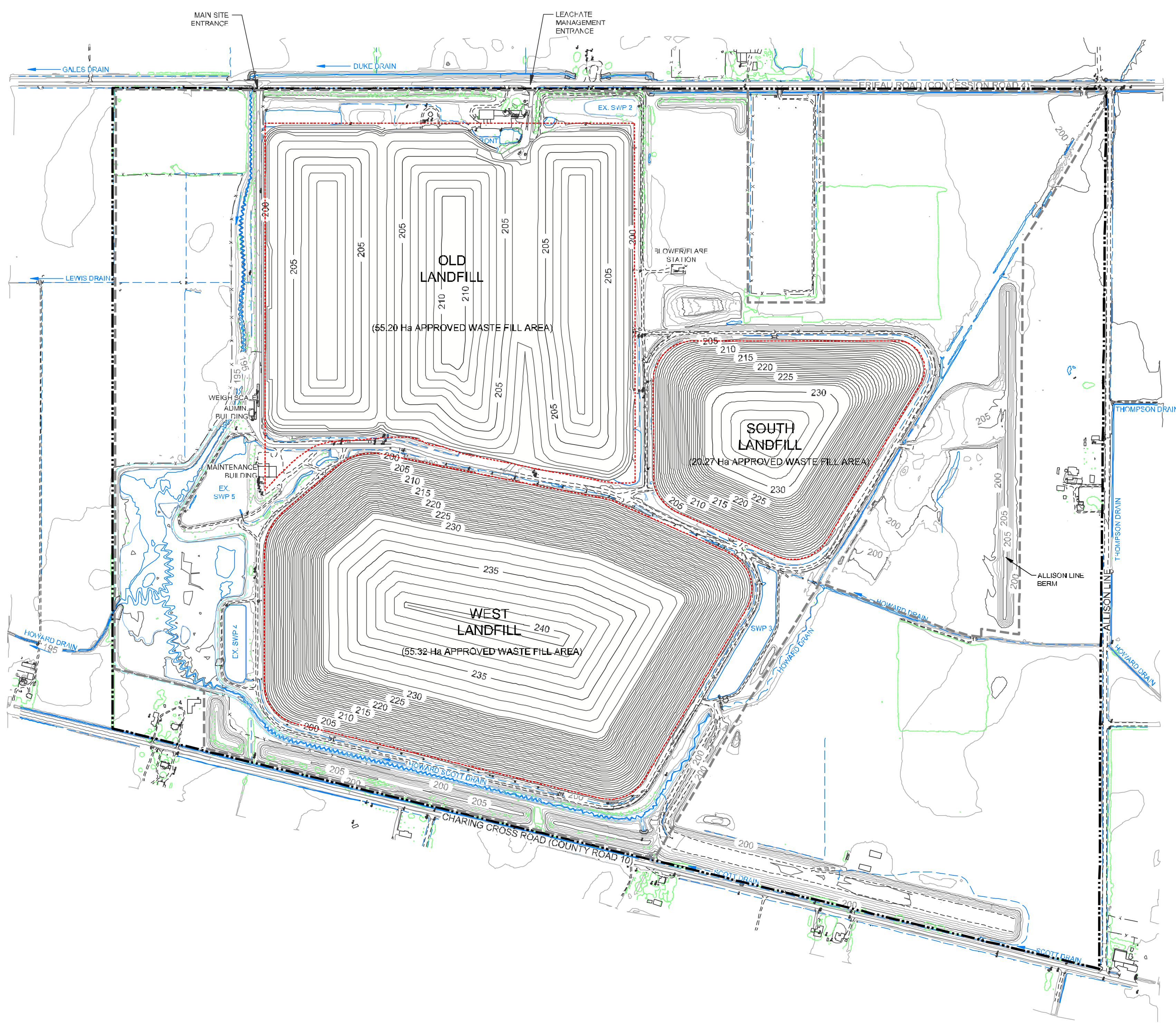
Drawings 3 and 4



LEGEND

- PROPERTY LIMIT (340 Ha AREA)
- APPROVED SITE BOUNDARY (262 Ha AREA)
- APPROVED WASTE FILL LIMIT (131 Ha TOTAL AREA)
- 235 — APPROVED PRE-EXPANSION LANDFILL TOP OF FINAL COVER CONTOUR (1.0 masl INTERVAL)
- 205 — EXISTING GROUND SURFACE CONTOUR (1.0 masl INTERVAL)
- EXISTING GRAVEL ROAD
- EXISTING PAVED ROAD
- EXISTING DRAINAGE DITCH
- EXISTING WATER BODY
- EXISTING TREE LINE
- EX. SWP 2 — EXISTING STORM WATER POND

NOTE(S)

1. PROJECTION: UTM NAD27-17N. VERTICAL DATUM: CGVD28 (GEODETIC).

REFERENCE(S)

1. TOPOGRAPHIC BASE PLAN FROM 6 cm GROUND SAMPLING DISTANCE, DATED MAY 1, 2018 BY THE BASE MAPPING CO. LTD.
2. APPROVED WASTE LIMITS AND PROPERTY LIMITS FROM FIGURE 2 - ALTERNATIVE 1 (HORIZONTAL AND VERTICAL EXPANSION) PREPARED BY DILLON CONSULTING.

0 200 400
1:5,000 METRES

FOR EA REVIEW

DRAFT

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
C	2019-07-10	ISSUED FOR DESIGN AND OPERATIONS REPORT APPROVAL (EA PHASE) - EA REVIEW	FRG	FC/MR	FRG	FSB
B	2019-06-10	ISSUED FOR DESIGN AND OPERATIONS REPORT APPROVAL (EA PHASE) - CLIENT REVIEW	FRG	FC	FRG	FSB
A	2019-01-31	ISSUED FOR CLIENT REVIEW	FRG	FC	FRG	FSB

SEAL

CLIENT
WASTE CONNECTIONS OF CANADA INC.

CONSULTANT
GOLDER
GOLDER ASSOCIATES LTD.
6925 CENTURY AVENUE, SUITE #100
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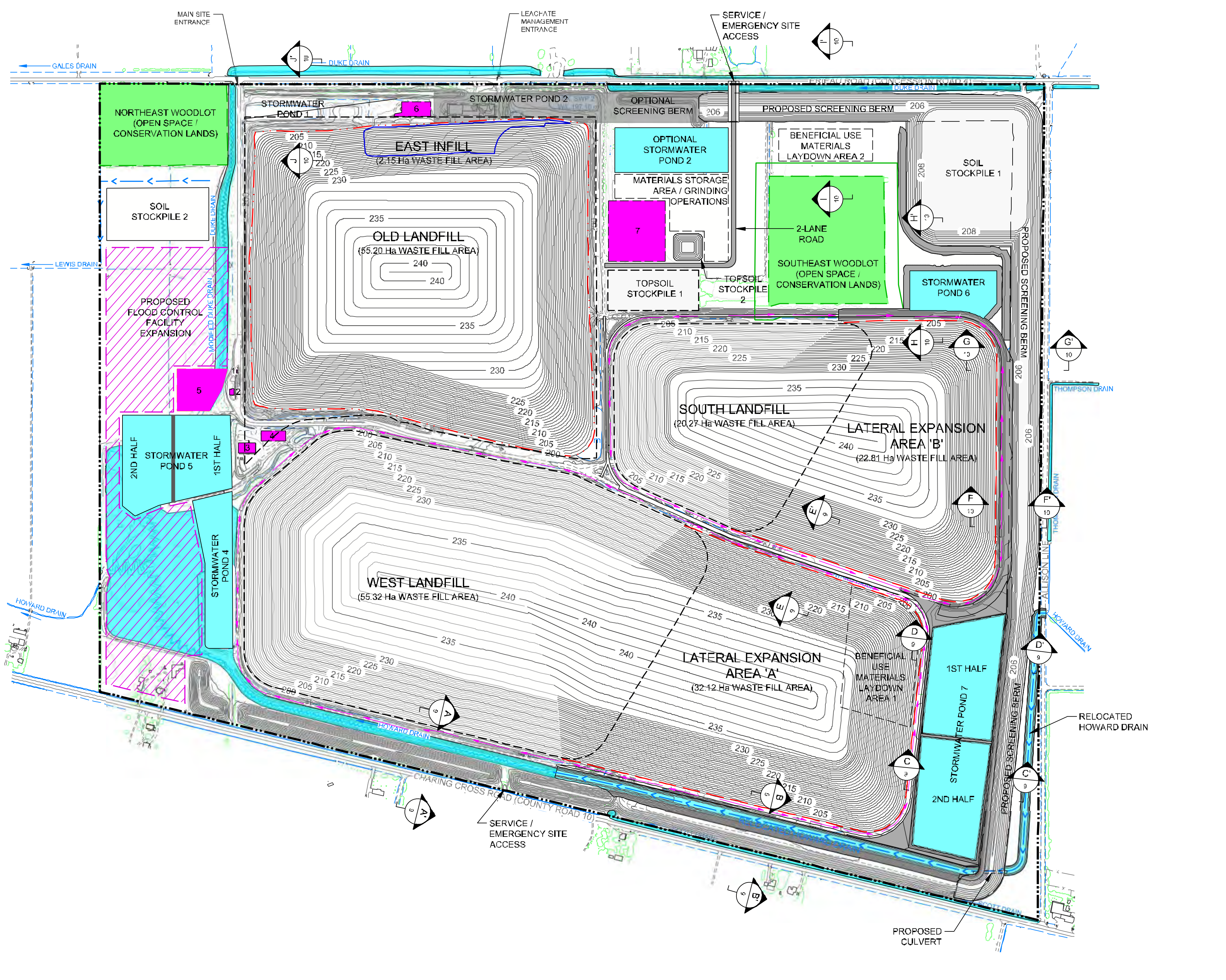
CANADA
[+1] (905) 567-4444
www.golder.com

PROJECT
PRELIMINARY DESIGN
RIDGE LANDFILL EXPANSION
BLENHEIM, ONTARIO

TITLE
APPROVED FINAL CONTOURS AND STOCKPILES (PRE-EXPANSION)

PROJECT NO.	CONTROL	REV.		DRAWING
18111331	0001	C	3 of 29	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D
25 mm



LEGEND

	PROPERTY LIMIT (340 Ha AREA)
	CURRENT APPROVED WASTE FILL LIMIT (131 Ha TOTAL AREA)
235	APPROVED PRE-EXPANSION LANDFILL TOP OF FINAL COVER CONTOUR (1.0 masl INTERVAL)
	PROPOSED EXPANSION WASTE FILL LIMIT (54.93 Ha ADDITIONAL AREA)
	OLD LANDFILL VERTICAL EXPANSION LIMIT (51.07 Ha)
	EAST INFILL WASTE FILL LIMIT (2.15 Ha)
235	PROPOSED EXPANSION LANDFILL TOP OF FINAL COVER CONTOUR (1.0 masl INTERVAL)
	PROPOSED ACCESS ROAD
	PROPOSED ROAD AND DITCH
	PROPOSED RELOCATED MUNICIPAL DRAIN
	EXISTING GROUND SURFACE CONTOUR (1.0 masl INTERVAL)
	EXISTING GRAVEL ROAD
	EXISTING PAVED ROAD
	EXISTING DRAINAGE DITCH
	EXISTING WATER BODY
	EXISTING TREE LINE
	EXISTING FENCE LINE
	PERIMETER DITCH FLOW DIRECTION
1	SCALE HOUSE
2	ADMINISTRATION BUILDING
3	MAINTENANCE BUILDING 1
4	MAINTENANCE BUILDING 2 / HOT BOX
5	PROPOSED ANCILLARY FACILITIES
6	EXISTING / FUTURE LEACHATE MANAGEMENT AREA
7	EXISTING / FUTURE LANDFILL GAS MANAGEMENT AREA

NOTE(S)

1. PROJECTION: UTM NAD27-17N. VERTICAL DATUM: CGVD28 (GEODETIC).

REFERENCE(S)

1. TOPOGRAPHIC BASE PLAN FROM 6 cm GROUND SAMPLING DISTANCE, DATED MAY 1, 2018 BY THE BASE MAPPING CO. LTD.
2. APPROVED SITE BOUNDARY, WASTE LIMITS AND PROPERTY LIMITS FROM 2018 FISCAL PLANNING MODEL REPORT DATED JUNE 18, 2018 BY DILLON CONSULTING LIMITED.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
C	2019-07-10	ISSUED FOR DESIGN AND OPERATIONS REPORT APPROVAL (EA PHASE) - EA REVIEW	FRG	FC/MR	FRG	FSB
B	2019-06-10	ISSUED FOR DESIGN AND OPERATIONS REPORT APPROVAL (EA PHASE) - CLIENT REVIEW	FRG	FC	FRG	FSB
A	2019-01-31	ISSUED FOR CLIENT REVIEW	FRG	FC	FRG	FSB

SEAL

CLIENT
WASTE CONNECTIONS OF CANADA INC.

CONSULTANT
GOLDER

GOLDER ASSOCIATES LTD.
6925 CENTURY AVENUE, SUITE #100
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CANADA
[+1] (905) 567-4444
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PROJECT
PRELIMINARY DESIGN
RIDGE LANDFILL EXPANSION
BLENHEIM, ONTARIO

TITLE
PROPOSED FINAL CONTOURS AND STOCKPILES (POST-EXPANSION)

PROJECT NO.	CONTROL	REV.		DRAWING
18111331	0001	C	4 of 29	4

Leachate analytical results

Table 1
Leachate Chemistry - Inorganics

		Metals																		
		Antimony	Arsenic	Cadmium	Calcium	Chromium Total (III+VI)	Cobalt	Copper	Iron	Lead	Magnesium	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Location	Sampled Date																			
Gormen Pump	1998-04-23	-	-	-	-	-	-	-	-	-	-	-	-	0.05	-	-	-	-	-	-
Gormen Pump	1998-05-29	-	-	-	-	-	-	-	-	-	-	-	-	0.12	-	-	-	-	-	-
Gormen Pump	1998-06-26	<0.04	<0.01	0.003	-	0.04	0.02	0.02	-	0.06	-	<0.0001	<0.02	0.21	-	0.02	<0.01	-	0.01	0.08
Gormen Pump	1998-07-24	-	-	-	-	-	-	-	-	-	-	-	-	0.18	-	-	-	-	-	-
Gormen Pump	1998-08-28	-	-	-	-	-	-	-	-	-	-	-	-	0.17	-	-	-	-	-	-
Gormen Pump	1998-09-25	0.04	0.01	<0.002	-	0.04	0.02	0.01	-	<0.03	-	<0.0001	<0.02	0.26	-	0.05	-	-	-	0.99
Gormen Pump	1998-10-30	<0.04	0.01	<0.002	-	0.04	0.02	0.01	-	<0.03	-	<0.0001	<0.02	0.23	-	0.05	-	-	-	0.07
Gormen Pump	1998-11-27	-	-	-	-	-	-	-	-	-	-	-	-	0.24	-	-	-	-	-	-
Gormen Pump	1998-12-29	<0.04	<0.01	<0.002	-	0.04	0.02	0.02	-	<0.03	-	<0.0001	<0.02	0.24	-	0.02	-	-	-	0.07
Gormen Pump	1999-01-26	-	-	-	-	-	-	-	-	-	-	-	-	0.19	-	-	-	-	-	-
Gormen Pump	1999-02-23	-	-	-	-	-	-	-	-	-	-	-	-	0.07	-	-	-	-	-	-
Gormen Pump	1999-03-30	<0.04	0.01	<0.002	-	0.02	<0.02	0.01	-	<0.03	-	0.0001	<0.02	0.08	-	<0.02	-	-	-	-
Gormen Pump	1999-04-27	-	-	-	-	-	-	-	-	-	-	-	-	0.08	-	-	-	-	-	-
Gormen Pump	1999-05-27	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-
Gormen Pump	1999-06-29	<0.04	<0.01	<0.002	-	0.04	<0.02	0.02	-	<0.03	-	0.0001	<0.02	0.18	-	0.03	-	-	-	0.08
Gormen Pump	1999-07-27	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-	-
Gormen Pump	1999-08-24	-	-	-	-	-	-	-	-	-	-	-	-	0.14	-	-	-	-	-	-
Gormen Pump	1999-09-28	<0.04	<0.01	<0.002	-	-	<0.02	0.02	-	<0.03	-	0.0002	<0.02	0.17	-	<0.02	-	-	-	0.13
Gormen Pump	1999-10-26	-	-	-	-	-	-	-	-	-	-	-	-	0.15	-	-	-	-	-	-
Gormen Pump	1999-11-23	-	-	-	-	-	-	-	-	-	-	-	-	0.13	-	-	-	-	-	-
Gormen Pump	1999-12-29	0.06	0.02	<0.002	-	0.02	<0.02	0.02	-	<0.03	-	0.0002	0.02	0.12	-	0.02	-	-	-	0.07
Gormen Pump	2000-01-26	-	-	-	-	-	-	-	-	-	-	-	-	0.08	-	-	-	-	-	-
Gormen Pump	2000-04-27	-	-	-	265	-	-	-	10.5	-	135	-	-	-	736	-	-	964	-	-
Gormen Pump	2000-12-20	-	-	-	225	-	-	-	7.29	-	150	-	-	-	966	-	-	1330	-	-
Gormen Pump	2001-04-24	-	-	-	267	-	-	-	6.45	-	101	-	-	-	399	-	-	554	-	-
Gormen Pump	2001-08-30	-	-	-	194	-	-	-	3.79	-	165	-	-	-	1350	-	-	1850	-	-
Gormen Pump	2001-12-20	-	-	-	218	-	-	-	7.74	-	108	-	-	-	430	-	-	615	-	-

Table 1
Leachate Chemistry - Inorganics

		Metals																		
		Antimony	Arsenic	Cadmium	Calcium	Chromium Total (III+VI)	Cobalt	Copper	Iron	Lead	Magnesium	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Location	Sampled Date																			
Gormen Pump	2002-04-25	-	-	-	362	-	-	-	11.3	-	98.3	-	-	-	260	-	-	475	-	-
Gormen Pump	2002-08-22	-	-	-	629	-	-	-	40.5	-	196	-	-	-	483	-	-	955	-	-
Gormen Pump	2002-12-18	-	-	-	493	-	-	-	7.8	-	172	-	-	-	255	-	-	433	-	-
Gormen Pump	2003-04-22	-	-	-	369	-	-	-	6.59	-	122	-	-	-	257	-	-	410	-	-
Gormen Pump	2003-08-26	-	-	-	478	-	-	-	4.03	-	168	-	-	-	231	-	-	577	-	-
Gormen Pump	2003-12-17	-	-	-	401	-	-	-	6.57	-	118	-	-	-	298	-	-	458	-	-
Gormen Pump	2004-05-20	-	-	-	287	-	-	-	3.96	-	113	-	-	-	331	-	-	721	-	-
Gormen Pump	2004-08-25	-	-	-	316	-	-	-	11.6	-	165	-	-	-	123	-	-	479	-	-
Gormen Pump	2004-12-15	-	-	-	625	-	-	-	24.5	-	164	-	-	-	119	-	-	378	-	-
Gormen Pump	2005-04-19	-	-	-	282	-	-	-	13.3	-	151	-	-	-	671	-	-	1230	-	-
Gormen Pump	2005-08-23	-	-	-	189	-	-	-	5.15	-	212	-	-	-	191	-	-	719	-	-
Gormen Pump	2005-12-06	-	-	-	360	-	-	-	9.7	-	130	-	-	-	360	-	-	660	-	-
Gormen Pump	2006-04-18	-	-	-	350	-	-	-	0.63	-	100	-	-	-	62	-	-	300	-	-
Gormen Pump	2006-08-22	-	-	-	250	-	-	-	2.9	-	160	-	-	-	130	-	-	520	-	-
Gormen Pump	2006-12-18	-	-	-	260	-	-	-	1.7	-	90	-	-	-	210	-	-	430	-	-
Gormen Pump	2007-04-17	<0.001	0.001	<0.0001	270	0.008	<0.003	<0.001	0.65	<0.0005	82	-	<0.001	0.042	55	<0.002	<0.0001	270	0.003	<0.005
Gormen Pump	2007-08-28	<0.003	<0.005	<0.0005	290	<0.03	0.004	<0.005	0.8	<0.003	120	-	<0.005	0.062	460	<0.001	<0.0005	730	0.006	0.055
Gormen Pump	2007-12-18	0.0012	0.005	<0.0001	520	<0.03	0.0013	0.0001	17	0.006	110	-	0.005	0.035	150	0.004	<0.0001	370	0.007	0.018
Gormen Pump	2008-04-22	0.0027	<0.005	<0.0001	370	<0.03	0.0009	0.002	13	0.0005	170	-	0.002	0.079	230	<0.002	<0.0001	670	<0.005	0.048
Gormen Pump	2008-08-19	0.0008	0.001	<0.0001	260	0.006	<0.0005	0.004	2.6	<0.0005	110	-	<0.001	0.065	88	<0.002	<0.0001	410	0.003	0.017
Gormen Pump	2008-12-12	<0.0005	<0.001	<0.0001	260	0.007	0.0019	<0.001	2.1	0.0008	100	-	0.002	0.043	220	<0.002	<0.0001	480	0.003	0.026
Gormen Pump	2009-04-14	<0.0008	<0.005	<0.0001	320	<0.03	<0.003	0.003	9.1	0.0007	120	-	0.001	0.057	230	<0.002	<0.0001	540	<0.005	0.044
Gormen Pump	2009-08-18	0.0009	<0.005	0.0002	210	0.014	0.002	0.001	1.6	0.0006	150	-	0.001	0.1	310	<0.002	<0.0001	890	<0.005	0.077
Gormen Pump	2009-12-15	<0.005	<0.01	<0.001	180	<0.05	<0.005	<0.01	4	<0.005	160	-	<0.001	0.12	510	<0.002	<0.001	1000	<0.01	<0.05
Gormen Pump	2010-04-21	0.0014	0.008	<0.0001	260	<0.03	0.0017	<0.001	0.84	<0.0005	130	-	0.003	0.072	250	<0.002	<0.0001	600	0.007	0.015
Gormen Pump	2010-08-18	<0.005	<0.01	<0.001	220	<0.05	<0.005	<0.01	<1	<0.005	180	-	<0.01	0.14	490	<0.02	<0.001	1300	<0.01	<0.05
Gormen Pump	2010-12-14	0.0023	0.021	<0.0001	170	0.029	0.0052	0.002	1.4	0.0014	160	-	0.005	0.15	850	<0.002	<0.0001	1600	0.011	0.023

Table 1
Leachate Chemistry - Inorganics

		Metals																		
		Antimony	Arsenic	Cadmium	Calcium	Chromium Total (III+VI)	Cobalt	Copper	Iron	Lead	Magnesium	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Location	Sampled Date																			
Gormen Pump	2011-04-12	<0.0005	0.002	<0.0001	210	<0.005	0.0014	0.001	5.4	0.001	69	-	0.005	0.026	140	<0.002	<0.0001	290	0.002	0.027
Gormen Pump	2011-08-30	0.0011	0.007	<0.0001	180	0.019	0.0024	<0.001	0.89	<0.0005	140	-	0.0015	0.1	420	<0.002	<0.0001	960	0.007	0.013
Gormen Pump	2011-12-14	<0.0005	0.002	<0.0001	160	<0.005	0.0006	0.0059	5.4	<0.00059	36	-	0.0012	0.013	22	<0.002	<0.0001	39	0.000082	0.23
Gormen Pump	2012-04-12	0.0018	<0.002	<0.001	250	0.0077	0.0037	<0.001	3	0.00056	110	-	0.0013	0.035	400	<0.002	<0.001	6100	<0.001	0.0092
Gormen Pump	2012-08-15	0.0021	<0.005	<0.001	470	0.025	<0.001	0.0013	0.11	<0.005	200	-	0.0054	0.077	170	<0.002	<0.001	1000	0.0032	<0.005
Gormen Pump	2012-12-12	0.0062	0.018	<0.005	210	0.041	0.0083	<0.005	2.5	<0.0025	200	-	0.0047	0.16	970	<0.01	<0.005	2100	0.028	<0.01
Gormen Pump	2013-04-16	0.0009	0.0023	<0.0001	250	0.0063	0.0015	<0.001	4	<0.0005	74	-	0.0026	0.016	200	<0.002	<0.0001	290	<0.0005	0.0086
Gormen Pump	2013-08-20	<0.001	0.0063	<0.0002	180	0.016	0.0024	<0.002	1.8	<0.001	120	-	0.0078	0.078	280	<0.004	<0.0002	770	0.0068	0.011
Gormen Pump	2013-12-17	<0.001	0.0073	<0.0002	230	0.024	0.0051	<0.002	1.8	<0.001	120	-	0.0041	0.1	390	<0.004	<0.0002	1100	0.0098	<0.01
Gormen Pump	2014-04-15	0.0046	0.018	<0.0005	150	0.037	0.0052	<0.005	1.6	<0.0025	210	-	0.0074	0.17	430	<0.01	<0.0005	1500	0.013	<0.025
Gormen Pump	2014-08-12	0.001	0.0051	<0.0001	190	0.011	0.003	0.002	2.4	0.001	110	-	0.026	0.48	210	0.003	<0.0001	600	0.0062	0.015
Gormen Pump	2014-12-16	0.006	0.036	<0.0005	190	0.1	0.023	<0.02	1.6	<0.0025	390	-	0.011	0.37	1700	<0.01	0.00052	6200	0.038	0.035
Gormen Pump	2015-04-14	<0.0025	<0.005	<0.0005	240	<0.025	<0.0025	0.0053	7.4	0.0026	90	-	0.0045	0.027	230	<0.01	<0.0005	610	0.0044	<0.025
Gormen Pump	2015-08-25	0.023	0.026	<0.0005	210	<0.025	0.0077	<0.005	29	<0.0025	130	-	<0.0025	0.072	970	<0.01	<0.0005	1400	<0.0025	0.036
Gormen Pump	2016-01-13	0.0095	0.021	<0.001	200	<0.05	0.0099	<0.01	1.6	<0.005	150	-	0.0092	0.16	1300	<0.02	<0.001	2400	0.023	<0.05
Gormen Pump	2016-04-26	0.003	0.027	<0.0005	130	0.074	0.018	<0.025	1.3	<0.0025	150	-	0.015	0.25	1900	<0.01	<0.0005	3200	0.033	<0.025
Gormen Pump	2016-08-16	<0.0005	0.0014	0.00012	130	<0.005	0.00068	0.086	0.79	0.003	48	-	0.0057	0.0048	13	<0.002	<0.0001	170	0.0009	0.11
Gormen Pump	2016-12-20	0.0012	0.0024	<0.0001	130	<0.005	0.0019	0.049	0.51	0.0017	56	-	0.0036	0.018	190	<0.002	<0.0001	420	0.0014	0.037
Gormen Pump	2017-04-25	0.00061	0.0016	<0.0001	250	0.0085	0.0034	0.016	7.5	0.0017	99	-	0.0027	0.044	300	<0.002	<0.0001	560	0.002	0.028
Gormen Pump	2017-09-12	0.0042	0.0073	<0.0001	310	0.011	0.008	0.015	7.7	0.0012	140	-	0.0044	0.051	760	<0.002	<0.0001	1100	0.0033	0.06
Gormen Pump	2018-04-26	<0.0025	0.032	<0.0005	160	0.094	0.016	0.012	3.8	<0.0025	160	-	0.015	0.2	1100	<0.01	<0.0005	3500	0.053	<0.025
Gormen Pump	2018-09-12	0.0073	0.037	<0.001	320	0.081	0.014	0.059	7.1	0.098	240	-	0.012	0.33	1000	<0.02	<0.001	3300	0.05	0.1
Gormen Pump	2018-12-20	0.0067	0.025	<0.0005	320	0.043	0.0083	0.017	11	<0.0025	150	-	0.0087	0.11	640	<0.01	<0.0005	1900	0.027	<0.025

Table 2
Leachate Chemistry - Volatile Organic Compounds

		VOCs																																			BTEX						Solvents	
		1,1,1,2-tetrachloroethane	1,1,1-trichloroethane	1,1,2,2-tetrachloroethane	1,1,2-trichloroethane	1,1-dichloroethane	1,1-dichloroethene	1,2-dibromoethane	1,2-dichloroethane	1,2-dichloropropane	1,2-Dichlorobenzene	1,3-dichlorobenzene	1,4-dichlorobenzene	Acetone	Acrolein	Bromodichloromethane	Bromoform	Bromomethane	Carbon tetrachloride	Chlorobenzene	Chlorodibromomethane	Chloroethane	Chloroform	Chloromethane	cis-1,2-dichloroethene	cis-1,3-dichloropropene	Dichloromethane	Methyl Ethyl Ketone (MEK)	Methyl tert-Butyl Ether (MTBE)	Styrene	Trichloroethene	Tetrachloroethene	trans-1,2-dichloroethene	trans-1,3-dichloropropene	Trichlorofluoromethane	Vinyl chloride	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylenes Total	Acrylonitrile	Methyl Isobutyl Ketone (MIK)
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Location	Sampled Date																																											
Gormen Pump	1997-09-27	-	3.5	<1	<1	20	<2	<1	<2	<1	<1	<1	3.4	-	<4	<1	<1	<8	<1	<1	<1	14	<1	<8	2.9	<2	27	-	-	<1	<1	<1	<2	<1	<8	<10	<1	<1	1.2	8.4	3.6	-	<4	-
Gormen Pump	1997-10-31	-	<0.9	<0.9	<0.9	2.3	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	2.6	-	-	<0.9	<0.9	<2.2	<0.9	<0.9	<0.9	3.5	<0.9	<2.2	1	<2.2	<2	-	-	<0.9	<0.9	<0.9	<0.9	<0.9	<1.3	<2.2	<0.9	<0.9	0.9	14	0.9	-	-	-
Gormen Pump	1998-12-29	-	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	-	-	<8.6	<8.6	<22	<8.6	<8.6	<8.6	<22	<8.6	<22	<8.6	<22	<43	-	-	<8.6	<8.6	<8.6	<8.6	<8.6	<13	<22	<8.6	<8.6	<8.6	<8.6	<8.6	-	-	-
Gormen Pump	1999-12-29	-	<1.7	<1.7	<1.7	2.5	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	-	-	<1.7	<1.7	<4.3	<1.7	<1.7	<1.7	<4.3	<1.7	<4.3	<1.7	<4.3	<9	-	-	<1.7	<1.7	<1.7	<1.7	<1.7	<2.6	<4.3	<1.7	<1.7	<0.2	<1.7	<1.7	-	-	-
Gormen Pump	2000-04-27	-	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	-	-	<8.6	<8.6	<22	<8.6	<8.6	<8.6	<22	<8.6	<22	<8.6	<22	<43	-	-	<8.6	<8.6	<8.6	<8.6	<8.6	<13	<22	<8.6	<8.6	<8.6	<8.6	<8.6	-	-	-
Gormen Pump	2001-04-24	-	<17	<17	<17	<17	<17	<17	<17	<17	<17	<17	<17	-	-	<17	<17	<43	<17	<17	<17	<43	<17	<43	<17	<43	<86	-	-	<17	<17	<17	<17	<17	<26	<43	<17	<17	<17	<17	<17	-	-	-
Gormen Pump	2002-04-25	-	<8.6	<8.6	<8.6	9.9	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	<8.6	-	-	<8.6	<8.6	<22	<8.6	<8.6	<8.6	<22	<8.6	<22	<8.6	<22	400	-	-	<8.6	<8.6	<8.6	<8.6	<8.6	<13	<22	<8.6	55	20	<8.6	22	-	-	-
Gormen Pump	2003-04-22	-	<0.9	<0.9	<0.9	2.5	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	1.9	-	-	<0.9	<0.9	<2.2	<0.9	2.2	<0.9	7.5	<0.9	<2.2	4.1	<2.2	37	-	-	<0.9	<0.9	<0.9	<0.9	<0.9	<1.3	0.8	1.5	12	6.1	20	11	-	-	-
Gormen Pump	2004-05-20	-	<0.9	<0.9	<0.9	3.8	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	3.1	-	-	<0.9	<0.9	<2.2	<0.9	<0.9	<0.9	7.4	<0.9	<2.2	1.8	<2.2	<4.3	-	-	<0.9	<0.9	<0.9	<0.9	<0.9	<1.3	1.3	3.2	4.6	3.8	28	18	-	-	-
Gormen Pump	2005-04-19	<0.5	<0.5	<0.5	<0.5	1.5	<0.5	<1	<0.5	<0.5	<0.5	<0.5	5.7	272	-	<0.5	<1	<3	<0.5	<0.5	<0.5	5	<0.5	<3	0.7	<1	<3	543	<1	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<0.5	<1	<0.5	4.8	<0.5	-	-	30
Gormen Pump	2006-04-18	<0.2	<0.2	<0.2	<0.4	0.9	<0.2	<0.4	1.3	<0.2	<0.4	<0.4	0.8	95	-	<0.2	<0.4	<1	<0.2	0.3	<0.4	-	<0.2	-	0.5	<0.4	5	150	3.4	<0.4	<0.2	<0.2	0.4	<0.4	-	1.9	5	26	19	16	4.1	20	-	11
Gormen Pump	2007-04-17	<0.5	<0.5	<0.5	<1	<0.5	<0.5	<1	<1	<0.5	<1	<1	1	<50	-	<0.5	<1	<3	<0.5	0.5	<1	<1	<0.5	<3	<0.5	<1	<3	<30	3	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	6.7	20	34	38	13	51	-	<30
Gormen Pump	2008-04-22	<5	<5	<10	<10	<5	<5	<10	<10	<5	<10	<10	<10	2300	-	<5	<10	<30	<5	<5	<10	<10	<5	<30	<5	<10	<30	2400	<10	<10	<5	<5	<5	<10	<10	<10	7	350	35	56	18	74	-	<300
Gormen Pump	2009-04-14	<10	<10	<20	<20	<10	<10	<20	<20	<10	<20	<20	<20	1700	-	<10	<20	<50	<10	<10	<20	<20	<10	<50	<10	<20	<50	1600	<20	<20	<10	<10	<10	<20	<20	<20	<10	690	15	31	<10	31	-	<500
Gormen Pump	2010-04-21	<1	<1	<2	<2	<1	<1	<2	<2	<1	<2	<2	<2	780	-	<1	<2	<5	<1	<1	<2	<2	<1	<5	<1	<2	<5	1100	2	<2	<1	<1	<1	<2	<2	<2	8	30	34	66	25	92	-	<50
Gormen Pump	2011-04-12	<0.5	3.8	<1	<1	12	<0.5	<1	<1	<0.5	<1	<1	2	85	-	<0.5	<1	<3	<0.5	1.3	<1	23	<0.5	<3	13	<1	25	<30	<1	<1	<0.5	<0.5	<0.5	<1	<1	2	4	37	16	48	27	75	-	<30
Gormen Pump	2012-04-12	<2	1	<2	<2	2.9	<1	<2	<2	<1	<2	<2	2.4	1800	-	<1	<2	<5	<1	2.7	<2	9.7	<1	<5	1.4	<2	<5	2100	<2	<2	<1	<1	<1	<2	<2	<2	3.3	16	9.4	25	9.6	35	-	80
Gormen Pump	2013-04-16	<1	6	<1	<1	8.4	<0.5	<1	<1	<0.5	<1	<1	1.9	840	-	<0.5	<1	<2.5	<0.5	2.3	<1	37	<0.5	<2.5	4.7	<1	3	690	<1	<1	<0.5	<0.5	<0.5	<1	<1	<1	2.8	16	12	45	15	60	-	34
Gormen Pump	2014-04-15	<2	<1	<2	<2	<1	<1	<2	2.3	<1	<2	<2	2.1	1000	-	<1	<2	<5	<1	1	<2	<2	<1	<5	1.1	<2	<5	1100	<2	<2	<1	<1	1.1	<2	<2	<2	6.8	33	24	55	17	72	-	65
Gormen Pump	2015-04-14	<1	0.96	<1	<1	2.8	<0.5	<1	<1	<0.5	<1	<1	2	280	-	<0.5	<1	<2.5	<0.5	2.1	<1	11	<0.5	<2.5	1.1	<1	<2.5	360	<1	<1	<0.5	<0.5	<0.5	<1	<1	<1	3.2	13	9.9	32	11	42	-	<25
Gormen Pump	2016-04-26	<2	<1	<2	<2	<1	<1	<2	<2	<1	<2	<2	4.6	100	-	<1	<2	<5	<1	1.5	<2	<2	<1	<5	<1	<2	<5	68	<2	<2	<1	<1	<1	<2	<2	<2	9.5	5.9	69	77	23	100	-	<50
Gormen Pump	2017-04-25	<2	14	<2	<2	29	<1	<2	<2	<1	<2	<2	<2	<100	-	<1	<2	<5	<1	1.8	<2	170	<1	<5	11	<2	<5	<50	<2	<2	<1	<1	<1	<2	<2	3.5	5.4	27	20	69	40	110	-	<50
Gormen Pump	2018-04-26	<5	<2.5	<5	<5	<2.5	<2.5	<5	<5	<2.5	<5	<5	<5	<250	-	<2.5	<5	<13	<2.5	<2.5	<5	8.8	<2.5	<13	<2.5	<5	<13	<130	<5	<5	<2.5	<2.5	<2.5	<5	<5	<5	4.5	22	23	58	23	80	-	<130
Gormen Pump	2018-12-20	<20	<10	<20	<20	<10	<10	<20	<20	<10	<20	<20	<20	10,000	-	<10	<20	<50	<10	<10	<20	<20	<10	<50	<10	<20	<50	9300	<20	<20	<10	<10	<10	<20	<20	<20	<10	31	33	46	17	63	-	<500

Ministry of the Environment, Conservation and Parks

Environmental Assessment and Permissions Branch

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November 29, 2019

MEMORANDUM

TO: Carolyn Lee
Special Project Officer
Environmental Assessment and Permissions Branch

FROM: Rick Li
Senior Waste Engineer
Environmental Assessment and Permissions Branch

RE: Ridge Landfill Expansion Draft EA
EA REF NO. 16019

I have reviewed the comment response table dated November 11, 2019 submitted by Waste Connections, and have further comments as follows:

Leachate Collection System for the Old Landfill Expansion

a) For the POLLUTE model, only the input parameters for the West Landfill and South Landfill are presented in Table 5. Please provide the input parameters for the Old Landfill. According to Section 7.7.4 of the Design & Operations report, the current leachate level is 202.6masl. The model should be calibrated using the current leachate head for the Old Landfill.
Proposed action: provide the input parameters table for the Old Landfill and calibrate the POLLUTE model for the Old Landfill using the current leachate head value.

b) In Attachment 4 – Calculation of Mounding Between Finger Drains, the lateral flux collected by the finger drains was re-calculated based on peak monthly average percolation rate through waste. The calculation underestimated the flux to the finger drains in several ways. First, according to the HELP model, the peak daily percolation through the waste is 3mm, which should have been used for the calculation. Second, the HELP model was only run for the closed site scenario. Simulation for the operation period without a final cover should have also been completed because for the active landfilling area, 100% of precipitation that comes into contact with waste will become leachate. Last, the calculation of Q_{INF} in Attachment 4 only accounts for the infiltration over the unit width area at each finger drain. However, as the finger drains are spaced at 25 metres, each drain will also collect leachate from its surrounding area (the space between two finger drains). Therefore the lateral flux as calculated is significantly underestimated. (It would be correct if there were a continuous drainage layer.) Proposed action: recalculate the finger drain flux and revise the design.

In summary, it is the reviewer's opinion that the perimeter and finger drains proposed for the Old landfill would not be adequate to handle leachate collection and control mounding at the Old Landfill. It is recommended that the design be reviewed by Dr. Kerry Rowe prior to acceptance by the ministry.

Rick Li

c:

RL/

Calculation of Mounding Between Finger Drains – Old Landfill Area Vertical Expansion **Ridge Landfill Expansion Environmental Assessment, Blenheim, Ontario**		
Job No: 18111331 (2000)	Made by: S. Rimal Updated by: F. Gondim Reviewed by: F. Barone	Date: December 20, 2019

References:

Ref. 1 – Rowe, R.K., Quigley, R.M., Brachman, R.W.I., and Booker, J.R. (2004). Barrier Systems for Waste Disposal Facilities, 2nd Edition, Spon Press, 587p.

Ref. 2 – Oweis, I.S. and Khera, R.P. (1998). Geotechnology for Waste Management, Second Edition, PWS Publishing Company, Boston, 471p.

Ref. 3 – Sharma, H.D. and Reddy, K.R. (2004). Geoenvironmental Engineering, Site Remediation, Waste Containment and Emerging Waste Management Technologies, John Wiley & Sons Inc., New Jersey, 968p.

As shown in the attached cross-sections we have:

q_{INF} = maximum monthly average percolation rate through waste = 35 mm/month = 0.035 m^3/m^2/month

Note: for the operational scenario (i.e., the worst case scenario), we considered that Cell O1, which is the largest cell of the Old Landfill, would have a 50 m x 100 m (i.e., 0.5 hectare) open working face without cover and 15.7 hectares with 0.30 m thick cover, for a total of 16.2 hectares. Using the maximum monthly percolation rates of 57 mm/month for the open working face area and 34 mm/month for the area with 0.30 m thick cover as per attached HELP model outputs, an equivalent maximum monthly percolation rate of 35 mm/year was obtained for the Cell O1 area using the following equation: q_{INF} = (0.5 hectare x 57 mm/month + 15.7 hectares x 34 mm/month)/16.2 hectares = 35 mm/month.

L = horizontal distance between the perimeter drain and central peak of the landfill = 400 m

Q_{INF} = total infiltration per unit width over the horizontal distance L (m^3/month)

= q_{INF} x L x 1 m (unit width)
= 0.035 m^3/m^2/month x 400 m x 1 m
= 14 m^3/month

H = vertical distance between the bottom elevation of the finger drains to the maximum top elevation of finger drains = 6 m

q_{LAT} = lateral flux collected by the finger drains (m/y)

= Q_{INF} / (H x 1 m) = 14 m^3/month / (6 m x 1 m) = 2.3 m/month

The mounding between the finger drains can be calculated as follows (Ref. 1): $H_{MAX} = 0.5\, l \sqrt{\frac{q_{LAT}}{k_W}}$

where,

H_{MAX} = maximum height of mounding (m)
l = distance between the finger drains = 25 m
k_W = hydraulic conductivity of waste = 1 x 10^{-3} cm/s = 26.3 m/month (Ref. 2 and 3)

Calculation of Mounding Between Finger Drains – Old Landfill Area Vertical Expansion Ridge Landfill Expansion Environmental Assessment, Blenheim, Ontario		
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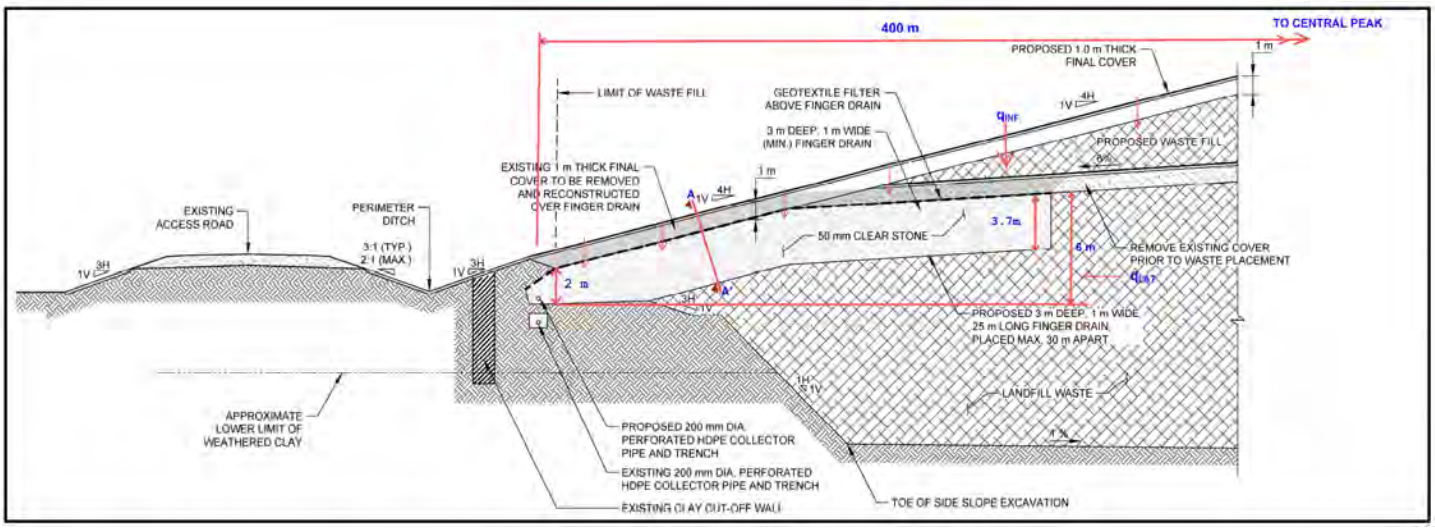
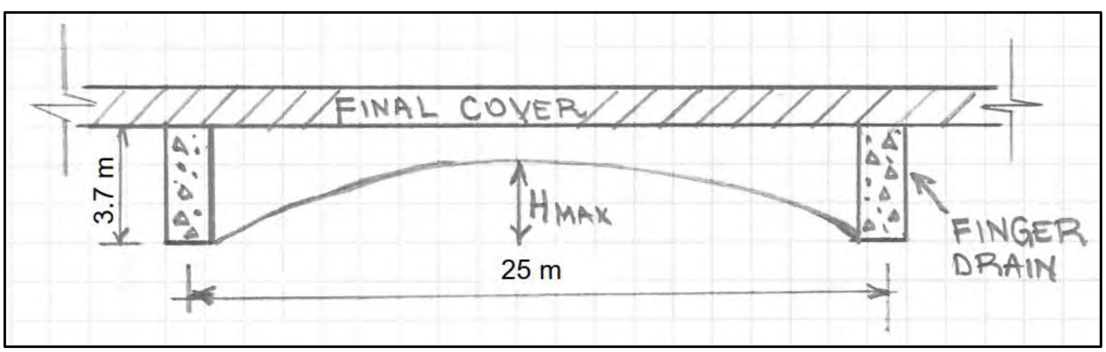
$$H_{MAX} = 0.5 \times 25\ \text{m} \sqrt{\frac{2.3\ \text{m/month}}{26.3\ \text{m/month}}} = 3.7\ m$$

H_{MAX} is equal to 3.7 m depth of the finger drains and therefore the maximum mounding between finger drains is predicted to be at the base of the final cover for the 25 m spacing.



Cross section showing proposed finger drain and vertical expansion.



Cross section A-A' showing mounding between two finger drains.

MEMO

TO:	Cathy Smith, Project Manager, Ridge Landfill EA, Waste Connections
FROM:	Robin Kell, Hydrogeologist, Dillon Consulting Limited
cc:	Bill Allison
DATE:	January 7, 2020
SUBJECT:	Ridge Landfill Contaminant Transport Modelling Sensitivity of Waste Hydraulic Conductivity, Old Landfill Mounding Calculations and POLLUTE Modelling
OUR FILE:	15-2456

1.0 Introduction

In 2019, contaminant transport modelling was completed to predict potential groundwater impacts resulting from the proposed landfill expansion of the Ridge Landfill. The computer program POLLUTE was used to simulate the movement of contaminants to predict groundwater quality in time and space as contaminants migrate from the landfill into the groundwater environment. The simulations incorporated the performance of the leachate control systems and the hydrogeologic setting of the area. Overall, there were two main simulations completed: a simulation for horizontal expansion of the South and West Landfills and a simulation for the vertical expansion of the Old Landfill.

As part of the review process, a concern was identified by the MECP with leachate mounding and seepage control to the side slopes and base of the Old Landfill. As part of the response to this concern, Waste Connections Canada through Golder Associates Ltd. retained R. Kerry Rowe to complete a peer review of the landfill design process of the perimeter drain including finger drains that will collect leachate generated from the proposed expanded Old Landfill.

The peer review concluded that revised calculations provided by the landfill design team addressed the issues raised by the MECP regarding the perimeter drain / finger drain system. The peer review also identified that consideration for a range of hydraulic conductivities of the waste used to calculate the amount of leachate mounding between the perimeter drains to account for consolidation of the waste caused by the vertical expansion of the Old Landfill. The simulations used a waste hydraulic conductivity of 2×10^{-6} m/s, which is the default value of the waste hydraulic conductivity in the USEPA HELP model (USEPA, 1984).

MEMO

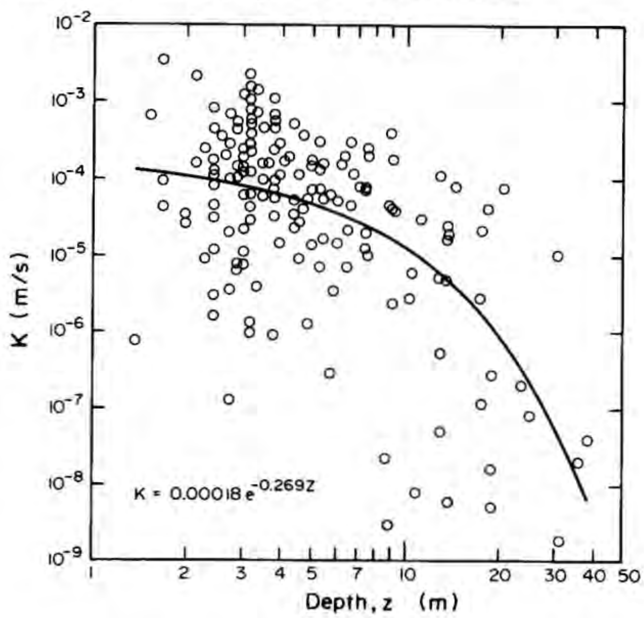
2.0 Waste Hydraulic Conductivity

The hydraulic conductivity of waste is significantly variable due to the heterogeneous nature of the waste coupled with the construction of the landfill with landfill cells constructed at different times and individual lifts in the cells separated by daily and intermediate cover. In an assessment of the use of pumping wells installed within waste, Rowe and Nadarajah (1996) stated:

"It is noted that the hydraulic conductivity may vary with depth (e.g., see Fig. 6) and may vary over several orders of magnitude from point to point (due to the heterogeneity of the waste)."

Figure 6 of Rowe and Nadarajah (1996), reproduced below, illustrates the variability of waste hydraulic conductivity and also indicates that waste hydraulic conductivity decreases with depth. The figure provides an equation for estimating waste hydraulic conductivity with depth ($K=0.00018\ e^{(-.269z)}$, where K is the waste hydraulic conductivity in m/s and z is the depth of waste in m).

Fig. 6. Variation in hydraulic conductivity with depth at the Fresh Kills landfill, New York. Based on data and a plot courtesy of the City of New York Department of Sanitation; IT Corporation; and Ogden Environmental and Energy Services, Inc. (personal communication).



This figure is reproduced from Rowe, R.K. and Nadarajah, P., 1996. Estimating Leachate Drawdown due to Pumping Wells in Landfills", Canadian Geotechnical Journal, 33(1):1-10.

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DILLON CONSULTING

Estimating an appropriate waste hydraulic conductivity to use in leachate mounding calculations between perimeter drains would be based on the depth of the waste mound. Since leachate will flow mainly horizontally to the perimeter drains, the height of waste above the invert of the perimeter drains should be considered. Further, since leachate will flow throughout the saturated thickness of the waste some leachate will flow at shallower depths where the waste hydraulic conductivity is higher and some will flow at lower depths where the waste hydraulic conductivity is lower. Therefore, a range of waste hydraulic conductivities was considered based on this equation (see Table 1).

3.0 POLLUTE Model

The approach used to complete Ridge Landfill contaminant transport modelling is documented in Sub-Appendix G of the Hydrogeological Impact Assessment. The equation used to predict landfill mounding is described in Section 3.2 of that document.

The results of additional simulations using the suggested range of waste hydraulic conductivities are summarized in Table 1.

Table 1: Waste Hydraulic Conductivity Assessment

Overlying Waste Height* (m)	Waste hydraulic conductivity (m/s)**	Max. Head on Landfill base (m)	Predicted Maximum Chloride Concentration (mg/L)	Time at Maximum Concentration (years)	Comment
Allowable Concentration			188		Reasonable Use Guideline Limit
17	2E-06	17.2	129	3400	USEPA HELP Default
19	1E-06	22.9	152	3000	Upper Estimate
21	6E-07	28.5	186	2600	Lower Estimate

*Height of waste used to determine waste hydraulic conductivity based on Rowe and Nadarajah (1996).
**based on the equation from Rowe and Nadarajah (1996).

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As indicated in the table, the predicted maximum chloride concentrations are below the allowable concentration based on the Reasonable Use Guideline. Two conservative assumptions were used in the mounding assessment: i) the maximum mound height was assumed to occur over the entire landfill base, however the mound height will vary from the maximum height and reduce closer to the perimeter drains and ii) at significant mound heights, (e.g., >25 m), the depth of overlying waste will be less than that assumed which would result in higher waste hydraulic conductivity (greater than the USEPA HELP default value).

Overall, although the assessment of the effect of lower waste hydraulic conductivities indicates higher predicted impacts, the predicted impacts remain below the allowable concentration based on the Reasonable Use Guideline for all conditions considered.

References

Ministry of Environment and Energy, 1994, Incorporation of the Reasonable Use Concept into MOEE Groundwater Management Activities, Guideline B-7, Revised April 1994.

Rowe, R.K. and Nadarajah, P., 1996. Estimating Leachate Drawdown due to Pumping Wells in Landfills", Canadian Geotechnical Journal, 33(1):1-10.

Rowe, R.K., R.M. Quigley, R.W.I Brachman and J.R. Booker, 2004, Barrier Systems for Waste Disposal Facilities, 2nd Edition, SPON Press.

United States Environmental Protection Agency (USEPA), 1984, The Hydrologic Evaluation of Landfill Performance (HELP) Model, Volume 1, User's Guide. Schroeder, P.R., J.M. Morgan, T.M. Walski and A.C. Gibson, U.S. Army Corps of Engineers, EPA/530-SW-84-009, June 1984.

Wesseling, J., 1972, Theories of Field Drainage and Watershed Runoff, Institute for Land and Water Management Research, Wagenigen.