (see Photo 8).

Animal carcasses are incinerated in the designated incineration drum (see Photo 9), and are then buried in the carcass pit and covered. Inspection of the facility revealed animal carcasses found outside of the designated bin, not properly buried. Additionally as noted in Photo 9, the incineration drum is partially filled with water and other waste, and incinerated carcasses have been left in the drum and not managed properly.

At the southeast extremity of the facility, propane tanks were noted as being stored on their side (Photo 10). Most household type propane cylinders are designed to be used, stored, and transported in an upright position. Propane tanks not designed for horizontal use may pose an extreme danger if stored horizontally and not upright. See the *Solid Waste Disposal Facilities Operation and Maintenance Plan* for more information.

3.2 Sewage Disposal Facilities

The discharge chute of the sewage disposal facility is located at the northeast corner of 'Lake A'. The end of the discharge chute is 700 mm above the lagoon surface. Riprap is present under the discharge point to reduce erosion (see Photo 1). The majority of the lagoon perimeter is sandy and vegetated. There was no significant algal growth at the surface of the lagoon. There was no signage observed indicating that the facility is an active sewage lagoon site. Wildlife including sandhill cranes and ducks were noted in and near 'Lake A' and the wetland. A black bear was observed in the vicinity of the sewage lagoon discharge chute.

There is significant windblown litter accumulating at the discharge point from the lagoon to the wetland (see Photo 2). A well-used ATV trail crosses the wetland, and a visible sheen was noted on the water (see Photo 3), approximately 20 m east of the shore of Darnley Bay. Some litter is present at the discharge point from the wetland to Darnley Bay (see Photo 4). There is continuous low flow from the wetland into Darnley Bay.

4.0 Site Survey

4.1 Solid Waste Disposal Facilities

The municipal waste cell has approximate full length dimensions of 40 m by 10 m. Approximately 18 m of this full length has been filled. The height of the berm and piled waste is approximately 3 m. In accordance with the *Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the Northwest Territories* by Kent, Marshall, & Hawke (2003), the maximum height of berm and waste using the area method is 2 m. The Northern Store cell is located to the west of the municipal cell, and has dimensions of 17.5 m (12 m filled) by 13 m wide. The berm and waste height are lower than the municipal cell, at 1.65 m. There are no design drawings for the dimensions of either cell.

4.2 Sewage Disposal Facilities

4.2.1 Lagoon and Sludge Depth Assessment

A Sludge Judge® was used to measure the depth of the lagoon and sludge layer of 'Lake A'. The sampling procedure was conducted as per the *Hamlet of Paulatuk, Sewage Disposal Facilities Operation and Maintenance Plan* (Dillon, 2017a). *Sludge Survey Methods for Anaerobic Lagoons* by Westerman, Shaffer, & Rice (2008) was consulted in the preparation of the sampling grid. Six sampling points per acre (approximately 4,000 m^2) is recommended by Westerman et al., (2008). With a surface area of approximately 64,000 m^2, 24 measurement points were taken, the maximum recommended by Westerman et al. (2008). Figure 1 shows the location of sampling points. Appendix A, Figure 6 details the numbering convention of the sampling points.

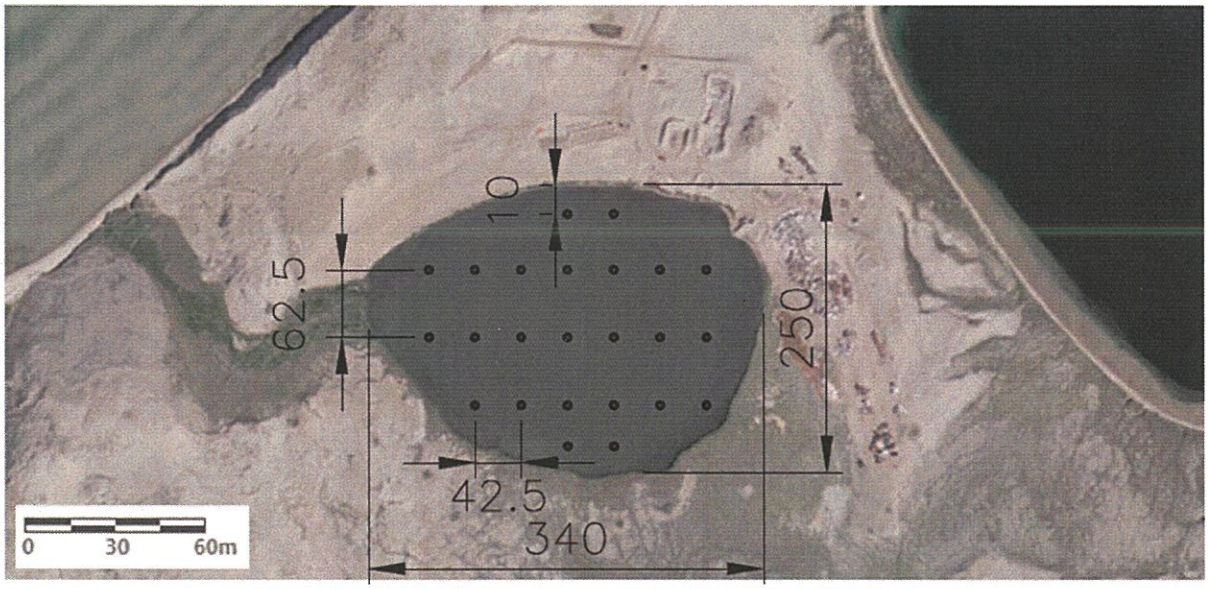

Figure 1: Paulatuk Sewage Lagoon 'Lake A' Sample Grid Reference
Source (Base Image): Land Administration, Department of Lands, Government of the Northwest Territories, NWT Centre for Geomatics (2013)

Appendix A, Table 13 presents the raw data of the sewage lagoon effluent layer. Three sampling points (7, 8, and 9) exceeded the length of the Sludge Judge® instrument. The depth of the effluent layer at these points is therefore greater than the total length of the instrument – greater than 4.36 m. For calculation and contour map development purposes, it was assumed that the depth at these locations is 4.36 m, to be conservative.

Appendix A, Table 13 presents the raw data of the sewage lagoon sludge layer. Data was not able to be collected for three sampling points (7, 8, and 9), as the sludge layer was not reached. For sample points 10 and 11, the sludge layer was reached, however the true depth of the sludge layer is unconfirmed, as the instrument was inserted to the maximum depth prior to reaching the bottom of the sludge layer. The average sludge layer thickness given the readings taken is 0.23 m, and this value was used for sample points 7, 8, and 9. The maximum thickness recorded was 0.6 m. The method of using the Sludge Judge® to measure sludge blanket depth can provide inaccurate results, as the sludge does not enter the instrument as easily as the effluent. Therefore, the sludge depth measurements may be less than the actual depth of the sludge blanket.

Future sludge and effluent depth studies should be taken in the same locations, if possible. Sampling locations were not marked with flags or markers. Reference should be made to the *Sewage Disposal Facilities Operation and Maintenance Manual* and Figure 1 above for future sludge thickness and effluent depth sampling.

4.2.2 Surface Maps

Figure 2 presents a surface map of the effluent depth of 'Lake A'. Figure 3 presents a surface map of the sludge thickness of 'Lake A' Sewage Lagoon. These maps provide a visual representation of the results of the bathymetric survey. The depth/thickness of points between sampling locations is interpolated.

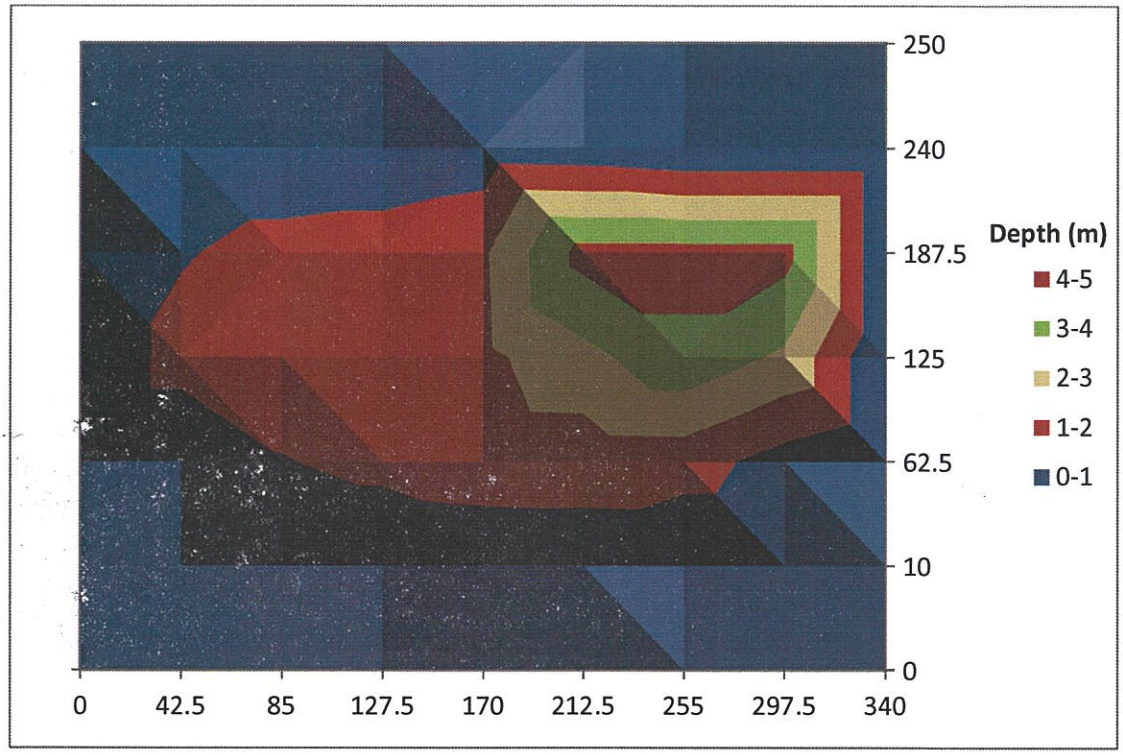

Figure 2: 'Lake A' - Effluent Depth Map

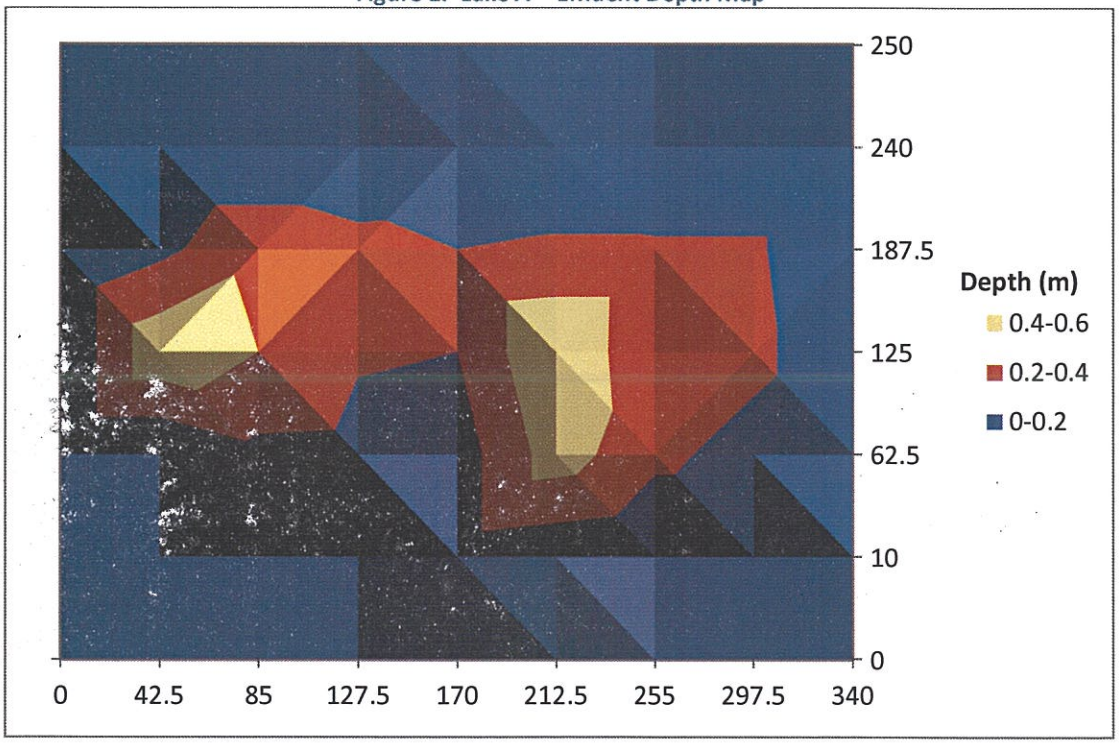

Figure 3: 'Lake A' - Sludge Thickness Map

5.0 Surveillance Network Program Sampling Results

5.1 Surveillance Network Program Details

Surveillance Network Program (SNP) water samples were collected July 28, 2017, at the five sites detailed in the Hamlet's water licence (Table 1) for the sewage and solid waste disposal facilities. Photographs of the sampling locations are presented in **Appendix C**. Part D: Conditions Applying to Sewage and Solid Waste Disposal, Item 2, of the Water Licence details the effluent quality standards for SNP stations 1619-2, 1619-3, and 1619-4. Standards for pH and TSS apply also to stations 1619-5 and 1619-6. Canadian Council of Ministers of the Environment (CCME) standards apply for metal concentrations. These standards are replicated in Table 2. CCME water quality guidelines for the protection of aquatic life, long-term freshwater standards were used.

Table 1: SNP Station Details

Sampling Station	Description	Coordinates
1619-2	Effluent discharge from existing SDF before entering adjacent wetland	69°20'19.45"N 124° 6'58.73"W
1619-3	Effluent discharge from adjacent wetland of existing SDF before entering Darnley Bay	69°20'22.32"N 124° 7'18.62"W
1619-4	Effluent discharge from Abandoned Sewage Lagoon before entering Darnley Bay	69°21'4"N 124° 5'28"W
1619-5	Run-off from existing SWDF	69°20'25.00"N 124° 6'35.35"W[1]
1619-6	Run-off from existing SWDF before entering Old Water Lake	69°20'25.68"N 124° 6'13.73"W

Table 2: Surveillance Network Program Effluent Quality Standards

Parameter	Maximum Average Concentration
Faecal Coliforms	1×10^4 CFU/100 mL
Biological Oxygen Demand (BOD_5)	100 mg/L
Oil and Grease	No visible sheen of oil and grease 5 mg/L

[1] Coordinates presented in Table indicate the intended sampling location as indicated in the *Hamlet of Paulatuk Solid Waste Disposal Facilities Operation and Maintenance Plan*. There was no surface water/runoff at this site, therefore an alternate solid waste disposal facility sample was taken. Actual coordinates of sample location: 69°20'19.64"N, 124° 6'24.81"W (surface water pool east of 'Lake A')

Parameter	Maximum Average Concentration
Total Suspended Solids (TSS)	120 mg/L
pH	6 – 9
Total Mercury	0.026 µg/L
Total Chromium	1 µg/L*
Total Copper	2 µg/L
Total Nickel	25 µg/L
Total Iron	300 µg/L
Total Cadmium	0.09 µg/L
Total Cobalt	40 µg/L**
Total Manganese	200 µg/L**
Total Lead	1 µg/L
Total Zinc	30 µg/L

Source: Inuvialuit Water Board (2015); CCME (2017)

*CCME outlines standards for Cr(VI) and Cr(III), use of more conservative Cr(VI) standard

**No standard available for Aquatic Life – Freshwater, use of available standard: Agriculture – Irrigation

5.2 Sample Results

A Hanna 991301 meter was used to obtain pH, electrical conductivity, and temperature readings at the time of sample collection. Table 3 presents these results and the results from Taiga Environmental Laboratories for the sewage disposal facilities sampling stations; table 4 presents the results for the solid waste disposal facilities sampling stations.

Table 3: Results Summary - Sewage Disposal Facilities Sampling Stations

Sampling Station	pH	BOD_5 (mg/L)	$cBOD_5$ (mg/L)	TSS (mg/L)	Faecal Coliforms (CFU/100mL)
1619-2	9.89	15	16	100	240
1619-3 (1619-3-D)*	6.77 (7.03)	4 (3)	3 (4)	137 (56)	<1 (<1)
1619-4	7.03	<2	<2	174	<1

*1619-3-D: Duplicate sample of 1619-3 for QA/QC.

Table 4: Results Summary - Solid Waste Disposal Facilities Sampling Stations

Sampling station	pH	TSS (mg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Iron (µg/L)	Manganese (µg/L)	Nickel (µg/L)
1619-5	7.98	<3	0.1	<0.1	<0.2	6	1.1	0.2
1619-6	6.97	10	0.1	0.1	0.9	497	17.7	1.1

No oil and grease was visible in collected samples, all hexane extractable material returned results less than the detection limit of 2 mg/L. Total cadmium, lead, mercury, and zinc results were less than the detection limit for sampling stations 1619-5 and 1619-6.

5.3 Compliance with Water Licence

With reference to the water licence compliance limits presented in Table 2, the sewage disposal facilities sampling stations are out of compliance as summarized below:

- 1619-2: pH exceeds limit;
- 1619-3: TSS may exceed limit;
- 1619-4: TSS exceeds limit;
- 1619-6: Iron exceeds limit.

6.0 Solid Waste Disposal Facilities Assessment

6.1 Current Facility Access, Control, and Signage

In accordance with the water licence N7L3-1619 Part B, Item 5, signage clearly indicating where different waste streams should be deposited is required at the waste disposal facility. It was noted by the Hamlet foreman that the Hamlet is in possession of signage supplied by MACA that can be installed, however reinforcing of the signs with plywood is necessary as the signs are Plexiglas. Vandalism of the signs (shooting) has been an issue in the past.

The gates at the entrance of the solid waste facility are capable of being locked, and were for a period being locked according to the intended operating hours of 08:00 – 17:00, Monday to Friday. They are currently not being locked. Concern was raised that illegal dumping may occur outside of the facility if the gates were to be locked, and the Hamlet Council stated that improper dumping is occasional and not a major concern. Further, the access road through the solid waste facility is used during high tide periods by residents to go out on the land by ATV, as the usual route becomes inaccessible. Should locking the gates become regular practice, the operator of the sewage truck has access to the key for the gate lock in the event of an emergency sewage pump-out request.

The Hamlet experiences strong south winds. The fencing along the northern perimeter of the facility is intended to prevent windblown litter from the landfill site from spreading. The northwest fencing has been installed in concrete, and is upright and in good condition. The northeast fencing has been installed in sand, and has fallen over and is in disrepair. The Hamlet is required to maintain fencing around the facility in accordance with Part B, Item 8, of the water licence, to prevent the spread of windblown litter. The Hamlet has indicated that the repair of the solid waste facility fencing is in progress. Hamlet is required to collect windblown litter in the facility and surrounding lands twice annually, in the spring and fall, in accordance with Part D, Item 20, of the water licence.

Full perimeter fencing around the solid waste facility was discussed by Hamlet Council members, and was deemed to be not necessary. Wildlife management is not a major concern, and the heavy snow is predicted to ruin the fence, making it useless. Particularly if the gates will remain open and unlocked, full perimeter fencing will not influence wildlife activity. The gates being left open are also a concern for the management of windblown litter. If the Hamlet prefers to leave the gates unlocked, consideration should be made to still close the gates to reduce the spread of windblown litter.

6.2 Municipal Solid Waste Generation Estimation

Solid waste production, based on the MACA standard generation rate of 0.015 m^3/capita/day, is estimated to be approximately 1,900 m^3/year. Including compaction and cover, the average generation is estimated to be 700 m^3/year. These generation estimates are for municipal solid waste, and do not include bulky waste or Northern Store waste which is collected at the facility.

The current municipal cell has been in use since 2014 (after the final cover of the historic cells), and given the observations recorded during the site investigation, these MACA derived values are estimated to be greater than the actual generation in Paulatuk. An uncompacted generation rate of approximately 550 m^3/year is estimated to reflect the actual disposal habits of the Hamlet's residents more accurately (0.0042 m^3/c/d). Following proper compaction and cover practices, this equals approximately 200 m^3/year of space required. Based on discussions with Hamlet staff regarding compaction at the landfill occurring irregularly, it is anticipated that the 3:1 compaction ratio is not achieved, therefore this generation estimate is conservative. This value of 0.0042 m^3/c/d has been carried through for estimations of usable life of the current solid waste disposal facility.

Annual solid waste generation rates were estimated using the solid waste generation formula as described in the Cold Regions Utilities Monograph (Smith, 1996):

$$V_{year} = 365VP_1(1+G) + 0.084VP_1^2(1+G)^{2n}$$

Cumulative solid waste generation over a 20-year planning horizon was determined by the following formula, with results presented in Table 5. Table 11 and Figure 5 provide a comparison of results between the use of the Hamlet of Paulatuk estimated generation rate (0.0042 m^3/c/d) vs. the MACA standard generation rate of 0.015 m^3/c/d.

$$V_n = \frac{365VP_1}{\ln(1+G)}[(1+G)^{PH+1} - (1+G)] + \frac{0.084VP_1^2}{2\ln(1+G)}[(1+G)^{2PH+1} - (1+G)^2] + [365VP_1(1+G) + 0.084VP_1^2(1+G)^2]$$

Where:

- V_{year} is the annual production of residential waste (m^3/year);
- V_n is the residential volume produced in n years;
- V is the average residential volume (m^3/person/day);
- P_n is the population in the n^{th} year (P_1 = 1st year);
- PH is the planning horizon in years (30 years); and
- G is the growth rate (persons/year or decimal percent).

Table 5: Municipal Solid Waste Generation Projections for the Hamlet of Paulatuk

Year	Population	Cumulative Volume of Waste (Covered and Compacted) (m^3)
2016	327	436
2020	334	1,239
2025	342	2,267
2030	350	3,322
2035	359	4,406
2040	367	5,519

Notes

- Communities with projected negative population growth are to use a +0.5% population growth rate for the planning of infrastructure (MACA guidelines)
- Compaction ratio is 3:1 (uncompacted : compacted)
- Intermediate cover ratio is 1:1.1 (compacted : compacted with cover)

6.3 Remaining Usable Life – Municipal Cell

Waste in the municipal cell should be brought down to a maximum height of 2 m, either by pushing the waste that exceeds this height into the empty space in the cell, or through compaction. For the following calculations, it was assumed that the waste currently in the municipal cell has been compacted to a 3:1 ratio, and cannot be compacted further. Therefore it is conservatively assumed that the municipal cell has 260 m^3 of space remaining.

The estimated remaining usable life of the landfill cell is dependent on management practices, but is estimated to occur in approximately 12 months. Proper compaction is an effective management practice to reduce waste volume and increase the usable life of landfill cell.

6.4 Potential for Extending the Lifespan of Solid Waste Disposal Facility

6.4.1 Extend Lifespan of Current Active – Waste Management Practices

There are several potential management practices that may be incorporated in the solid waste facility operations to reduce the volume of waste sent to the landfill, and to increase the capacity and extend the lifespan of the facility.

6.4.1.1 Compaction

The *Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the Northwest Territories* (Kent et al., 2003) document recommends that compaction should be done at least weekly. A bulldozer or other heavy equipment should compact the waste by running over it 3 – 5 times, which can achieve compaction rates of 3:1.

6.4.1.2 Waste Diversion and Recycling

The Hamlet currently collects beverage containers for recycling in sea cans. Recycling in the Hamlet could be expanded to include tin cans, glass, and paper products to divert these items from the landfill. The success of this initiative would require the involvement and commitment of community members to source separate these items from general waste destined for the landfill. Additionally, a plan to store and remove these items from the community by plane or barge would need to be developed.

6.4.1.3 Open Burning of Waste

Burning permissible wastes reduces the volume of waste that requires landfilling. Part D, Item 11 of the water licence details that paper products, paperboard packaging, untreated wood, and animal carcasses may be burned. Significant amounts of paper based products are visible in the Northern Store cell (Photo 11). Typical waste compositions in the Northwest Territories suggest that approximately 27% of waste by weight is cardboard, newsprint, or other paper products, with wood accounting for an additional 9.9% by weight (Kent et al., 2003). Volume reduction of 80 – 90% may be achieved by incineration (The World Bank, 1999). Safe burning practices and the risk of air pollution as a result of burning would require consideration. Additionally, as with recycling, the involvement of the community would be necessary to achieve the separation of these items at the source for burning. Paper products in the landfill were noted by the Hamlet Council to be a primary source of windblown litter in the community, and the separation and burning of these items may result in a reduction in windblown litter. Any disposal by burning is subject to the conditions of the Municipal Solid Wastes Suitable for Open Burning guidelines[2] from the Department of Environment and Natural Resources (Environmental Protection Division, 1993). Conditions for burning include, but are not limited to, applying the principles of reduce, reuse, recycle, burning in a controlled manner when conditions are favourable (no or low wind blowing away from the community), receiving applicable permits and abiding by permit conditions, removal of all non-burnable material, and compliance with any other site specific conditions.

6.4.2 Opportunities for Expansion within Current Facility Limits

6.4.2.1 Bulky Waste

By obtaining the services of a crusher, bulky wastes such as barrels and end-of-life vehicles could be crushed and removed from the Hamlet's landfill for recycling. Proper procedures detailed in the *Solid Waste Disposal Facilities Operation and Maintenance Plan* must be adhered to for the preparation of items, the operation of the crusher, and subsequent cleanup.

[2] Municipal Solid Wastes Suitable for Open Burning available at: http://www.enr.gov.nt.ca/sites/enr/files/guidelines/solid_wastes_suitable_open_burning.pdf. (Last accessed August 14, 2017)

6.4.2.2 Repurpose Existing Underutilized Cell

The bermed area currently containing minor amounts of hazardous waste (Photo 5) and geotextile rolls could be repurposed to yield a new municipal or Northern Store waste cell. The construction and use of an appropriate hazardous waste area or the storage of these hazardous wastes at the Hamlet maintenance garage would result in this cell being available for other wastes. The current dimensions of the cell would yield an estimated 220 m^3 of landfilling capacity. It is recommended that the geotextile rolls be stored in a safe location as they may be of use for future construction or improvement work at the site.

Repurposing this cell would increase the lifespan of the current landfill by an estimated one year, given current municipal solid waste disposal practices.

6.4.2.3 Area (Mounding) Method

As detailed in the Hamlet's *Solid Waste Disposal Facilities Operation and Maintenance Plan* (SWDF O&M Plan) and the *Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the Northwest Territories* document by Kent et al., (2003), the use of the area method (mounding method) allows for the use of solid waste disposal facility airspace to increase landfilling volume rather than expanding the facility footprint.

This method may be put into practice when the active cells have been compacted, covered, and closed following the SWDF O&M Plan, and over the area of the old cell to the west of the access road. This method would yield 560 m^3 of landfilling volume over the current municipal cell. Extending the area method over the current Northern Store cell and further north over the historic covered cell to meet the extent of the municipal cell would yield an estimated 700 m^3 of volume. An anticipated 2,800 m^3 of additional landfilling space may be achieved by using the area method over the old cell.

The use of the area method over these areas is estimated to extend the lifespan of the facility to the year 2036, given current disposal practices of municipal solid waste.

6.5 New Solid Waste Disposal Facility

6.5.1 Waste Generation Estimates and Planning Horizon

It is recommended to use a planning horizon of 20 years in assessing new solid waste disposal facility location and design (Kent et al., 2003). Further, it is recommended to use the MACA standard municipal solid waste generation rate of 0.015 m^3/c/d in planning new facilities to be conservative.

It is assumed that a new solid waste disposal facility will not be needed until 2036, assuming the Hamlet takes advantage of the opportunities to extend the lifespan of its current facility. Population and waste generation data is provided in Table 12. For a 20-year planning horizon from 2036 – 2060 (rounding), 21,777 m^3 of airspace should be planned for in siting the location of a new facility.

6.5.2 Solid Waste Disposal Facility Siting Criteria

The siting of a new solid waste facility must be selected in accordance with the requirements listed in Table 6, established in the *Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the Northwest Territories* document by Kent et al., (2003). **Figure 6** presents the minimum buffer distances solid waste facilities must be located from surface water and the airport as per Kent et al., (2003).

Table 6: Modified Landfill Siting Criteria

Criterion	Stipulation
Solid waste sites should be designed for a minimum 20 year design life with planning considerations for at least a 40-year life	Solid waste volume model given in guidelines
Areas in flood plain	Restricted beyond 1 in 200 year return
Climatic conditions of region; geological and terrain conditions of site	Consider and take into account
Cover material availability	Where possible, in a location where cover material is readily available
Distance from airport to avoid hazard to aircraft from scavenging birds	3 kilometers
Distance from community to avoid unsightliness, odour, and smoke	Not visible from community and/or main road (where possible)
Distance from community to minimize construction and maintenance costs of access road	As close as possible while complying with the previous stipulation
Distance from housing	450 m
Distance from public roads, railways, right-of-way's, and cemeteries	90 m
Distance from surface water to minimize fisheries habitat impacts	30 m from high water mark
Distance from treeline	10 m if no burning, 30 m if burning will occur
Geotechnical features of the site	Consider and take into account
Located to ensure protection of drinking water	In a watershed that drains away from the community drinking water supply
Located to ensure protection of national/territorial parks, game and wildlife reserves, special fisheries areas	Restricted
Minimize impacts to land, birds, animals, vegetation	Contaminants may not be discharged to the environment
Zoning	Accordance with current planning documents
Wind direction	Downwind of prevailing winds if possible
Snow accumulation	Potential considered and addressed through site grading and location of appropriate fences

Source: Kent et al., (2003)

6.5.3 Land Acquisition

The land surrounding the existing solid waste disposal and sewage disposal facilities boundaries is Inuvialuit Land Administration (ILA) land. A change in land title is required for the Hamlet of Paulatuk to make use of additional land for the purpose of expanding the municipal landfill.

7.0 Sewage Disposal Facilities Assessment

7.1 Sewage Generation Estimation

Using the more conservative sewage generation estimation based on water withdrawal data from the Hamlet, and the MACA guideline of assuming a 0.5% population increase for communities expecting to experience negative population growth, Table 7 presents the estimated sewage generation rates for the Hamlet. The *Sewage Disposal Facilities Operation and Maintenance Plan* provides further detail regarding these generation estimates (Dillon, 2017a). Based on historic data, the Hamlet's average water use is 108 L/c/d.

Table 7: Sewage Generation Projections for the Hamlet of Paulatuk

Year	Population Projection	Estimated Sewage Generation Rates (m^3/year)
2016	327	12,846
2020	334	13,121
2025	342	13,435
2030	350	13,749
2035	359	14,103
2040	367	14,417

7.2 Sewage Lagoon Capacity Assessment

The approximate surface area of 'Lake A' is 64,000 m^2, from aerial imagery. Given the assumptions outlined in Section 4.2.1 regarding the assumption of depth at sampling locations too deep for the Sludge Judge® instrument, the approximate total volume of 'Lake A' is 128,000 m^3. Of the total volume, approximately 113,000 m^3 is effluent, and 15,000 m^3 is accumulated sludge (12% of total volume).

Annual sewage generation in 2040 is 12% of the lagoon's total volume. As detailed below in Section 7.3, it is anticipated that external factors are reducing the capacity of the lagoon.

When the sludge layer thickness reaches 0.5 m from the bottom of the lagoon floor and has reached the bottom of the decant screen structure, it is recommended to assess desludging alternatives (Dillon, 2017a). Given that 'Lake A' has been used as the sewage lagoon since the early 1990s (at most, 27 years to date), and the average depth of sludge is 0.23 m, the lagoon has approximately 30 years of use remaining prior to requiring desludging.

7.3 Berm Feasibility

Overflowing of the sewage lagoon occurs periodically, during spring runoff and high precipitation events, and potentially causes effluent to spread overland outside the bounds of the lagoon. Modifications in order to better control sewage treatment and discharge into the environment should be considered. The main concern is whether the lagoon has sufficient capacity to meet the needs of the community. Based on information provided by the Hamlet with respect to the lagoon overflowing during spring snow melt and high precipitation events, it is anticipated that the lagoon collects a large amount of surface runoff, lessening the amount of space available for the storage and treatment of the sewage effluent.

It is also difficult to determine whether sewage effluent is receiving sufficient primary treatment prior to discharging into the wetland. In order to better assess the lagoon's ability to provide sufficient capacity and treatment of the collected sewage effluent, one of the recommended steps was to determine the feasibility of constructing a berm around the lagoon exterior to reduce the amount of surface runoff entering the lagoon. This reduction in surface water entering the lagoon would reduce overflow and therefore allow for more treatment capacity.

7.3.1 Proposed Berm Design

The approximate drainage area was delineated during the site investigation. A differential topographic survey was conducted to record various locations and elevations between the edge of the lagoon and the edge of the approximate drainage area boundary. Roughly 300 topographic survey shots were taken and used to create contour data and grading profiles. This topographic information was used to estimate the volume of runoff that the berm would aim to divert along with the lagoon volume change that the berm would aim to retain during a 25-year, 24-hour precipitation event. The exterior berm is ideally kept as small as possible while still providing adequate containment and freeboard to prevent overtopping from storm events. Based on an additional freeboard of 750 mm (1 m total), the 25-year return storm rainfall amount of 40 mm, and an assumed lifetime loss of freeboard due to sediment and vegetation accumulation of 10 mm/year over 25 years, it was calculated the berm should have a minimum height of 1.4 m above existing ground.

The berm was designed with a top width of 3 m. This dimension was selected to facilitate the use of construction equipment or other vehicular traffic on top of the berm crest. It was assumed that berm side slopes of 3:1 would be acceptable for the geotechnical stability considerations as well as the construction considerations. Figure 4 below shows a typical cross-section of the proposed lagoon berm. During the site investigation, it was observed that the area currently had problems regarding erosion, sediment transport, and rodent burrowing. To prevent erosion and rodent burrowing, the outside berm slope may be riprapped with stone. Without this stone protection, the berm may not prove sufficient with regard to water restriction as an additional volume of water would be allowed to percolate through the rodent burrows and eroded side material. The poor grading surrounding the edge of the berm would require the use of a collection ditch to convey the diverted surface runoff around and away from the lagoon.

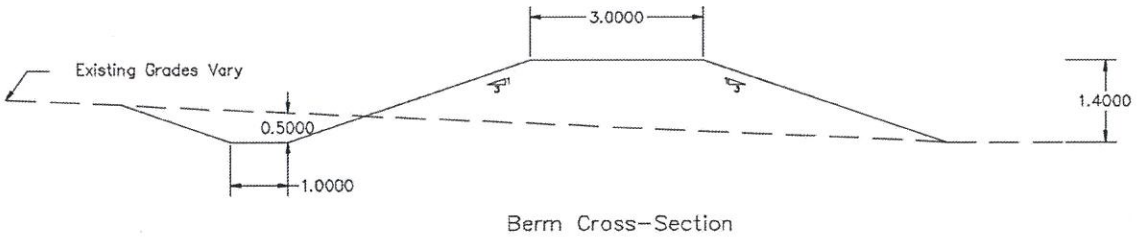

Figure 4: Berm Cross-Section

A drainage ditch was included in the berm cross-section for two primary purposes. Firstly, the ditch is a means to direct and move surface runoff away from the berm and the lagoon. If there was no drainage ditch, there would be significant standing water and ponding surrounding the berm due to various depressions in the natural topography along with the generally poor natural grading of the area. Secondly, the ditch facilitates the use of reused 'cut' material to lessen the amount of 'fill' material that would otherwise need to be hauled in from off site. The reused material was estimated to be half the cost of material brought in, with unit prices of $\$30/m^3$ and $\$60/m^3$ respectively.

From this model it was estimated that approximately 7,000 m^3 of material would be needed to construct the berm around the lagoon exterior edge. Roughly 4,500 m^3 of fill material would need to be hauled to site and approximately 2,500 m^3 of reused cut material would be utilized to facilitate the use of a berm drainage ditch. Should the Hamlet wish to also install the recommended riprap protection to prevent erosion and rodent burrowing, they would require approximately 1,250 tonnes or 500 m^3 of stone. Table 8 below outlines the assumed unit costs of these items and presents a rough pricing estimate for the berm construction materials.

Table 8: Berm Material Costs

Item	Unit Cost	Quantity	Estimated Material Cost
Cut (re-use on site)	$\$30/m^3$	2,500 m^3	$75,000
Fill (hauled from off site)	$\$60/m^3$	4,500 m^3	$270,000
Total:			**$345,000**
Rip-rap*	$\$60/m^3$	500 m^3	$30,000
Total:			**$375,000**

**Provisional*

Berms should be constructed on the basis of standard geotechnical considerations. The materials that are available dictate how berms will be designed and constructed. It was assumed that the native soils available in the surrounding areas would likely be comprised of primarily silt or other fines, so a low hydraulic conductivity was implied upon the design. Based on this implication, no other liners or measures were included in the design of the berm. It was assumed that the earthen berm would be sufficient to restrict the flow of water in and out of the lagoon. The geotextile material located at the solid waste disposal facility may be of use to strengthen the berms.

7.4 Sewage Lagoon Effluent Management and Decanting

Review of available Annual Reports indicates that the lagoon self-decants in the spring. There have been no recorded decants or sludge removal activities. With reference to the SNP results detailed in Section 5.2, current management practices at the sewage lagoon are not adequate.

To meet the required minimum quality standards established by the IWB, it is recommended that scheduled decanting should occur instead of current continual natural decanting. Based on natural TSS and pH cycles related to microorganism activity in the lagoon, to achieve SNP results within criteria, the lagoon should be manually decanted in the fall, mid-August to the first week of October, after the first frost occurs. This decant should lower the lagoon levels such that no natural decanting occurs during the year. This will allow for longer treatment over summer months, and will target decanting when effluent is most likely to fall within the IWB effluent criteria.

8.0 Finalization of Draft Documents

8.1 Operation and Maintenance Plans

Revisions to the following plans were noted to be required in the letter from the Inuvialuit Water Board, dated November 3rd, 2015, regarding the Hamlet of Paulatuk Municipal Water Licence Renewal Application:

- Sewage Disposal Facilities Operation and Maintenance Plan;
- Solid Waste Disposal Facilities Operation and Maintenance Plan; and
- Spill Contingency Plan.

The changes made in response to the October 1st, 2015 letter from the IWB were additionally reviewed, and current updates were applied to address all gaps identified and to reflect Hamlet staffing changes.

8.2 Abandonment & Restoration Plan

The Abandonment and Restoration Plan for the Sewage and Solid Waste Disposal Facilities was reviewed and updated, and issued for finalization.

9.0 Recommendations

9.1 9.2 Solid Waste Disposal Facilities Remedial Action

Concerns identified as part of the assessment of the solid waste disposal facility are listed in Table 10, along with recommended remedial actions.

Table 9: Concerns Related to Current Solid Waste Disposal Facilities and Recommended Remedial Actions

Concern	Description	Remedial Actions
Hazardous waste spills or site contamination	Some hazardous materials are being stored in an unlined berm and in the bulky waste area, including used vehicle batteries and paint	The Spill Contingency Plan and Solid Waste Disposal Facilities Operation and Maintenance Plan should be followed; and hazardous waste should be stored at the Hamlet maintenance garage or in a lined/bermed area designed by a professional engineer
Proper management practices are not being followed	Compaction and cover guidelines are not being followed at the solid waste disposal facility	The Hamlet should consider hiring an experienced site operator and/or an individual familiar with the published guidelines on solid waste disposal facility operation to educate and train Hamlet staff on proper operation and maintenance of the landfill cells
Active municipal landfill cell is near capacity	The active municipal landfill cell is filled higher than recommended; and estimated waste generation rates indicate that the cell will be full within 12 months.	The waste within the landfill cells should be compacted/bulldozed to a maximum of 2 m in height; and cover material should be applied
Require additional solid waste storage space	Additional space is required for the purpose of solid waste disposal in the community, and the existing site is surrounded by ILA land	The area method should be used over the old cell area and over the Northern Store and municipal cell (once closed)
Processing and removal of hazardous components in ELVs and white goods	Most white good and ELVs in the bulky waste area have not had hazardous components and fluids removed; and barrels have not been properly cleaned	White goods and ELVs should have hazardous components and fluids removed, barrels should be cleaned, and hazardous materials should be stored as per the Solid Waste Disposal Facilities Operation and Maintenance Plan
Standing water on site in bulky waste sorting area	Low areas in the bulky waste area allow surface water runoff to collect	Pump out water; backfill, compact, and grade low lying areas

9.2 Sewage Disposal Facilities Remedial Action

Concerns identified as part of the assessment of the sewage lagoon facility are listed in Table 10, along with recommended remedial actions.

Table 10: Concerns Related to Current Sewage Lagoon Facilities and Recommended Remedial Actions

Concern	Description	Remedial Actions
Collection and reporting of effluent quality according to water licence requirements	Sampling requirements for assessing the effectiveness of the sewage treatment process as outlined in the Hamlet's water licence are not being completed	Samples should be collected, analyzed and reported as per water licence requirements
Deterioration of the discharge chute infrastructure and erosion of slope	The discharge chute is in poor condition and in need of repair to reduce erosion of the slope and failure of the discharge chute and truck pad	The discharge chute should be replaced and mounted with properly anchored supports; a splash pad should be incorporated underneath the discharge chute to reduce erosion effects on the lagoon slope; and bollards or another type of vehicle barrier should be installed to prevent sewage trucks from backing up too far and damaging the discharge chute and/or backing into the lagoon
Accumulation of litter along the banks of the lagoon	Windblown litter from the solid waste disposal facilities is entering the lagoon	Begin application of cover material to waste disposed of in landfill cells on a regular basis; and conduct litter cleanup in accordance with the water licence requirements (twice annually)
SNP results from sewage lagoon stations are not within the effluent criteria established by the IWB	Stations 1619-2, 1619-3, and 1619-4 results do not meet the pH and TSS effluent criteria values	Continuous natural decanting at the active sewage lagoon should cease, and manual decanting should occur annually in the fall to allow for longer treatment over summer months

Figures

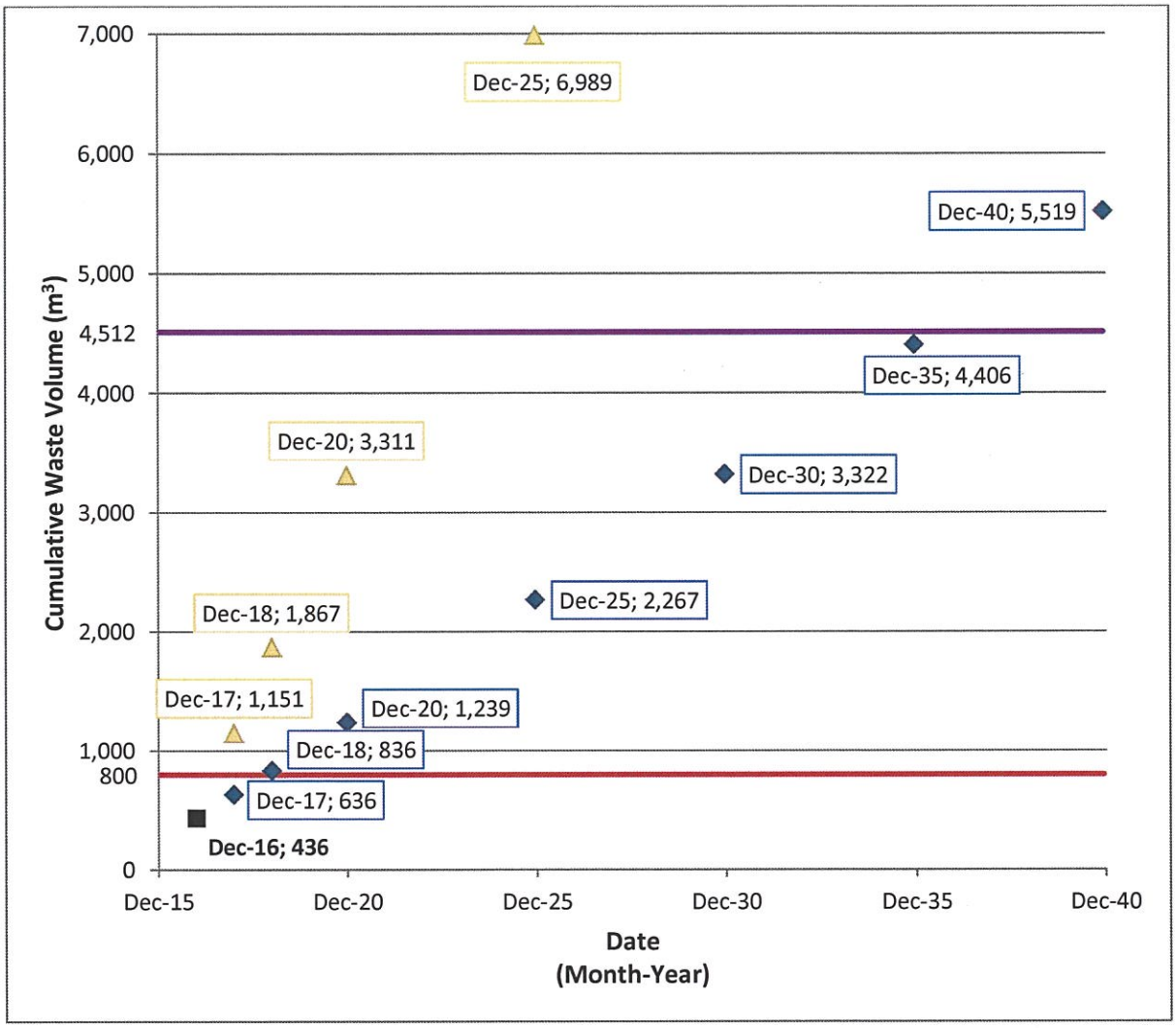

Figure 5: Cumulative Solid Waste Generation (20-year Planning Horizon at Current Facility)

Tables

Table 11: Annual and Cumulative Solid Waste Generation (20-year Planning Horizon at Current Facility)

Year	Paulatuk – Annual Solid Waste Generation (m^3/year)	MACA – Annual Solid Waste Generation (m^3/year)	Paulatuk – Cumulative Solid Waste at Year End (m^3)	MACA – Cumulative Solid Waste at Year End (m^3)
2016	541	1,935	436	436
2017	544	1,948	636	1,151
2020	553	1,980	836	3,311
2025	567	2,031	1,239	6,989
2030	581	2,082	2,267	10,767
2035	598	2,139	3,322	14,647
2040	612	2,191	5,519	18,633

Notes:

- Paulatuk data based on an estimated generation rate of 0.0042 m^3/c/d;
- MACA data based on MACA standard generation rate of 0.015 m^3/c/d (Kent et al., 2003); and
- Cumulative value includes compaction and cover.

Table 12: Annual and Cumulative Solid Waste Generation (20-year Planning Horizon at New Facility)

Year	Population	Annual Solid Waste Generation (m^3/year)	Cumulative Solid Waste at Year End (m^3)	Cumulative Solid Waste at Year End – Compacted & Covered (m^3)
2035	359	2,139	784	784
2040	367	2,191	11,626	4,760
2045	375	2,242	22,764	8,843
2050	383	2,294	34,205	13,039
2055	391	2,346	45,960	17,349
2060	399	2,398	58,036	21,777

Appendix A

Sewage Lagoon Bathymetry – Raw Data

Raw Data

Table 13: Sewage Lagoon Depth Assessment Raw Data

Sample Point	Sludge Depth (cm)	Effluent Depth (cm)
1	3	30
2	2	40
3	15	89
4	35	145
5	27	165
6	20	186
7	No data*	436**
8	No data*	436**
9	No data*	436**
10	26	281
11	22***	375
12	60***	270
13	20	177
14	22	162
15	40	155
16	55	145
17	15	95
18	14	130
19	10	137
20	50	141
21	25	145
22	12	59
23	5	48
24	10	50

**Unable to reach sludge layer*

***Exceeds depth of Sludge Judge®*

****Approximate measurement, depth of Sludge Judge® exceeded before reached bottom of sludge layer*

Lagoon Depth Assessment Numbered Sampling Location Map

Figure 6: Lagoon Depth Assessment Numbered Sampling Locations

Appendix B

Photo Log

Photo 1: Sewage Lagoon Discharge Chute Outlet

Photo 2: Accumulated Litter at SNP Station 1619-2, Outlet of Lagoon to Wetland

Photo 3: ATV Path Across Wetland, Looking South

Photo 4: Accumulated Litter at Outlet of Wetland to Darnley Bay

Photo 5: Geotextile Rolls and Hazardous Waste in Bermed Area, East of Active Cells

Photo 6: Access Road to Solid Waste Disposal Facility, Only Signage at the Facilities

Photo 7: Downed Fence East of the Access Road, Looking North

Photo 8: Accumulated Litter North of Solid Waste Disposal Facility, at Shore of Old Water Lake, Approximate Location of SNP Station 1619-6

Photo 9: Animal Carcass Burning Pit

Photo 10: East End of Solid Waste Disposal Facility, Looking West to 'Lake A'

Photo 11: Northern Store Cell, Looking Southwest

Appendix C

SNP Sampling Locations

Photo 12: SNP Station 1619-2

Photo 13: SNP Station 1619-3

Photo 14: SNP Station 1619-4

Photo 15: SNP Station 1619-5 (Ponded Water Adjacent to 'Lake A' and White Goods)

References

Canadian Council of Ministers of the Environment (CCME). (2017). *Water Quality Guidelines for the Protection of Aquatic Life, Water Quality Guidelines for the Protection of Agriculture.* Retrieved September 8, 2017 from http://st-ts.ccme.ca/en/index.html?chems=4,8,9,12,15,16,20,21,61,63,62,65,71,123,124,127,129,131,138,139,197,198,200,211,213,225,226,229&chapters=1,2

Dillon Consulting Limited. (2015). *Hamlet of Paulatuk, NT Sewage Treatment Facility Operation and Maintenance Manual.*

Dillon Consulting Limited. (2017). *Sewage Lagoon and Solid Waste Site Assessment, Hamlet of Paulatuk - Final Report.*

Inuvialuit Water Board. (2015). *N7L3-1619 - Hamlet of Paulatuk, Municipal Water Licence Renewal.*

Inuvialuit Water Board. (n.d). *Inuvialuit Water Board - About the Board.* Retrieved September 1, 2017 from http://www.inuvwb.ca/aboutTheBoard.html.

Westerman, S. R. (2008). *Sludge Survey Methods for Anaerobic Lagoons.* North Carolina Cooperative Extension Service.

PAULATUK
SOUTHWIND CAPITAL

HAMLET OF PAULATUK

PAULATUK SEWAGE LAGOON UPGRADES

ISSUED FOR TENDER

AUGUST 2018

SHEET LIST	
SHEET NUMBER	**SHEET TITLE**
	COVER
100	SEWAGE LAGOON BERM AND DRAINAGE DITCH
101	DITCH PROFILE AND SITE SECTIONS
102	DETAILS AND SITE SECTIONS 1 OF 2
103	SITE SECTIONS 2 OF 2

DILLON PROJECT NO. 17-6028

DILLON CONSULTING

4920 47TH STREET, YELLOWKNIFE NT, X1A 2P1, PHONE 867.920.4555

GENERAL NOTES:

1. ALL DIMENSIONS IN MILLIMETERS UNLESS NOTED OTHERWISE.
2. ALL DIMENSIONS TO BE CHECKED AND VERIFIED IN THE FIELD PRIOR TO ANY CONSTRUCTION. ANY DISCREPENCIES TO BE REPORTED TO THE ENGINEER BEFORE PROCEEDING.
3. QUANTITIES SHOWN ARE APPROXIMATE AND FOR TENDERING PURPOSES ONLY.
4. ALL CONSTRUCTION WORK IS TO BE CARRIED OUT IN ACCORDANCE WITH THE REQUIREMENTS OF THE OCCUPATIONAL HEALTH AND SAFETY ACT AND REGULATIONS FOR CONSTRUCTION PROJECTS.
5. THIS PLAN IS TO BE READ IN CONJUNCTION WITH THE ENTIRE DRAWING SET AND CONTRACT DOCUMENTS.
6. ALL WORK AND MATERIALS SHALL BE IN ACCORDANCE WITH THE DRAWINGS AND SPECIFICATIONS AS WELL AS ANY APPLICABLE TERRITORIAL STANDARD SPECIFICATIONS AND STANDARD DRAWINGS.
7. ANY SURVEY FOR THE PURPOSE OF LAYOUT, QUANTITY CALCULATIONS, OR RECORD DRAWING TO BE CONDUCTED WITH REFERENCE TO A CANADA LANDS AND SURVEY MONUMENT.
8. DESIGN CONTOURS SHOWN ARE FINAL GRADE AND REPRESENT BERM MATERIAL OR EXCAVATED SURFACE.
9. TOPOGRAPHY SHOWN IS BASED ON CADASTRAL AND CONTOUR INFORMATION PROVIDED BY MACA AND IS APPROXIMATE.
10. A SURVEY OF THE IMMEDIATE LAGOON AREA WAS CONDUCTED BY DILLON CONSULTING, LTD. 2017 FOR THE PURPOSES OF DESIGN: CLSR PLAN 80643, CCM4089707, NAD83, ZONE10,GSD95 GEOID.

SCALE 1:1,000

LEGEND:

- MAJOR CONTOUR (2.5m)
- MINOR CONTOUR (0.5m)
- TOE OF SLOPE
- TOP OF BERM
- DRAINAGE DIRECTION (0.25%)
- PROPOSED GRADE
- DITCH EXCAVATION
- BERM CONSTRUCTION

POINT TABLE				
No.	ELEVATION	NORTHING	EASTING	DESCRIPTION
100	23.13	7692454.013	455862.709	4089707
101	14.40	7692585.320	456044.489	Ditch CL
102	14.44	7692616.051	456068.961	Ditch CL
103	14.48	7692637.028	456104.185	Ditch CL
104	14.52	7692653.696	456142.021	Ditch CL
105	14.58	7692668.360	456196.139	Ditch CL
106	14.62	7692671.971	456237.633	Ditch CL
107	14.66	7692672.444	456271.811	Ditch CL
108	17.23	7692667.083	456326.370	Ditch CL
109	16.68	7692663.020	456342.095	Ditch CL
110	15.56	7692638.850	456376.524	Ditch CL
111	15.16	7692623.736	456388.391	Ditch CL
112	14.46	7692594.022	456396.805	Ditch CL
113	13.50	7692551.233	456408.750	Ditch CL
114	13.44	7692490.704	456389.498	Ditch CL
115	13.38	7692440.356	456365.942	Ditch CL
116	13.31	7692398.271	456310.986	Ditch CL
117	13.23	7692391.683	456232.815	Ditch CL
118	13.13	7692419.815	456141.227	Ditch CL
119	13.08	7692448.344	456102.588	Ditch CL
120	12.98	7692529.525	456043.598	Ditch CL
121	12.96	7692530.703	456023.819	Ditch CL
122	12.94	7692525.612	456005.466	Ditch CL

DITCH DAYLIGHT

DITCH DAYLIGHT

LAGOON ELEV. 13.391
SURVEYED JULY, 2017

BERM CONSTRUCTION:
3.0m WIDE 3:1 SIDE SLOPES
BERM HEIGHT 1.4m
TOP OF BERM ELEVATION: 14.79
(TOTAL FILL: 3,970m³)

EXCAVATED DITCH:
(SITE TOTAL CUT: 1,512m³)

DILLON CONSULTING LIMITED 4920 47TH STREET, YELLOWKNIFE, NORTHWEST TERRITORIES, X1A 3P1, PHONE (867) 920-4555, FAX (867) 873-3328

FILENAME: C:\CAD\176028\176028-03-SITE-DES-DITCHING.DWG PLOTTED BY: TREVOR
PLOT DATE: 2018-09-06 @ 9:40:59 AM PLOT SCALE: 1=1 PLOT STYLE: DILLON.CTB

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PERMIT NUMBER P 010
DILLON CONSULTING LIMITED

REGISTERED PROFESSIONAL ENGINEER K.G. BARNES LICENSEE NWT/NU

ISSUED FOR TENDER

PAULATUK
SOUTHWIND CAPITAL

DILLON CONSULTING

No.	ISSUED FOR	DATE	BY
2	ISSUED FOR TENDER	09/09/18	KB
1	ISSUED FOR INTERNAL REVIEW	08/24/18	GS

DESIGN	GS
REVIEWED BY	GS/KB
DRAWN	TPW
CHECKED BY	GS/KB
DATE	AUGUST 2018
SCALE	1:1000

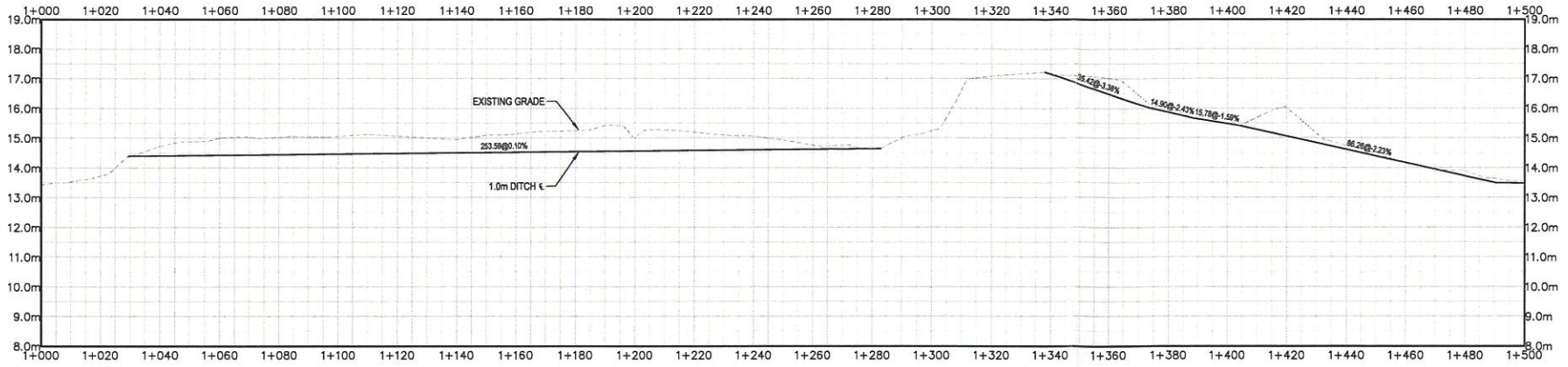
PAULATUK SEWAGE LAGOON UPGRADES
HAMLET OF PAULATUK, NORTHWEST TERRITORIES

PROJECT NO. 17-6028

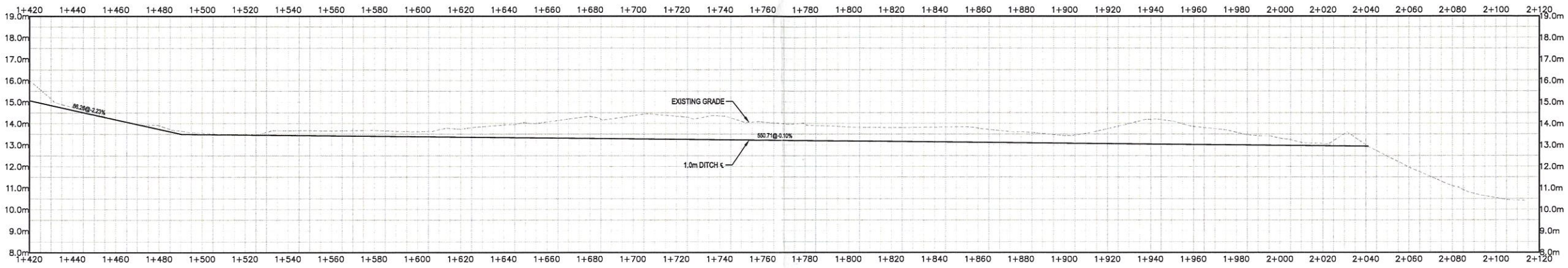
ISSUED FOR TENDER

SEWAGE LAGOON BERM AND DRAINAGE DITCH

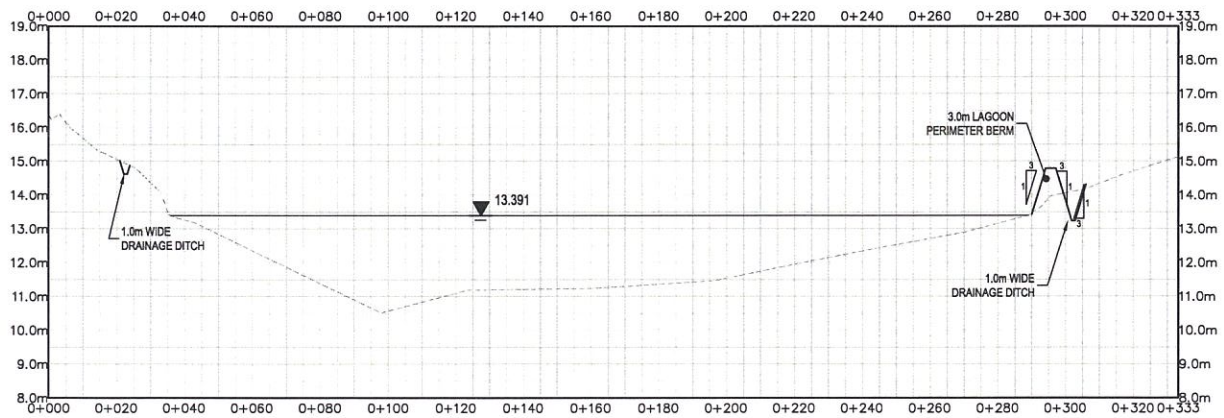
SHEET NO. 100



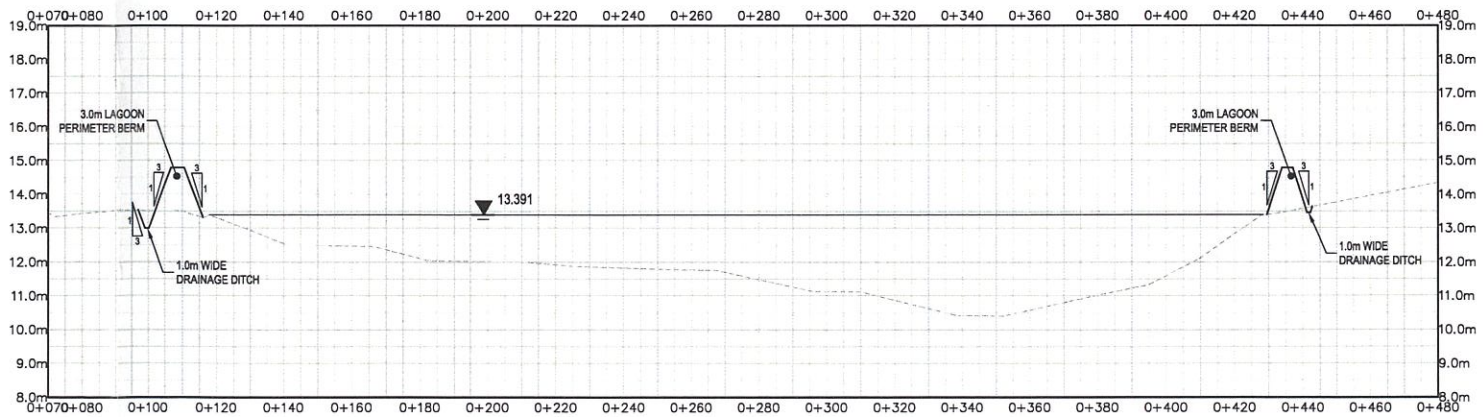
DITCH PROFILE 1 (1/100)
SCALE: 1:1000H 1:100V



DITCH PROFILE 2 (2/100)
SCALE: 1:1000H 1:100V



Section 1 (3/100)
SCALE: 1:1000H 1:100V



SECTION 2 (4/100)
SCALE: 1:1000H 1:100V

LEGEND:
- EXISTING GROUND
- PROPOSED DITCH/BERM CONSTRUCTION
- LAGOON LEVEL

GENERAL NOTES:
1. SEE DITCH/BERM CL STATIONING ON DRAWING 100.
2. THIS PLAN IS TO BE READ IN CONJUNCTION WITH THE ENTIRE DRAWING SET AND CONTRACT DOCUMENTS.

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FILENAME: C:\2017\17028\17028-03-SITE-DCS-DWTING.DWG PLOTTED BY: TREVOR
PLOT DATE: 2018-09-06 @ 9:42:1+ AM PLOT SCALE: 1:1 PLOT STYLE: DILLON.CTB

Conditions of Use

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Do not scale dimensions from drawing.

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2	ISSUED FOR TENDER	09/06/18	KB
1	ISSUED FOR INTERNAL REVIEW	08/24/18	GS

DESIGN: GS	REVIEWED BY: GS/KB
DRAWN: TPW	CHECKED BY: GS/KB
DATE: AUGUST 2018	
SCALE: AS SHOWN	

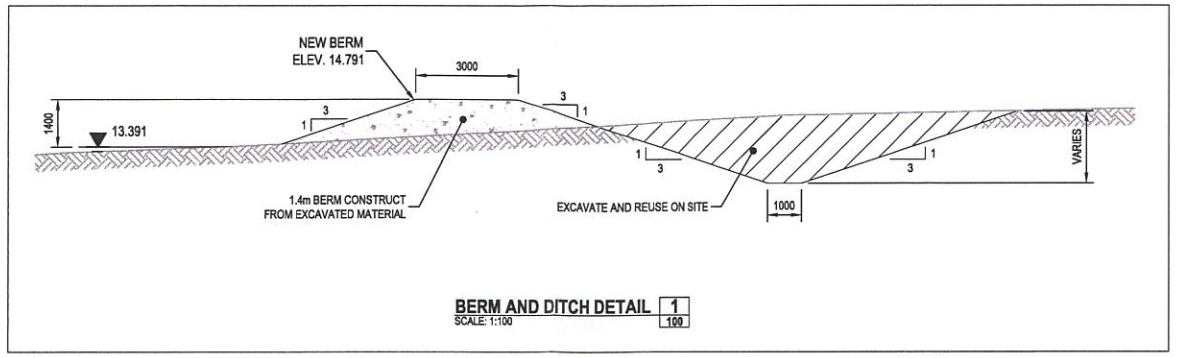
PAULATUK SEWAGE LAGOON UPGRADES
HAMLET OF PAULATUK, NORTHWEST TERRITORIES

PROJECT NO. 17-6028

ISSUED FOR TENDER

DITCH PROFILE AND SITE SECTIONS

SHEET NO. 101



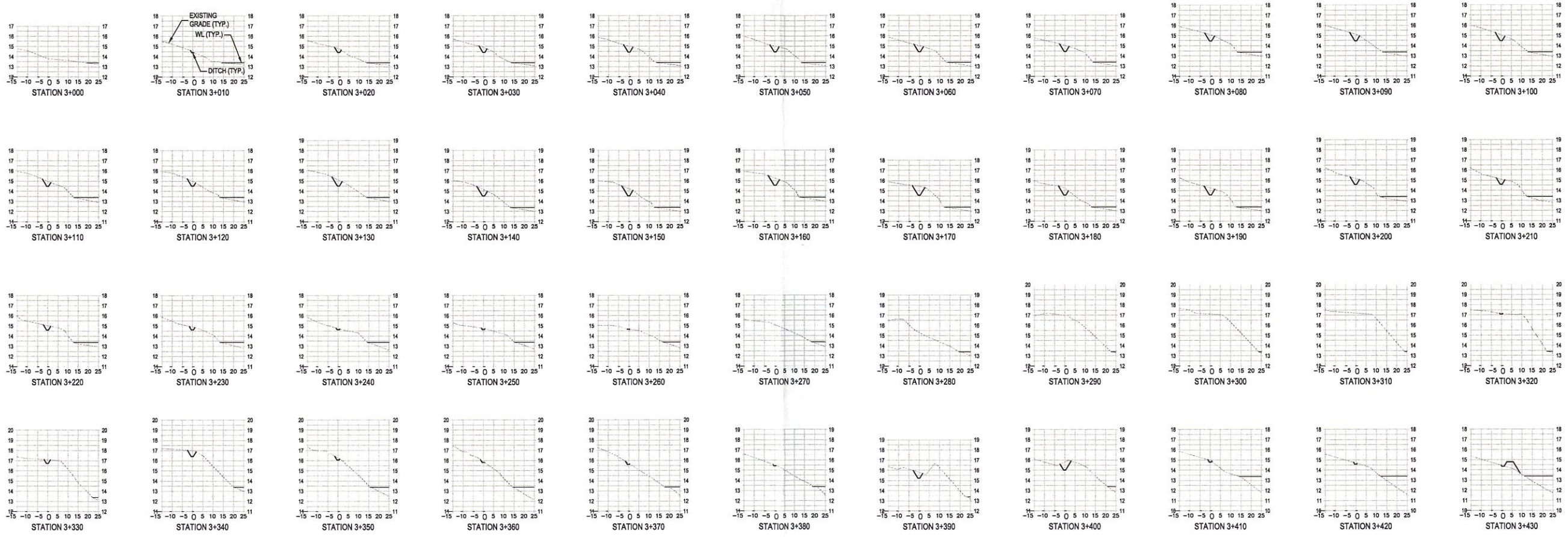
BERM AND DITCH DETAIL 1
SCALE: 1:100 100

LEGEND:

- EXISTING GROUND / ROCK OUTCROP
- PROPOSED DITCH/BERM CONSTRUCTION
- LAGOON LEVEL

GENERAL NOTES:

1. SEE DITCH CL STATIONING ON DRAWING 100.
2. THIS PLAN IS TO BE READ IN CONJUNCTION WITH THE ENTIRE DRAWING SET AND CONTRACT DOCUMENTS.



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1	ISSUED FOR INTERNAL REVIEW	08/24/18	GS

DESIGN: GS | REVIEWED BY: GS/KB
DRAWN: TPW | CHECKED BY: GS/KB
DATE: AUGUST 2018
SCALE: 1:500 1:100

PAULATUK SEWAGE LAGOON UPGRADES
HAMLET OF PAULATUK, NORTHWEST TERRITORIES

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DETAILS AND SITE SECTIONS 1 OF 2

PROJECT NO. 17-6028

SHEET NO. 102

FILENAME: C:\JOB\176028\176028-03-SITE-RDS-DITTING.DWG PLOTTED BY: TREVOR
PLOT DATE: 2018-09-06 @ 9:42:40 AM PLOT SCALE: 1:1 PLOT STYLE: DILLON.CTB
DILLON CONSULTING LIMITED 4918 47TH STREET, YELLOWKNIFE, NORTHWEST TERRITORIES, X1A 2P1, PHONE (867) 920-4555, FAX (867) 873-3328

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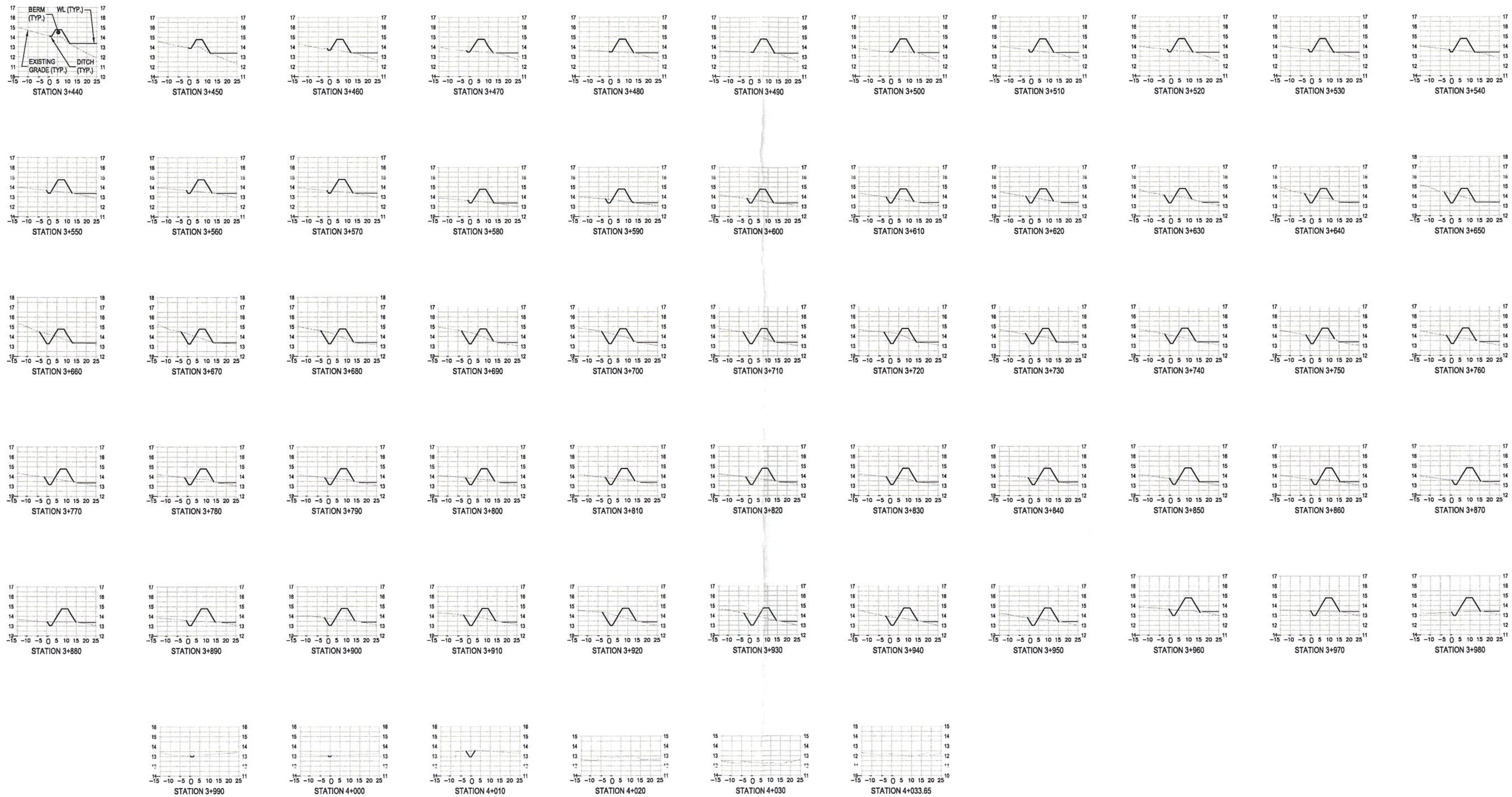
FILENAME: C:\CAD\176028\176028-03-SITE-DES-EXISTING.DWG PLOTTED BY: TREVOR
PLOT DATE: 2018-09-06 @ 9:42:56 AM PLOT SCALE: 1:1 PLOT STYLE: DILLON.CTB

LEGEND:

EXISTING GROUND / ROCK OUTCROP
PROPOSED DITCH/BERM CONSTRUCTION
LAGOON LEVEL

GENERAL NOTES:
1. SEE DITCH CL STATIONING ON DRAWING 100.
2. THIS PLAN IS TO BE READ IN CONJUNCTION WITH THE ENTIRE DRAWING SET AND CONTRACT DOCUMENTS.



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DILLON CONSULTING LIMITED

REGISTERED PROFESSIONAL ENGINEER — K.G. BARNES — LICENSEE — NWT/NU

ISSUED FOR TENDER

PAULATUK — SOUTHWIND CAPITAL

DILLON CONSULTING

No.	ISSUED FOR	DATE	BY
2	ISSUED FOR TENDER	09/06/18	KB
1	ISSUED FOR INTERNAL REVIEW	08/24/18	GS

DESIGN: GS	REVIEWED BY: GS/KB
DRAWN: TPW	CHECKED BY: GS/KB
DATE: AUGUST 2018	
SCALE: 1:500 1:100	

PAULATUK SEWAGE LAGOON UPGRADES
HAMLET OF PAULATUK, NORTHWEST TERRITORIES

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SITE SECTIONS 2 OF 2

PROJECT NO. 17-6028

SHEET NO. **103**