Environment

City of Lethbridge

Lethbridge Waste and Recycling Centre Master Plan Executive Summary

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1. Waste and Recycling Center Scope and Setting

1.1 Scope of Master Plan

The Master Plan provides a plan that outlines the phased expansion of the Waste and Recycling Centre. The expansion of the facility is necessary to accommodate the project growth and population increase of the City, County and surrounding communities throughout Southern Alberta that rely on the facility to manage their waste.

The Waste and Recycling Centre is an integrated waste management facility that provides recycling, composting and landfill services. The Master Plan is intended to create a long term plan for the design and development of the facilities, and to support the City's existing and future waste management objectives to provide effective and sustainable waste management options.

The Master Plan satisfies the following goals, objectives and commitments:

1. Mitigate concerns of the community and stakeholders through the design process
2. Meet Alberta Environment's applicable standards and regulatory requirements
3. Provide disposal space for a minimum of 50 years
4. Respect the residential and water well setbacks
5. Maintain the minimum 30 metre (m) setback from the property line
6. Vertical and lateral expansion on existing quarter sections SW 4-10-21- W4 and northwest portion of SE 4-10-21 W4 presently approved for landfill operation
7. Expand site laterally east to adjacent land, SE 4-10-21 W4, and adjacent north quarter section NE 4-10-21 W4
8. Optimize depth and heights of landfill taking into consideration factors such as: excavation depth, soil balance, visual impact, cost and determine airspace

The Master Plan also considers the City of Lethbridge Comprehensive Waste Diversion/Waste Prevention Master Plan (Sonnevera, May 2008) as the report includes recommendations that influence site infrastructure designs. They include:

1. Designing an expanded recycle facility for municipal, industrial, commercial and institutional materials
2. Developing organics management capacity
3. Developing infrastructure capacity for construction and demolition (C&D) diversion- concrete and asphalt recycling

1.2 Current Landfill Site

1.2.1 Site Location

The existing Lethbridge Waste and Recycling Centre (LWRC) facility is located approximately 10 kilometres (km) north of the City of Lethbridge in the SW ¼ 4-10-21-W4 and SE ¼ 4-10-21-W4. The lateral expansion of the facility is planned for the SE ¼ 4-10-21-W4 and the NE ¼ 4-10-21-W4. The landfill property is surrounded primarily by agricultural land and coulee to the north, Secondary Highway 843 to the east (43 Street), Township Road 10-0 to the south, and coulee and Oldman River to the west. Access to the site is off of Township Road (Twp Rd) 10-0. An active feed lot is located to the south west of the site and the St. Mary River Irrigation District (SMRID) canal is located south and east of the site. A site location plan is provided on Drawing 00-C-1000 in Appendix A.

Table 1 lists the current ownership, land use and zoning for properties within 800 m of the site.

Table 1 Ownership, Land Use and Zoning for Properties within 800 m

Location	Ownership	Land Use	Zoning
NE5 10-21-4	Gary G Neher and Ray Colleen Neher		Rural Agricultural
NW4 10-21-4	City of Lethbridge	Coulee land	Rural Agricultural
NE4 10-21-4	City of Lethbridge		Rural Agricultural
NW3 10-21-4	Tom and Gena Kotke	Residence, Farming	Rural Agricultural
SE5 10-21-4	Brett and Michelle Logue – North and West of Oldman River City Packers Feedlot (2003) Ltd. – South of Oldman River	Residential, farming, Gravel pit Feed Lot	Rural Agricultural
SW4 10-21-4	City of Lethbridge	Coulee and Oldman River in the west. Existing Waste and Recycling Centre Disposal Site in the east.	Rural Agricultural – Isolated Single Lot Rural Industry (discretionary use)
SE4 10-21-4	City of Lethbridge	Proposed Waste and Recycling Centre Disposal Site expansion.	Rural Agricultural – Isolated Single Lot Rural Industry (discretionary use)
SW3 10-21-4	KLC Cattle Company Ltd.	Farming	Rural Agricultural
NE32 9-21-4	West Coast Reduction Ltd. – West half of quarter section City Packers Feedlot (2003) Ltd. – East half of quarter section		Rural Agricultural; some Rural Grouped Industrial
NW33 9-21-4	City Packers Feedlot (2003) Ltd. – Northwest of canal DHS Holdings Ltd. – Southeast of canal (small area)	Feedlot	Rural Agricultural
NE33 9-21-4	DHS Holdings Ltd.	Farming	Rural Agricultural
NW34 921-4	Bernard Alexander Lastuka	Farming	Rural Agricultural

Two registered utility right of ways (R/W) intersect SW4 10-21-4. The R/Ws are registered as Plan 2597 J.K. and a power line plan 801 0511.

1.2.2 Service Area

The landfill operates as a regional landfill and therefore accepts waste from the City of Lethbridge as well as the following regional customers:

- Lethbridge Regional Waste Management Services Commission:
  - Members: County of Lethbridge, Town of Picture Butte, Village of Nobleford
  - Transfer stations at: Picture Butte, Nobleford, Coaldale, Iron Springs
- Vulcan District Waste Commission:
  - Members: Town of Vulcan, Vulcan County, Arrowwood, Carmangay, Champion, Lomond, Milo
  - Transfer stations at: Champion/Carmangay, Milo, Lomond, Vulcan, Mossleigh
- Village of Barons
- Town of Coalhurst
- Town of Coaldale

The landfill also accepts waste, on an occasional basis, from Chief Mountain Regional Solid Waste Authority, the Taber and District Regional Waste Management Authority, and Siksika Nation. The decision to deliver to Lethbridge is made by the customer and is generally based on conditions at their usual receiving landfill.

1.2.3 Landfill Facilities

The existing landfill development is shown on Drawing 00-C-1001 in Appendix A and is comprised of the following components:

- Landfill office, shop and indoor tipping facility with large capacity solid waste baler
- Weigh scale house
- Residential drop off area
- Residential recycle area
- Contractor C&D recycle area
- Class III Compost collection, processing, and curing area
- Class II Hydrocarbon Contaminated Soil (HCS) disposal cells
- Class II landfill cells with an asbestos disposal area
- Wood recycling area
- Liquid waste disposal area
- Class III Construction and demolition waste cell
- Stormwater Management Ponds

The landfill complies with the following setbacks as shown on Drawing 00-C-1002 in Appendix A:

- Minimum 100 m from land subject to slope failure
- Minimum 300 m from natural area permanently containing water, i.e. lake, creek, or river
- Minimum 300 m from man-made area permanently containing water, i.e. irrigation canal or drainage ditch excluding road-side ditch / dugout
- Minimum 30 m from the landfill property line
- Minimum 450 m from residential property

1.3 Development History

1.3.1 Site

The facility consists of the following historical developments:

- Phase II – Class II municipal waste disposal area
- Phase IV – Class II municipal waste disposal area
- Class III disposal area
- Hydrocarbon Contaminated Soils (HCS) treatment area
- HCS – Class II disposal cells

Table 2 provides a summary of the development of the landfill disposal cells.

Table 2 Landfill Development Summary

Cell Number and Phase	Approximate Capacity	Waste Accepted	Liner Design	Notes
Identified as Cells 1, 2, 3 and 4. HCS	Unknown, temporary storage of hydrocarbon contaminated soils	Quantity unknown, used from 1989 to 2000 to treat HCS soils, treated soils used as MSW daily cover	[1]Constructed with 0.5 and 1.0 m thick liners and perimeter berms satisfying a minimum hydraulic conductivity of $1x10^{-7}$ cm/sec.	Not in use since 2001. ROC facility installed in 2010.
Phase II	Estimated 1,450,000 m^3	Estimated 1,305,000 m3, or 920,000 tonne at waste density of 700kg/m^3	[2]Unlined, leachate drains to MH 1. North end of the cell has a liner installed.	South sloping face closed 2008. The current design is 600 mm compacted clay 400 mm subsoil (uncompacted clay) 200 mm topsoil
Phase III	N/A	Never Developed	N/A	
Phase IV	[3]Estimated 3,930,939 m^3	1,169,271 tonne @ 750kg/m^3 = 1,559,028 m^3	1 m CCL and single leachate pipe down the centre	" "
Class III	unknown	unknown	Unlined	Planned for closure in 2013
HCS Disposal Cell 5 & 6		191,122 tonne @1500 kg/m3 = 286,683 m^3	1 m CCL	The current design is 600 mm compacted clay 400 mm subsoil (uncompacted clay) 200 mm topsoil or TBD

Notes: 1 City of Lethbridge Approval Renewal Application, Response to AENV "Issues for Clarification" July 6, 2006; EBA Engineering Consultants Ltd
2 Design Basis Report, Lethbridge Regional Landfill, Lethbridge, Alberta, September 1996; EBA Engineering Consultants Ltd
3 Site Development, Staging Plan Projection, Lethbridge Regional Landfill, July 2005; EBA Engineering Consultants Ltd

The Phase II landfill area is located in a coulee that extends from the County Road allowance, Twp Rd 10-0, to the junction of another coulee at the north end of the SW ¼ 4-10-21-W4M. Landfilling in Phase II commenced in 1985.[1]

The Phase III landfill area was never developed. Instead, there was a revised development plan issued involving the Phase IV area as outlined in the Design Basis Report, Lethbridge Regional Landfill, Lethbridge, Alberta, September 1996; EBA Engineering Consultants Ltd. An Approval, No. 19028-00-02, dated April 15, 1997 was issued by Alberta Environment for the revised landfill design.

In 2000 the operation of the landfill was acquired by the City of Lethbridge from Kedon Waste Services Ltd, The Approval for the landfill operation was transferred to the City of Lethbridge as per Consent To Transfer Approval 71535-00-00 dated May 1, 2000, issued by Alberta Environment.

The landfill is presently operating under an approval issued by Alberta Environment Sustainable Resource Development (Alberta Environment) to the City of Lethbridge, Approval No. 19028-01-00, dated October 26, 2006. The Approval has an expiry date of October 25, 2016.

[1] *Design Basis Report, Lethbridge Regional Landfill, Lethbridge, Alberta September 1996, EBA Engineering Consultants Ltd.*

1.3.2 Engineering

1.3.2.1 Phase II

Based on information contained in Design Basis Report, Lethbridge Regional Landfill, Lethbridge, Alberta, September 1996, by EBA Engineering Consultants Ltd., prepared for Kedon Waste Services Ltd., the following design elements were provided in Phase II:

1. To facilitate closure of Phase II an engineered containment berm was constructed at the north end in the coulee. The containment berm closed off Phase II development and facilitated Phase IV development.
2. The lower end of the coulee was utilized for both Phase II and Phase IV development, therefore a liner was constructed at the base of the entire coulee system, upstream of the containment berm. The upstream face of the containment berm was also constructed as liner. The liner was constructed of select clay material placed within -1% and +4% of the optimum moisture content, to a minimum of 95% Standard Proctor Maximum Dry Density (SPMDD).
3. A leachate collection sump and manhole (MH1) was constructed to collect and remove any leachate generated in Phase II and Phase IV.

Based on known historical information Phase II has no engineered liner or leachate collection system other than what has been described above.

1.3.2.2 Phase IV

The Phase IV development is designed with a 1.0 m compacted clay liner and leachate collection system. The Phase generally has the following features.

1. Cell bottom elevation set from the Cell 1 elevation sloping upgradient to the south at 1%. This results in the present cells being 30 m below grade. The cells have a 2% crossfall east-west to a central leachate collection pipe.
2. Compacted clay liner constructed to a minimum depth of 1.0 m, meeting the requirement of a hydraulic conductivity of $1x10^{-9}$ metres/second (m/s) or less.
3. The central leachate collection pipe is a 200 millimetre (mm) BOSS 2000 HDPE perforated pipe. The leachate drainage layer consists of scrap tire shred placed to a minimum depth of 450 mm.
4. The leachate pipes drain to two manholes, MH 1 and MH2. MH 1 located at the containment berm is utilized to remove all leachate for the landfill cells. MH 2 is located in Cell 3 at the end of Cell 2.

1.3.2.3 Hydrocarbon Contaminated Soils (HCS) Cells 5 and 6

The hydrocarbon contaminated soils disposal cells are located along the west side of the landfill between Phase II and the power line ROW’s. The cells have the following engineering features.

1. Compacted clay liner constructed to a depth of one metre on the base of the cells as well as along the west slope of the Phase II cell.
2. A 200 mm diameter leachate collection pipe was installed on the base of the liner along the toe of the Phase II disposal cell. The leachate drain pipe is covered with a minimum of 300 mm of washed rock wrapped in a filter fabric.
3. The leachate drain pipe drains to a leachate collection pond located at the north end of HCS Cell 6.

2. Expansion Master Plan

2.1 General

The expansion of the LWRC involves the following:

1. Vertical expansion over the approved landfill Cells Phase II and Phase IV from the presently approved maximum elevation of 910 m above sea level (mASL) to approximately 927 mASL
2. Lateral expansion of the landfill into the SE ¼ Sec 4, Twp 10, Rge 21, W4M and the NE ¼ Sec 4, Twp 10, Rge 21, W4M. to a maximum elevation of approximately 927 mASL
3. Relocation of existing infrastructure
4. Staged storm water management
5. Staged closure of the landfill
6. Providing a minimum of 50 additional years of disposal capacity

The present active landfill area is identified as stage 4 on Drawing 00-C-1002.

The proposed future development stages consist of eight (8) in-ground excavation stages and six (6) above ground stages. The in-ground stages, 5, 7A, 7B, 9A, 9B, 11, 13, and 15, are illustrated on Drawing 00-C-1002. The proposed above ground stages, 6, 8,10,12,14, and 16, are illustrated on drawing 00-C-1003.

Drawings 00-C-1009 through 00-C-1021 provide a three dimensional image of each development stage and a three dimensional image of the overall landfill development.

2.2 Population and Waste Projections

To determine the estimated life of the proposed expansion an analysis of waste generation and population growth was undertaken. The following tables provide historical population growth for the landfill's contributing municipalities and the waste disposal growth. The tonnage data has been recorded by the Landfill operators and reported in the Lethbridge Regional Landfill Annual Reports prepared by the City of Lethbridge.

2.2.1 Historical Population

Table 3 provides the historical population data for the main contributing communities to the LWRC.

Table 3 Population Data

Community	Estimated Population						% Population Increase	
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**05-10**	**09 -10**
City of Lethbridge	77,202	78,713	81,692	83,960	85,492	87,882	13.8	2.8
County of Lethbridge	9,930	9,930	9,930	9,930	10,302	10,302	3.7	0
Town of Coaldale	5,941	6,104	6,104	6,104	6,943	6,943	16.9	0
County of Vulcan	3,778	3,778	3,778	3,778	3,830	3,830	1.4	0
Town of Vulcan		1,762	1,762	1,762	1,940	1,940	10.1	0
Town of Coalhurst	1,493	1,493	1,493	1,493	1,810	1,953	30.8	7.9
Town of Picture Butte	1,610	1,701	1,701	1,701	1,592	1,658	3	4.1
Village of Nobleford	679	676	676	676	877	877	29	0
Village of Barons	295	294	294	294	297	326	10.5	9.7
TOTALS	**100,928**	**104,451**	**107,430**	**109,698**	**113,083**	**115,711**	**14.6**	**2.3**

From population data, the population of the main contributing communities has increased, on average, between 2% and 3% per year over the past six years.

2.2.2 Historical Waste

Table 4 provides the historical waste delivery to the landfill based on the source of the waste by municipality.

Table 4 Waste Delivery by Source

Community	Tonnage Delivered						
	2005	2006	2007	2008	2009	2010	2011
City of Lethbridge	82,975	89,382	99,473	103,608	101,413	104,202	108,677
County of Lethbridge	6,475	6,444	7,625	9,083	4,860	5,583	7,371
Willow Creek Municipal District	1,642	1,860	1,181	741	496	668	1,230
Town of Coaldale	3,550	2,948	2,905	2,884	2,941	3,136	3,111
Town of Coalhurst	595	548	633	650	538	566	655
Village of Barons	98	102	95	136	114	173	112
Chief Mountain - Raymond	292	331	282	649	668	722	1,230
Siksika Nation	1,704	1,353	244	203	79	222	0
County of Vulcan	2,400	2,556	2,798	2,962	3,104	3,037	2,716
County of Taber	21,568	6,885	6,754	6,776	5,855	2,014	40,671
Haves/Enchant/Grassy Lake	403	403	462	476	176	93	58
Vauxhall	591	586	579	586	48	233	320
East Kooteney	8,561	8,955	8,698	8,809	5,418	0	0
TOTALS	130,854	122,353	131,729	137,563	125,710	120,649	166,151

From the historical data the volume of waste managed by the facility has grown by 27% from 2005 for an average of 3.9% per year over the seven year period.

Table 5 provides the breakdown of the amount of wastes managed by the various management units at the facility over the past seven years. The information is from Annual reports filed with Alberta Environment.

Table 5 Waste by Management Area

Volume of Waste Received (tonnes)							
Waste Type	2005	2006	2007	2008	2009	2010	2011
Class II Landfill	109,340	121,022	140,211	144,489	136,053	128,332	117,037
Class III Landfill	1,684	2,145	1,218	3,073	4,477	3,312	2,744
HCS Soil	16,807	17,648	23,958	45,581	17,806	72,028	42,305
Organics	2,033	2,173	47	-	-		
Liquid Waste	990	1,150	1,180	1,535	1,977	1,766	217
Recyclables	225	12,100	5,883	4,090	4,283	3,118	626
Composting Area					1	878	4096

2.2.3 Waste Types Accepted

The facility accepts solid non-hazardous residue and waste from residential, commercial and industrial sources from the contributing municipalities, and from construction and demolition generators. Non-hazardous contaminated soil is typically received directly from industrial and commercial sources and from "upstream" and "downstream" petroleum industry sources in compliance with Energy Resources Conservation Board (ERCB) and Alberta Environment. Leaf and yard wastes are received from the City of Lethbridge program and managed at the compost facility. A household hazardous waste (HHW) drop off facility is provided as well as recycle drop off facility for scrap tires and e-wastes. Facilities are provided for the drop off and recycling of concrete and asphalt.

The waste types identified in the annual report include the following:

Mixed Solid Waste	Grain dust	Ashes	Freon
Demolition	Sludge	Car Wash Sump	Metal
Concrete	City Sludge	Asbestos	Tires
Asphalt	Industrial Sump	Creosote	Grass/Leaves
Shingles	Mud	Contaminated Soil	Wood (Green, White, Chip)
Iron Dust	Clay	Clean Fill	Manure
Paint solids	Packing House	Computers and TV's	Compost
Casting Sand	Industrial Process	Other Recycle	Straw
Other, Special	Mustard Hulls	Non Freon	

2.3 Class II Landfill Design

2.3.1 Design Approach

The design of the Class II landfill is based on developing a facility that meets the regulatory criteria established by provincial and municipal requirements. The design was developed in accordance with applicable provincial and municipal regulations and bylaws, with specific reference to:

- Standards for Landfills in Alberta (SLA), February 2010
- The Standards for Composting Facilities in Alberta
- Waste Control Regulation 192/96, Environmental Protection and Enhancement Act
- Subdivision and Development Regulation 43/2002, Municipal Government Act
- Nuisance and General Sanitation Regulation 243/2003, Public Health Act
- County of Lethbridge Landuse Bylaw

2.3.2 Design Criteria

The following design criteria are used to develop the design of the expansion of the Class II Landfill and ancillary facilities:

- Minimum landfill site life: 50years
- Annual waste growth: 2% per year, based on historical growth as provided in Table 3
- In place waste density: 0.720 tonnes per cubic metre (m^3)
- Waste to soil ratio: 4:1
- Maximum of 4 horizontal to 1 vertical (4H:1V) above ground side slopes
- Minimum 5% top slopes
- Maximum 2H:1V below ground side slopes

- Typical maximum excavation depth: 20 m
- Berms construction around waste cells: height 3 m 4:1 outside slopes, 2:1 inside slopes to match excavation slopes
- Maximum design elevation, excluding final cover: 927 mASL

2.3.3 Landfill Development Limits

The development of the landfill is constrained by setbacks as detailed in the following Table 6. The setbacks are also illustrated on Drawing 00-C-1002.

Table 6 Regulatory Requirements

Constraint	Relevant Regulatory Document	Use	Design Consideration
Land subject to slope failure	SLA s2.1(a)	Development to be 100 m from un-stable slopes	Slope stability analysis to be completed to determine minimum distance from top of bank.
A natural area that permanently contains water such as a lake, river or creek	SLA s2.1(a)	To exclude landfill development within 300 m of a permanent body of water	Landfill development is more than 300 m form the Oldman River
A man-made surface feature that permanently contains water such as an irrigation canal drainage ditch but not a road-side ditch or dugout	SLA s2.1(a)	To exclude development of a landfill within 300 m of a man-made feature that contains water. This restriction does not apply to laterally expanding landfill that existed prior to September 1, 1996.	The landfill development falls within 300 m of the SMRID irrigation canal, however the landfill is exempt as the landfill existed prior to the September 1, 1996 date.
Must not be situated within a ravine, coulee, or gully	SLA s2.1(c)	To exclude development of landfills within ravines, coulees or gullies	The proposed lateral expansion does not occur in any ravine, coulee or gully.
30 m separation between waste footprint and landfill property line	SLA s3.1(b)(ii)c. SLAs5.5(a)	To establish landfill compliance boundary	Landfill footprint developed to maintain the required setback from property lines.
Residence, Hospital, Food Establishment, School	Subdivision and Development Regulation 43/2002 s13(4)	Requires that a landfill working area must be at least 450 m from the property line of a residence, hospital, food establishment, school, or building site proposed for same establishments	The landfill development working area has been established to maintain the required setback. “Working area” is defined as those areas that are currently being used or that still remain to be used for the placing of waste material.
Highways	Highways Development and Protection Regulation 326/209 s4(1)	To control development within specified distances from the different highway classifications. For a minor provincial highway a permit is required for a development within 150 m beyond the limit of the highway, or within 400 m from the centre point of the intersection of the highway and another highway	Due to the location of SH 843(43 St) a development permit is likely required from Alberta Transportation.

Airports	Lethbridge Airport Zoning Regulations C.R.C.,c.92 March 6, 2012	Restrict development around the airport	The landfill falls outside of the Regulation control area and is also outside of the 8 km zone for landfill development restriction as recommended in Transport Canada Wildlife Bulletin No. 14
Public Roads	County of Lethbridge Landuse Bylaw No. 1211	Restricts development adjacent to county roads. No development within 38 m of the centerline of a county road.	All development will be outside of the setback area.
Water wells	Nuisance and General sanitation Regulation 243/2003 S15(2)(e)	No landfill can be located where waste will be disposed within 450 m of a water well	No water wells are located within 450 m

2.3.4 Landfill Capacity

There are factors that will impact future waste production and landfill disposal requirements, and the ultimate landfill site life. Some of the factors that could affect the site life are:

- Implementing a waste reduction strategy as per the City of Lethbridge Comprehensive Waste Diversion/Waste Prevention Master Plan (Sonnevera, May 2008)
- Economic development opportunities
- Alberta Landuse Act – Regional Planning – South Saskatchewan Basin – is just initiating but may include waste management
- Waste diversion activities in contributing municipalities
- Alberta Environment waste reduction strategies, Too Good to Waste
- Contaminated sites (soils) reclamation
- Alberta Environment reclamation requirements
- Development of private waste disposal and recycling companies
- Environmental disasters and emergency response wastes (eg. mass carcass disposal, tornado, and floods)

For design purposes it is recommended that a conservative approach be taken. Waste projections will be based on a status quo approach, with no factoring for waste diversion strategies. This approach will provide a 50 year site life requirement. Any reductions in waste disposal requirements realized through waste diversion strategies will result in extended site life.

To develop the site life projections and site phasing the following assumptions are used.

- Annual waste growth (based on historical population and waste growth): 2% per year
- In place waste density (based on past performance): 720 kilograms per cubic metre
- Waste to soil ratio: 4:1

The City of Lethbridge established a minimum landfill site life criterion of 50 years to allow the City to effectively manage the long term waste disposal needs of their stakeholders. The maximum waste elevation of the site was developed through the public consultation process, and considering set back requirements, the depth of the landfill was established to create the required landfill disposal airspace.

Table 7 provides the breakout of the estimated total landfill capacity based on the proposed footprint.

Table 7 Landfill Capacity

Description		Capacity
1.	**Gross Airspace** **Volume of landfill between top of clay liner and top of final waste elevation**	22,125,683 m^3
2.	**Less Cover Soil** **Allowance of cover soil estimated at 20% (4:1 waste to soil ratio)**	4,425,137 m^3
3.	**Net Airspace (cubic metres)**	17,700,546 m^3
4.	**Net Airspace (tonnes)** **Based on waste in place compacted density of 720kg/m^3**	12,744,393 tonnes

The following table provides the estimated site life projection along with the estimated phased cell construction sequence.

Table 8 Site Life Projections

Year	Projected Annual Waste (tonnes)	Airspace (tonnes at year end)	Staging	Stage Airspace (tonnes)
2009	136,053			
2010	128,332	423,155	**airspace in Phase 4 (Existing)**	
2011	117,037	306,118		
2012	119,378	186,740	Construct 5	
2013	121,765	645,495	**add Stage 5**	**580520**
2014	124,201	521,294		
2015	126,685	394,610		
2016	129,218	265,391		
2017	131,803	133,589		
2018	134,439	1,525,071	**add Stage 6 (**vertical expansion over Phase II)	**1525921**
2019	137,127	1,387,944		
2020	139,870	1,248,074		
2021	142,667	1,105,406		
2022	145,521	959,885		
2023	148,431	811,454		
2024	151,400	660,054		
2025	154,428	505,626		
2026	157,516	348,110		
2027	160,667	187,443		
2028	163,880	23,563	need to construct 7A	
2029	167,158	453,492	**add Stage 7A**	**597086**
2030	170,501	282,991		
2031	173,911	109,080	need to construct 7B	
2032	177,389	403,332	**add Stage 7B**	**471641**
2033	180,937	222,395		

2034	184,556	37,839		
2035	188,247	375,854	**add Stage 8**	**526261**
2036	192,012	183,842	need to construct 9A	
2037	195,852	429,615	**add Stage 9A**	**441625**
2038	199,769	229,846	need to construct 9B	
2039	203,764	547,258	**add Stage 9B**	**521176**
2040	207,840	339,419		
2041	211,996	807,239	**add stage 10**	**679817**
2042	216,236	591,003		
2043	220,561	370,442	need to construct 11	
2044	224,972	921,676	**add Stage 11**	**776206**
2045	229,472	692,204		
2046	234,061	458,143		
2047	238,742	744,875	**add Stage 12**	**525474**
2048	243,517	501,358	need to construct 13	
2049	248,387	1,121,448	**add Stage 13**	**868478**
2050	253,355	868,093		
2051	258,422	609,671		
2052	263,591	760,636	**add Stage 14 &** need to construct 15	**414556**
2053	268,863	2,706,306	**add Stage 15**	**2214533**
2054	274,240	2,432,067		
2055	279,725	2,152,342		
2056	285,319	1,867,023		
2057	291,026	1,575,997		
2058	296,846	1,279,151		
2059	302,783	976,368		
2060	308,839	2,845,476	**add Stage 16**	**2177946**
2061	315,015	2,530,460		
2062	321,316	2,209,145		
2063	327,742	1,881,402		
2064	334,297	1,547,106		
2065	340,983	1,206,123		
2066	347,802	858,320		
2067	354,758	503,562		
2068	361,854	141,708		
2069	369,091	-227,382		
2070	376,473	-603,855		
2071	384,002	-987,857		

The proposed landfill footprint is partitioned into development stages. Table 9 provides the development stages with estimate capacity and disposal life.

Table 9 Development Staging

Stage	Gross Airspace Volume Cubic metres	Airspace less Cover Soil Cubic metres	Net Airspace (waste density 720kg/m^3) Tonnes	Estimated Life years
4 **– existing Stage IV**	734,644	587,715	423,155	1 - (- 2013)
5 **– cell 5 Stage IV**	1,007,848	806,278	580,520	5 - (2013 – 2018)
6 **- over Stage II**	2,649,168	2,119,334	1,525,921	11 – (2018 – 2029)
7A **– in ground**	1,036,607	829,286	597,086	3 – (2029 – 2032)
7B **– in ground**	818,821	655,057	471,641	3 – (2032 – 2035)
8 **– above ground over 7**	913,647	730,918	526,261	2 – (2035 – 2037)
9A **– in ground**	766,710	613,368	441,625	2 – (2037 – 2039)
9B **– in ground**	904,819	723,855	521,176	2 – (2039 – 2041)
10**- above ground over 9**	1,180,237	944,190	679,817	3 – (2041 – 2044)
11 **– in ground**	1,347,579	1,078,063	776,206	3 – (2044 – 2047)
12 **– above ground over 11**	912,281	729,825	525,474	2 – (2047 – 2049)
13 **– in ground**	1,507,774	1,206,219	868,478	3 – (2049 – 2052)
14 **– above ground over 13**	719,716	575,773	414,556	1 – (2052 – 2053)
15 **– in ground**	3,844,676	3,075,741	2,214,533	7 – (2053 – 2060)
16 **– above ground over 15**	3,781,156	3,024,925	2,177,946	11 – (2060 – 2069)
TOTALS	**22,125,683**	**17,700,546**	**12,744,393**	**57**

The estimated life of each stage is based on the assumptions presented in 2.3.2 Design Criteria, and waste generation as developed in Table 9. The actual stage life realized will be dependent on the actual waste volume delivered to the landfill for disposal, compacted waste density, and amount of cover soil used.

2.3.5 Soils Balance

All soils materials generated from site excavation activities will be stockpiled for future use in site reclamation (closure), landfill berm construction, and daily cover and intermediate cover requirements. As the will have a surplus of clay soils the clay material may be sold to outside users.

Top soil and subsoil will be preserved for use at final closure. For the borehole logs it is estimated that the topsoil layer is approximately 200 mm thick. There is no apparent identification of a subsoil layer.

Table 10 provides the estimated soil balance for the proposed expanded site. The soil balance does not take into account any of the existing material that is in stockpile on the north end of the site.

Table 10 Soils Balance

Description	Clay volume (m^3)	Topsoil volume (m^3)	Total Soil Volume (m^3)
1. Excavation volume, existing ground to cell subgrade	8,650,000	44,500	8,694,500
2. Removal from future administration/ operations area	20,000	7,000	27,000
3. Total excavated soils available	**8,670,000**	**68,500**	**8,738,500**
4. Clay liner requirement	343,000		343,000
5. Final cap requirement (assuming ET Cover at 2 meter depth of clay and 150 mm topsoil)	1,400,000	103,000	1,503,000
6. Cover soil requirement (daily & intermediate at 4:1 ratio	4,450,000		4,450,000
7. Operational (cell perimeter berm) requirement	110,000		110,000
8. Screening berm requirement	90,000	5,300	95,300
9. Total soils requirements	**6,393,000**	**108,300**	**6,501,300**
10. Soils Balance: surplus (+) / deficit (-)	**+2,277,000**	**-39,800**	**+2,237,200**

2.4 Site Infrastructure

Drawing 00-C-1004 illustrates the proposed staged relocation and development of the various existing and expanded site infrastructure components.

2.4.1 Site Entrance

The existing site entrance is off of Twp Road 10-0, with all landfill traffic encouraged to access the landfill from 28 Street. All traffic enters the site through a gated entrance that is locked when the site is not in operation. The off-site access roads, 28 Street and Twp Rd 10-0 are paved to the landfill entrance. All on site access roads past the scale and to public drop off areas are paved. Typical site traffic consists of waste haulage vehicles, contaminated soil haulers, waste self haul customers, customers accessing the recycle drop off area and household hazardous waste (HHW) drop-off depot, employees, service vehicles, and visitors. Signage at the entrance provides facility information, hours of operation, acceptable/unacceptable wastes, contact personnel and phone numbers.

It is anticipated the present site entrance will stay at this location until year 2030-2032 when site infrastructure will be relocated to the east of the site.

2.4.2 Scale House

All site customers delivering wastes for disposal or recyclable materials, as well as all site visitors, are required to report to the Scale House. The scale house structure is located between the in-bound and out-bound scales. The electronic truck scales record all inbound waste materials for disposal as well as materials directed to the public drop-off area, recycle material storage areas, and compost pad. The out-bound scale records empty vehicle weights and the weights of all out-bound recycle materials. The scale operator records waste source/customer, and waste type in the computerized scale data base. The scale house is also the first level of waste screening and acceptance for detecting the presence of unacceptable wastes in customer loads, and directing the customer to the appropriate disposal/drop-off area.

The scale facility will be moved in year 2030-2032 when the site entrance is relocated.

2.4.3 Public Drop-Off Centre

The Public Drop-off Centre is available to area residences for the drop off of designated products. The centre is accessible via the scale house to control the entry and confirm that only acceptable materials are dropped off. The centre consists of designated storage containers, storage compounds and a roofed structure. All bins and storage compounds are labeled for the designated materials which include: cardboard, paper products, clear glass, plastics, scrap metal, appliances, electronic wastes, household hazardous wastes (HHW), paint, used motor oil, used cooking oil, scrap tires, clean wood, propane bottles and car batteries. As accumulated quantities warrant, the materials are moved off site to recycling facilities or other appropriate facilities for further management.

The Public Drop-Off Centre will be relocated in year 2030-2032 when the site entrance and scale is relocated.

2.4.4 Compost Area

A compost pad, complete with a pad run-off storage pond, is located to the north of the scale facility. The compost feedstock includes leaf and yard waste, branch and tree trimmings and clean wood. The facility is managed as a static pile windrow compost operation. The branch and tree trimmings and clean wood are chipped for further use. The pad is designed and constructed in compliance with Alberta Environment's Code of Practice for Compost Facilities.

The compost pad will require relocation in year 2027 to provide the area necessary for the construction of Phase 7A and 7B. It is proposed to relocate the facility first to an area to the east of the existing scale house to keep the facility in close proximity to the scale house. The facility will then require relocation in year 2039-2040 when the entrance facility is relocated.

The compost pad area is to be designed to meet the following City of Lethbridge compost targets:

- Grass: 2,000 TPA (tonnes per annum)
- Yard trimmings (green wood): 3,000 TPA
- Municipal Solid Wastes (MSW) organics: 5,000TPA

Based on this composting objective, the composting area will require an area of approximately 13,000 square metres (m^2) for a windrow composting facility.

2.4.5 Concrete and Asphalt Recycling

An area has been designated for the acceptance, storage and processing of waste recyclable concrete and recyclable asphalt. The materials will be stored until there are sufficient quantities to crush the material for beneficial re-use.

The storage and processing area will be relocated in year 2013 to the east of the scale house to allow construction of Phase 7A and 7B. It is proposed that the C&D recycling operation will remain at this location until approximately 2047. In 2047 the operation will be relocated to the area east of Stage 9B.

2.4.6 Administration Building and Indoor Tipping Facility

The administration building and indoor tipping facility is one building located to the west of the scale facility. The administration portion of the building houses the maintenance facility and staff amenities. The maintenance facility provides bays to allow routine repair and maintenance of site equipment and the staff amenities include office space, lockers, showers, lunch room and training/meeting room.

The north end of the building contains the indoor tipping facility. This facility houses a high capacity baler for the baling of MSW wastes. During high wind conditions MSW waste loads are directed to this facility for tipping of waste onto the tipping floor and subsequent baling. The baled and plastic wrapped waste is then hauled and placed into the active tipping face. This procedure is followed during high wind conditions to mitigate the windblown litter issue.

The administration and Indoor tipping facility will be relocated along with the entrance facility in year 2030-2032.

2.4.7 Waste Liquids Management

Until 2012 liquid car wash sumps wastes were accepted and managed in a liquid dewatering lagoon. In 2012, to facilitate the construction of Phase IV cell 5A the dewatering lagoon was decommissioned. Car wash sump water is now managed at the waste water treatment plant and only the dewatered residual accepted at the landfill. This waste, which still has a liquid content and may not pass the paint filter test, will be disposed of directly at the working face.

2.4.8 Class III Disposal Cell – Construction and Demolition Management

The existing Class III Disposal Cell located in a coulee fill on the west side of the facility is being reclaimed and the final cap constructed in 2012. A new Class III Disposal Cell will not be constructed. Recyclable concrete and asphalt will be diverted to the concrete and asphalt recycling area. A new construction and demolition management area will be developed on the east side of the expansion area in 2013/2014. This facility will be developed to accept drywall, shingles, and recyclable wood waste. In the future other acceptable recyclable debris will be accepted as demand and markets emerge. All other construction and demolition debris not acceptable for management and recycling will be disposed of in the class II cells.

2.4.9 Hydrocarbon Contaminated Soils (HCS) Disposal

HCS soils are presently accepted and disposed of in cells identified as Industrial Cell 5 and Industrial Cell 6 on the west side and abutting the Phase II area. An additional disposal cell, Industrial Cell 7 will be developed north of Cell 6 and abutting the west face of Phase II. The master plan provides for the development of additional HCS disposal cells along the north end of the site once capacity has been reached in the existing disposal area as indicated in drawing 00-C-1001. Leachate from the HCS cells is managed separately from the MSW leachate.

2.5 Landfill Development

2.5.1 Landfill staging

The landfill development master plan has established the staged sequenced development of the site, beginning with the development of cell 5 at the south end of Phase IV. Cell 5 has been split into two cells with 5A scheduled for construction in 2012. It is anticipated that Cell 5B may not be constructed until airspace in Phase 4 and a large part of Stage 6 has been utilized. Drawings -00-C-1002 to 00-C-1021 provide the staged development of the site. Each below grade stage of the landfill can be divided into “cells” for development and construction. On average it is anticipated that a cell will be developed to provide two to three years of disposal capacity.

As final waste fill elevation is reached, intermediate or final cover will be installed. Once final fill elevation is achieved within Stage 6 it is anticipated final cover will commence with construction of Cell 5B and Stage 7A and 7B. Thereafter it is anticipated that final cover will be completed with the excavation of new cells.

2.5.2 Landfill Cell Base Design and Leachate Collection System

2.5.2.1 Liner System

The lateral expansion of the landfill has been modeled to a nominal excavation depth of 20 mm with excavation side slopes of 2H: 1V. The liner system proposed for both the cell side walls and cell base is a composite clay liner (CCL) system consisting of the following components:

- Prepared subgrade
- Re-compacted clay to a depth of 0.60 m meeting a hydraulic conductivity of 1 x 10^{-9}m/s
- 60 mil HDPE geomembrane placed in direct contact with the clay liner

The liner system could be modified for the cell side walls to be a 1.0 m compacted clay liner transitioning into a CCL system at the base of the cell. The CCL system would extend several metres up the side wall as shown in drawing 00-C-1026.

Using the regulatory requirement of a 30 centimetre (cm) leachate head level on a 1.0 m compacted clay liner with a conductivity of 1 $x10^{-9}$ m/s, Darcy's law shows that a theoretical advective flow through the one metre clay liner is 410 m^3/ha/yr. With the proposed CCL liner system, and the HDPE liner appropriately constructed, the theoretical advective flow, using Giroud and Boneparte (1989) equations, is 0.79 m^3/ha/yr. The Giroud and Boneparte calculation assumed 2.5 circular defects, 2 mm in diameter, per hectare

The base of the landfill is to be designed to provide a hill and valley approach to convey leachate to collection trenches. Generally the valleys will be 60 metres apart with the sides of each valley having a slope of 2%. The base of the landfill will slope to one side at a slope of 0.5 % to 1%. Drawing 00-C-1005 provides a concept plan of the proposed landfill liner base and leachate pipe location. A cross section of the proposed landfill liner base and leachate collection system is provided on drawing 00-C-1022.

2.5.2.2 Leachate Collection System

The objective of the leachate collection system (LCS) is to collect and convey leachate generated in the landfill to collection sumps for removal. The collection system must be designed and constructed to control the depth of leachate to no more than 0.30 m above the liner at the lowest point of the liner (excluding sumps and trenches). The leachate collection system is to be designed as a full underdrain collection system with collection pipes and granular drainage material placed on top of the liner system. A typical section representing the LCS is provided in drawing 00-C-1022. Generally the LCS will consist of the following components:

- Minimum 200 mm diameter perforated HDPE leachate collection pipes spaced at a maximum distance of 60 m apart at the bottom of each liner valley. The grade of the leachate pipe shall be at a minimum slope of 0.5%. The pipes will be complete with vertical risers to facilitate inspection and cleaning of the leachate pipe.
- 300 mm diameter perforated HDPE leachate header pipe, located at the toe of the slope of the liner. Each header pipe is to be installed with a minimum grade of 0.5% to the leachate collection sump and connects the downstream end of each 200 mm diameter collection pipe. Leachate flows by gravity through each collection pipe to the header pipe to the sump.
- Leachate sumps that contain the leachate withdrawal pipes and pumps. Drawing 00-C-1005 shows the proposed leachate sump and pump locations. Drawings 00-C-1023 and 00-C-1024 provide typical sump details.
- Leachate drainage layer installed as a continuous blanket over the base of the landfill. The drainage layer will consist of either rounded drain rock or tire shred.
    - If the drainage layer is granular, the material should be clean screened cobble rock 20 to 40 mm in size placed to a depth of 300 mm minimum above the liner.
    - If the drainage layer is tire shred, the shred should have the following gradation.

Sieve size (mm)	Minimum Passing (% by weight)
300	100
150	95
75	85
50	50

- For the Lethbridge landfill the shred should be placed to a minimum depth of 450 mm to compensate for thickness reduction due to compression. A sand protection layer is to be placed over the HDPE liner to minimum depth of 150 mm.

- Two non-woven geotextiles, one placed directly on top of the cell base HDPE liner as a protection layer, and one laid on top on the LCS drainage material as a separation layer.
- A geocomposite drainage layer placed on the cell sidewalls directly on top of the HDPE liner.

2.5.2.3 Interim Gas Collection

In order to pull gas from the waste mass as soon as possible, the leachate collection system will be utilized as an interim gas collection network. Until the landfill is brought to final elevation and vertical gas wells are installed the leachate collection pipes can be used to effectively draw off gas. A gas header pipe will be installed at the high end of the leachate pipes in stages 7A, 7B, 11, 13 and 15. Gas collection well heads will be installed at the high end of the leachate pipes in Stage 9B which will pull gas from 9A and 9B. Drawing 00-C-1002 shows the location of the proposed gas headers and gas ports. A typical detail of the proposed gas port connection to the leachate cleanout riser and gas header is provided on drawing 00-C-1025. Once the waste reaches a depth of 15 to 20 m in each stage gas can start to be withdrawn.

2.6 Cell Integration

2.6.1 Phase II

The Phase II area of the landfill has no liner or leachate collection system. The landfill is in a coulee with the slope of the coulee to the north. During the construction of Phase IV accommodation was made to allow leachate from Phase II to flow into the Phase IV collection system.

The EBA Engineering Design Basis Report[2] stated that the calculated hydraulic conductivity of the clay till in the area of Phase II was likely to be in the range of 3.8×10^{-6} m/s.

The expansion of the landfill contemplates vertical expansion over the Phase II waste area. Once the additional waste has been placed over Phase II, gas wells will be installed that can also serve as leachate extraction wells. This arrangement will allow the extraction of leachate from the Phase II area should a leachate mound exist or develop due to inadequate drainage into the Phase IV system.

2.6.2 Phase IV

The Phase IV landfill area, Cells 1 to 4, have been constructed with a one metre thick clay liner and leachate collection system. Leachate flows to a central leachate collection pipe where it flows by gravity to the leachate collection manhole. Cell 5A and 5B will be constructed with a clay liner with the leachate from the cells flowing to the south end of Phase IV to a new leachate removal system.

The Phase IV cells have been constructed to a depth of 30 m, and the expansion cells (Stages 7, 9, 11, 13, and 15) will be constructed to a depth of 20 m. The base grades of the expansion cells will be sloped away from Phase IV to minimize the flow of leachate from the expansion area into the Phase IV cells.

2.6.3 HCS Cells to MSW Cells

The City of Lethbridge has developed HCS disposal cells along the west side of the Phase II MSW disposal area. These disposal cells have a clay liner and a leachate collection system independent from the MSW system. To facilitate the expansion of the MSW disposal area it is proposed to continue placing the HCS material against the MSW waste to the elevation of the existing MSW material, approximate elevation of 908 mASL. The western face of the MSW waste will be capped with a one m thick clay liner prior to placing the HCS material against the MSW waste. The HCS material will be placed with a 4:1 exterior (west) face meeting a 3:1 face built from the MSW

[2] *Design Basis Report Lethbridge Regional Landfill Lethbridge, Alberta September 1996 EBA Engineering Consultants Ltd*

material at the approximately elevation 908 mASL. This will bring the HCS material to a peak height of approximately 916 mASL. The exterior 4:1 face (west) will be capped with an appropriately designed Evapotranspiration Cover/Water Balance Cover (ET), or barrier cap as approved. Drawing 00-C-1008 provides the conceptual design for the proposed integration.

2.7 Surface Water Management

The Standards for Landfills in Alberta requires the following:

- A run-on control system to prevent flow onto the active landfill area for events up to at least the peak discharge from a one in 25 year – 24 hour duration rainfall event
- A run-off control system for the active landfill area to collect and control at least the run-off water volume resulting from a one in 25 year – 24 hour duration rainfall event.

2.8 Final Cover System

The Standards for Landfills in Alberta provide that the final cover system shall include slopes at a minimum of 5% and a maximum of 30%. The final cover system is to consist of three layers which are to include:

- A 0.60 barrier layer with a maximum hydraulic conductivity of 1×10^{-7} m/s
- Subsoil
- Topsoil

The standards also allow for an alternative final cover system if approved by the Director.

The landfill is in a unique situation where there will be an excess of excavated soil material and is located in a semi-arid climate. The City proposes to construct an alternative cover system called an Evapotranspiration Cover or Water Balance Cover (ET), which relies on a combination of temporary storage of precipitation in the soil followed by removal of the stored water by evaporation and transpiration. The ET cover system will be designed to transmit equal or less percolation than the conventional barrier cover system. Studies conducted in the U.S have shown that ET covers can provide equivalent or better performance when compared to conventional covers.

To support the acceptability of an ET Cover the City will construct a test section of conventional cover system and appropriately designed ET cover system at the landfill. The amount of percolation through the two cover systems will be monitored for performance and submit to Alberta Environment for Director Approval. The City proposes to construct the cover test sections in 2013 to allow approval of the ET cover system for use in the final capping of a portion of Phase 6 estimated to commence in about 2015.

2.9 End Use

During the public consultation phase of the project the public participants were asked what their vision of the end use of the site should be. As well, the City convened a Technical Steering Committee to discuss the end use options. The general consensus was to develop the site into a natural area park/public space. The site should be developed with plant materials to create a prairie natural habitat. The site should be developed to provide linkage to the river valley and fit into the additional three river valley quarters owned by the City. As the site will not reach closure for over 50 years it was suggested that no formal final closure plan be developed at this time. The site should be developed now to allow linkage to the river valley and the final direction on actual site development be left to the citizens at the actual time of closure.

3. Landfill Gas Management

The scope of the Landfill Gas (LFG) evaluation was limited to an overview of LFG related air emissions. The potential effects of leachate recirculation or bioreactor landfill operation are not considered in this LFG evaluation.

The Alberta Environment template titled "No Landfill Gas Collection" was used to estimate the "k" (methane generation rate) and "Lo" (methane generation capacity) factors for input into both the US EPA LandGEM software and the Alberta Environment gas generation model. LandGEM was used to estimate the LFG generation rate over time; because the projected life of the landfill (from initiation of waste filling in Phase 2 through the proposed expansion) extends beyond the maximum input range of the Alberta Environment template. The projected site life also extends beyond the maximum input range of the LandGEM model. However, the format of the LandGEM output reports allows two overlapping models to be easily summed in a separate Excel® spreadsheet to arrive at the total estimated LFG generation rate over the landfill life.

The basic inputs to the Alberta Environment template and the LandGEM model ("k", "L_o", and annual waste placement rate) are the same. The Alberta Environment template calculates "k" and "L_o" factors based on the local annual precipitation rate and waste composition. Local precipitation rates are those reported on the Environment Canada web site for the "Lethbridge A" station. The waste composition, which is 27.2% paper and textiles, 10.8% garden or park waste, 12.1% food waste, and 7.4% wood or straw is based on the waste characteristics provided in the "City of Lethbridge Comprehensive Waste Diversion and Waste Prevention Master Plan".

The annual waste placement rates from 2009 through 2072 are based on an analysis of the "staged site life" of the landfill which was developed by AECOM Canada as part of the landfill expansion design. That staged site life analysis includes a 2 % annual increase in the waste placement rate.

The estimated waste placement rate from 1985 through 1999 is based on an August 12, 2010 update of a 2009 greenhouse gas (GHG) report for the Lethbridge Waste and Recycling Centre Disposal Site. Page 13 of 15 of the GHG report states: "*Scale records prior to 2000 do not exist. Tonnage was estimated by estimating the volume of Phase II, based on information provided in the Landfill Design Basis Report (EBA 1997). The estimated overall volume is 1,450,000 m^3. It was assumed that 10% of the volume was used by cover soil. Therefore, 1,305,000 m^3 are filled with waste. An in-place waste density of 700 kg/m^3 was assumed to calculate the waste tonnage placed into phase II. Based on all above assumptions, it is estimated that a total mass of 920,000 tonnes of waste was placed into Phase II*".

For the current evaluation, the estimated 920,000 tonnes of waste in place in Phase II was allocated to the years 1985 through 1999, and the same 2 % annual increase used for 2009 through 2072 was applied for 1985 through 1999. Actual waste placement records, as shown in Annual Reports were used for 2000 through 2008.

Comparing the Alberta Environment template output to the LandGEM output, there appears to be very good correlation between the models. The minor variations between the two models are likely due to the different "k" and "L_o" factors used by the two models. Prior to 2006, the "k" and "L_o" factors used by the Alberta Environment template vary annually, based on local precipitation reported on the Environment Canada web site; while the LandGEM model uses a fixed precipitation rate equal to the 30 year mean annual precipitation in Lethbridge, as reported on the Environment Canada web site.

3.1 Air Emissions

The US EPA LandGEM software projects that the peak LFG generation rate may reach approximately 2,606 standard cubic feet per minute (scfm) in 2072. This is equivalent to approximately 311,985 CO_2e tonnes/year (assuming that methane (CH_4) has a Global Warming Potential (GWP) equivalent to 21 tonnes of carbon dioxide (CO_2e), in accordance with page 10 of Alberta Environment's November, 2008 "Technical Guidance for the

Quantification of Specified Gas Emissions from Landfills, Version 1.2"; no LFG is stored in the landfill; and that the LFG is approximately 50 % CH_4 and 50 % CO_2).

In Alberta landfills are required to report LFG emissions upon reaching 50,000 CO_2e tonnes per year and must have a mitigation plan or pay an offset fee once they reach the 100,000 CO_2e tonnes per year threshold. Based on the modeling completed the landfill reached the 50,000 CO_2e (413 scfm) thresholds in approximately 2009, and it is estimated the landfill will reach the 100,000 CO_2e (918 scfm) threshold in year 2026.

3.2 Potential for Beneficial Use of LFG

If Lethbridge chose to pursue a LFG-to-energy project, and we assume that:

1. The waste stream remains consistent,
2. About 75% of the LFG generated by the landfill can be collected and utilized (which is conservative)
3. Conventional large reciprocating engine driven electric generators (rated capacity of 1,600 kilo-Watts (kW), each) will be used.

The Lethbridge Landfill should then be able to generate approximately 1,600 kW beginning in about 2021. Additional generators will be added as the volume of gas generated increases up to a long-term (20-year) sustained average generating capacity of approximately 4.80 mega-Watts (MW) from about 2062 through 2081.

In addition, waste heat can be recovered from the engine/generators to increase the thermal efficiency and, therefore, the economic viability of such beneficial use projects. There are also other alternatives to large reciprocating engine driven electric generators; such as direct use as boiler fuel, smaller reciprocating engine driven electric generators, microturbines, large turbines, cleaning the LFG to pipeline natural gas (NG) quality and producing compressed or liquefied gas (CNG/LNG) vehicle fuel, which could provide additional flexibility to meet economic conditions at the time the beneficial use project is undertaken. Some of these alternatives may also allow earlier beneficial use of the LFG, increasing the total economic and environmental benefits. The structure of the project (for example: a City owned and operated system, versus a contract between the City and a developer; who would construct, finance, own and operate the system) will also affect the capacity and timing of implementation and, therefore, the economics of a LFG beneficial use project. The inclusion of proceeds from the sale of carbon and/or GHG emission reduction credits, and/or reduced penalties for GHG emissions will also affect project economics.

4. Leachate Management

The Scope of the leachate management evaluation includes:

1. An estimate of the rate at which leachate may be generated by the proposed landfill
2. An estimate of the hydraulic head on the base-liner at the bottom of the landfill
3. An estimate of the volume of liquid that would be required to be added to the landfilled waste if the City chooses to pursue a "true bioreactor" operation in the future

4.1 Leachate Generation Rate

The potential leachate generation rate was estimated using the US Army Corps of Engineers Hydrologic Evaluation of Landfill Performance (HELP) model. The HELP model is widely accepted by regulatory agencies throughout the world for estimating the leachate generation rate and the potential hydraulic head on the base-liner at the bottom of the landfill. The HELP model uses local climate data (precipitation, humidity, temperature, average wind speed, average length of growing season, solar radiation, and evapotranspiration) and landfill design data (final cover configuration, average waste thickness, leachate collection system configuration, and base liner configuration) to estimate the rate of surface water run-off, head build-up on the base liner, and leachate generation.

Two leachate generation rate analyses were performed: one for the largest open cell which, theoretically, results in the largest leachate generation rate, and one for the closed landfill which represents a long-term average condition, and is often used to estimate post-closure care costs. Both analyses are used to size leachate pumps and to estimate maximum hydraulic head on the base-liner.

The climate data used with the HELP model is from the same source (Environment Canada, for the "Lethbridge A" station) used to estimate the LFG generation rate. The basic landfill geometry is shown on Drawings No 00-C-1002, 00-C-1003, and 00-C-1005. The characteristics of the final cover, leachate collection layer and base-liner are as follows.

1) **Final cover:** A total of 120 cm of on-site soils, including 20 cm of rooting soil, 40 cm of freeze/thaw protection soil, and 60 cm of barrier soil was assumed. However, the City of Lethbridge is proposing to utilize an E.T. cover system. The intent is to design and install an E.T. cap system that has a performance level that is equal to, or better than, the conventional barrier cap system.

   The maximum drainage length and minimum slope on the final cover are approximately 225 m and 5%, respectively. The steeper slopes at the perimeter of the final cover are not critical to the HELP model, because the increased slope significantly increases run-off and significantly reduces infiltration in those areas. 100% of the final cover area was assumed to contribute to runoff. The evaporative zone depth was assumed to be approximately 30 cm. A maximum leaf area index of 1 was assumed, to represent fair vegetation on the final cover. The long-term effective hydraulic conductivity of the final cover barrier soil was assumed to be approximately 1.0×10^{-3} cm/sec, which accounts for the effects of freeze/thaw and landfill settlement.

   The HELP model uses input provided by the user to calculate runoff curve number (in this case, 91.3) and the initial moisture content of the various soil layers.

2) **Waste Mass:** The average waste mass thickness is approximately 40 m. The waste mass provides a significant amount of moisture storage prior to reaching the point at which water begins to drain from the waste (due to consolidation, settlement, and absorption of liquid by the waste over time), increasing the leachate generation rate. For this reason, two HELP models are run: one for active landfill operations, and a second one representing closed conditions. While the active conditions model has only daily and/or intermediate cover in place; it also has less waste in place and, therefore, less absorptive capacity. The open conditions model is run

for five years which is less than the active life of the area being modeled. The closed conditions model includes a final cover which will significantly reduce the amount of precipitation that gets into the landfill, and the total amount of waste in place at landfill closure is greater than during active waste filling; which provides additional adsorptive capacity. The closed condition model is run for 30 years to account for the gradual release of leachate from the waste mass and to model beyond the 25 year Alberta Environment post-closure care duration.

3) **Leachate collection system:** 30 cm of granular material assumed. The maximum drainage length and minimum slope through the leachate collection layer are approximately 202.24 m and 0.79%, respectively. This is based on the design base geometry, which includes leachate collection pipes spaced approximately 60 m apart, and base slopes of 2% toward the leachate collection pipes and a minimum of 0.5% along the leachate collection pipes to sumps from which leachate is pumped out of the landfill for treatment and disposal. The effective hydraulic conductivity of the leachate drainage layer was assumed to be approximately 0.3 cm/sec. This results in a conservative head build-up evaluation. The head on the liner was checked using the same parameters assuming a bioreactor operation. The model results indicate that the design on the base and the spacing of the collection pipes is adequate for bioreactor operation. The leachate drainage layer assuming a 20 to 40 mm cobble size, with a hydraulic conductivity of 0.3 cm/sec is also adequate for bioreactor operation. However, should the City decide to pursue leachate recirculation and/or bioreactor operation, the granular material must be specified to meet, or provide a greater hydraulic conductivity, of 0.3 cm/sec.
4) **Base-liner:** A protective geotextile, a 1.5 mm high-density polyethylene (HDPE) geomembrane and 100 cm of compacted barrier soil. A “Good” geomembrane placement was assumed for the model which is achievable with modern construction quality assurance methods.

Closed Conditions

Based on the design geometry of the Lethbridge Landfill expansion, the average annual leachate generation rate in the years following placement of final cover is estimated to be approximately 251 cubic meters per hectare per year (m^3/ha/yr). The peak day leachate generation rate during the same post-closure period is estimated to be approximately 22 m^3/ha/day. The “footprint” area of the proposed landfill (including the proposed expansion) is approximately 63.0 ha. Therefore, the estimated total annual average leachate generation rate in the years following landfill closure is approximately 15,813 m^3/yr, and the peak day leachate generation rate is estimated to be approximately 1,386 m^3/day.

Active Conditions

Similarly, the unit leachate generation rate from the largest active landfill, Phase 16, prior to final closure is estimated to be an average of approximately 177 m^3/ha/yr. The peak day leachate generation rate during the same active waste filling period is estimated to be approximately 11 m^3/ha/day. The “footprint” area of the largest active landfill Phase (16) is approximately 21 ha. Therefore, the estimated maximum average leachate generation rate during active waste filling is approximately 3,717 m^3/yr, and the peak day leachate generation rate is estimated to be approximately 231 m^3/day.

Leachate Generation Factors

The leachate generation rate will be affected by the manner in which the landfill is operated. Leachate recirculation and/or bioreactor operation will increase the leachate generation rate during and for some period of time following those modes of operation. Conversely, limiting the amount of open landfilling area, sloping intermediate cover grades to drain away from waste filling areas, and use of effective daily and intermediate cover materials can significantly reduce the leachate generation rate.

4.2 Leachate pump sizing

The eight below grade Stages cover a total of approximately 50.5 ha. Therefore, the average base area of each Stage covers approximately 6.3 ha (50.5 ha divided by 8 Stages equals 6.3 ha/Stage). With the peak daily leachate generation rate estimated at 22 m^3/ha/day, the average peak leachate pumping rate from each Stage of the expansion will be approximately 1.6 liters per second (25.4 US gallons per minute).

For initial cell operations a larger pump will be necessary to accommodate precipitation events until there is at least one complete lift (approximately 4.5 m) of waste in place across a cell for adsorptive capacity.

4.3 Estimated Hydraulic Head on the Base Liner

The HELP model output for the closed and open active conditions, respectively show the estimated hydraulic head on the base-liner to be:

- Under closed conditions: annual average 3.4 mm, and peak day 169.6 mm
- Under open, active, conditions: annual average 2.4 mm, and peak day 92.7 mm

4.4 Estimated Volume of Liquid Required for "Bioreactor" Operation

Based on the mean annual precipitation rate in Lethbridge of approximately 386 mm/yr, the local environment is classified as semi-arid. Assuming that MSW arrives at the landfill with an average moisture content of approximately 21% by weight, and that the field capacity of typical MSW is approximately 41%; the incoming waste has a moisture deficit of about 20% by weight.

Raising the waste moisture content to field capacity (which is widely considered to be the definition of "bioreactor" operation) will require increasing the moisture content by 20%. This equates to the addition of approximately 0.05 m^3 of water per m^3 of incoming MSW assuming that MSW arrives at the landfill at a density of 0.23 tonne/m^3. To operate as a bioreactor the calculations shows that there in not enough leachate generated for circulation and that supplemental liquids ranging from approximately 22,200 m^3/yr for 2013 to 63,900 m^3/yr at landfill closure in 2072 will be necessary. These estimates are based on the average leachate generation rate of 177 m^3/ha/yr, previously discussed in sub-section 4.1, only the expansion cells with liner and leachate collection system could be authorized for bioreactor operations by Alberta Environment.,

The amount of liquid required to operate the landfill expansion as a bioreactor is significant. Increasing the amount of liquid added to the landfill *will* increase the waste decomposition rate. The increased rate of waste degradation results in several benefits of operating as a bioreactor in which there is regained air-space, a degree of waste stabilization which can reduce long-term environmental liability, and an increased rate of landfill gas generation. By simply adding liquid including leachate recirculation, but not achieving field capacity the full benefits of a bioreactor landfill will not be realized. Unless the City can locate and enter into a long-term contract with a generator of liquid waste that can supply the required volume of water, it may not be worthwhile to consider bioreactor operation.

Leachate Disposal

Recirculation of leachate is increasingly being utilized as strategy to manage leachate. Leachate recirculation is the controlled application of landfill leachate to the waste mass. Leachate recirculation has the following benefits:

- Increasing waste degradation and the rate of landfill gas generation where the waste moisture content is favorable to microorganisms
- Increased compaction density
- Delays leachate treatment and disposal costs
- Increases leachate evaporation

The disadvantages of leachate recirculation are:

- Biofowling the leachate collection system
- Concentrated leachate to ultimately treat and dispose

Based on the HELP modeling the proposed landfill design can manage recirculation of leachate. Recirculation should be utilized as a method to dispose of leachate and maximize gas production to optimize the City's ability to collect GHG credits and meet regulatory compliance requirements.

The following recirculation methods are proposed for the landfill.

1) Direct Application on the Working Face

Leachate is sprayed at low pressure on to the active working face on top of the freshly placed waste prior to compaction. Landfilling activities continue as the next loads of waste are placed directly over or adjacent to the waste that has been sprayed. This method is effective as leachate is applied to the surface, requires minimum infrastructure and leachate application can be monitored. This method:

- Effectively adds moisture to waste while minimizing oversaturation and enhances waste compaction as moist waste compacts better than dry waste
- Allows leachate to be applied to a large portion of the waste mass
- Reduces leachate volume through evaporation

2) Surface Pits

Leachate is applied to surface pits that are dug by an excavator in the existing waste. This method allows for the gradual introduction of leachate into the waste. This method should be used away from side slopes to minimize the potential for leachate seeps and side slope instability. The pond can be sized to match the estimated volume of leachate that will be managed. This method:

- Effectively adds moisture to waste
- Allows leachate to be applied to a large portion of the waste mass
- Reduces leachate volume through evaporation

3) Leachate Pond

A leachate pond is also being provided in the master plan development. The leachate pond provides an alternative to immediately recirculating leachate. It provides a method to effectively remove leachate from the cells, store, and allow loading of tanker trucks for transport to a treatment and disposal facility or to a location in the landfill for recirculation. The leachate pond should be constructed with a shallow depth, 2.5 m to 3 m deep, to allow UV penetration and maximize surface area to enhance evaporation and provide some treatment ability. It is recommended that the pond sized to store at least six (6) months of the annual average, after closure, leachate generation amount. Based on this criterion the pond should have a storage capacity of approximately 8,000 m^3. The leachate pond will:

- Allow for ease and timely leachate management, be it recirculation or off site disposal
- Reduce leachate volume through evaporation

Appendix A
Drawings

The City of Lethbridge
Lethbridge Waste and Recycling Centre

Master Plan

LIST OF PROJECT DRAWINGS

00-C-0000	Cover Sheet	00-C-1013	Staging Plan - Cell 8
00-C-1000	Location Plan	00-C-1014	Staging Plan - Cell 9A and 9B
00-C-1001	Existing Site Plan	00-C-1015	Staging Plan - Cell 10
00-C-1002	In-Ground Staging	00-C-1016	Staging Plan - Cell 11
00-C-1003	Above Ground Staging	00-C-1017	Staging Plan - Cell 12
00-C-1004	Infrastructure Staging Plan	00-C-1018	Staging Plan - Cell 13
00-C-1005	Leachate and Gas Management Conceptual Plan	00-C-1019	Staging Plan - Cell 14
00-C-1006	Cross Sections - Sheet 1 of 2	00-C-1020	Staging Plan - Cell 15
00-C-1007	Cross Sections - Sheet 2 of 2	00-C-1021	Staging Plan - Cell 16
00-C-1008	HCS Intigration	00-C-1022	Typical Details - Sheet 1 of 5
00-C-1009	Staging Plan - Cell 4	00-C-1023	Typical Details - Sheet 2 of 5
00-C-1010	Staging Plan - Cell 5	00-C-1024	Typical Details - Sheet 3 of 5
00-C-1011	Staging Plan - Cell 6	00-C-1025	Typical Details - Sheet 4 of 5
00-C-1012	Staging Plan - Cell 7A and Cell 7B	00-C-1026	Typical Details - Sheet 5 of 5

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Issue Date: 2012/07/30

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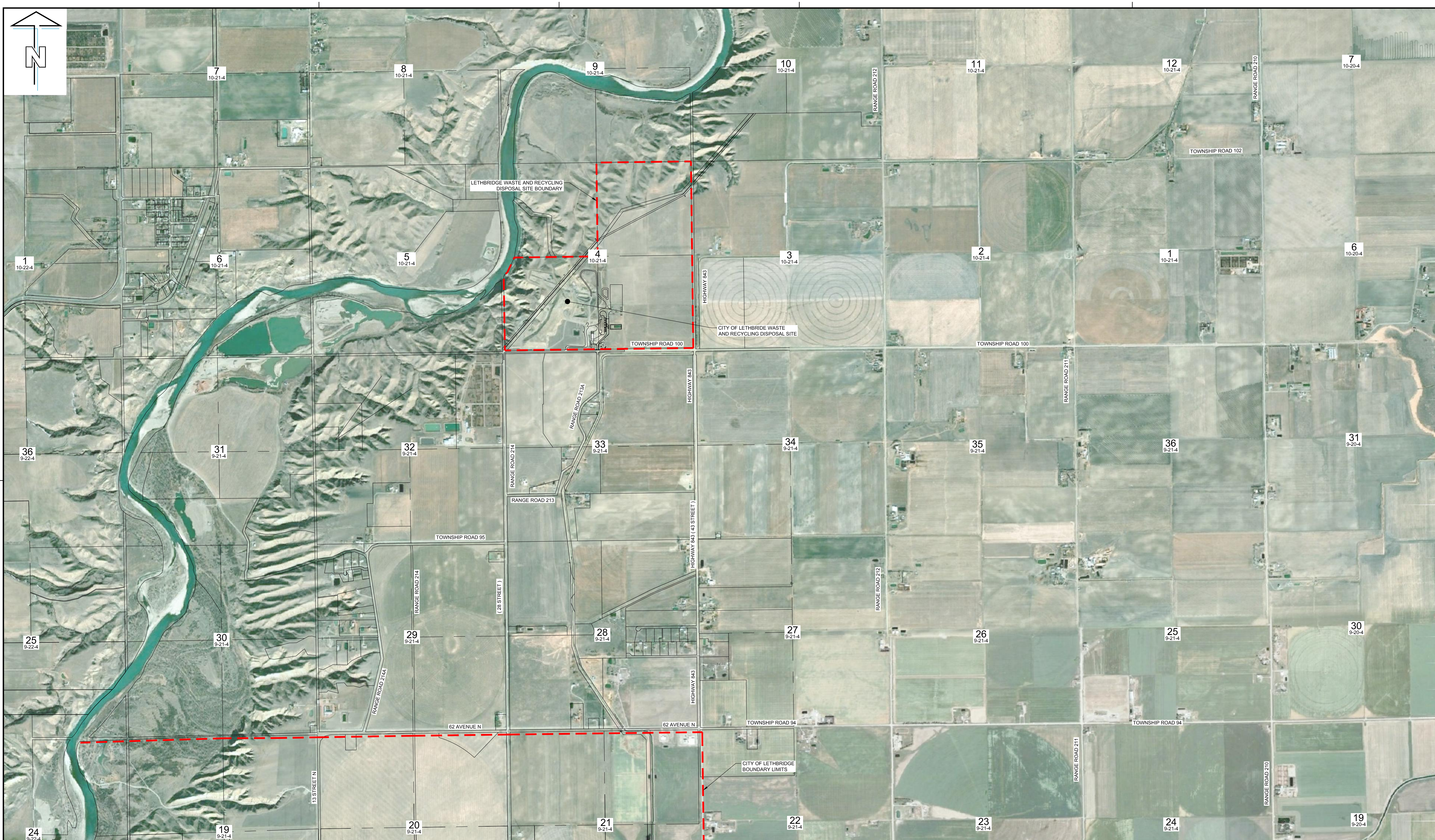

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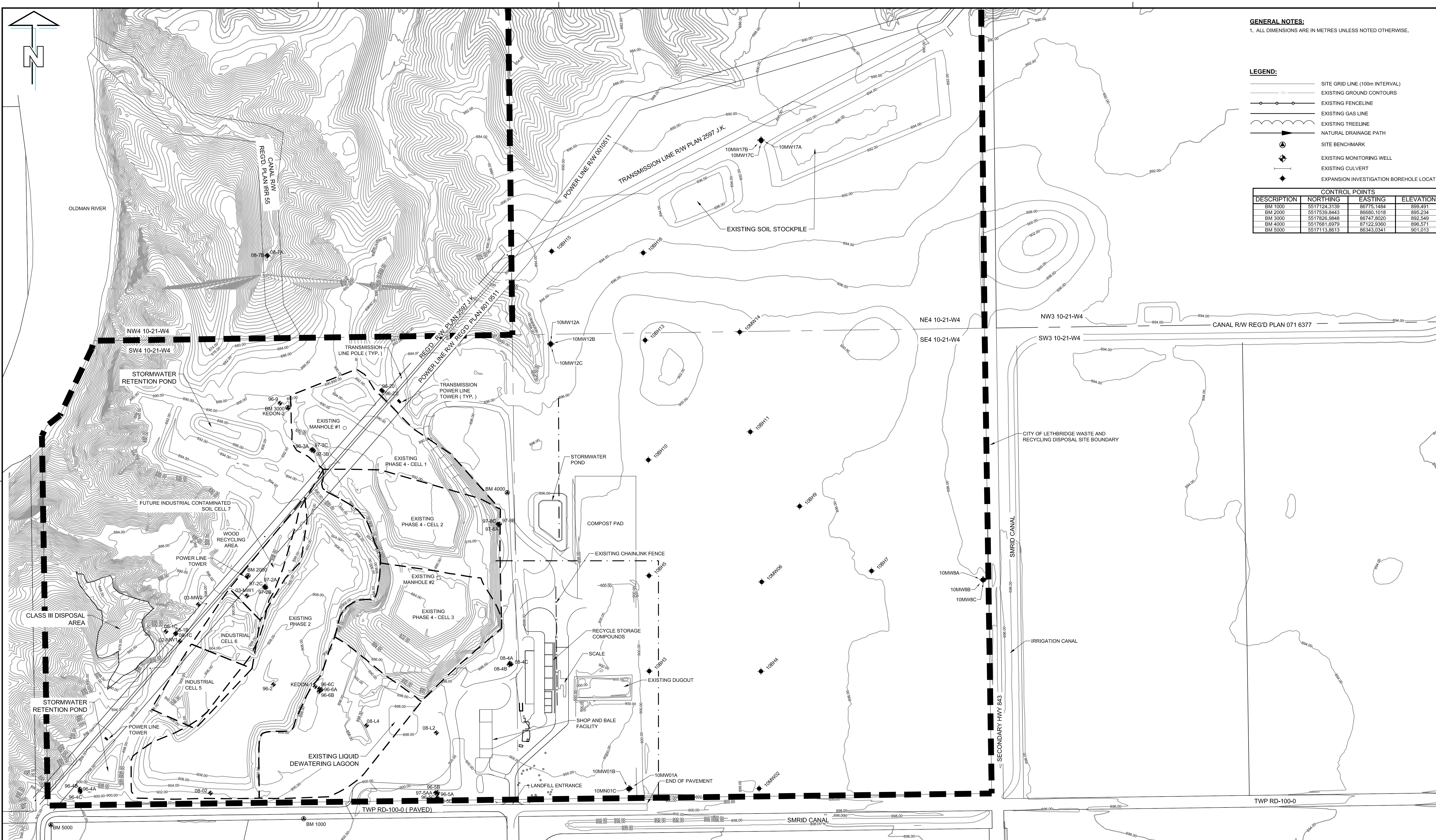
The City of Lethbridge
Lethbridge Waste and Recycling Centre
Master Plan

Location Plan

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
060153727	00-C-1000	C



GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.

LEGEND:

- SITE GRID LINE (100m INTERVAL)
- 791 EXISTING GROUND CONTOURS
- EXISTING FENCELINE
- EXISTING GAS LINE
- EXISTING TREELINE
- NATURAL DRAINAGE PATH
- SITE BENCHMARK
- EXISTING MONITORING WELL
- EXISTING CULVERT
- EXPANSION INVESTIGATION BOREHOLE LOCATION

CONTROL POINTS			
DESCRIPTION	NORTHING	EASTING	ELEVATION
BM 1000	5517124.3139	86775.1484	899.491
BM 2000	5517539.8443	86680.1018	895.234
BM 3000	5517826.9848	86747.8020	892.549
BM 4000	5517681.6979	87122.9360	896.571
BM 5000	5517113.8613	86343.0341	901.013

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Master Plan

Existing Site Plan

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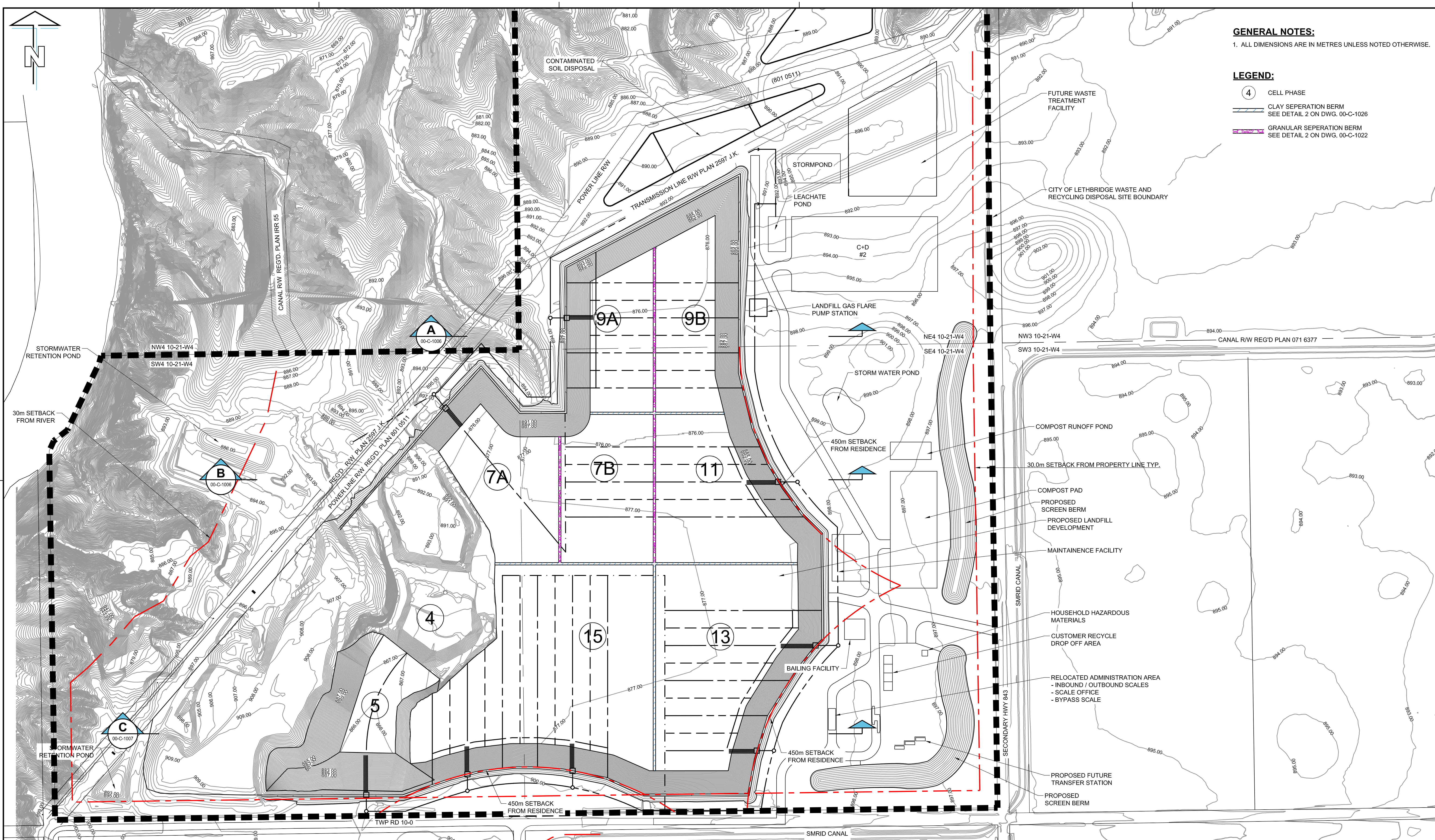

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LEGEND:

- (4) CELL PHASE
- CLAY SEPERATION BERM SEE DETAIL 2 ON DWG. 00-C-1026
- GRANULAR SEPERATION BERM SEE DETAIL 2 ON DWG. 00-C-1022

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In-Ground Staging

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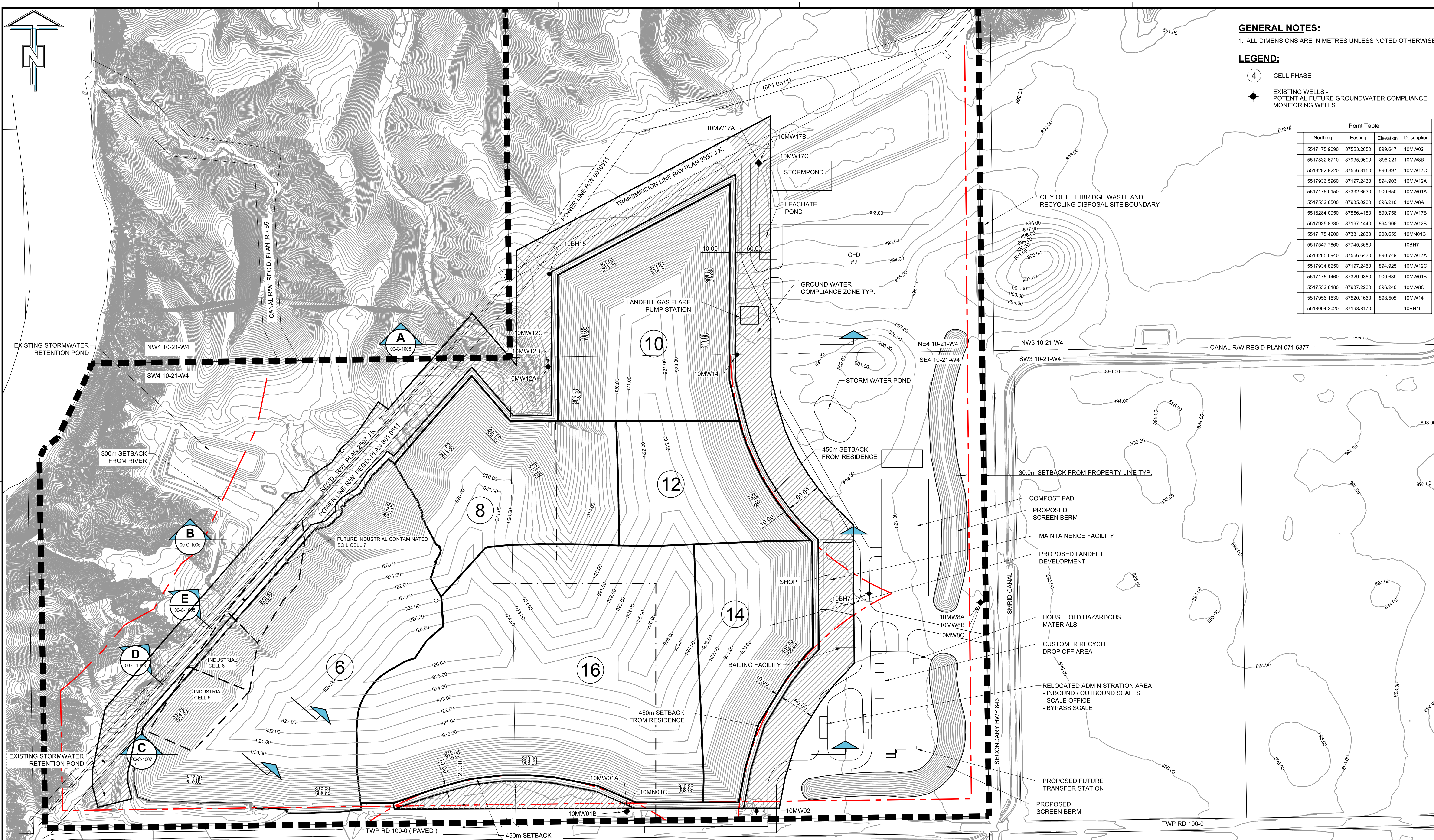

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LEGEND:

4 CELL PHASE

EXISTING WELLS - POTENTIAL FUTURE GROUNDWATER COMPLIANCE MONITORING WELLS

Point Table				
	Northing	Easting	Elevation	Description
	5517175.9090	87553.2650	899.647	10MW02
	5517532.6710	87935.9690	896.221	10MW8B
	5518282.8220	87556.8150	890.897	10MW17C
	5517936.5960	87197.2430	894.903	10MW12A
	5517176.0150	87332.6530	900.650	10MW01A
	5517532.6500	87935.0230	896.210	10MW8A
	5518284.0950	87556.4150	890.758	10MW17B
	5517935.8330	87197.1440	894.906	10MW12B
	5517175.4200	87331.2830	900.659	10MN01C
	5517547.7860	87745.3680		10BH7
	5518285.0940	87556.6430	890.749	10MW17A
	5517934.8250	87197.2450	894.925	10MW12C
	5517175.1460	87329.9880	900.639	10MW01B
	5517532.6180	87937.2230	896.240	10MW8C
	5517956.1630	87520.1660	898.505	10MW14
	5518094.2020	87198.8170		10BH15

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Above Ground Staging

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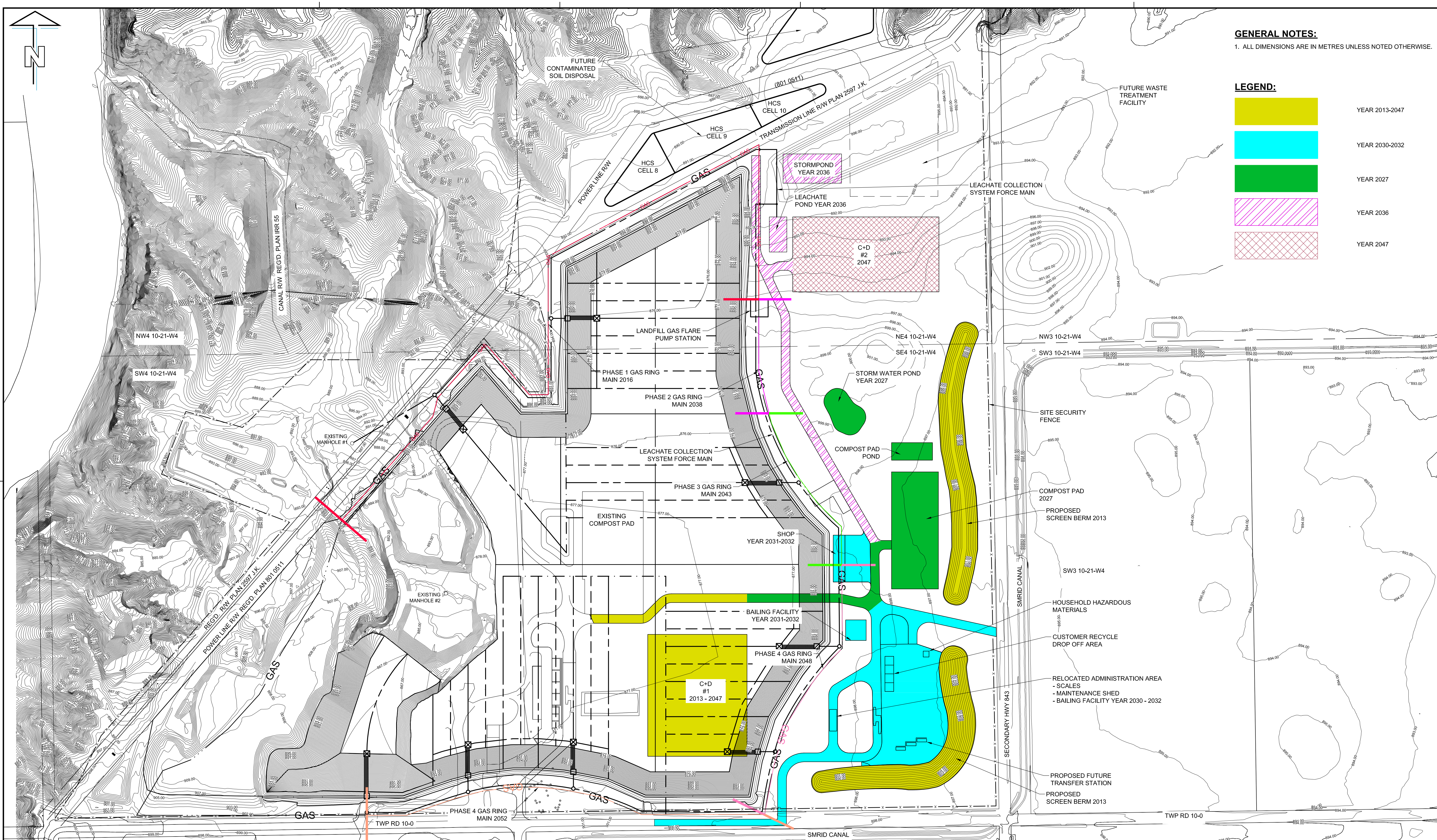

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Infrastructure Staging

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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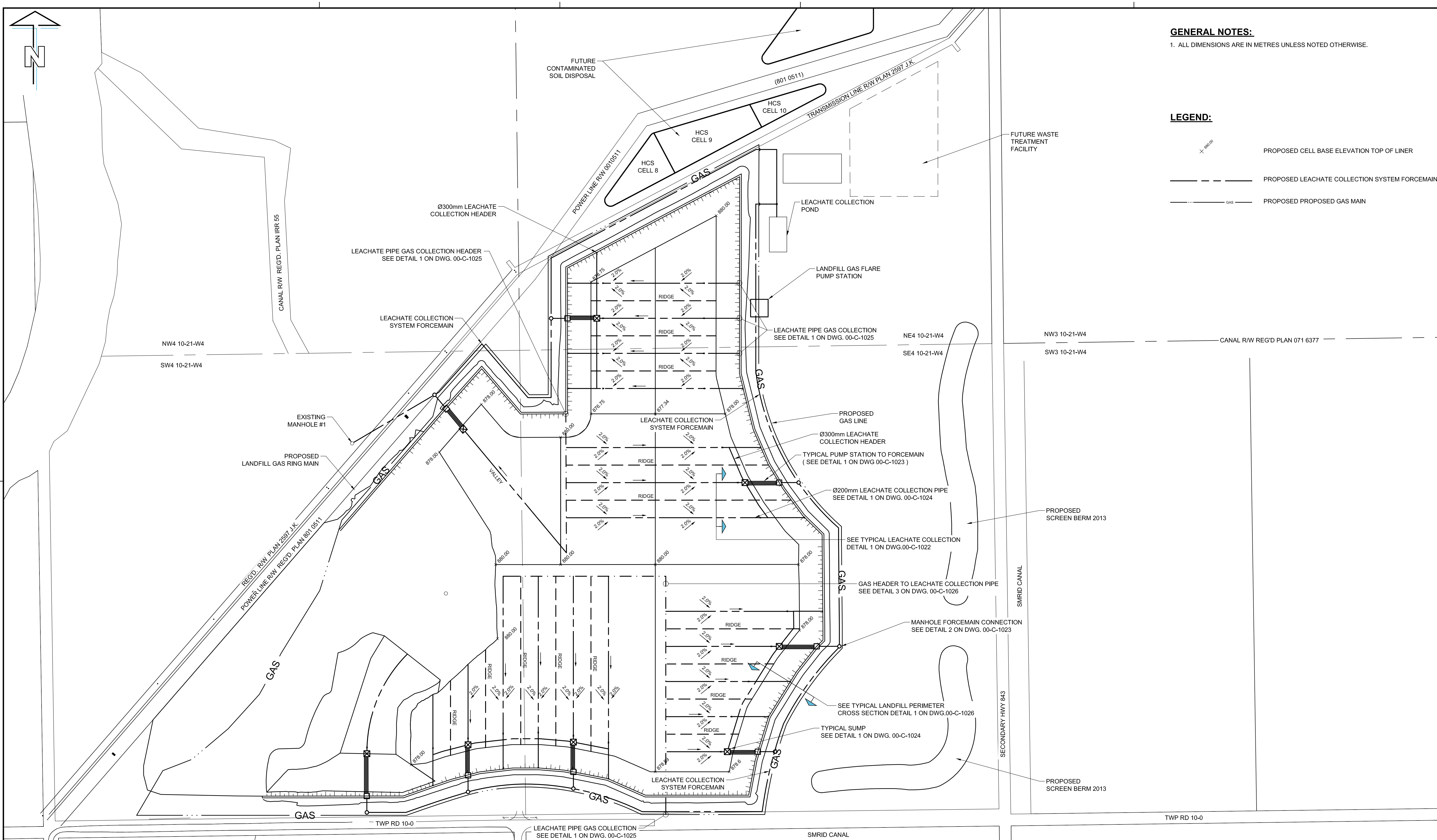

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.

LEGEND:

PROPOSED CELL BASE ELEVATION TOP OF LINER

PROPOSED LEACHATE COLLECTION SYSTEM FORCEMAIN

PROPOSED PROPOSED GAS MAIN

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A	12/05/14	Issued for Client Review	KHN	-	-	-	-	-

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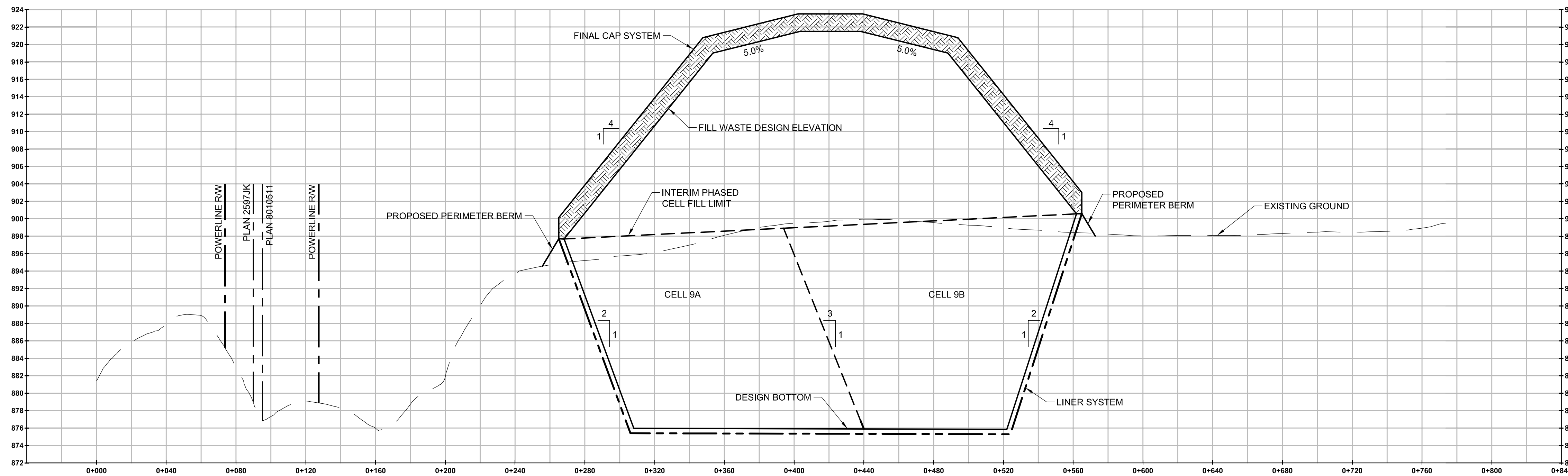

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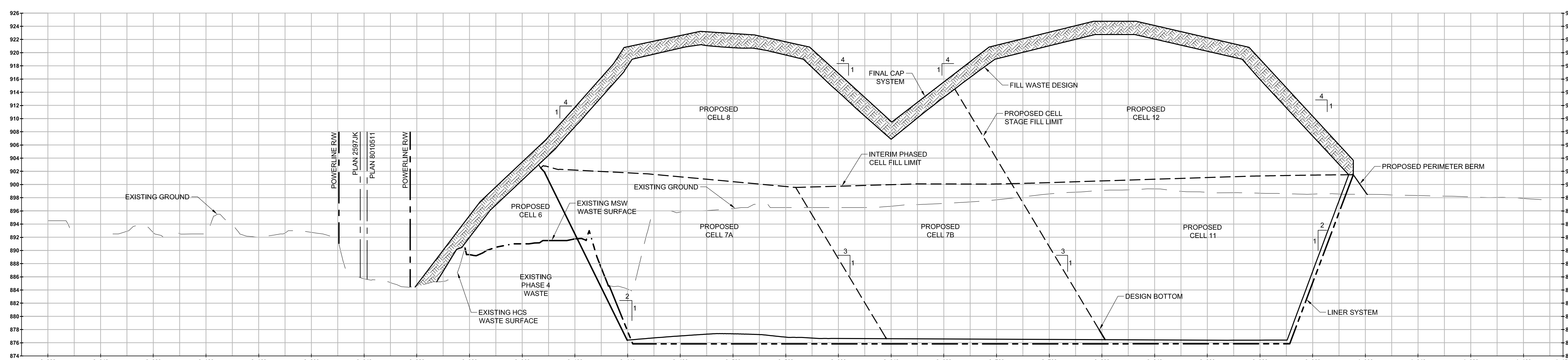

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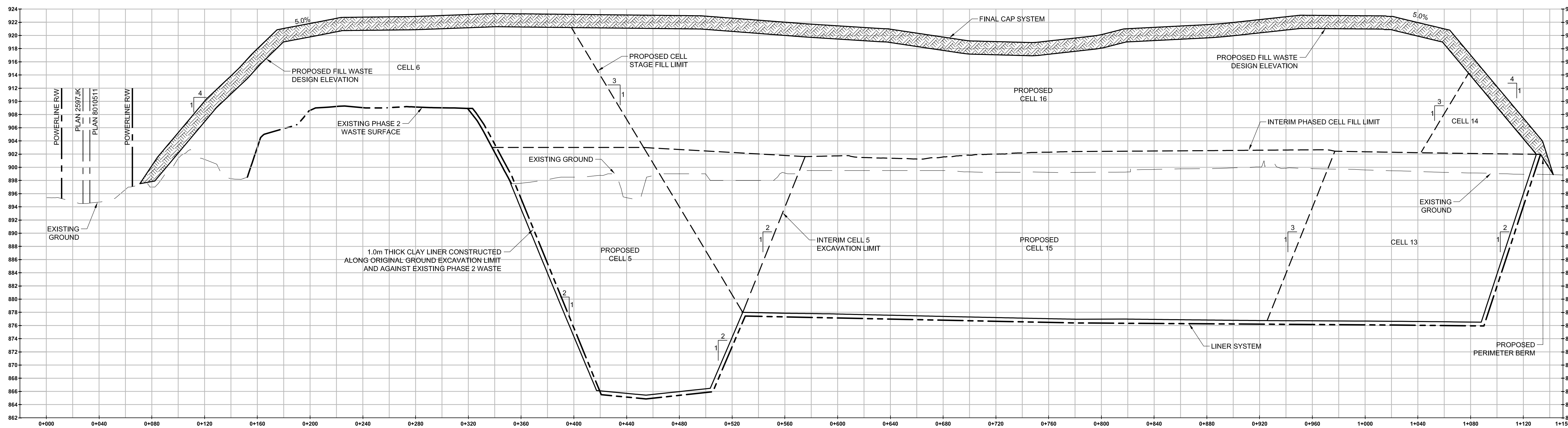
Cross Sections **Sheet 1 of 2**

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
060153727	00-C-1006	C



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Cross Sections **Sheet 2 of 2**

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
060153727	00-C-1007	C

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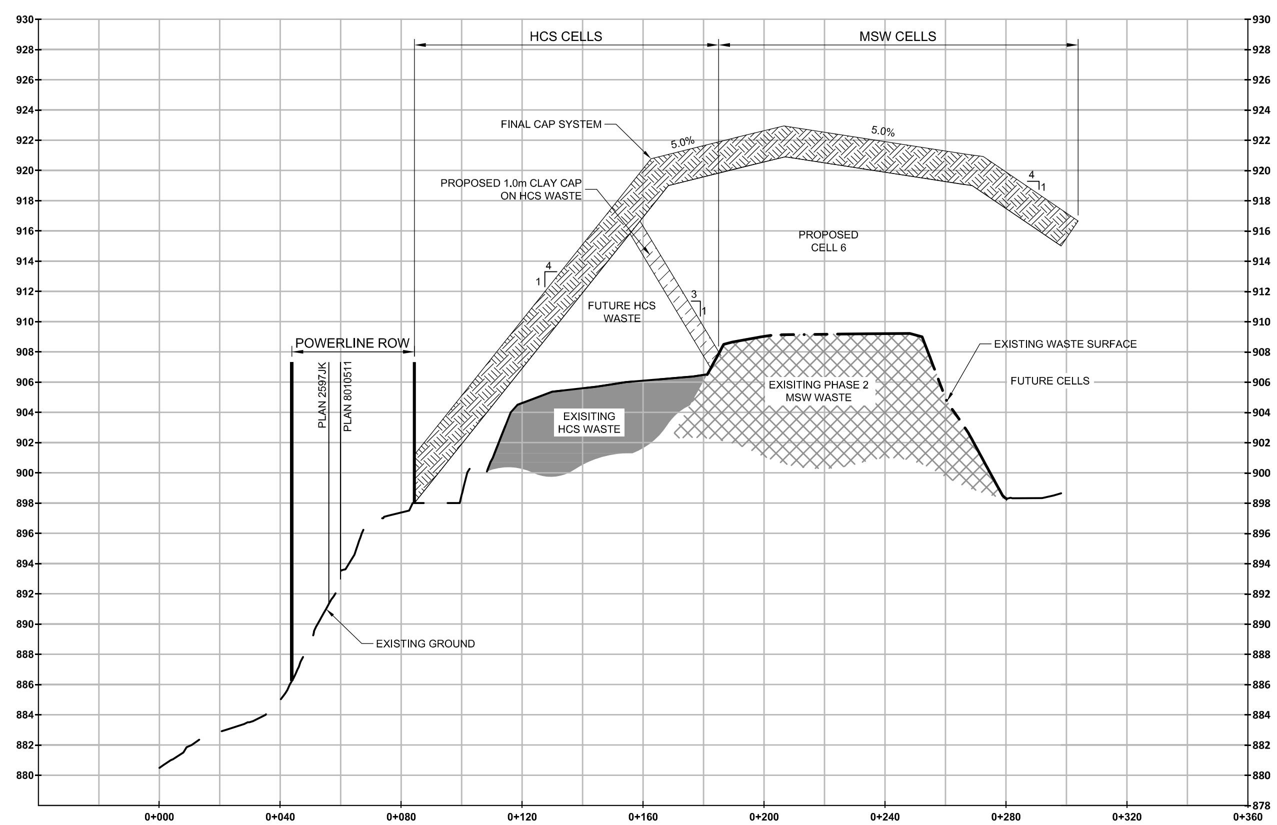

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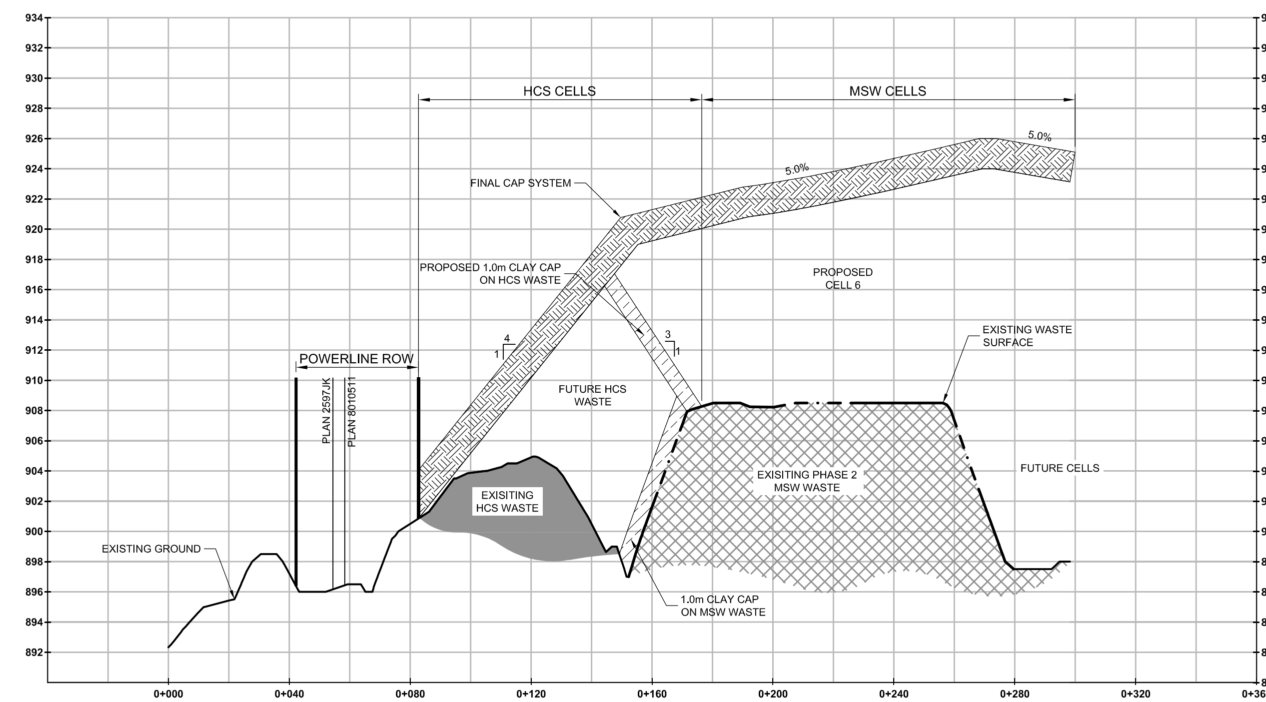
HCS CELL 5



SECTION E 00-C-1003

0 12.5 25 37.5 m SCALE 1:1250

HCS CELL 6

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PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
060153727	00-C-1008	C

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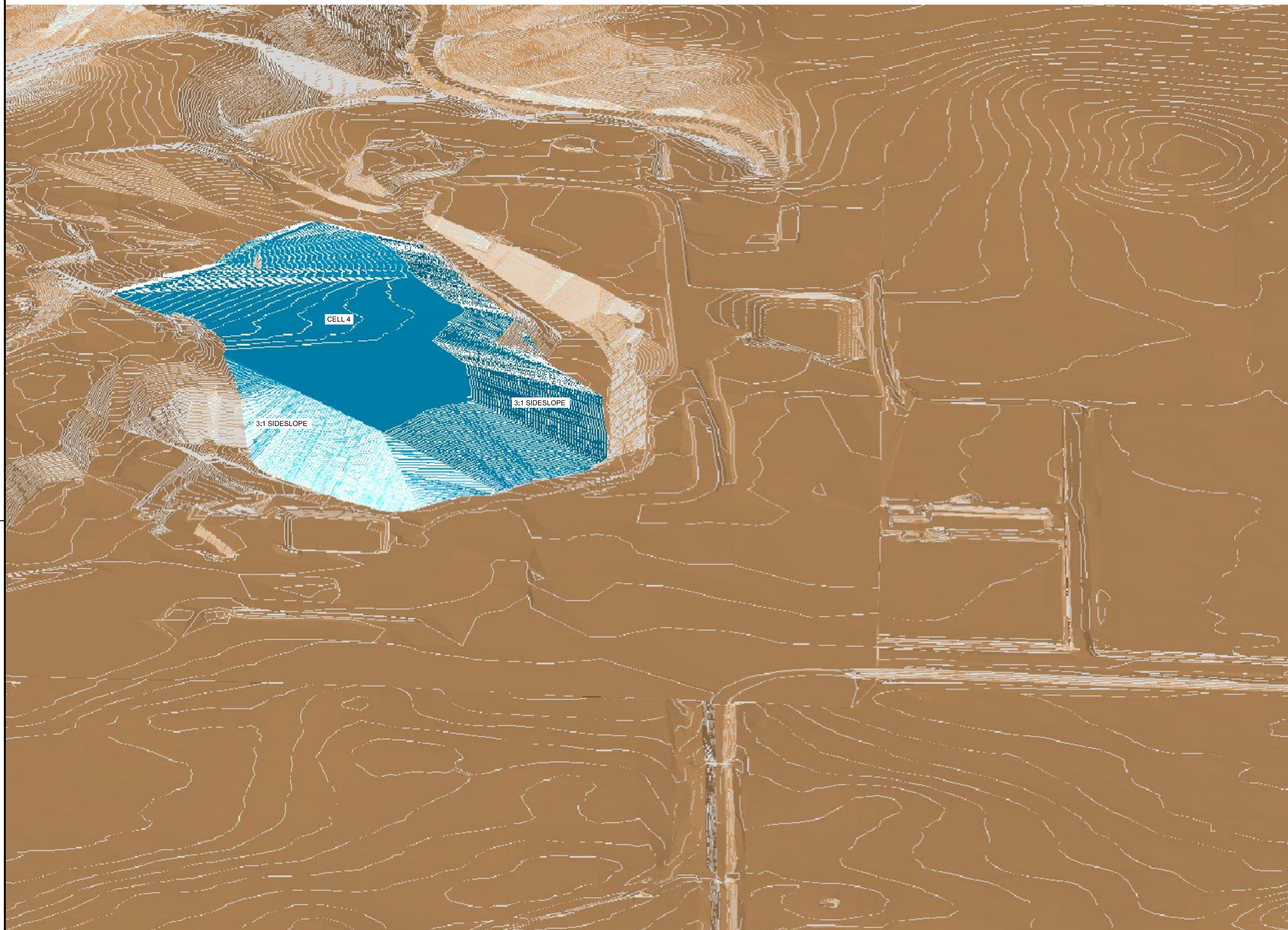

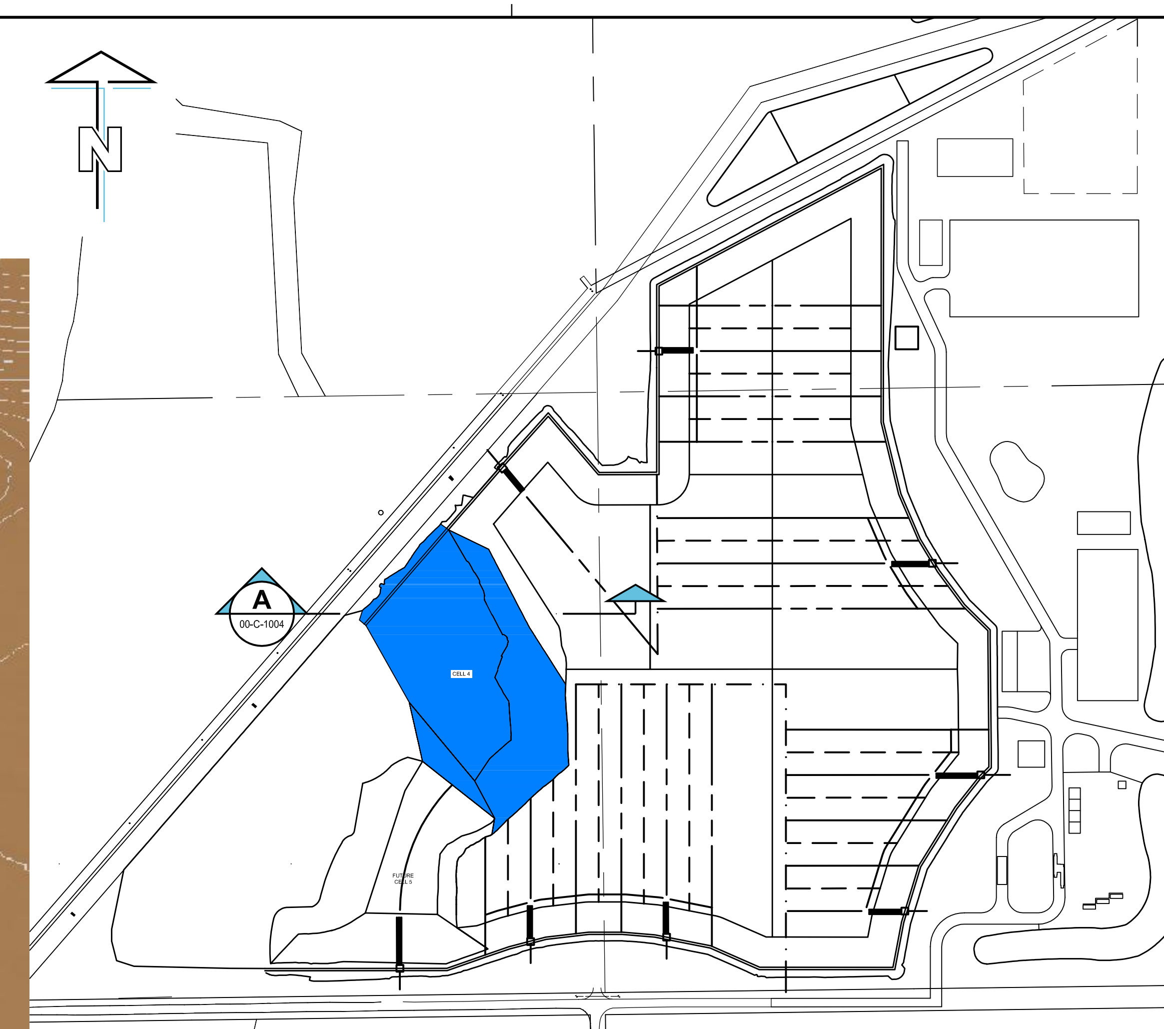

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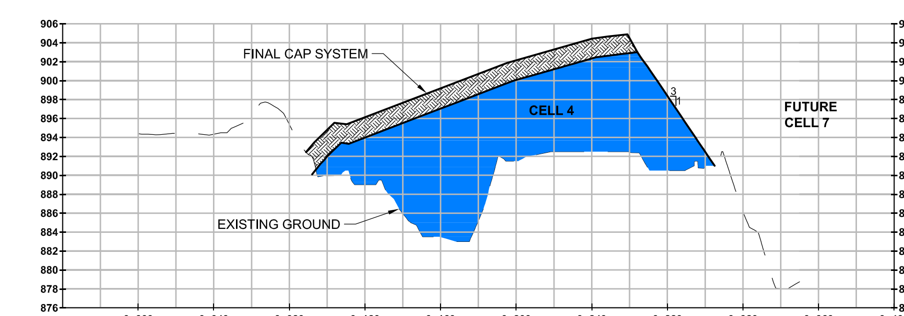

SECTION A

00-C-1004

H=1:2000
V=1:1000

NOTE:

CELL 4
AIRSPACE : 734,644m³ 423,155 mt
LIFESPAN : PRESENT TO 2013

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PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
060153727	00-C-1009	C

D SIZE 22" x 34" (558.8mm x 863.6mm)

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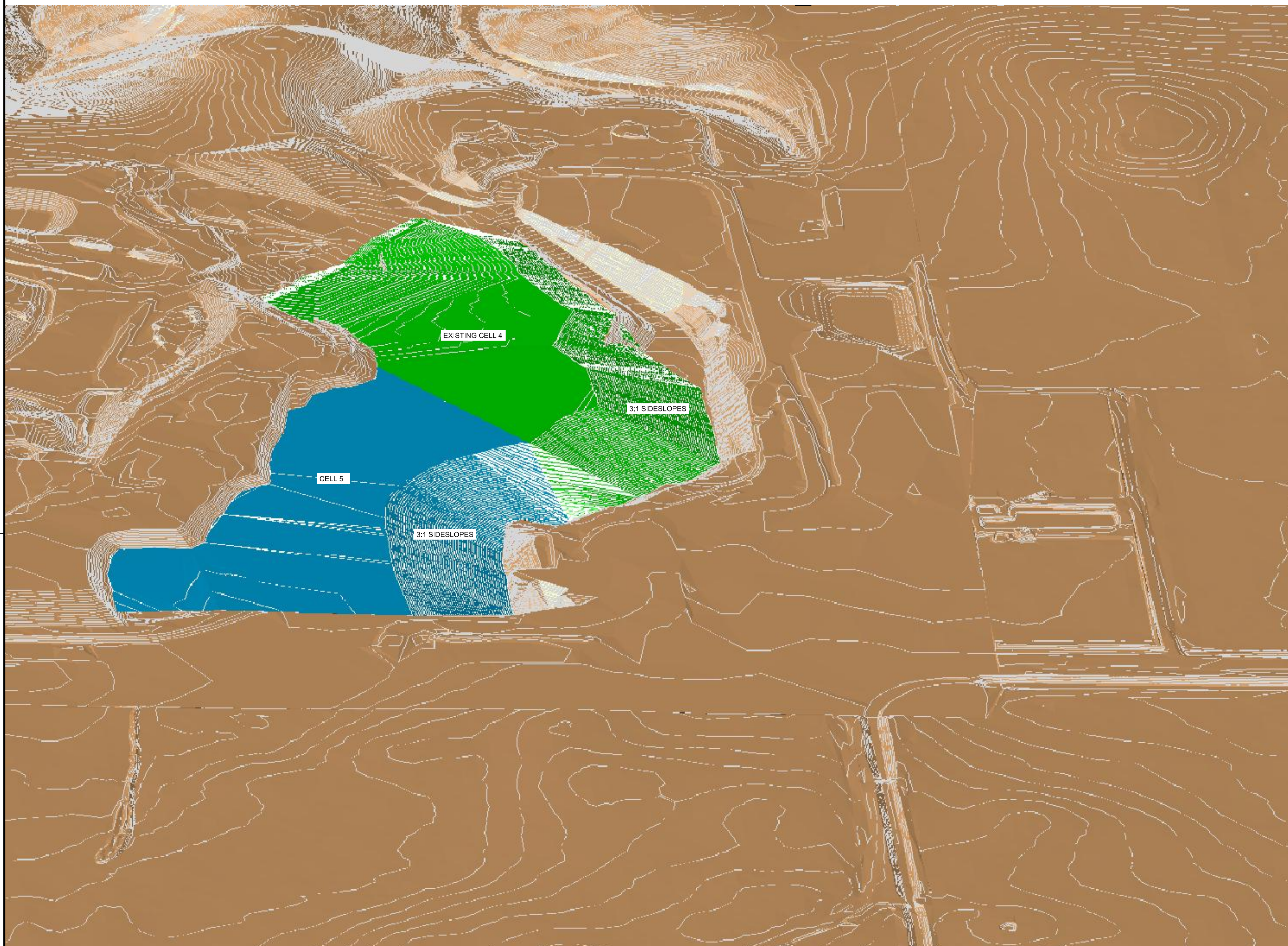

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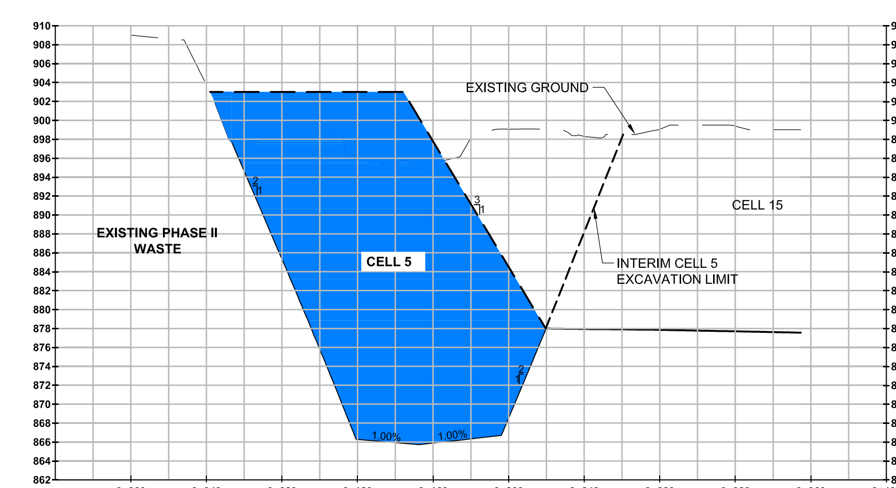

SECTION B

00-C-1005

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V=1:1000

NOTE:

CELL 5
AIRSPACE : 1,007,848m³ 580,520mt
CONSTRUCTION : 2012
LIFESPAN : 2013 TO 2018

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PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
060153727	00-C-1010	C

D SIZE 22" x 34" (558.8mm x 863.6mm)

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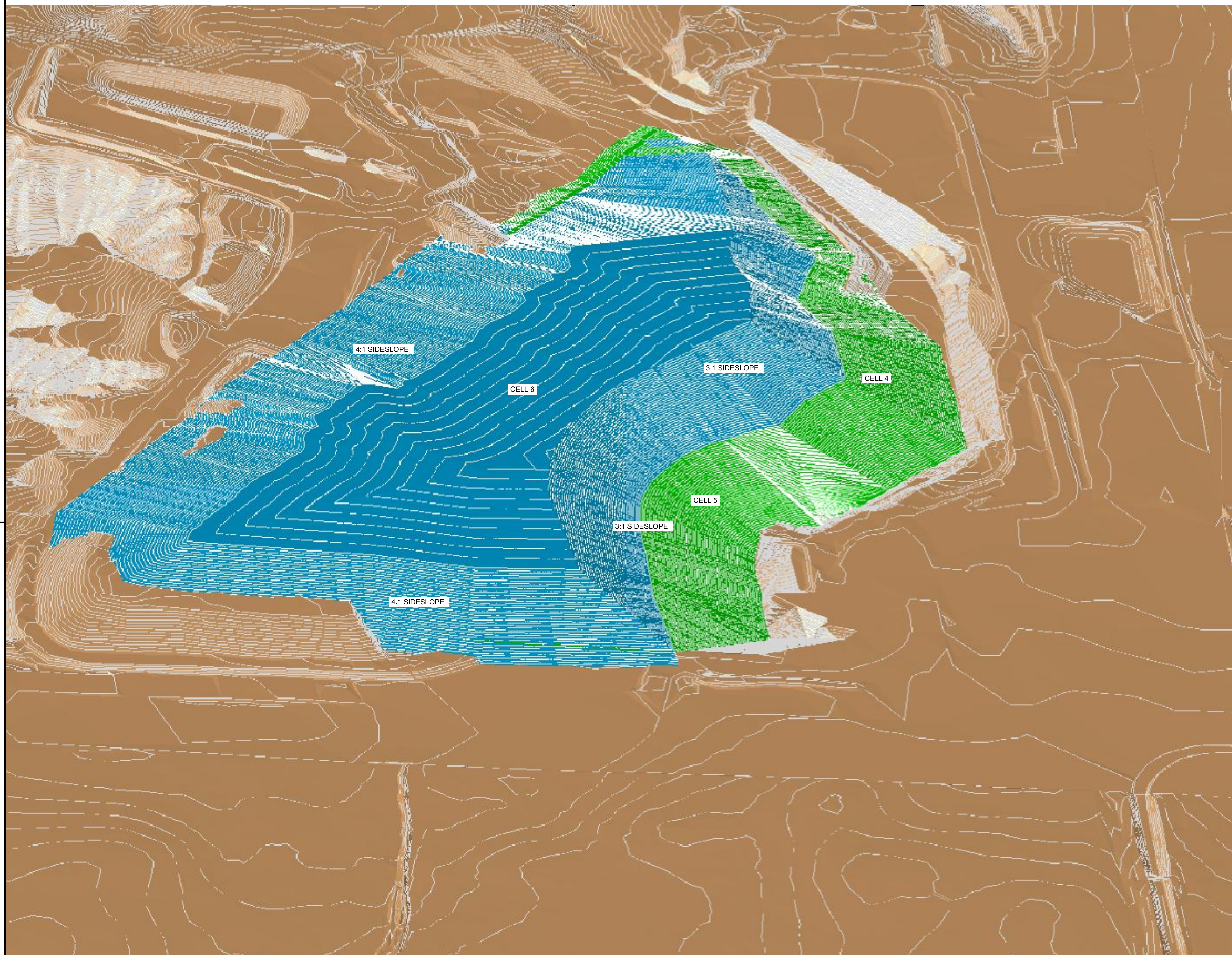

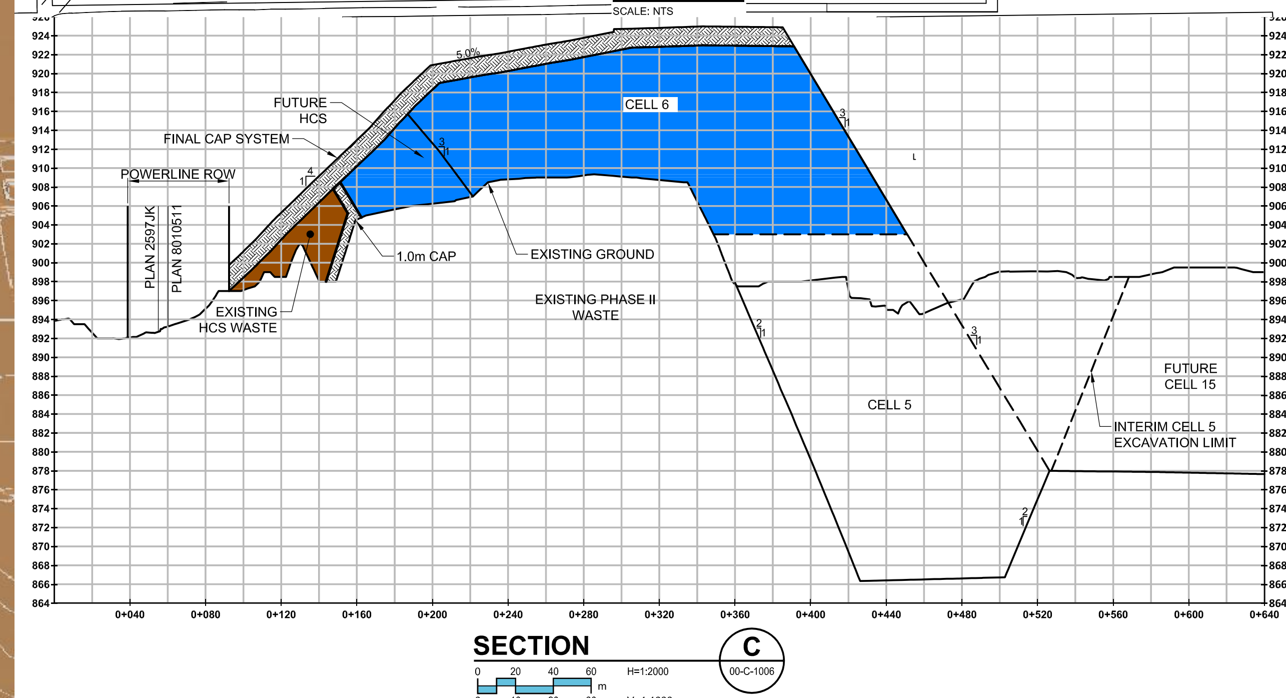

NOTE:

CELL 6
AIRSPACE : 2,649,168m³ 1,525,921mt
LIFESPAN : 2018 TO 2029

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PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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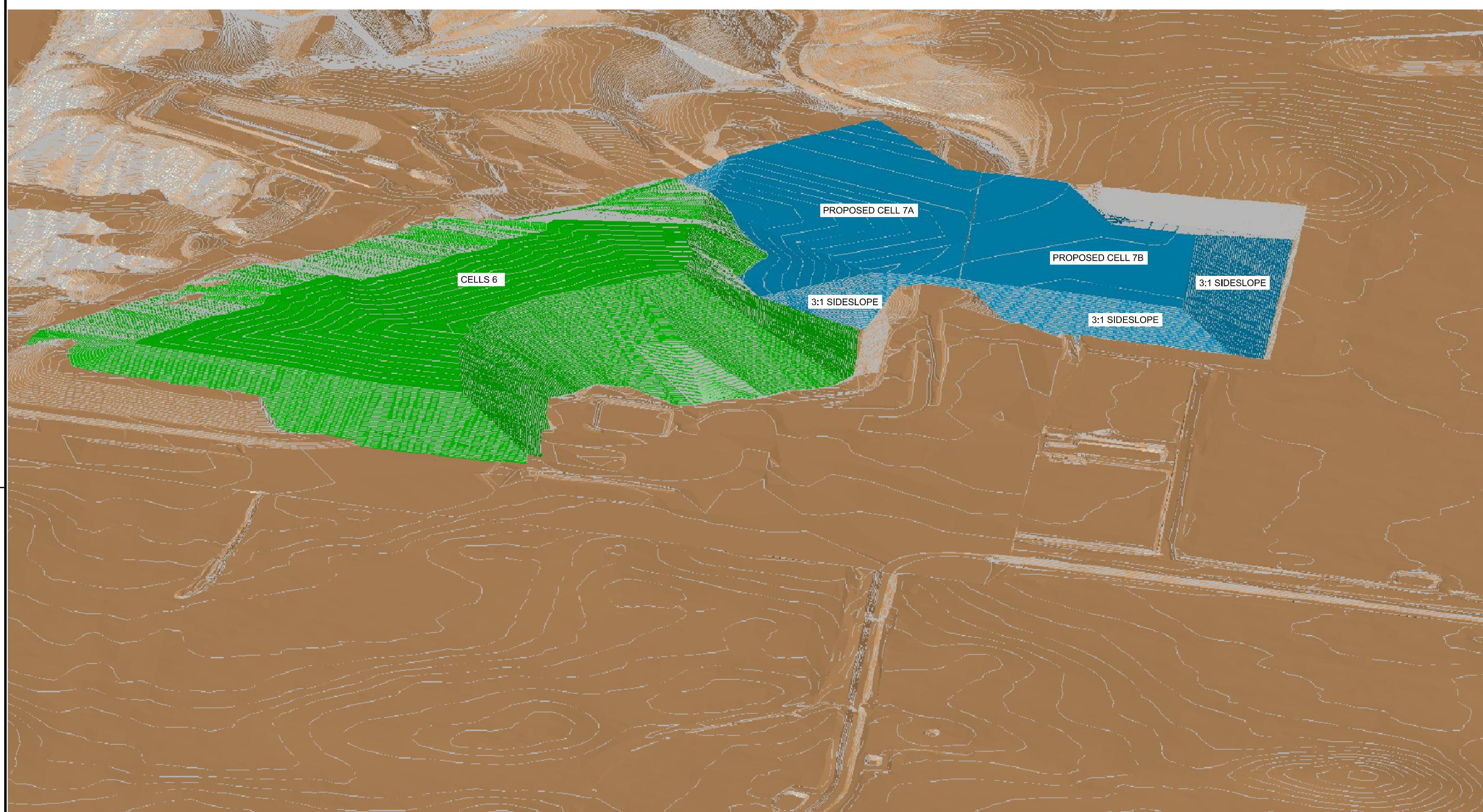

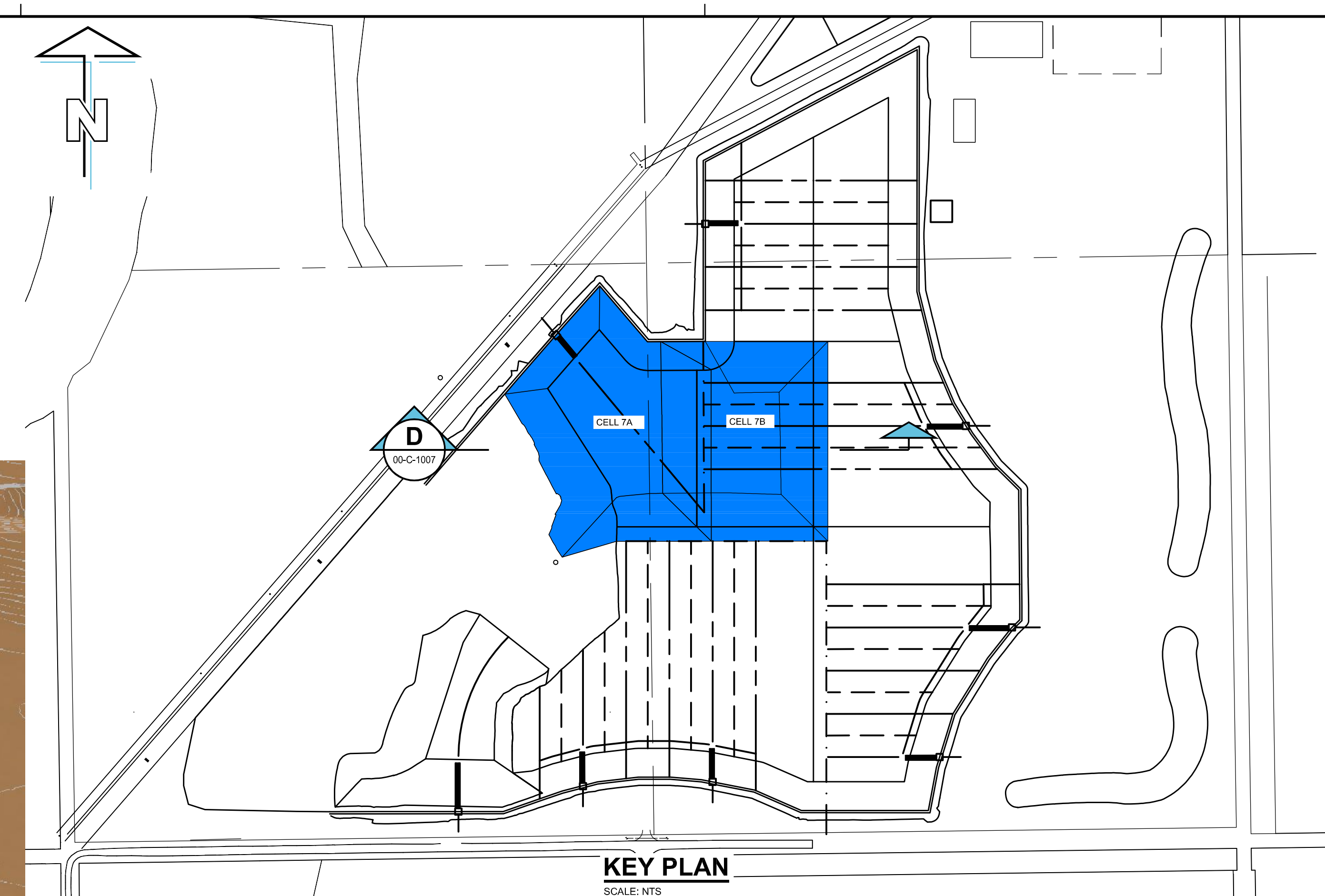

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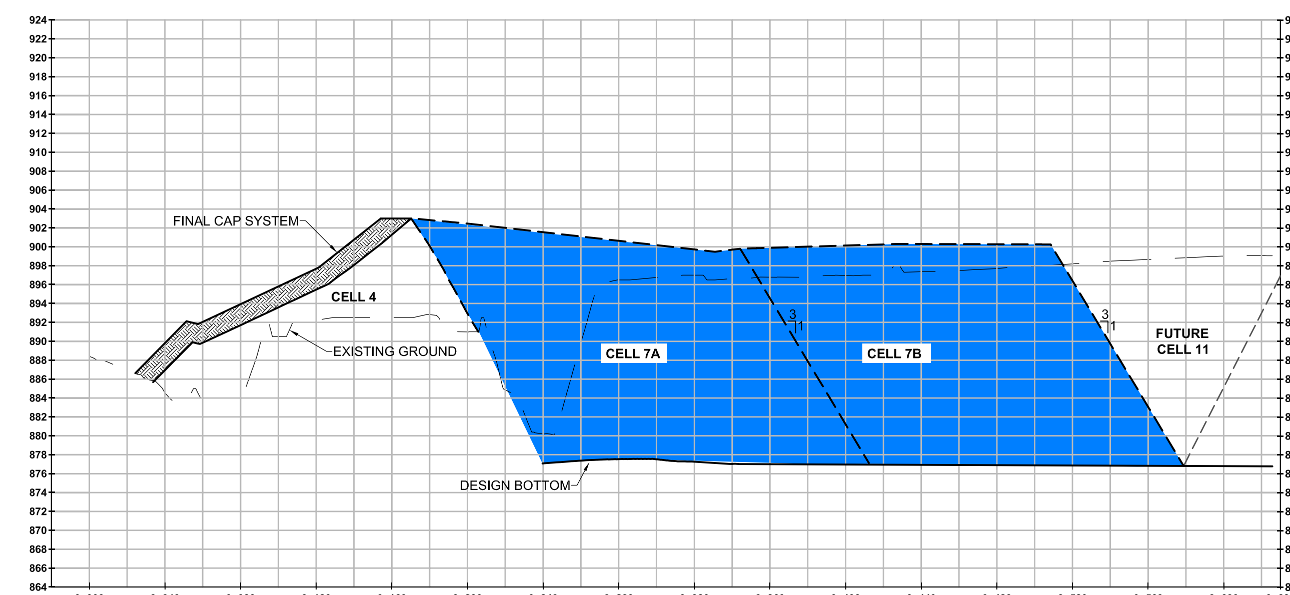

SECTION D

00-C-1007

H=1:2000

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NOTE:

CELL 7A

AIRSPACE : 1,,036,607m³ 597,086mt

CONSTRUCTION : 2028

LIFE SPAN : 2029 TO 2032

CELL 7B

AIRSPACE : 818,821m³ 471,641mt

CONSTRUCTION : 2031

LIFE SPAN : 2032 TO 2035

D SIZE 22" x 34" (558.8mm x 863.6mm)

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Staging Plan - Cell 7A and Cell 7B

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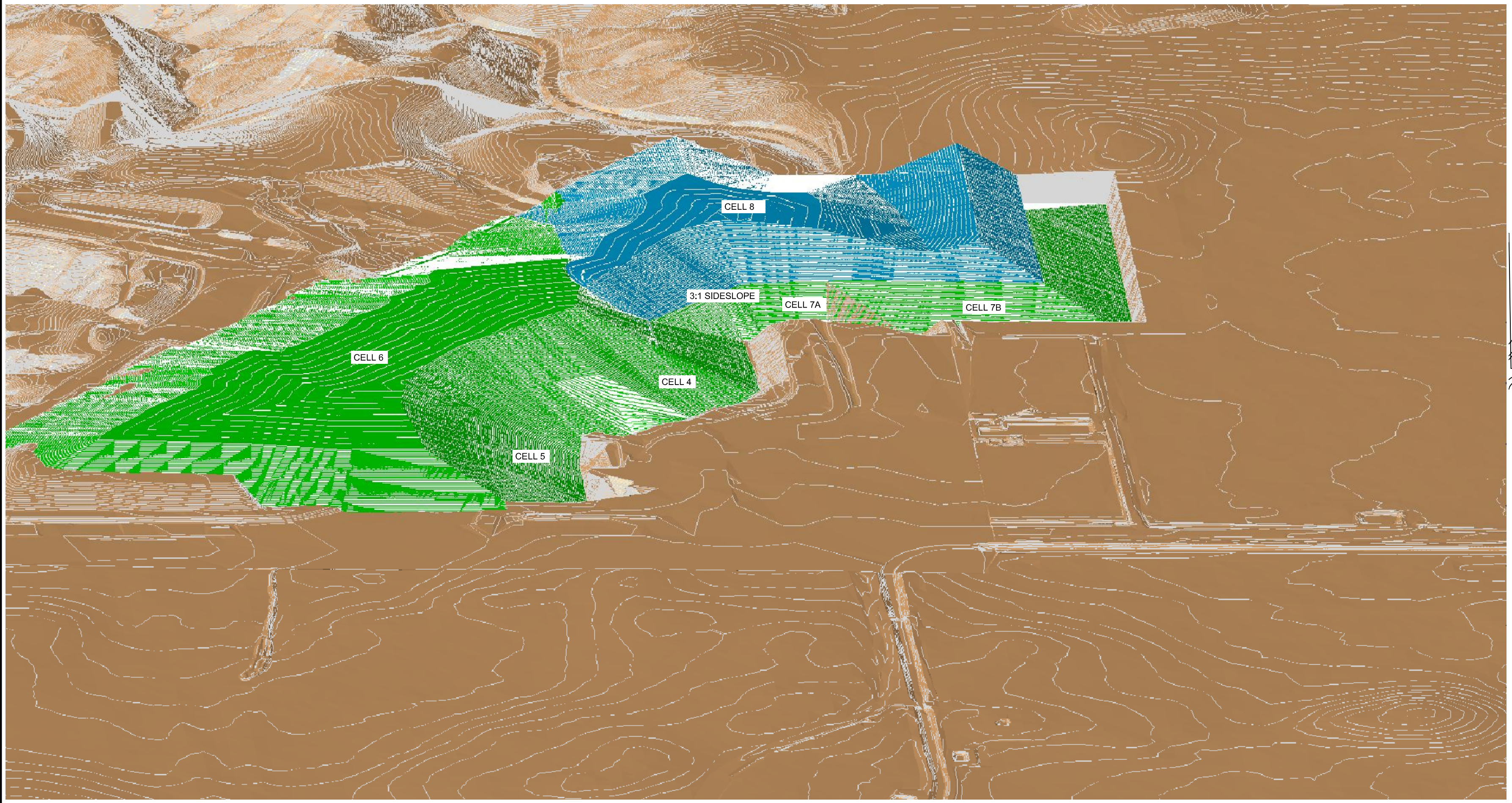

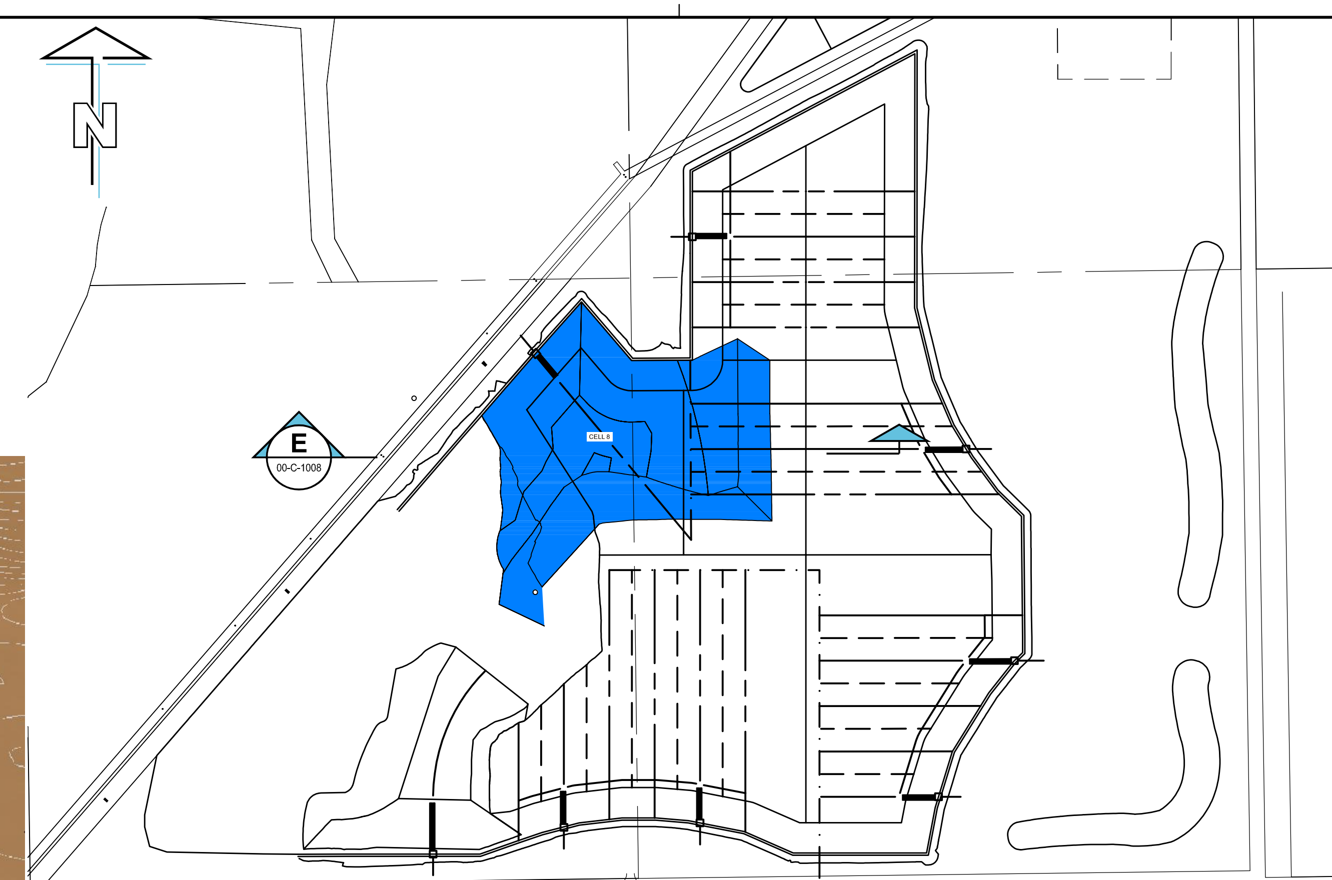

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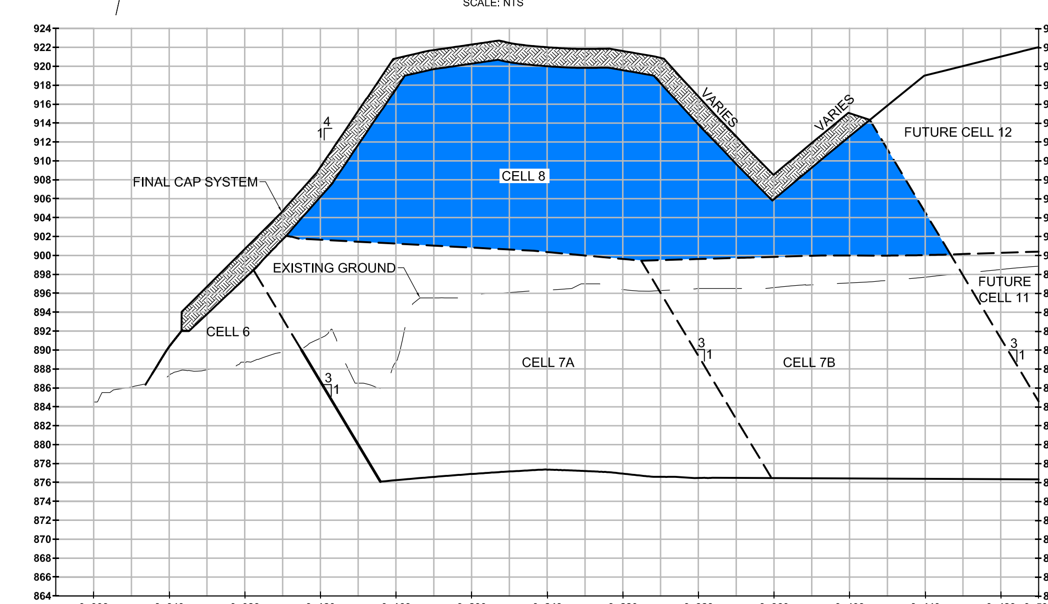

SECTION E

00-C-1008

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V=1:1000

NOTE:

CELL 8
AIRSPACE : 730,918m³ 526,261mt
LIFESPAN : 2035 TO 2037

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PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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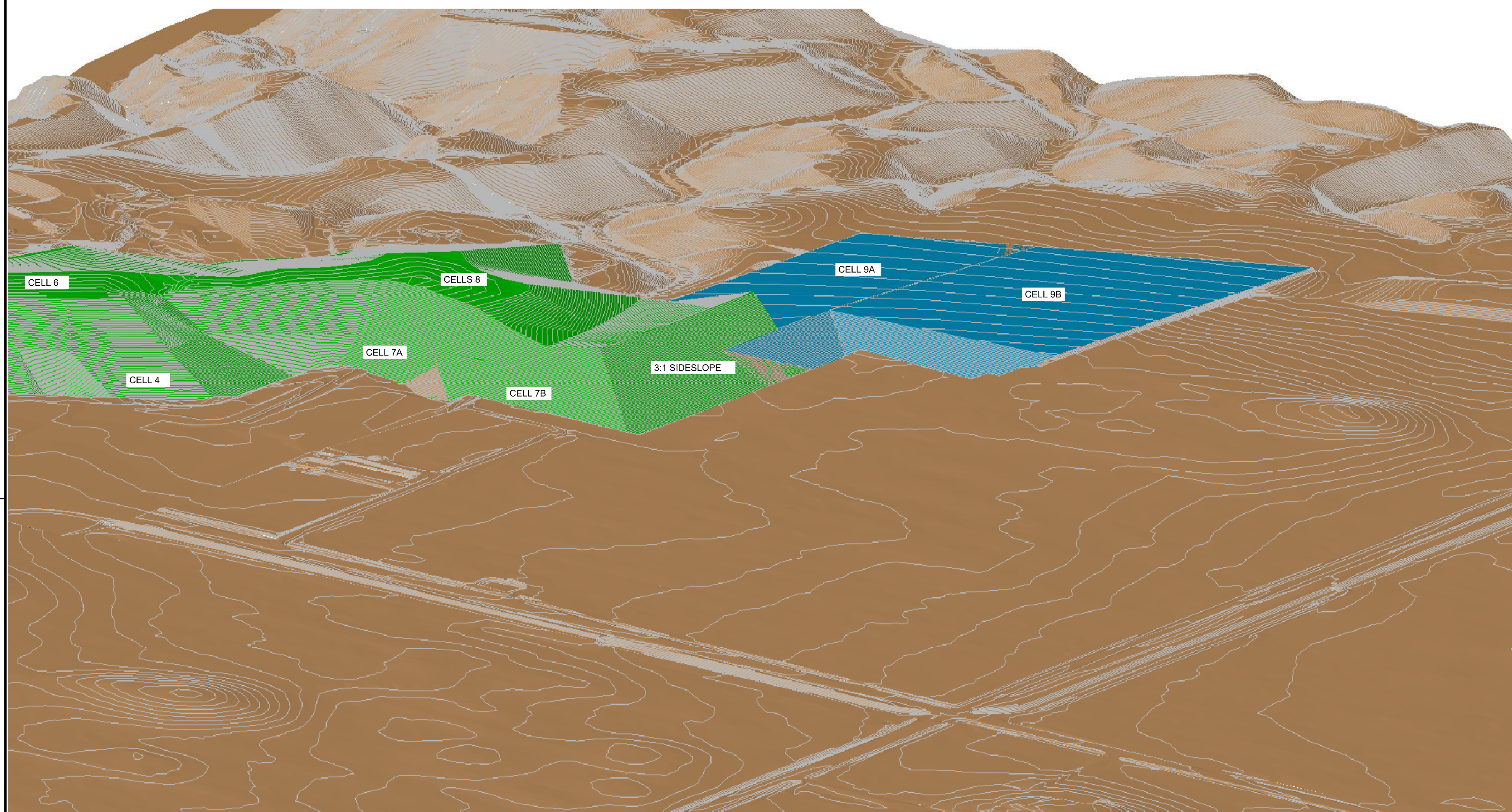

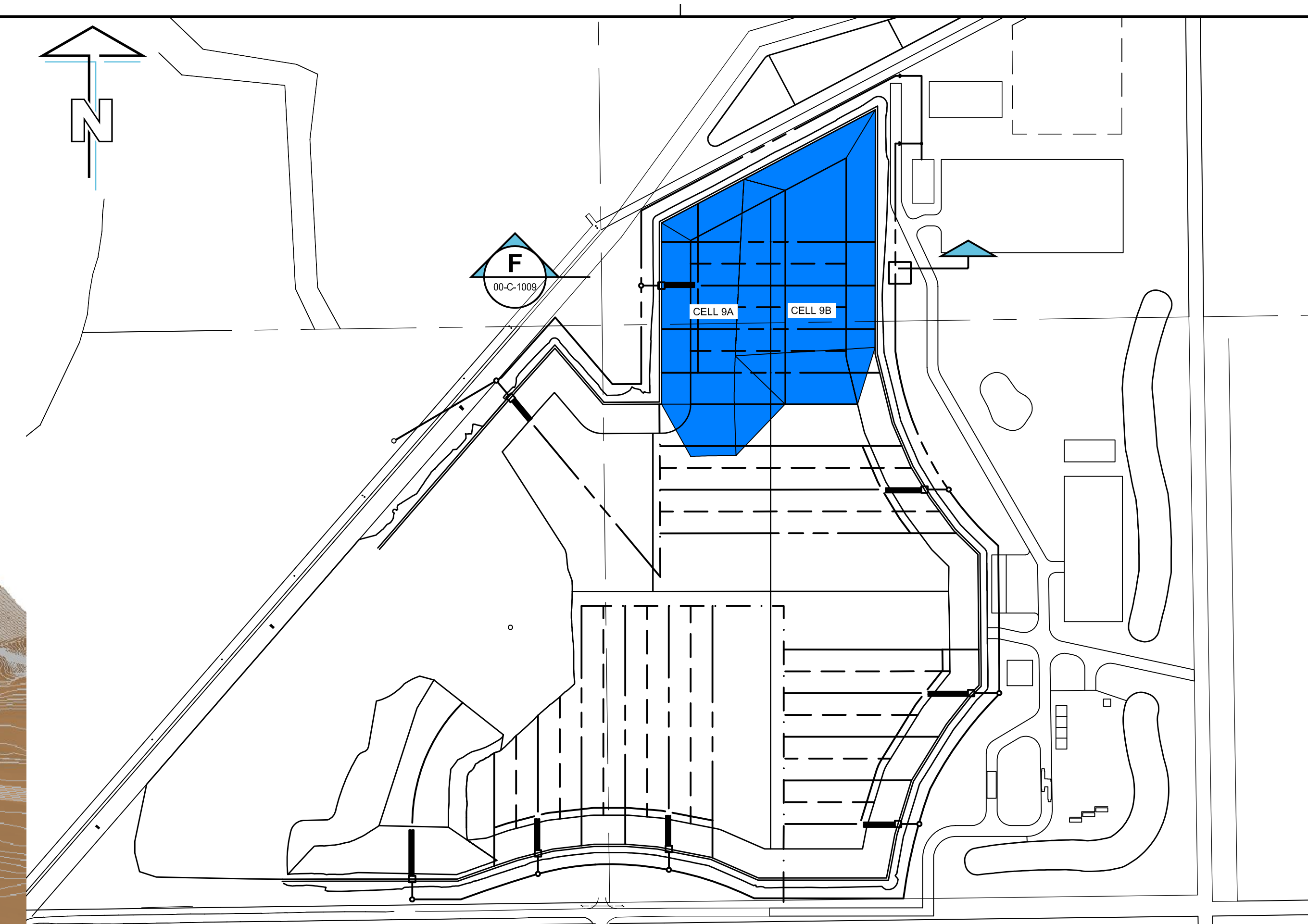

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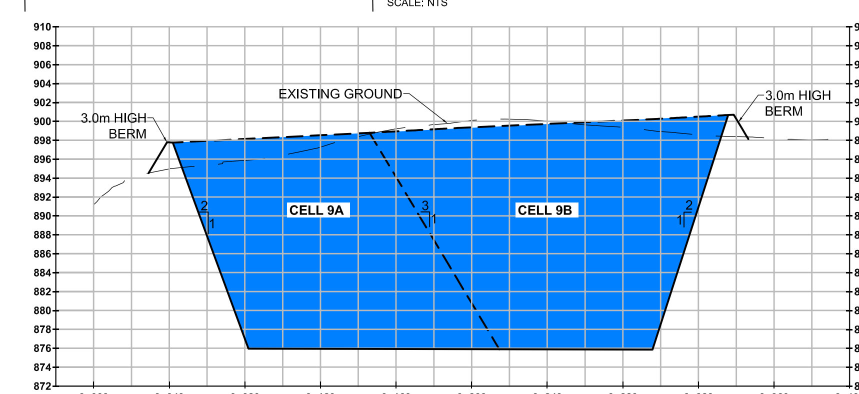

SECTION F

00-C-1009

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NOTES:

CELL 9A
AIRSPACE : 613,368m³ 441,625mt
CONSTRUCTION : 2036
LIFE SPAN : 2037 TO 2039

CELL 9B
AIRSPACE : 723,855m³ 521,176mt
CONSTRUCTION : 2038
LIFE SPAN : 2039 TO 2041

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Staging Plan - Cell 9A and 9B

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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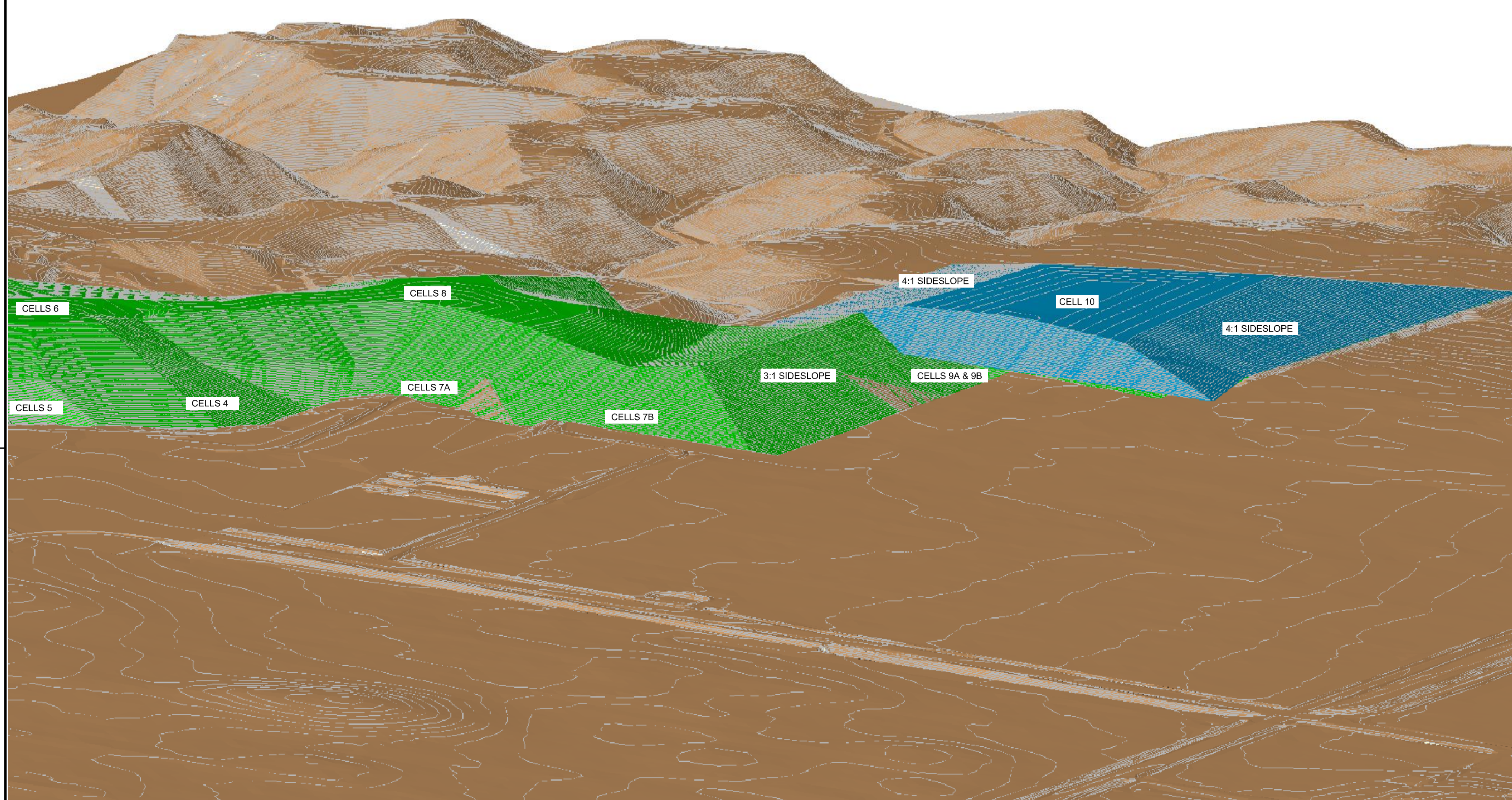

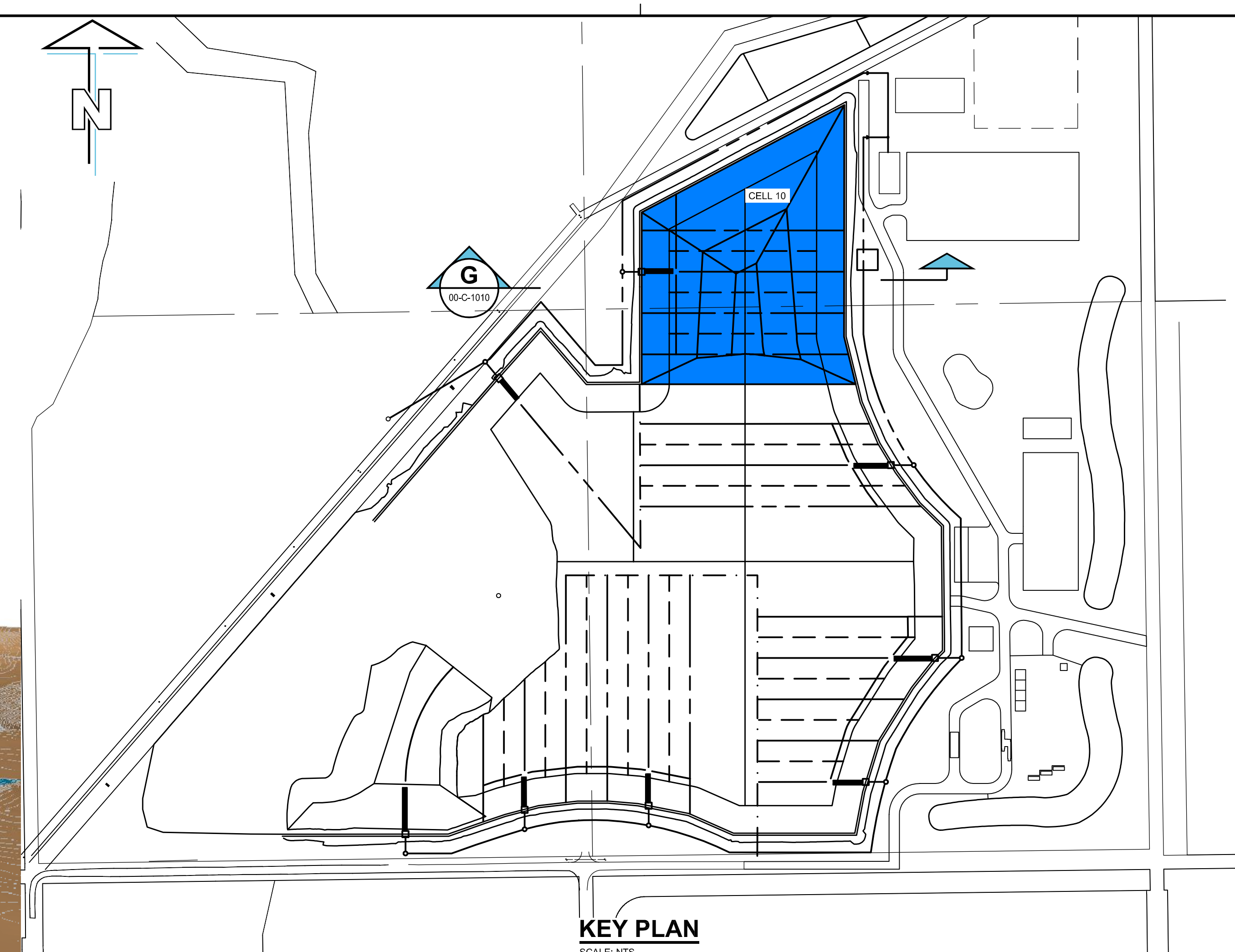

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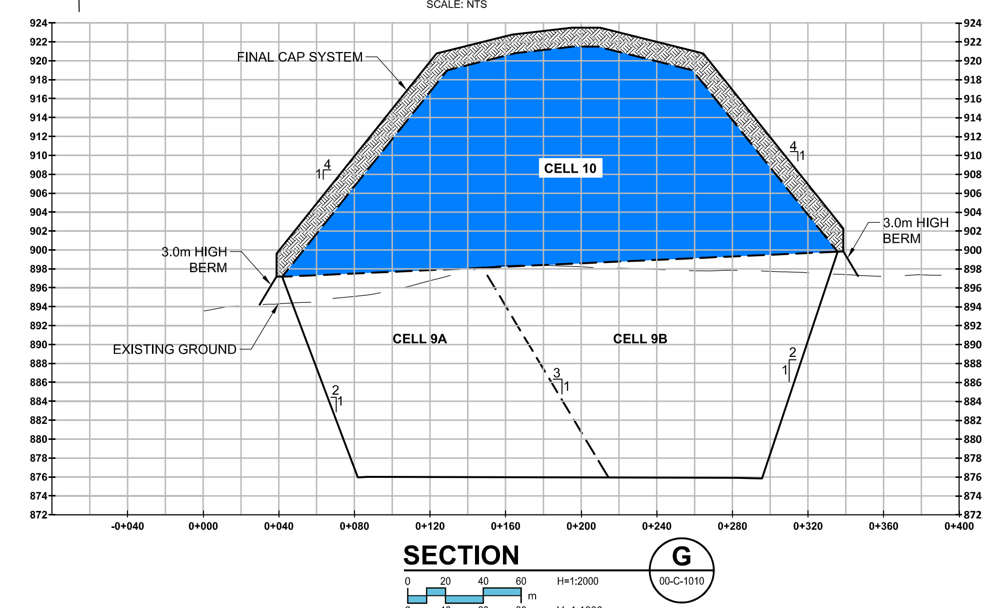

SECTION G

00-C-1010

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NOTE:

Cell 10
AIRSPACE : 944,190m³ 679,817mt
LIFE SPAN : 2041 TO 2044

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A	12/05/14	Issued for Client Review	KHN	-	-	-	-	-

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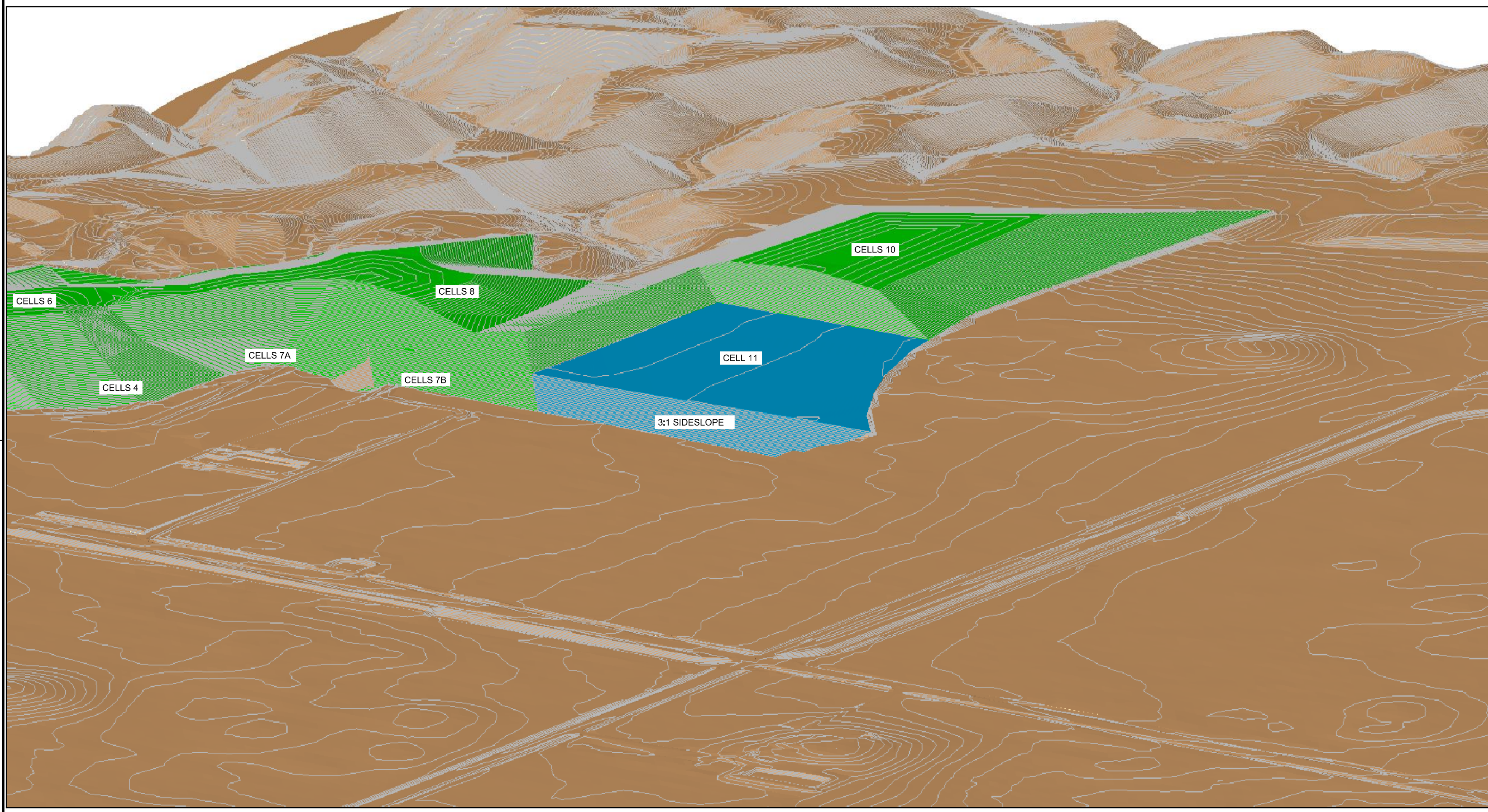
Staging Plan - Cell 10

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
060153727	00-C-1015	C



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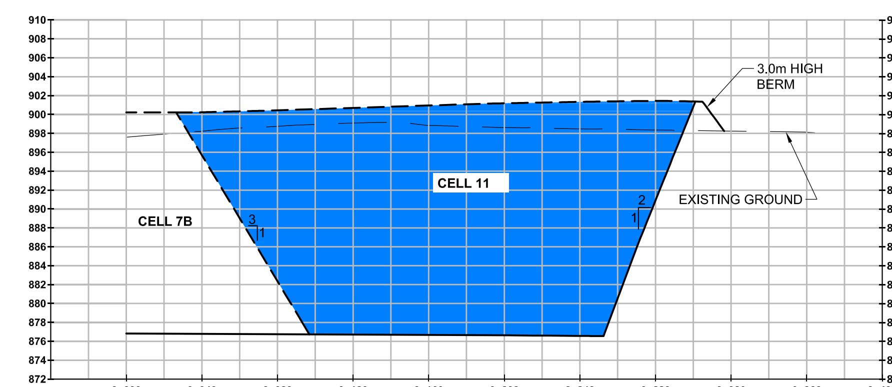

SECTION H 00-C-1011

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NOTE:

CELL 11
AIRSPACE : 1,347,579m³ 776,206mt
CONSTRUCTION : 2043
LIFE SPAN : 2044 TO 2047

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PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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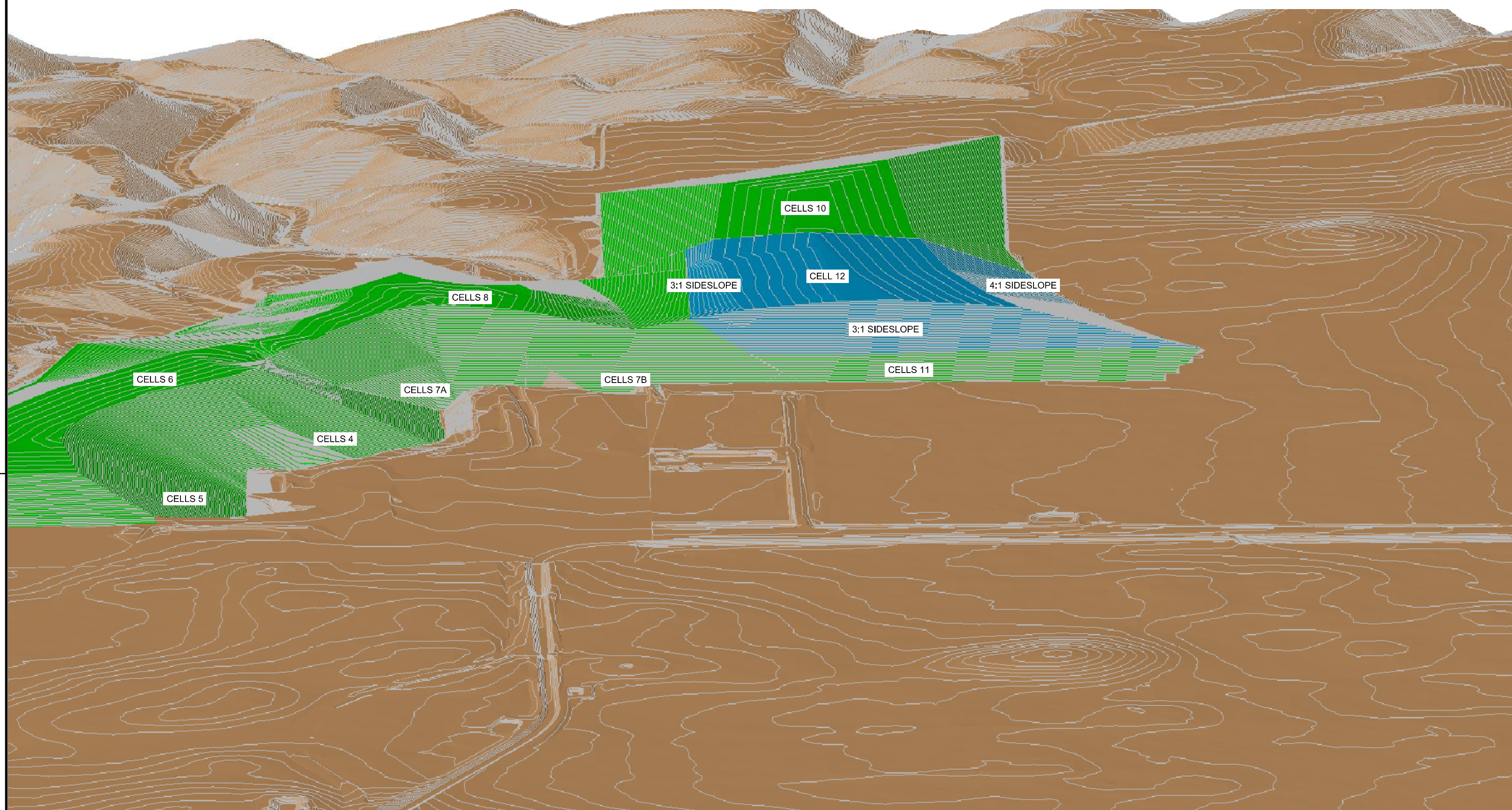

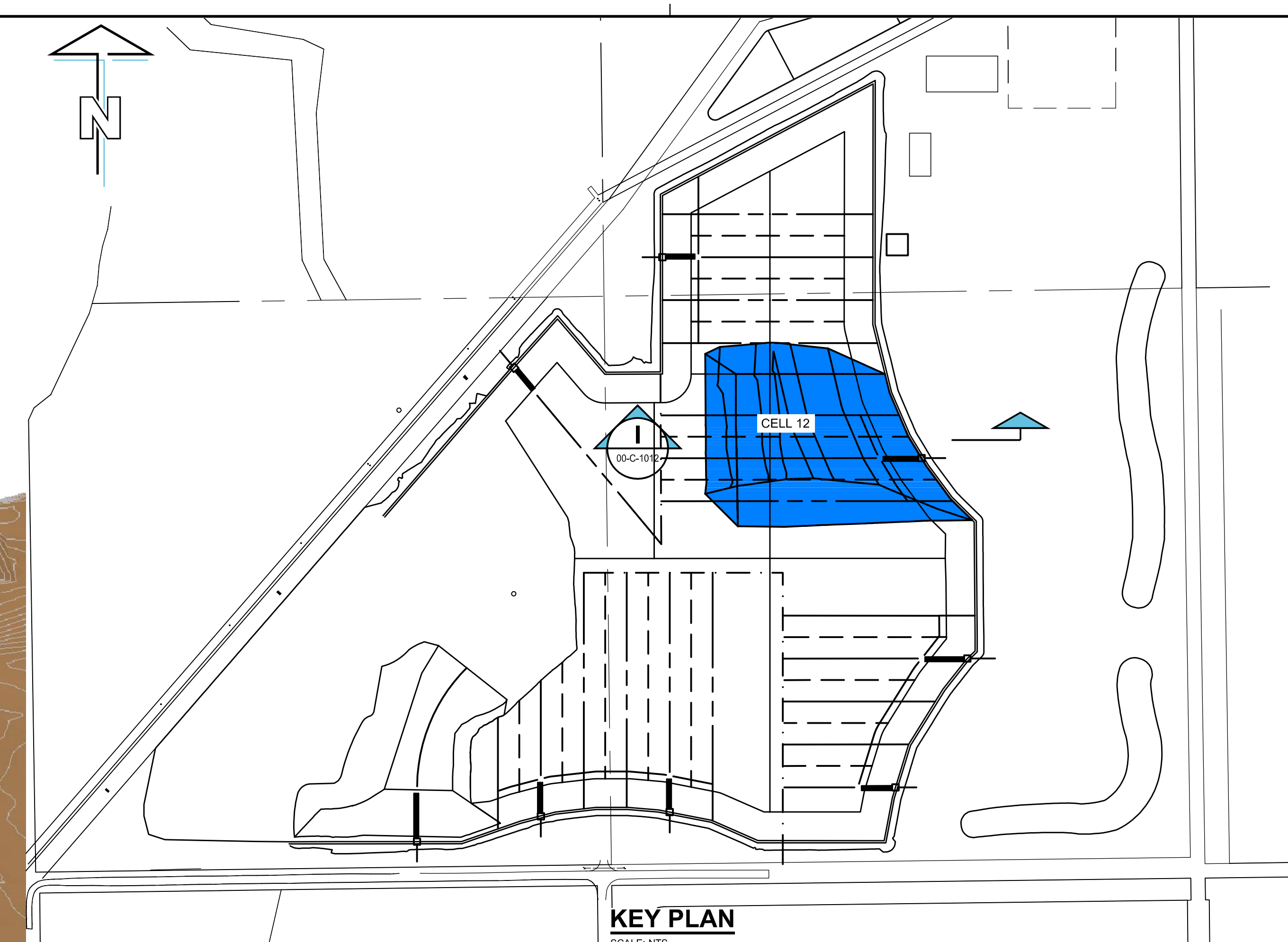

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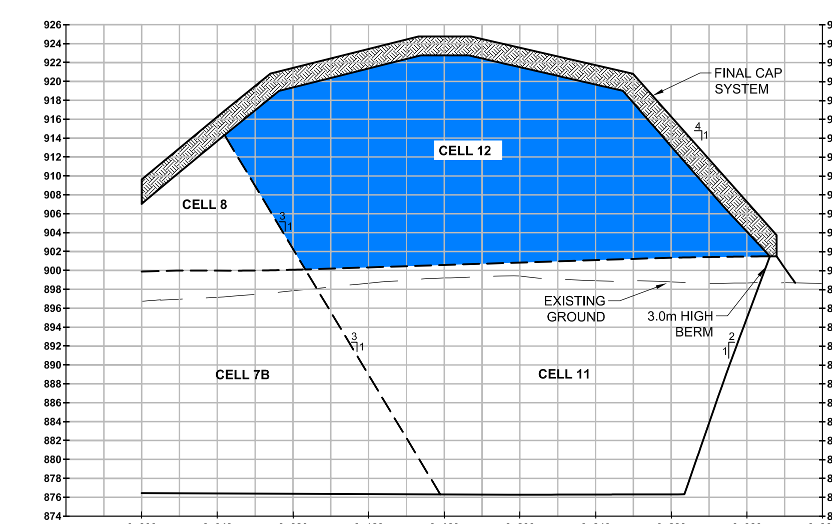

SECTION I

00-C-1012

H=1:2000
V=1:1000

NOTE:

CELL 12
AIRSPACE : 912,281m³ 525,474mt
LIFE SPAN : 2047 TO 2049

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060153727	00-C-1017	C

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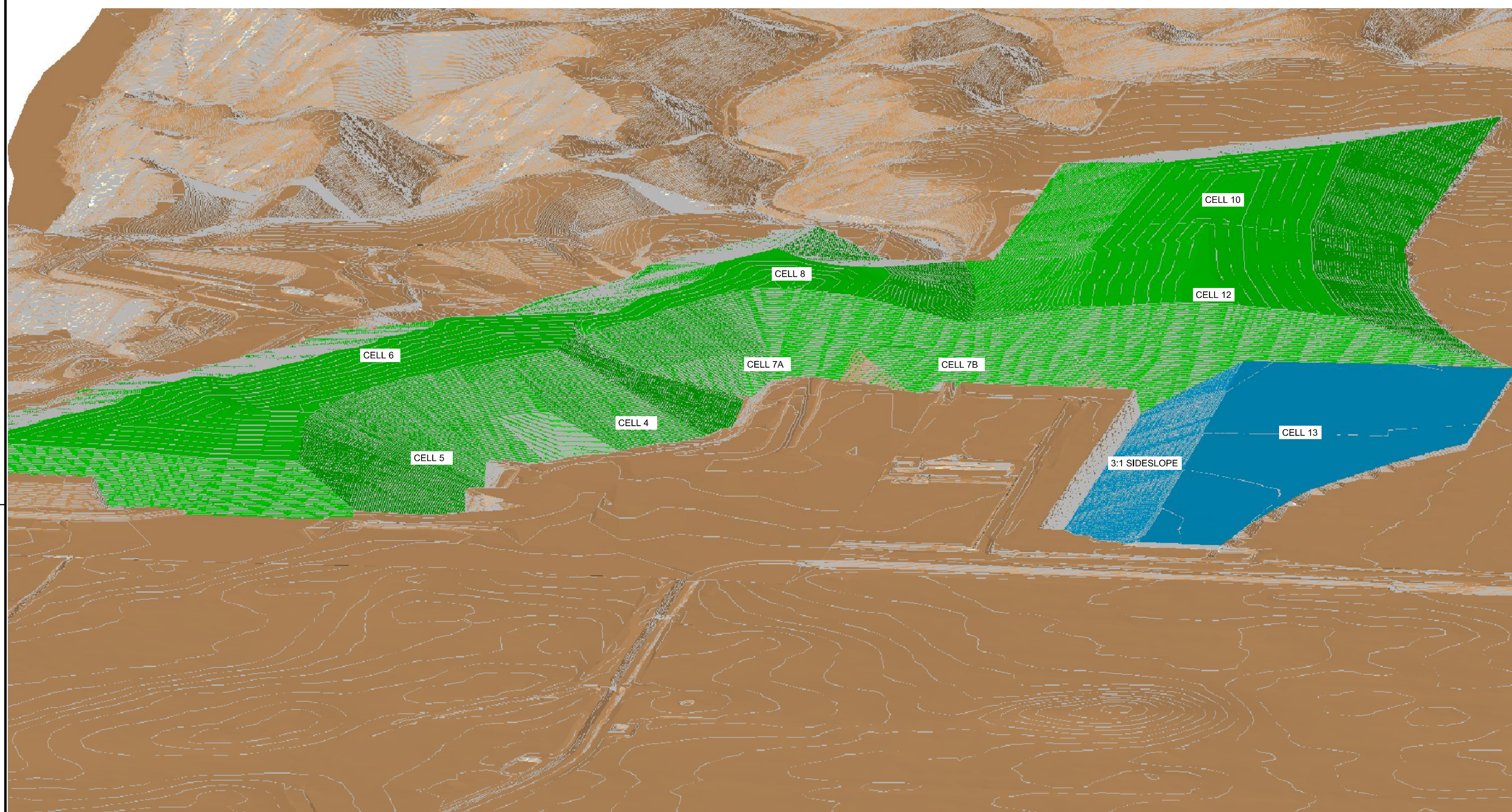

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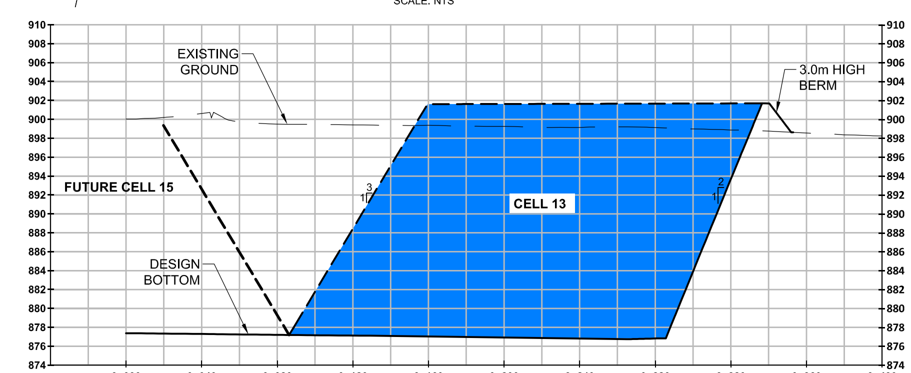

SECTION J

00-C-1013

H=1:2000

V=1:1000

NOTE:

CELL 13
AIRSPACE : 1,507,774m³ 868,478mt
CONSTRUCTION : 2048
LIFE SPAN : 2049 TO 2052

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KEY PLAN
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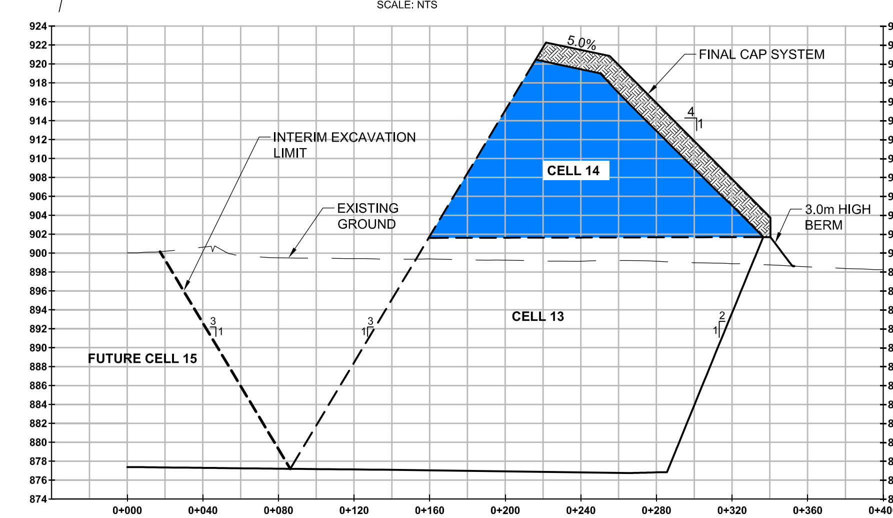

SECTION K 00-C-1014
H=1:2000
V=1:1000

NOTE:

CELL 14
AIRSPACE : 719,716m³ 414,556mt
LIFE SPAN : 2052 TO 2053

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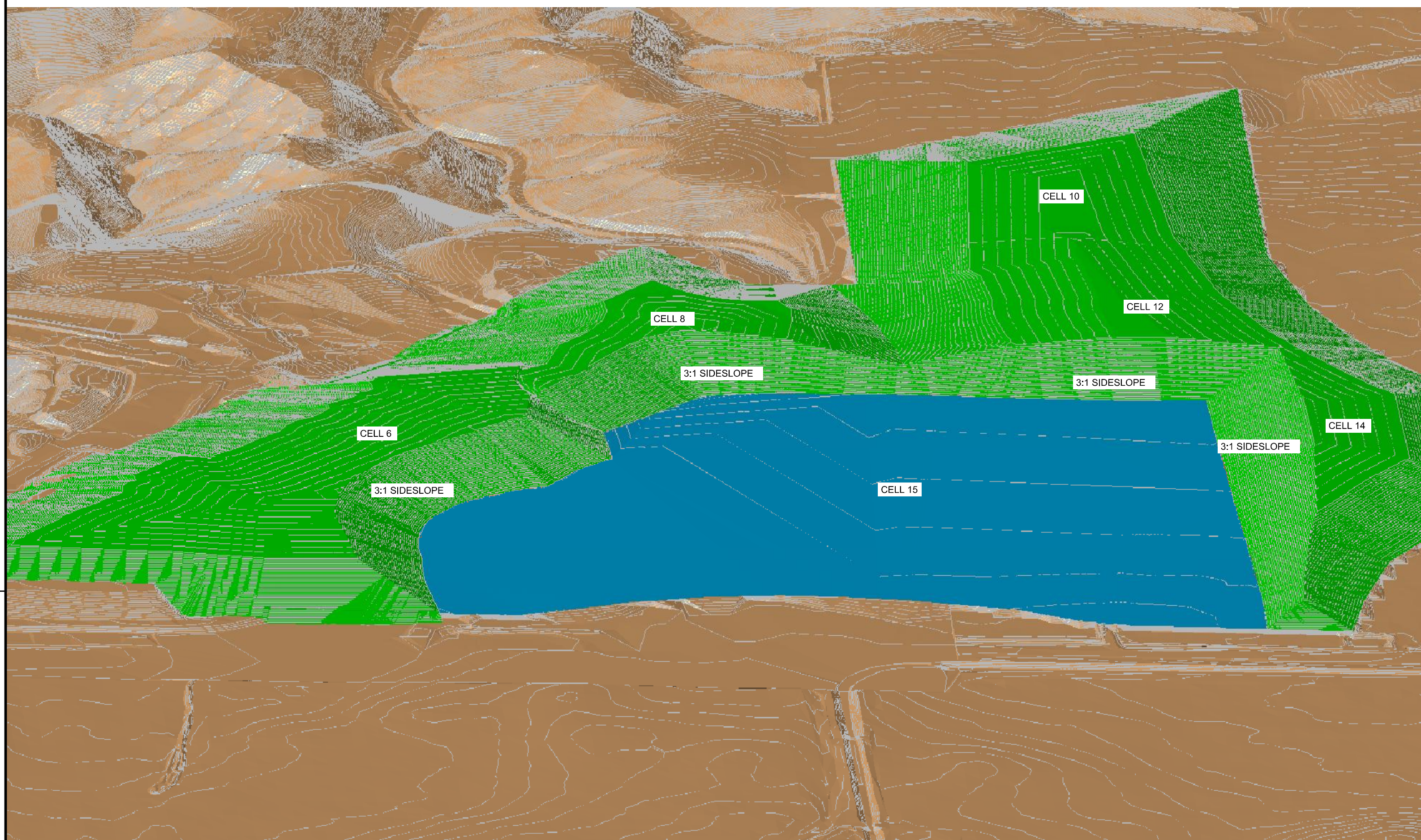

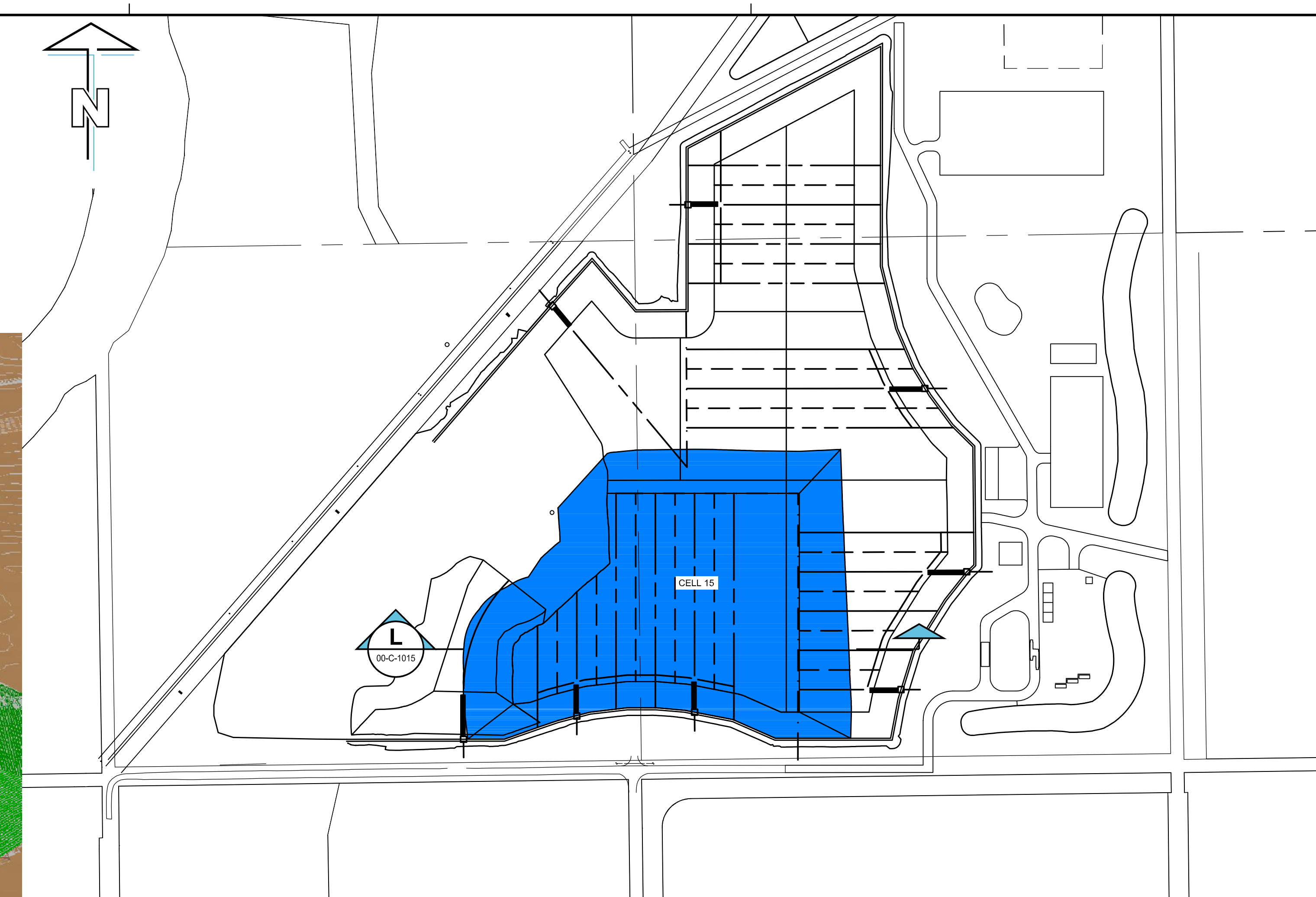

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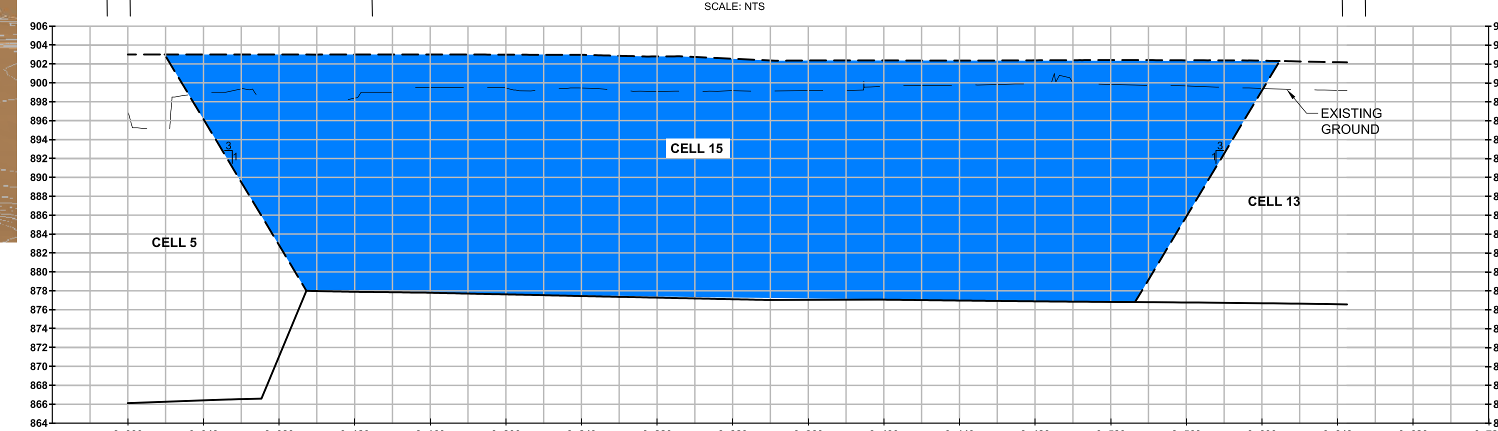

SECTION

L 00-C-1015

H=1:2000
V=1:1000

NOTE:

CELL 15
AIRSPACE : 3,844,676m³ 2,214,533mt
CONSTRUCTION : 2052
LIFE SPAN : 2053- TO 2060

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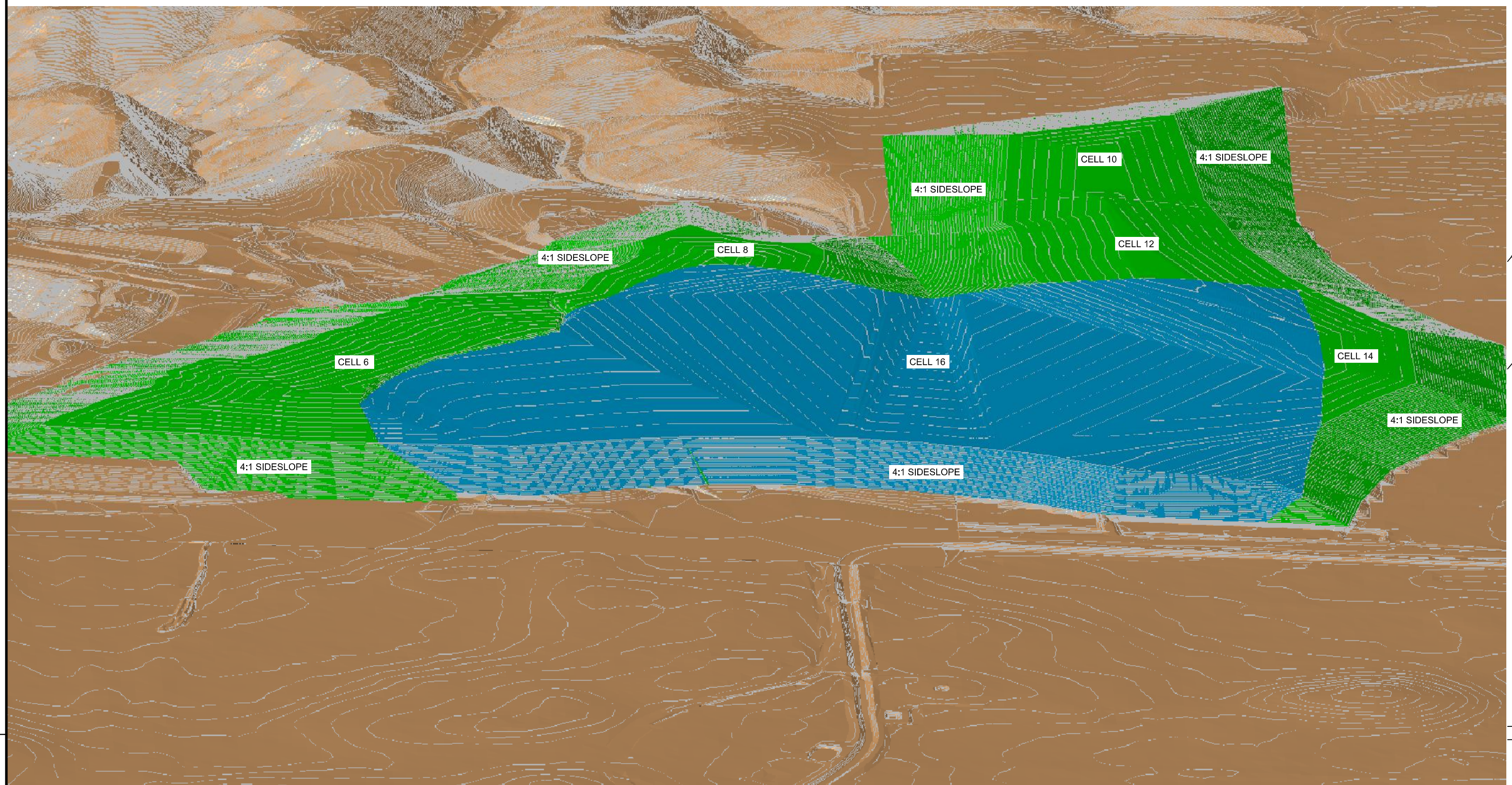

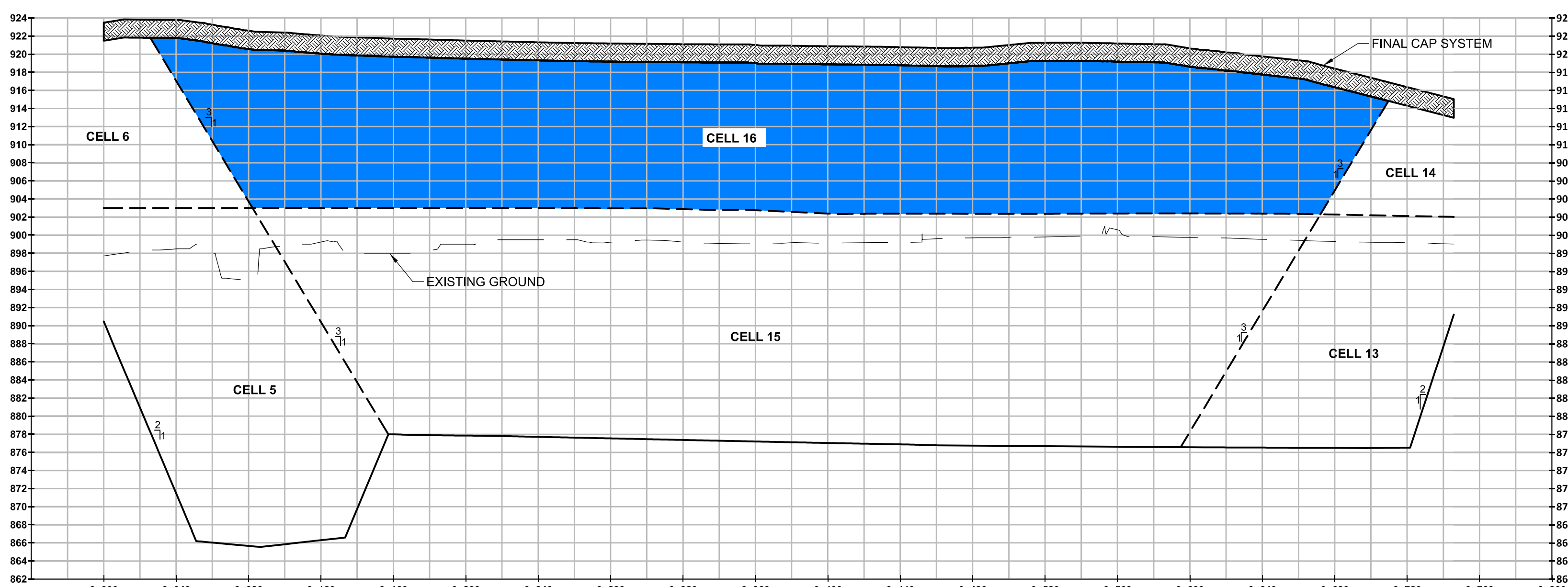

SECTION

M
00-C-1016

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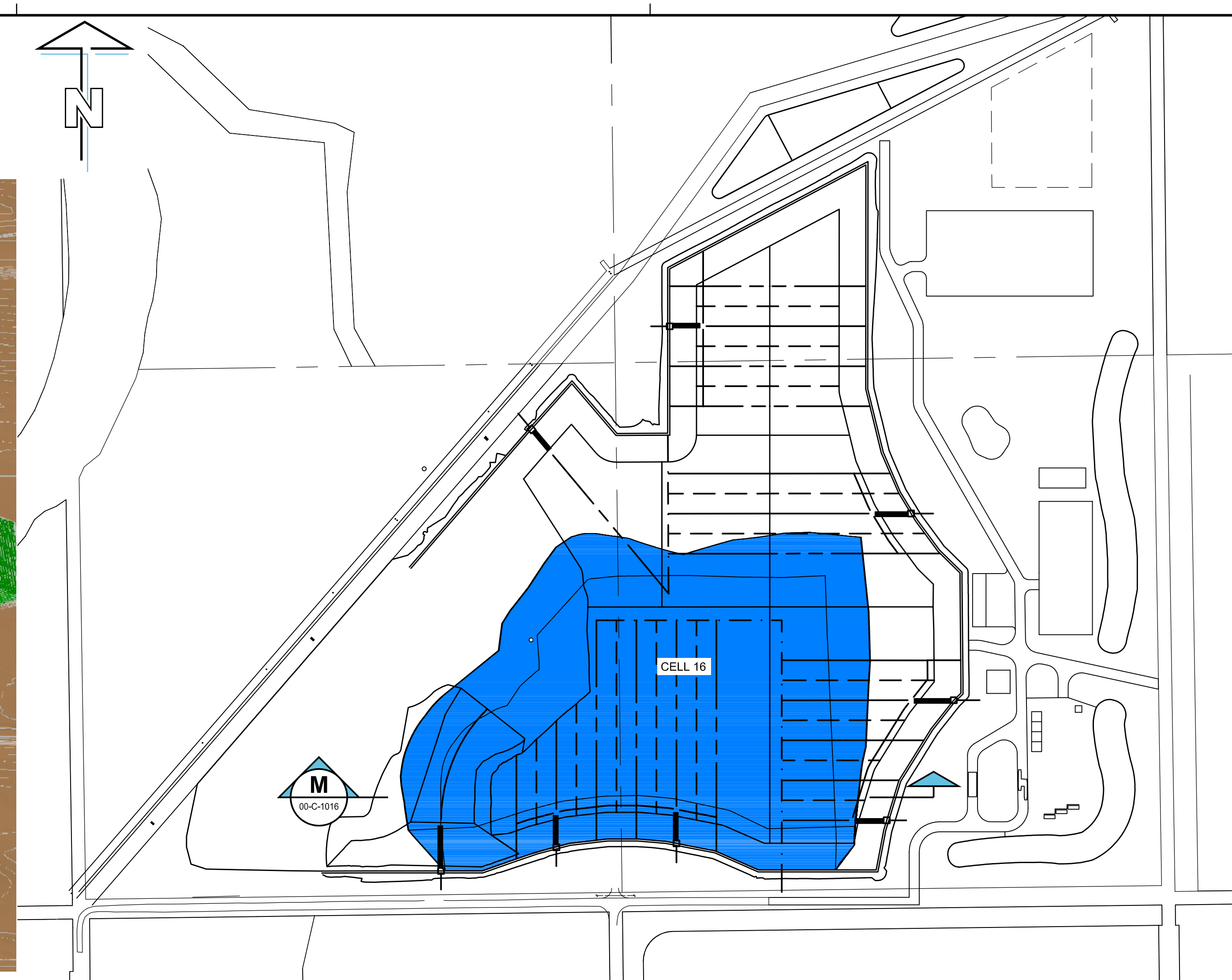

KEY PLAN

SCALE: NTS

NOTE:

CELL 16
AIRSPACE : 3,781,156m³ 2,177,948mt
LIFE SPAN : 2060 TO 2069

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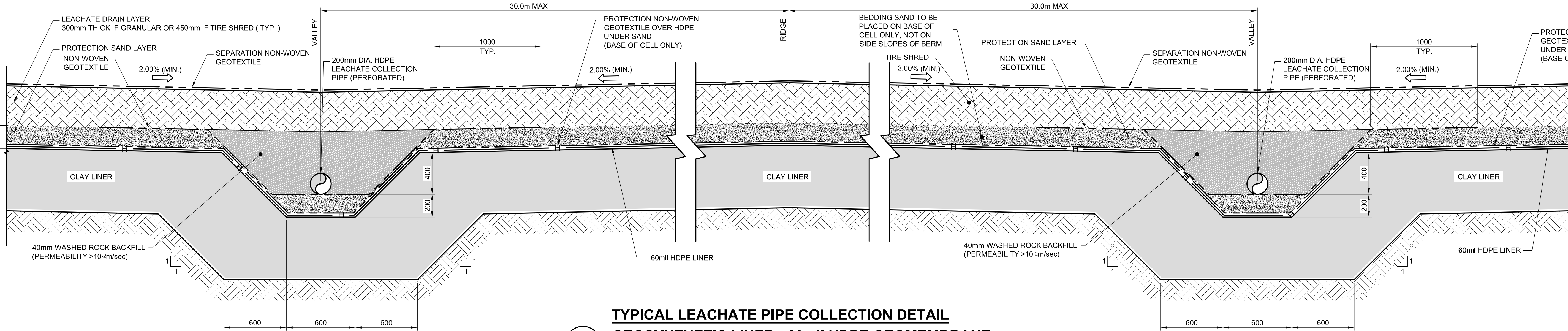
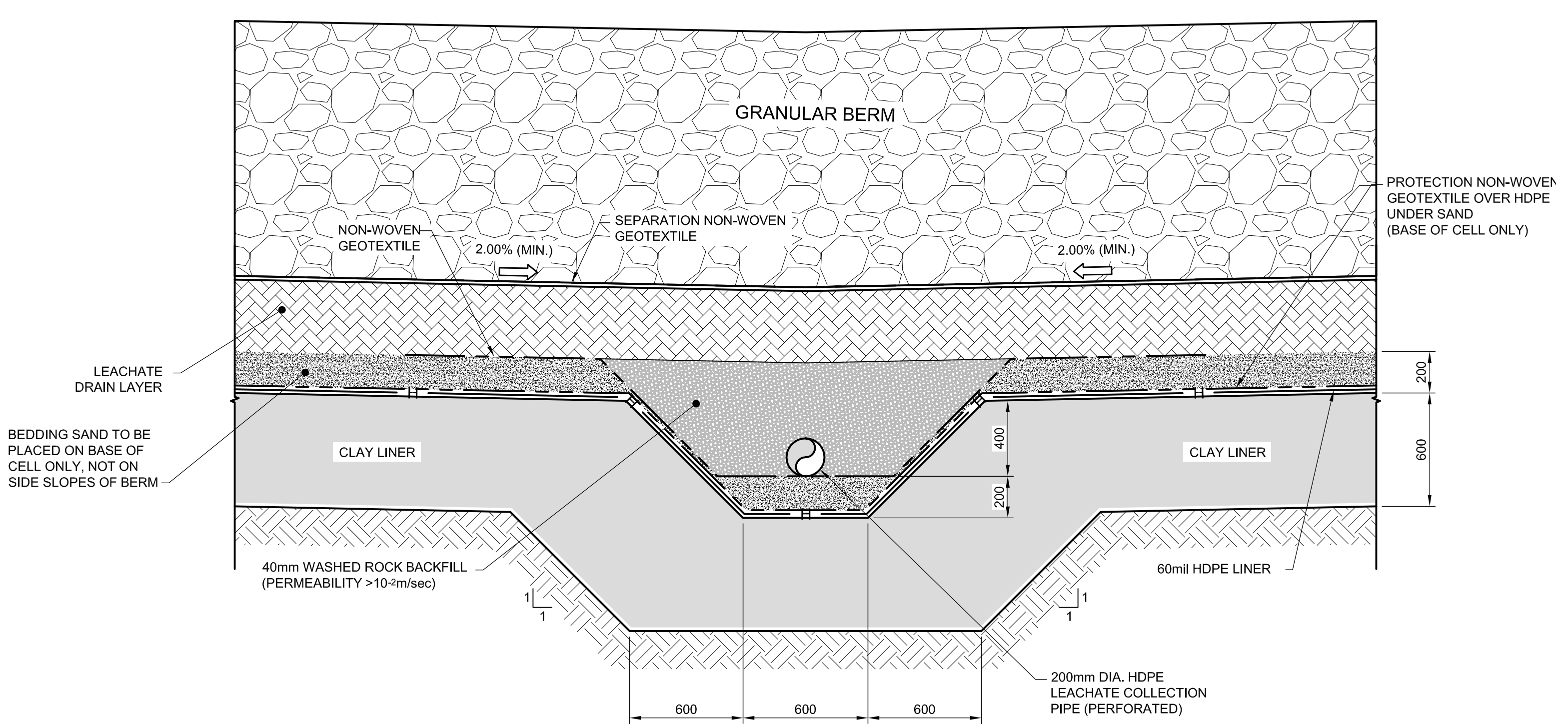


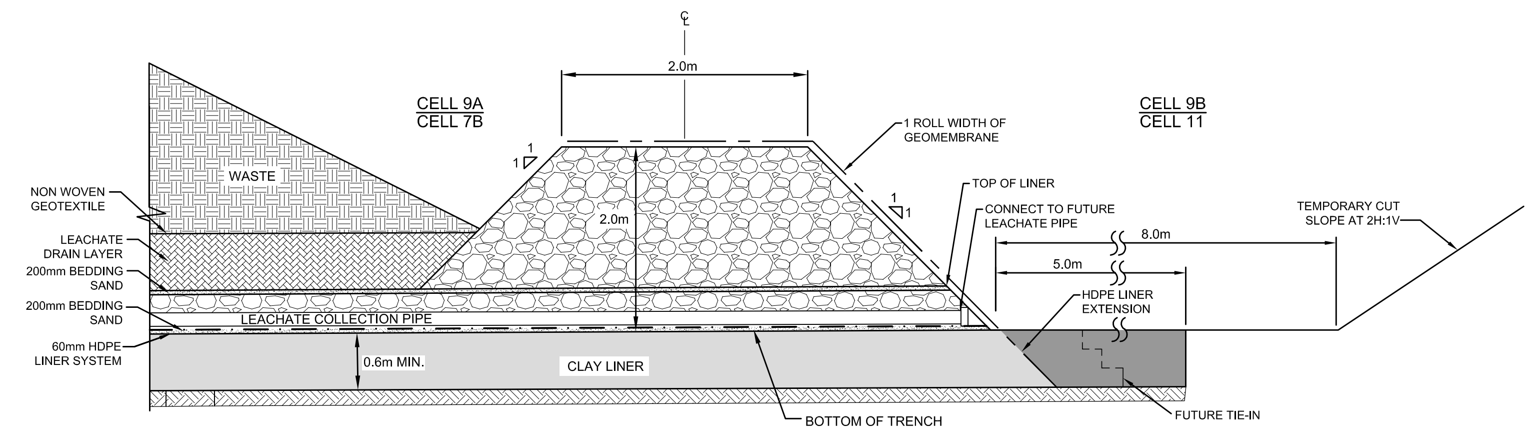
TYPICAL LEACHATE PIPE COLLECTION DETAIL
GEOSYNTHETIC LINER - 60mil HDPE GEOMEMBRANE

1 00-C-1005
SCALE: NTS

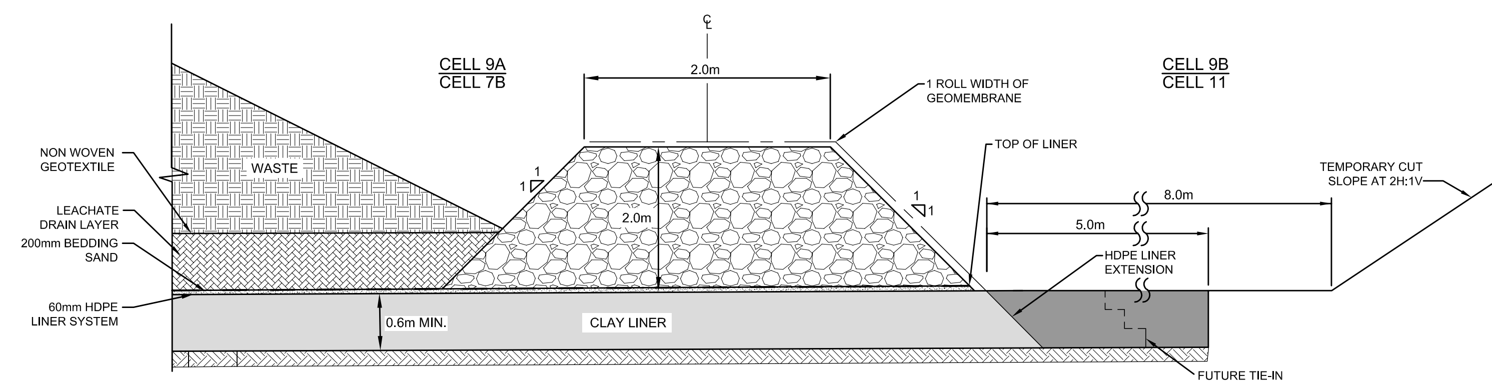
A 00-C-1022
B 00-C-1022



DETAIL 2 00-C-1002
SCALE: NTS
TYPICAL CROSS SECTION AT GRAVEL SEPARATION BERM



SECTION A 00-C-1022
SCALE: NTS
TYPICAL SEPARATION BERM SECTION BETWEEN 9A/9B, AND 7B/11 IN TRENCH



SECTION B 00-C-1022
SCALE: NTS
TYPICAL SEPARATION BERM SECTION BETWEEN 9A/9B, AND 7B/11

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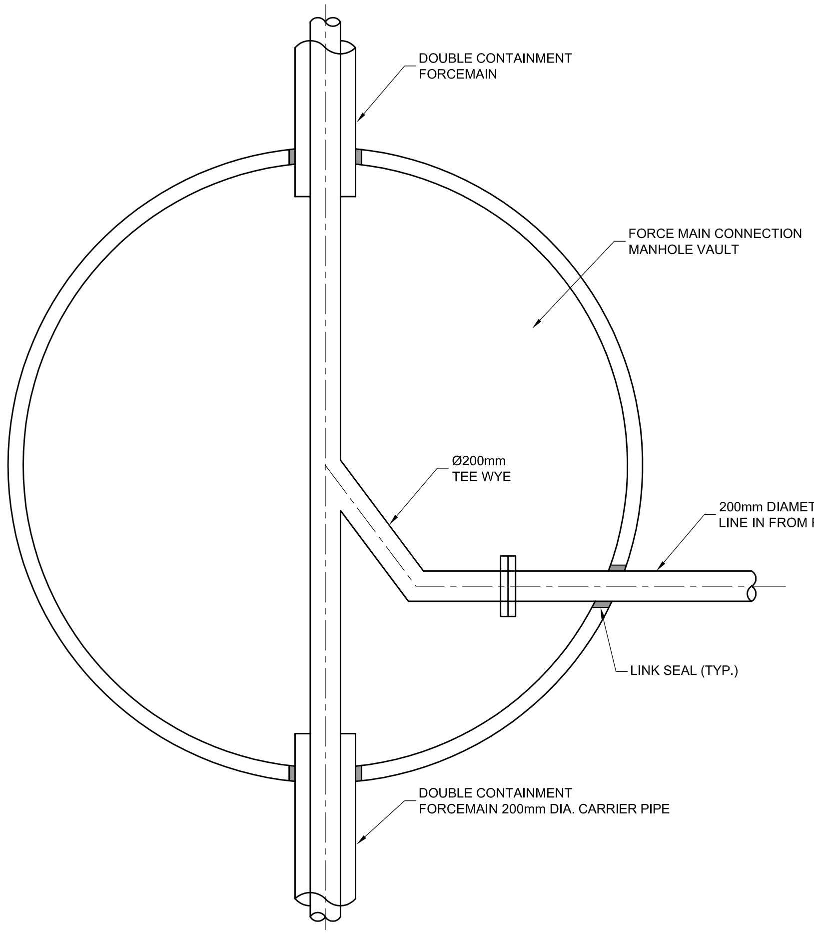
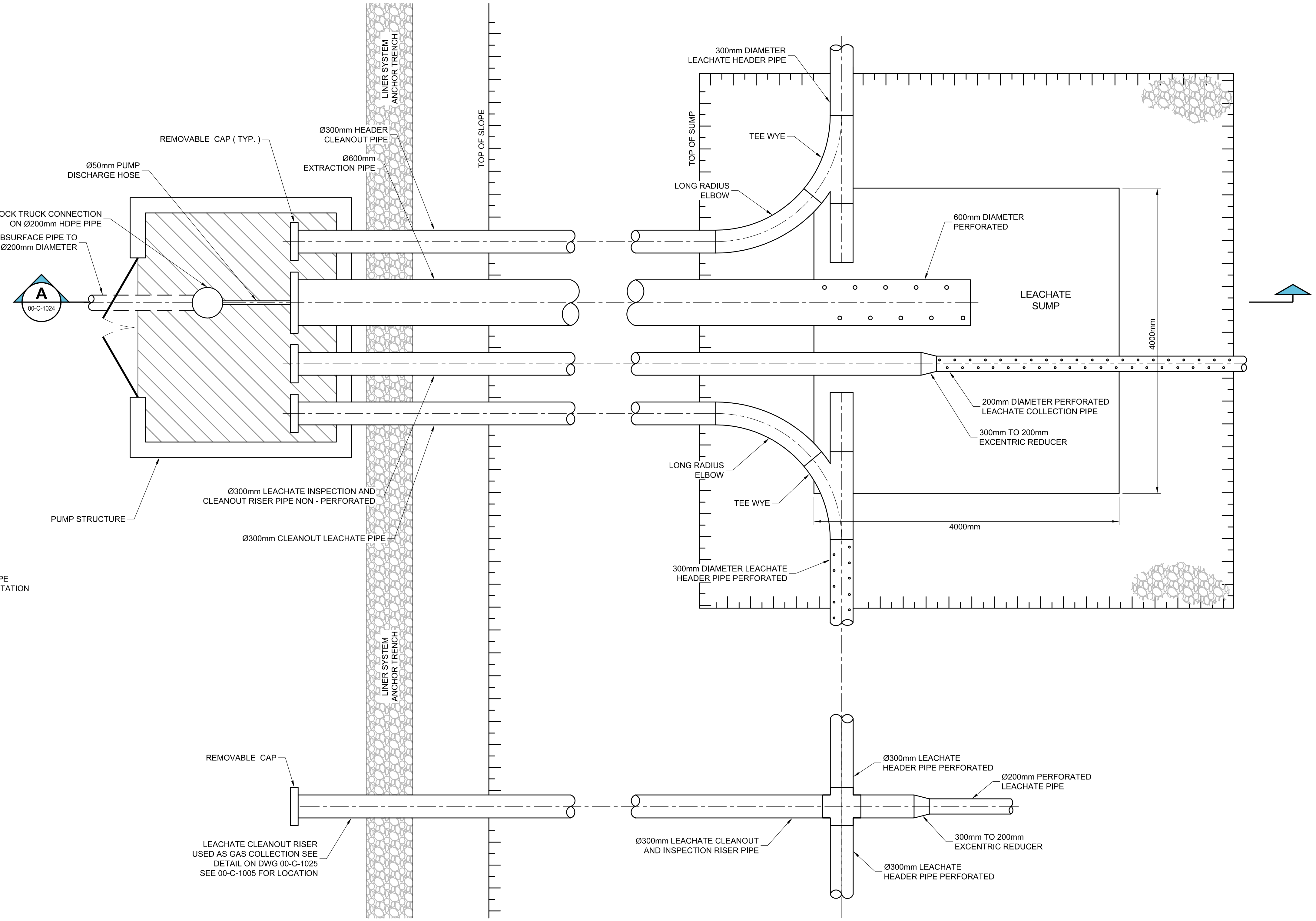


TYPICAL MANHOLE FORCEMAIN CONNECTION DETAIL 2 (00-C-1005)

0 0.25 0.5 0.75 m SCALE 1:25



TYPICAL PUMP STATION, HEADER CLEANOUT AND
HEADER / LEACHATE PIPE CONNECTION DETAIL 1 (00-C-1005)

0 0.3 0.6 0.9 m SCALE 1:30

AECOM FILE NAME: P:\60153727\4 DEVELOPMENT\3 CADD WIP\1 ICS\00\C-060153727-00-C-1023_RX.DWG

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PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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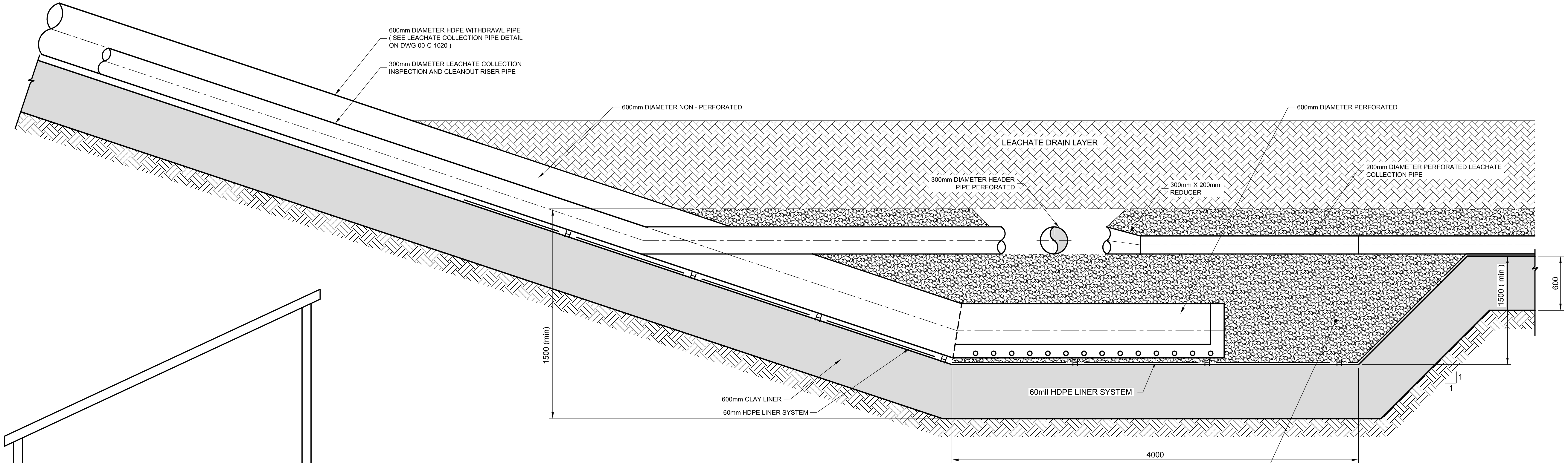
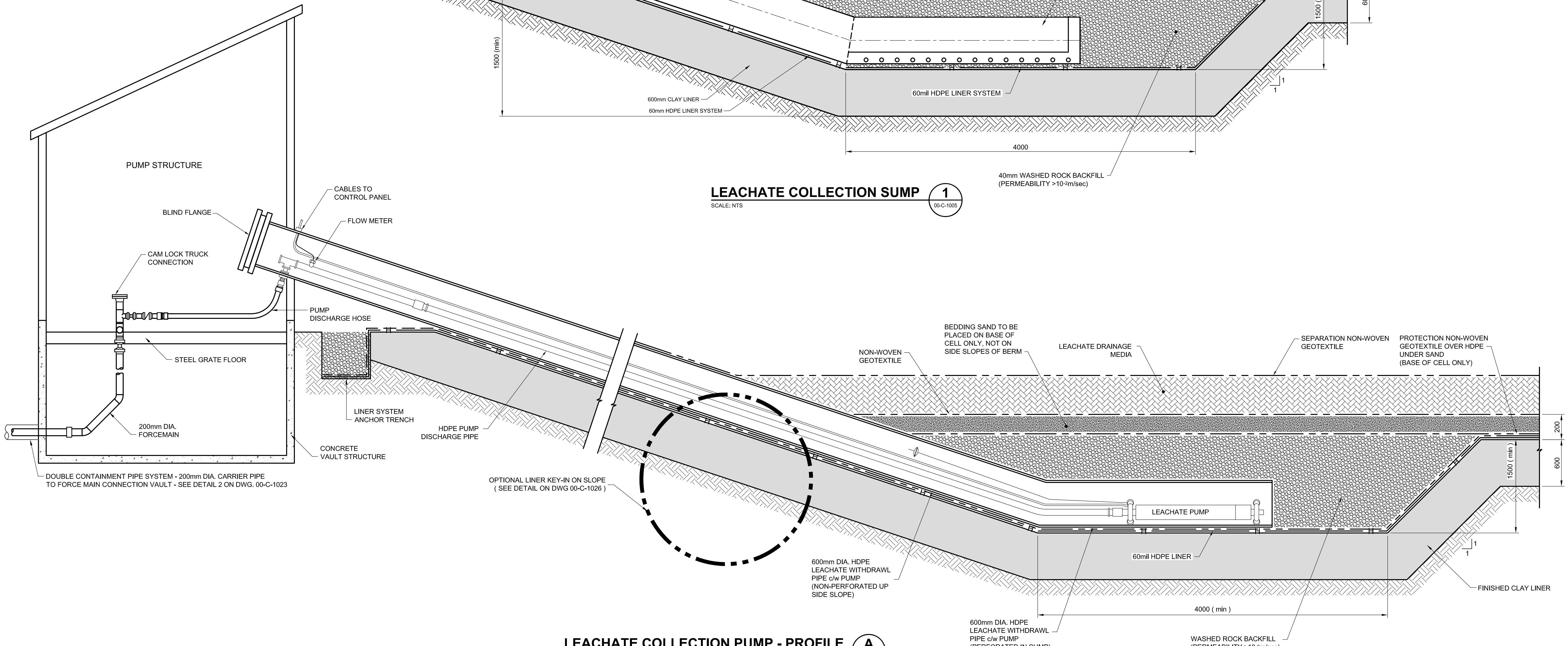
D SIZE 22" x 34" (558.8mm x 863.6mm)



LEACHATE COLLECTION SUMP 1 00-C-1005

SCALE: NTS



LEACHATE COLLECTION PUMP - PROFILE A 00-C-1023

SCALE: NTS

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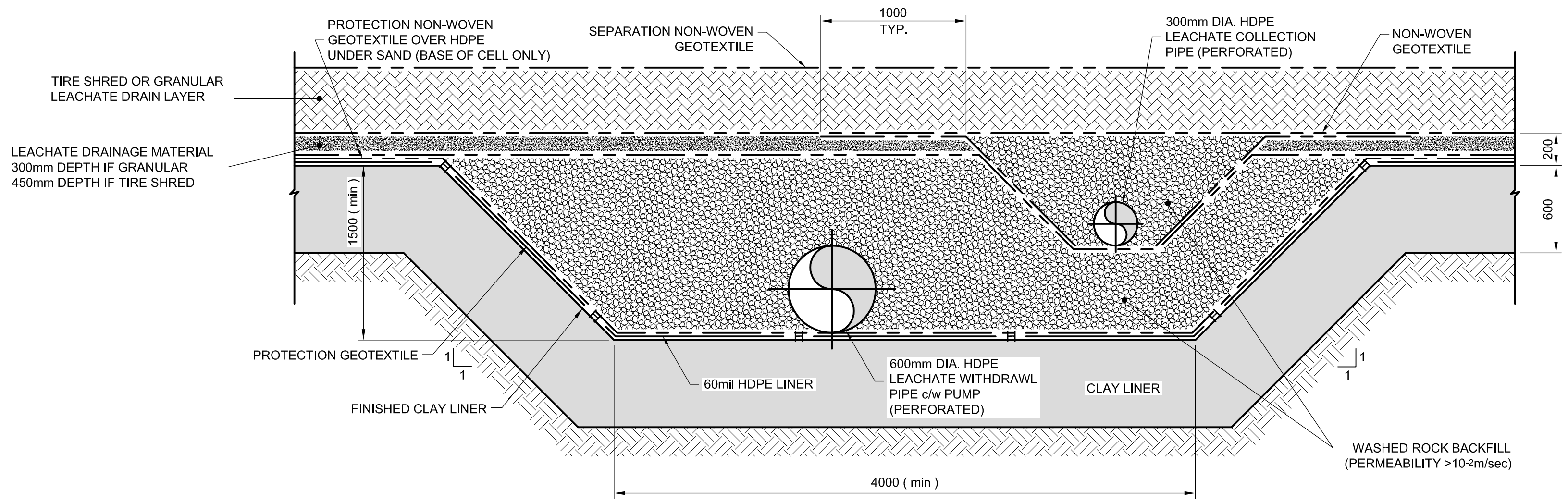

LEACHATE COLLECTION SUMP - SECTION A

00-C-1023

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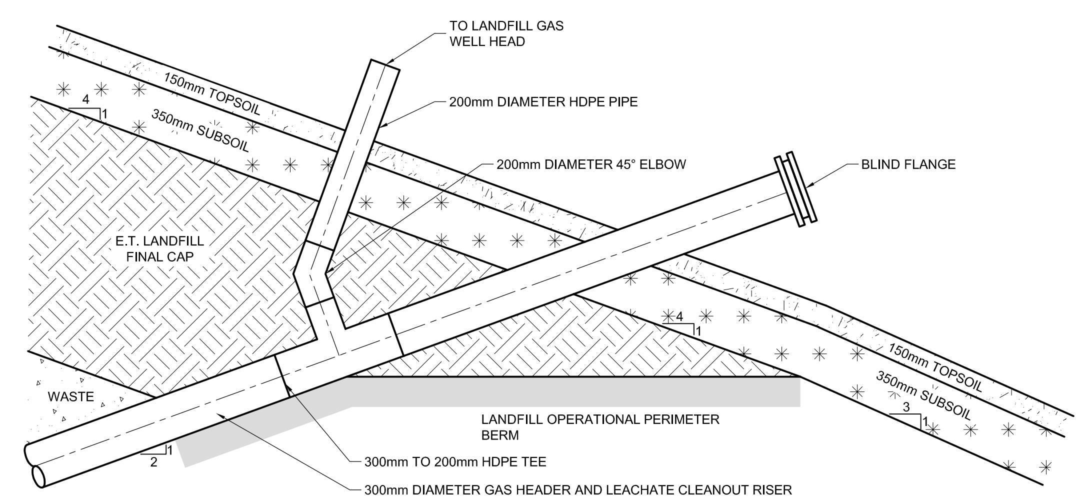

LEACHATE PIPE GAS COLLECTION DETAIL 1

00-C-1005

0 0.25 0.5 0.75 m SCALE 1:25

NOTE:

LEACHATE COLLECTION PIPE USED AS GAS COLLECTION PIPE
- SEE DRAWING 00-C-1005 FOR PROPOSED LOCATION

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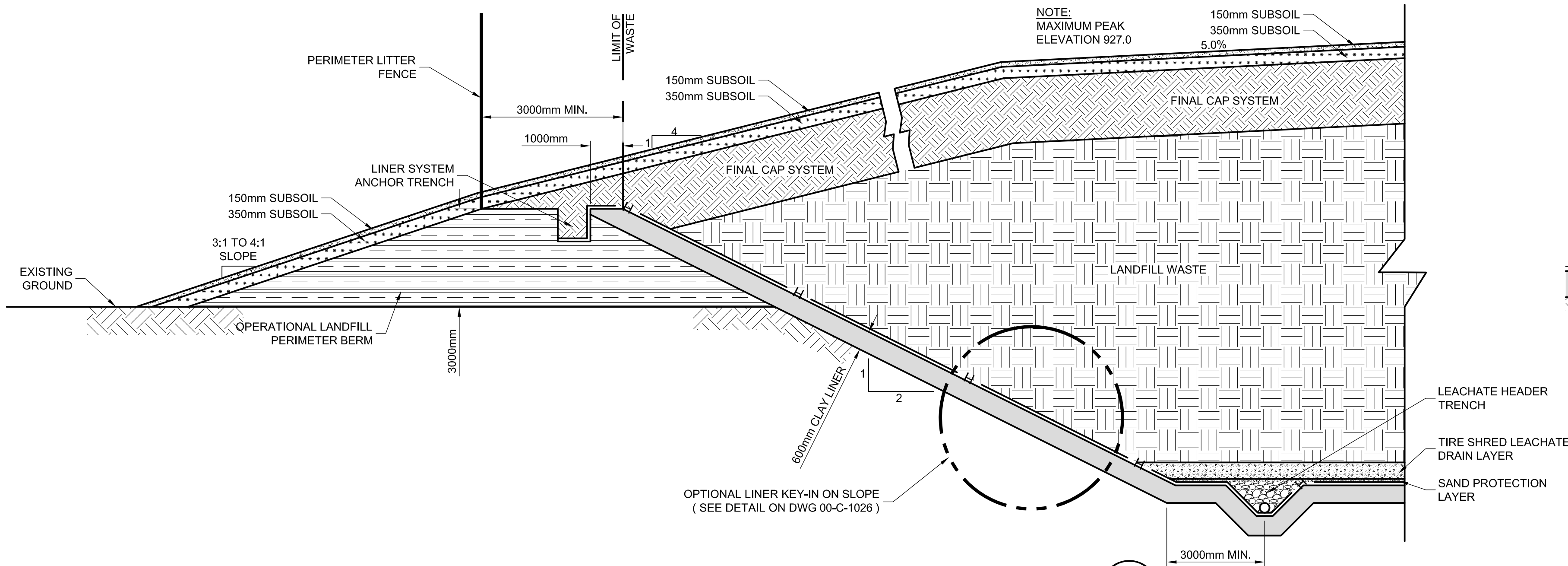
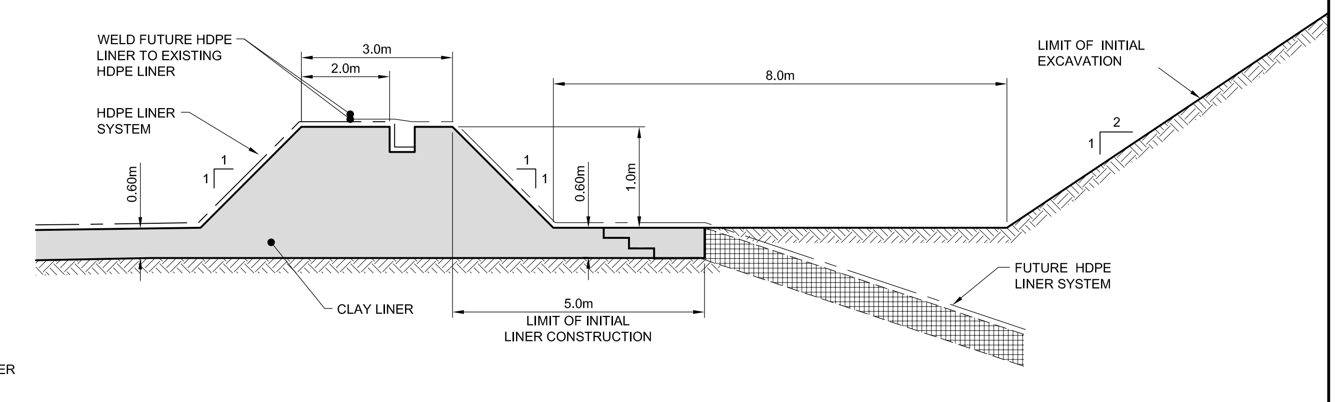


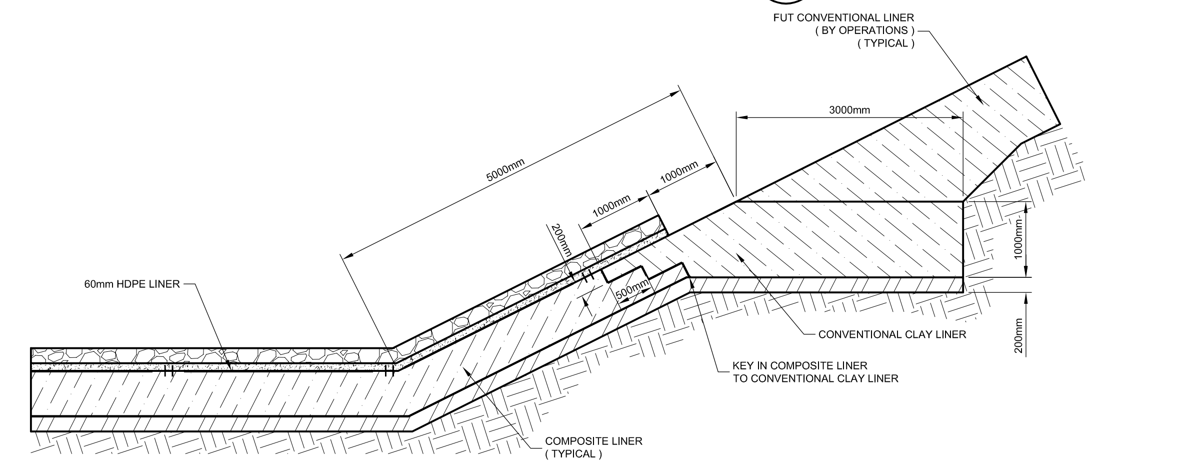
TYPICAL LANDFILL PERIMETER CROSS SECTION FULL HDPE 1 00-C-1005

0 1 2 3 m SCALE 1:100



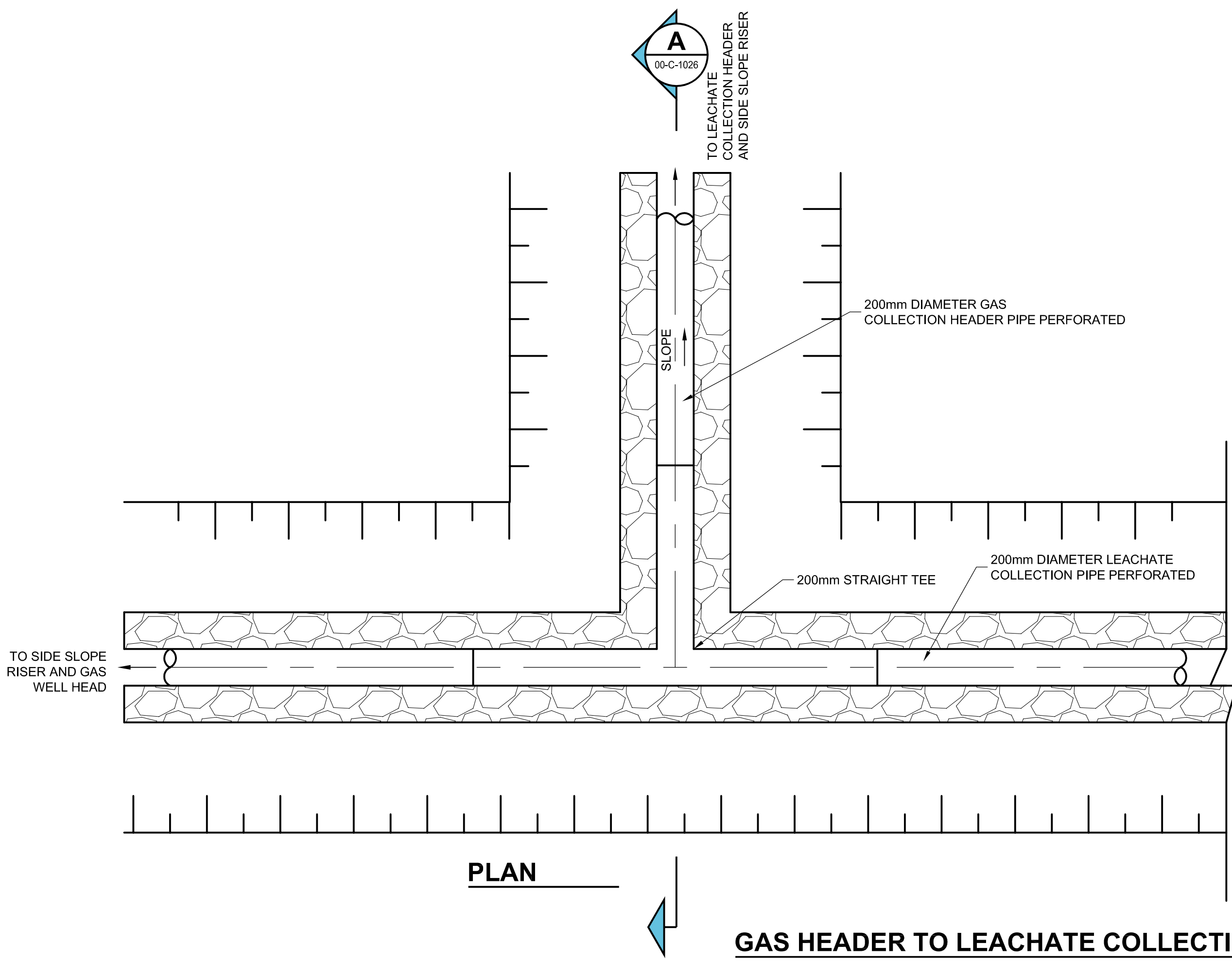
TYPICAL CLAY SEPARATION BERM 2 00-C-1002

SCALE: NTS



OPTIONAL CLAY AND COMPOSITE LINER KEY-IN ON SLOPE DETAIL

0 0.5 1 1.5 m SCALE 1:50



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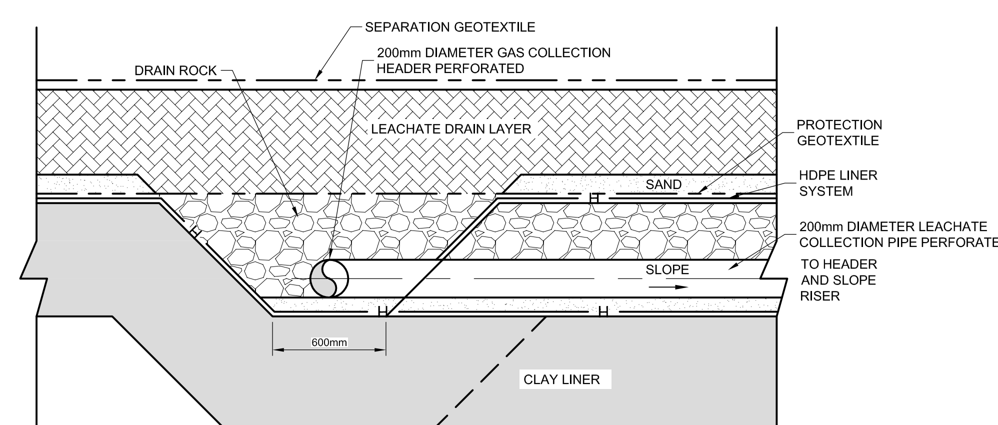

SECTION A 00-C-1026

0 0.2 0.4 0.6 m SCALE 1:20

GAS HEADER TO LEACHATE COLLECTION PIPE DETAIL 3 00-C-1005

0 0.2 0.4 0.6 m SCALE 1:20

D SIZE 22" x 34" (558.8mm x 863.6mm)

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PLOT: 8/2/2012 2:16:44 PM

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PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
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