BETHEL LANDFILL

Closure Study and Cost Estimate Report

Prepared for:

City of Bethel
P.O. Box 1388
Bethel, AK 99559

Prepared by:

DOWL

4041 B St.
Anchorage, AK 99503

August 2019

1529.50150.01

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ACRONYMS

City ..... City of Bethel
cy ..... cubic yard
DEC ..... State of Alaska Department of Environmental Conservation
GCL ..... geosynthetic clay layer
HDPE ..... high-density polyethylene
SM ..... Silty sands, sand-silt mixtures
SP ..... Poorly graded sands, gravelly sands, little or no fines
YK ..... Yukon-Kuskokwim

EXECUTIVE SUMMARY

This Closure Study and Cost Estimate Report has been prepared for the City of Bethel as part of the Engineering and Planning Term Contract.

This report was developed to assess the regulatory requirements to close the Bethel Landfill, to determine the remaining life of the landfill before closure, and the estimated costs involved in the closure process and in post-closure monitoring.

At the current fill rate, the landfill will reach its capacity in 2043. The remaining capacity is approximately 974,000 cubic yards.

The estimated cost to close the landfill is $4,068,373. Thirty years of monitoring is required post-closure, which is estimated to cost a total of $1,689,450. The City currently has $2,517,098 in an account designated for closure and post-closure expenses.

Based on this study, it is recommended the City of Bethel designate $64,636 per year toward closure and $70,394 per year toward post-closure expenses, not factoring in inflation. As actual closure approaches, the City should further evaluate annual contributions for required post-closure monitoring. It is also recommended the City of Bethel evaluate recycling, biomass separation and composting, and other waste-reduction efforts to prolong the life of the landfill.

1.0 INTRODUCTION

The City of Bethel (City) retained DOWL to provide consulting services related to the City landfill's permit requirement to develop a landfill closure plan and accompanying cost estimate for closure and post-closure activities. Permit #SW2A002-22a was issued July 14, 2017.

The existing Bethel landfill is located on approximately 17 acres east of the wastewater treatment lagoon off Ridgecrest Drive. The landfill was constructed in 1991 with a design life of 25 years. The City of Bethel Solid Waste and Sewage Lagoon Facilities Design Study and Master Plan Update (September 2002) estimated the remaining landfill capacity at 857,407 cubic yards (cy). Based on the City continuing to aggressively compact, recycle, bale, and incinerate the accumulated waste, and a final contour slope of 5:1, the study found that the landfill would reach capacity around 2030.

Another landfill study completed in 2007 estimated the remaining landfill capacity at 856,370 cy and the end of its life in 2038. Additional steps could increase capacity, such as higher recycling rates, or decrease capacity, such as large vehicle disposal. Currently, the landfill neither bales nor incinerates waste, and these volume reduction measures were not factored into this closure plan. The ongoing construction of the new Bethel Hospital has contributed substantial amounts of construction waste to the landfill, according to the Public Works Director, and the Kilbuck School Facility Fire will add 14,300 cy of mixed construction and demolition waste to the landfill, according to the State of Alaska Department of Environmental Conservation (DEC).

The landfill currently contains approximately 570,000 cy of waste, based on the existing landfill modeled in Civil3D. Any slope greater than 4:1 requires static and seismic stability analysis, and would reach an imposing height. This study applies a side slope of 4:1, resulting in a final height of 165 feet, which is appropriate to minimize wind erosion as well as visual impacts (See Appendix A). State of Alaska regulations and Bethel Municipal Code do not specify height restrictions. The existing slopes of the landfill are 2:1, and vegetation is well established. Even if the slopes stabilize quickly with vegetation and crushed cars, the landfill would reach a height of over 200 feet if the 2:1 slope was continued.

This analysis found the remaining capacity of the Bethel Landfill to be 974,000 cy. Based on the available landfill intake forms, since 2005 the average annual intake has been approximately 30,000 cy (Appendix B). Factoring in the daily cover, which is about a third of the total volume of waste received, the annual volume of cover and waste is around 40,000 cy (Appendix C). Assuming the City does not implement volume reduction measures before closure, the landfill is estimated to have 24 years of capacity remaining and will reach capacity in 2043. The final footprint will be approximately 17 acres (Appendix A).

Closure of the landfill entails ongoing monitoring, which presents additional costs to the City. The purpose of this document is to outline the requirements and estimated costs for the landfill closure process and post-closure monitoring (Appendix D). With this information, the City has a compelling motivation to extend the life of the landfill and to budget for the eventual closure and post-closure expenses.

1.1 Location

The City of Bethel is a Second-Class City located in the Yukon Delta National Wildlife Refuge at the mouth of the Kuskokwim River, 40 miles inland from the Bering Sea (60.7968, -161.7714). It

is the largest community in Western Alaska by population (approximately 6,300 residents) and covers approximately 44 square miles.

The City is located along the Kuskokwim River, in a treeless subarctic tundra floodplain terrain that is characterized as poorly drained with a shallow permafrost table. Along Bethel's waterfront and townsite, the soils are poorly drained silts, with permafrost depth ranging from 30 to 40 feet. Further inland from the river, the ground is usually saturated or covered with surface water or sandy soils covered with silt loams and 12 inches of peaty mat. Vegetation is typically low-growing shrubs, grasses, and mats of moss and lichens.

Bethel can experience flooding by the Kuskokwim River. Flooding in 1985 was three to four feet deep, which resulted in the flooding of several homes, while the flooding in 1988 was approximately 5 feet deep and flooded 600 homes. Bethel experiences constant erosion from the Kuskokwim River as it is located on the eroding bend of the river.

Bethel averages 16 inches of rain and 50 inches of snow per year. The temperature ranges from 42°F to 62°F in the summer to -2°F to 19°F in the winter.

The community of Bethel is a major transportation hub for the Yukon-Kuskokwim (YK) Delta. The YK Delta has a population of about 26,000 people in its 56 remote villages. The hub nature of the community of Bethel makes it the most important in the region for connection between smaller villages and to the higher-level services of Fairbanks and Anchorage. The City provides many services to its citizens, including water treatment and distribution, sewage collection and treatment, fire and police services, and solid-waste collection and disposal.

The Class II landfill is located on 320 acres within Sections 4 and 5, Township 8 North, Range 71 West, Seward Meridian.

1.2 Geology and Soils

The project area is on the Kuskokwim River floodplain and is within the Subarctic Coastal Plain ecoregion, which is characterized by low relief, the predominance of wetlands, and braided or meandering streams and rivers. Permafrost is widespread but inconsistent, and vegetative cover generally consists of wet graminoid herbaceous communities. Soil is generally characterized as sandy silt with fine grained sand, medium loam, and medium erosion potential with a poorly-drained peat surface layer.

Soil samples were collected from three different stockpiles in "The Pit" near the Bethel Airport to determine the permeability at 90 percent compaction. Table 1 shows the results of the soil analysis from May 2019.

None of the material sites contain soil with low enough permeability to be suitable for the low-permeability component of the final landfill cover; however, local material can be used to smooth the landfill surface and for the top layer to support native vegetation.

Table 1: Bethel Soils Permeability Results

Sample Name	Classification	Permeability (cm/sec)
Road Sand	Poorly Graded Sand with Silt (SP-SM)	7.0×10^{-4}
Landfill Cover	Silty Sand (SM)	3.1×10^{-4}
Cover Topsoil	Silty Sand (SM)	2.8×10^{-4}

Notes: SP = Poorly graded sands, gravelly sands, little or no fines; SM = Silty sands, sand-silt mixtures

2.0 CLOSURE PROCESS

2.1 Collection and Consolidation

Pre-closure will include a sweep of the surrounding area to collect all loose litter and waste and dispose of it in the landfill prior to placement of final cover.

Before final closure, the City will remove easily-extricated scrap metal and divert to recycling, and bulky burnable items such as pallets and lumber will be removed for local woodburning stoves. Other large bulky items will be crushed or cut to maximize compaction and minimize settlement of the final cap.

Sorting out hazardous waste, such as used oil, batteries, antifreeze, and appliances with chlorofluorocarbons (refrigerant gas) is an ongoing effort in Bethel, and will continue through the life of the landfill. All drums and containers will be inspected and, if potentially hazardous, tested and disposed of properly. Motor vehicle fluids will be drained, and batteries removed before vehicle compaction and burial in the landfill.

2.2 Capping and Grading

The permit requires a daily cover of 6 inches of soil or other approved alternate cover, and at least 12 inches of soil within 7 days of last waste placement. Within 90 days of the last waste placement, the City will install a final cover system over the landfill designed to minimize infiltration and erosion. This infiltration layer must have a permeability no greater than 1×10^{-5} centimeters per second. Permeability test data will be submitted prior to beginning closure to demonstrate that the final cover materials meet 18 AAC 60.395.

Due to the prevalence of poorly-draining silty sand in the Bethel area, material will need to be imported to meet the standard for the low permeability layer. This material could be a natural product such as silt or clay, or a geosynthetic clay layer (GCL), which consists of bentonite clay sandwiched between two sheets of geotextile, or an impermeable membrane such as high-density polyethylene (HDPE) or specialized geotextile.

Prior to closure, permeability test data must be submitted to DEC to demonstrate the proposed final cover system meets the state requirement of less than 1×10^{-5} cm/sec permeability.

For the final cover system, this study recommends:

- 12 inches of local soil over the compacted waste to smooth and properly slope the surface;

- Reinforced polyethylene 30-mil geotextile (with a permeability of 2.2×10^{-10} cm/sec) to minimize infiltration;
- 18 inches of locally available silt/sand for the infiltration layer; and
- 6 inches of topsoil (locally derived) to support native vegetation to minimize erosion.

Depending on the low-permeability material selected, vents will be required to release trapped gases through the cap. Proper grading of the final cover to promote surface water run-off will prevent erosion or ponding. The vegetated layer must provide protection from wind and water erosion and have run-on and run-off measures in place to prevent any erosion or damage to the final cover.

In 2017 and 2018 the City dredged and dewatered approximately 50,000 CY of sludge from the sewage lagoon, which occupies the site adjacent to the landfill. DEC issued a Notice of Violation (NOV) for failure to comply with conditions regarding disposal of sewage sludge. In August 2019 DEC approved a request by the City to use the biosolids as landfill cover material. If the biosolids stockpile remains at time of closure, the sludge could substitute for the local materials listed above in the final cover system or mix with local materials to create the vegetative layer. The processed biosolids can also be used in the interim for cover to reduce operations costs.

3.0 POST-CLOSURE MONITORING

The Bethel Landfill's surface water monitoring was suspended by DEC in April 2018 because the landfill qualified for the allowable exceptions, and monitoring had not produced any usable results. Groundwater monitoring is not required since the area receives less than 25 inches of precipitation per year. Per 18 AAC 60.396, if surface water or groundwater monitoring requirements are reestablished by DEC during the active life of the Bethel Landfill, those activities must continue during the post-closure period. Additional requirements for a hydrological evaluation and for potential monitoring of drinking water wells may be discussed in the near future. If surface water or groundwater monitoring is not established prior to the closure of the landfill, post-closure surface water or groundwater monitoring will not be required.

Similarly, there are currently no leachate or gas/methane collection systems to monitor, and if they are not installed prior to closure, post-closure gas monitoring will not be required. However, installation of landfill gas vents may be required during the closure, which would entail quarterly sampling and inspections. Quarterly monitoring is currently conducted for exceedances of 25 percent of the lower explosive limit inside structures and at ambient air sampling locations; this sampling would be discontinued if landfill gas vents are installed.

4.0 SCHEDULE

Prior to initiating closure of the landfill, the City will submit written notification to DEC of the intent to close the landfill and prepare a written post-closure plan. The plan will include descriptions of any monitoring and maintenance requirements, the contact information for the person or office in charge of post-closure activities, and descriptions of any planned post-closure uses of the property. The City will also submit permeability test data for the selected final cover system.

Within 30 days of the last date the landfill accepts waste, the City will commence closure activities.

Within 180 days after commencing closure, the City will complete closure activities, depending on seasonal constraints. The City will submit written notification to DEC of closure completion in accordance with the closure plan, certified by an engineer or approved by DEC.

Upon closure, the City will record on the landfill property deed, for perpetuity, that the land was used as an MSWLF and future land uses are restricted.

For 30 years following closure, the City will conduct post-closure maintenance, including maintaining the final cover against erosion, settlement, subsidence, and any damage from run-off. Any active groundwater, leachate, or gas monitoring systems will be maintained and operated.

Following the 30-year post-closure period, the City will submit signed and sealed certification to DEC that the post-closure care has been completed in accordance with the post-closure plan. The City will also submit a request for approval to terminate post-closure care, including:

- a report on the post-closure monitoring findings;
- drawings, photographs, and other documentation regarding the landfill condition at the time of the request; and
- analysis of any potential problems at the landfill (settlement, slope instability, cracking, erosion, etc.) and how any problems will be identified.

5.0 LANDFILL IDENTIFICATION

Once closed, the landfill will remain fenced with gates and signs. The City will record on the deed or other legal title document a permanent notification identifying the property as a landfill facility which entails restricted permissible land uses. Written notification will be submitted to DEC showing the notation has been recorded and a copy has been filed in the operating record.

6.0 POST CLOSURE REQUIREMENTS

The City will develop a post-closure plan to include:

- a description of monitoring and maintenance activities and their respective frequencies;
- the name, address, and telephone number of the contact point for information about the facility during the post-closure period; and
- a description of the planned uses of the property during the period.

During the 30 years following closure of the landfill, the City will maintain the following:

- The integrity and effectiveness of the final cover, including:
  - making any repairs to address settlement or erosion and
  - preventing run-off from eroding or damaging the final cover.
- Adherence to the post-closure plan, including care of and acceptable use of the closed landfill.
- If applicable, any leachate collection, leachate monitoring or gas monitoring systems. These systems are not currently installed or required, but may be established before the

existing landfill closes, in which case maintenance and operation of those systems will be required during the 30-year post-closure period.

- If applicable, the groundwater monitoring system. Groundwater monitoring was suspended for the Bethel Landfill by DEC in April 2018. If groundwater monitoring is reestablished before closure, then monitoring will be required during the 30-year post-closure period.

At the end of the post-closure period, the City will submit an engineer-signed and -sealed certification to DEC, stating that post-closure care is completed in accordance with the plan.

7.0 CLOSURE COSTS

Table 2 shows approximate costs associated with closure of the Bethel Landfill.

Table 2: Bethel Landfill Closure Costs

Item Description	Unit	Estimated Quantity	Unit Price	Total Cost
Local Soil to Smooth Surface, Placed, Spread, and Compacted (12 inches deep)	cy	39,000	$ 20.00	$ 794,889
Reinforced Polyethylene Geotextile, including freight & installation	Square Feet	1,065,000	$ 0.83	$ 885,441
Local Soil Cover Layer, Placed, Spread, and Compacted (18 inches thick)	cy	58,000	$ 20.00	$1,192,333
Local Soil Vegetation Layer, Placed, Spread, and Compacted (6 inches thick)	cy	19,500	$ 20.00	$ 397,444
Soil Testing	Lump Sum	1	$2,675.00	$ 2,675
Silt Fencing Perimeter Erosion Control	Linear Foot	4,000	$ 10.00	$ 39,000
Perimeter Fencing	Linear Foot	4,000	$ 60.00	$ 234,000
Barrier Gate	Unit	1	$1,000.00	$ 1,000
Closure Signage	Unit	10	$ 930.00	$ 9,300
Contingency (10%)				$ 355,608
Construction QA/QC (1%)				$ 35,561
Closure Certificate, Survey, Deed and As-builts (2%)				$ 71,122
Final Closure Plan				$ 50,000
			TOTAL	**$4,068,373**

If landfill gas monitoring is reinstated, installation of the probes, vents and other equipment would add an additional $45,000 to the above closure costs, as well as associated operating and maintenance costs.

Table 3 shows approximate costs associated with post-closure monitoring and activities of the Bethel Landfill.

Table 3: Bethel Landfill Post-Closure Costs

Item Description	Unit	Estimated Quantity	Unit Price	Total Annual Cost
Cap Maintenance & Repair	Acre/year	2.5	$21,780	$ 53,655
Gas Monitoring in Buildings	Events/year	4	$ 40	$ 160
DEC Annual Post-Closure Period Fee	Lump sum/year	1	$ 2,020	$ 2,020
General Inspections	Events/year	12	$ 40	$ 480
			TOTAL PER YEAR	$ 54,295
			TOTAL POST-CLOSURE COSTS (30 years)	**$1,689,450**

Table 4 shows the estimated costs for closure and post-closure, the amount in the financial assurance account, and the future annual savings to reach the amount needed at time of closure. Assuming the City will seek grants to open the future landfill, and financial assurance will be required by those grants to commence operation, this report combines the closure and post-closure expenses and applies the closure date as the target date for saving for the existing landfill.

Table 4: Bethel Landfill Cost Summary

Item Description	Total Amount
Closure Expenses	$ 4,068,373
Post-Closure Expenses	$ 1,689,450
Total Needed by Closure	$ 5,757,823
Financial Assurance Savings	$ 2,517,098
Total Remaining Needed by Closure in 24 years	$ 3,240,725
Annual Contribution for Closure	$ 64,636
Annual Contribution for Post-Closure	$ 70,394
TOTAL CONTRIBUTIONS PER YEAR	**$ 135, 030**

Note: Expenses and contributions do not include inflation adjustment

Since groundwater, leachate, and gas vent monitoring are not currently required, the associated costs were not included in this estimate. If monitoring of these parameters is reinstated before closure, additional costs will be incurred.

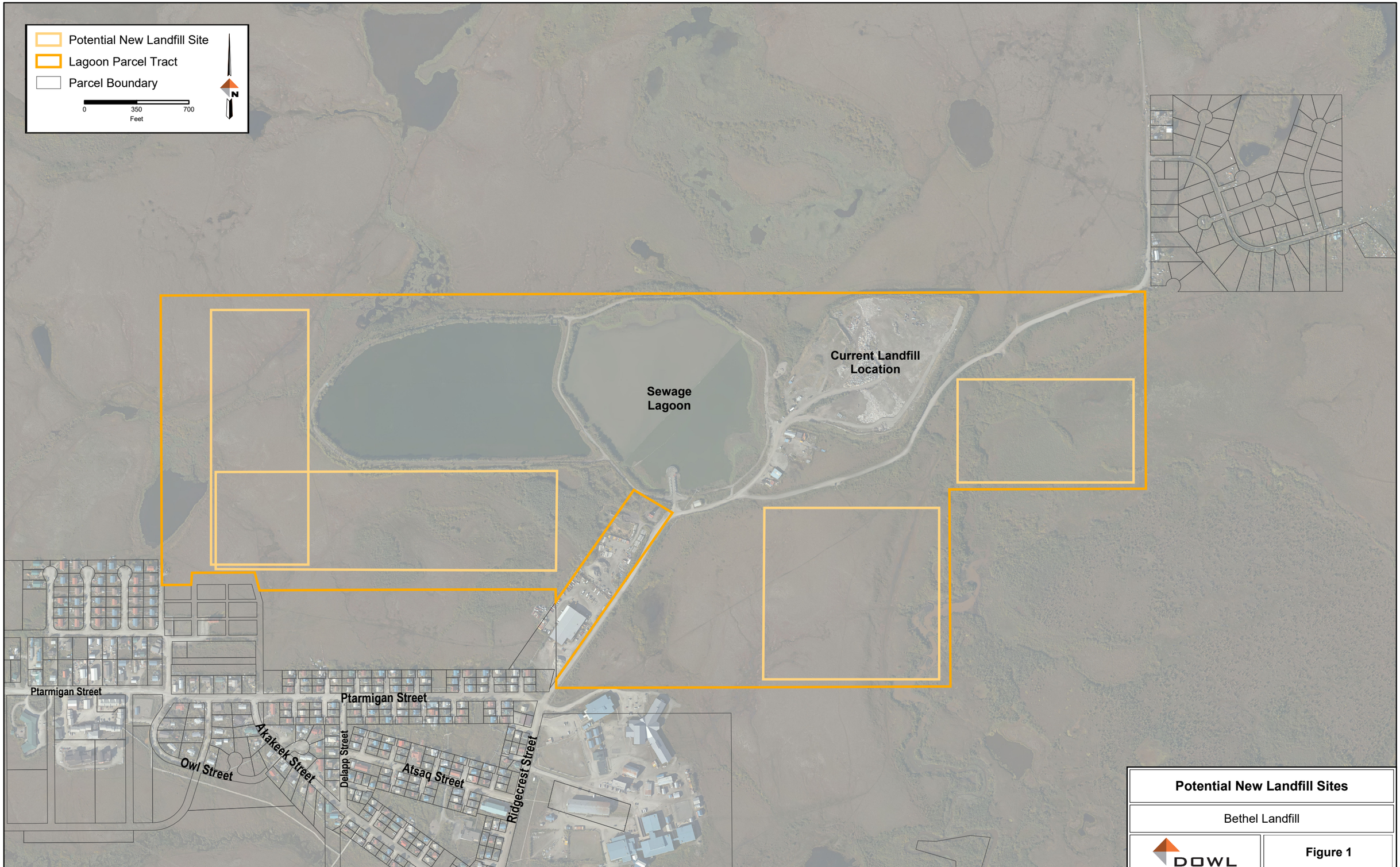
The City is required to demonstrate financial assurance for closure and post-closure costs by the time of closure. The City might consider adjusting rates and tipping fees to cover landfill expenses.

This study recommends the City should continue to contribute toward closure costs and further evaluate annual contributions for post-closure monitoring as actual closure nears.

8.0 FUTURE LANDFILL

With the closure of the existing landfill will come the need to open a new landfill. The City should begin evaluating potential sites for the new landfill and commence the property acquisition process. The City should have a site selected 3 to 5 years before the new landfill will be needed. A Preliminary Engineering Report will be needed to determine which site(s) is most appropriate for a landfill, evaluate any environmental, cultural, or geotechnical concerns, and estimate the associated costs of establishing the new landfill. Characteristics to consider for initial evaluation of potential sites are at least 10,000 feet must separate the site from the airport, the site must cover at least 25 acres, and new regulations may require additional maintenance and monitoring, such as drainage. If surface water or groundwater monitoring requirements are reestablished, it makes sense to locate the future landfill as close to the existing landfill as possible so any long-term monitoring requirements can cover both cells and the City avoids having two separate 30-year monitoring plans.

The parcel on which the existing landfill sits is 320 acres. The sewage lagoon, adjacent to the landfill, shares this parcel. The parcel has sufficient area to the west of the sewage lagoon and to the east of the existing landfill for the future landfill (Figure 1). The above considerations, in addition to concerns from neighboring residents, must be evaluated to determine the feasibility of developing the future landfill on the Lagoon Parcel.



Potential New Landfill Sites

Bethel Landfill

DOWL

Figure 1

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APPENDIX A: BETHEL LANDFILL DRAWINGS

BETHEL LANDFILL CLOSURE PLAN
BETHEL, ALASKA

DOWL
AECL848
WWW.DOWL.COM
4041 B Street
Anchorage, Alaska 99503
907-562-2000

PROJECT LOCATION:
BETHEL, ALASKA

CLIENT INFORMATION:
CITY OF BETHEL
PO BOX 1388
BETHEL, AK 99559

Tt PROJECT No.:

DOWL PROJECT No.:
1529.50150.03

PROJECT DESCRIPTION/NOTES:
BETHEL LANDFILL CLOSURE PLAN AND COST ESTIMATE

ISSUED:

June 28, 2019
PLANNING DOCUMENTS

LOCATION MAP
SCALE: NTS

DRAWING INDEX

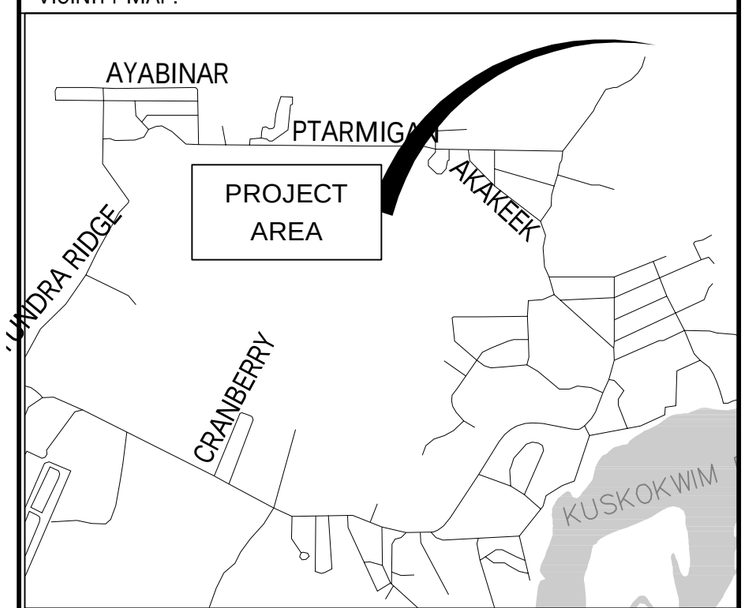
GENERAL

G000	COVER SHEET, VICINITY MAP, LOCATION MAP, DRAWING INDEX
G1	ABBREVIATIONS, REFERENCES, AND GENERAL NOTES

CIVIL

C1.0	EXISTING LANDFILL SITE PLAN
C2.0	FINAL GRADING PLAN
C3.0	CLOSURE SIGN DETAILS
C4.0	FINAL COVER AND FENCING DETAILS

VICINITY MAP:



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ABBREVIATIONS

CF	CUBIC FEET
DIA	DIAMETER
FT	FEET
GA	GAUGE
GB	GRADE BREAK
GFCI	GROUND FAULT CIRCUIT INTERRUPTOR
IN	INCH
MAX	MAXIMUM
MIL	ONE THOUSANDTH OF AN INCH
MIN	MINIMUM
NE	NORTHEAST
NOM	NOMINAL
NTS	NOT TO SCALE
NW	NORTHWEST
OC	ON CENTER
PSI	POUNDS PER SQUARE INCH
ROW	RIGHT-OF-WAY
SCHE	SCHEDULE
SDR	STANDARD DIMENSION RATIO
SE	SOUTHWEST
SW	SOUTHWEST
SQ	SQUARE
TYP	TYPICAL
W/	WITH

REFERENCE

DETAIL TITLE

SHEET NUMBERING

X-###

DISCIPLINE
GENERAL – G
CIVIL – C

LEGEND

- UTILITY POLE
- UTILITY ANCHOR
- ELECTRIC METER
- BOLLARD / POST
- BULDING
- FENCE LINE
- EDGE OF GRAVEL / DIRT
- OVERHEAD ELECTRIC
- BOUNDARY LINE
- PROPERTY LINE
- MAJOR CONTOUR (5')
- MINOR CONTOUR (1')

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BETHEL LANDFILL CLOSURE PLAN
BETHEL, ALASKA

ABBREVIATIONS, REFERENCES, AND GENERAL NOTES

TRACT C, BOOK 32, PAGE 244,
BETHEL RECORDING DISTRICT, FOURTH JUDICIAL DISTRICT, ALASKA

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DATE 06/26/2019

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SHEET
G1

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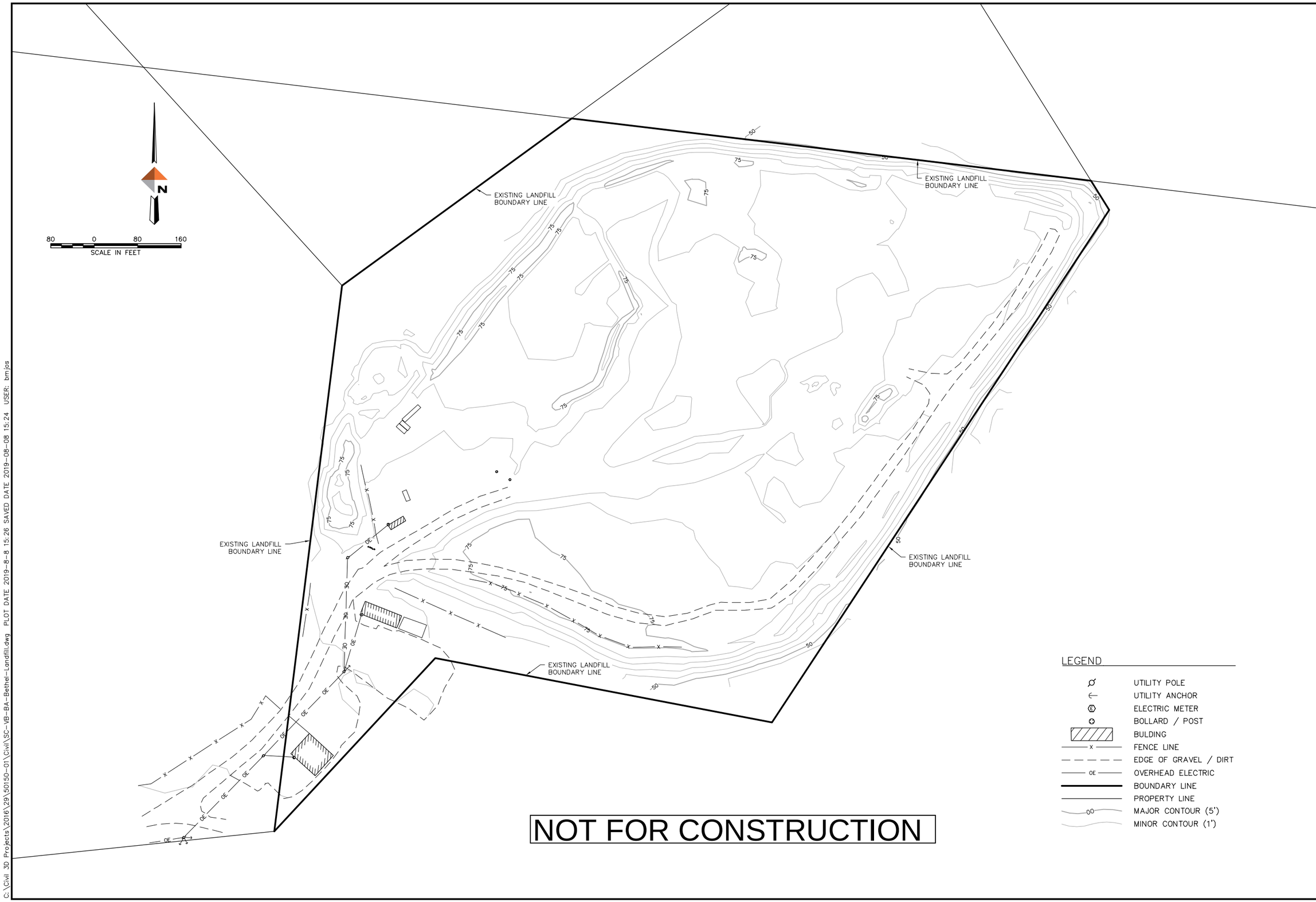

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BETHEL LANDFILL CLOSURE PLAN
BETHEL, ALASKA
EXISTING LANDFILL
SITE PLAN
TRACT C, BOOK 32, PAGE 244,
BETHEL RECORDING DISTRICT, FOURTH JUDICIAL DISTRICT, ALASKA

PROJECT 1529.50150.03
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C1.0

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NOTES:

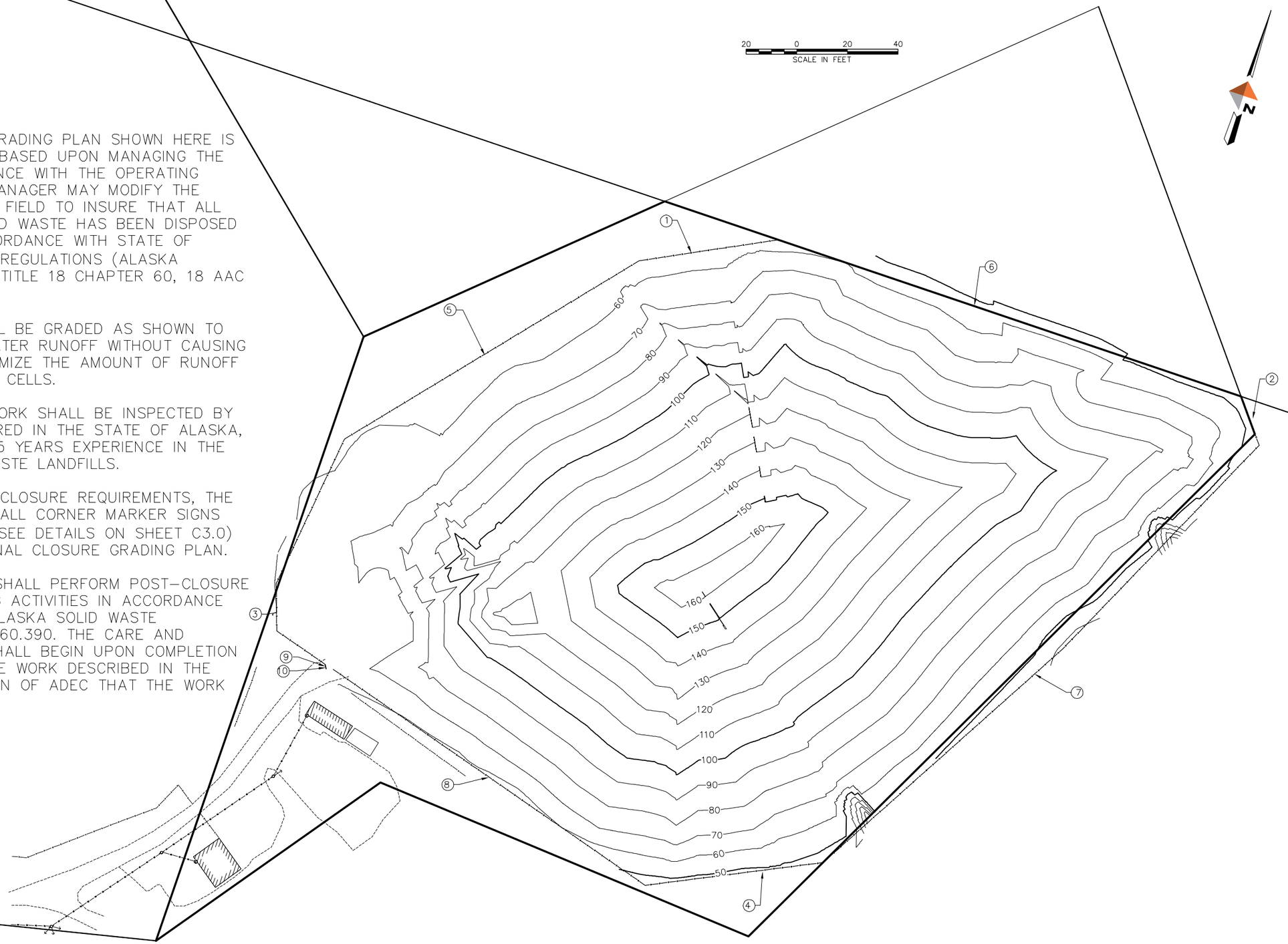
1. THE FINAL CLOSURE GRADING PLAN SHOWN HERE IS APPROXIMATE AND IS BASED UPON MANAGING THE LANDFILL IN ACCORDANCE WITH THE OPERATING PLAN. THE FACILITY MANAGER MAY MODIFY THE GRADING PLAN IN THE FIELD TO INSURE THAT ALL LANDS ON WHICH SOLID WASTE HAS BEEN DISPOSED ARE COVERED IN ACCORDANCE WITH STATE OF ALASKA SOLID WASTE REGULATIONS (ALASKA ADMINISTRATIVE CODE TITLE 18 CHAPTER 60, 18 AAC 60.)

2. COVERED AREAS SHALL BE GRADED AS SHOWN TO PROMOTE SURFACE WATER RUNOFF WITHOUT CAUSING EROSION, AND TO MINIMIZE THE AMOUNT OF RUNOFF ENTERING THE REFUSE CELLS.

3. ALL FINAL CLOSURE WORK SHALL BE INSPECTED BY AN ENGINEER REGISTERED IN THE STATE OF ALASKA, WHO HAS A MINIMUM 5 YEARS EXPERIENCE IN THE CLOSURE OF SOLID WASTE LANDFILLS.

4. IN ADDITION TO ADEC CLOSURE REQUIREMENTS, THE OPERATOR SHALL INSTALL CORNER MARKER SIGNS AND WARNING SIGNS (SEE DETAILS ON SHEET C3.0) AS SHOWN ON THE FINAL CLOSURE GRADING PLAN.

5. THE CITY OF BETHEL SHALL PERFORM POST-CLOSURE CARE AND MONITORING ACTIVITIES IN ACCORDANCE WITH THE STATE OF ALASKA SOLID WASTE REGULATIONS 18 AAC 60.390. THE CARE AND MONITORING PERIOD SHALL BEGIN UPON COMPLETION OF THE FINAL CLOSURE WORK DESCRIBED IN THE PLAN AND NOTIFICATION OF ADEC THAT THE WORK HAS BEEN COMPLETED.



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BETHEL LANDFILL CLOSURE PLAN
BETHEL, ALASKA

FINAL GRADING PLAN

TRACT C, BOOK 32, PAGE 244,
BETHEL RECORDING DISTRICT, FOURTH JUDICIAL DISTRICT, ALASKA

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DATE 06/26/2019

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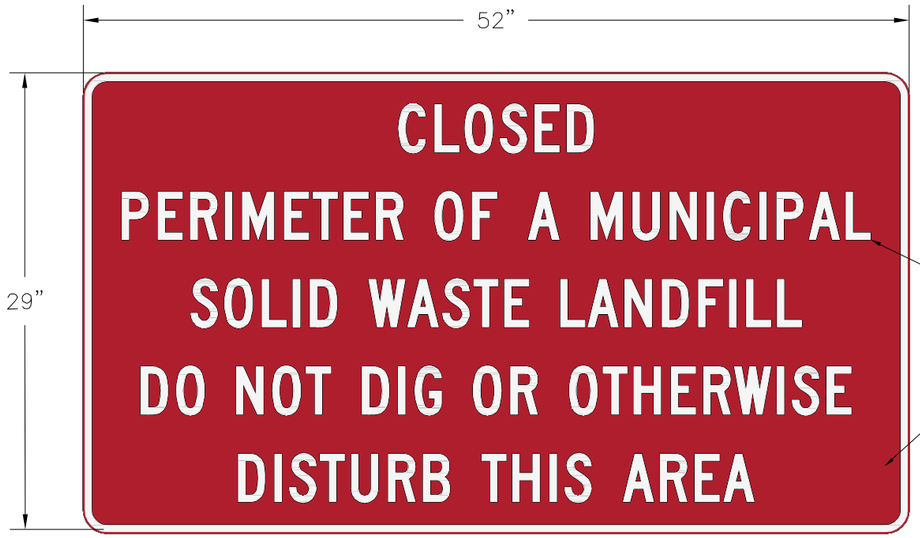

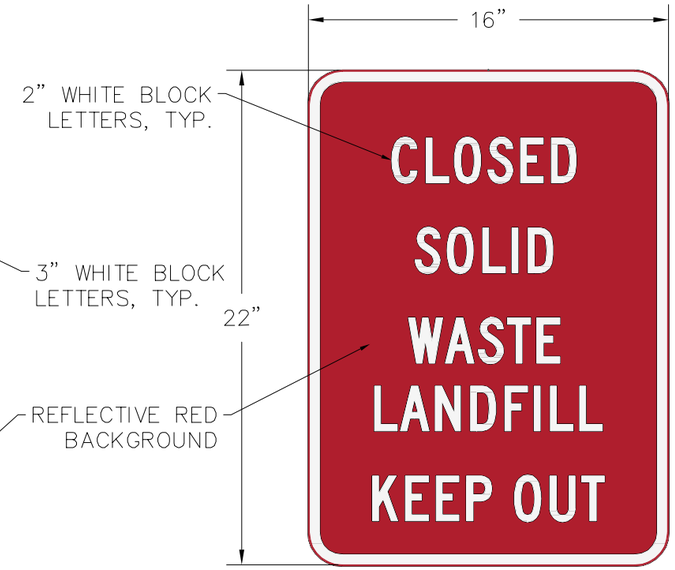

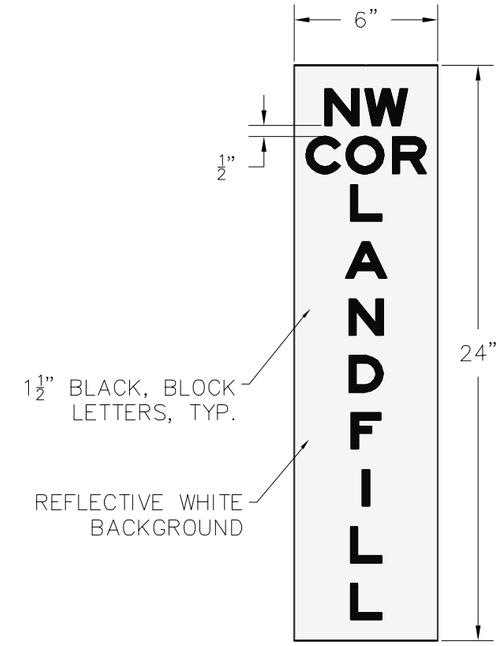

1 / C3.0

PUBLIC INFORMATION SIGN DETAILS

NOT TO SCALE

SIGN SUMMARY					
SIGN NO.	TYPE	LEGEND	SIZE INCHES W	SIZE INCHES H	AREA SQ. FT.
1 TO 4	SPECIAL	NW, NE, SW, & SE CORNER LANDFILL	6	24	1.00
5 TO 8	SPECIAL	CLOSED SOLID WASTE LANDFILL KEEP OUT	16	22	2.44
9	SPECIAL	LANDFILL CLOSED NO DUMPING	24	12	2.00
10	SPECIAL	CLOSED PERIMETER OF MUNICIPAL SW LANDFILL	52	29	10.47

NOTES:

1. ALL SIGNS SHALL CONFORM TO THE PLANS AND THE LATEST EDITION OF THE ALASKA TRAFFIC MANUAL. THE ALASKA TRAFFIC MANUAL CONSISTS OF MUTCD, THE ALASKA TRAFFIC MANUAL SUPPLEMENT TO THE MUTCD, AND THE ALASKA SIGN DESIGN SPECIFICATIONS.
2. SIGNS 1–4 AND 5–8 SHALL BE INSTALLED ON 2.5" PTT POSTS. SIGNS 9 & 10 SHALL BE MOUNTED TO THE LANDFILL PERIMETER FENCE AND SECURED AT ALL CORNERS WITH WIRE TIES.
3. ALL SIGNS SHALL BE 0.125" THICK.

NOT FOR CONSTRUCTION

REVISIONS

REV	DATE	DESCRIPTION	BY

DOWL
AECL848
www.dowl.com
4041 B Street
Anchorage, Alaska 99503
907-562-2000

BETHEL LANDFILL CLOSURE PLAN
BETHEL, ALASKA

CLOSURE SIGN DETAILS

TRACT C, BOOK 32, PAGE 244,
BETHEL RECORDING DISTRICT, FOURTH JUDICIAL DISTRICT, ALASKA

PROJECT 1529.50150.03
DATE 06/26/2019

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SHEET
C3.0

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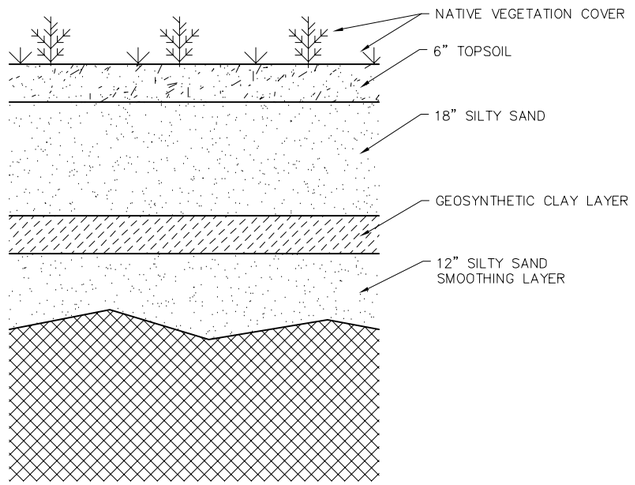
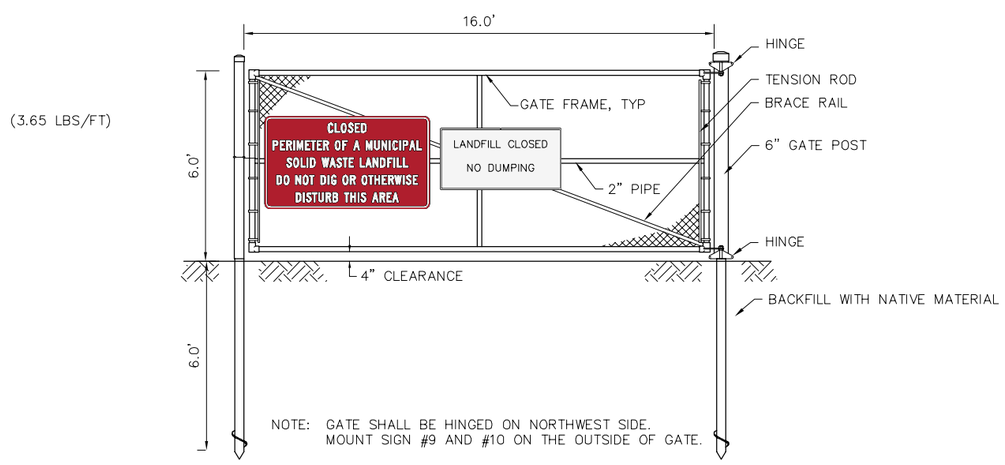


1 C4.0 FINAL COVER LAYERS
NTS

NOTES:

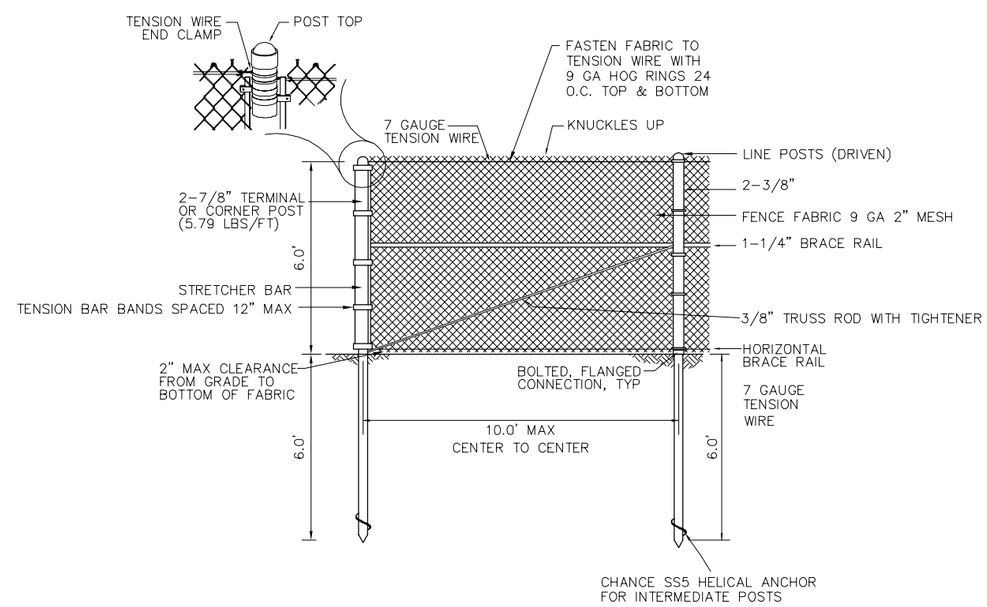
1. AS AN ALTERNATIVE TO THE SHOWN HELICAL ANCHOR FENCE POST EMBEDMENT SYSTEM, 6"X6"X $\frac{1}{4}$" STEEL PLATES FIELD WELDED TO BOTTOM OF POSTS MAY BE SUBSTITUTED.
2. POST SPACING
   - LINE POSTS 10 FT MAX
   - PULL POSTS 250 FT MAX
3. EACH PULL POST SHALL BE SUPPORTED WITH A DIAGONAL BRACE RAIL TO THE ADJACENT LINE POSTS.
4. BRACE RAILS AND TRUSS RODS SHALL BE SECURELY FASTENED TO POSTS WITH BRACE BANDS AND THREADED TAKE-UP ADAPTER FOR TRUSS RODS.

NOT FOR CONSTRUCTION



NOTE: GATE SHALL BE HINGED ON NORTHWEST SIDE.
MOUNT SIGN #9 AND #10 ON THE OUTSIDE OF GATE.

2 C4.0 TYPICAL SWING GATE DETAIL
NTS



3 C4.0 CHAIN LINK FENCE DETAIL
NTS

REV	DATE	REVISIONS DESCRIPTION	BY

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Anchorage, Alaska 99503
907-562-2000

BETHEL LANDFILL CLOSURE PLAN
BETHEL, ALASKA

FINAL COVER AND
CLOSURE SIGN DETAILS

TRACT C, BOOK 32, PAGE 244,
BETHEL RECORDING DISTRICT, FOURTH JUDICIAL DISTRICT, ALASKA

PROJECT 1529.50150.03
DATE 06/26/2019

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APPENDIX B: LANDFILL INTAKE FORMS

2005

MONTHLY
YEARLY
LANDFILL LOG

MONTH YEAR	DUMPSTER LOADS	BACKLOADER/ PICKUP LOADS	COMMERCIAL YARDS	PRIVATE LOADS	REFRIGERATORS FREEZERS	AUTOS - TRUCKS	MISC - ITEMS/ LARGE TANKS	
JAN 05	74	0	708	85	8	1		
FEB "	65	0	453	81	1	1		
MAR "	73	8	524	95	3	1		
APRIL "	79	6	700	141	8	4		
MAY "	84	63	1291	341	26	11	2 LARGE TANKS *	* City BROUGHT IN
JUNE "	72	22	5658	237	32	18 *	*	City 10
JULY "	69	41	1680	246	30	4		
AUGUST "	81	42	1733	233	23	18 *	*	State DOT - 8
SEPT "	72	39	1758	248	20	2		
OCT "	77	44	1098	186	14	19 *	*	City-19
NOV "	70	36	598	93	7	1		
DEC 05	71	81	659	71	6	0		
TOTALS	877	382	16860	2057	178	80		

2006

MONTHLY
YEARLY
LANDFILL LOG

MONTH YEAR	DUMPSTER LOADS	BACKLOADER/ PICKUP LOADS	COMMERCIAL YARDS	PRIVATE LOADS	REFRIGERATORS FREEZERS	AUTOS - TRUCKS	MISC - ITEMS/ LARGE TANKS
JAN 06	71	38	355	53	7	1	0
FEB	58	22	319	43	10	1	0
MAR	77	12	447	72	8	3	1
APRIL	69	32	384	70	6	3	0
MAY	90	118	742	290	19	35	0
JUNE	83	263	1206	398	57	46	0
JULY	67	268	619	268	29	27	0
AUGUST	82	319	980	232	29	2	0
SEPT	65	232	1183	190	21	0	0
OCT	76	204	1149	132	22	1	0
NOV	65	172	644	102	13	0	0
DEC 06	68	129	363	96	7	8	0
TOTALS	871	1759	8391	1946	228	127	1

2007

MONTHLY
YEARLY
LANDFILL LOG

MONTH YEAR	DUMPSTER LOADS	BACKLOADER/ PICKUP LOADS	COMMERCIAL YARDS	PRIVATE LOADS	REFRIGERATORS FREEZERS	AUTOS - TRUCKS	MISC - ITEMS/ LARGE TANKS
JAN	70	32	239	53	6	0	0
FEB	62	69	372	66	10	0	0
MAR	71	53	445	65	4	7	0
APRIL	70	247	725	170	23	2	0
MAY	83	290	680	336	28	28	0
JUNE	73	272	933	226	27	4	0
JULY	66	247	888	277	28	4	0
AUGUST	78	212	515	245	29	3	0
SEPT	62	191	534	153	15	0	SEWER TANKS (?) ESTIMATED 4
OCT	86	153	500	141	17	1	0
NOV	65	76	762	79	9	10	0
DEC	77	49	235	55	4	0	0
TOTALS	863	1891	6328	1866	200 ea.	59 ea.	4
	x 20 = 17260 cu yds.	x 2 = 3782 Misc pick-up	Comm yds.	x 1 = 1866 cu yds.			

2008

MONTHLY
YEARLY
LANDFILL LOG

MONTH YEAR	DUMPSTER LOADS	BACKLOADER/ PICKUP LOADS	COMMERCIAL YARDS	PRIVATE LOADS	REFRIGERATORS FREEZERS	AUTOS - TRUCKS	MISC - ITEMS/ LARGE TANKS
JAN	78	51	226	34	6	2	0
FEB	73	68	298	22	2	0	0
MAR	75	38	248	46	3	0	0
APRIL	76	42	265	58	7	0	0
MAY	81	184	749	198	26	0	0
JUNE	71	171	785	193	12	16	0
JULY	80	200	536	179	16	3	1
AUGUST	84	199	668	220	21	2	0
SEPT	95	147	907	187	15	5	0
OCT	87	106	2075	126	14	3	0
NOV	85	61	492	52	1	0	0
DEC	78	52	381	49	3	0	0
TOTALS	963	1319	7630 cu. yds	1364	126 refrigerators & freezers	31	1
	X20	X2		X1		X1	1
	19,260	2638		1364		31	

MONTHLY
YEARLY
LANDFILL LOG

2009

MONTH YEAR	DUMPSTER LOADS	BACKLOADER/ PICKUP LOADS	COMMERCIAL YARDS	PRIVATE LOADS	REFRIGERATORS FREEZERS	AUTOS - TRUCKS	MISC - ITEMS/ LARGE TANKS
JAN	79	83	210	71	7	0	0
FEB	67	30	190	41	8	0	0
MAR	74	18	239	22	5	1	0
APRIL	75	18	318	39	4	0	0
MAY	94	77	732	187	6	2	0
JUNE	81	65	1037	136	12	4	0
JULY	73	48	419	111	8	1	0
AUGUST	80	64	763	100	1	0	0
SEPT	72	43	213	142	4	8	0
OCT	80	45	304	222	3	5	0
NOV	72	23	293	36	7	4	0
DEC	80	27	266	67	6	4	0
TOTALS	977	558	5084	1174	71	29	0

2010

MONTHLY
YEARLY
LANDFILL LOG

MONTH YEAR	DUMPSTER LOADS	BACKLOADER/ PICKUP LOADS	COMMERCIAL YARDS	PRIVATE LOADS	REFRIGERATORS FREEZERS	AUTOS - TRUCKS	MISC - ITEMS/ LARGE TANKS
JAN	65	19	140	51	3		
FEB	66	16	149	34	4	8	
MAR	77	28	210	69	0	1	
APRIL	73	23	173	61	4	7	
MAY	89	73	2171	154	36	18	
JUNE	77	56	943	167	21	17	
JULY	79	70	732	112	25	0	
AUGUST	79	54	596	123	16	1	
SEPT	66	47	423	107	24	1	
OCT	67	49	509	79	12	0	
NOV	67	45	243	57	13	1	
DEC	71	7	397	63	2	0	
TOTALS	876	487	6686	1077	160	54	

35 cu yds per load ?

MONTHLY
YEARLY
LANDFILL LOG

2011

MONTH YEAR	DUMPSTER LOADS	BACKLOADER/ PICKUP LOADS	COMMERCIAL YARDS	PRIVATE LOADS	REFRIGERATORS FREEZERS	AUTOS - TRUCKS	MISC - ITEMS/ LARGE TANKS
JAN	73	18	360	68	6	3	0
FEB	64	18	219	57	7	0	0
MAR	74	41	320	66	15	0	0
APRIL	71	22	150	60	6	9	0
MAY	83	48	631	162	32	8	0
JUNE	80	76	1289	186	40	44	0
JULY	72	39	1076	112	28	27	0
AUGUST	83	60	676	118	31	23	0
SEPT	78	29	1113	110	23	12	0
OCT	87	42	736	110	30	6	0
NOV	73	20	514	59	8	1	0
DEC	73	11	235	54	15	1	0
TOTALS	921	424	7419	1222	241	131	0

MONTHLY
YEARLY
LANDFILL LOG 2015

MONTH YEAR	DUMPSTER LOADS	BACKLOADER/ PICKUP LOADS	COMMERCIAL YARDS	PRIVATE LOADS	REFRIGERATORS FREEZERS	AUTOS - TRUCKS	MISC - ITEMS/ LARGE TANKS
JAN	73	4	565	56	7	0	
FEB	79	1	1144	56	5	0	
MAR	80	2	788	66	6	0	
APRIL	76	4	998	54	5	2	
MAY	70	2	855	122	1	0	
JUNE	93	5	907	213	8	18	
JULY	86	2	1018	86	18	6	
AUGUST	80	3	693	84	6	0	
SEPT	80	0	674	87	7	0	
OCT	86	0	799	84	1	0	
NOV	86	0	415	72	2	0	
DEC	88	0	478	91	7	0	
TOTALS	977	23	9,344	1071	73	26	

MONTHLY
YEARLY
LANDFILL LOG

2017

MONTH YEAR	DUMPSTER LOADS	BACKLOADER/ PICKUP LOADS	COMMERCIAL YARDS	PRIVATE LOADS	REFRIGERATORS FREEZERS	AUTOS - TRUCKS	MISC - ITEMS/ LARGE TANKS
JAN	79		297	72	3	0	
FEB	74		345	76	2	2	
MAR	82	2	372	81	4	6	
APRIL	76	4	667	86	11	15	
MAY	84	5	857	131	9	16	
JUNE	76	4	1905	195	4	4	
JULY	80	2	872	176	7	3	
AUGUST	78	2	1291	154	3	4	
SEPT	80		854	130	4	2	
OCT	86		798	72	0	3	
NOV	85		690	70	2	2	
DEC	88		623	68	2	1	
TOTALS	968	19	9571	1311	51	58	

MONTHLY
YEARLY
LANDFILL LOG

2018

MONTH YEAR	DUMPSTER LOADS	BACKLOADER/ PICKUP LOADS	COMMERCIAL YARDS	PRIVATE LOADS	REFRIGERATORS FREEZERS	AUTOS - TRUCKS	MISC - ITEMS/ LARGE TANKS
JAN	76	0	868	71	2	8	1
FEB	77	0	1043	69	3	1	
MAR	76	0	949	78	13	2	
APRIL	82	3	1358	83	4	15	
MAY	78	2	1467	82	5	11	
JUNE	73	4	1490	88	13	6	
JULY	77	4	1313	91	6	4	
AUGUST	75	7	1316	92	14	7	2
SEPT	74	2	~~[illegible]~~ 980	72	4	2	
OCT	74	3	699	77	3	4	
NOV	73	2	371	68	4	1	
DEC	76	2	159	60	4	3	1
TOTALS	911	29	12,013		75	64	4

MONTHLY
YEARLY
LANDFILL LOG 2019

MONTH YEAR	DUMPSTER LOADS	BACKLOADER/ PICKUP LOADS	COMMERCIAL YARDS	PRIVATE LOADS	REFRIGERATORS FREEZERS	AUTOS - TRUCKS	MISC - ITEMS/ LARGE TANKS
JAN	75	3	585	71	3	3	
FEB	71	0	604		3	4	
MAR	76	1	596		5	3	
APRIL							
MAY							
JUNE							
JULY							
AUGUST							
SEPT							
OCT							
NOV							
DEC							
TOTALS							

APPENDIX C: CITY OF BETHEL 2014 LANDFILL COSTS SPREADSHEET

Cost Estimate Used to Calculate Cost of Cubic Foot of Bethel Landfill Space and Value of Time Landfill Remains Active

Landfill Expenses	FY04 Budget	FY05 Estimates	FY06 Budget	FY97 Actual & Budget	FY98 Actual	FY99 Actual	FY00 Actual	FY01 Actual	FY02 Actual	FY03 Actual	FY04 Actual	FY 05 Budget	FY06 Budget	FY07	FY 08	FY09	FY10	FY11	FY12	FY13	FY14	Post-Closure FY15 - FY45	Total	Landfill Expenses
Landfill Opening Cost	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------			Landfill Opening Cost
Landfill Operations	$33,993	$57,812	$81,632	$160,993	$244,775	$277,318	$225,450	$282,391	$202,101	$272,094	$555,840	$259,189	$271,077	$278,125	$285,356	$292,776	$300,388	$308,198	$316,211	$324,432	$332,868	$0	$5,363,019	Landfill Operations
Capital Expenses	------	------	------	------	------	------	------	------	------	------	------	------	$92,564	$94,971	$97,440	$99,973	$102,573	$105,240	$107,976	$110,783	$113,663	$0	$925,182	Capital Expenses
Landfill Closure Cost	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	$983,000	$983,000	Landfill Closure Cost
Post-closure costs	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	$420,000	$420,000	Post-closure costs
																						Total	$7,691,201	
Less Landfill Revenues																								**Less Landfill Revenues**
Landfill Dump Fees	$2,200	$2,200	$2,200	$2,200	$10,818	$21,407	$39,983	$52,138	$71,994	$47,584	$61,247	$60,000	$43,133	$44,254	$45,405	$46,586	$47,797	$49,040	$50,315	$51,623	$52,965	$0	$798,488	Landfill Dump Fees
Volume Deposited (cu. yds.)	15,632	15,886	16,144	16,407	16,673	16,944	17,220	17,500	17,780	18,064	18,354	18,647	18,946	19,249	19,557	19,870	20,187	20,510	20,839	21,172	21,511	------	387,092	**Volume Deposited (cu. yds.)**
Cover + Waste (cu. yds.)	20,842	21,181	21,525	21,875	22,231	22,592	22,959	23,333	23,707	24,086	24,471	24,863	25,261	25,665	26,076	26,493	26,917	27,347	27,785	28,229	28,681	------	516,118	**Cover + Waste (cu. yds.)**

Explanation of Calculations Used and Information Sources

Life of Landfill = 8.5 years, ending in 2014. Assumes 5% grade as defined in current Solid Waste Permit No. 0024-BA001 and use of steel wheeled compactor, which began in spring 2004. (Source: City of Bethel Solid Waste and Sewage Lagoon Facilities Design Study/Master Plan Update)

Inflation = 2.6%, the 2004 Anchorage Consumer Price Index. Used to project Landfill Operations costs for FY07-FY14. (Source: U.S. Dept. of Labor, Bureau of Labor Statistics).

Capital Expenses = Average actual capital expenditures incurred during years FY2001-FY2004 was $92,564 ($370,257 total exp./4 yrs). This figure used to project average likely capital expenditures the City would incur in FY06-FY14.

Calculations used for FY07 and beyond projections are based on FY06 dollars.

Current Useable Landfill Space = 17.6 acres out of 18 acres total.

Weight of Cubic Yard compacted and covered in landfill is estimated to be 900 lbs./cy. (Source: City of Bethel Solid Waste and Sewage Lagoon Facilities Design Study/Master Plan Update.

One Acre = 43,560 square feet.

Landfill Operations Costs:

- Fiscal Year 1997 was the first year in which landfill operations were recorded in an account separate from Solid Waste Services. The Solid Waste Services account included refuse hauling operations. Landfill operations figures for FY04-FY06 include only salaries and benefits identifiable with landfill operations (e.g., Landfill Operator and Landfill Attendant). Landfill Dumping Fees was not broken out from Solid Waste Services account and therefore not able to be obtained for years prior to FY 97.
- FY06 Budget Landfill Operations Cost: Landfill Operator Salary ($33,338) + Landfill Attendant Salary ($27,788) + Benefits (Group Health Insurance ($410/mo. * 12 mos. * 2 employees) + 17.45% of salary for PERS, Medicare, Unemployment, Worker's Comp., and Accrued Vacation & Sick.
- FY05 Budget does not identify salaried positions for landfill operations. All salaries expenses are lumped together in Solid Waste Services account. The Landfill Operations figure used here was an average of FY 04 and FY06, which included two positions (Landfill Operator and Landfill Attendant) and their benefits.
- FY 94 is the first budget year that included a salary figure for Landfill Attendant. No salary figure is given for Landfill Operator, implying that the position of Landfill Operator appeared on the scene as early as FY05, and definitely by FY 06.

Landfill Operations Costs (Continued):

- FY04, FY05, FY06 Landfill Dump Fees were estimated by using the amount budgeted for FY07.

Total landfill capacity in cubic feet was estimated by multiplying the amount of cubic feet remaining by three to compensate for landfill space already full. (Source: City of Bethel Solid Waste and Sewage Lagoon Facilities Design Study/Master Plan Update, p. 6-36, Figure 6-15.

Total cost associated with landfill does not include: expenses incurred in fiscal years previous to FY04 (City began managing landfill in 1980), capital expenses incurred in years previous to FY07, landfill opening costs (purchase price, permits, site preparation), and in-kind use of labor, materials, and equipment used to make berms around landfill and make other improvements to the facility.

FY Budget and Actual figures obtained from printed budgets. Electronic information is only available from FY2001 to present on Caselle database program.

Total cu. yds. waste & cover remaining (FY06-FY14)	229,824
Total Net Cost Associated with Landfill	$6,892,713
Landfill total cubic yards	862,134
Landfill total weight (lbs.)	775,920,600
Landfill total weight (tons)	387,960
Cost per cubic yard	$8
Cost per ton	$18
Remaining years (FY06-FY14)	8.5
Remaining avg. cu. yds. waste/yr.	45,540
Remaining avg. cu. yds. waste & cover/yr.	60,720
Value per acre	$391,631
Value per sq. ft.	$8.99
Value of one year	$485,451
Value of one month	$40,454.27
Value of one day	$9,335.60
Use of commercial baling system to bale aluminum, cardboard, paper, plastics would extend the landfill life by two years at a value of:	**$970,902**

Need to figure cubic yards per year over the life of landfill, not just to end of its life.
Key Figure: How many cubic yards in a year can landfill handle to end of its life.

Check permit to see if it estimates total space available in landfill.

APPENDIX D: LANDFILL CLOSURE AND POST-CLOSURE COST ESTIMATE SPREADSHEETS

ESTIMATION OF CLOSURE COSTS

Soil Cap Components

I.	**Slope & Fill to Smooth out Surface (local silt/sand)**			Calculation or Conversion		
a.	Area to be capped	25	acres	x 4,840yd2/ac	119,233	yd2
b.	Depth of soil needed for slope and fill	12	inches	x 1yd/36in	0.33	yd
c.	Quantity of soil needed			a x b	39,744	yd3
d.	Percentage of soil from off-site	0%				
e.	Purchase unit cost for off-site material	$100.00	/yd3			
f.	Percentage of soil from on-site			(1 - d)	100%	
g.	Excavation unit cost (on-site material)		/yd3		0	
h.	Total soil unit cost			(d x e) + (f x g)	$0.00	/yd3
i.	Hauling, Placement, Spreading and Compacting unit cost	$20.00	/yd3		0	
j.	Total soil unit cost			h + i	$20.00	/yd3
	Subotal Slope & Fill Cost			j x c	***$794,889***	

II.	**Infiltration Layer Soil**					
Infiltration Soil Cost						
a.	Area to be capped	25	acres	x 4,840yd2/ac	119,233	yd2
b.	Depth of infiltration soil needed	18	inches	x 1yd/36in	0.50	yd
c.	Quantity of infiltration soil needed			a x b	59,617	yd3
d.	Percentage of soil from off-site	0%				
e.	Purchase unit cost for off-site material	$100.00	/yd3			
f.	Percentage of soil from on-site			(1 - d)	100%	
g.	Excavation unit cost (on-site material)		/yd3			
h.	Total infiltration soil unit cost			(d x e) + (f x g)	$0.00	/yd3
i.	Hauling, Placement, Spreading, and compacting unit cost	$20.00	/yd3			
j.	Total infiltration soil unit cost			h + i	$20.00	/yd3
	Subtotal Infiltration Soil Cost			**j x c**	***$1,192,333***	

III. Erosion Control / Protective Cover Soil Topsoil using local silt/sand for vegetation

a.	Area to be capped	25	acres	x 4,840yd2/ac	119,233	yd2
b.	Depth of soil needed	6	inches	x 1yd/36in	0.17	yd
c.	Quantity of soil needed			a x b	19,872	yd3
d.	Percentage of soil from off-site	0%				
e.	Purchase unit cost for off-site material	$100.00	/yd3			
f.	Percentage of soil from on-site			(1 - d)	100%	
g.	Excavation unit cost (on-site material)		/yd3			
h.	Total erosion/protective soil unit cost			(d x e) + (f x g)	$0.00	/yd3
i.	Hauling, Placement, Spreading, and compacting unit cost	$20.00	/yd3			
j.	Total soil unit cost			h + i	$20.00	/yd3
	Total Erosion Control/Protective Cover Soil Cost			j x b	***$397,444***	

IV. Soil Testing

a.	Area to be capped	25	acres
b.	Testing unit cost		/acre
c.	Alaska Testlab	$875.00	
d.	Field Technician	$1,800.00	
	Subtotal soil testing cost	c+d	***$2,675***

Soil Cap Subtotal (I-IV): $2,387,342

Geosynthetic Barrier & Infiltration Layers

V. Geosynthetic Clay Liner/HDPE

a.	Quantity of GCL needed	25	acres	x 43,560 ft2/ac	1,065,000	ft2
b.	Purchase unit cost, including freight & in	0.83	/ft2			
c.	Total GCL unit cost			b	$0.8314	/ft2
	Total GCL Cost			a x c	***$885,441***	

Geosynthetic Layers Subtotal (V): $885,441

Landfill Gas and Groundwater Features (Not included in total. May be required by time of closure.)

				Calculation	
VI.	**Landfill Gas Monitoring & Control Components**				
Landfill Perimeter System					
a.	Number of probes to be installed	9	probes		
b.	LFG probe unit cost	$5,000	/probe		
c.	*Subtotal LFG probe cost*			a x b	*$45,000*
Landfill Control Systems					
d.	Area to be closed	25	acres		
e.	Average number of vents per acre		vents / acre		
f.	LFG vent unit cost		/vent		
g.	*Subtotal LFG vent cost*			d x e x f	*$0*
h.	Length of header pipe needed		LF		
i.	Header pipe unit cost		/LF		
j.	Header pipe installation cost		/LF		
k.	*Subtotal LFG active vent hook-up*			h x (i + j)	*$0*
	Total Landfill Gas Management Cost			c + g + k	***$45,000***
VII.	**Groundwater Monitoring Components**				
a.	Hydrogeologic study cost				
b.	Number of wells to be installed	5	wells		
c.	GW Monitoring Well unit cost		/well		
d.	Number of wells > 50 ft length		wells		
e.	Additional well length over 50 ft		LF/well		
f.	Unit cost for additional well length		/LF		
	Total Groundwater Monitoring Well Cost			a + (b x c) + (d x e x f)	***$0***
				Landfill Gas & Groundwater Features Subtotal (VI-VII):	**$45,000**

Miscellaneous

VIII.	**Erosion/Sediment Control**				
a.	Quantity of silt fence needed	3,900	LF		
b.	Silt Fence unit cost	$10.00	/LF		
	Total Silt Fence Cost			a x b	***$39,000***

IX. Site Security

Fencing

a.	Length of fencing needed	3,900	ft		
b.	Fence unit cost	$60.00	/ft		
c.	*Subtotal fencing cost*			a x b	*$234,000*

Gate or Barrier

d.	Number of gates required	1			
e.	Gate unit cost	$1,000.00	/gate		
f.	*Subtotal gate cost*			d x e	*$1,000*

Closed Signage

g.	Number of signs required	10			
h.	Sign unit cost	$930.00	/sign		
i.	*Subtotal sign cost*			g x h	*$9,300*
	Total site security cost			c + f + i	***$244,300***

Miscellaneous Subtotal (VIII-IX): $283,300

Closure Cost Subtotal (CCS):	(I + … + IX)	$3,556,083	$3,556,082.67
Contingency (10%):	CCS x 0.10	$355,608	
Engineering & Documentation:			
Construction QA/QC (1%)	CCS x 0.01	$35,561	
Closure Certificaiton, Survey, Deed and as-builts (2%)	CCS x 0.02	$71,122	
Total Engineering & Documentation Costs		***$106,682***	
Final Closure Plan Development:		***$50,000***	
Total Closure Cost:	CCS + Contingency + Engineering		**$4,068,373**

ESTIMATION OF POST-CLOSURE COSTS

I. Groundwater Monitoring

				Calculation or Conversion		
a.	Total number of monitoring wells	5	wells			
b.	Total number of sampling events/year	1	events/yr	a x b	5	samples/yr
c.	Quantity of additional samples (e.g. QA/QC)	1	samples/event	b x c	1	samples/yr
d.	Total samples per year			b + c	6	samples/yr
e.	Analysis unit cost (40 CFR 258 Appendix I constituents)		/sample			
f.	*Total Analysis cost*			d x e	*$0.00*	/yr
g.	GW Monitoring unit cost		/event			
h.	*Total sampling cost*			f + (g x b)	*$0.00*	/yr
i.	Engineering fees & reports		/yr			
	Yearly Groundwater Monitoring Cost			h+i	***$0***	***/yr***

II. Landfill Gas Monitoring, Maintenance, and Control

	Total number of gas vents	8				
a.	Frequency of LFG compliance monitoring	4	events/yr			
b.	LFG Monitoring unit cost	N/A	/event			
c.	*Total perimeter LFG monitoring cost*			a x b	*$0*	/yr
d.	Frequency of surface monitoring (air permit)	4	events/yr			
e.	Surface monitoring unit cost	$40.00	/event			
f.	*Total surface monitoring cost*			d x e	*$160*	/yr
	Yearly Landfill Gas Monitoring, Maintenance, & Control Cost			c + f	***$160***	***/yr***

III. Cap Maintenance & Repair

a. Closed Landfill Area	25	acres			
Cap Erosion & Repair					
b. Area to reseed/year			10% x a	2.5	acres
c. Reseeding unit cost	$21,780	/acre			
d. *Total reseeding cost*			b x c	*$53,655.00*	/yr
e. Area of cap erosion/year			10% x a	2.5	acres
f. Cap erosion repair unit cost		/acre			
g. Mobilization/Demobilization		/yr			
h. *Total cap erosion repair cost*			(e x f) + g	*$0*	/yr
Yearly Cap Maintenance & Repair cost			d + h	***$53,655***	***/yr***

IV. Post-Closure Care General Inspections

a. General Inspection unit cost	$40	/inspection			
b. Number of inspections per year	12				
Yearly Post-Closure Care General Inspection Cost			a x b	***$480***	***/yr***

Annual Post-Closure Care Cost (APCC)			I + … + IV	$54,295	/yr
Length of Post-Closure Care (LPCC)	30	years			
ADEC Post-Closure Period Fee	$2,020	$/yr		$60,600	
Post-Closure Care Cost			(APCC x LPCC)	$1,628,850	
FA Mechanism Maintenance Cost		/yr	FA maintenance x LPCC	$0	
Total Post-Closure Care Cost			Post-Closure Cost + Engineering + FA Maintenance		**$1,689,450**
Financial Assurance Account Balance					**$2,517,098**

APPENDIX E: GEOTEXTILE TECHNICAL INFORMATION

DURA♦SKRIM® N30BT1

SCRIM REINFORCED POLYETHYLENE – NSF/ANSI STANDARD 61 CERTIFIED

RAVEN

PRODUCT DESCRIPTION

DURA♦SKRIM® N30BT1 is a one-side textured flexible geomembrane, reinforced with a closely knit 9x9 weft inserted polyester scrim fully encapsulated between two layers of highly UV stabilized linear low density polyethylene. Exceptional toughness, high tensile and puncture strength is achieved with the combination of premium high strength LLDPE and dense scrim reinforcement. A highly stabilized formulation consisting of antioxidants, UV stabilizers and carbon black provide excellent protection for long-term exposed or barrier applications.

DURA♦SKRIM® N30BT1 contains a cast textured surface produced with Raven's exclusive GeoGrip™ technology. The GeoGrip™ texture is made up of durable random spikes and diamond shaped bidirectional bars for unmatched uniform stabilization and support. DURA♦SKRIM® NT-Series geomembranes are produced in the color black as standard, and are available in other custom manufactured colors with minimum order quantity requirements.

PRODUCT USE

DURA♦SKRIM® textured NT-Series are used for applications that require an anti-skid surface or to provide a high friction surface between unlike soil types and geosynthetic materials for steeper slope designs depending upon application requirements. Common applications include landfill caps, mining leach pads and containment ponds. DURA♦SKRIM® N30BT1 is used in applications that require exceptional outdoor life, high tear properties, exceptional tensile strength, and puncture resistance. DURA♦SKRIM® NT-Series is manufactured from a very chemical-resistant, linear-low-density polyethylene with excellent cold crack performance and resistance to thermal expansion.

DURA♦SKRIM® N30BT1 meets the physical property values as stated in GRI test method GM25, and is certified under the NSF/ANSI Standard 61, Drinking Water System Components – Health Effects.

SIZE & PACKAGING

DURA♦SKRIM® NT-Series is available in a variety of widths and lengths to meet the project requirements. Large diameter mill rolls are available to assure an efficient seaming process. Factory welded panels are produced in a controlled environment and are accordion folded and tightly rolled on a heavy-duty core for ease of handling and time saving installation.

Containment Liner

PRODUCT	PART #
DURA♦SKRIM	N30BT1

APPLICATIONS

- Waste Lagoon Liners
- Landfill Caps
- Canal Liners
- Disposal Pit Liners
- Water Containment Ponds
- Heap Leach Liners
- Tunnel Liners
- Earthen Liners
- Interim Landfill Covers
- Mining Tailing Ponds

DURA♦SKRIM®

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DURA♦SKRIM® N30BT1

SCRIM REINFORCED POLYETHYLENE — NSF/ANSI STANDARD 61 CERTIFIED

PRO-FORMA DATA SHEET

		DURA♦SKRIM® N30BT1			
		IMPERIAL		METRIC	
PROPERTIES	TEST METHOD	MINIMUM	TYPICAL	MINIMUM	TYPICAL
Appearance		Black 1-Side Texture		Black 1-Side Texture	
Core Thickness	ASTM D5994	27 mil	30 mil	0.69 mm	0.76 mm
Asperity Height	ASTM D7466	16 mil	20 mil	0.41 mm	0.51 mm
Weight	ASTM D751	127 lbf/msf	142 lbf/msf	620 g/m^2	693 g/m^2
Construction		9 x 9 – 1,000 Denier PET Scrim Reinforced Polyethylene			
Tongue Tear Strength	ASTM D5884	70 lbf	106 lbf	311 N	471 N
Grab Tensile at Break	ASTM D7004	220 lbf	260 lbf	978 N	1156 N
Tensile Elongation at Break	ASTM D7004	22 %	27 %	22 %	27 %
Puncture Resistance	ASTM D4833	80 lbf	90 lbf	356 N	400 N
Standard OIT or High Pressure HPOIT	ASTM D3895 ASTM D5885	100 min 400 min	150 min 2400 min	100 min 400 min	150 min 2400 min
Hydraulic Conductivity		2.2 x 10^{-10} cm/sec			
Maximum Static Use Temperature		180° F		82° C	
Minimum Static Use Temperature		-70° F		-57° C	

PRO-FORMA SHEET CONTENTS: The data listed in the Pro-Forma data sheet is representative of initial production runs. These values may be revised at anytime without notice as additional test data becomes available.

DURA♦SKRIM® N30BT1 is a one-side textured flexible geomembrane, reinforced with a closely knit 9x9 weft inserted polyester scrim fully encapsulated between two layers of highly UV stabilized linear low density polyethylene. Exceptional toughness, high tensile and puncture strength is achieved with the combination of premium high strength LLDPE and dense scrim reinforcement. A highly stabilized formulation consisting of antioxidants, UV stabilizers and carbon black provide excellent protection for long-term exposed or barrier applications.

Scan QR Code to download technical data sheets.

Note: To the best of our knowledge, unless otherwise stated, these are typical property values and are intended as guides only, not as specification limits. Chemical resistance, odor transmission, longevity as well as other performance criteria is not implied or given and actual testing must be performed for applicability in specific applications and/or conditions. RAVEN INDUSTRIES MAKES NO WARRANTIES AS TO THE FITNESS FOR A SPECIFIC USE OR MERCHANTABILITY OF PRODUCTS REFERRED TO, no guarantee of satisfactory results from reliance upon contained information or recommendations and disclaims all liability for resulting loss or damage. Limited Warranty available at www.ravenefd.com

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