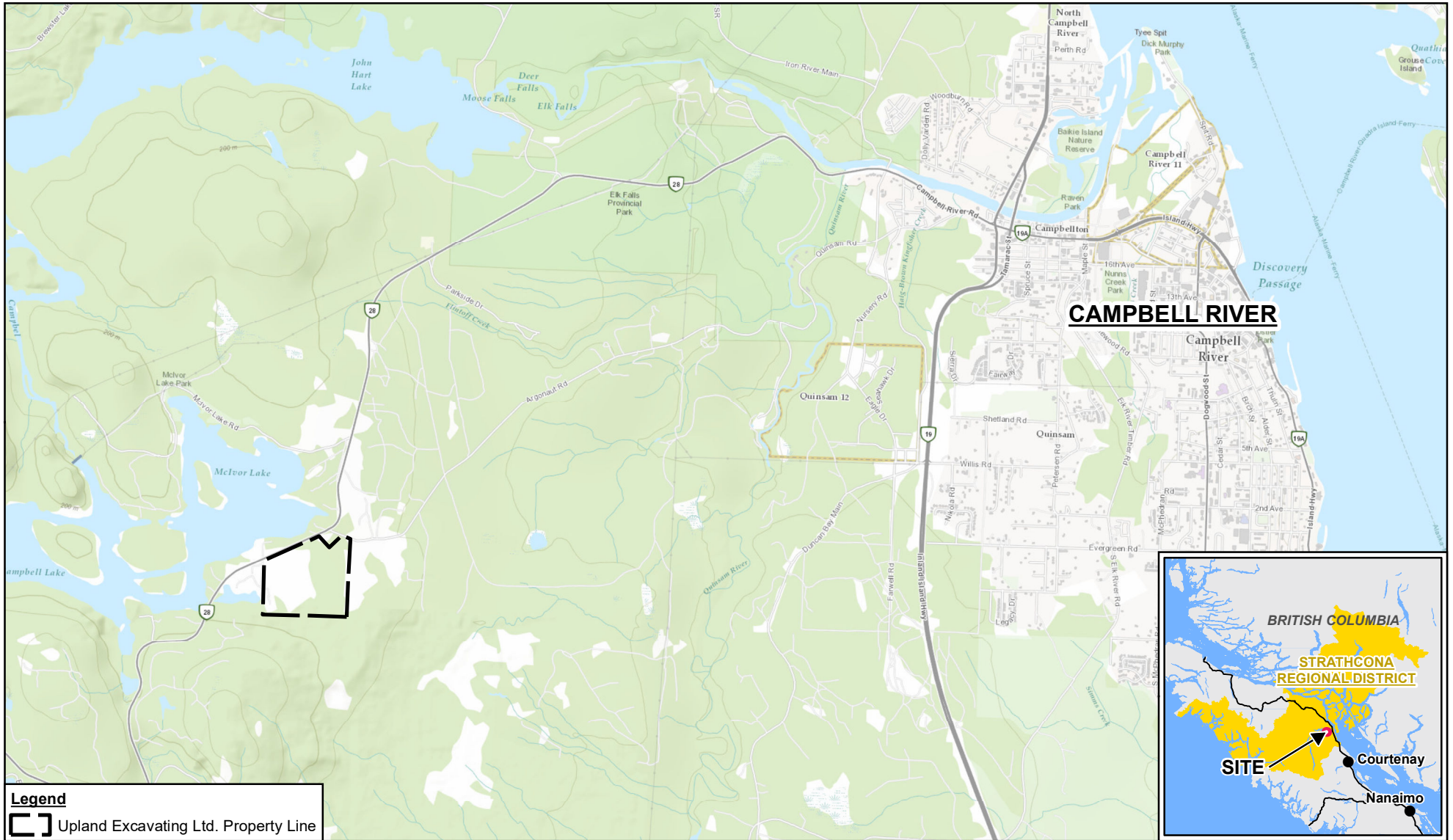
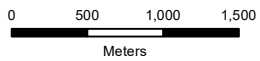


Figures



Source: ESRI Topographic Basemapping, Accessed 2020



Coordinate System:
 NAD 1983 UTM Zone 10N

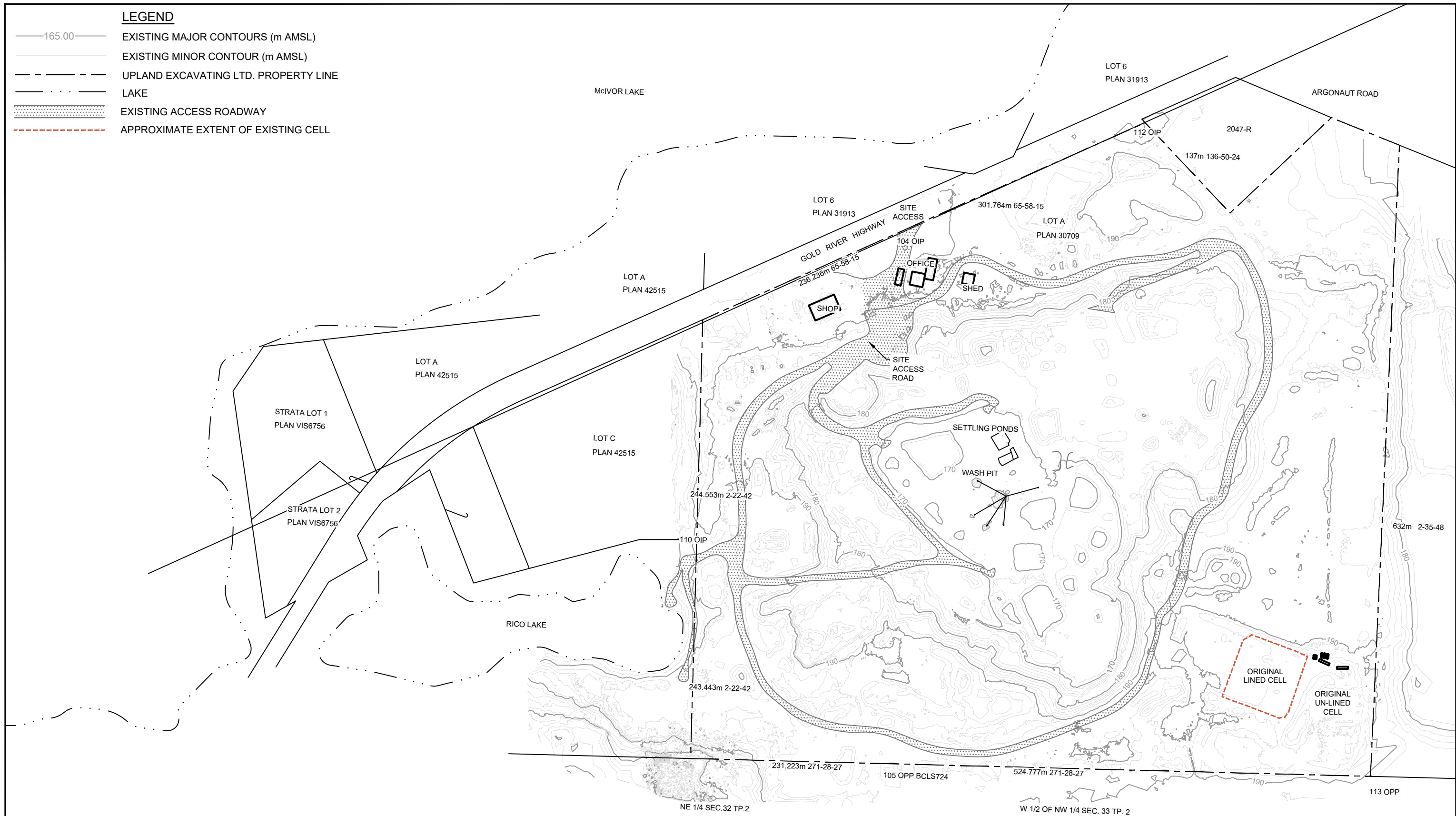


UPLAND EXCAVATING LTD.
 2021 DESIGN, OPERATIONS AND CLOSURE PLAN
 NORTHWIN LANDFILL, CAMPBELL RIVER, B.C.

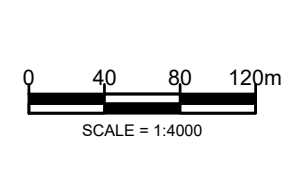
SITE LOCATION MAP

088877
 Jun 24, 2020

FIGURE 1.1



SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY McELHANNEY ASSOCIATES LAND SURVEYING LTD., NOVEMBER 21, 2016.

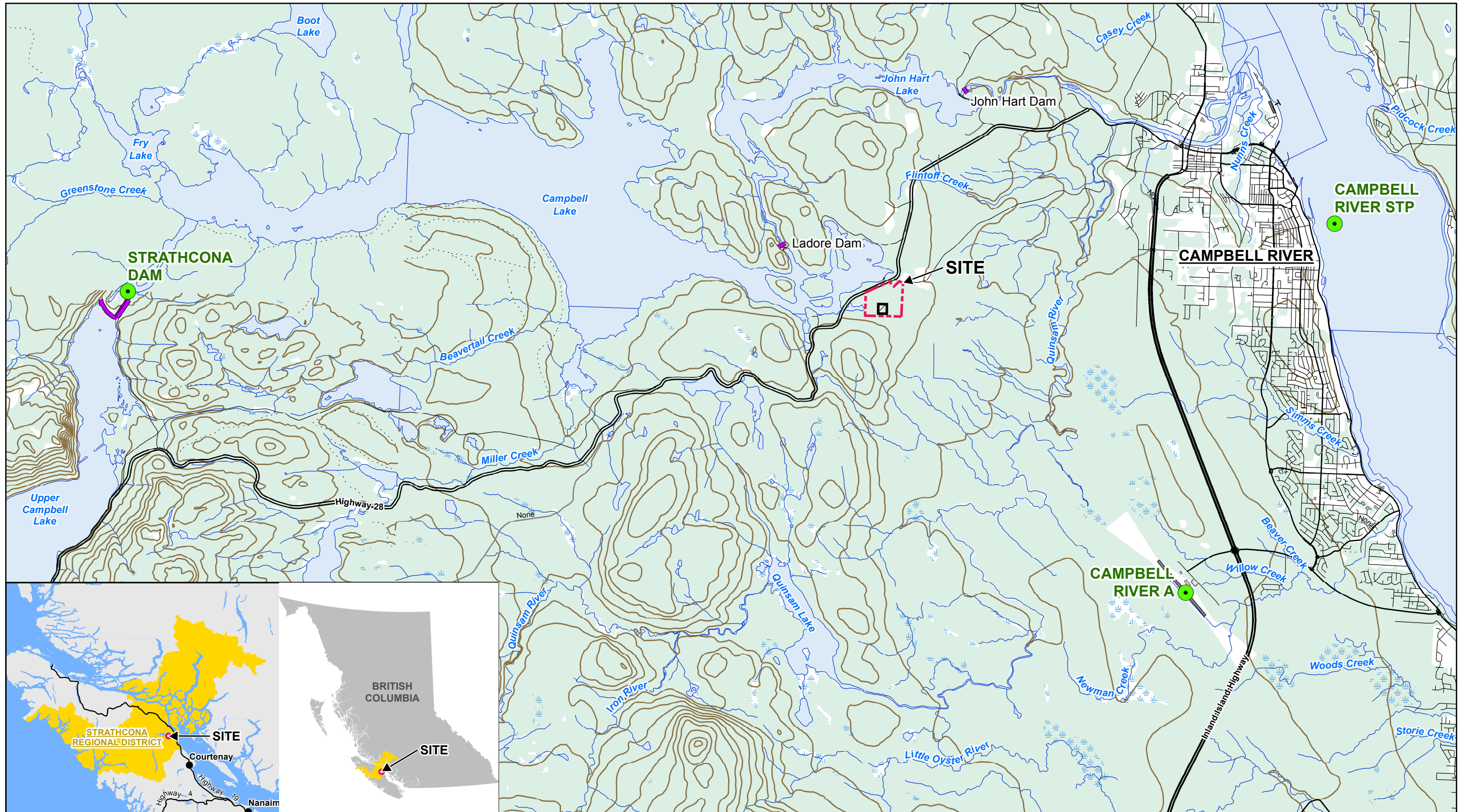


UPLAND EXCAVATING LTD.
 2021 DESIGN, OPERATIONS AND CLOSURE PLAN
 NEW LANDFILL (NORTHWIN LANDFILL), CAMPBELL RIVER, B.C.

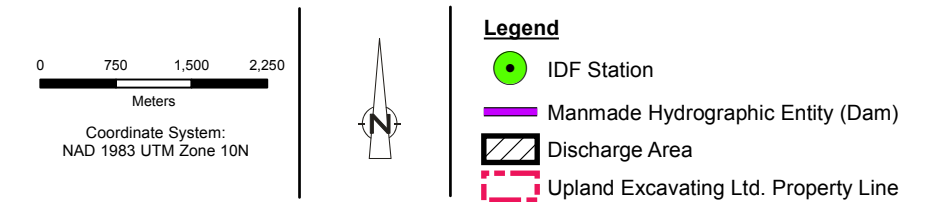
088877-11
 Jul 7, 2021

EXISTING SITE PLAN

FIGURE 1.2



Source: CanVec Edition 1.1 © Department of Natural Resources Canada, all rights reserved. National Road Network 2.0 GeoBase. ESRI Base Data, 2008.

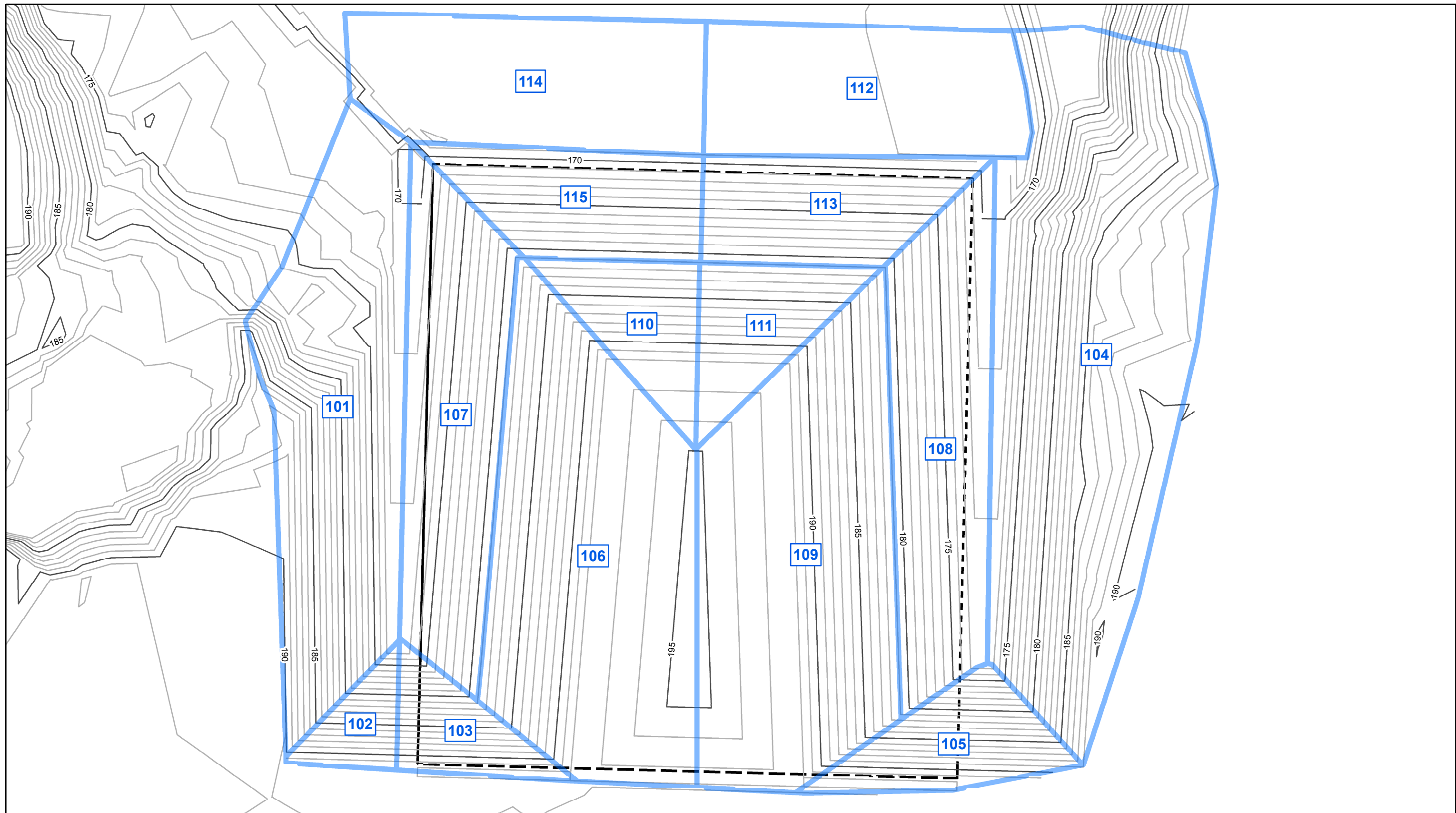


UPLAND EXCAVATING LTD.
2021 DESIGN, OPERATIONS, AND CLOSURE PLAN
NORTHWIN LANDFILL, CAMPBELL RIVER, B.C.

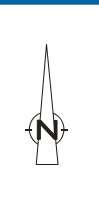
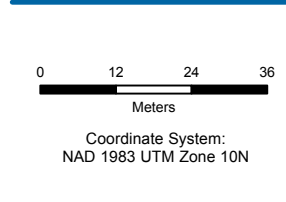
SITE LOCATION & IDF STATION LOCATIONS

088877-03
Jun 28, 2021

FIGURE 8.1



Source: CanVec Edition 1.1 © Department of Natural Resources Canada, all rights reserved. National Road Network 2.0 GeoBase. ESRI Base Data, 2008.



- Legend**
- Limit of Waste
 - Subcatchment Boundary
 - Major Contour (5 m)
 - Minor Contour (1 m)
 - Subcatchment Number

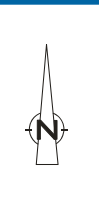
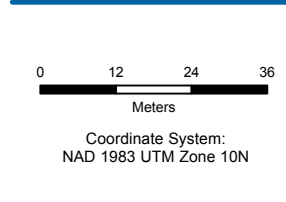
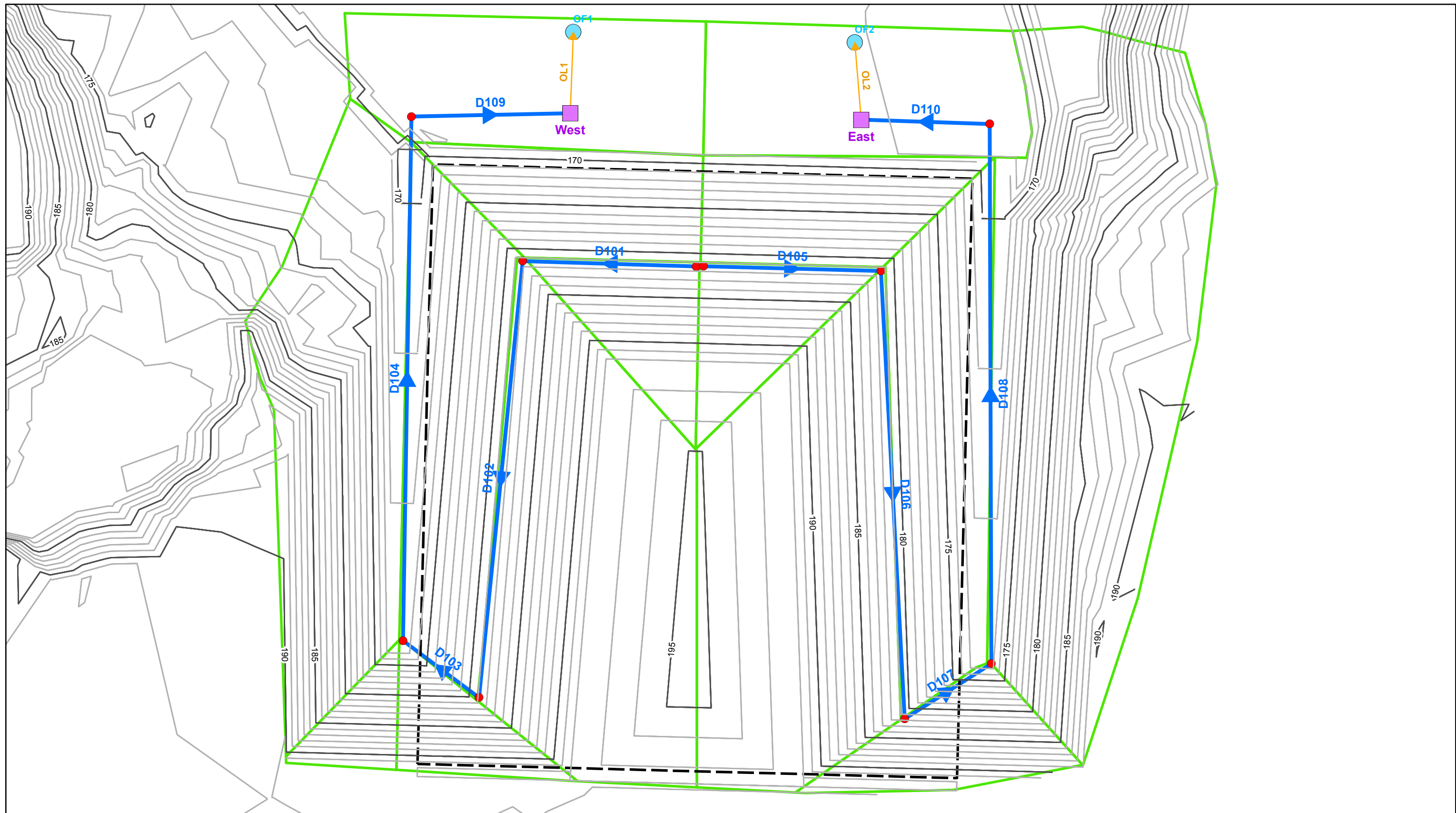


UPLAND EXCAVATING LTD.
 2021 DESIGN, OPERATIONS, AND CLOSURE PLAN
 NORTHWIN LANDFILL, CAMPBELL RIVER, B.C.

SURFACE WATER CATCHMENT BOUNDARIES

088877-03
 June 28, 2021

FIGURE 8.2



Legend

- Limit of Waste
- Major Contour (5 m)
- Minor Contour (1 m)
- Conduits
- Outlets
- Sediment Forebay
- Junctions
- Infiltration Area

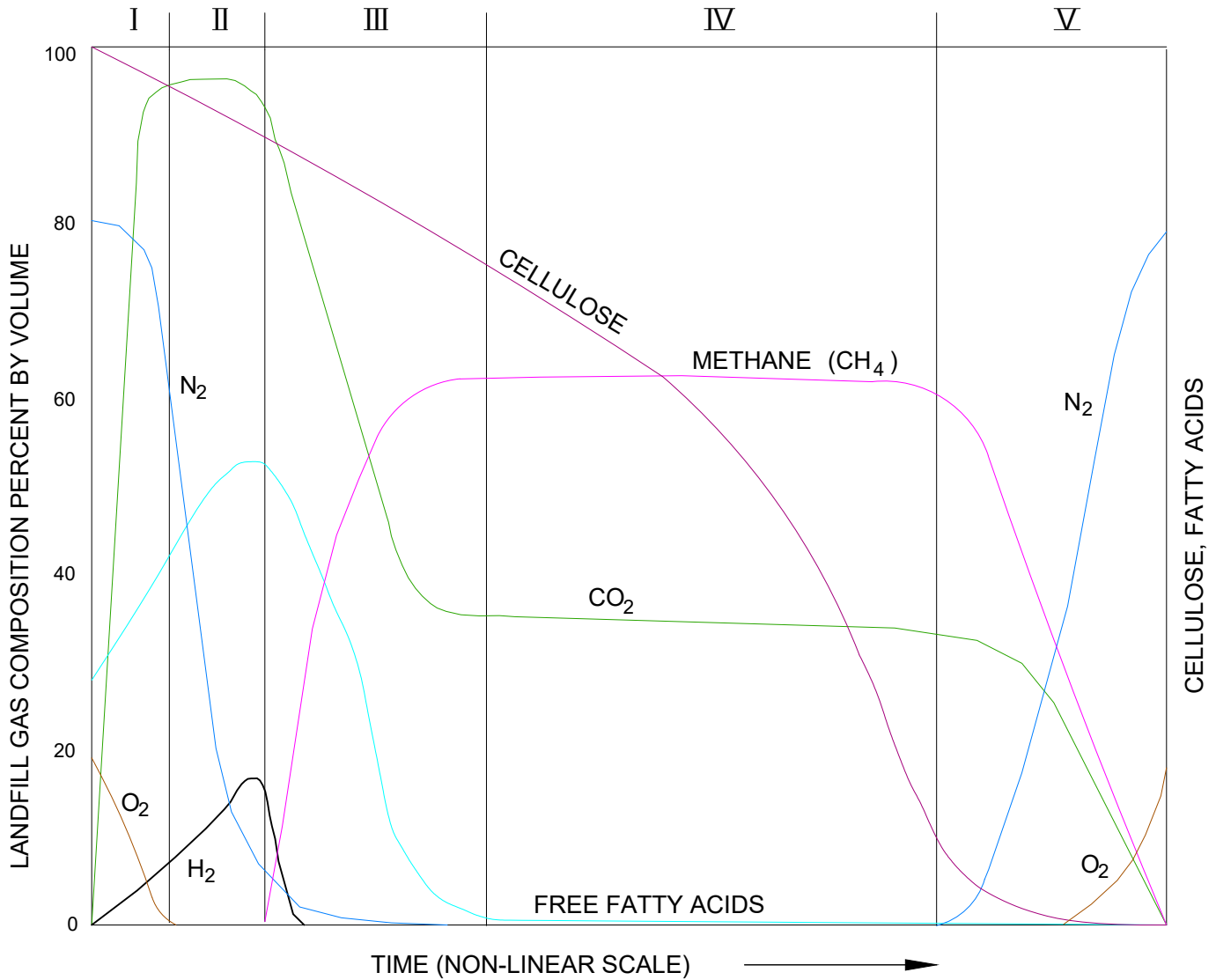


UPLAND EXCAVATING LTD.
2021 DESIGN, OPERATIONS, AND CLOSURE PLAN
NORTHWIN LANDFILL, CAMPBELL RIVER, B.C.
SURFACE WATER FLOW SCHEMATIC

088877-03
June 28, 2021

FIGURE 8.3

LANDFILL GAS PRODUCTION PATTERN
PHASES



PHASES	CONDITION	TIME FRAME - TYPICAL
I	AEROBIC	HOURS TO 1 WEEK
II	ANOXIC	1 TO 6 MONTHS
III	ANAEROBIC, METHANOGENIC, UNSTEADY	3 MONTHS TO 3 YEARS
IV	ANAEROBIC, METHANOGENIC, STEADY	8 TO 40 YEARS
V	ANAEROBIC, METHANOGENIC, DECLINING	1 TO 40+ YEARS
TOTAL		10 TO 80+ YEARS

SOURCE:

FARQUHAR AND ROVERS, 1973,
AS MODIFIED BY REES, 1980,
AND AUGENSTEIN & PACEY, 1991.

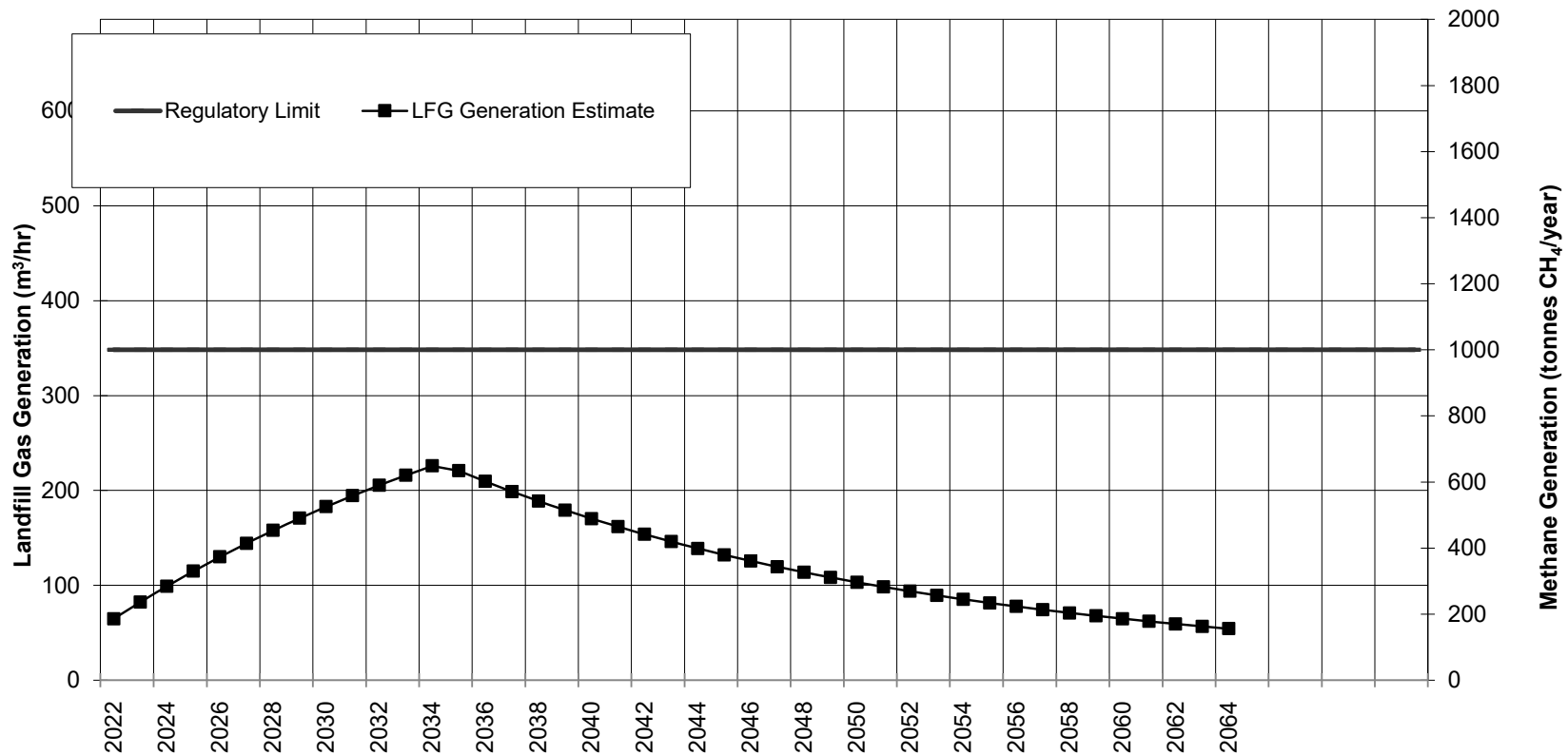


UPLAND EXCAVATING LTD.
2021 DESIGN, OPERATIONS AND CLOSURE PLAN
NORTHWIN LANDFILL, CAMPBELL RIVER, B.C.

88877
Jun 10, 2020

TYPICAL LANDFILL GAS PRODUCTION STAGES

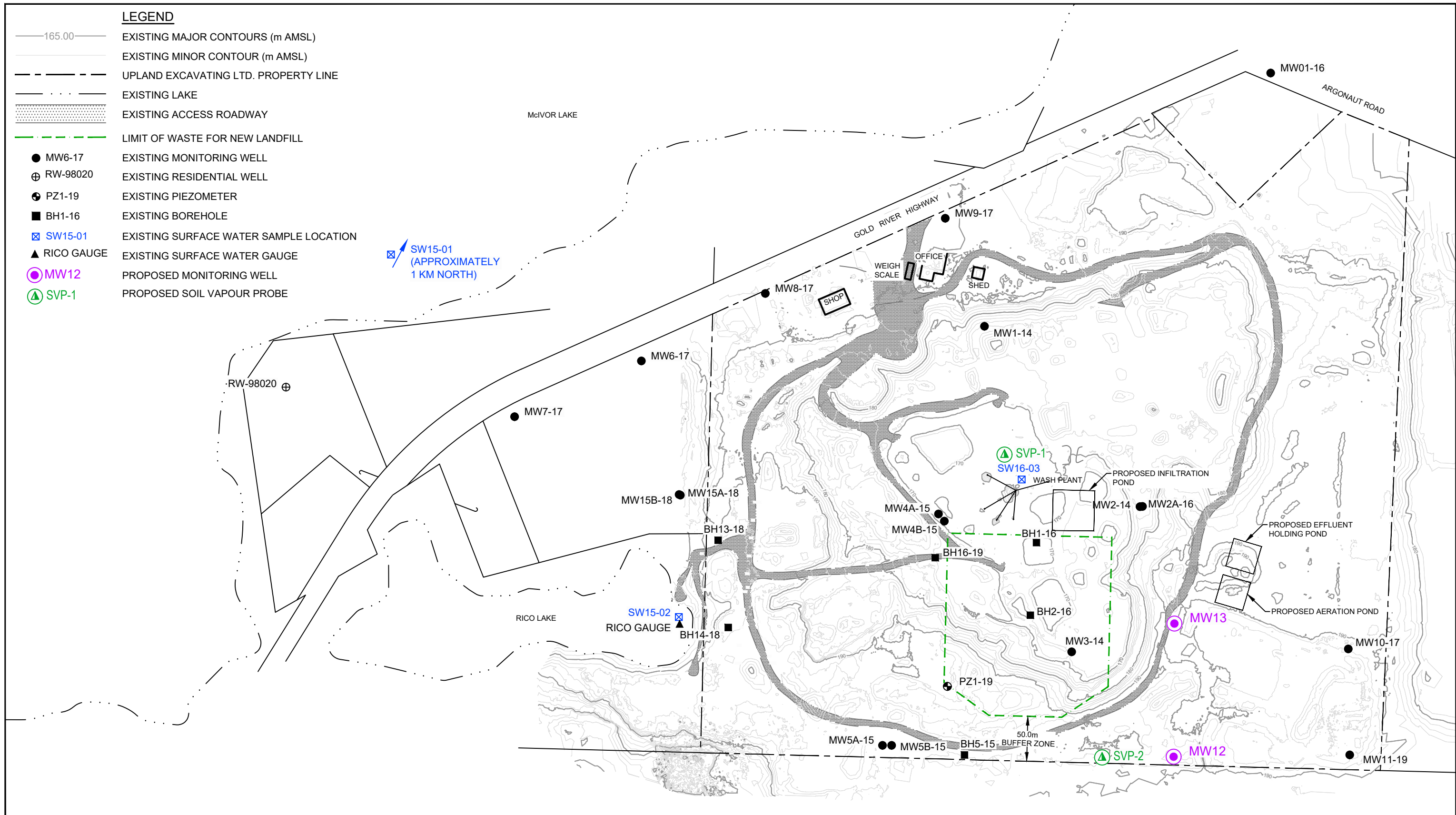
FIG. 10.1



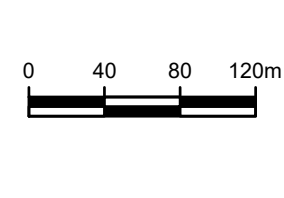
k values (year ⁻¹)	0.02, 0.06, 0.11	<u>Waste Composition</u>	
L ₀ (weighted) (m ³ CH ₄ /tonne)	20, 120, 160	Relatively Inert (%)	75.0%
Precipitation (mm/year)	1,489	Moderately Decomposable (%)	25.0%
Volumetric LFG Composition (percent methane)	50%	Decomposable (%)	0.0%



FIGURE 10.2
LANDFILL GAS GENERATION ESTIMATE
2021 DESIGN, OPERATIONS, AND CLOSURE PLAN
NORTHWIN LANDFILL
Upland Excavations Ltd.
Campbell River, British Columbia



SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY McELHANNEY ASSOCIATES LAND SURVEYING LTD., NOVEMBER 21, 2016.



UPLAND EXCAVATING LTD.
 2021 DESIGN, OPERATIONS AND CLOSURE PLAN
 NORTHWIN LANDFILL, CAMPBELL RIVER, B.C.
ENVIRONMENTAL MONITORING PROGRAM
PROPOSED INVESTIGATION LOCATIONS

88877

July 3, 2020

FIGURE 14.1

Tables

Table 2.1

Climate Data
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Month	Daily Average Temperature (Celcius)	Daily Maximum Temperature (Celcius)	Daily Minimum Temperature (Celcius)	Rainfall (mm)	Snowfall (cm) ¹	Precipitation (mm) ¹
January	2.4	5.5	-0.8	195	23	218
February	3.2	7.2	-0.7	136	14	150
March	5.2	9.7	0.7	128	12	140
April	8	13.2	2.8	92	1	92
May	11.6	17	6.2	68	0	68
June	14.7	20.1	9.3	63	0	63
July	17.3	23	11.5	39	0	39
August	17.2	23.3	11.1	45	0	45
September	13.7	19.8	7.6	55	0	55
October	8.6	13.1	4.0	161	1	162
November	4.4	7.7	1.0	222	11	232
December	2.1	4.9	-0.8	204	23	226
Annual	9.0	13.7	4.3	1408	84	1489
Plan2Adapt Climate Change Factor	+ 1.5					+ 5.2%
Annual (Adjusted for Climate Change)	10.5					1567

Notes:

Source: Environment Canada: Climate Normals - Campbell River Airport (Station No. - 1021261), 1981 - 2010 Station Data

¹ 1 cm of snowfall corresponds to 1 mm of precipitation

Table 4.1

**Average Annual Tonnes of Waste to be Disposed in Landfill
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia**

	Year	Stage	Forecasted Annual Waste Discharged (tonnes)	Waste in Place Cummulative (tonnes)
1	2022	Stage 1 East	138,238	138,238
2	2023	Stage 1 West	45,000	183,238
3	2024	Stage 1 West	45,000	228,238
4	2025	Stage 1 West/ Stage 2 A	45,000	273,238
5	2026	Stage 2 A	45,000	318,238
6	2027	Stage 2 A	45,000	363,238
7	2028	Stage 2 A	45,000	408,238
8	2029	Stage 2 A/ Stage 2 B	45,000	453,238
9	2030	Stage 2 B/ Stage 2 C	45,000	498,238
10	2031	Stage 3 A	45,000	543,238
11	2032	Stage 3 A	45,000	588,238
12	2033	Stage 3 A / Stage 3 B	45,000	633,238
13	2034	Stage 3 B / Stage 3C	45,000	678,238
14	2035	Stage 3 C	13,836	692,075

Table 5.1

**Landfill Stages
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia**

Landfill Phase	Landfill Capacity			Years Active	
	m ³	tonnes	No. of Years		
Phase 1 East	106,337	138,238	1.0	2022	2023
Phase 1 West	101,447	131,881	2.9	2023	2025
Phase 2A	106,823	138,870	3.1	2025	2029
Phase 2B	44,912	58,386	1.3	2029	2030
Phase 2C	27,085	35,211	0.8	2030	2031
Phase 3A	67,949	88,334	2.0	2031	2033
Phase 3B	44,266	57,546	1.3	2033	2034
Phase 3C	33,546	43,610	1.0	2034	2035
Total	532,365	692,075	13.3	2022	2035

Notes:

Apparent Density of Waste

1.3 t/m³

Allowable Discharge Year 1 = original landfill tonnes + allowable tonnes

138,238 tonnes

Allowable Discharge Year 2 onward

45,000 t/yr

Table 5.2

Material Requirement
2020 Design, Operations and Closure Plan
New Landfill (Northwin Landfill)
Upland Excavating Ltd.
Campbell River, British Columbia

		Cell Construction				Operations		Final Cover			
		Area		Volume		Volume	Area	Volume			
Phase	Stage	Base Liner Geomembrane + GCL Area (m ²)	Secondary Liner Geomembrane + GCL Area (m ²)	Non-Woven Geotextile (m ²)	Woven Geotextile (m ²)	Geocomposite drainage layer (m ²)	Drain Rock (m ³)	Intermediate Cover Volume (m ³)	Final Cover GCL Area (m ²)	Final Cover Sand (m ³)	Final Cover Topsoil (m ³)
1	East	13,763	13,763	13,763	13,763	13,763	4,129	0	0	0	0
1	West	8,527	8,527	8,527	8,527	8,527	2,558	2,744	0	0	0
2	2A	9,117	9,117	9,117	9,117	9,117	2,735	3,792	9,650	5,790	1,448
2	2B	0	0	0	0	0	0	2,975	0	0	0
2	2C	0	0	0	0	0	0	3,843	0	0	0
3	3A	3,225	3,225	3,225	3,225	3,225	968	263	8,165	4,899	1,225
3	3B	0	0	0	0	0	0	2,390	0	0	0
3	3C	0	0	0	0	0	0	0	16,330	9,798	2,450
Total		34,632	34,632	34,632	34,632	34,632	10,390	16,006	34,145	20,487	5,122

¹Intermediate Cover 300 mm thickness

**Design Storm Parameters
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia**

Return Period	Type	Depth	Snowmelt Correction Factor	Climate Change Correction Factor	Rainfall Depth with Snowmelt and Climate Change Correction	Peak Intensity	Duration
		(mm)	(%)	(%)	(mm)	(mm/hr)	(hour)
5-year	SCS Type 1A	70.0	10	5.2	80.6	12.65	24
10-year	SCS Type 1A	77.7	10	5.2	89.5	14.05	24
100-year	SCS Type 1A	101.9	10	5.2	117.4	18.43	24
200-year	SCS Type 1A	110.1	10	5.2	126.8	19.91	24

Note:

1. 5-year, 10-year and 100-year design storm depths obtained from Environment Canada intensity-duration-frequency data for the Campbell River A (1021261) IDF Station. 200-year storm depth extrapolated

Table 8.2

**Post Development Conditions Catchment Parameters
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia**

Subcatchment ID	Area (ha)	Flow length (m)	Slope (%)	Imperviousness (%)	Manning' n		Depression Storage		Infiltration	
					Impervious (-)	Pervious (-)	Impervious (mm)	Pervious (mm)	Maximum (mm/hr)	Minimum (mm/hr)
101	0.79	40	45	0	0.01	0.05	1.27	2.5	7	0.2
102	0.08	40	45	0	0.01	0.05	1.27	2.5	7	0.2
103	0.13	40	45	0	0.01	0.05	1.27	2.5	7	0.2
104	1.35	55	35	0	0.01	0.05	1.27	2.5	7	0.2
105	0.20	30	20	0	0.01	0.05	1.27	2.5	7	0.2
106	0.95	65	22	0	0.01	0.24	1.27	5.1	5	0.1
107	0.51	35	30	0	0.01	0.24	1.27	5.1	5	0.1
108	0.53	35	30	0	0.01	0.24	1.27	5.1	5	0.1
109	0.92	65	22	0	0.01	0.24	1.27	5.1	5	0.1
110	0.18	45	22	0	0.01	0.24	1.27	5.1	5	0.1
111	0.19	45	22	0	0.01	0.24	1.27	5.1	5	0.1
115	0.28	35	30	0	0.01	0.24	1.27	5.1	5	0.1
112	0.46	25	15	100	0.01	0.24	1.27	5.1	5	0.1
114	0.50	25	15	100	0.01	0.24	1.27	5.1	5	0.1
113	0.29	35	30	0	0.01	0.24	1.27	5.1	5	0.1
Total	7.38									

**Post Development Conditions Peakflow Summary
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia**

Subcatchment ID	<i>Peak Discharge Rate</i>			
	5-year (m³/s)	10-year (m³/s)	100-year (m³/s)	200-year (m³/s)
101	0.03	0.03	0.04	0.04
102	0.00	0.00	0.00	0.00
103	0.00	0.01	0.01	0.01
104	0.05	0.05	0.07	0.07
105	0.01	0.01	0.01	0.01
106	0.03	0.04	0.05	0.05
107	0.02	0.02	0.03	0.03
108	0.02	0.02	0.03	0.03
109	0.03	0.04	0.05	0.05
110	0.01	0.01	0.01	0.01
111	0.01	0.01	0.01	0.01
115	0.01	0.01	0.01	0.02
112	0.02	0.02	0.02	0.03
114	0.02	0.02	0.03	0.03
113	0.01	0.01	0.01	0.02

Table 8.4

**Post Development Conditions Runoff Volume Summary
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia**

Subcatchment ID	<i>Runoff Volume</i>			
	5-year (m³)	10-year (m³)	100-year (m³)	200-year (m³)
101	570	640	860	940
102	60	70	90	100
103	100	110	150	160
104	980	1100	1480	1610
105	150	170	220	240
106	680	770	1030	1120
107	370	410	560	600
108	380	420	570	620
109	660	740	1000	1080
110	130	150	200	210
111	140	150	210	220
115	200	230	310	330
112	370	410	540	580
114	400	440	580	630
113	210	230	310	340

Table 8.5

**Channel Performance Summary
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia**

Channel Section	Length (m)	Slope (m/m)	Cross-Section (-)	Depth (m)	Bottom Width (m)	Left Side Slope (H:V)	Right Side Slope (H:V)	Manning's 'n' Value	200-Year Storm					Recommended Channel Lining
									Max. Flowrate (m ³ /s)	Max. Velocity (m/s)	Max. Depth (m)	Minimum Freeboard (m)	Max. Shear Stress (Pa)	
D101	58	0.003	TRIANGULAR	0.6	3.6	NA	NA	0.03	0.02	0.02	0.29	0.31	10	Vegetation, Unreinforced
D102	146	0.002	TRIANGULAR	0.6	3.6	NA	NA	0.03	0.07	0.10	0.22	0.38	4	Vegetation, Unreinforced
D103	32	0.261	TRAPEZOIDAL	0.5	0.5	3	3	0.03	0.08	0.01	0.12	0.39	294	FLEXMAT
D104	175	0.017	TRAPEZOIDAL	0.5	0.5	3	3	0.03	0.16	0.08	0.15	0.35	25	Vegetation, Unreinforced
D105	59	0.003	TRIANGULAR	0.6	3.6	NA	NA	0.03	0.00	0.00	0.25	0.35	8	Vegetation, Unreinforced
D106	150	0.002	TRIANGULAR	0.6	3.6	NA	NA	0.03	0.05	0.07	0.20	0.40	4	Vegetation, Unreinforced
D107	34	0.241	TRAPEZOIDAL	0.5	0.5	3	3	0.03	0.06	0.01	0.12	0.39	271	FLEXMAT
D108	180	0.017	TRAPEZOIDAL	0.5	0.5	3	3	0.03	0.16	0.09	0.16	0.35	25	Vegetation, Unreinforced

Table 8.6

**Post-Development Conditions Infiltration Pond Performance Summary
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia**

West Infiltration Pond

Design Storm	Peak Inflow (m ³ /s)	Infiltration Discharge (m ³ /s)	Maximum Depth (m)	Maximum Elevation (AMSL m)	Maximum Storage (m ³)	Minimum Freeboard (m)	Duration Time (Hour)	Peak Time Baseline Time		
5-Year	0.13	0.049	0.13	150.13	375	0.87	6	9:35 AM	3:30 PM	5:55
10-Year	0.14	0.049	0.16	150.16	481	0.84	8	9:55 AM	5:35 PM	7:40
100-Year	0.18	0.049	0.30	150.30	902	0.70	14	11:30 AM	1:10 AM	13:40
200-Year	0.20	0.049	0.35	150.35	1082	0.65	15	11:55 AM	3:10 AM	15:15

East Infiltration Pond

Design Storm	Peak Inflow (m ³ /s)	Infiltration Discharge (m ³ /s)	Maximum Depth (m)	Maximum Elevation (AMSL m)	Maximum Storage (m ³)	Minimum Freeboard (m)	Duration Time (Hour)	Peak Time Baseline Time		
5-Year	0.13	0.049	0.14	150.14	404	0.86	7	9:40 AM	4:05 PM	6:25
10-Year	0.14	0.049	0.17	150.17	520	0.83	9	10:00 AM	6:15 PM	8:15
100-Year	0.19	0.049	0.32	150.32	975	0.68	14	11:40 AM	1:30 AM	13:50
200-Year	0.21	0.049	0.38	150.38	1164	0.62	16	12:00 PM	3:50 AM	15:50

Table 9.1

Forecasted Leachate Quality Profile
 2020 Design, Operations and Closure Plan
 New Landfill (Northwin Landfill)
 Upland Excavating Ltd.
 Campbell River, British Columbia

Parameters	Units	Historical Results from Similar Landfills for Comparison							Original Upland Landfill 2019	Forecasted Upland Landfill Leachate Concentrations		Discharge Criteria	Treatment Efficiency		Forecasted Upland Landfill Treated Leachate Concentrations	
		HWMF Lowest Concentration Observed in Leachate 2012-2015 ⁽¹⁾	HWMF Average Concentration Observed in Leachate 2012-2015 ⁽²⁾	Confidential BC Contaminated Soil Landfill - Average Concentrations Observed in Leachate 2012 ⁽⁶⁾	Confidential BC Contaminated Soil Landfill - Average Concentration Observed in Leachate 2013 ⁽⁷⁾	Highest observed - C&D Levis Landfill, Quebec 2003 ⁽³⁾	Highest observed - Mayer Waste Disposal Site 1994-2001 ⁽⁴⁾	Highest observed - Inter-Recycling Systems Landfill 1988-2001 ⁽⁵⁾		Minimum	Maximum		Minimum Percent Reduction From Leachate Treatment	Maximum Percent Reduction From Leachate Treatment	Minimum	Maximum
		CSR Schedule 3.2 DW														
Zinc (Dissolved)	mg/L	0.006	0.137	0.020	0.030			0.01	0.025	1	3	-	-	0.025	1	
PAHs																
1-Methylnaphthalene	ug/L	-	-	-	-	-	-	74	50	150	5.5	89%	96%	5.5	5.5	
2-Methylnaphthalene	ug/L	-	-	-	-	-	-	100	50	150	15	70%	90%	15	15	
Acenaphthene	ug/L	-	-	-	-	-	-	70	50	150	250	50%	90%	25	15	
Anthracene	ug/L	-	-	-	-	-	-	6.1	1	10	1000	50%	90%	0.5	1	
Benzo(a)anthracene	ug/L	-	-	-	-	-	-	2.1	0.1	5	0.07	30%	99%	0.07	0.07	
Benzo(a)pyrene	ug/L	-	-	-	-	-	-	1.2	0.1	5	0.01	90%	100%	0.01	0.01	
Benzo(b)fluoranthene/Benzo(j)fluoranthene	ug/L	-	-	-	-	-	-	1.6	0.1	5	0.07	30%	99%	0.07	0.07	
Benzo(b)pyridine (Quinoline)	ug/L	-	-	-	-	-	-	1.2	0.1	5	0.05	50%	99%	0.05	0.05	
Chrysene	ug/L	-	-	-	-	-	-	2.7	0.1	5	7	50%	90%	0.05	0.5	
Dibenz(a,h)anthracene	ug/L	-	-	-	-	-	-	0.11	0.01	1	0.01	50%	99%	0.005	0.01	
Fluoranthene	ug/L	-	-	-	-	-	-	11	1	50	150	50%	90%	0.5	5	
Fluorene	ug/L	-	-	-	-	-	-	28	1	50	150	50%	90%	0.5	5	
Naphthalene	ug/L	-	-	-	-	-	-	900	100	1500	80	20%	95%	80	80	
Pyrene	ug/L	-	-	-	-	-	-	8.8	1	50	100	50%	90%	0.5	5	

- Notes:
- (1) Chemical analyses results - HWMF surface water - Highest concentration -1995 (Appendix B).
 - (2) Chemical analyses results - HWMF ash leachate - Highest concentration -1995 (Appendix B).
 - (3) Highest concentration reported for the C&D Landfill in Levis, Quebec in 2005 (Appendix C).
 - (4) Highest concentration reported for the Mayer Industrial Landfill Site between 1994 and 2001 (Appendix C).
 - (5) Highest concentration reported for the Inter-Recycling Systems Landfill Site between 1988 and 2001 (Appendix C).
 - (6) Confidential Landfill Leachate - Treatment Program 2013 - Tables 5,6,7. Concentrations represent average of 4 samples.
 - (7) Confidential Landfill Leachate - Leachate Treatment Program 2013 - Tables 5,6,7. Concentrations represent average of 3 samples.
 - (8) Concentration represents average of 2 samples.

Table 9.2

**HELP Model Results
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia**

	<u>Daily Cover - New cell</u>	<u>Daily Cover</u>	<u>Intermediate Cover</u>	<u>Final Cover</u>
	mm			
Jan	222.68	176.93	177.40	2.92
Feb	155.72	162.00	165.02	2.69
Mar	124.98	157.48	160.20	2.40
Apr	68.62	122.23	122.31	1.96
May	34.31	50.57	37.41	1.48
Jun	26.80	26.91	13.18	0.91
Jul	22.54	22.34	10.61	0.62
Aug	18.67	18.87	8.44	0.43
Sep	27.85	26.60	13.98	0.29
Oct	108.64	59.91	46.16	0.12
Nov	187.21	117.04	110.28	0.20
Dec	209.02	162.09	160.08	1.81
Total:	1207.05	1102.97	1025.06	15.82
Peak Daily:	20.56	14.79	14.76	0.21

Table 9.3

**Cover Areas
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia**

Areas (m²)

Stage	New Cell	Daily Cover	Intermediate Cover	Final Cover
1 East - Half	6,882	0	0	0
1 East	6,882	6,882	0	0
1 West - Half	4,559	3,053	10,710	0
1 West	4,559	7,612	7,710	3,720
2A	10,590	0	10,217	9,050
2B	0	10,160	10,647	9,050
2C	0	7,047	13,854	9,050
3A	3,212	13,583	207	16,235
3B	0	8,393	8,609	16,235
3C	0	0	0	34,145

Table 10.1

**Waste Characterization
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia**

Waste Type	Percent of Total Waste Composition	Percent Relatively Inert	Percent Moderately Decomposable	Percent Decomposable
Waste Soil	50%	100%	0%	0%
Construction, Demolition and Land Clearing Debris	50%	50%	50%	0%
Total	100%	75%	25%	0%

Landfill Gas Generation Summary
2021 Design, Operations and Closure Plan
New Landfill (Northwin Landfill)
Upland Excavating Ltd.
Campbell River, British Columbia

Year	Annual Waste Tonnage (tonnes)	Methane Generation (tonnes CH ₄ /year)	Total Waste in Place (tonnes)
2022	138,238	0	138,238
2023	45,000	186	183,238
2024	45,000	236	228,238
2025	45,000	285	273,238
2026	45,000	330	318,238
2027	45,000	373	363,238
2028	45,000	414	408,238
2029	45,000	453	453,238
2030	45,000	490	498,238
2031	45,000	525	543,238
2032	45,000	559	588,238
2033	45,000	590	633,238
2034	45,000	620	678,238
2035	13,836	649	692,075
2036	0	634	692,075
2037	0	602	692,075
2038	0	571	692,075
2039	0	542	692,075
2040	0	515	692,075
2041	0	489	692,075
2042	0	464	692,075
2043	0	441	692,075
2044	0	419	692,075
2045	0	399	692,075
2046	0	379	692,075
2047	0	361	692,075
2048	0	343	692,075
2049	0	327	692,075
2050	0	311	692,075
2051	0	297	692,075
2052	0	283	692,075
2053	0	269	692,075
2054	0	257	692,075
2055	0	245	692,075
2056	0	234	692,075
2057	0	223	692,075
2058	0	213	692,075
2059	0	204	692,075
2060	0	195	692,075
2061	0	186	692,075
2062	0	178	692,075
2063	0	170	692,075
2064	0	163	692,075

Note:

This table presents the results of the landfill gas (LFG) assessment from the anticipated year where waste placement will begin to the estimated year of closure with anticipated annual waste tonnages.

Table 10.3

**Landfill Gas Generation Results
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia**

Gas Production potential, Lo =	Relatively Inert	Moderately Decomposable	Decomposable	m ³ CH ₄ /tonne
Waste Composition (2006 SWMP)	20	120	160	
lag time before start of gas production, lag =	75.0%	25.0%	0.0%	
Historical Data Used (years)	1 years			
1st Year of Historical Data Used	30			
Proposed year of closure	2021			
methane (by volume)	2033			
carbon dioxide (by volume)	50%			
methane (density)	0.6557 kg/m ³		(25°C,1ATM)	
carbon dioxide (density)	1.7988 kg/m ³		(25°C,1ATM)	

Year	Annual Tonnage (tonnes)	Cumulative Waste-in-place (tonnes)	Waste Tonnage			Methane Generation Rate, k			Annual Methane Production (tonnes/yr)	Landfill Gas Production (m ³ /hr)	Greenhouse Gas Emissions (as CO ₂ e/year)
			Relatively Inert (tonnes)	Moderately Decomposable (tonnes)	Decomposable (tonnes)	Relatively Inert (year ⁻¹)	Moderately Decomposable (year ⁻¹)	Decomposable (year ⁻¹)			
2022	138,238	138,238	103,679	34,560	0	0.02	0.06	0.11	185.8	64.7	3,901
2023	45,000	183,238	33,750	11,250	0	0.02	0.06	0.11	236.5	82.3	4,966
2024	45,000	228,238	33,750	11,250	0	0.02	0.06	0.11	284.5	99.1	5,975
2025	45,000	273,238	33,750	11,250	0	0.02	0.06	0.11	330.1	114.9	6,932
2026	45,000	318,238	33,750	11,250	0	0.02	0.06	0.11	373.3	130.0	7,840
2027	45,000	363,238	33,750	11,250	0	0.02	0.06	0.11	414.3	144.3	8,701
2028	45,000	408,238	33,750	11,250	0	0.02	0.06	0.11	453.2	157.8	9,518
2029	45,000	453,238	33,750	11,250	0	0.02	0.06	0.11	490.2	170.7	10,293
2030	45,000	498,238	33,750	11,250	0	0.02	0.06	0.11	525.2	182.9	11,030
2031	45,000	543,238	33,750	11,250	0	0.02	0.06	0.11	558.5	194.5	11,729
2032	45,000	588,238	33,750	11,250	0	0.02	0.06	0.11	590.1	205.5	12,393
2033	45,000	633,238	33,750	11,250	0	0.02	0.06	0.11	620.2	215.9	13,024
2034	45,000	678,238	33,750	11,250	0	0.02	0.06	0.11	648.7	225.9	13,623
2035	13,836	692,075	10,377	3,459	0	0.02	0.06	0.11	634.0	220.8	13,314
2036	0	692,075	0	0	0	0.02	0.06	0.11	601.5	209.4	12,632
2037	0	692,075	0	0	0	0.02	0.06	0.11	570.9	198.8	11,989
2038	0	692,075	0	0	0	0.02	0.06	0.11	541.9	188.7	11,380
2039	0	692,075	0	0	0	0.02	0.06	0.11	514.6	179.2	10,806
2040	0	692,075	0	0	0	0.02	0.06	0.11	488.7	170.2	10,263
2041	0	692,075	0	0	0	0.02	0.06	0.11	464.3	161.7	9,750
2042	0	692,075	0	0	0	0.02	0.06	0.11	441.2	153.6	9,266
2043	0	692,075	0	0	0	0.02	0.06	0.11	419.4	146.0	8,808
2044	0	692,075	0	0	0	0.02	0.06	0.11	398.8	138.9	8,375
2045	0	692,075	0	0	0	0.02	0.06	0.11	379.3	132.1	7,965
2046	0	692,075	0	0	0	0.02	0.06	0.11	360.9	125.6	7,578
2047	0	692,075	0	0	0	0.02	0.06	0.11	343.4	119.6	7,212
2048	0	692,075	0	0	0	0.02	0.06	0.11	326.9	113.8	6,866
2049	0	692,075	0	0	0	0.02	0.06	0.11	311.3	108.4	6,538
2050	0	692,075	0	0	0	0.02	0.06	0.11	296.6	103.3	6,228
2051	0	692,075	0	0	0	0.02	0.06	0.11	282.6	98.4	5,935
2052	0	692,075	0	0	0	0.02	0.06	0.11	269.4	93.8	5,657
2053	0	692,075	0	0	0	0.02	0.06	0.11	256.9	89.4	5,395
2054	0	692,075	0	0	0	0.02	0.06	0.11	245.0	85.3	5,146
2055	0	692,075	0	0	0	0.02	0.06	0.11	233.8	81.4	4,910
2056	0	692,075	0	0	0	0.02	0.06	0.11	223.2	77.7	4,687
2057	0	692,075	0	0	0	0.02	0.06	0.11	213.1	74.2	4,476
2058	0	692,075	0	0	0	0.02	0.06	0.11	203.6	70.9	4,276
2059	0	692,075	0	0	0	0.02	0.06	0.11	194.6	67.7	4,086
2060	0	692,075	0	0	0	0.02	0.06	0.11	186.0	64.8	3,906
2061	0	692,075	0	0	0	0.02	0.06	0.11	177.9	61.9	3,735
2062	0	692,075	0	0	0	0.02	0.06	0.11	170.2	59.2	3,573
2063	0	692,075	0	0	0	0.02	0.06	0.11	162.9	56.7	3,420
2064	0	692,075	0	0	0	0.02	0.06	0.11	155.9	54.3	3,274

Sources:

- Landfill Gas Generation Assessment Procedure Guidance Report, Conestoga-Rovers & Associates, March 2009
- Annual waste tonnage data is estimated.

Table 13.1 A
Groundwater Compliance Forecast
Scenario 1 - Liner Failure
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Parameters	Units	Average Pre-Landfill Concentrations ⁽¹⁾ 2015 - 2017	Contaminant Masses & Source Volumes ⁽²⁾							Final Forecasted Groundwater Concentrations ⁽³⁾	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017
			Forecasted Upland Landfill Leachate Concentrations	Forecasted Upland Landfill Treated Leachate Concentrations	Flux into Landfill Footprint Area (minimum)	Landfill Leakage (primary liner failure with leak detection system)	Treated Leachate Infiltration (Designed)	Infiltration of Runoff and Lateral Drainage from Landfill Cap (dry periods)	Infiltration Downgradient of Landfill ⁽⁴⁾ (dry periods)			
			Maximum mg/L	Maximum mg/L	Units m3/day L/day	500 500,000	0.00010 0.10	67 67,000	1.0 1750.0			
liner failure (with leak detection system), max. mass loading (leachate & effluent), min. upgradient flux, dry season runoff & downgradient infiltration												
Scenario Liner Failure (mg/L)												
Drinking Water (DW) (mg/L)												
Aquatic Life (AW) (mg/L)												
GENERAL CHEMISTRY												
Contaminant Masses Maximum												
Alkalinity (total)	mg/L	54.7	2500	250	m3/day	27350000	250	16750000	95725	3993100	75.1	-
Ammonia-N	mg/L	0.08	30	3	m3/day	40000	3.0	201000	140	5840	0.38	-
BOD	mg/L	2.07	50	17.5	m3/day	1035000	5.0	1172500	3622.5	151110	3.88	-
Chloride (Cl) (dissolved)	mg/L	4.15	1500	250	m3/day	20750000	150	16750000	7262.5	302950	23.82	250
COD	mg/L	39.1	500	150	m3/day	19550000	50	10050000	68425	2854300	50.68	-
Conductivity ⁽⁵⁾	us/cm	137	7500	7500	us/cm	-	-	-	-	846	-	-
Hardness	mg/L	60	2500	2500	m3/day	30000000	250	16750000	105000	4380000	315	-
pH ⁽⁶⁾	pH units	7.86	8	8	std. units	-	-	-	-	7.4	-	-
Phenols	mg/L	0.0	0.1	0.01	m3/day	0	0.01	670	0	0.00104	1	2
Sulphate (SO42-)	mg/L	5.72	1000	500	m3/day	2860000	100	33500000	10010	417560	57.32	500
Subphide	mg/L	0.006	5	0.05	m3/day	3000	5	3350	10.5	438	0.0106	0.05
Total Suspended Solids (TSS)	mg/L	390	150	75	m3/day	1.95E+08	15.0	5025000	682500	28470000	357	-
Total Dissolved Solids (TDS)	mg/L	31	10000	5000	m3/day	15500000	1000	33500000	54250	2263000	550	-
Total Kjeldahl Nitrogen (TKN)	mg/L	0.143	60	21	m3/day	71500	6.00	1407000	250.25	10439	2.321	-
Phosphorous	mg/L	0.551	0.5	0.5	m3/day	2755000	0.05	33500	864.25	46223	0.546	-
HYDROCARBONS												
HEPH	mg/L	0.0	2	2	m3/day	0	0.20	134000	2	0	0.2088	-
LNPH	mg/L	0.0	2	0.5	m3/day	0	0.20	33500	0	0	0.0522	-
METALS												
Aluminum	mg/L	-	1	1	m3/day	-	0.100	67000	-	-	9.5	-
Aluminum (Dissolved)	mg/L	0.00737	0.1	0.1	m3/day	3685	0.010	6700	12.8975	538.01	0.02	-
Arsenic	mg/L	-	0.04	0.01	m3/day	-	0.004	670	-	-	-	-
Arsenic (Dissolved)	mg/L	0.00014	0.04	0.01	m3/day	70	0.004	670	0.245	10.22	0.0012	0.01
Barium	mg/L	-	0.7	0.7	m3/day	-	0.070	46900	-	-	-	-
Barium (Dissolved)	mg/L	0.0014	0.7	0.7	m3/day	700	0.07	46900	2.45	102.2	0.074	1
Boron	mg/L	-	5	5	m3/day	-	1.00	335000	-	-	-	-
Boron (Dissolved)	mg/L	0.0	10	5	m3/day	0	1.00	335000	0	0	0.522	5
Cadmium	mg/L	-	0.0003	0.0003	m3/day	-	3.0E-05	20.1	-	-	-	-
Cadmium (Dissolved)	mg/L	0.00001	0.0003	0.0003	m3/day	5.0	3.0E-05	20.1	0.0175	0.73	0.00004	0.005
Calcium	mg/L	-	700	700	m3/day	-	70.00	46900000	-	-	-	-
Calcium (Dissolved)	mg/L	18.842	700	700	m3/day	9421000	70	46900000	32973.5	1375466	89.96	-
Chromium	mg/L	-	0.05	0.05	m3/day	-	0.005	3350	-	-	-	-
Chromium (Dissolved)	mg/L	0.0	0.05	0.05	m3/day	0	0.005	3350	0	0	0.00522	0.05
Cobalt	mg/L	-	0.01	0.01	m3/day	-	0.0010	670	-	-	-	-
Cobalt (Dissolved)	mg/L	0.0	0.01	0.01	m3/day	0	0.0010	670	0	0	0.0010	0.01
Copper	mg/L	-	0.05	0.05	m3/day	-	0.0050	3350	-	-	-	-
Copper (Dissolved)	mg/L	0.0008	0.05	0.05	m3/day	400	0.005	3350	1.4	58.4	0.0059	1.5
Iron	mg/L	-	70	6.5	m3/day	-	7.0	435500	-	-	-	-
Iron (Dissolved)	mg/L	0.056	7	6.5	m3/day	28000	0.7	435500	98	4088	0.73	6.5
Lead	mg/L	-	0.01	0.01	m3/day	-	0.0010	670	-	-	-	-
Lead (Dissolved)	mg/L	0.0	0.01	0.01	m3/day	0	0.0010	670	0	0	0.0010	0.01
Magnesium	mg/L	-	300	100	m3/day	-	30.0	6700000	-	-	-	-
Magnesium (Dissolved)	mg/L	3.28	300	100	m3/day	1640000	30.0	6700000	5740	239440	13.38	-
Manganese	mg/L	-	5	0.55	m3/day	-	0.5	36850	-	-	-	-
Manganese (Dissolved)	mg/L	0.03	5	0.55	m3/day	15000	0.5	36850	52.5	2190	0.084	1.5
Mercury	mg/L	-	0.00003	0.00003	m3/day	-	3.0E-06	2.01	-	-	-	-
Mercury (Dissolved)	mg/L	0.0	0.0001	0.0001	m3/day	0	0.0001	670	0	0	0.000001	0.001
Molybdenum	mg/L	-	0.002	0.002	m3/day	-	0.0002	134	-	-	-	-
Molybdenum (Dissolved)	mg/L	0.0	0.002	0.002	m3/day	0	0.0002	134	0	0	0.0002	0.25
Nickel	mg/L	-	0.02	0.02	m3/day	-	0.002	1340	-	-	-	-
Nickel (Dissolved)	mg/L	0.0	0.02	0.02	m3/day	0	0.002	1340	0	0	0.0021	0.08
Selenium	mg/L	-	0.005	0.005	m3/day	-	0.0005	335	-	-	-	-
Selenium (Dissolved)	mg/L	0.0002	0.005	0.005	m3/day	100	0.001	335	0.35	14.6	0.0007	0.01
Silver	mg/L	-	0.00002	0.00002	m3/day	-	2.0E-06	1.34	-	-	-	-
Silver (Dissolved)	mg/L	0.0	0.0002	0.0002	m3/day	0	2.0E-05	13.4	0	0	0.00002	0.02
Sodium	mg/L	-	1000	200	m3/day	-	100	13400000	-	-	-	-
Sodium (Dissolved)	mg/L	3.89	1000	200	m3/day	1945000	100	13400000	6807.5	283970	24.36	200
Zinc	mg/L	-	2	2	m3/day	-	0.20	134000	-	-	-	-
Zinc (Dissolved)	mg/L	0.002	1	1	m3/day	1000	0.10	67000	3.5	146	0.106	3

Notes:
 (1) Concentrations have been calculated using the average concentration of each sample collected from the overburden, sand and gravel aquifer between 2015 and 2017.
 For the purposes of predicting the mass inputs, concentrations of 0.0 mg/L have been used wherever samples were below detection limits (ND or less than the reporting limit).
 (2) Contaminant masses are calculated by multiplying the forecasted concentration by the volume of the respective source
 (3) Final Forecasted Groundwater Concentrations = (sum of masses)/(sum of source volumes)
 (4) The forecasted concentration approach is inappropriate for pH and conductivity.
 (5) Infiltration rates used are 72% in the pit (with no vegetation) and 50% for above the pit (with vegetation) - derived from HELP modeling.
 - not analyzed or no standard/criteria available.
 ND - not detected above the respective laboratory reporting limit
 [a] - Limit varies with pH. Ranges are calculated using average pre-landfilling and final predicted concentrations
 [b] - Limit varies with Hardness. Ranges are calculated using average pre-landfilling and final predicted concentrations
 [c] - Limit is set for hexavalent chromium
 (SAD)(WAD) - strong acid dissolvable/weak acid dissolvable

exceeds the BC CSR Drinking Water (DW) Standards
 exceeds the BC CSR Aquatic Life (AW) Standards

Table 13.1 B
Groundwater Compliance Forecast
Scenario 2 - Base Case
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Parameters	Units	Average Pre-Landfilling Concentrations ⁽¹⁾ 2015 - 2017	Forecasted Upland Landfill Leachate Concentrations		Forecasted Upland Landfill Treated Leachate Concentrations			Contaminant Masses & Source Volumes ⁽²⁾					Final Forecasted Groundwater Concentrations ⁽³⁾	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017		
			Minimum	Average	Maximum	Minimum	Average	Maximum	Flux into Landfill Footprint Area (average)	Landfill Leakage (primary liner only)	Treated Leachate Infiltration (Designed)	Infiltration of Runoff and Lateral Drainage from Landfill Cap (average)				Infiltration Downgradient of Landfill ⁽⁵⁾ (average)	
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Units m ³ /day								
									Contaminant Masses					Scenario Base Case			
									Maximum					max mass loading (leachate & effluent), average upgradient flux, average runoff & downgradient infiltration			
									Maximum					Drinking Water (DW)			
														Aquatic Life (AW)			
GENERAL CHEMISTRY																	
Alkalinity (total)	mg/L	54.7	500	1500	2500	50	150	250	mg/day	35008000	826	16750000	191450	12307500	68.6	-	-
Ammonia-N	mg/L	0.08	1	15.5	30	0.10	1.55	3	mg/day	51200	9.9	201000	280	18000	0.29	-	11.3 [a]
BOD	mg/L	2.07	10	30	50	3.5	10.5	17.5	mg/day	1324800	16.5	1172500	7245	465750	3.17	-	-
Chloride (Cl) (dissolved)	mg/L	4.15	100	800	1500	16.7	133.3	250	mg/day	2656000	495	16750000	14525	933750	21.73	250	1500
COD	mg/L	39.1	50	275	500	15	82.5	150	mg/day	25024000	165	10050000	136850	8797500	46.98	-	-
Conductivity ⁽⁴⁾	us/cm	137	200	3850	7500	200	3850	7500	us/cm	-	-	-	-	-	595.20	-	-
Hardness	mg/L	60	750	1625	2500	750	1625	2500	mg/day	38400000	826	167500000	210000	13500000	234	-	-
pH ⁽⁴⁾	pH units	7.86	6	7	8	6	7	8	std. units	-	-	-	-	-	7.8	-	-
Phenols	mg/L	0.0	0.005	0.0525	0.1	0.0005	0.00525	0.01	mg/day	0	0.03	670	0	0	0.00072	1	2
Sulphate (SO4 ²⁻)	mg/L	5.72	50	525	1000	25	263	500	mg/day	3660800	330	33500000	20020	1287000	41.06	500	2180 - 4290 [b]
Sulphide	mg/L	0.006	0.1	2.55	5	0.001	0.026	0.05	mg/day	3840	1.65	3350	21	1350	0.0091	0.05	0.02
Total Suspended Solids (TSS)	mg/L	390	10	80	150	5	40	75	mg/day	2.50E+08	49.5	5025000	1365000	87750000	367	-	-
Total Dissolved Solids (TDS)	mg/L	31	2000	6000	10000	1000	3000	5000	mg/day	19840000	3302	335000000	108500	6975000	386	-	-
Total Kjeldahl Nitrogen (TKN)	mg/L	0.143	3	31.5	60	1.05	11.03	21	mg/day	91520	19.81	1407000	501	32175	1.635	-	-
Phosphorus	mg/L	0.551	0.1	0.3	0.5	0.1	0.3	0.5	mg/day	352640	0.17	33500	1928.5	123975	0.547	-	-
HYDROCARBONS																	
HEPH	mg/L	0.0	0.5	1.25	2	0.5	1.25	2	mg/day	0	0.66	134000	0	0	0.1430	-	-
LEPH	mg/L	0.0	0.5	1.25	2	0.125	0.313	0.5	mg/day	0	0.66	33500	0	0	0.0358	-	0.5
METALS																	
Aluminum	mg/L	-	0.1	0.55	1	0.1	0.55	1	mg/day	-	0.330	67000	-	-	0.07	-	-
Aluminum (Dissolved)	mg/L	0.00737	0.01	0.055	0.1	0.01	0.055	0.1	mg/day	4717	0.033	6700	25.8	1658	0.01	9.5	-
Arsenic	mg/L	-	0.001	0.0205	0.04	0.00025	0.005	0.01	mg/day	-	0.013	670	-	-	-	-	-
Arsenic (Dissolved)	mg/L	0.00014	0.001	0.0205	0.04	0.00025	0.005	0.01	mg/day	90	0.013	670	0.49	32	0.0008	0.01	0.05
Barium	mg/L	-	0.05	0.375	0.7	0.05	0.375	0.7	mg/day	-	0.231	46900	-	-	-	-	-
Barium (Dissolved)	mg/L	0.0014	0.05	0.375	0.7	0.05	0.375	0.7	mg/day	896	0.23	46900	5	315	0.051	1	10
Boron	mg/L	-	5	7.5	10	2.5	3.75	5	mg/day	-	3.30	335000	-	-	-	-	-
Boron (Dissolved)	mg/L	0.0	5	7.5	10	2.5	3.75	5	mg/day	0	3.30	335000	0	0	0.358	5	12
Cadmium	mg/L	-	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	mg/day	-	9.9E-05	20.1	-	-	-	-	-
Cadmium (Dissolved)	mg/L	0.00001	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	mg/day	6.4	9.9E-05	20.1	0.04	2	0.00003	0.005	0.0015 - 0.004 [b]
Calcium	mg/L	-	200	450	700	200	450	700	mg/day	-	231.15	46900000	-	-	-	-	-
Calcium (Dissolved)	mg/L	18.842	200	450	700	200	450	700	mg/day	12058880	231	46900000	65947	4239450	67.53	-	-
Chromium	mg/L	-	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	-	0.017	3350	-	-	-	-	-
Chromium (Dissolved)	mg/L	0.0	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	0	0.017	3350	0	0	0.00358	0.05	0.01 [c]
Cobalt	mg/L	-	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	-	0.0033	670	-	-	-	-	-
Cobalt (Dissolved)	mg/L	0.0	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	0	0.0033	670	0	0	0.0007	0.001	0.04
Copper	mg/L	-	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	-	0.0165	3350	-	-	-	-	-
Copper (Dissolved)	mg/L	0.0008	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	512	0.017	3350	2.8	180	0.0043	1.5	0.03-0.09 [b]
Iron	mg/L	-	1	3.55	7	0.09	3.3	6.5	mg/day	-	23.1	435500	-	-	-	-	-
Iron (Dissolved)	mg/L	0.056	0.1	3.55	7	0.09	3.3	6.5	mg/day	35840	2.3	435500	196	12600	0.52	6.5	-
Lead	mg/L	-	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	-	0.0033	670	-	-	-	-	-
Lead (Dissolved)	mg/L	0.0	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	0	0.0033	670	0	0	0.0007	0.01	0.05 - 0.16 [b]
Magnesium	mg/L	-	30	165	300	10	55	100	mg/day	-	99.1	6700000	-	-	-	-	-
Magnesium (Dissolved)	mg/L	3.28	30	165	300	10	55	100	mg/day	2099200	99.1	6700000	11480	738000	10.19	-	-
Manganese	mg/L	-	1	3	5	0.11	0.33	0.55	mg/day	-	1.7	36850	-	-	-	-	-
Manganese (Dissolved)	mg/L	0.03	1	3	5	0.11	0.33	0.55	mg/day	19200	1.7	36850	105	6750	0.067	1.5	-
Mercury	mg/L	-	0.00001	0.00002	0.00003	0.00001	0.00002	0.00003	mg/day	-	9.9E-06	2.01	-	-	-	-	-
Mercury (Dissolved)	mg/L	0.0	0.00001	0.00002	0.00003	0.00001	0.00002	0.00003	mg/day	0	3.3E-06	0.67	0.0	0	0.000001	0.001	0.00025
Molybdenum	mg/L	-	0.001	0.0015	0.002	0.001	0.0015	0.002	mg/day	-	0.0007	134	-	-	-	-	-
Molybdenum (Dissolved)	mg/L	0.0	0.001	0.0015	0.002	0.001	0.0015	0.002	mg/day	0	0.0007	134	0.0	0	0.0001	0.25	10
Nickel	mg/L	-	0.0075	0.01375	0.02	0.0075	0.014	0.02	mg/day	-	0.007	1340	-	-	-	-	-
Nickel (Dissolved)	mg/L	0.0	0.0075	0.01375	0.02	0.0075	0.014	0.02	mg/day	0	0.007	1340	0.0	0	0.0014	0.08	0.65-1.5 [b]
Selenium	mg/L	-	0.001	0.003	0.005	0.001	0.003	0.005	mg/day	-	0.0017	335	-	-	-	-	-
Selenium (Dissolved)	mg/L	0.0002	0.001	0.003	0.005	0.001	0.003	0.005	mg/day	128	0.002	335	0.70	45	0.0005	0.01	0.02
Silver	mg/L	-	0.0001	0.00006	0.00002	0.0001	0.00006	0.00002	mg/day	-	6.6E-06	1.34	-	-	-	-	-
Silver (Dissolved)	mg/L	0.0	0.0001	0.00015	0.0002	0.0001	0.00015	0.0002	mg/day	0	6.6E-05	13.4	0	0	0.00001	0.02	0.0005-0.015
Sodium	mg/L	-	100	550	1000	20	110	200	mg/day	-	330	13400000	-	-	-	-	-
Sodium (Dissolved)	mg/L	3.89	100	550	1000	20	110	200	mg/day	2489600	330	13400000	13615	875250	17.91	200	-
Zinc	mg/L	-	0.05	1.025	2	0.05	1.03	2	mg/day	-	0.66	134000	-	-	-	-	-
Zinc (Dissolved)	mg/L	0.002	0.025	0.5125	1	0.025	0.51	1	mg/day	1280	0.33	67000	7	450	0.073	3	0.075-2.4 [b]

Notes:
(1) Concentrations have been calculated using the average concentration of each sample collected from the overburden, sand and gravel aquifer between 2015 and 2017.
For the purposes of predicting the mass inputs, concentrations of 0.0 mg/L have been used wherever samples were below detection limits (ND or less than the reporting limit).
(2) Contaminant masses are calculated by multiplying the forecasted concentration by the volume of the respective source
(3) Final Forecasted Groundwater Concentrations = (sum of masses)/(sum of source volumes)
(4) The forecasted concentration approach is inappropriate for pH and conductivity.
conductivity is estimated as TDS/0.67; pH is expected to fall within the min. and max. range in pre-Landfill, leachate, or effluent.
(5) Infiltration rates used are 72% in the pit (with no vegetation) and 50% for above the pit (with vegetation) - derived from HELP modeling.
- not analyzed or no standard/criteria available.
ND - not detected above the respective laboratory reporting limit
[a] - Limit varies with pH. Ranges are calculated using average pre-landfilling and final predicted concentrations
[b] - Limit varies with Hardness. Ranges are calculated using average pre-landfilling and final predicted concentrations
[c] - Limit is set for hexavalent chromium
(SAD)/(WAD) - strong acid dissolvable/weak acid dissolvable

exceeds the BC CSR Drinking Water (DW) Standards
exceeds the BC CSR Aquatic Life (AW) Standards

Table 13.1 C
Groundwater Compliance Forecast
Scenario 3 - Dry Season
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Parameters	Units	Average Pre-Landfill Concentrations ⁽¹⁾ 2015 - 2017	Forecasted Upland Landfill Leachate Concentrations		Forecasted Upland Landfill Treated Leachate Concentrations			Contaminant Masses & Source Volumes ⁽²⁾					Final Forecasted Groundwater Concentrations ⁽³⁾	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017		
			Minimum	Average	Maximum	Minimum	Average	Maximum	Flux into Landfill Footprint Area (minimum)	Landfill Leakage (primary liner only)	Treated Leachate Infiltration (Designed)	Infiltration of Runoff and Lateral Drainage from Landfill Cap (dry periods)				Infiltration Downgradient of Landfill ⁽⁵⁾ (dry periods)	
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Units m3/day	mg/day	mg/day	mg/day				mg/day	mg/day
									Contaminant Masses					min. upgradient flux, average mass loading (leachate & effluent), dry season runoff & downgradient infiltration			
									Maximum					Scenario Dry Season			
									Maximum					(mg/L)			
GENERAL CHEMISTRY																	
Alkalinity (total)	mg/L	54.7	500	1500	2500	50	150	250	mg/day	27350000	826	16750000	95725	3993100	75.2	-	-
Ammonia-N	mg/L	0.08	1	15.5	30	0.10	1.55	3	mg/day	40000	9.9	201000	140	5840	0.39	-	11.3 [a]
BOD	mg/L	2.07	10	30	50	3.5	10.5	17.5	mg/day	1035000	16.5	1172500	3622.5	151110	3.68	-	-
Chloride (Cl) (dissolved)	mg/L	4.15	100	800	1500	16.7	133.3	250	mg/day	2075000	495	16750000	7262.5	302950	29.85	250	1500
COD	mg/L	39.1	50	275	500	15	82.5	150	mg/day	19550000	165	10050000	68425	2854300	50.73	-	-
Conductivity ⁽⁴⁾	us/cm	137	200	3850	7500	200	3850	7500	us/cm	-	-	-	-	-	845.81	-	-
Hardness	mg/L	60	750	1625	2500	750	1625	2500	mg/day	30000000	826	167500000	105000	4380000	315.09	-	-
pH ⁽⁴⁾	pH units	7.86	6	7	8	6	7	8	std. units	-	-	-	-	-	7-8	-	-
Phenols	mg/L	0.0	0.005	0.0525	0.1	0.0005	0.00525	0.01	mg/day	0	0.03	670	0	0	0.00105	1	2
Sulphate (S042-)	mg/L	5.72	50	525	1000	25	263	500	mg/day	2860000	330	33500000	10010	417560	57.39	500	2180 - 4290 [b]
Sulphide	mg/L	0.006	0.1	2.55	5	0.001	0.026	0.05	mg/day	3000	1.65	3350	10.5	438	0.0106	0.05	0.02
Total Suspended Solids (TSS)	mg/L	390	10	80	150	5	40	75	mg/day	1.95E+08	49.5	5025000	682500	28470000	358	-	-
Total Dissolved Solids (TDS)	mg/L	31	2000	6000	10000	1000	3000	5000	mg/day	15500000	3302	335000000	54250	2263000	550	-	-
Total Kjeldahl Nitrogen (TKN)	mg/L	0.143	3	31.5	60	1.05	11.03	21	mg/day	71500	19.81	1407000	250.25	10439	2.323	-	-
Phosphorus	mg/L	0.551	0.1	0.3	0.5	0.1	0.3	0.5	mg/day	275500	0.17	33500	964.25	40223	0.546	-	-
HYDROCARBONS																	
HEPH	mg/L	0.0	0.5	1.25	2	0.5	1.25	2	mg/day	0	0.66	134000	0	0	0.2090	-	-
LEPH	mg/L	0.0	0.5	1.25	2	0.125	0.313	0.5	mg/day	0	0.66	33500	0	0	0.0523	-	0.5
METALS																	
Aluminum	mg/L	-	0.1	0.55	1	0.1	0.55	1	mg/day	-	0.330	67000	-	-	0.02	-	-
Aluminum (Dissolved)	mg/L	0.00737	0.01	0.055	0.1	0.01	0.055	0.1	mg/day	3685	0.033	6700	12.8975	538.01	9.5	-	-
Arsenic	mg/L	-	0.001	0.0205	0.04	0.00025	0.005	0.01	mg/day	70	0.013	670	0.245	10.22	0.0012	0.01	0.05
Arsenic (Dissolved)	mg/L	0.00014	0.001	0.0205	0.04	0.00025	0.005	0.01	mg/day	-	0.013	670	0.245	10.22	0.0012	0.01	0.05
Barium	mg/L	-	0.05	0.375	0.7	0.05	0.375	0.7	mg/day	-	0.231	46900	-	-	-	-	-
Barium (Dissolved)	mg/L	0.0014	0.05	0.375	0.7	0.05	0.375	0.7	mg/day	700	0.23	46900	2.45	102.2	0.074	1	10
Boron	mg/L	-	5	7.5	10	2.5	3.75	5	mg/day	-	3.30	335000	-	-	-	-	-
Boron (Dissolved)	mg/L	0.0	5	7.5	10	2.5	3.75	5	mg/day	0	3.30	335000	0	0	0.523	5	12
Cadmium	mg/L	-	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	mg/day	-	9.9E-05	20.1	-	-	-	-	-
Cadmium (Dissolved)	mg/L	0.00001	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	mg/day	5.0	9.9E-05	20.1	0.0175	0.73	0.00004	0.005	0.0015 - 0.004 [b]
Calcium	mg/L	-	200	450	700	200	450	700	mg/day	-	231.15	46900000	-	-	-	-	-
Calcium (Dissolved)	mg/L	18.842	200	450	700	200	450	700	mg/day	9421000	231	46900000	32973.5	1375466	-	-	-
Chromium	mg/L	-	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	-	0.017	3350	-	-	-	-	-
Chromium (Dissolved)	mg/L	0.0	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	0	0.017	3350	0	0	0.00523	0.05	0.01 [c]
Cobalt	mg/L	-	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	-	0.0033	670	-	-	-	-	-
Cobalt (Dissolved)	mg/L	0.0	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	0	0.0033	670	0	0	0.0010	0.001	0.04
Copper	mg/L	-	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	-	0.0165	3350	-	-	-	-	-
Copper (Dissolved)	mg/L	0.0008	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	400	0.017	3350	1.4	58.4	0.0059	1.5	0.03-0.09 [b]
Iron	mg/L	-	1	35.5	70	0.9	3.3	6.5	mg/day	-	23.1	435500	-	-	-	-	-
Iron (Dissolved)	mg/L	0.056	0.1	3.55	7	0.9	3.3	6.5	mg/day	28000	2.3	435500	98	4088	0.73	6.5	-
Lead	mg/L	-	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	-	0.0033	670	-	-	-	-	-
Lead (Dissolved)	mg/L	0.0	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	0	0.0033	670	0	0	0.0010	0.01	0.05 - 0.16 [b]
Magnesium	mg/L	-	30	165	300	10	55	100	mg/day	-	99.1	6700000	-	-	-	-	-
Magnesium (Dissolved)	mg/L	3.28	30	165	300	10	55	100	mg/day	1640000	99.1	6700000	5740	239440	13.39	-	-
Manganese	mg/L	-	1	3	5	0.11	0.33	0.55	mg/day	-	1.7	36850	-	-	-	-	-
Manganese (Dissolved)	mg/L	0.03	1	3	5	0.11	0.33	0.55	mg/day	15000	1.7	36850	52.5	2190	0.084	1.5	-
Mercury	mg/L	-	0.00001	0.00002	0.00003	0.00001	0.00002	0.00003	mg/day	-	9.9E-06	2.01	-	-	-	-	-
Mercury (Dissolved)	mg/L	0.0	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	mg/day	0	3.3E-06	0.67	0	0	0.000001	0.001	0.00025
Molybdenum	mg/L	-	0.001	0.0015	0.002	0.001	0.0015	0.002	mg/day	-	0.0007	134	-	-	-	-	-
Molybdenum (Dissolved)	mg/L	0.0	0.001	0.0015	0.002	0.001	0.0015	0.002	mg/day	0	0.0007	134	0	0	0.0002	0.25	10
Nickel	mg/L	-	0.0075	0.01375	0.02	0.0075	0.014	0.02	mg/day	-	0.007	1340	-	-	-	-	-
Nickel (Dissolved)	mg/L	0.0	0.0075	0.01375	0.02	0.0075	0.014	0.02	mg/day	0	0.007	1340	0	0	0.0021	0.08	0.65-1.5 [b]
Selenium	mg/L	-	0.001	0.003	0.005	0.001	0.003	0.005	mg/day	-	0.0017	335	-	-	-	-	-
Selenium (Dissolved)	mg/L	0.0002	0.001	0.003	0.005	0.001	0.003	0.005	mg/day	100	0.002	335	0.35	14.6	0.0007	0.01	0.02
Silver	mg/L	-	0.0001	0.00006	0.00002	0.0001	0.00006	0.00002	mg/day	-	6.6E-06	1.34	-	-	-	-	-
Silver (Dissolved)	mg/L	0.0	0.0001	0.00015	0.0002	0.0001	0.00015	0.0002	mg/day	0	6.6E-06	13.4	0	0	0.00002	0.02	0.0005-0.015
Sodium	mg/L	-	100	550	1000	20	110	200	mg/day	-	330	13400000	-	-	-	-	-
Sodium (Dissolved)	mg/L	3.89	100	550	1000	20	110	200	mg/day	1945000	330	13400000	6807.5	283970	24.39	200	-
Zinc	mg/L	-	0.05	1.025	2	0.05	1.03	2	mg/day	-	0.66	134000	-	-	-	-	-
Zinc (Dissolved)	mg/L	0.002	0.025	0.5125	1	0.025	0.51	1	mg/day	1000	0.33	67000	3.5	146	0.106	3	0.075-2.4 [b]

Notes:
(1) Concentrations have been calculated using the average concentration of each sample collected from the overburden, sand and gravel aquifer between 2015 and 2017.
For the purposes of predicting the mass inputs, concentrations of 0.0 mg/L have been used wherever samples were below detection limits (ND or less than the reporting limit).
(2) Contaminant masses are calculated by multiplying the forecasted concentration by the volume of the respective source
(3) Final Forecasted Groundwater Concentrations = (sum of masses)/(sum of source volumes)
(4) The forecasted concentration approach is inappropriate for pH and conductivity.
conductivity is estimated as TDS/0.67; pH is expected to fall within the min. and max. range in pre-Landfill, leachate, or effluent.
(5) Infiltration rates used are 72% in the pit (with no vegetation) and 50% for above the pit (with vegetation) - derived from HELP modeling.
- not analyzed or no standard/criteria available.

ND - not detected above the respective laboratory reporting limit
[a] - Limit varies with pH. Ranges are calculated using average pre-landfilling and final predicted concentrations
[b] - Limit varies with Hardness. Ranges are calculated using average pre-landfilling and final predicted concentrations
[c] - Limit is set for hexavalent chromium
(SAD)/(WAD) - strong acid dissolvable/weak acid dissolvable
exceeds the BC CSR Drinking Water (DW) Standards
exceeds the BC CSR Aquatic Life (AW) Standards

Table 13.1 D
Groundwater Compliance Forecast
Scenario 4 - Wet Season
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Parameters	Units	Average Pre-Landfilling Concentrations ⁽¹⁾ 2015 - 2017	Forecasted Upland Landfill Leachate Concentrations		Forecasted Upland Landfill Treated Leachate Concentrations			Contaminant Masses & Source Volumes ⁽²⁾					Final Forecasted Groundwater Concentrations ⁽³⁾	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017	BC Contaminated Site Regulation Schedule 3.2, Nov. 2017		
			Minimum	Average	Maximum	Minimum	Average	Maximum	Flux into Landfill Footprint Area (maximum)	Landfill Leakage (primary liner only)	Treated Leachate Infiltration (Designed)	Infiltration of Runoff and Lateral Drainage from Landfill Cap (wet periods)				Infiltration Downgradient of Landfill ⁽⁵⁾ (wet periods)	
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Units m3/day	mg/day	mg/day	mg/day				mg/day	mg/day
									Contaminant Masses					Scenario Wet Season			
									Maximum					max. upgradient flux, average mass loading (leachate & effluent), wet season runoff & downgradient infiltration			
									Maximum					Drinking Water (DW)			
														Aquatic Life (AW)			
GENERAL CHEMISTRY																	
Alkalinity (total)	mg/L	54.7	500	1500	2500	50	150	250	mg/day	47042000	826	16750000	363208	23521000	64.3	-	-
Ammonia-N	mg/L	0.08	1	15.5	30	0.10	1.55	3	mg/day	68800	9.9	201000	531	34400	0.22	-	11.3 [a]
BOD	mg/L	2.07	10	30	50	3.5	10.5	17.5	mg/day	1780200	16.5	1172500	13744.8	890100	2.83	-	-
Chloride (Cl) (dissolved)	mg/L	4.15	100	800	1500	16.7	133.3	250	mg/day	3569000	495	16750000	27556	1784500	16.23	250	1500
COD	mg/L	39.1	50	275	500	15	82.5	150	mg/day	33626000	165	10050000	259624	16813000	44.55	-	-
Conductivity ⁽⁴⁾	us/cm	137	200	3850	7500	200	3850	7500	us/cm	-	-	-	-	-	423.30	-	-
Hardness	mg/L	60	750	1625	2500	750	1625	2500	mg/day	51600000	826	167500000	398400	25800000	180	-	-
pH ⁽⁴⁾	pH units	7.86	6	7	8	6	7	8	std. units	-	-	-	-	-	7.8	-	-
Phenols	mg/L	0.0	0.005	0.0525	0.1	0.0005	0.00525	0.01	mg/day	0	0.03	670	0	0	0.00049	1	2
Sulphate (S042-)	mg/L	5.72	50	525	1000	25	263	500	mg/day	4919200	330	33500000	37980.8	2459600	30.01	500	2180 - 4290 [b]
Sulphide	mg/L	0.006	0.1	2.55	5	0.001	0.026	0.05	mg/day	5160	1.65	3350	40	2580	0.0082	0.05	0.02
Total Suspended Solids (TSS)	mg/L	390	10	80	150	5	40	75	mg/day	3.35E+08	49.5	5025000	2589600	167700000	375	-	-
Total Dissolved Solids (TDS)	mg/L	31	2000	6000	10000	1000	3000	5000	mg/day	26660000	3302	335000000	205840	13330000	275	-	-
Total Kjeldahl Nitrogen (TKN)	mg/L	0.143	3	31.5	60	1.05	11.03	21	mg/day	122980	19.81	1407000	950	61490	1.168	-	-
Phosphorus	mg/L	0.551	0.1	0.3	0.5	0.1	0.3	0.5	mg/day	473860	0.17	33500	3658.64	236930	0.548	-	-
HYDROCARBONS																	
HEPH	mg/L	0.0	0.5	1.25	2	0.5	1.25	2	mg/day	0	0.66	134000	0	0	0.0983	-	-
LEPH	mg/L	0.0	0.5	1.25	2	0.125	0.313	0.5	mg/day	0	0.66	33500	0	0	0.0246	-	0.5
METALS																	
Aluminum	mg/L	-	0.1	0.55	1	0.1	0.55	1	mg/day	-	0.330	67000	-	-	0.01	-	-
Aluminum (Dissolved)	mg/L	0.00737	0.01	0.055	0.1	0.01	0.055	0.1	mg/day	6338.2	0.033	6700	48.9	3169	9.5	-	-
Arsenic	mg/L	-	0.001	0.0205	0.04	0.00025	0.005	0.01	mg/day	-	0.013	670	-	-	-	-	-
Arsenic (Dissolved)	mg/L	0.00014	0.001	0.0205	0.04	0.00025	0.005	0.01	mg/day	120.4	0.013	670	0.93	60	0.0006	0.01	0.05
Barium	mg/L	-	0.05	0.375	0.7	0.05	0.375	0.7	mg/day	-	0.231	46900	-	-	-	-	-
Barium (Dissolved)	mg/L	0.0014	0.05	0.375	0.7	0.05	0.375	0.7	mg/day	1204	0.23	46900	9	602	0.036	1	10
Boron	mg/L	-	5	7.5	10	2.5	3.75	5	mg/day	-	3.30	335000	-	-	-	-	-
Boron (Dissolved)	mg/L	0.0	5	7.5	10	2.5	3.75	5	mg/day	0	3.30	335000	0	0	0.246	5	12
Cadmium	mg/L	-	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	mg/day	-	9.9E-05	20.1	-	-	-	-	-
Cadmium (Dissolved)	mg/L	0.00001	0.0001	0.0002	0.0003	0.0001	0.0002	0.0003	mg/day	8.6	9.9E-05	20.1	0.07	4	0.0002	0.005	0.0015 - 0.004 [b]
Calcium	mg/L	-	200	450	700	200	450	700	mg/day	-	231.15	46900000	-	-	-	-	-
Calcium (Dissolved)	mg/L	18.842	200	450	700	200	450	700	mg/day	16204120	231	46900000	125111	8102060	52.31	-	-
Chromium	mg/L	-	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	-	0.017	3350	-	-	-	-	-
Chromium (Dissolved)	mg/L	0.0	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	0	0.017	3350	0	0	0.00246	0.05	0.01 [c]
Cobalt	mg/L	-	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	-	0.0033	670	-	-	-	-	-
Cobalt (Dissolved)	mg/L	0.0	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	0	0.0033	670	0	0	0.0005	0.001	0.04
Copper	mg/L	-	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	-	0.0165	3350	-	-	-	-	-
Copper (Dissolved)	mg/L	0.0008	0.005	0.0275	0.05	0.005	0.03	0.05	mg/day	688	0.017	3350	5.3	344	0.0032	1.5	0.03-0.09 [b]
Iron	mg/L	-	1	35.5	70	0.09	3.3	6.5	mg/day	-	23.1	435500	-	-	-	-	-
Iron (Dissolved)	mg/L	0.056	0.01	3.55	7	0.09	3.3	6.5	mg/day	48160	2.3	435500	372	24080	0.37	6.5	-
Lead	mg/L	-	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	-	0.0033	670	-	-	-	-	-
Lead (Dissolved)	mg/L	0.0	0.001	0.0055	0.01	0.001	0.006	0.01	mg/day	0	0.0033	670	0	0	0.0005	0.01	0.05 - 0.16 [b]
Magnesium	mg/L	-	30	165	300	10	55	100	mg/day	-	99.1	6700000	-	-	-	-	-
Magnesium (Dissolved)	mg/L	3.28	30	165	300	10	55	100	mg/day	2820800	99.1	6700000	21779	1410400	8.03	-	-
Manganese	mg/L	-	1	3	5	0.11	0.33	0.55	mg/day	-	1.7	36850	-	-	-	-	-
Manganese (Dissolved)	mg/L	0.03	1	3	5	0.11	0.33	0.55	mg/day	25800	1.7	36850	199	12900	0.056	1.5	-
Mercury	mg/L	-	0.00001	0.00002	0.00003	0.00001	0.00002	0.00003	mg/day	-	9.9E-06	2.01	-	-	-	-	-
Mercury (Dissolved)	mg/L	0.0	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	mg/day	0	3.3E-06	0.67	0.0	0	0.000000	0.001	0.00025
Molybdenum	mg/L	-	0.001	0.0015	0.002	0.001	0.0015	0.002	mg/day	-	0.0007	134	-	-	-	-	-
Molybdenum (Dissolved)	mg/L	0.0	0.001	0.0015	0.002	0.001	0.0015	0.002	mg/day	0	0.0007	134	0.0	0	0.0001	0.25	10
Nickel	mg/L	-	0.0075	0.01375	0.02	0.0075	0.014	0.02	mg/day	-	0.007	1340	-	-	-	-	-
Nickel (Dissolved)	mg/L	0.0	0.0075	0.01375	0.02	0.0075	0.014	0.02	mg/day	0	0.007	1340	0.0	0	0.0010	0.08	0.65-1.5 [b]
Selenium	mg/L	-	0.001	0.003	0.005	0.001	0.003	0.005	mg/day	-	0.0017	335	-	-	-	-	-
Selenium (Dissolved)	mg/L	0.0002	0.001	0.003	0.005	0.001	0.003	0.005	mg/day	172	0.002	335	1.33	86	0.0004	0.01	0.02
Silver	mg/L	-	0.0001	0.00006	0.00002	0.0001	0.00006	0.00002	mg/day	-	6.6E-06	1.34	-	-	-	-	-
Silver (Dissolved)	mg/L	0.0	0.0001	0.00015	0.0002	0.0001	0.00015	0.0002	mg/day	0	6.6E-06	13.4	0	0	0.00001	0.02	0.0005-0.015
Sodium	mg/L	-	100	550	1000	20	110	200	mg/day	-	330	13400000	-	-	-	-	-
Sodium (Dissolved)	mg/L	3.89	100	550	1000	20	110	200	mg/day	3345400	330	13400000	25830	1672700	13.53	200	-
Zinc	mg/L	-	0.05	1.025	2	0.05	1.03	2	mg/day	-	0.66	134000	-	-	-	-	-
Zinc (Dissolved)	mg/L	0.002	0.025	0.5125	1	0.025	0.51	1	mg/day	1720	0.33	67000	13	860	0.051	3	0.075-2.4 [b]

Notes:
(1) Concentrations have been calculated using the average concentration of each sample collected from the overburden, sand and gravel aquifer between 2015 and 2017.
For the purposes of predicting the mass inputs, concentrations of 0.0 mg/L have been used wherever samples were below detection limits (ND or less than the reporting limit).
(2) Contaminant masses are calculated by multiplying the forecasted concentration by the volume of the respective source
(3) Final Forecasted Groundwater Concentrations = (sum of masses)/(sum of source volumes)
(4) The forecasted concentration approach is inappropriate for pH and conductivity.
conductivity is estimated as TDS/0.67; pH is expected to fall within the min. and max. range in pre-Landfill, leachate, or effluent.
(5) Infiltration rates used are 72% in the pit (with no vegetation) and 50% for above the pit (with vegetation) - derived from HELP modeling.
- not analyzed or no standard/criteria available.

ND - not detected above the respective laboratory reporting limit
[a] - Limit varies with pH. Ranges are calculated using average pre-landfilling and final predicted concentrations
[b] - Limit varies with Hardness. Ranges are calculated using average pre-landfilling and final predicted concentrations
[c] - Limit is set for hexavalent chromium
(SAD)/(WAD) - strong acid dissolvable/weak acid dissolvable
exceeds the BC CSR Drinking Water (DW) Standards
exceeds the BC CSR Aquatic Life (AW) Standards

Table 14.1

**Well, Borehole and Test Pit Completion Details
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia**

Monitoring ID	Installation Date	Completed By	Borehole Depth (mBGS)	Easting	Northing	2015 Reference Elevation Ground Surface (mAMSL) ²	2015 Reference Elevation TOR (mAMSL) ²	2017 Reference Elevation Ground Surface (mAMSL) ¹	2017 Reference Elevation TOR (mAMSL) ¹	Stick-up (m)	Screened Interval (mBGS)	Screen Interval (mAMSL)	Screen Length (m)	Well Diameter (mm)	Primary Constituent of Completed Unit		
Date:																	
MW1-14	12/4/2014	RWD	10.97	330788.539	5541791.638	154.5	172.9	-	-	1.1	11.0	4.9	160.8	149.6	6.1	50.8	Sand/gravel
MW2-14	12/4/2014	RWD	21.64	330961.402	5541591.181	155.8	156.5	-	-	0.8	21.6	15.5	151.4	140.2	6.1	50.8	Sand/gravel
MW2A-16	1/27/2016	Drillwell	45.42	330964.560	5541591.419	155.8	156.6	173.1	173.9	0.8	40.5	37.5	132.6	118.3	6.1	50.8	Sand
MW3-14	12/4/2014	RWD	18.59	330885.439	5541429.793	150.3	151.3	-	-	1.0	17.4	11.3	150.2	139.0	6.1	50.8	Sand/gravel
MW4A-15	8/5/2015	Blue Max	21.33	330737.351	5541583.042	151.2	152.0	-	-	0.8	21.4	19.8	147.2	131.4	1.5	50.8	Bedrock
MW4B-15	8/5/2015	Blue Max	18.28	330743.926	5541575.024	151.1	152.0	-	-	0.9	18.3	15.2	150.1	135.9	3.0	50.8	Sand
MW5A-15	8/7/2015	Blue Max	10.66	330675.167	5541325.831	174.0	174.6	-	-	0.6	10.7	9.1	180.6	164.8	1.5	50.8	Bedrock
MW5B-15	8/7/2015	Blue Max	8.23	330685.323	5541325.831	191.3	174.7	-	-	1.7	7.9	4.9	182.4	186.4	3.0	50.8	Sand/Silt with clay
MW6-17	3/22/2017	Drillwell	11.89	330407.086	5541753.092	-	-	185.5	185.4	-0.1	11.3	9.8	174.2	175.7	1.5	50.8	Sand
MW7-17	3/14/2017	Drillwell	5.03	330266.457	5541691.359	-	-	186.9	187.5	0.7	4.3	2.7	182.6	184.1	1.5	50.8	Gravel
MW8-17	2/22/2017	Blue Max	28.96	330544.895	5541828.138	-	-	191.3	192.5	1.2	18.8	15.8	172.5	175.5	3.0	50.8	Gravel
MW9-17	3/14/2017	Drillwell	33.53	330744.892	5541911.675	-	-	190.9	191.7	0.8	33.5	30.5	157.3	160.4	3.0	50.8	Sand/gravel
MW10-17	3/27/2017	Drillwell	47.87	331208.625	5541441.665	-	-	188.2	189.1	0.8	46.3	43.2	142.0	145.0	3.0	50.8	Sand
RW-98020	5/13/2008	RWD	60.96	330012.000	5541724.000	178.3	179.6	-	-	1.3	61.0	1.8	134.7	176.5	41.8	152.4	Bedrock
BH1-16	1/27/2016	Drillwell	24.08	330846.010	5541551.180	168.41	-	-	-	-	-	-	-	-	-	-	Bedrock
BH2-16	1/28/2016	Drillwell	16.46	330839.010	5541470.180	167.83	-	-	-	-	-	-	-	-	-	-	Bedrock
BH5-15	8/6/2015	Blue Max	24.38	330765.701	5541327.331	ns	-	-	-	-	-	-	-	-	-	-	Sand/gravel
TP1-17	3/23/2017	Upland	4.57	330375.872	5541665.807	-	-	182.14	-	-	-	-	-	-	-	-	Sand with gravel
TP2-17	3/23/2017	Upland	2.44	330340.223	5541649.458	-	-	182.78	-	-	-	-	-	-	-	-	Bedrock
TP3-17	3/23/2017	Upland	5.49	330445.9487	5541608.703	-	-	182.61	-	-	-	-	-	-	-	-	Bedrock
TP4-17	3/23/2017	Upland	4.11	330471.1766	5541750.688	-	-	191.23	-	-	-	-	-	-	-	-	Sand with gravel
TP5-17	3/23/2017	Upland	5.64	330467.1592	5541418.59	-	-	189.44	-	-	-	-	-	-	-	-	Silty Sand
TP6-17	3/24/2017	Upland	5.79	330407.0856	5541753.092	-	-	191.89	-	-	-	-	-	-	-	-	Sand with gravel
TP7-17	3/24/2017	Upland	6.40	330509.0192	5541457.215	-	-	191.82	-	-	-	-	-	-	-	-	Sand with gravel
TP8-17	3/24/2017	Upland	3.35	330492.9906	5541417.832	-	-	192.15	-	-	-	-	-	-	-	-	Bedrock
TP9-17	3/24/2017	Upland	0.61	330535.6659	5541369.794	-	-	191.99	-	-	-	-	-	-	-	-	Bedrock

Notes:

1 - Surveys completed by McElhanney on April 6, 2016 and March 16 and 31, 2017

2 - Survey completed by Upland Excavating Ltd. on January 29th, 2015, March 8, 2016 and April 6th, 2016. Elevations measured with respect to AMSL.

mBGS - metres below ground surface

mAMSL - metres above mean sea level

TOR - top of riser

ns - not surveyed

RWD - Red Williams Well Drilling Ltd.

Upland - Upland Excavating Ltd.

Drillwell - Drillwell Enterprises Ltd.

Blue Max - Blue Max Drilling Inc.

Table 14.2
Hydraulic Monitoring Results
2021 Design, Operations and Closure Plan
Northwin Landfill
Upland Excavating Ltd.
Campbell River, British Columbia

Monitoring ID	Borehole Depth (m BGS)	2015/2016 Reference Elevation TOR (m AMSL) ²	2017 Reference Elevation TOR (m AMSL) ¹	Depth to Water (m BTOR)												Water Elevation (m AMSL)				Hydraulic Conductivity (cm/s)	Screened Unit/Aquifer				
				11-Sep-15	17-Sep-15	5-Oct-15	25-Jan-16	29-Jan-16	15-Feb-16	8-Mar-16	15-Mar-17	6-Apr-17	11-Sep-15	17-Sep-15	5-Oct-15	25-Jan-16	29-Jan-16	15-Feb-16	8-Mar-16			6-Apr-16	15-Mar-17	6-Apr-17	
Date:																								Primary Constituent	
MW1-14	10.97	172.9	-	5.6	6.3	6.1	6.0	-	-	-	-	8.1	7.7	167.3	166.6	166.9	166.9	-	-	-	-	164.8	165.2	-	Sand/gravel (S&G Aquifer)
MW2-14	21.64	173.8	-	14.5	14.7	15.2	14.7	-	-	-	-	15.9	15.8	159.4	159.1	158.6	159.1	-	-	-	-	159.3	158.0	-	Sand/gravel (S&G Aquifer)
MW2A-16	45.42	173.9	173.9	-	-	-	-	-	-	-	-	15.9	15.8	-	-	-	159.3	-	-	-	-	159.3	158.1	-	Sand (S&G Aquifer)
MW3-14	18.59	168.6	-	12.8	12.7	12.8	11.3	-	-	-	-	12.1	12.1	155.8	155.9	155.8	157.2	-	-	-	-	-	156.5	-	Sand/gravel (S&G Aquifer)
MW4A-15	21.33	169.3	-	3.9	4.3	4.9	4.0	-	-	-	-	5.7	3.4	165.4	165.0	164.4	165.3	-	-	-	-	-	163.6	2.2 x 10 ⁻²	Bedrock (S&G Aquifer)
MW4B-15	18.28	169.3	-	4.1	4.5	5.1	4.2	-	-	-	-	5.9	5.7	165.2	164.8	164.1	165.0	-	-	-	-	-	163.3	2.0 x 10 ⁻²	Sand (S&G Overburden)
MW5A-15	10.66	191.9	-	9.0	9.0	8.3	7.3	-	-	-	-	8.1	7.7	182.9	182.9	183.6	184.6	-	-	-	-	-	183.8	1.4 x 10 ⁻⁵	Bedrock Ridge (S&G Aquifer)
MW5B-15	8.22	192.0	-	7.1	7.2	7.0	5.4	-	-	-	-	7.1	6.1	184.9	184.9	185.0	186.6	-	-	-	-	-	184.9	-	Sand/Silt with clay (S&G Aquifer)
MW6-17	11.28	-	185.4	-	-	-	-	-	-	-	-	-	7.5	-	-	-	-	-	-	-	-	-	177.9	-	Sand (S&G Aquifer)
MW7-17	4.29	-	187.5	-	-	-	-	-	-	-	-	3.3	2.9	-	-	-	-	-	-	-	-	-	184.2	-	Gravel (Shallow Aquifer)
MW8-17	18.80	-	192.5	-	-	-	-	-	-	-	-	19.7	19.7	-	-	-	-	-	-	-	-	-	172.8	-	Gravel (S&G Aquifer)
MW9-17	33.54	-	191.7	-	-	-	-	-	-	-	-	24.8	24.4	-	-	-	-	-	-	-	-	-	166.8	-	Sand/gravel (S&G Aquifer)
MW10-17	46.25	-	189.1	-	-	-	-	-	-	-	-	-	39.0	-	-	-	-	-	-	-	-	-	150.1	-	Sand (S&G Aquifer)
RW-98020	60.96	196.9	-	-	-	-	-	-	-	-	-	17.1	-	-	-	-	-	-	-	-	-	-	-	-	Bedrock Ridge
Mclvor Lake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	177.5 ⁽³⁾	-	177.9 ⁽²⁾	177.0 ⁽²⁾	177.6 ⁽³⁾	177.6 ⁽³⁾	-	-
SW15-02	-	-	-	-	-	-	-	0.88	-	0.91	0.06	0.09	-	-	-	-	-	181.2	-	181.2 ⁽²⁾	180.8 ⁽²⁾	180.4	180.4	-	-
Rico Lake	-	180.33*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
 1 - Surveys completed by McElhanney on April 6, 2016 and March 16 and 31, 2017
 2 - Survey completed by Upland Excavating Ltd. on January 29th, 2015, March 8, 2016 and April 6th, 2016. Elevations measured with respect to AMSL.
 3 - Based on BC Hydro record of water elevations at Ladore Dam recorded every three hours. (https://www.bchydro.com/energy-in-bc/our_system/transmission_reservoir_data/previous_reservoir_elevations/vancouver_island/ladore_ldr.html)

* Surface water gauge reference elevation refers to the bottom of the gauge. (0 m on gauge = 180.33 m amsl)
 m BGS - metres below ground surface
 m AMSL - metres above mean sea level (WGS1984)
 TOR - top of riser
 S&G - Sand and gravel

Drawings

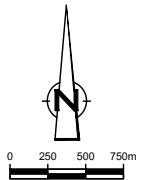
UPLAND EXCAVATING LTD. CAMPBELL RIVER, B.C.



GHD Limited
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Richmond British Columbia V6X 2W8 Canada
T 604 214 0510 F 604 214 0525 W www.ghd.com

NORTHWIN LANDFILL 2021 DESIGN, OPERATIONS AND CLOSURE PLAN JUNE 2021

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LOCATION MAP

DRAWING LIST

DWG. No.	DRAWING TITLE
G-01	COVER
C-01	EXISTING CONDITIONS
C-02	SITE OPERATIONS
C-03	BASE GRADES AND LEAK DETECTION SYSTEM
C-04	LEACHATE COLLECTION SYSTEM
C-05	LEACHATE COLLECTION SYSTEM - TOP OF DRAINAGE LAYER
C-06	FINAL GRADES (TOP OF FINAL COVER)
C-07	CROSS-SECTIONS - A-A', B-B' AND C-C'
C-08	FILL PLAN - STAGE 1 EAST
C-09	FILL PLAN - STAGE 1 WEST & STAGE 2A
C-10	FILL PLAN - STAGE 2B & STAGE 2C
C-11	FILL PLAN - STAGE 3A & STAGE 3B
C-12	FILL PLAN - STAGE 3C
C-13	DETAILS - LINER DETAILS
C-14	DETAILS - LEACHATE COLLECTION SUMP
C-15	DETAILS - LEACHATE LEAK DETECTION SUMP
C-16	DETAILS - LEACHATE COLLECTION SYSTEM
C-17	DETAILS - PERIMETER TIE-IN DETAILS I
C-18	DETAILS - PERIMETER TIE-IN DETAILS II
C-19	DETAILS - LEACHATE MANAGEMENT

Client
**UPLAND EXCAVATING LTD.
CAMPBELL RIVER, B.C.**

Project
**2021 DESIGN, OPERATIONS,
AND CLOSURE PLAN**

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020

Drawn **T.WAGSTAFF** Designer **R. HASIOR**

Drafting Check Design Check

Project Manager **D. LIDDY** Date **Jun 10, 2016**

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Original Size
ANSI D Scale **1:25000**
Bar is 20mm on original size drawing
0 20mm

Project No. **88877-11**

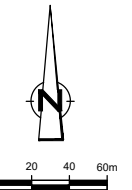
Title
COVER

Sheet No.
G-01



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Project
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1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020
No.	Issue	Drawn	Approved	Date
Drawn	T. WAGSTAFF	Designer	R. HASIOR	
Drafting Check		Design Check		
Project Manager	D. LIDDY	Date	July 2, 2021	
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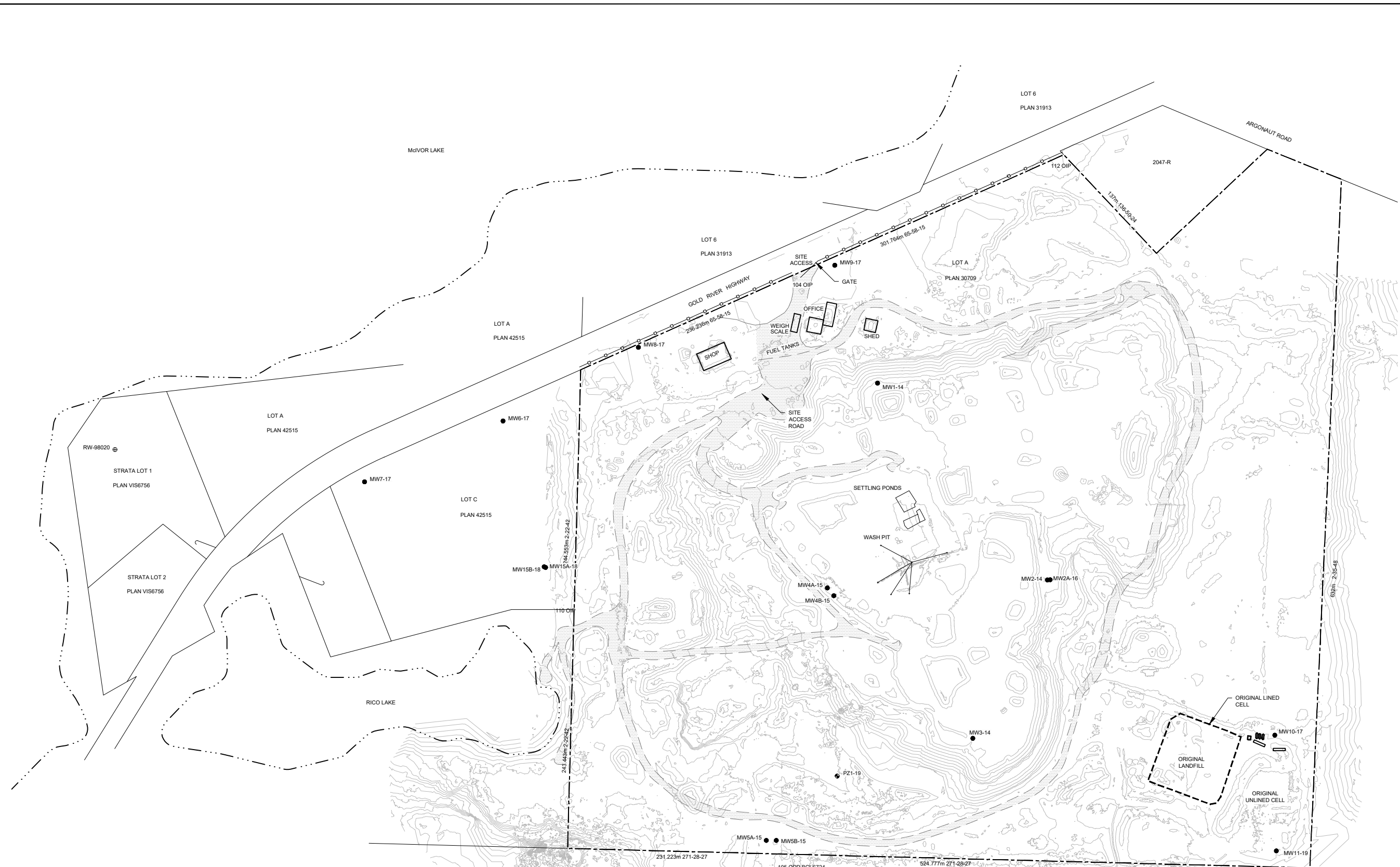
Project No. **88877-11**

Title

EXISTING CONDITIONS

Sheet No.

C-01



- LEGEND**
- 165 — EXISTING MAJOR CONTOURS
 - — EXISTING MINOR CONTOUR
 - - - - PROPERTY LINE
 - . . . - EXISTING LAKE SHORELINE
 - - - - EXISTING FENCELINE
 - ▨▨▨▨ EXISTING ACCESS ROADWAY
 - MW3-14 EXISTING MONITORING WELLS

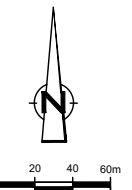
SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY McELHANNEY ASSOCIATES LAND SURVEYING LTD., MARCH 2020 AND SEPTEMBER 2020.



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2021 DESIGN, OPERATIONS AND CLOSURE PLAN

1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020
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No.	Issue	Drawn	Approved	Date
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Drawn	T. WAGSTAFF	Designer	R. HASIOR
Drafting Check		Design Check	

Project Manager	D. LIDDY	Date	July 2, 2021
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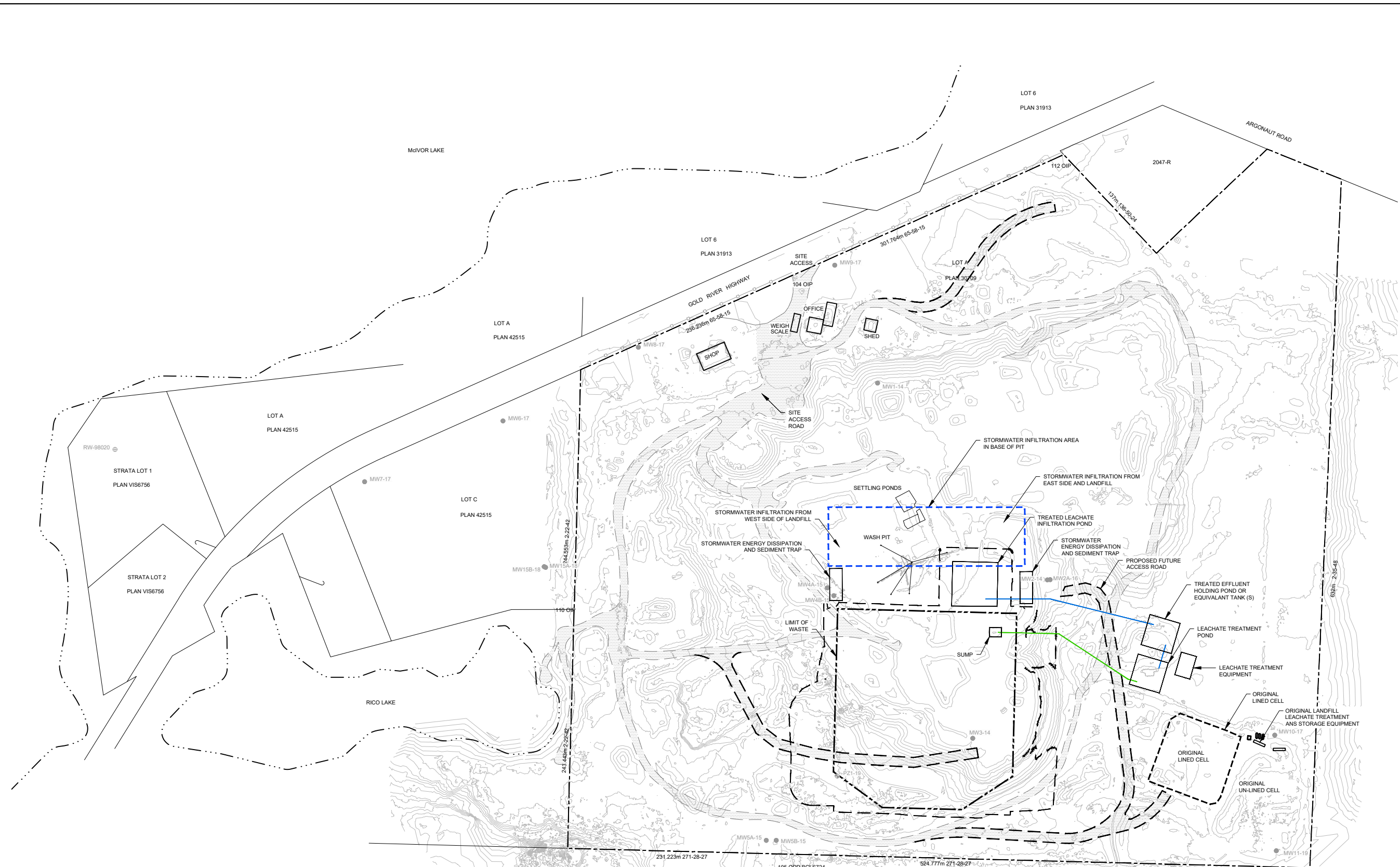
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Project No.	88877-11
Title	

SITE OPERATIONS

Sheet No.	
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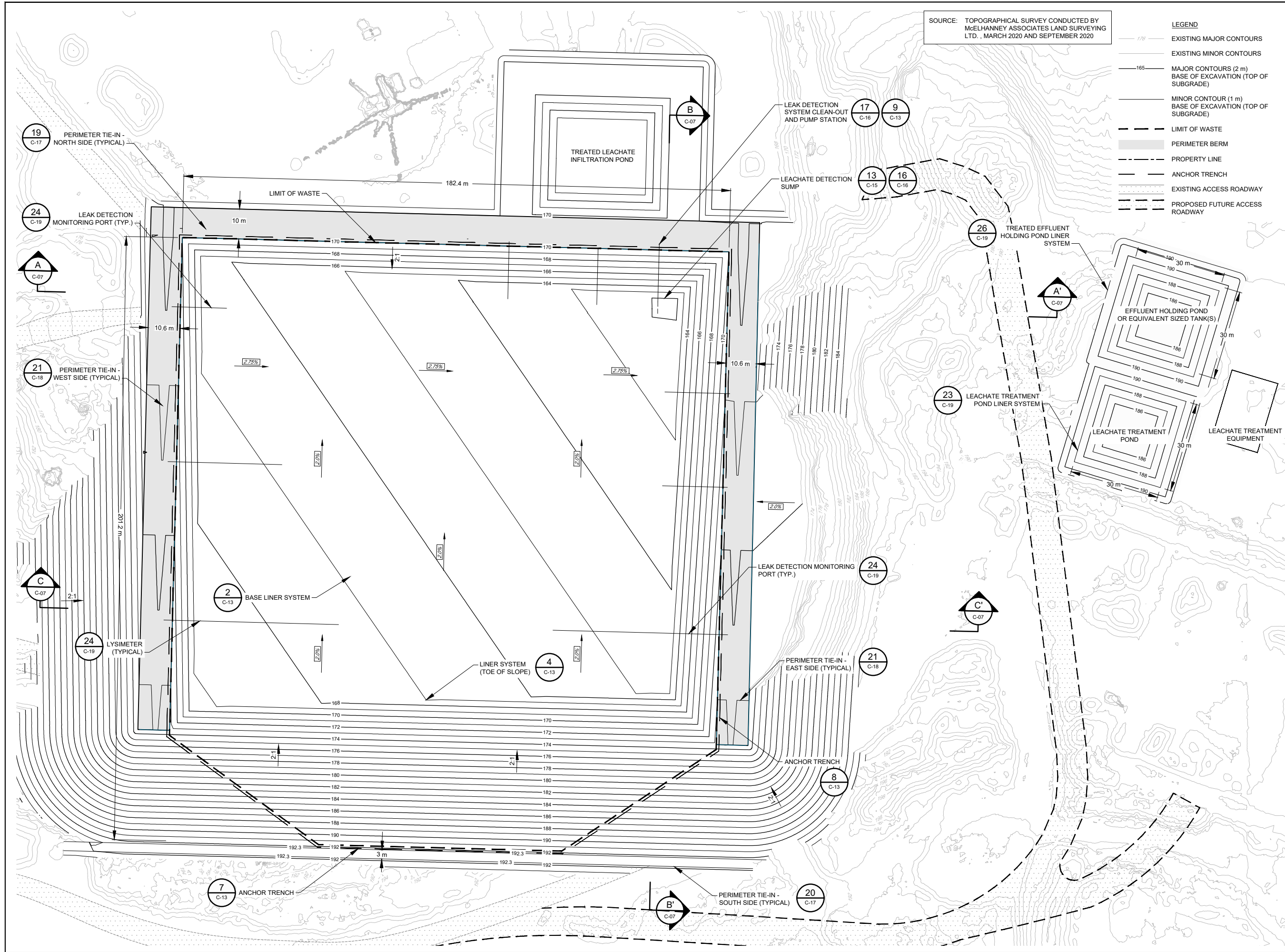
C-02



LEGEND

	EXISTING MAJOR CONTOURS		LIMIT OF WASTE	
	EXISTING MINOR CONTOUR		LIMIT OF EXCAVATION	
	PROPERTY LINE		LEACHATE CONVEYANCE PIPE	
	EXISTING LAKE SHORELINE		TREATED EFFLUENT CONVEYANCE PIPE	
	EXISTING ACCESS ROADWAY		EXISTING FENCELINE	
	PROPOSED FUTURE ACCESS ROADWAY		EXISTING MONITORING WELL	
				EXISTING PIEZOMETER

SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY McELHANNEY ASSOCIATES LAND SURVEYING LTD., MARCH 2020 AND SEPTEMBER 2020.



SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY
McELHANNAY ASSOCIATES LAND SURVEYING
LTD., MARCH 2020 AND SEPTEMBER 2020

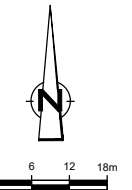
- LEGEND**
- 176 — EXISTING MAJOR CONTOURS
 - 165 — EXISTING MINOR CONTOURS
 - 165 — MAJOR CONTOURS (2 m) BASE OF EXCAVATION (TOP OF SUBGRADE)
 - 166 — MINOR CONTOUR (1 m) BASE OF EXCAVATION (TOP OF SUBGRADE)
 - - - - - LIMIT OF WASTE
 - ▬ PERIMETER BERM
 - - - - - PROPERTY LINE
 - - - - - ANCHOR TRENCH
 - ▬ EXISTING ACCESS ROADWAY
 - - - - - PROPOSED FUTURE ACCESS ROADWAY



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1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020

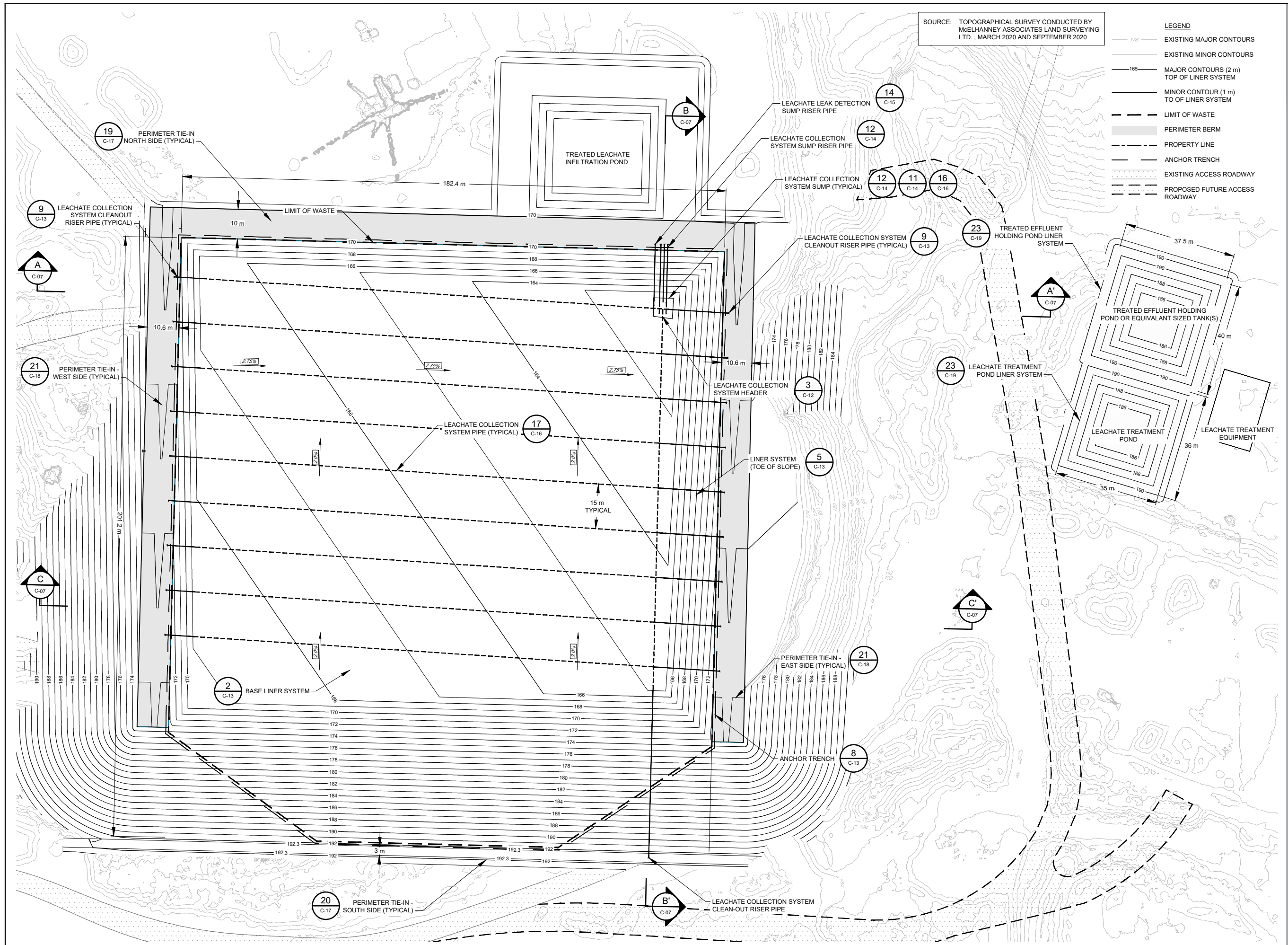
Drawn	T.WAGSTAFF	Designer	R. HASIOR
Drafting Check		Design Check	
Project Manager	D. LIDDY	Date	July 5, 2021
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Original Size	ANSI D		
	Bar is 20mm on original size drawing 0 20mm		

Project No. **88877-11**

Title
**BASE GRADES AND
LEAK DETECTION SYSTEM**

Sheet No.
C-03

Sheet 4 of 20

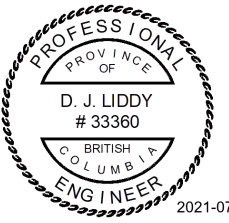


SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY McELHANNEY ASSOCIATES LAND SURVEYING LTD., MARCH 2020 AND SEPTEMBER 2020

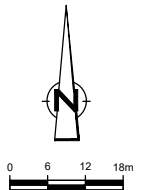
- LEGEND**
- 176 — EXISTING MAJOR CONTOURS
 - — — EXISTING MINOR CONTOURS
 - 165 — MAJOR CONTOURS (2 m) TOP OF LINER SYSTEM
 - — — MINOR CONTOUR (1 m) TO OF LINER SYSTEM
 - - - - - LIMIT OF WASTE
 - ▬ PERIMETER BERM
 - - - - - PROPERTY LINE
 - — — ANCHOR TRENCH
 - ▬ EXISTING ACCESS ROADWAY
 - - - - - PROPOSED FUTURE ACCESS ROADWAY



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Project
2021 DESIGN, OPERATIONS AND CLOSURE PLAN

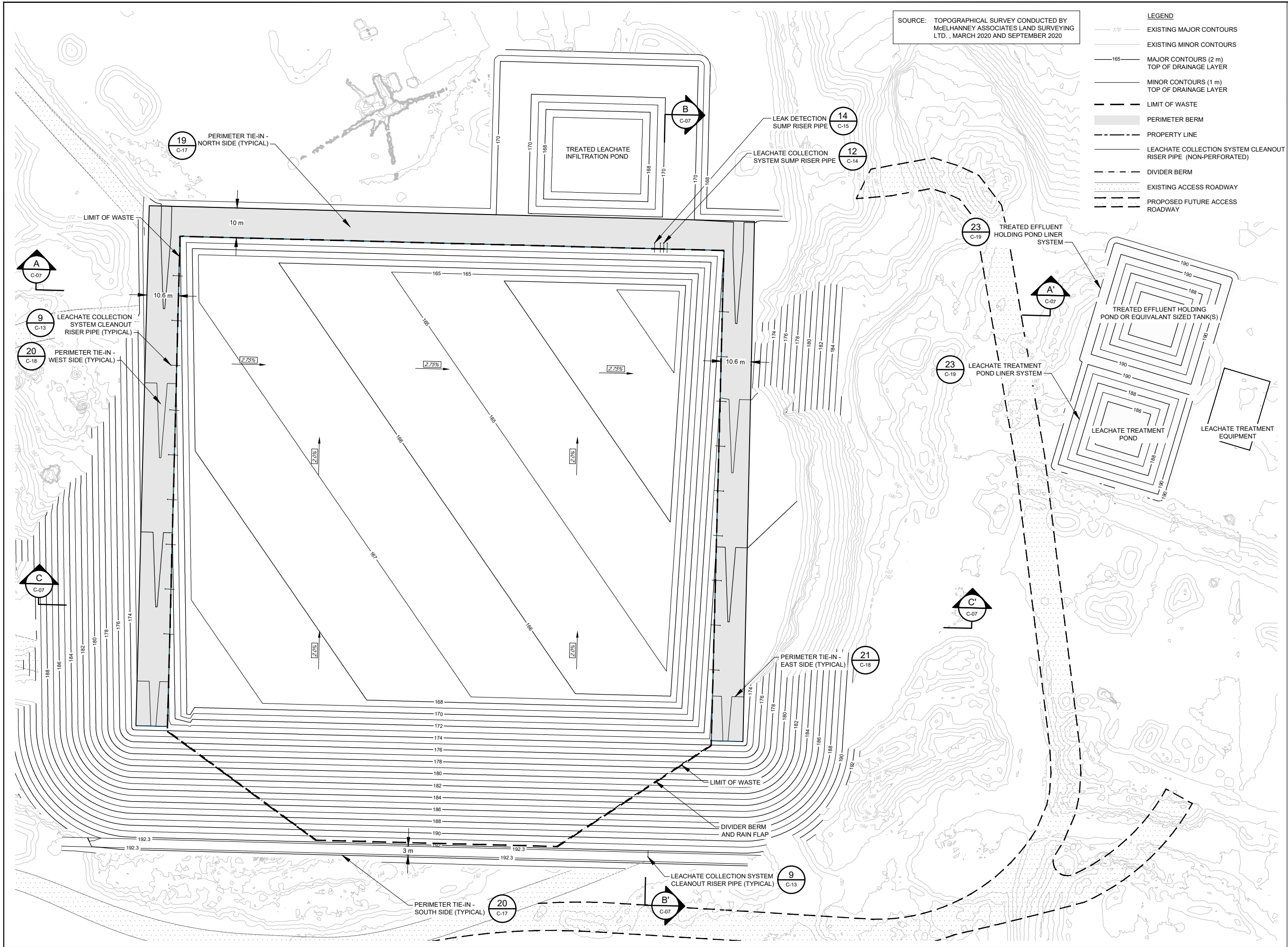
No.	Issue	Drawn	Approved	Date
1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020

Drawn	T.WAGSTAFF	Designer	R. HASIOR
Drafting Check		Design Check	
Project Manager	D. LIDDY	Date	July 5, 2021
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		Bar is 20mm on original size drawing 0 20mm	

Project No. **88877-11**

Title
LEACHATE COLLECTION SYSTEM

Sheet No.
C-04



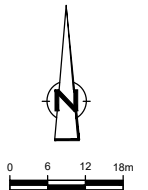
SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY
McLHANNAY ASSOCIATES LAND SURVEYING
LTD., MARCH 2020 AND SEPTEMBER 2020

- LEGEND**
- 1/76 --- EXISTING MAJOR CONTOURS
 - --- EXISTING MINOR CONTOURS
 - 165--- MAJOR CONTOURS (2 m) TOP OF DRAINAGE LAYER
 - --- MINOR CONTOURS (1 m) TOP OF DRAINAGE LAYER
 - - - - - LIMIT OF WASTE
 - ▬ PERIMETER BERM
 - - - - - PROPERTY LINE
 - LEACHATE COLLECTION SYSTEM CLEANOUT RISER PIPE (NON-PERFORATED)
 - - - - - DIVIDER BERM
 - --- EXISTING ACCESS ROADWAY
 - - - - - PROPOSED FUTURE ACCESS ROADWAY

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PROFESSIONAL
OF
D. J. LIDDY
33360
COLUMBIA
ENGINEER
2021-07-08

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**2021 DESIGN, OPERATIONS
AND CLOSURE PLAN**

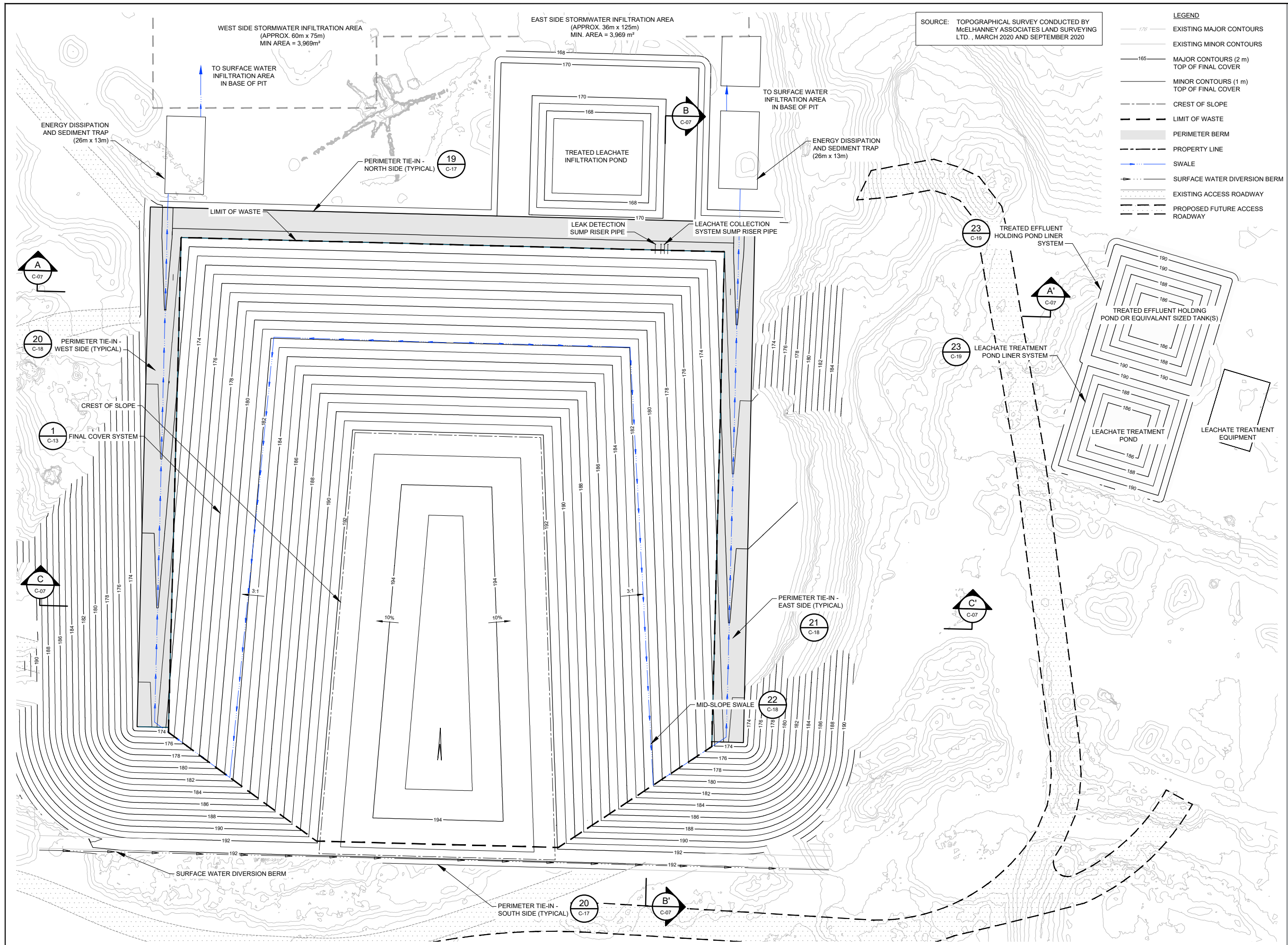
1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020
No.	Issue	Drawn	Approved	Date
Drawn	T.WAGSTAFF	Designer	R. HASIOR	
Drafting Check		Design Check		
Project Manager	D. LIDDY	Date	July 5, 2021	
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Original Size	ANSI D			Bar is 20mm on original size drawing 0 20mm

Project No. 88877-11

**LEACHATE COLLECTION SYSTEM
TOP OF DRAINAGE LAYER**

Sheet No.

C-05

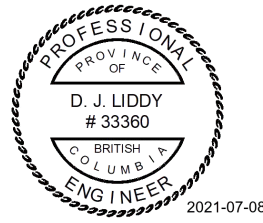


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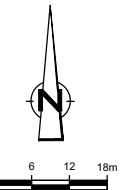
- 178 --- EXISTING MAJOR CONTOURS
- --- EXISTING MINOR CONTOURS
- 165 --- MAJOR CONTOURS (2 m) TOP OF FINAL COVER
- --- MINOR CONTOURS (1 m) TOP OF FINAL COVER
- - - - - CREST OF SLOPE
- - - - - LIMIT OF WASTE
- ▭ PERIMETER BERM
- - - - - PROPERTY LINE
- ▬ SWALE
- ▬ SURFACE WATER DIVERSION BERM
- ⋯ EXISTING ACCESS ROADWAY
- - - - - PROPOSED FUTURE ACCESS ROADWAY



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**2021 DESIGN, OPERATIONS,
 AND CLOSURE PLAN**

1	ISSUED FOR REVIEW	D.C.	D.L. 06-08-2020

No.	Issue	Drawn	Approved	Date
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Drawn **T.WAGSTAFF** Designer **R. HASIOR**

Drafting Check Design Check

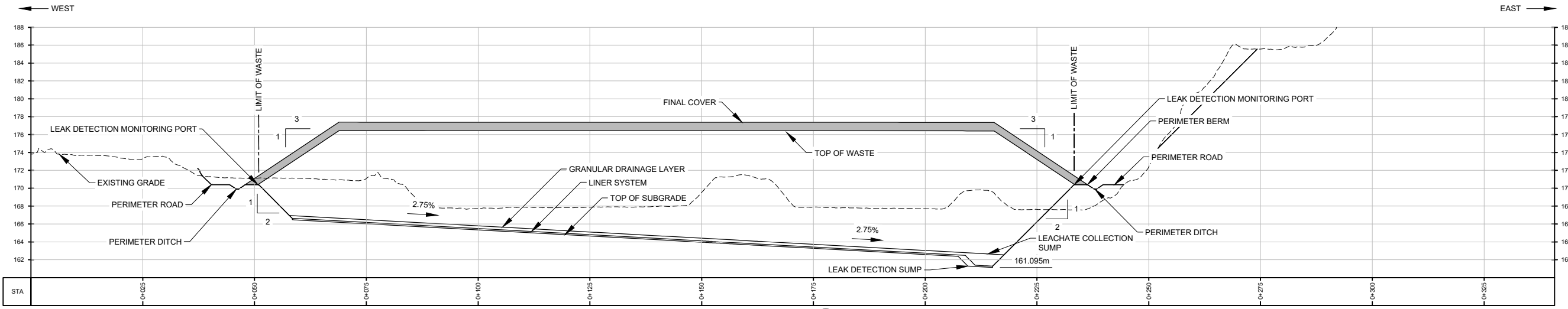
Project Manager **D. LIDDY** Date July 5, 2021

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ANSI D
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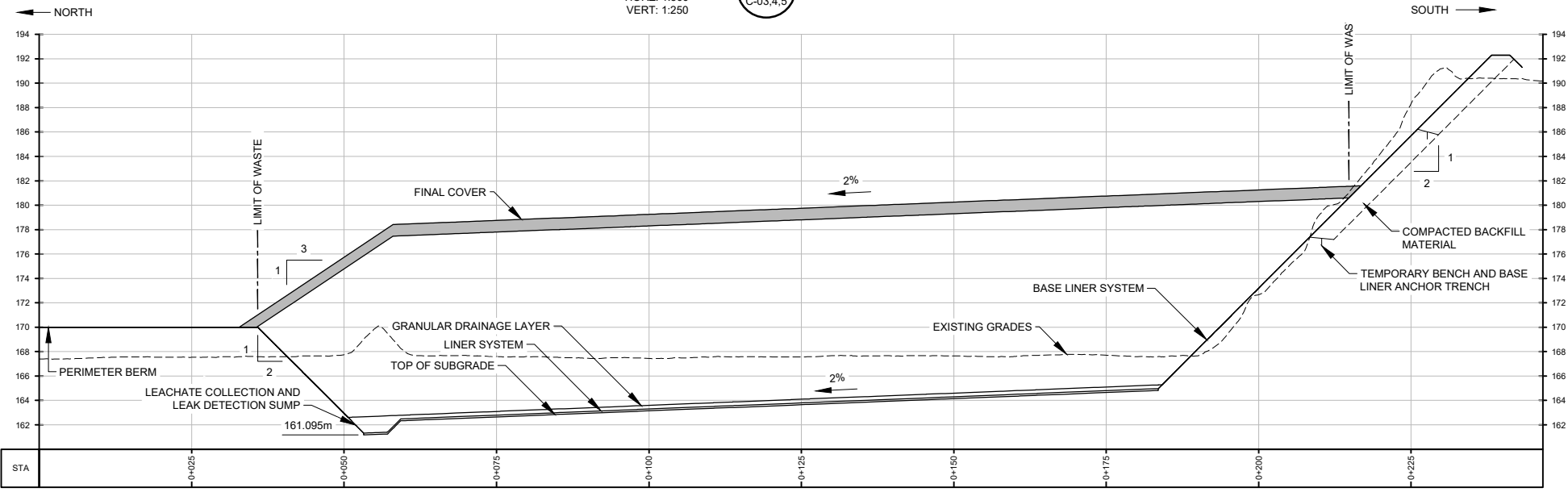
Project No. **88877-11**

Title
**FINAL GRADES
 (TOP OF FINAL COVER)**

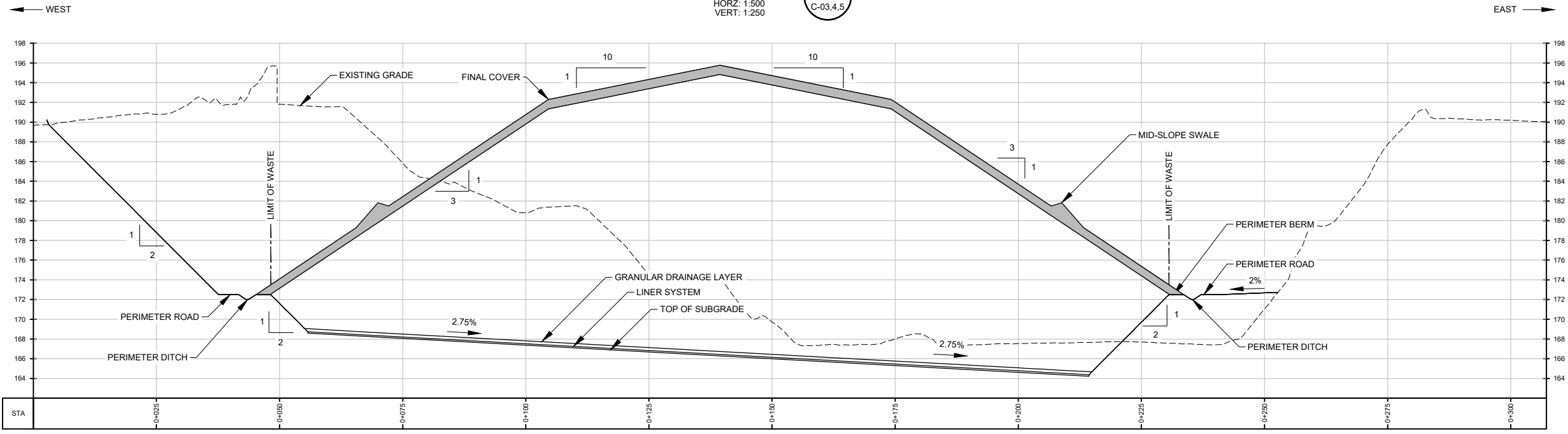
Sheet No.
C-06
 Sheet 7 of 20



SECTION A-A'
 HORZ: 1:500
 VERT: 1:250
 C-03,4,5



SECTION B-B'
 HORZ: 1:500
 VERT: 1:250
 C-03,4,5



SECTION C-C'
 HORZ: 1:500
 VERT: 1:250
 C-03,4,5

SOURCE: TOPOGRAPHICAL SURVEY CONDUCTED BY McELHANNEY ASSOCIATES LAND SURVEYING LTD., DECEMBER 18, 2018.

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PROFESSIONAL ENGINEER
 PROVINCE OF BRITISH COLUMBIA
 D. J. LIDDY
 # 33360
 2021-07-08

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2021 DESIGN, OPERATIONS, AND CLOSURE PLAN

No.	Issue	Drawn	Approved	Date
1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020

Drawn: T.WAGSTAFF Designer: R. HASIOR
 Drafting Check: Design Check
 Project Manager: D. LIDDY Date: July 5, 2021
 Scale: AS SHOWN
 Original Size: ANSI D Bar is 20mm on original size drawing (0 to 20mm)

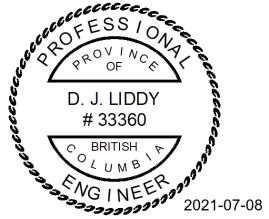
Project No. 88877-11

Title
CROSS-SECTIONS A-A', B-B' AND C-C'

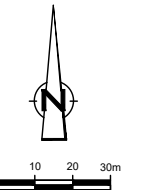
Sheet No.
C-07



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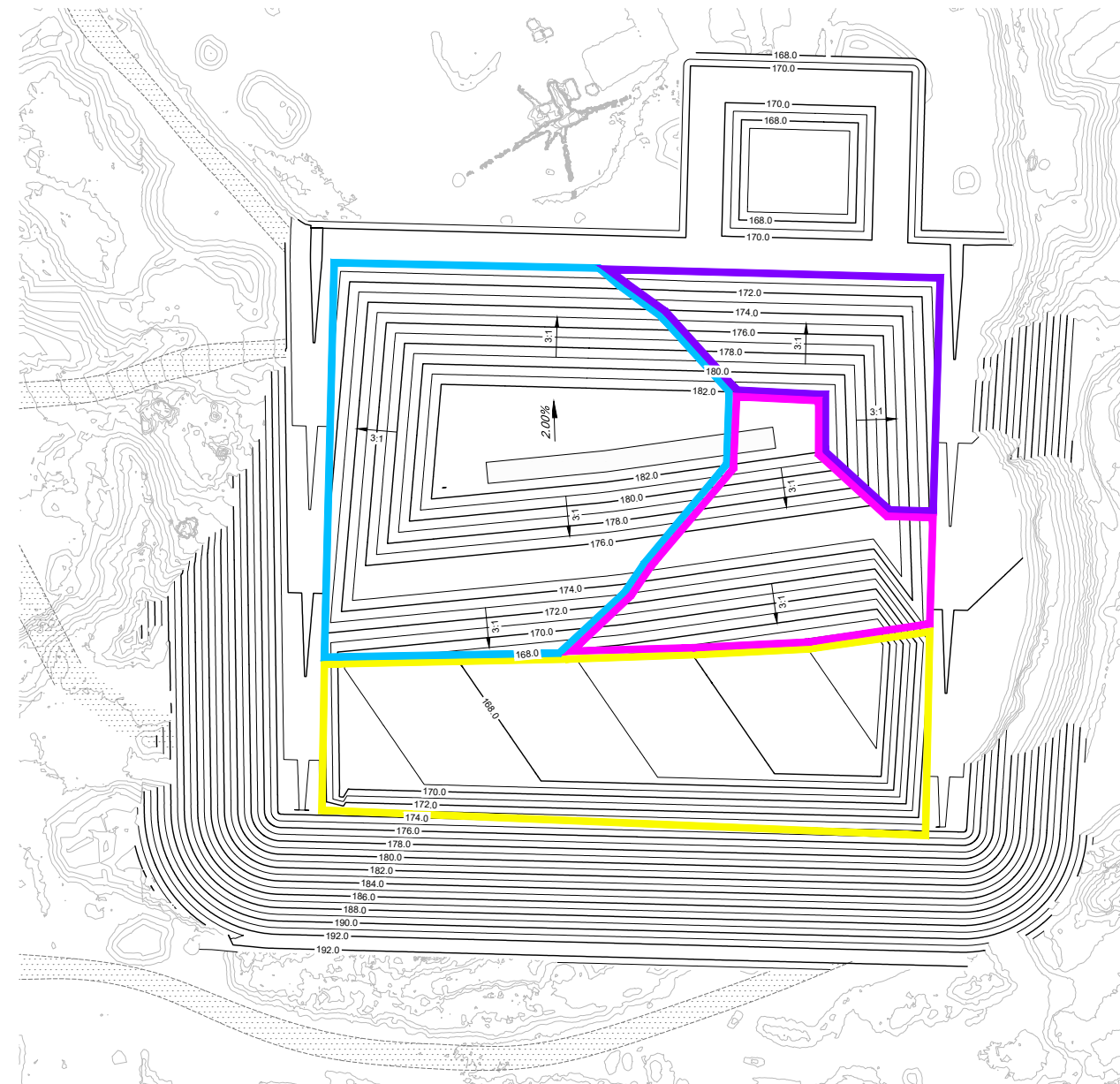
Project
2021 DESIGN, OPERATIONS,
AND CLOSURE PLAN

1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020
No.	Issue	Drawn	Approved	Date
Drawn	T.WAGSTAFF	Designer	R. HASIOR	
Drafting Check		Design Check		
Project Manager	D. LIDDY	Date	July 5, 2021	
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Original Size	Bar is 20mm on original size drawing			
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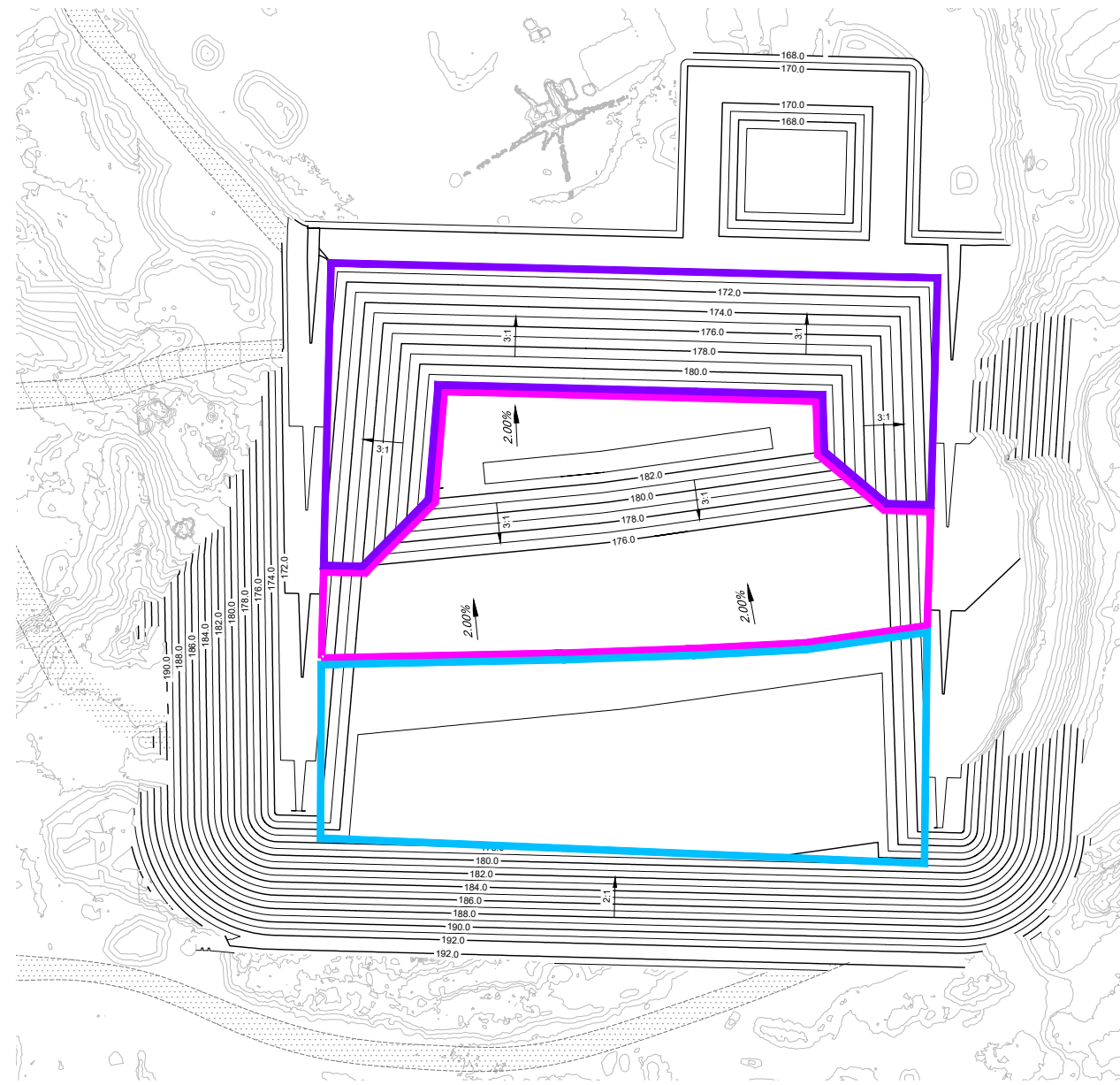
Project No. **88877-11**

Title
FILL PLAN
STAGE 1 WEST & STAGE 2A

Sheet No.
C-09



PHASE I: STAGE 1 WEST
FILL VOLUME = 101,447 m³



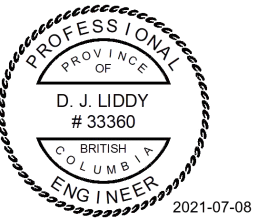
PHASE II: STAGE 2A
FILL VOLUME = 106,823 m³

LEGEND

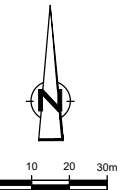
- █ BASE LINER PREPARATION / CONSTRUCTION FOR NEXT STAGE
- █ DAILY COVER AREA
- █ INTERMEDIATE COVER AREA
- █ FINAL COVER AREA



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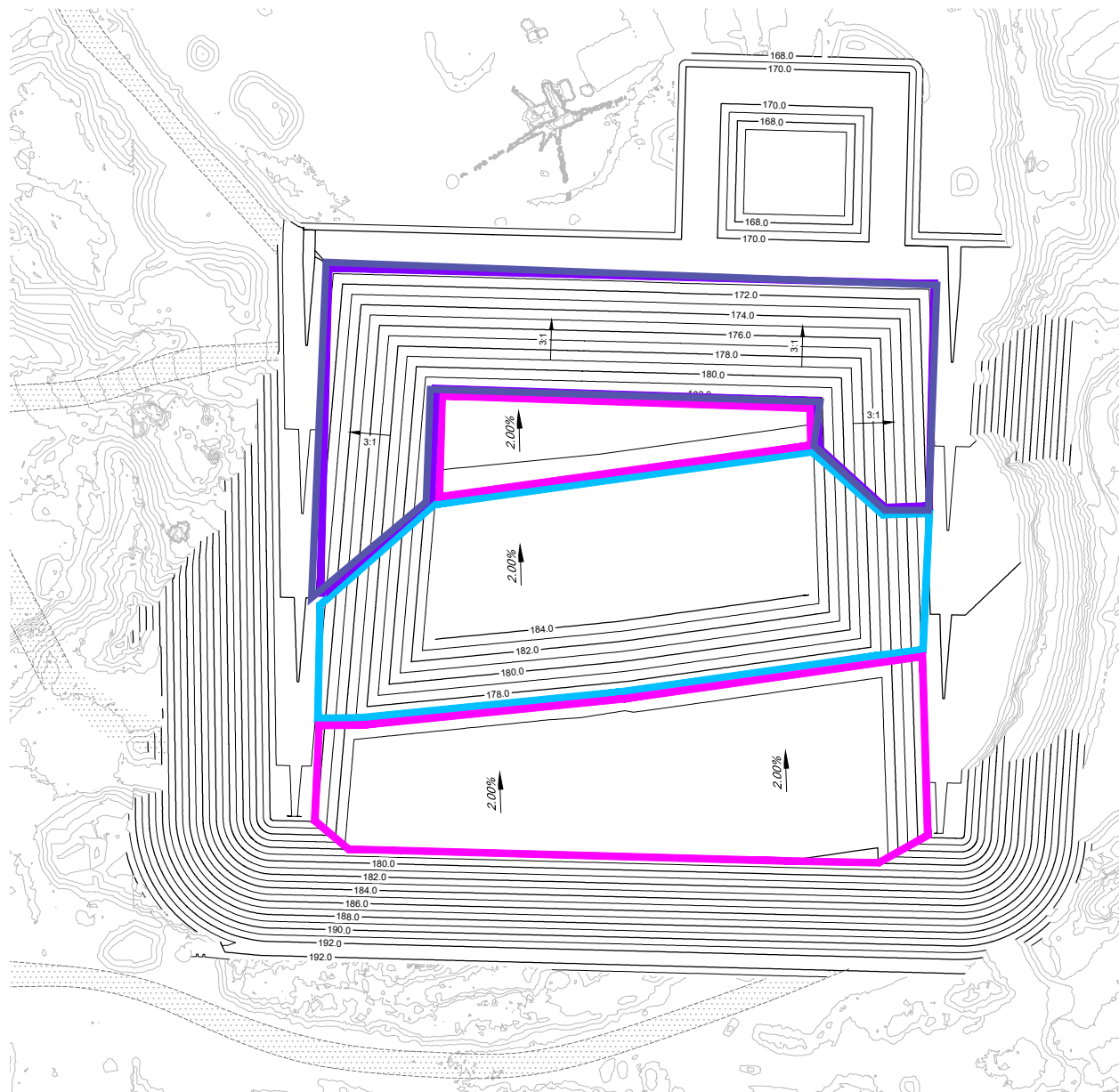


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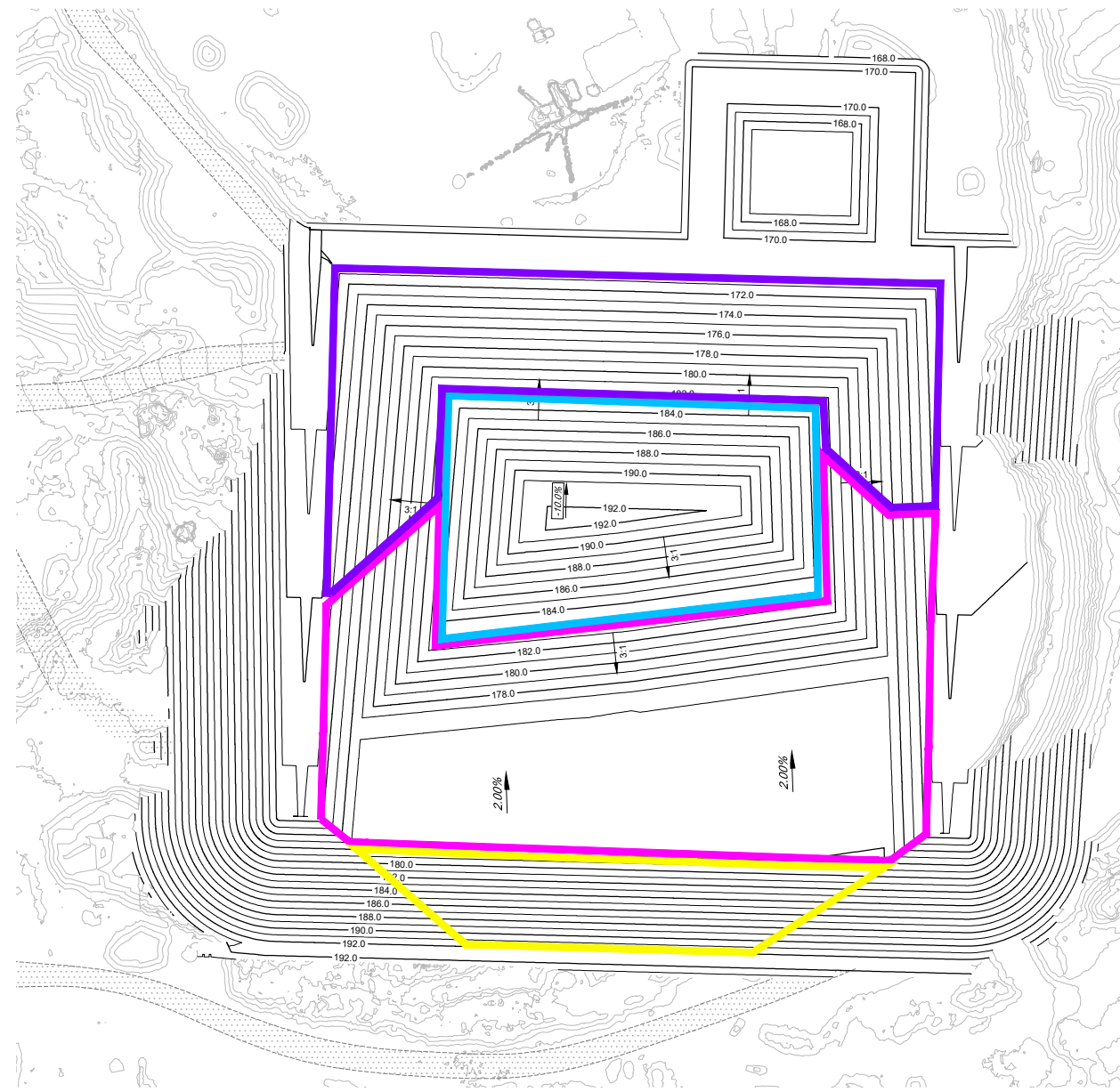
1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020
No.	Issue	Drawn	Approved	Date
Drawn	T.WAGSTAFF	Designer	R. HASIOR	
Drafting Check		Design Check		
Project Manager	D. LIDDY	Date	July 2, 2021	
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Original Size	ANSI D	Bar is 20mm on original size drawing 0 20mm		

Project No. 88877-11
 Title
**FILL PLAN
 STAGE 2B & STAGE 2C**

Sheet No.
C-10



PHASE II: STAGE 2B
FILL VOLUME = 44,912 m³

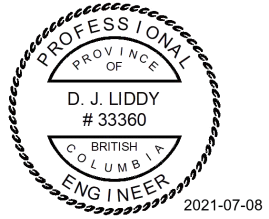


PHASE II: STAGE 2C
FILL VOLUME = 27,085 m³

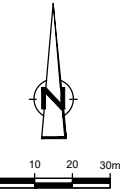
- LEGEND**
- BASE LINER PREPARATION / CONSTRUCTION FOR NEXT STAGE
 - DAILY COVER AREA
 - INTERMEDIATE COVER AREA
 - FINAL COVER AREA



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AND CLOSURE PLAN

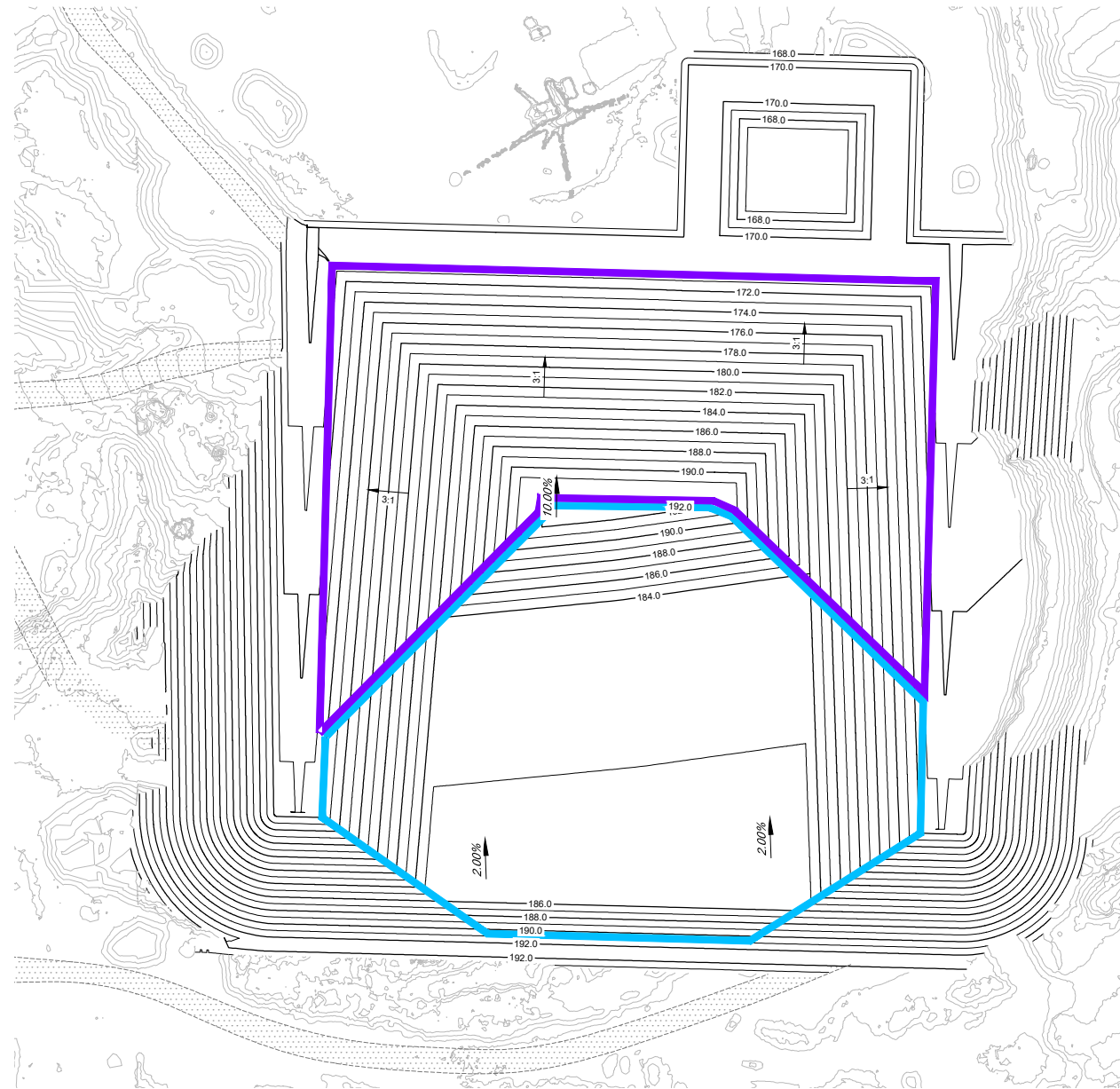
1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020
No.	Issue	Drawn	Approved	Date
Drawn	T.WAGSTAFF	Designer	R. HASIOR	
Drafting Check		Design Check		
Project Manager	D. LIDDY	Date	July 5, 2021	
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Original Size	Bar is 20mm on original size drawing			
ANSI D	0 20mm			

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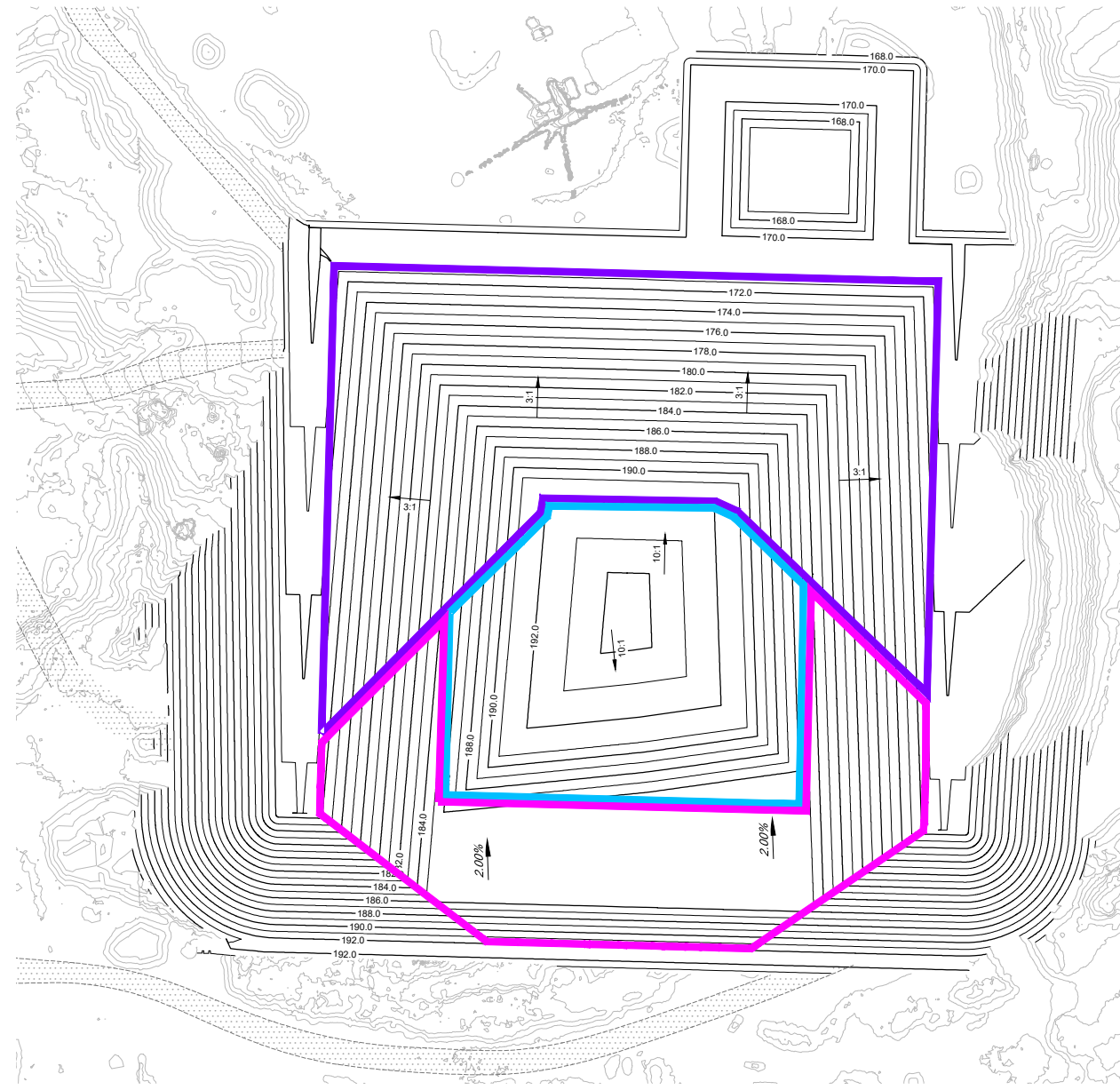
Title
FILL PLAN
STAGE 3A & STAGE 3B

Sheet No.

C-11



PHASE III: STAGE 3A
FILL VOLUME = 67,949 m³



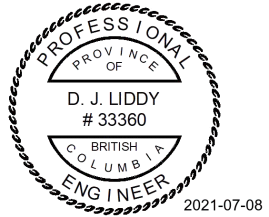
PHASE III: STAGE 3B
FILL VOLUME = 44,266 m³

LEGEND

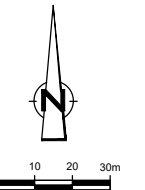
- █ DAILY COVER AREA
- █ INTERMEDIATE COVER AREA
- █ FINAL COVER AREA



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1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020
No.	Issue	Drawn	Approved	Date

Drawn	T.WAGSTAFF	Designer	R. HASIOR
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Drafting Check	Design Check
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Project Manager	D. LIDDY	Date	July 2, 2021
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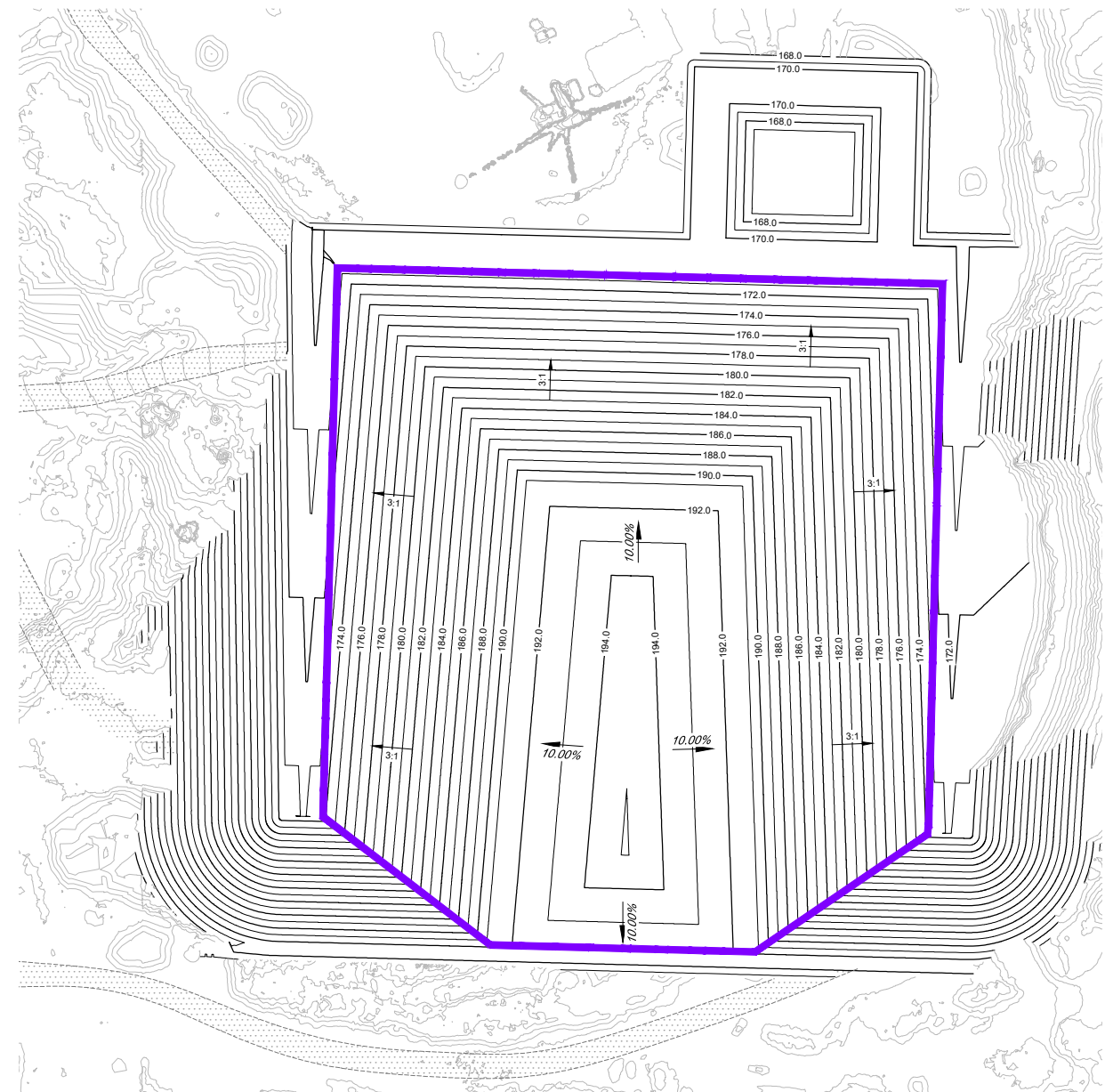
Project No. **88877-11**

Title

FILL PLAN
STAGE 3C

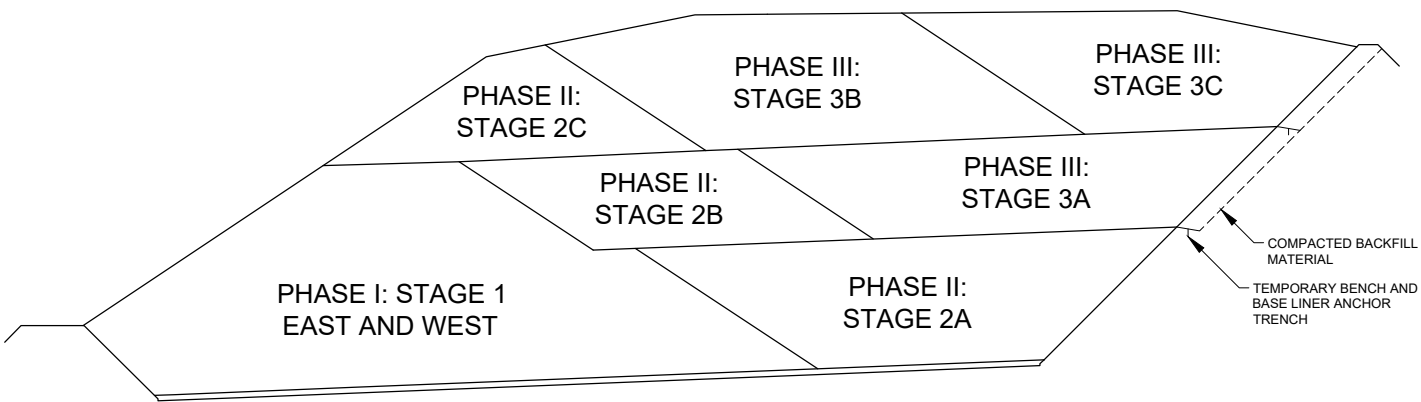
Sheet No.

C-12

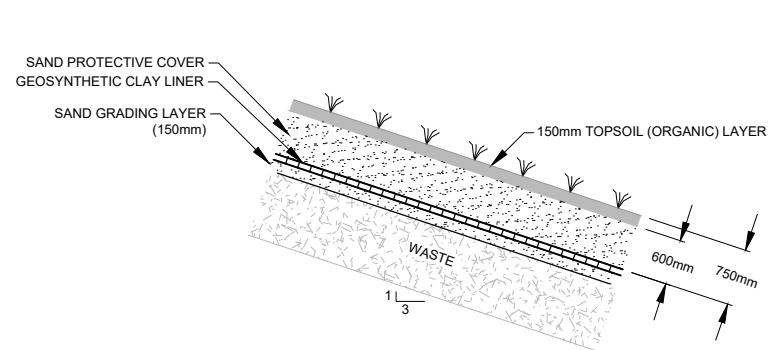


PHASE III: STAGE 3C
FILL VOLUME = 33,546 m³

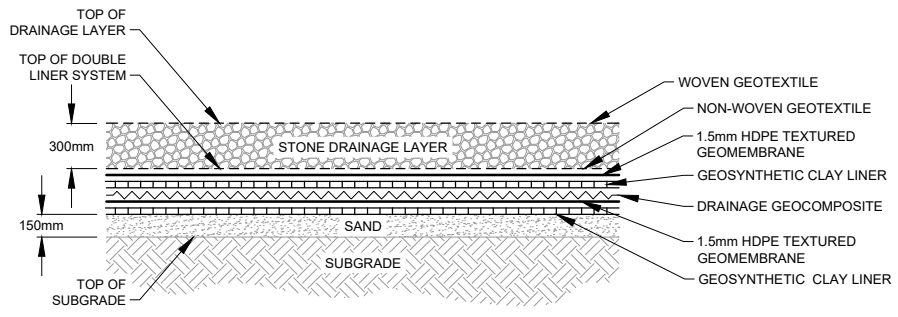
- LEGEND**
- █ DAILY COVER AREA
 - █ INTERMEDIATE COVER AREA
 - █ FINAL COVER AREA



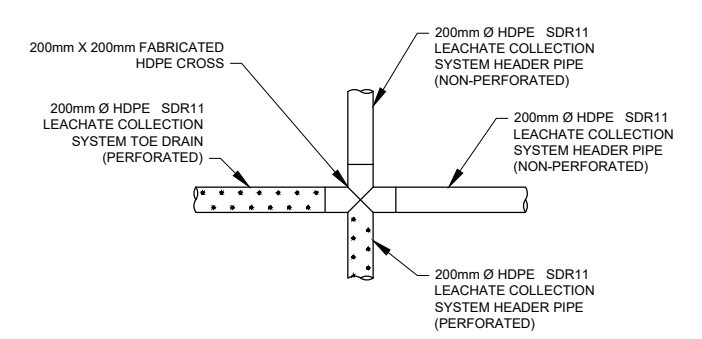
FILL SEQUENCE
HOR. SCALE 1:600
VERT. SCALE 1:300



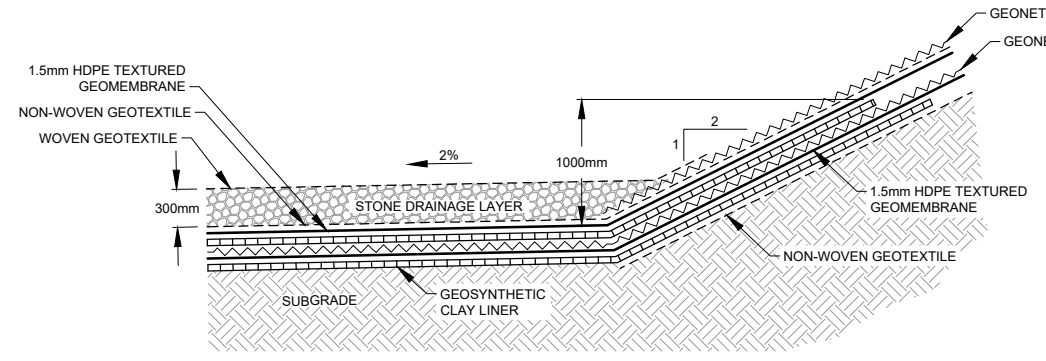
DETAIL 1
1:50
C-06.17
FINAL COVER SYSTEM



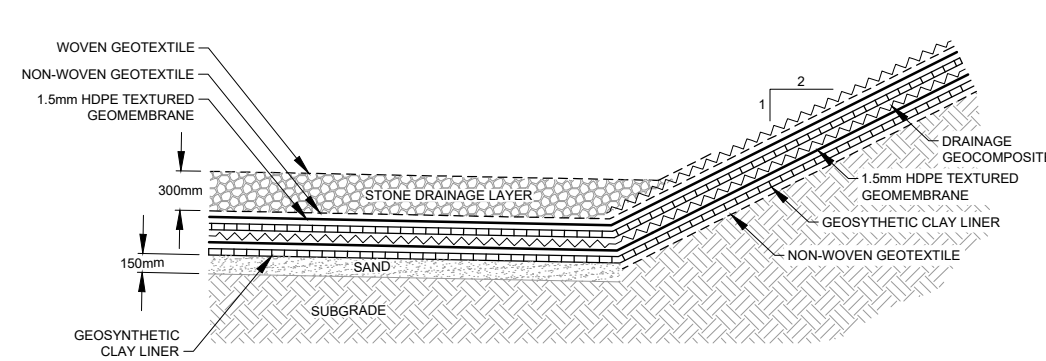
DETAIL 2
1:25
C-03.04.13
BASE LINER AND LEAK DETECTION SYSTEM



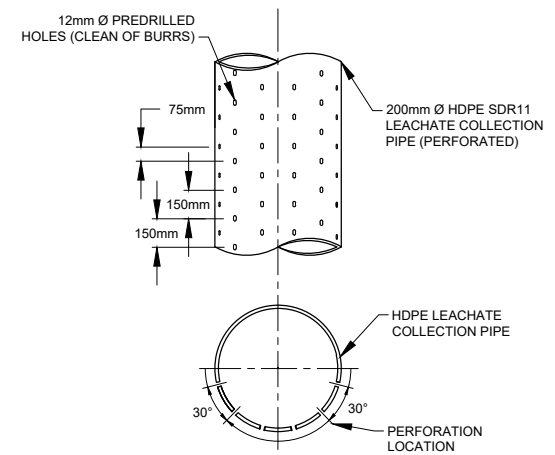
DETAIL 3
1:30
C-04
LEACHATE COLLECTION SYSTEM TOE DRAIN / LEACHATE COLLECTION SYSTEM PIPE CONNECTION



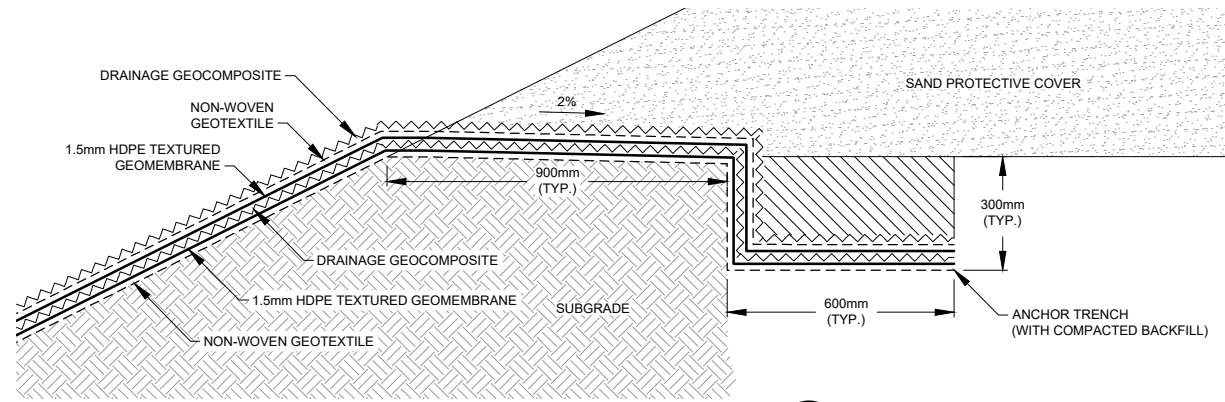
DETAIL 4
1:30
C-03
LINER SYSTEM (TOE OF SLOPE) SOUTH (TYP.)



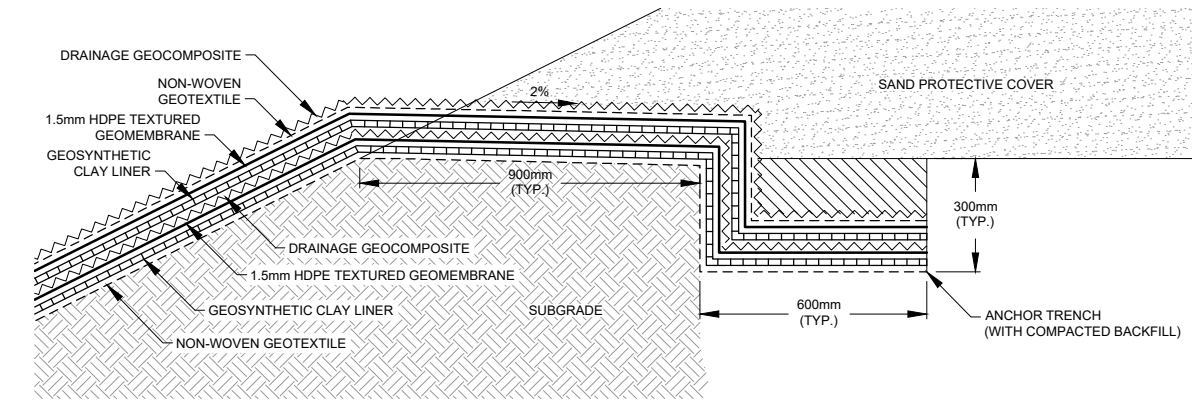
DETAIL 5
1:30
C-04
LINER SYSTEM (TOE OF SLOPE) NORTH, WEST AND EAST (TYP.)



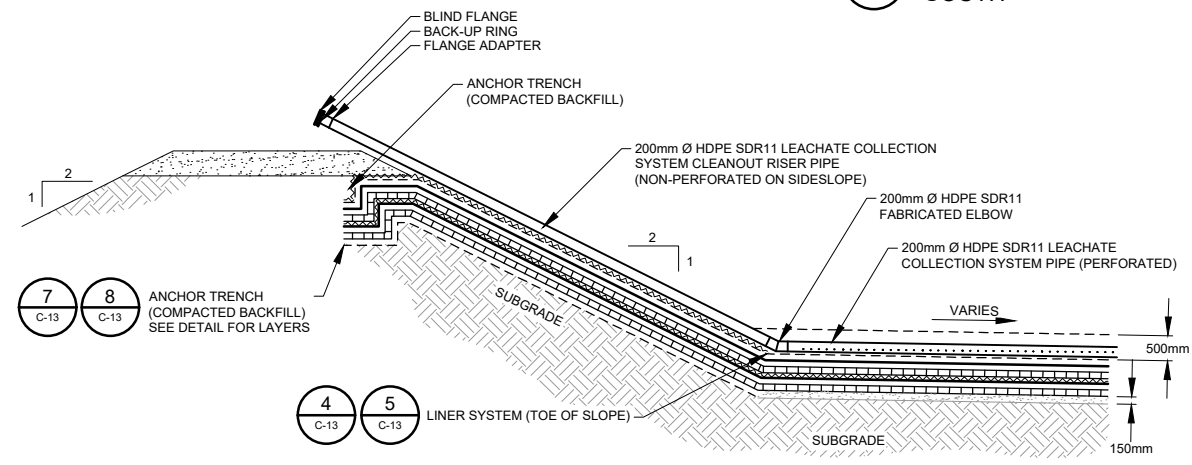
DETAIL 6
N.T.S.
C-04
LEACHATE COLLECTION SYSTEM TOE DRAIN / LEACHATE COLLECTION SYSTEM PIPE PERFORATIONS



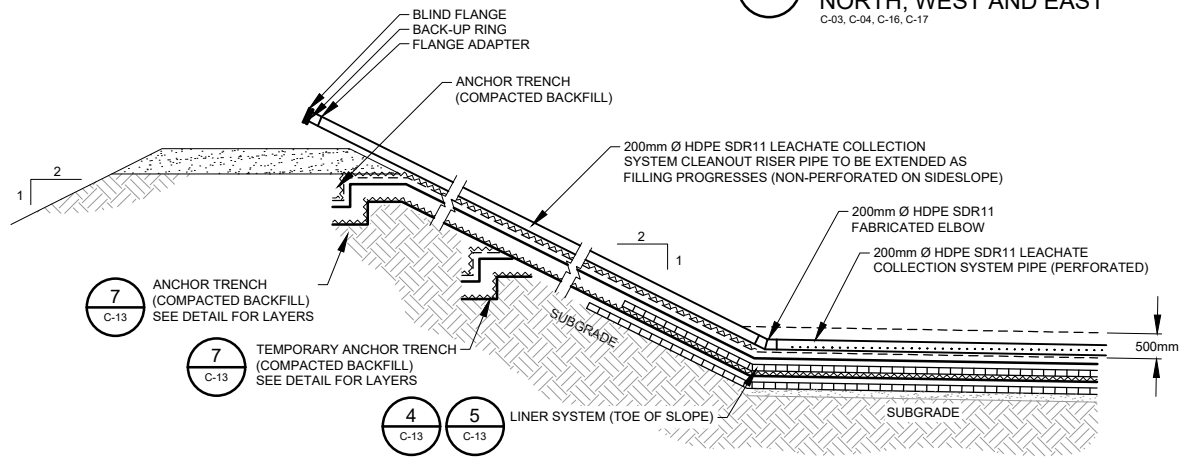
DETAIL 7
1:10
C-03
ANCHOR TRENCH (TYPICAL) SOUTH



DETAIL 8
1:10
C-03, C-04, C-16, C-17
ANCHOR TRENCH (TYPICAL) NORTH, WEST AND EAST



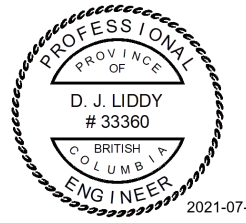
DETAIL 9
1:75
C-04.05
LEACHATE COLLECTION SYSTEM CLEANOUT RISER PIPE (TYPICAL) NORTH



DETAIL 10
1:75
C-04.05
LEACHATE COLLECTION SYSTEM CLEANOUT RISER PIPE (TYPICAL) SOUTH



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No.	Issue	Drawn	Approved	Date
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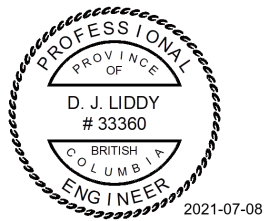
Drawn **T.WAGSTAFF** Designer **R. HASIOR**
Drafting Check Design Check
Project Manager **D. LIDDY** Date **July 5, 2021**
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Project No. **88877-11**
Title
DETAILS LINER DETAILS
Sheet No.

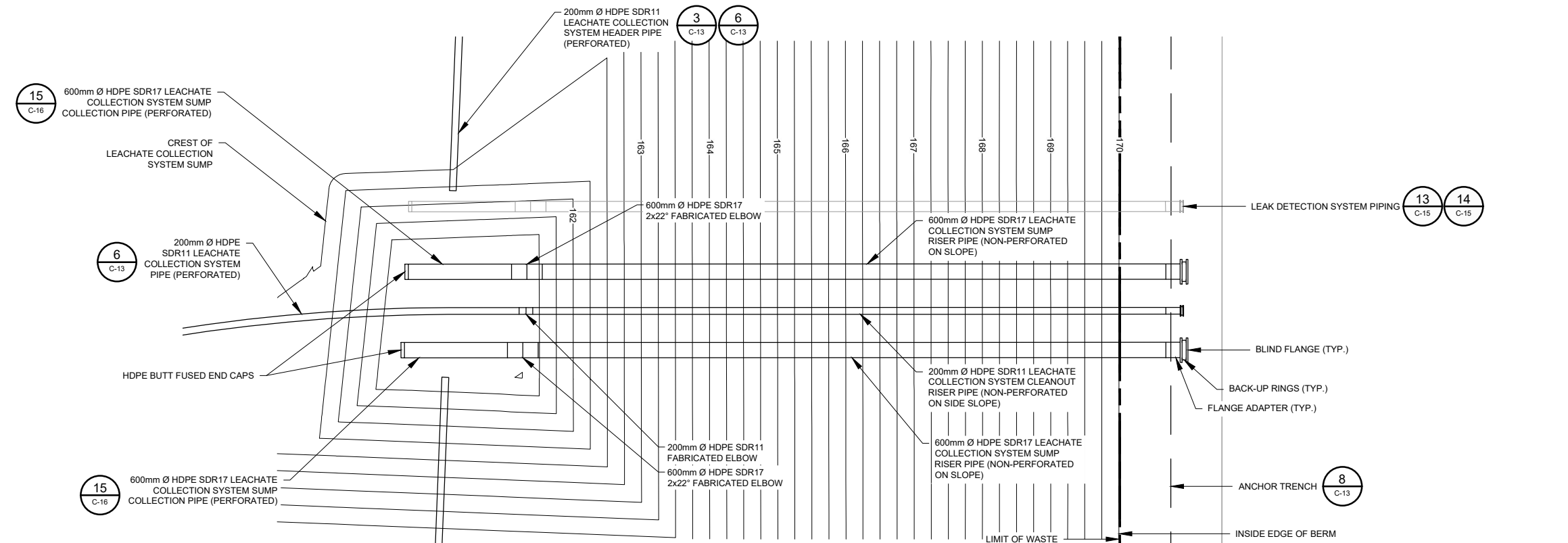
C-13



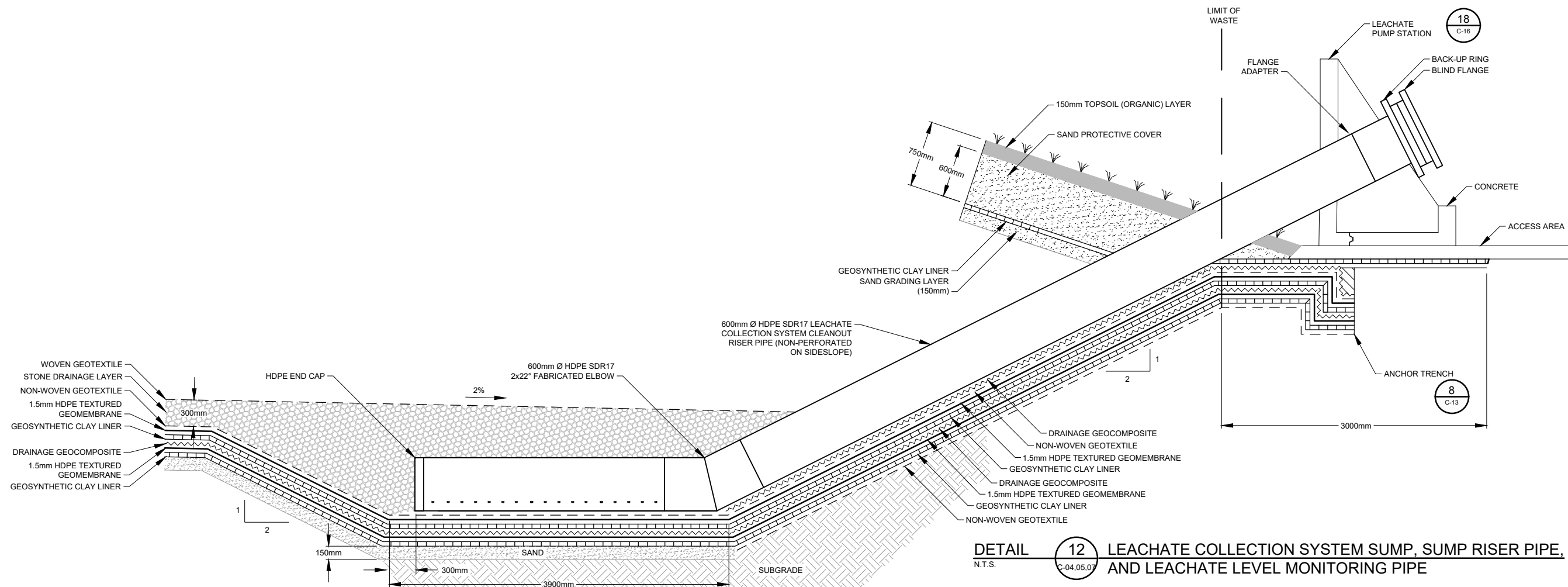
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DETAIL 11 LEACHATE COLLECTION SYSTEM SUMP (TOP OF LINER)
 1:75



DETAIL 12 LEACHATE COLLECTION SYSTEM SUMP, SUMP RISER PIPE, AND LEACHATE LEVEL MONITORING PIPE
 N.T.S.

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1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020
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Title
DETAILS LEACHATE COLLECTION SUMP

Sheet No.

C-14



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Drawn **T.WAGSTAFF** Designer **R. HASIOR**

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Project Manager **D. LIDDY** Date **July 2, 2021**

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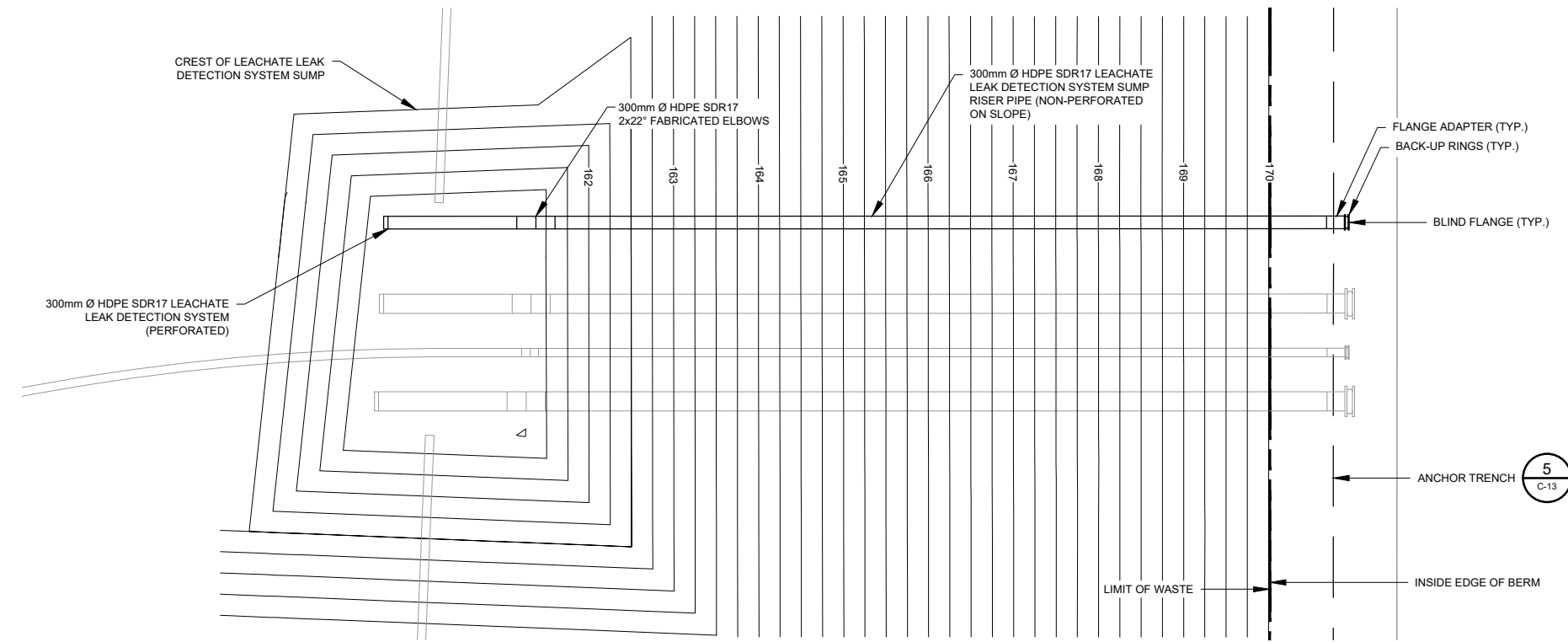
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Project No. **88877-11**

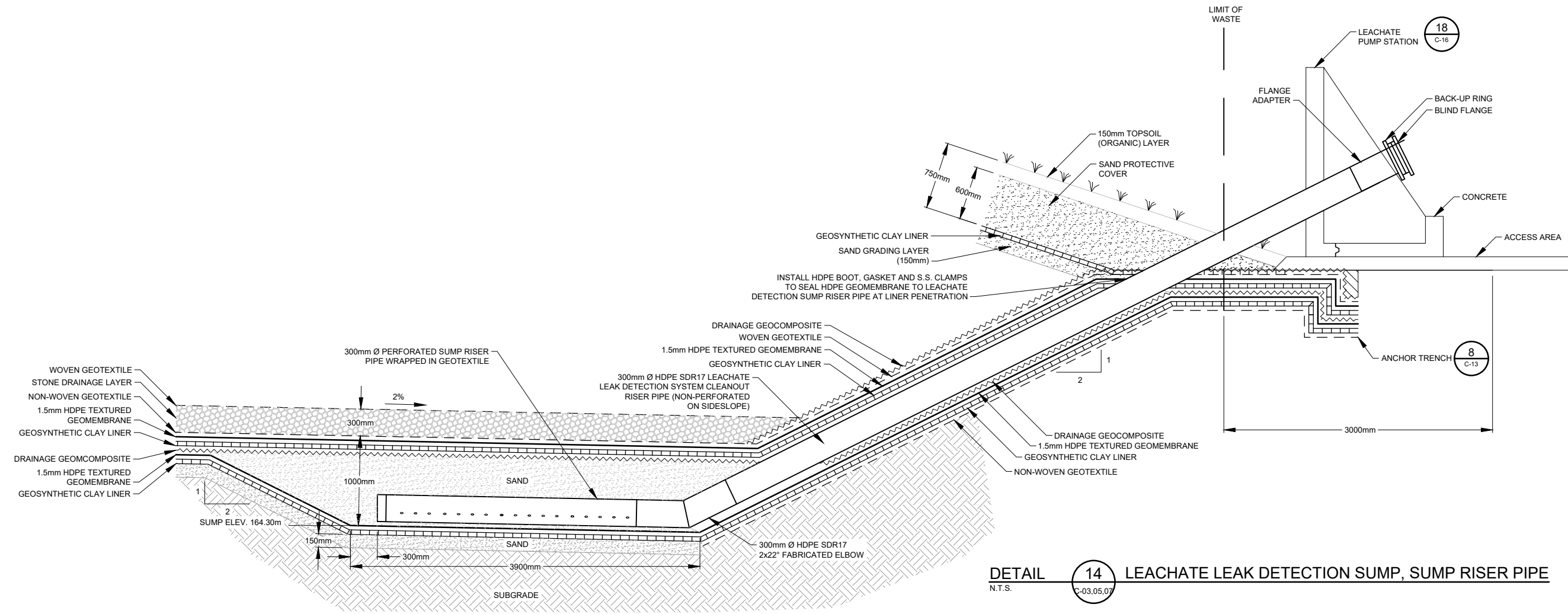
Title
DETAILS
LEACHATE LEAK
DETECTION SUMP

Sheet No.

C-15



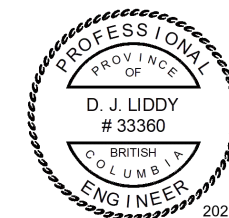
DETAIL 13 LEACHATE LEAK DETECTION SUMP
 1:75 C-03



DETAIL 14 LEACHATE LEAK DETECTION SUMP, SUMP RISER PIPE
 N.T.S. C-03.05.07



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1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020
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No.	Issue	Drawn	Approved	Date
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Drawn	T.WAGSTAFF	Designer	R. HASIOR
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Project Manager	D. LIDDY	Date	July 2, 2021
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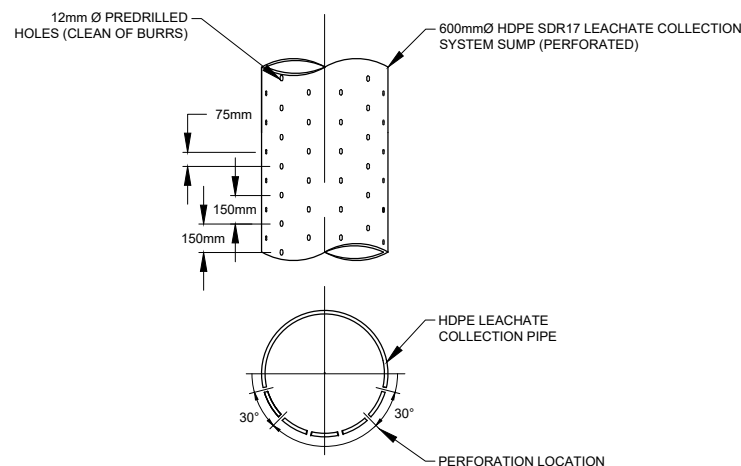
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**DETAILS
LEACHATE COLLECTION
SYSTEM**

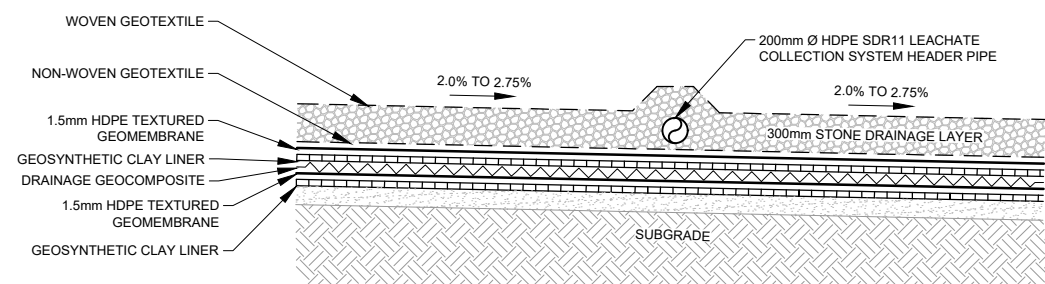
Sheet No.

C-16

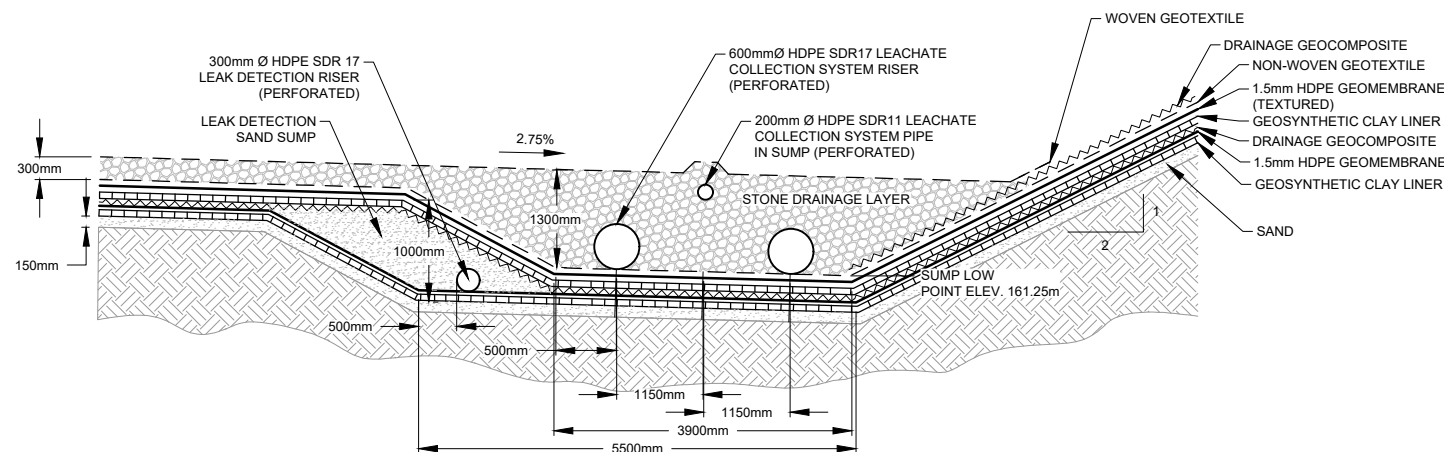
Sheet 17 of 20



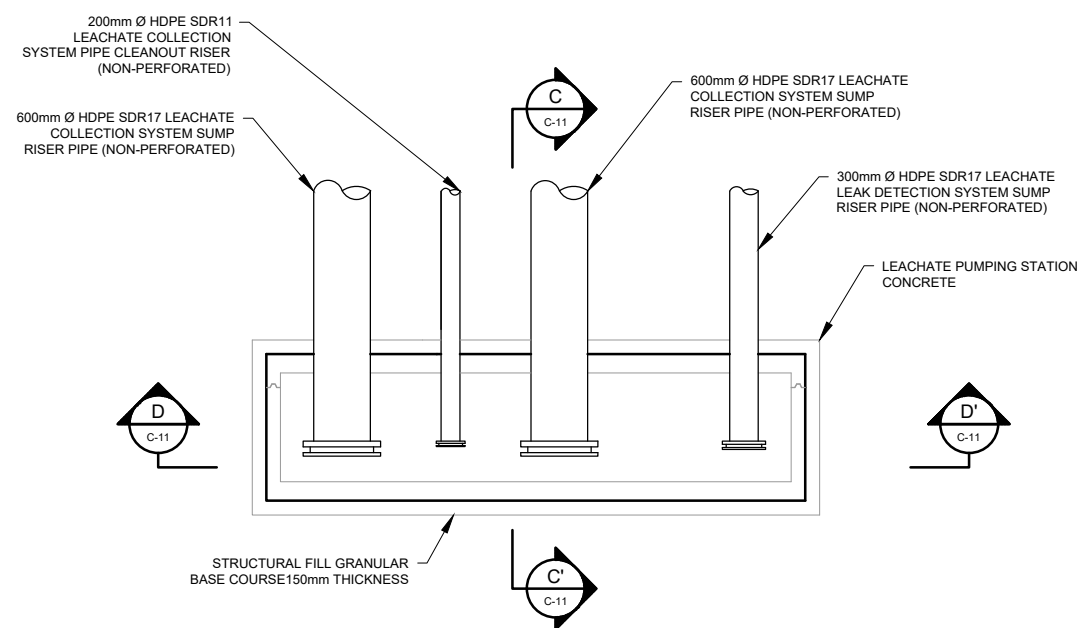
DETAIL 15 600mm LEACHATE COLLECTION SYSTEM SUMP PIPE PERFORATIONS
NTS C-04



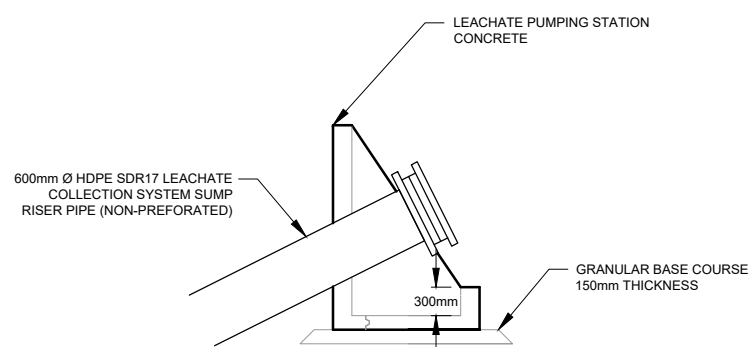
DETAIL 17 LEACHATE COLLECTION SYSTEM TOE DRAIN/ LEACHATE COLLECTION SYSTEM PIPE
1:30 C-04



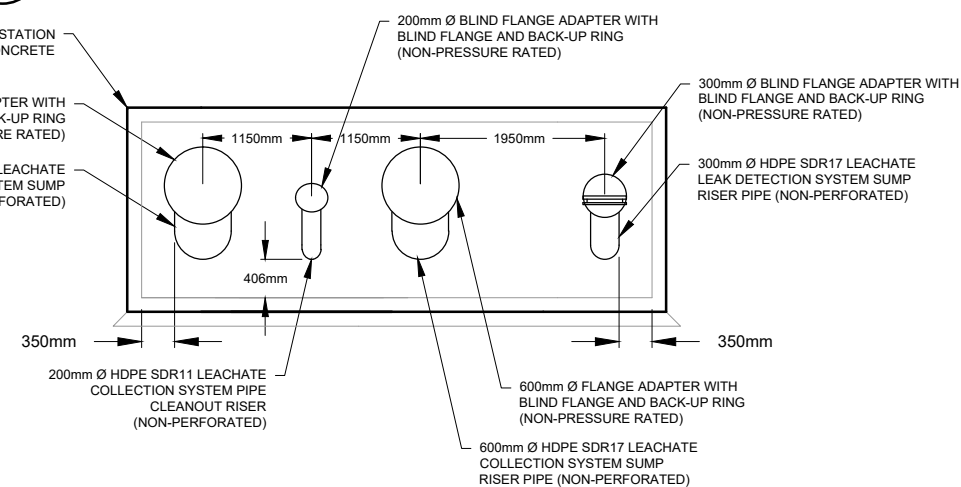
DETAIL 16 LEACHATE COLLECTION SYSTEM SUMP
1:50 C-03,04,07



DETAIL 18 LEACHATE PUMP STATION (PLAN VIEW)
1:40 C-03



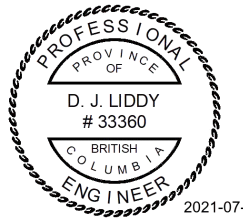
SECTION C-C
1:40 C-16



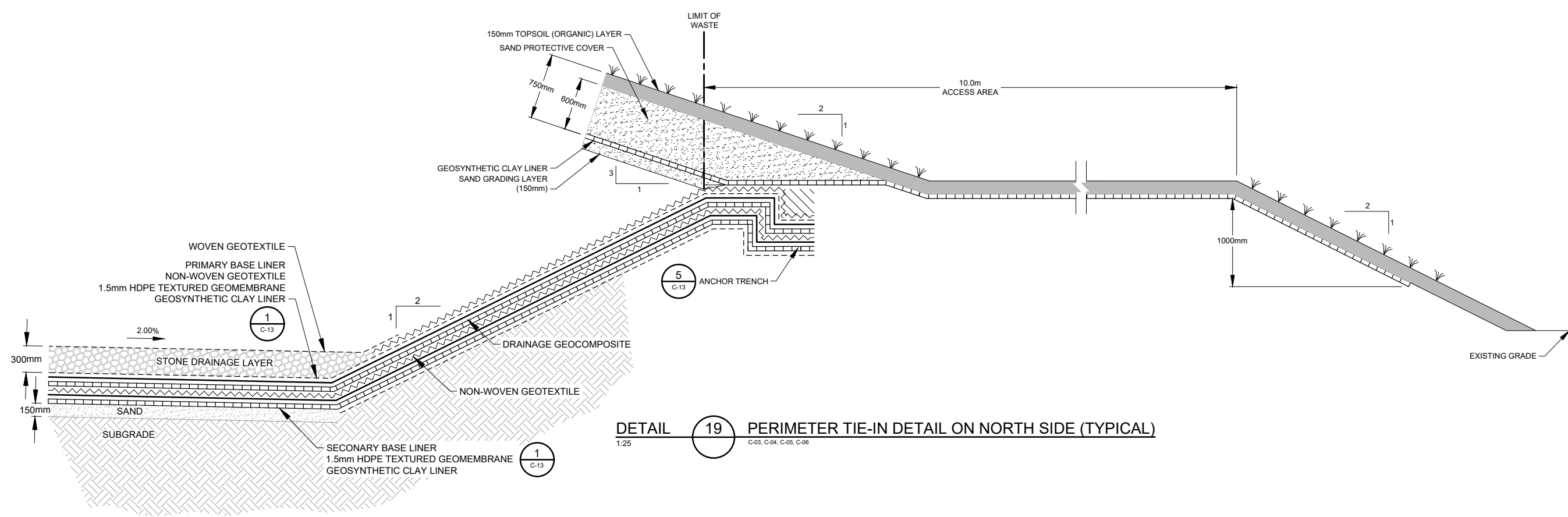
SECTION D-D
1:40 C-16



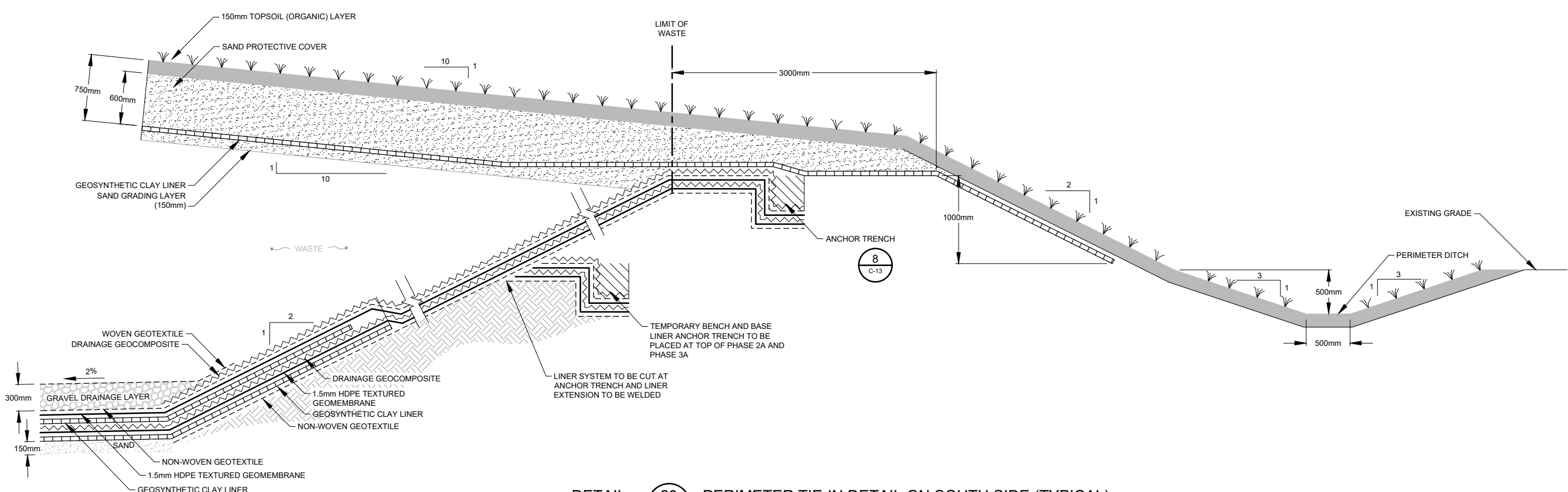
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DETAIL 19 PERIMETER TIE-IN DETAIL ON NORTH SIDE (TYPICAL)
 1:25 C-03, C-04, C-05, C-06



DETAIL 20 PERIMETER TIE-IN DETAIL ON SOUTH SIDE (TYPICAL)
 1:25 C-03, C-04, C-05, C-06

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Project
2021 DESIGN, OPERATIONS, AND CLOSURE PLAN

No.	Issue	Drawn	Approved	Date
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Drawn **T.WAGSTAFF** Designer **R. HASIOR**

Drafting Check Design Check

Project Manager **D. LIDDY** Date **July 2, 2021**

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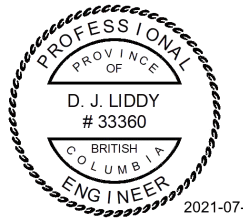
Title
DETAILS PERIMETER TIE-IN DETAILS I

Sheet No.
C-17

Sheet 18 of 20



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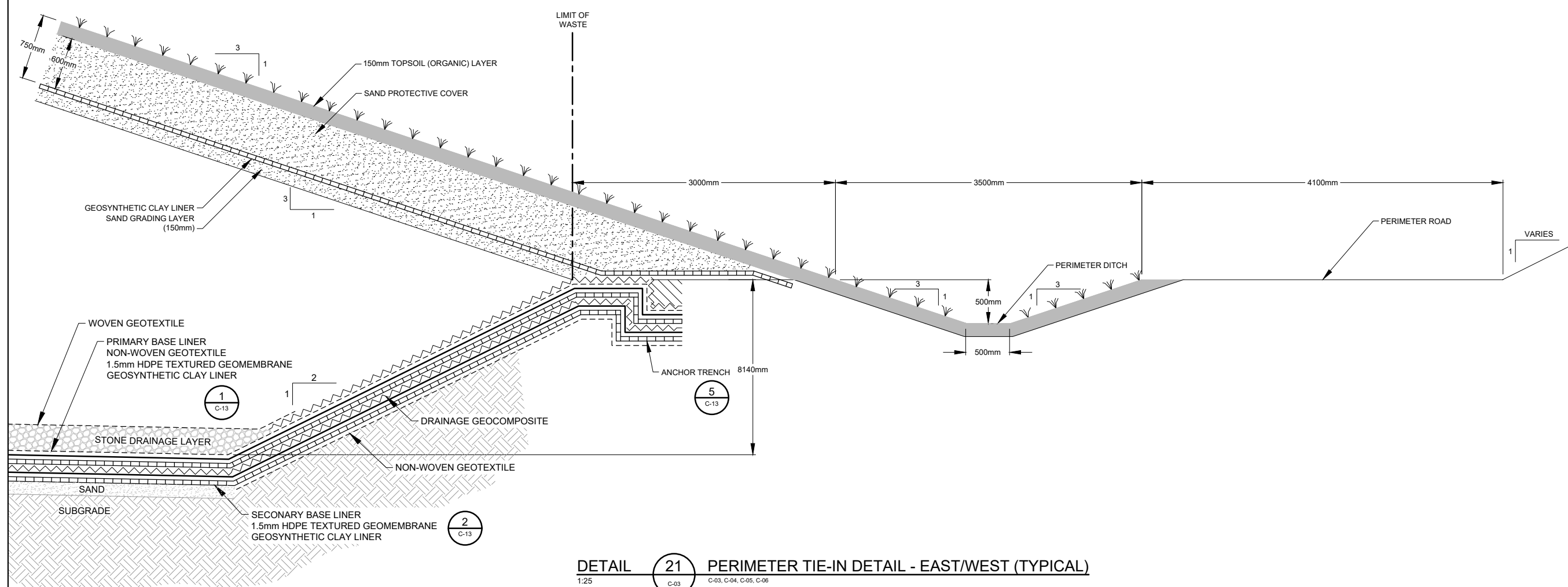
No.	Issue	Drawn	Approved	Date
1	ISSUED FOR REVIEW	D.C.	D.L.	06-08-2020
Drawn		Designer		
T.WAGSTAFF		R. HASIOR		
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Project Manager		Date	June 29, 2021	
D. LIDDY		Scale	AS SHOWN	
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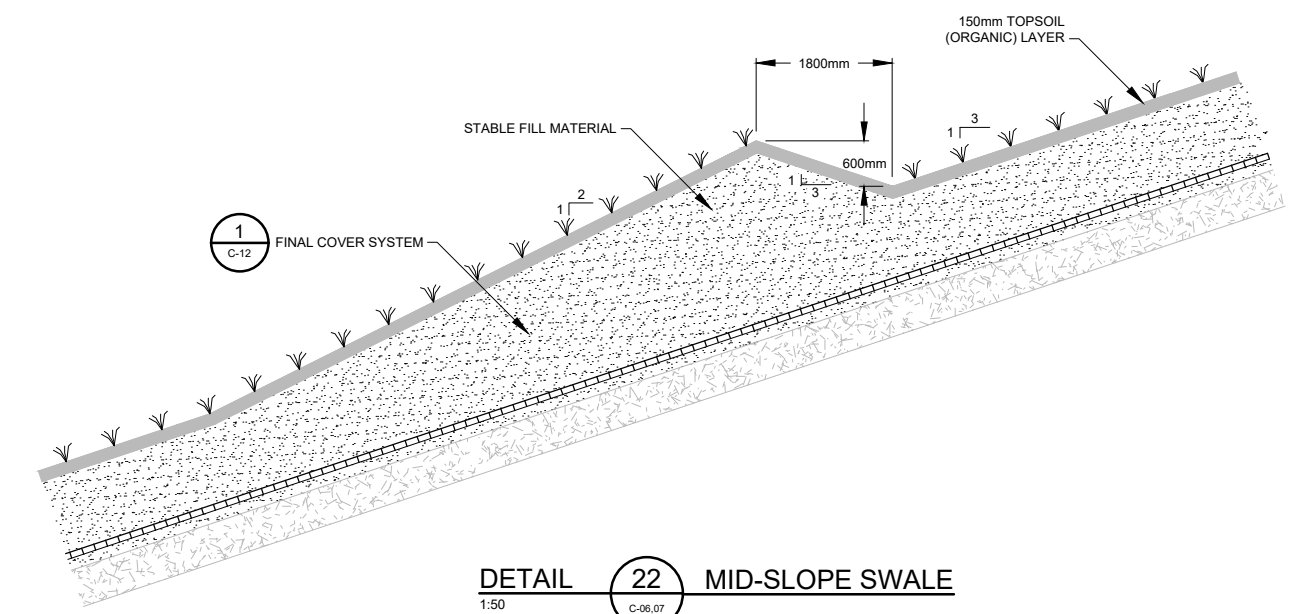
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DETAILS
PERIMETER TIE-IN DETAILS II

Sheet No.

C-18



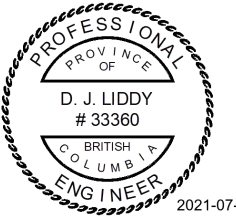
DETAIL 21 PERIMETER TIE-IN DETAIL - EAST/WEST (TYPICAL)
 1:25 C-03 C-03, C-04, C-05, C-06



DETAIL 22 MID-SLOPE SWALE
 1:50 C-06,07



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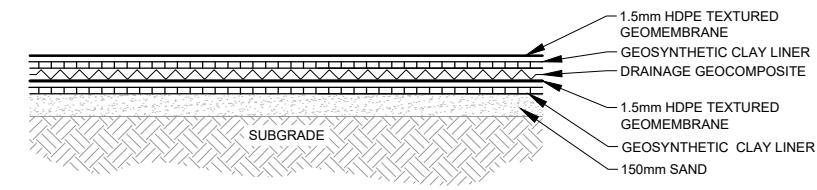
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Project Manager	D. LIDDY	Date	July 5, 2021
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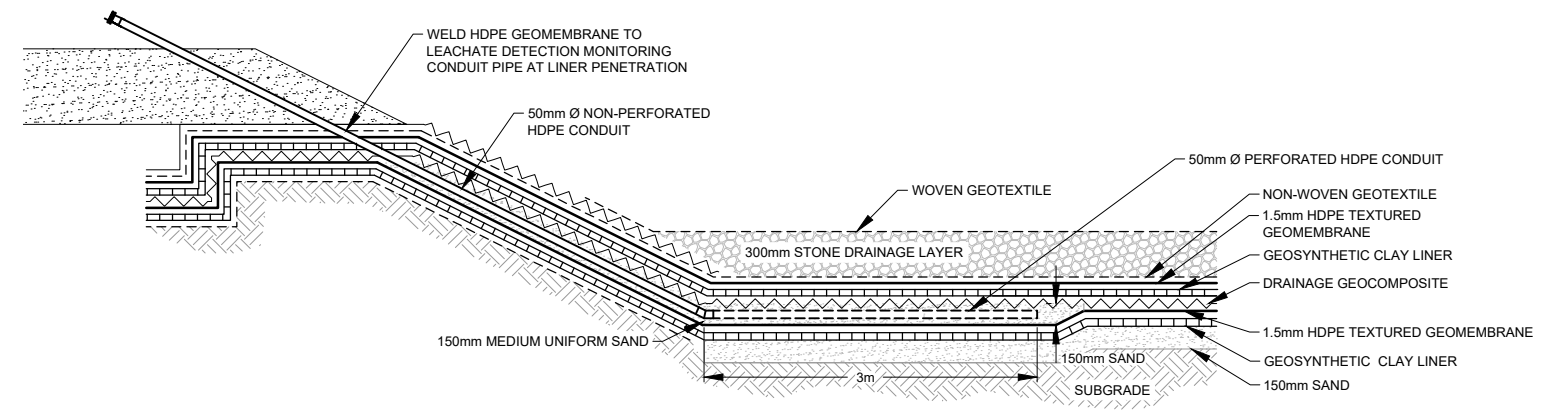
Title
DETAILS LEACHATE MANAGEMENT

Sheet No.

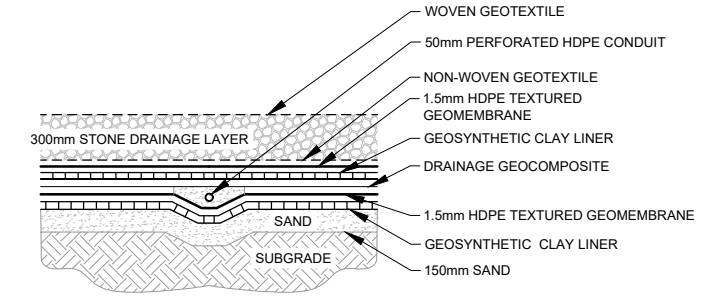
C-19



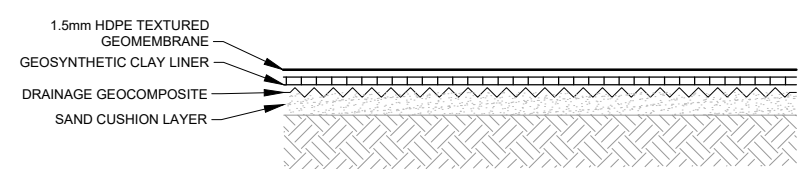
DETAIL 23 LEACHATE TREATMENT POND LINER SYSTEM
 1:25 C-04



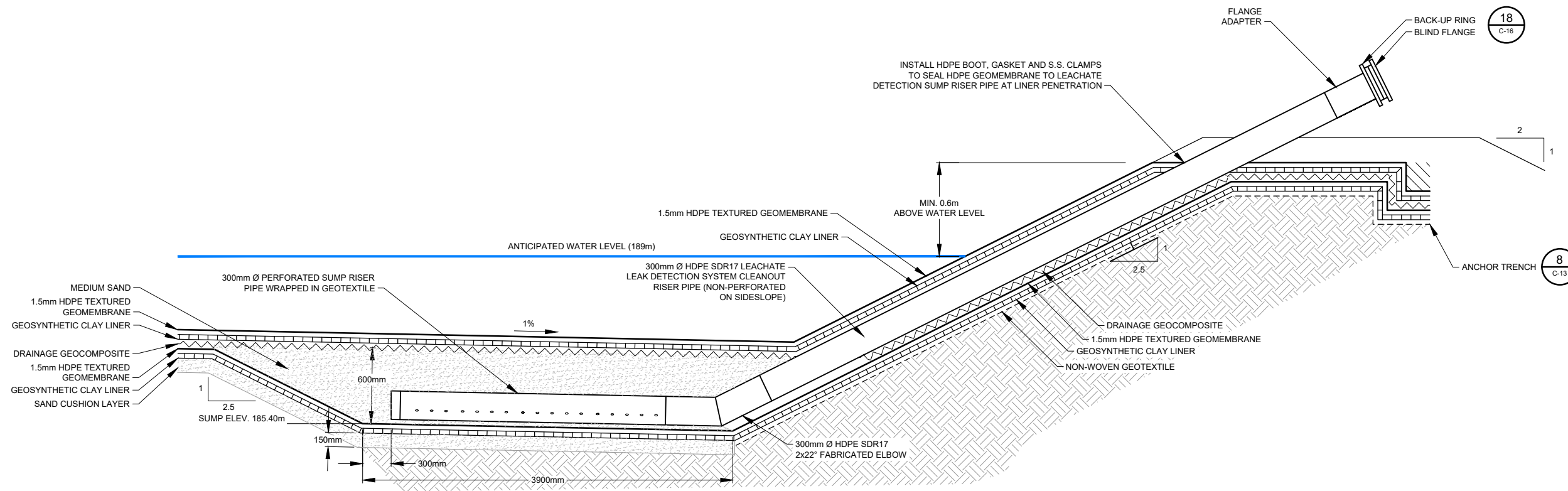
DETAIL 24 LEAK DETECTION LYSIMETER MONITORING PORT
 1:25 C-04



DETAIL 25 LEAK DETECTION LYSIMETER MONITORING PORT CROSS-SECTION
 1:25 C-18



DETAIL 26 TREATED EFFLUENT HOLDING POND LINER SYSTEM
 1:25 C-04



DETAIL 27 LEACHATE TREATMENT POND LEAK DETECTION SUMP RISER PIPE
 N.T.S. C-13



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GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

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