Appendix D
Landfill Monitoring – Stormwater, Groundwater and Leachate

Appendix D1 – Historic Monitoring

Appendix D2 – Project Monitoring

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Appendix D1

Historic Monitoring

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(Extracted from Appendix C of 'Closed Landfill Consent Monitoring Report – Rosedale Closed Landfill' – May 2016. Prepared by Tonkin & Taylor Ltd (Ref: 28645.500) for Auckland Council – Closed Landfill and Contaminated Land Response Team)

Rosedale Closed Landfill - Groundwater well monitoring results

Monitoring Location: BH2007A South of Landfill

	Trigger (alert) levels[1]	Response Levels[1]	5/11/2007	5/05/2008	5/11/2008	7/05/2009	9/11/2009	5/05/2010	9/11/2010	12/05/2011	26/10/2011	17/04/2012	6/11/2012	23/04/2013	22/10/2013	15/04/2014	4/11/2014	14/05/2015	25/11/2015
Lab No.																			1506885.1
Temperature (°C)			16.8	16.9	16.9	16.4	16.7	17.4		17.1	17.1		17.9		18.4	16.3	15.7	15.9	16.2
Ammonia (mg/l)	0.8	3	0.082	0.11	0.096	0.099	0.09	0.147	0.075	0.099	0.11	0.099	0.101	0.097	0.132	0.24	0.104	0.125	<0.010
Chloride (mg/l)	55.2	230	43	42	45	44	47	49	50	51	56	52	53	55	58	58	58	61	59
Dissolved Copper (mg/l)	0.014	0.02		0.0029		0.0039		0.00073		0.00084		0.0017		0.0039		0.0025		<0.00053	
pH			6.6	6.5	6.5	6.5	6.4	6.5	6.4	6.4	6.2	6.6	6.4	6.4	6.5	6.4	6.4	6.5	7
Dissolved Zinc (mg/l)	0.08	0.11		0.0067		0.0073		0.0028		0.0028		0.0045		0.0089		0.0049		<0.0011	

Monitoring Location: BH2008R West of Landfill

	Trigger (alert) levels[1]	Response Levels[1]	5/11/2007	5/05/2008	5/11/2008	7/05/2009	9/11/2009	5/05/2010	9/11/2010	12/05/2011	26/10/2011	17/04/2012	6/11/2012	23/04/2013	22/10/2013	15/04/2014	4/11/2014	14/05/2015	25/11/2015
Lab No.																			1506885.2
Temperature (°C)			17.8	18.1	17.6	17.4	18	18.3		17.9	17.9		17.9		18.5	17.2	16.6	16.7	17.4
Ammonia (mg/l)	0.15	2.5	0.044	0.054	0.084	0.061	0.041	0.04	0.042	0.025	0.044	0.038	0.063	0.027	0.038	0.042	0.043	0.045	<0.010
Chloride (mg/l)	151.6	230	82	80	89	92	88	88	90	48	49	88	92	98	62	97	70	100	32
Dissolved Copper (mg/l)	0.014	0.02		0.0054		0.00066		<0.00053		<0.00053		0.0013		0.00059		0.0024		0.00077	
pH			6.1	6.1	6.2	6	5.9	6.1	6.1	6.1	6.2	6.1	6	6.1	6.1	6.3	6.2	6.2	7.1
Dissolved Zinc (mg/l)	0.08	0.11		0.013		0.0013		0.0017		0.0027		0.0037		0.0018		0.0042		0.0018	

Monitoring Location: BH2015 South of Landfill

	Trigger (alert) levels[1]	Response Levels[1]	5/11/2007	5/05/2008	5/11/2008	7/05/2009	9/11/2009	5/05/2010	9/11/2010	12/05/2011	26/10/2011	17/04/2012	6/11/2012	23/04/2013	24/10/2013	28/04/2014	4/11/2014	14/05/2015	25/11/2015
Lab No.																			1506885.3
Temperature (°C)			17.6	19.6	17.2	16.9	16.8	17.4	18.8	17.2	18		17.6		16.8	16.6	15.5	16.8	15.8
Ammonia (mg/l)	0.25	2.5	0.11	0.1	0.12	0.11	0.18	0.144	0.059	0.098	0.044	0.114	0.092	0.13	0.023	0.135	0.072	0.124	0.081
Chloride (mg/l)	110.6	230	28	27	29	28	29	27	33	36	36	32	31	28	30	27	33	28	29
Dissolved Copper (mg/l)	0.014	0.02		<0.00053		<0.00053		0.00161		<0.00053		<0.00053		0.00063		0.00105		0.00054	
pH			7	6.9	7	7.2	6.9	7.3	6.8	6.6	6.8	7	6.7	7.2	7.2	7.5	7	7.3	7.5
Dissolved Zinc (mg/l)	0.08	0.11		0.0051		0.0029		0.0072		0.0072		0.0025		0.002		0.0024		0.0038	

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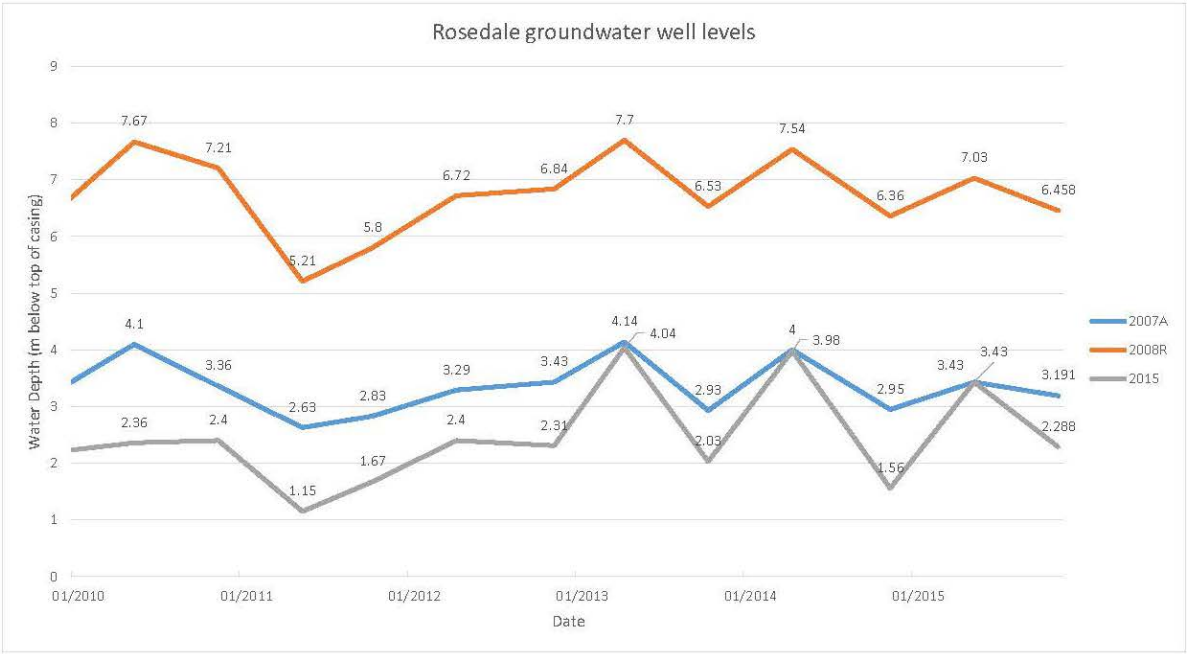
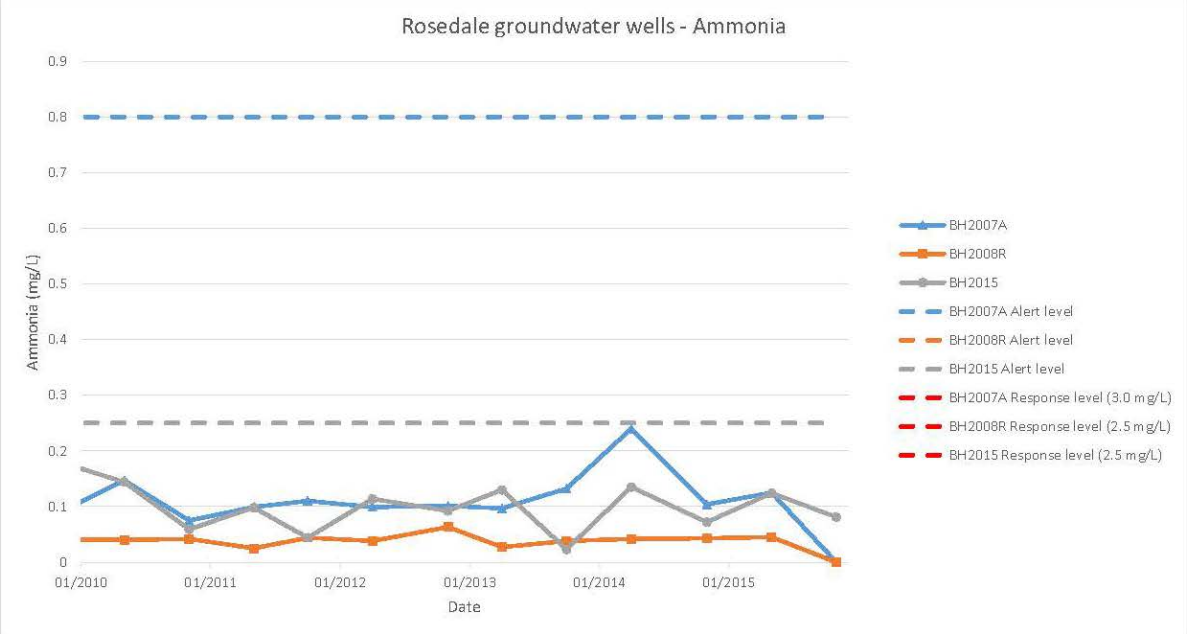
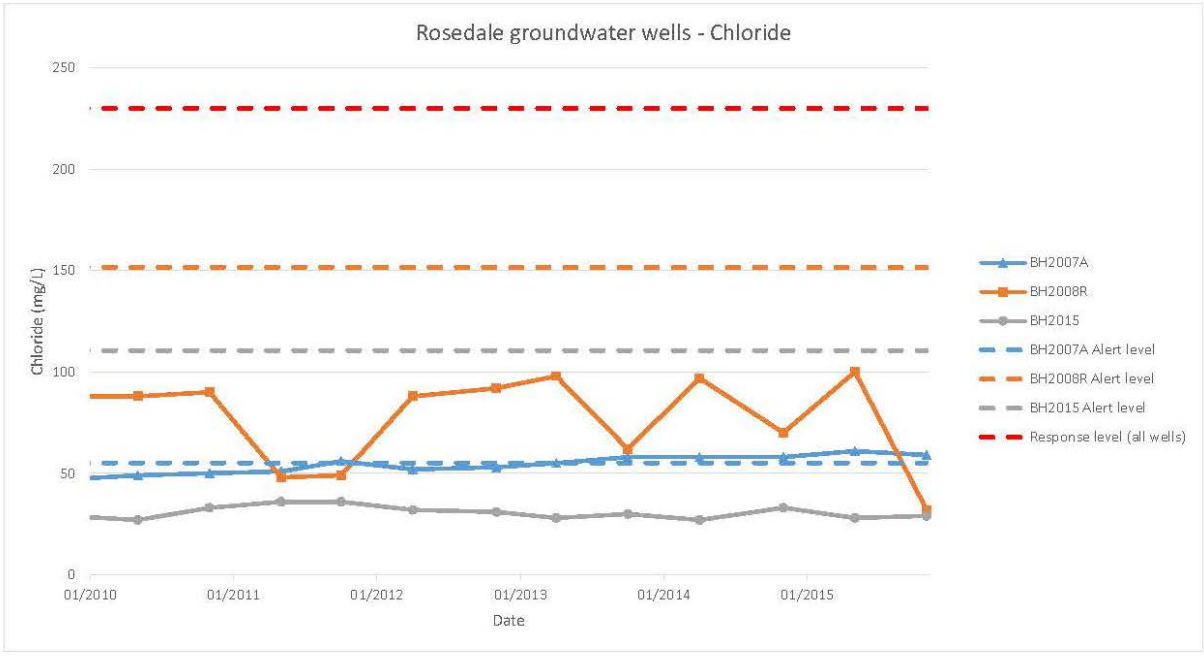
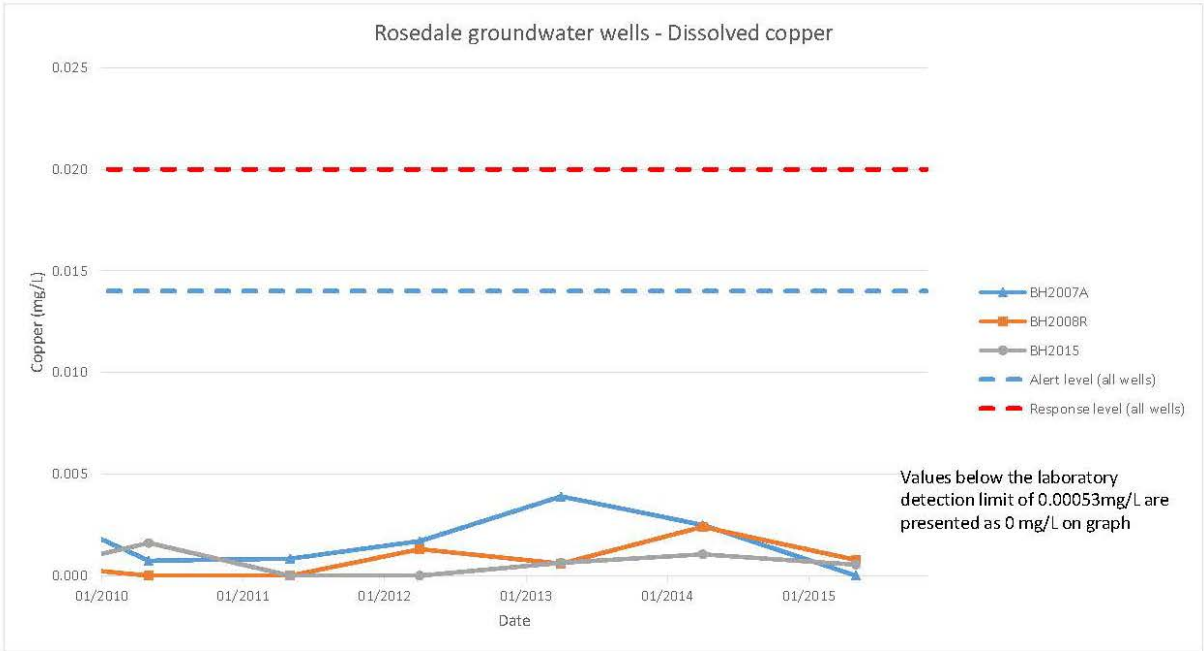
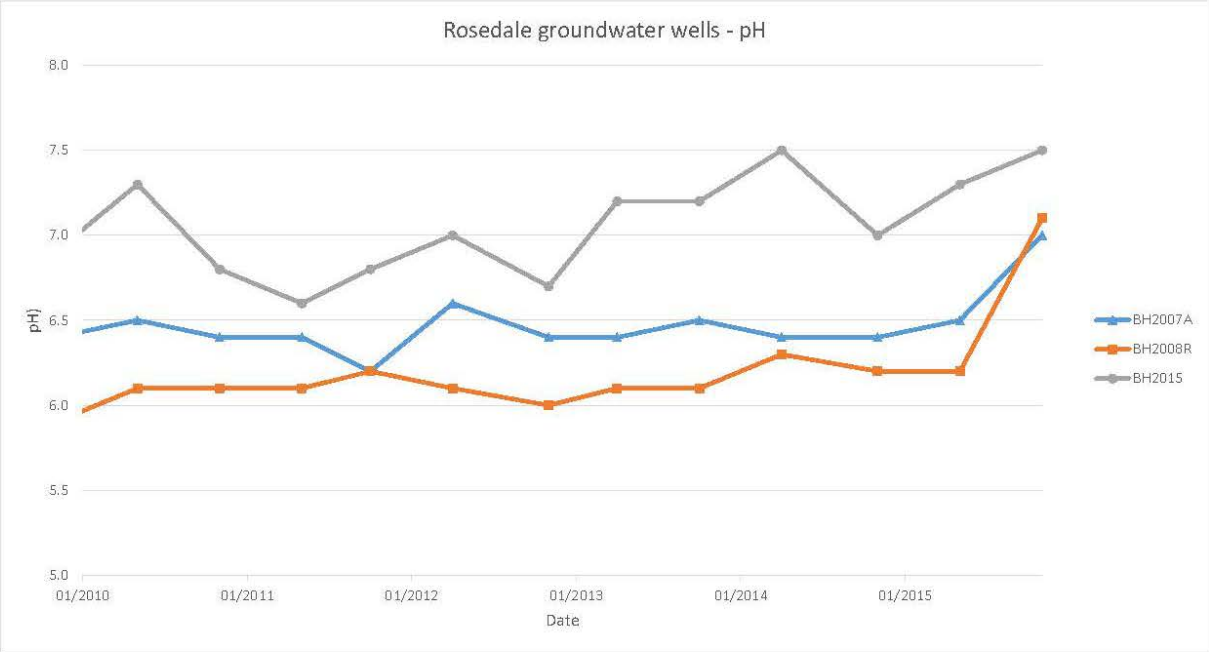
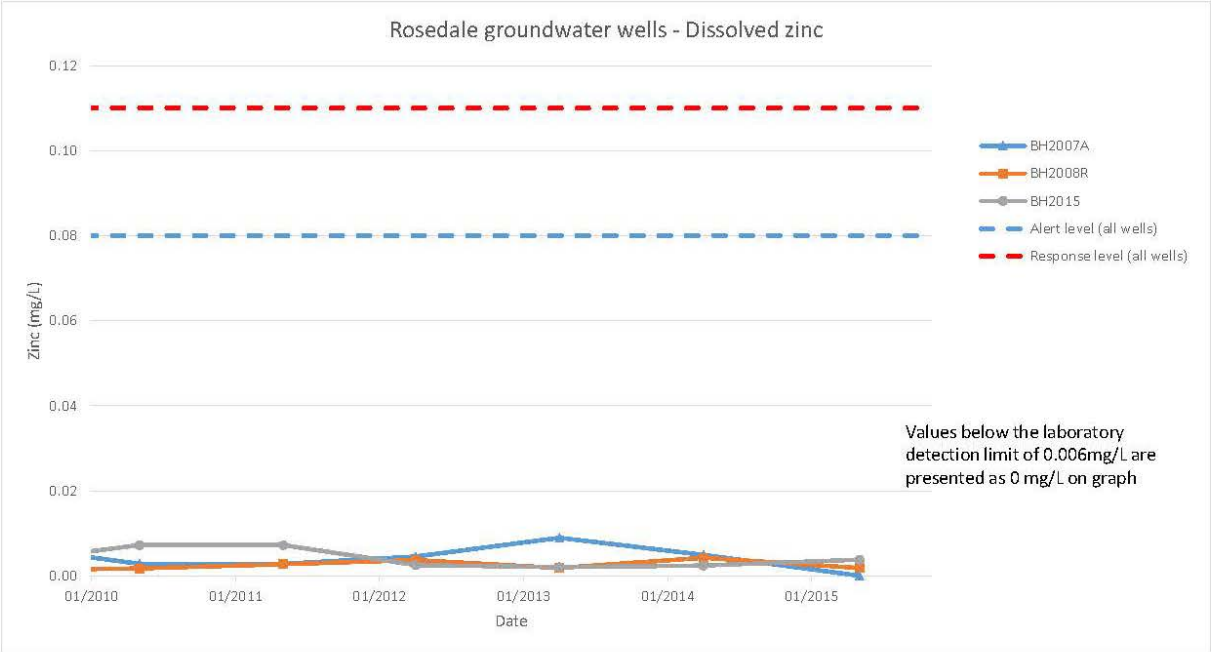

Rosedale groundwater well levels
Water Depth (m below top of casing)
Date
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
2007A
2008R
2015
7.67
7.21
5.21
5.8
6.72
6.84
7.7
6.53
7.54
6.36
7.03
6.458
4.1
3.36
2.63
2.83
3.29
3.43
4.14
4.04
2.93
4
3.98
2.95
3.43
3.43
3.191
2.36
2.4
1.15
1.67
2.4
2.31
2.03
1.56
2.288

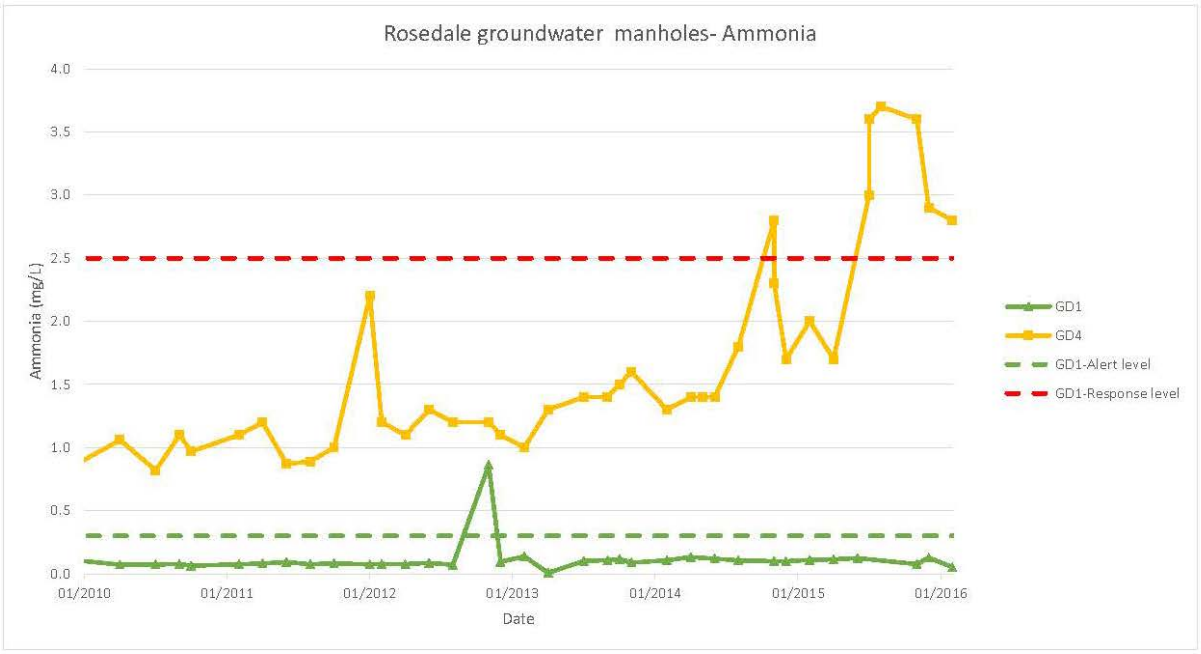

Rosedale groundwater wells - Ammonia
Ammonia (mg/L)
Date
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
BH2007A
BH2008R
BH2015
BH2007A Alert level
BH2008R Alert level
BH2015 Alert level
BH2007A Response level (3.0 mg/L)
BH2008R Response level (2.5 mg/L)
BH2015 Response level (2.5 mg/L)

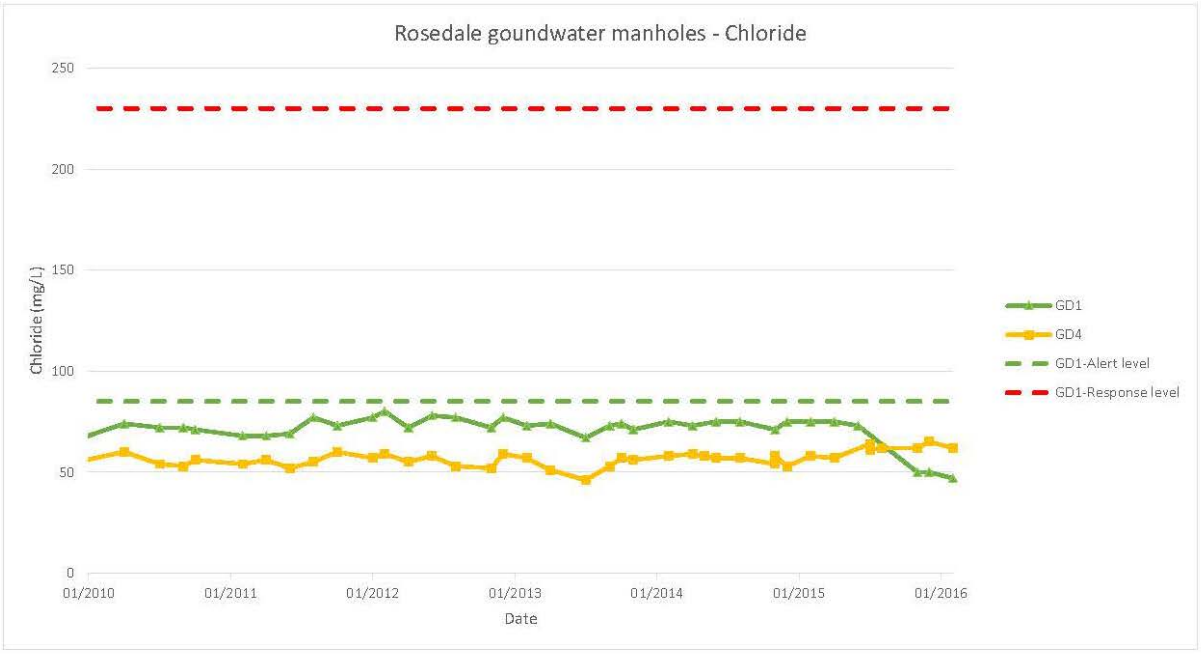

Rosedale groundwater wells - Chloride
250
200
150
100
50
0
Chloride (mg/L)
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
Date
BH2007A
BH2008R
BH2015
BH2007A Alert level
BH2008R Alert level
BH2015 Alert level
Response level (all wells)

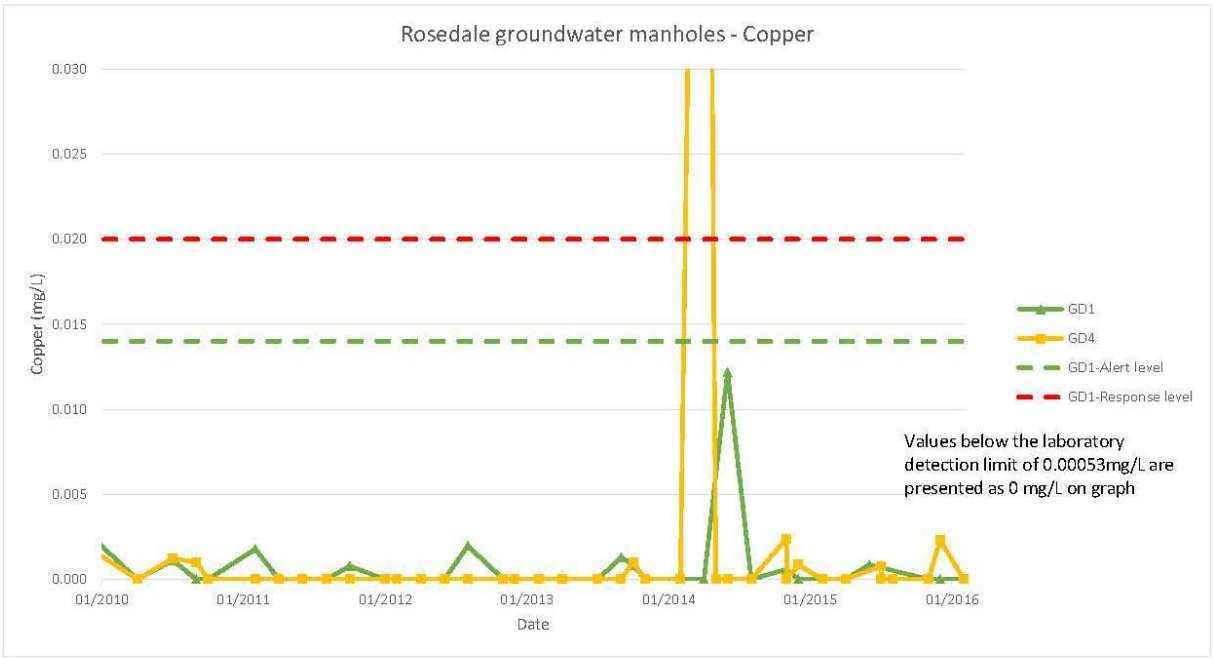

Rosedale groundwater wells - Dissolved copper
0.025
0.020
0.015
0.010
0.005
0.000
Copper (mg/L)
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
Date
BH2007A
BH2008R
BH2015
Alert level (all wells)
Response level (all wells)
Values below the laboratory detection limit of 0.00053mg/L are presented as 0 mg/L on graph

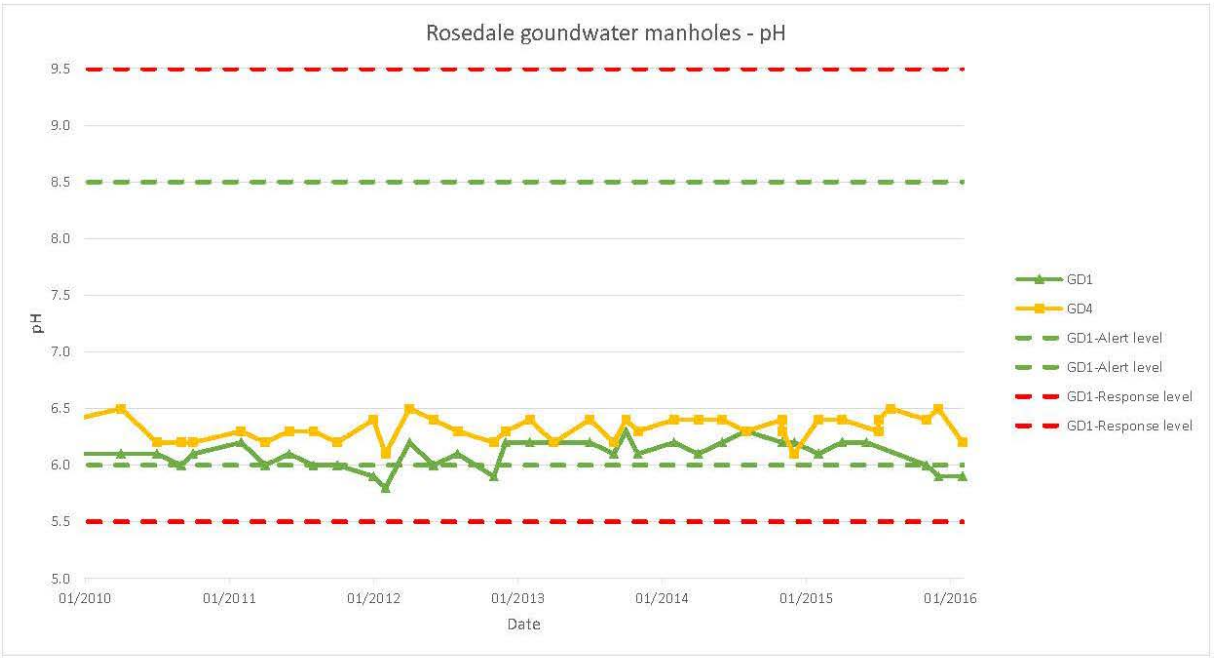

Rosedale groundwater wells - pH
8.0
7.5
7.0
6.5
6.0
5.5
5.0
pH)
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
Date
BH2007A
BH2008R
BH2015

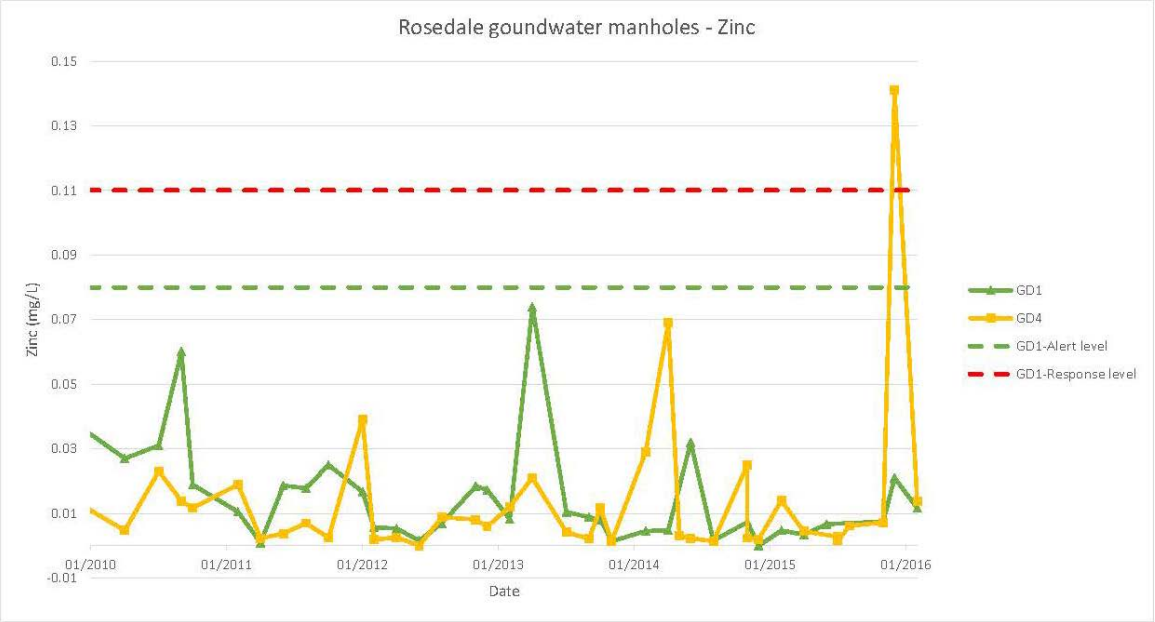

Rosedale groundwater wells - Dissolved zinc
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Zinc (mg/L)
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
Date
BH2007A
BH2008R
BH2015
Alert level (all wells)
Response level (all wells)
Values below the laboratory detection limit of 0.006mg/L are presented as 0 mg/L on graph


Rosedale groundwater manholes- Ammonia
Ammonia (mg/L)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
GD1
GD4
GD1-Alert level
GD1-Response level


Rosedale goundwater manholes - Chloride
Chloride (mg/L)
250
200
150
100
50
0
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
GD1
GD4
GD1-Alert level
GD1-Response level


Rosedale groundwater manholes - Copper
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Copper (mg/L)
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
GD1
GD4
GD1-Alert level
GD1-Response level
Values below the laboratory detection limit of 0.00053mg/L are presented as 0 mg/L on graph


Rosedale goundwater manholes - pH
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
pH
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
GD1
GD4
GD1-Alert level
GD1-Alert level
GD1-Response level
GD1-Response level


Rosedale goundwater manholes - Zinc
0.15
0.13
0.11
0.09
0.07
0.05
0.03
0.01
-0.01
Zinc (mg/L)
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
GD1
GD4
GD1-Alert level
GD1-Response level

Rosedale Closed Landfill - Stormwater monitoring results

Monitoring Location: Pond 2

	Trigger (alert) levels[1]	Response Levels[1]	22/10/2013	22/10/2013	24/02/2014	15/04/2014	15/04/2014	13/08/2014	11/04/2014	11/04/2014	17/02/2015	14/05/2015	19/08/2015	25/11/2015	15/02/2016
Lab No.															
Temperature (°C)			19.1	19.1	21.4	19.5	19.5	12	20	20	22.3	16.2	12.6	20	21.7
pH (field)			9.7			8.1			7.1	7.1	9.4	8.4	7.9	7	6.49
Conductivity (mS/m) (field)	83	118	23.9			18		40.6	25	25	19.7	13	29	16.07	17.7
pH (lab)	6-8.5	5.5-9.5	9.9	9.9	7.6	8.2	8.2	7.4	7.3	7.3	9.7	9.4	7.6		6.9
Ammonia (mg/l)	0.5	2.5	<0.010	<0.010	<0.010	0.014	0.014	0.027	0.133	0.133	<0.010	<0.010	<0.010	<0.010	0.47
Chloride (mg/l)	78	230	19.1	19.1	11.5	15.3	15.3	45	16.7	16.7	16.3	13.7	26	54	20
Total Hardness (mg/l)	200	286	73			48			81			35			
COD (mg/l)	100	143	45	45	20	32	32	77	44	44	32	13	72	82	39
Sulphate (mg/l)	175	250	23			3.9			36			12.1		22	
Suspended Solids (mg/l)	50	250	5	5	10	5	5	7	8	8	94	37	62		
Dissolved Chromium (mg/l)	0.05	0.07	0.00053			<0.00053			0.00124			0.00055			
Dissolved Copper (mg/l)	0.0025	0.004	0.0021			<0.00053			0.0028			0.00133			
Dissolved Nickel (mg/l)	0.017	0.024	0.0022			0.00059			0.0026			<0.00053			
Dissolved Zinc (mg/l)	0.013	0.044	0.0025			0.0013			0.0058			0.0043			

Monitoring Location: Pond 7

	Trigger (alert) levels[1]	Response Levels[1]	22/10/2013	22/10/2013	24/02/2014	15/04/2014	15/04/2014	13/08/2014	11/04/2014	11/04/2014	17/02/2015	14/05/2015	19/08/2015	25/11/2015	15/02/2016
Lab No.															
Temperature (°C)			19.5	19.5	21.9	19	19	11.8	18	18	21.7	14.9	11.9	20.9	24.6
pH (field)			6.8	6.8	8.1	9.1	9.1		7.1	7.1	8.4	6.8	7.7	7.09	8.25
Conductivity (mS/m) (field)	83	118	29			34		47.9	41	41	41	40	44	56.5	60.4
pH (lab)	6-8.5	5.5-9.5	7.8	7.8	8.3	8.5	8.5	7.7	8	8	8.2	8	7.7		7.5
Ammonia (mg/l)	0.5	2.5	0.087	0.087	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.56	0.016	0.42
Chloride (mg/l)	78	230	17.3	17.3	23	23	23	39	29	29	35	33	34	16.2	52
Total Hardness (mg/l)	200	286	97			91			134			120			
COD (mg/l)	100	143	42	42	50	38	38	44	42	42	46	26	68	38	52
Sulphate (mg/l)	175	250	21			15			28			18.3		7.2	
Suspended Solids (mg/l)	50	250	<3	<3	16	3	3	9	4	4	4	<3	40		
Dissolved Chromium (mg/l)	0.05	0.07	0.00073			<0.00053			0.00058			<0.00053			
Dissolved Copper (mg/l)	0.0025	0.004	0.0027			<0.00053			0.00195			0.00054			
Dissolved Nickel (mg/l)	0.017	0.024	0.00143			0.00088			0.00157			0.0007			
Dissolved Zinc (mg/l)	0.013	0.044	0.0021			<0.0011			0.0034			<0.0011			

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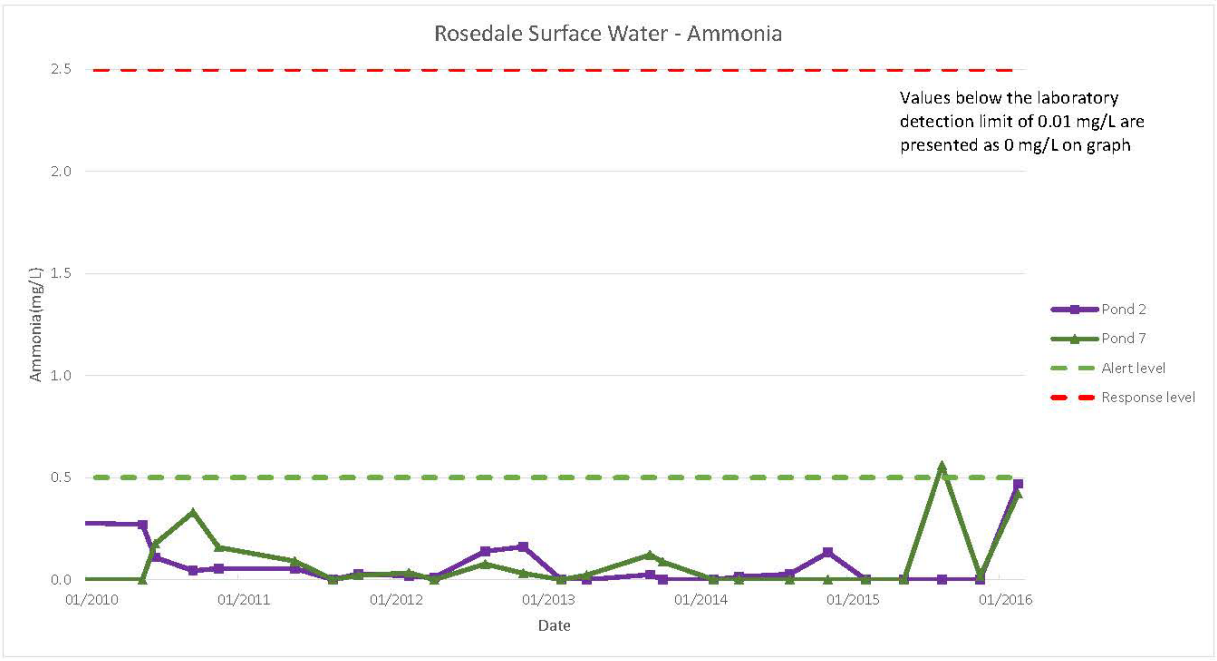
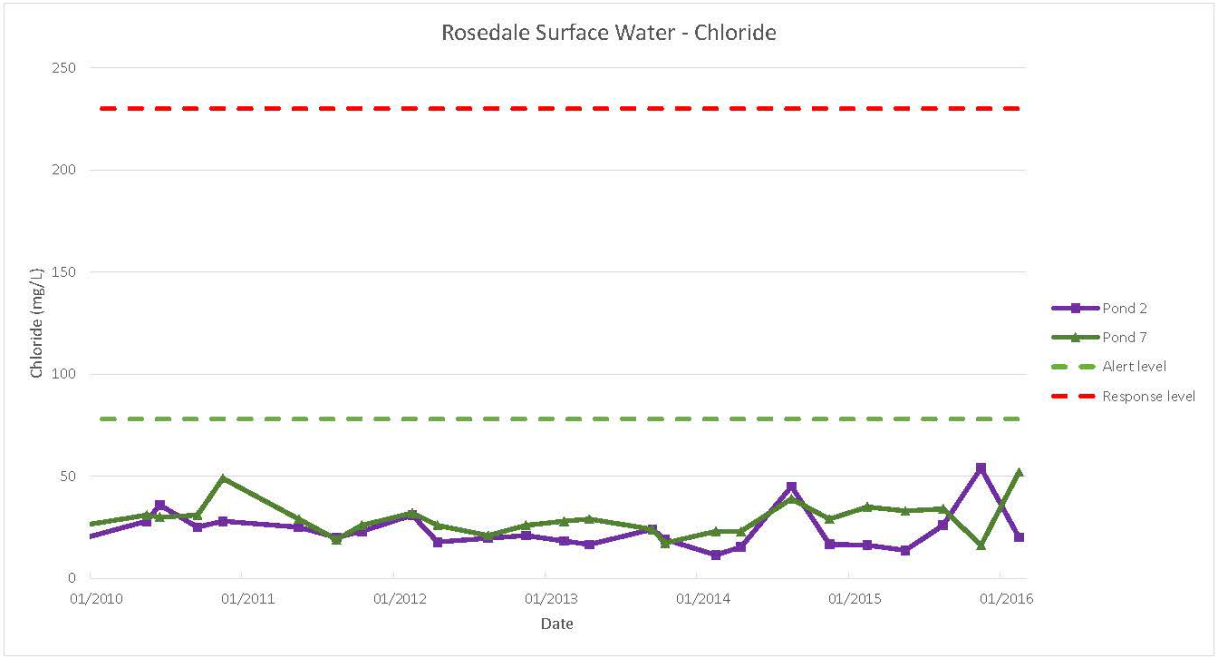
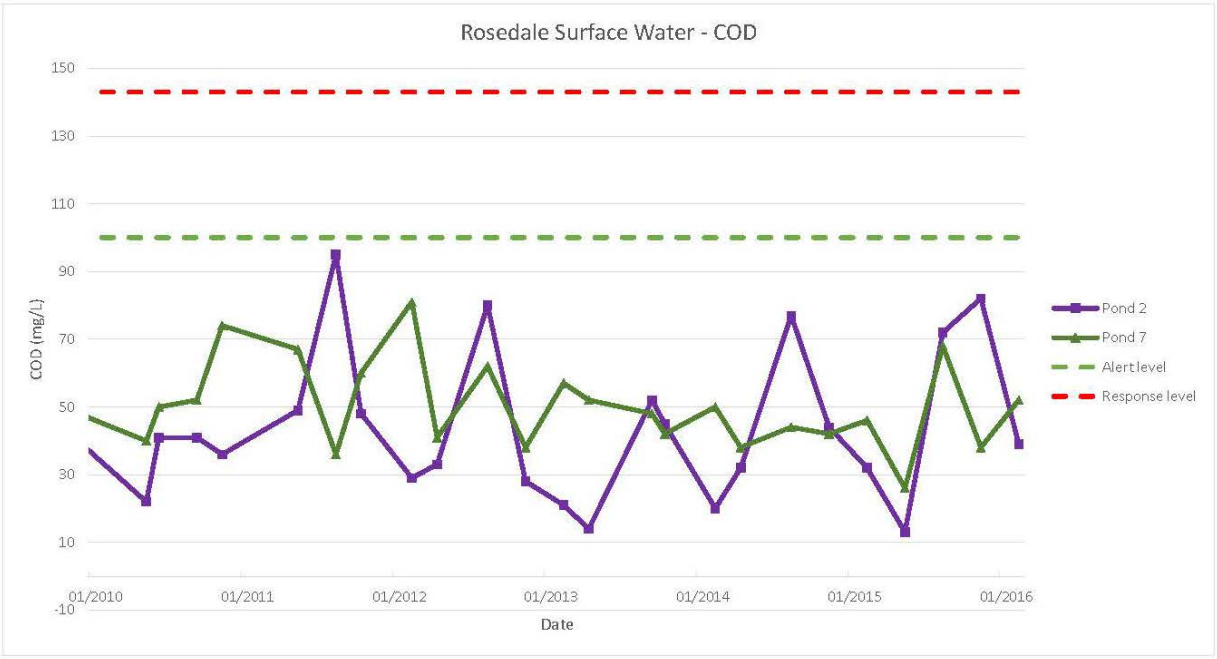
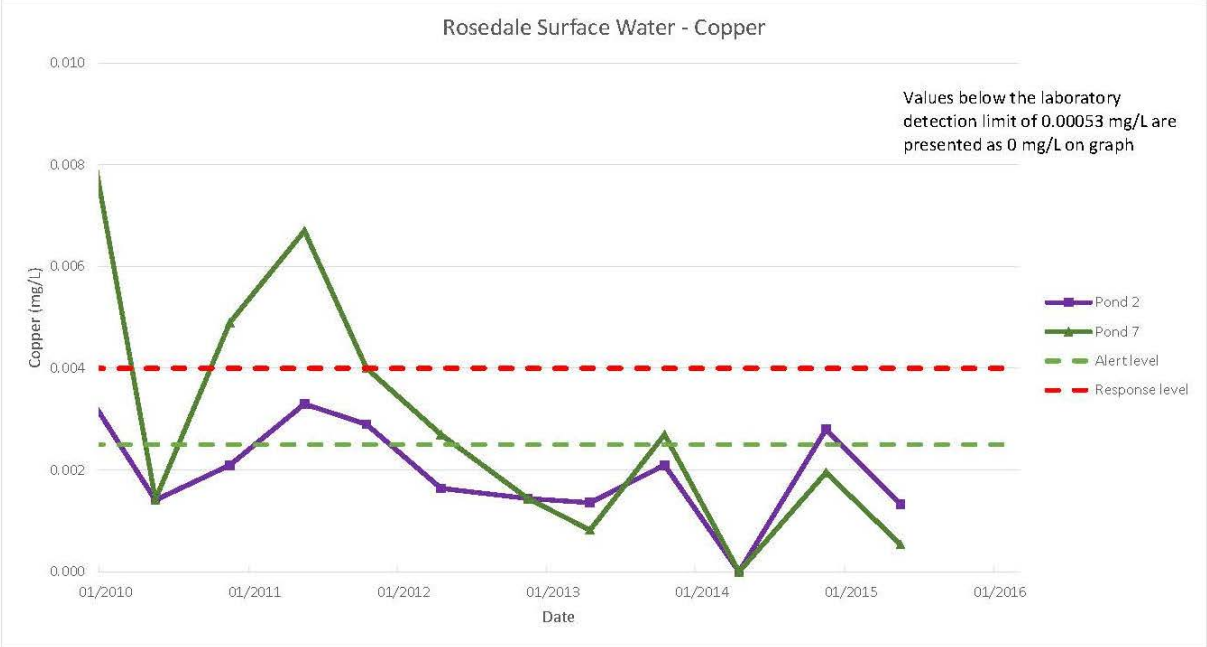
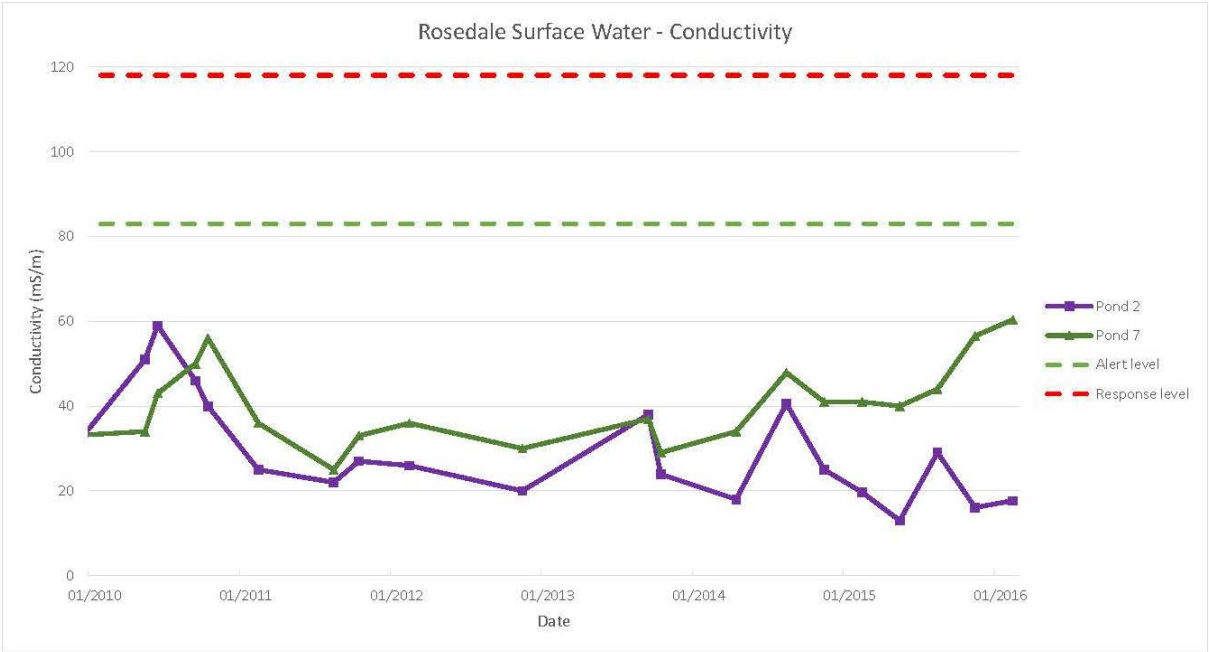

Rosedale Surface Water - Ammonia
Values below the laboratory detection limit of 0.01 mg/L are presented as 0 mg/L on graph
Ammonia (mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Pond 2
Pond 7
Alert level
Response level

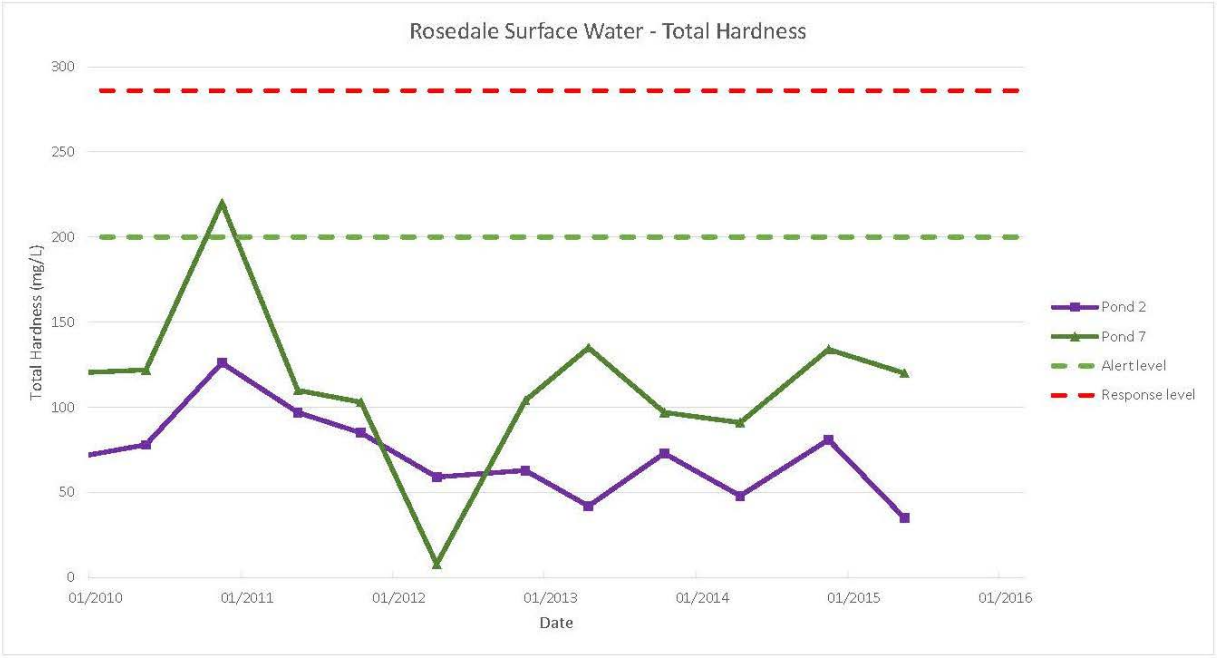

Rosedale Surface Water - Chloride
Chloride (mg/L)
250
200
150
100
50
0
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Pond 2
Pond 7
Alert level
Response level

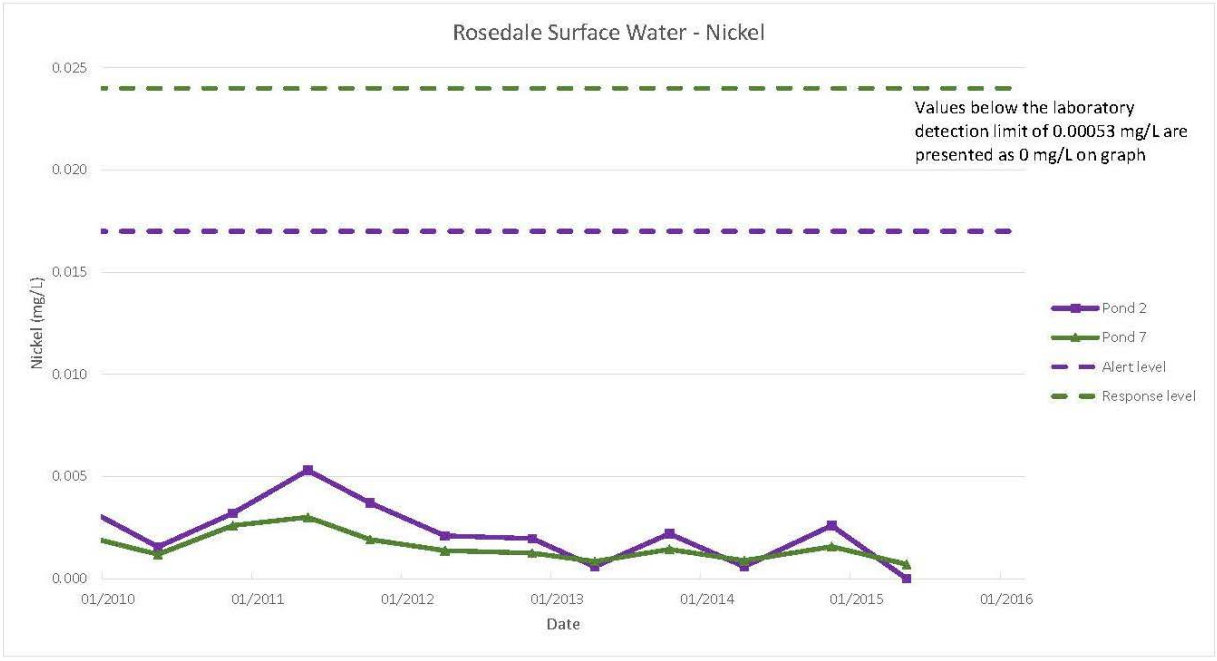

Rosedale Surface Water - Chromium
0.005
0.004
0.003
0.002
0.001
0
Chromium (mg/L)
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Pond 2
Pond 7
Alert level (0.05mg/L)
Response level (0.07 mg/L)
Values below the laboratory detection limit of 0.00053 mg/L are presented as 0 mg/L on graph

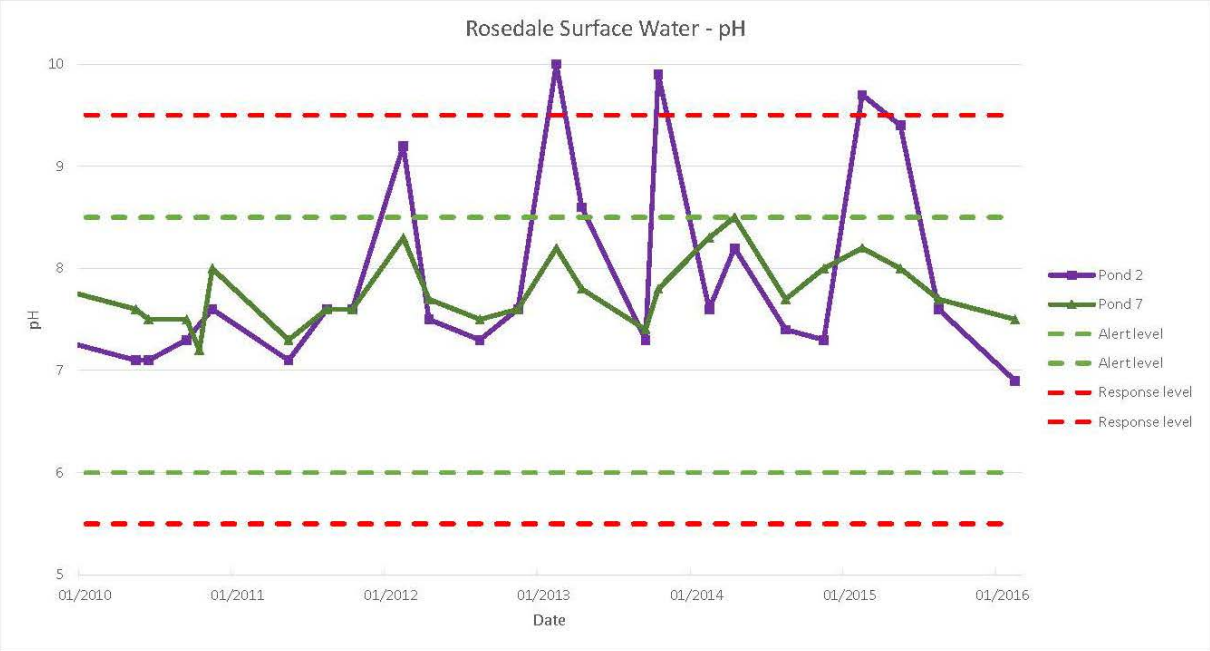

Rosedale Surface Water - COD
150
130
110
90
70
50
30
10
-10
COD (mg/L)
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Pond 2
Pond 7
Alert level
Response level

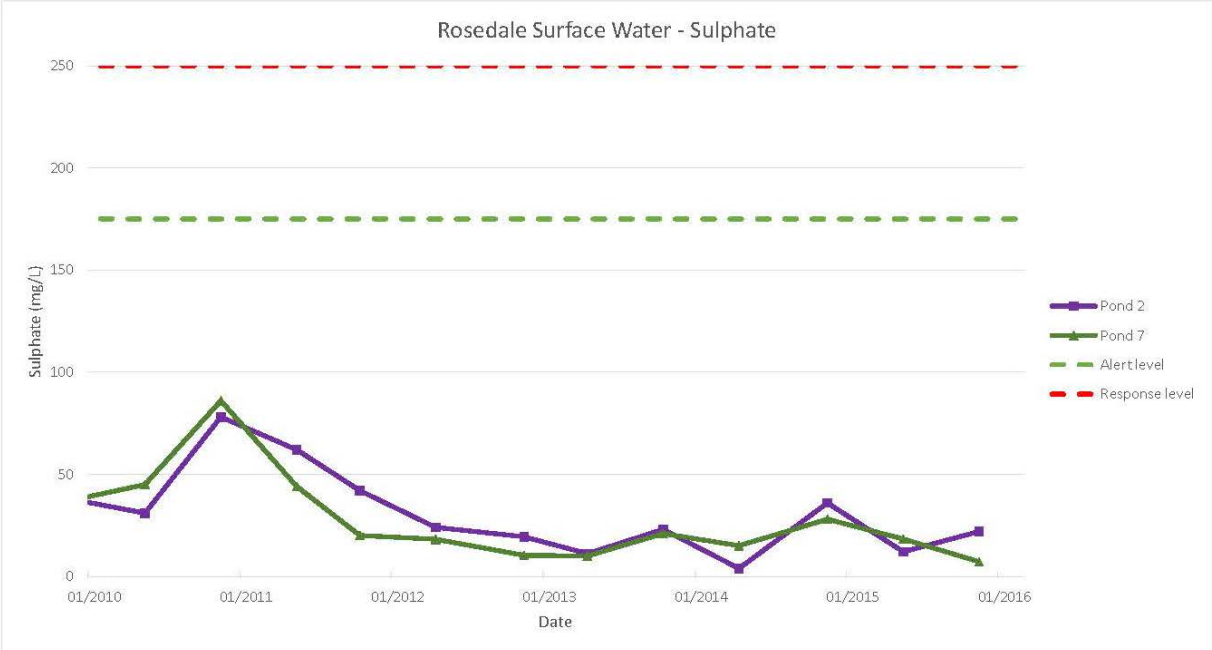

Rosedale Surface Water - Copper
Values below the laboratory detection limit of 0.00053 mg/L are presented as 0 mg/L on graph
Copper (mg/L)
0.010
0.008
0.006
0.004
0.002
0.000
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Pond 2
Pond 7
Alert level
Response level

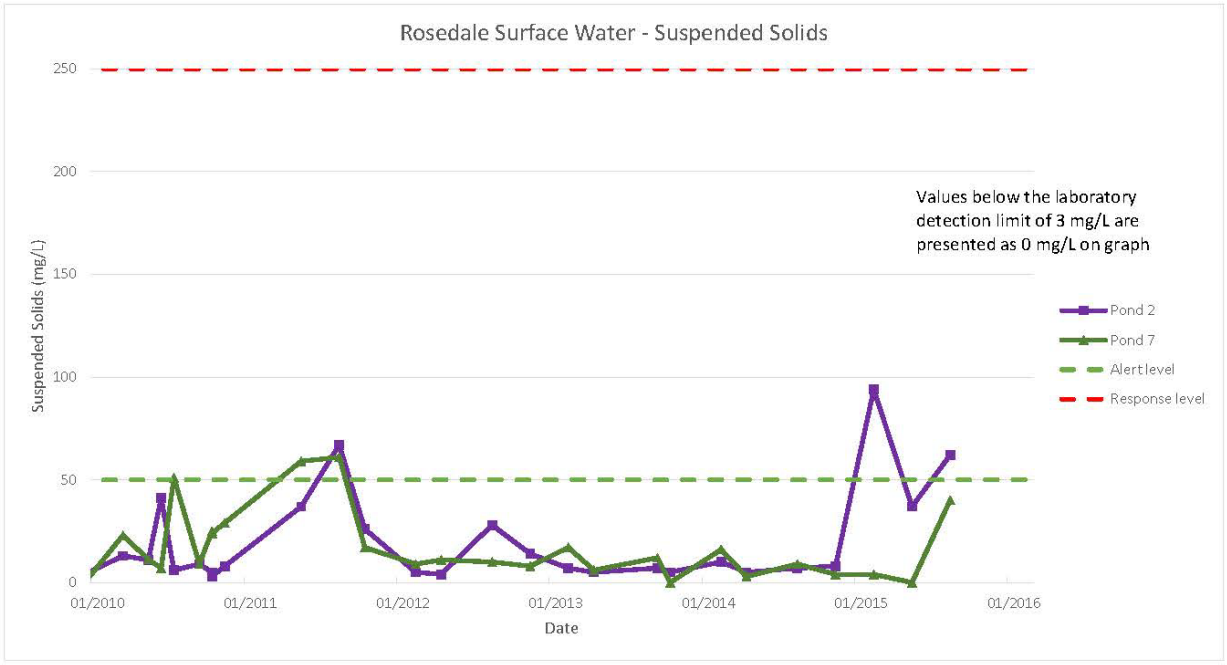

Rosedale Surface Water - Conductivity
Conductivity (mS/m)
120
100
80
60
40
20
0
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Pond 2
Pond 7
Alert level
Response level

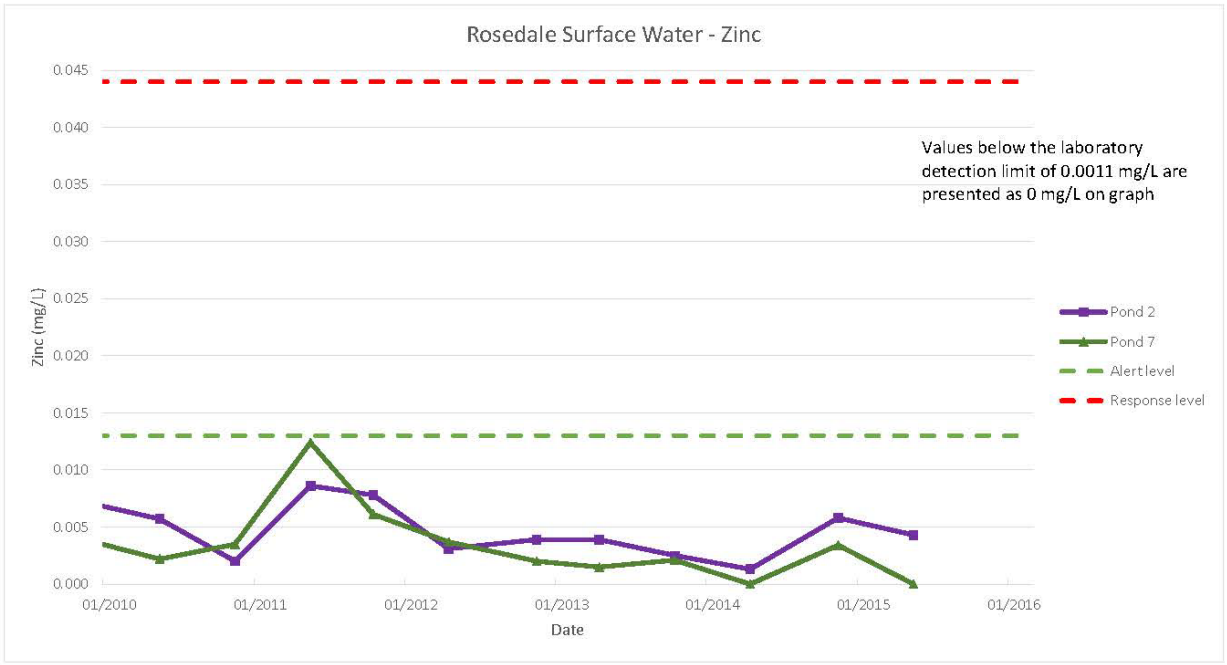

Rosedale Surface Water - Total Hardness
300
250
200
150
100
50
0
Total Hardness (mg/L)
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Pond 2
Pond 7
Alert level
Response level


Rosedale Surface Water - Nickel
0.025
0.020
0.015
0.010
0.005
0.000
Nickel (mg/L)
Values below the laboratory detection limit of 0.00053 mg/L are presented as 0 mg/L on graph
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Pond 2
Pond 7
Alert level
Response level


Rosedale Surface Water - pH
10
9
8
7
6
5
pH
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Pond 2
Pond 7
Alert level
Alert level
Response level
Response level


Rosedale Surface Water - Sulphate
250
200
150
100
50
0
Sulphate (mg/L)
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Pond 2
Pond 7
Alert level
Response level


Rosedale Surface Water - Suspended Solids
250
200
150
100
50
0
Suspended Solids (mg/L)
Values below the laboratory detection limit of 3 mg/L are presented as 0 mg/L on graph
Pond 2
Pond 7
Alert level
Response level
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date


Rosedale Surface Water - Zinc
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Zinc (mg/L)
Values below the laboratory detection limit of 0.0011 mg/L are presented as 0 mg/L on graph
Pond 2
Pond 7
Alert level
Response level
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date

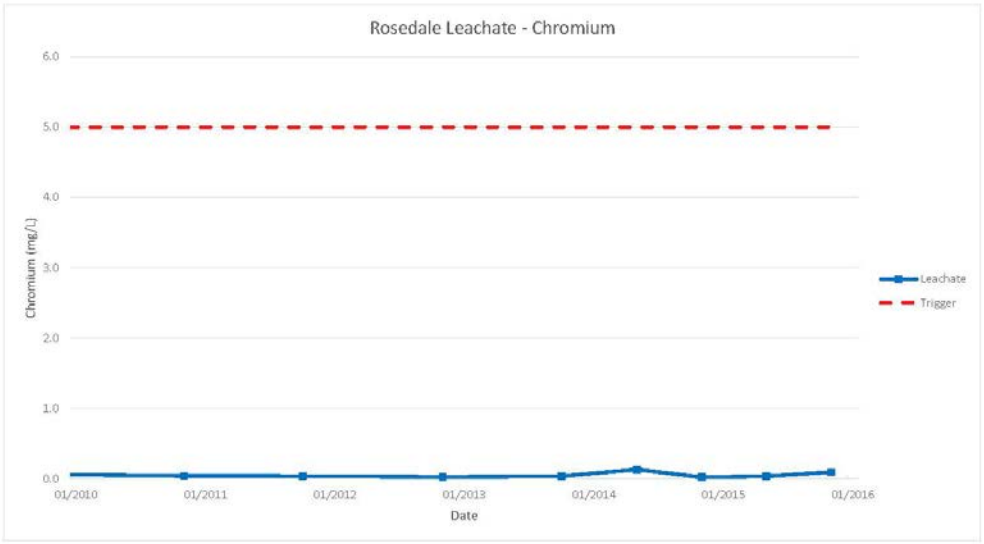
Rosedale Closed Landfill - Leachate monitoring results

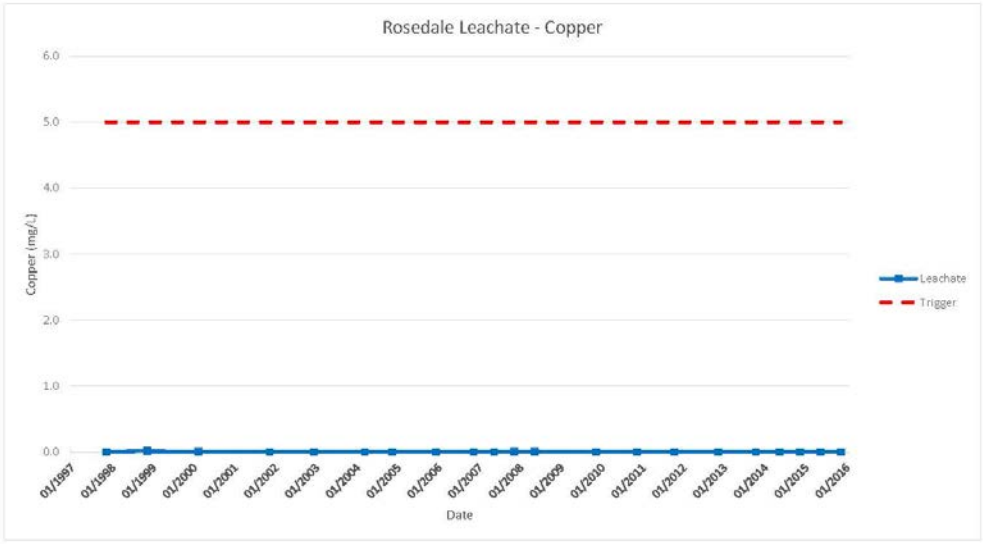
Parameters (all units in g/m^3 unless specified otherwise)	Trade Waste Limits[1]	20/11/1997	30/11/1998	30/11/1998	2/03/2000	12/12/2000	28/11/2001	31/12/2002	3/11/2004	30/06/2004	30/11/2004	21/12/2005	11/07/2006	5/08/2007
Lab No.														1506885.6
pH														
Alkalinity		3144	4723	1260	2650	3159	3453	3244						
Ammonia (mg/l)		575	766	178.4	453	516	583.8	633						
Total Arsenic		0.038	0.0845	0.0073	0.08	0.0083	0.0195	0.035						
BOD	6000	140	220	<23	321	52	150	510			97			
Boron Total by ICP		5.18	7.9	2.1	5	5.58	5.87	5.15						
Cadmium Total by ICP	5	<0.006	<0.005	<0.005	<0.0002	<0.006	<0.002	<0.006	<0.006					
Calcium		222.5	215	172.5	108	147	103	119						
Chloride		716	1024	294	687	710	711	859						
Chromium, total	5	0.09	0.218	0.015	0.15	0.066	0.07	0.06						
Cobalt (total)														
COD					716				1276	790				
Conductivity (mS/m)		688.8	1131	328	59	850	825	790						
Copper by Total ICP	5	<0.02	0.019	0.013	0.003		<0.006	<0.006	<0.006		0.0013	<0.003	<0.003	<0.003
Iron, total		528	7.57	8.2	12	24.6								
Lead Total by ICP	5	<0.03	<0.02	<0.02	<0.001	<0.02	<0.03	<0.02						
Magnesium		56	82	36.5	61	98.9	70.9	54.9						
Nickel Total by ICP	5	0.11	0.093	0.034	0.077	0.088	<0.06	0.063		0.072	0.1	0.073	0.056	0.069
Nitrate		0.113	0.026	4.155	0.33	0.136	0.038							
Phosphorous (total)		2.7	6.4	0.29	2.6	0.03	1.9	1.8						
Potassium		362	540	131.2	263	312	346	371						
Sodium		560	812	222	497	448	633	705						
Sulphate	500	7	53.1	18.5	20	12.9	4.8	1.32			2.39	3.9	6.1	6.8
Sulphide	5								<0.1					
Suspended Soilds									57	77				
TKN									543.4	573				
Zinc by Total ICP	5	0.262	0.158	0.145	0.12	0.046	0.56	0.075	0.042	0.086	0.069	0.048	0.034	0.031
Ethane														
Ethylene														
Methane														

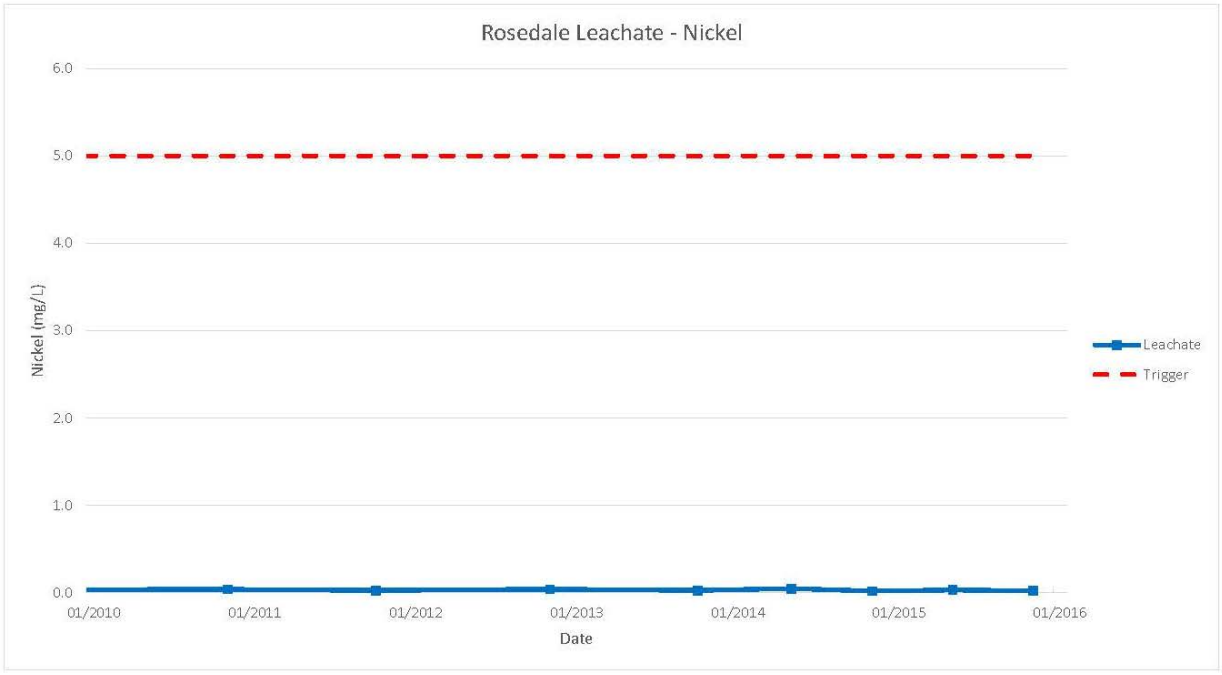
Rosedale Closed Landfill - Leachate monitoring results

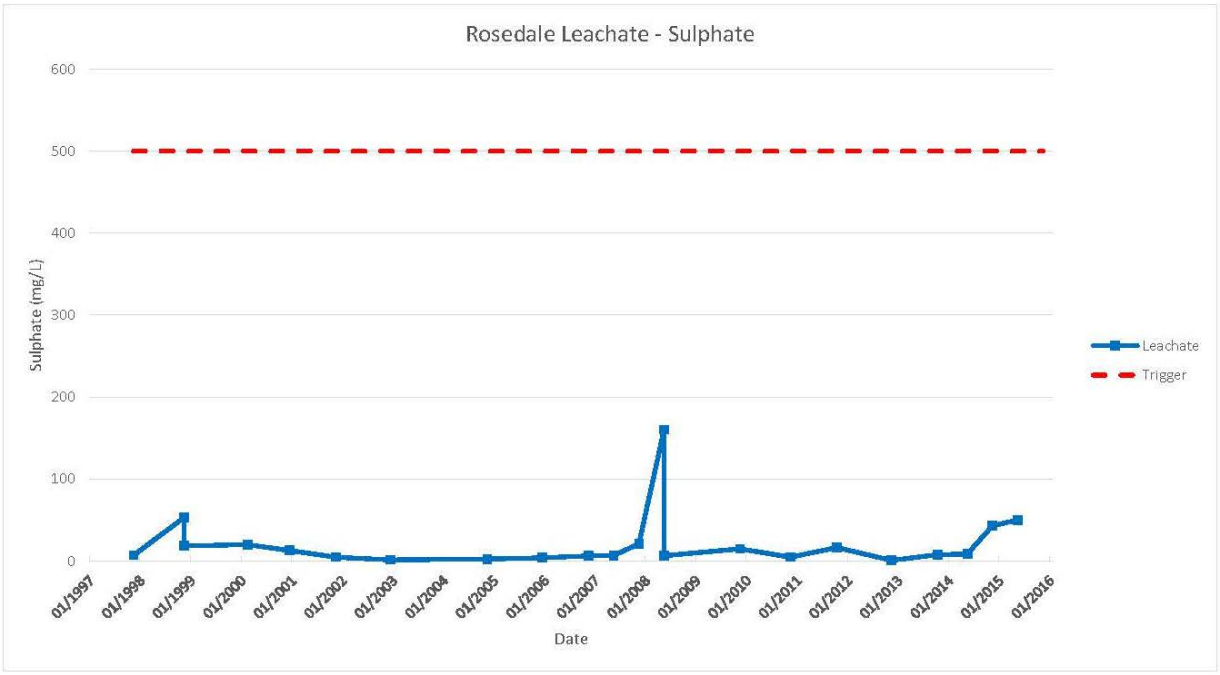
Parameters (all units in g/m³ unless specified otherwise)	Trade Waste Limits[1]	11/05/2007	5/05/2008	14/05/2008	11/09/2009	11/09/2010	26/10/2011	11/06/2012	22/10/2013	5/08/2014	11/04/2014	14/05/2015	25/11/2015	
Lab No.													1506885.6	
pH													7.1	
Alkalinity														
Ammonia (mg/l)										380	191	260	192	
Total Arsenic													0.06	
BOD	6000													
Boron Total by ICP													1.91	
Cadmium Total by ICP	5												<0.0011	
Calcium														
Chloride										510				
Chromium, total	5	0.076	0.027	0.061	0.059	0.04	0.037	0.027	0.035	0.131	0.021	0.036	0.094	
Cobalt (total)													0.0149	
COD					52								520	
Conductivity (mS/m)													371	
Copper by Total ICP	5	0.0033	0.0059	0.0013	<0.0027	<0.0011	0.0011	<0.0011	<0.0027	<0.011	0.0015	<0.0027	<0.011	
Iron, total														
Lead Total by ICP	5									0.0101			0.0141	
Magnesium														
Nickel Total by ICP	5	0.044	0.019	0.039	0.036	0.038	0.027	0.041	0.027	0.048	0.0191	0.031	0.021	
Nitrate														
Phosphorous (total)														
Potassium														
Sodium														
Sulphate	500	21	160	6.4	15	4.7	16.5	0.8	7.7	8.6	43	50		
Sulphide	5												0.34	
Suspended Soilds													710	
TKN										360				
Zinc by Total ICP	5	0.035	0.076	0.021	0.13	0.06	0.038	0.0116	0.0176	0.138	0.0157	0.018	0.2	
Ethane													<0.003	
Ethylene													<0.004	
Methane													4.9	

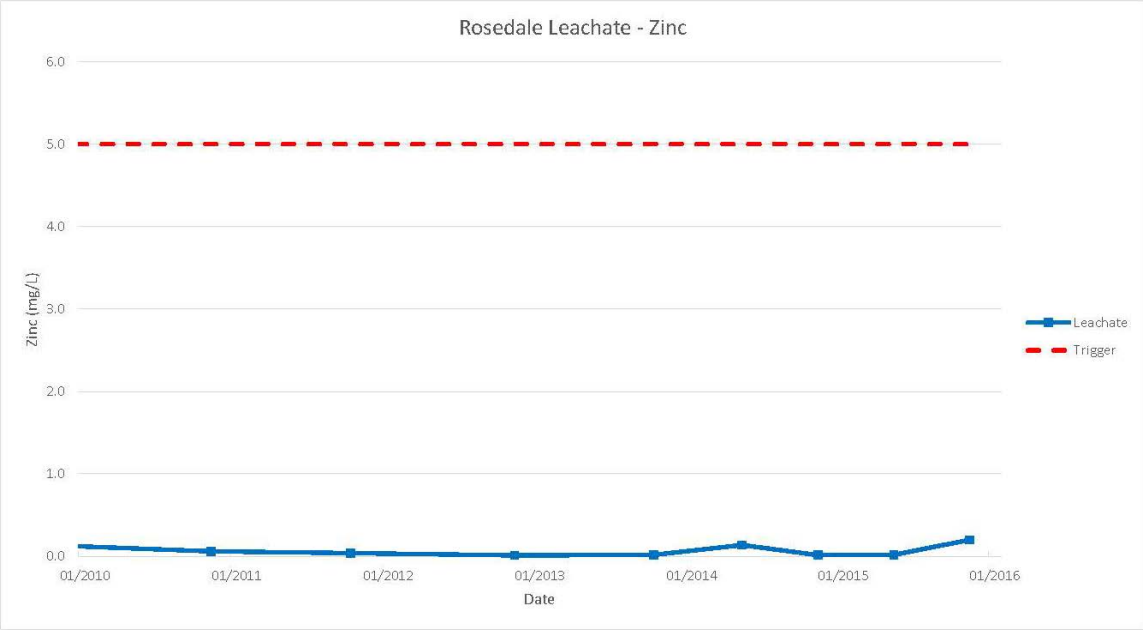
Notes: Waste Bylaws 1993 and Trade Waste Consent


Rosedale Leachate - Chromium
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Chromium (mg/L)
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Leachate
Trigger


Rosedale Leachate - Copper
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Copper (mg/L)
01/1997
01/1998
01/1999
01/2000
01/2001
01/2002
01/2003
01/2004
01/2005
01/2006
01/2007
01/2008
01/2009
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Leachate
Trigger


Rosedale Leachate - Nickel
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Nickel (mg/L)
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Leachate
Trigger


Rosedale Leachate - Sulphate
600
500
400
300
200
100
0
Sulphate (mg/L)
01/1997
01/1998
01/1999
01/2000
01/2001
01/2002
01/2003
01/2004
01/2005
01/2006
01/2007
01/2008
01/2009
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Leachate
Trigger


Rosedale Leachate - Zinc
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Zinc (mg/L)
01/2010
01/2011
01/2012
01/2013
01/2014
01/2015
01/2016
Date
Leachate
Trigger

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Appendix D2

Project Monitoring

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Leachate Monitoring Results from MH3

Hill Laboratories
BETTER TESTING BETTER RESULTS

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Pattle Delamore Partners Limited	**Lab No:**	1621507	SPv1
Contact:	A Rumsby	**Date Received:**	27-Jul-2016	
	C/- Pattle Delamore Partners Limited	**Date Reported:**	10-Aug-2016	
	PO Box 9528	**Quote No:**	79313	
	Newmarket	**Order No:**		
	Auckland 1149	**Client Reference:**	A02951600	
		Submitted By:	Erin Gasston	

Sample Type: Aqueous

Sample Name:		MH3 25-Jul-2016 12:00 pm	MH3Q 25-Jul-2016 12:00 pm			
Lab Number:		1621507.1	1621507.2			
Individual Tests						
Sum of Anions	meq/L	24	24	-	-	-
Sum of Cations	meq/L	24	23	-	-	-
pH	pH Units	7.0	6.9	-	-	-
Total Acidity (pH 8.3)	g/m³ as $CaCO_3$	220	220	-	-	-
Total Alkalinity	g/m³ as $CaCO_3$	830	820	-	-	-
Bicarbonate	g/m³ at 25°C	1,010	1,000	-	-	-
Total Hardness	g/m³ as $CaCO_3$	370	370	-	-	-
Electrical Conductivity (EC)	mS/m	229	230	-	-	-
Dissolved Calcium	g/m³	95	95	-	-	-
Dissolved Magnesium	g/m³	33	33	-	-	-
Dissolved Potassium	g/m³	56	53	-	-	-
Dissolved Sodium	g/m³	163	158	-	-	-
Chloride	g/m³	198	200	-	-	-
Total Ammoniacal-N	g/m³	103	102 #2	-	-	-
Nitrite-N	g/m³	0.03	0.04	-	-	-
Nitrate-N	g/m³	0.35	0.42	-	-	-
Nitrate-N + Nitrite-N	g/m³	0.39	0.45	-	-	-
Total Kjeldahl Nitrogen (TKN)	g/m³	105	96 #2	-	-	-
Total Sulphide	g/m³	0.027	0.031	-	-	-
Sulphate	g/m³	77	76	-	-	-
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	g O_2/m³	5 #1	4 #1	-	-	-
Chemical Oxygen Demand (COD)	g O_2/m³	260	210	-	-	-
Basic metals suite, dissolved, trace						
Dissolved Aluminium	g/m³	0.041	0.050	-	-	-
Dissolved Antimony	g/m³	0.0002	0.0002	-	-	-
Dissolved Arsenic	g/m³	0.006	0.005	-	-	-
Dissolved Boron	g/m³	0.84	0.82	-	-	-
Dissolved Cadmium	g/m³	< 0.00005	< 0.00005	-	-	-
Dissolved Chromium	g/m³	0.0090	0.0090	-	-	-
Dissolved Cobalt	g/m³	0.0076	0.0071	-	-	-
Dissolved Copper	g/m³	0.0015	0.0017	-	-	-
Dissolved Iron	g/m³	9.1	9.4	-	-	-
Dissolved Lead	g/m³	0.00030	0.00032	-	-	-
Dissolved Lithium	g/m³	0.0079	0.0078	-	-	-
Dissolved Manganese	g/m³	0.99	1.03	-	-	-
Dissolved Molybdenum	g/m³	0.0005	0.0003	-	-	-

ilac-MRA IANZ ACCREDITED LABORATORY

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

Sample Type: Aqueous						
Sample Name:		MH3 25-Jul-2016 12:00 pm	MH3Q 25-Jul-2016 12:00 pm			
Lab Number:		1621507.1	1621507.2			
Basic metals suite, dissolved, trace						
Dissolved Nickel	g/m³	0.0136	0.0127	-	-	-
Dissolved Tin	g/m³	0.0013	0.0012	-	-	-
Dissolved Vanadium	g/m³	0.0045	0.0047	-	-	-
Dissolved Zinc	g/m³	0.0153	0.0156	-	-	-
Haloethers in SVOC Water Samples by GC-MS						
Bis(2-chloroethoxy) methane	g/m³	< 0.005	< 0.005	-	-	-
Bis(2-chloroethyl)ether	g/m³	< 0.005	< 0.005	-	-	-
Bis(2-chloroisopropyl)ether	g/m³	< 0.005	< 0.005	-	-	-
4-Bromophenyl phenyl ether	g/m³	< 0.005	< 0.005	-	-	-
4-Chlorophenyl phenyl ether	g/m³	< 0.005	< 0.005	-	-	-
Nitrogen containing compounds in SVOC Water Samples by GC-MS						
2,4-Dinitrotoluene	g/m³	< 0.010	< 0.010	-	-	-
2,6-Dinitrotoluene	g/m³	< 0.010	< 0.010	-	-	-
Nitrobenzene	g/m³	< 0.005	< 0.005	-	-	-
N-Nitrosodi-n-propylamine	g/m³	< 0.010	< 0.010	-	-	-
N-Nitrosodiphenylamine + Diphenylamine*	g/m3	< 0.010	< 0.010	-	-	-
Organochlorine Pesticides in SVOC Water Samples by GC-MS						
Aldrin	g/m³	< 0.005	< 0.005	-	-	-
alpha-BHC	g/m³	< 0.005	< 0.005	-	-	-
beta-BHC	g/m³	< 0.005	< 0.005	-	-	-
delta-BHC	g/m³	< 0.005	< 0.005	-	-	-
gamma-BHC (Lindane)	g/m³	< 0.005	< 0.005	-	-	-
4,4'-DDD	g/m³	< 0.005	< 0.005	-	-	-
4,4'-DDE	g/m³	< 0.005	< 0.005	-	-	-
4,4'-DDT	g/m³	< 0.010	< 0.010	-	-	-
Dieldrin	g/m³	< 0.005	< 0.005	-	-	-
Endosulfan I	g/m³	< 0.010	< 0.010	-	-	-
Endosulfan II	g/m³	< 0.010	< 0.010	-	-	-
Endosulfan sulfate	g/m³	< 0.010	< 0.010	-	-	-
Endrin	g/m³	< 0.010	< 0.010	-	-	-
Endrin ketone	g/m³	< 0.010	< 0.010	-	-	-
Heptachlor	g/m³	< 0.005	< 0.005	-	-	-
Heptachlor epoxide	g/m³	< 0.005	< 0.005	-	-	-
Hexachlorobenzene	g/m³	< 0.005	< 0.005	-	-	-
Polycyclic Aromatic Hydrocarbons in SVOC Water Samples by GC-MS						
Acenaphthene	g/m³	< 0.003	< 0.003	-	-	-
Acenaphthylene	g/m³	< 0.003	< 0.003	-	-	-
Anthracene	g/m³	< 0.003	< 0.003	-	-	-
Benzo[a]anthracene	g/m³	< 0.003	< 0.003	-	-	-
Benzo[a]pyrene (BAP)	g/m³	< 0.003	< 0.003	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m³	< 0.003	< 0.003	-	-	-
Benzo[g,h,i]perylene	g/m³	< 0.003	< 0.003	-	-	-
Benzo[k]fluoranthene	g/m³	< 0.003	< 0.003	-	-	-
1&2-Chloronaphthalene	g/m³	< 0.003	< 0.003	-	-	-
Chrysene	g/m³	< 0.003	< 0.003	-	-	-
Dibenzo[a,h]anthracene	g/m³	< 0.003	< 0.003	-	-	-
Fluoranthene	g/m³	< 0.003	< 0.003	-	-	-
Fluorene	g/m³	< 0.003	< 0.003	-	-	-
Indeno(1,2,3-c,d)pyrene	g/m³	< 0.003	< 0.003	-	-	-
2-Methylnaphthalene	g/m³	< 0.003	< 0.003	-	-	-
Naphthalene	g/m³	< 0.003	< 0.003	-	-	-
Phenanthrene	g/m³	< 0.003	< 0.003	-	-	-

Sample Type: Aqueous						
Sample Name:		MH3 25-Jul-2016 12:00 pm	MH3Q 25-Jul-2016 12:00 pm			
Lab Number:		1621507.1	1621507.2			
Polycyclic Aromatic Hydrocarbons in SVOC Water Samples by GC-MS						
Pyrene	g/m³	< 0.003	< 0.003	-	-	-
Phenols in SVOC Water Samples by GC-MS						
4-Chloro-3-methylphenol	g/m³	< 0.010	< 0.010	-	-	-
2-Chlorophenol	g/m³	< 0.005	< 0.005	-	-	-
2,4-Dichlorophenol	g/m³	< 0.005	< 0.005	-	-	-
2,4-Dimethylphenol	g/m³	< 0.005	< 0.005	-	-	-
3 & 4-Methylphenol (m- + p-cresol)	g/m³	< 0.010	< 0.010	-	-	-
2-Methylphenol (o-Cresol)	g/m³	< 0.005	< 0.005	-	-	-
2-Nitrophenol	g/m³	< 0.010	< 0.010	-	-	-
Pentachlorophenol (PCP)	g/m³	< 0.10	< 0.10	-	-	-
Phenol	g/m³	< 0.010	< 0.010	-	-	-
2,4,5-Trichlorophenol	g/m³	< 0.010	< 0.010	-	-	-
2,4,6-Trichlorophenol	g/m³	< 0.010	< 0.010	-	-	-
Plasticisers in SVOC Water Samples by GC-MS						
Bis(2-ethylhexyl)phthalate	g/m³	< 0.03	< 0.03	-	-	-
Butylbenzylphthalate	g/m³	< 0.010	< 0.010	-	-	-
Di(2-ethylhexyl)adipate	g/m³	< 0.005	< 0.005	-	-	-
Diethylphthalate	g/m³	< 0.010	< 0.010	-	-	-
Dimethylphthalate	g/m³	< 0.010	< 0.010	-	-	-
Di-n-butylphthalate	g/m³	< 0.010	< 0.010	-	-	-
Di-n-octylphthalate	g/m³	< 0.010	< 0.010	-	-	-
Other Halogenated compounds in SVOC Water Samples by GC-MS						
1,2-Dichlorobenzene	g/m³	< 0.010	< 0.010	-	-	-
1,3-Dichlorobenzene	g/m³	< 0.010	< 0.010	-	-	-
1,4-Dichlorobenzene	g/m³	< 0.010	< 0.010	-	-	-
Hexachlorobutadiene	g/m³	< 0.010	< 0.010	-	-	-
Hexachloroethane	g/m³	< 0.010	< 0.010	-	-	-
1,2,4-Trichlorobenzene	g/m³	< 0.005	< 0.005	-	-	-
Other compounds in SVOC Water Samples by GC-MS						
Benzyl alcohol	g/m³	< 0.05	< 0.05	-	-	-
Carbazole	g/m³	< 0.005	< 0.005	-	-	-
Dibenzofuran	g/m³	< 0.005	< 0.005	-	-	-
Isophorone	g/m³	< 0.005	< 0.005	-	-	-
Total Petroleum Hydrocarbons in Water						
C7 - C9	g/m³	< 0.10	< 0.10	-	-	-
C10 - C14	g/m³	< 0.2	< 0.2	-	-	-
C15 - C36	g/m³	< 0.4	< 0.4	-	-	-
Total hydrocarbons (C7 - C36)	g/m³	< 0.7	< 0.7	-	-	-
BTEX in VOC Water by Purge&Trap GC-MS						
Benzene	g/m³	< 0.005	< 0.005	-	-	-
Toluene	g/m³	< 0.010	< 0.010	-	-	-
Ethylbenzene	g/m³	< 0.005	< 0.005	-	-	-
m&p-Xylene	g/m³	0.007	0.007	-	-	-
o-Xylene	g/m³	< 0.005	< 0.005	-	-	-
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
Bromomethane (Methyl Bromide)	g/m³	< 0.02	< 0.02	-	-	-
Carbon tetrachloride	g/m³	< 0.005	< 0.005	-	-	-
Chloroethane	g/m³	< 0.005	< 0.005	-	-	-
Chloromethane	g/m³	< 0.005	< 0.005	-	-	-
1,2-Dibromo-3-chloropropane	g/m³	< 0.005	< 0.005	-	-	-
1,2-Dibromoethane (ethylene dibromide, EDB)	g/m³	< 0.005	< 0.005	-	-	-
Dibromomethane	g/m³	< 0.005	< 0.005	-	-	-
Dichlorodifluoromethane	g/m³	< 0.005	< 0.005	-	-	-

Sample Type: Aqueous						
Sample Name:		MH3 25-Jul-2016 12:00 pm	MH3Q 25-Jul-2016 12:00 pm			
Lab Number:		1621507.1	1621507.2			
Halogenated Aliphatics in VOC Water by Purge&Trap GC-MS						
1,1-Dichloroethane	g/m³	< 0.005	< 0.005	-	-	-
1,2-Dichloroethane	g/m³	< 0.005	< 0.005	-	-	-
1,1-Dichloroethene	g/m³	< 0.005	< 0.005	-	-	-
cis-1,2-Dichloroethene	g/m³	< 0.005	< 0.005	-	-	-
trans-1,2-Dichloroethene	g/m³	< 0.005	< 0.005	-	-	-
Dichloromethane (methylene chloride)	g/m³	< 0.10	< 0.10	-	-	-
1,2-Dichloropropane	g/m³	< 0.005	< 0.005	-	-	-
1,3-Dichloropropane	g/m³	< 0.005	< 0.005	-	-	-
1,1-Dichloropropene	g/m³	< 0.005	< 0.005	-	-	-
cis-1,3-Dichloropropene	g/m³	< 0.005	< 0.005	-	-	-
trans-1,3-Dichloropropene	g/m³	< 0.005	< 0.005	-	-	-
Hexachlorobutadiene	g/m³	< 0.005	< 0.005	-	-	-
1,1,1,2-Tetrachloroethane	g/m³	< 0.005	< 0.005	-	-	-
1,1,2,2-Tetrachloroethane	g/m³	< 0.005	< 0.005	-	-	-
Tetrachloroethene (tetrachloroethylene)	g/m³	< 0.005	< 0.005	-	-	-
1,1,1-Trichloroethane	g/m³	< 0.005	< 0.005	-	-	-
1,1,2-Trichloroethane	g/m³	< 0.005	< 0.005	-	-	-
Trichloroethene (trichloroethylene)	g/m³	< 0.005	< 0.005	-	-	-
Trichlorofluoromethane	g/m³	< 0.005	< 0.005	-	-	-
1,2,3-Trichloropropane	g/m³	< 0.005	< 0.005	-	-	-
1,1,2-Trichlorotrifluoroethane (Freon 113)	g/m³	< 0.05	< 0.05	-	-	-
Vinyl chloride	g/m³	< 0.005	< 0.005	-	-	-
Haloaromatics in VOC Water by Purge&Trap GC-MS						
Bromobenzene	g/m³	< 0.005	< 0.005	-	-	-
Chlorobenzene (monochlorobenzene)	g/m³	< 0.005	< 0.005	-	-	-
2-Chlorotoluene	g/m³	< 0.005	< 0.005	-	-	-
4-Chlorotoluene	g/m³	< 0.005	< 0.005	-	-	-
1,2-Dichlorobenzene	g/m³	< 0.005	< 0.005	-	-	-
1,3-Dichlorobenzene	g/m³	< 0.005	< 0.005	-	-	-
1,4-Dichlorobenzene	g/m³	< 0.005	< 0.005	-	-	-
1,2,3-Trichlorobenzene	g/m³	< 0.005	< 0.005	-	-	-
1,2,4-Trichlorobenzene	g/m³	< 0.005	< 0.005	-	-	-
1,3,5-Trichlorobenzene	g/m³	< 0.005	< 0.005	-	-	-
Monoaromatic Hydrocarbons in VOC Water by Purge&Trap GC-MS						
n-Butylbenzene	g/m³	< 0.005	< 0.005	-	-	-
tert-Butylbenzene	g/m³	< 0.005	< 0.005	-	-	-
Isopropylbenzene (Cumene)	g/m³	< 0.005	< 0.005	-	-	-
4-Isopropyltoluene (p-Cymene)	g/m³	< 0.005	< 0.005	-	-	-
n-Propylbenzene	g/m³	< 0.005	< 0.005	-	-	-
sec-Butylbenzene	g/m³	< 0.005	< 0.005	-	-	-
Styrene	g/m³	< 0.005	< 0.005	-	-	-
1,2,4-Trimethylbenzene	g/m³	< 0.005	< 0.005	-	-	-
1,3,5-Trimethylbenzene	g/m³	< 0.005	< 0.005	-	-	-
Ketones in VOC Water by Purge&Trap GC-MS						
Acetone	g/m³	< 0.5	< 0.5	-	-	-
2-Butanone (MEK)	g/m³	< 0.05	< 0.05	-	-	-
Methyl tert-butylether (MTBE)	g/m³	< 0.05	< 0.05	-	-	-
4-Methylpentan-2-one (MIBK)	g/m³	< 0.05	< 0.05	-	-	-
Trihalomethanes in VOC Water by Purge&Trap GC-MS						
Bromodichloromethane	g/m³	< 0.005	< 0.005	-	-	-
Bromoform (tribromomethane)	g/m³	< 0.005	< 0.005	-	-	-
Chloroform (Trichloromethane)	g/m³	< 0.005	< 0.005	-	-	-
Dibromochloromethane	g/m³	< 0.005	< 0.005	-	-	-

Sample Type: Aqueous						
Sample Name:		MH3 25-Jul-2016 12:00 pm	MH3Q 25-Jul-2016 12:00 pm			
Lab Number:		1621507.1	1621507.2			
Other VOC in Water by Purge&Trap GC-MS						
Carbon disulphide	g/m³	< 0.05	< 0.05	-	-	-
Naphthalene	g/m³	< 0.005	< 0.005	-	-	-
System monitoring Compounds for VOC - % Recovery						
4-Bromofluorobenzene	%	101	96	-	-	-
Toluene-d8	%	102	100	-	-	-

Analyst's Comments

#1 A result of < 10 g/m3 was obtained for carbonaceous Biochemical Oxygen Demand (cBOD5) during the original analysis. In order to achieve a lower detection limit the cBOD5 analysis was repeated on a sub-sample that had been stored frozen, using a larger volume.

#2 It has been noted that the result for Total Ammoniacal-N was greater than that for Total Kjeldahl Nitrogen, but within the analytical variation of these methods.

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Basic metals suite, dissolved, trace	0.45µm Filtration, ICP-MS, trace level	0.00005 - 0.02 g/m³	1-2
Semivolatile Organic Compounds Screening in Water by GC-MS	Liquid/Liquid extraction, GPC cleanup (if required), GC-MS FS analysis	-	1-2
Total Petroleum Hydrocarbons in Water	Hexane extraction, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines [KBIs:2803,10734]	0.10 - 0.7 g/m³	1-2
Volatile Organic Compounds Screening in Water by Purge&Trap	Purge & Trap, GC-MS FS analysis [KBIs:28233,2694]	0.005 - 1.0 g/m³	1-2
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-2
Total Kjeldahl Digestion	Sulphuric acid digestion with copper sulphate catalyst.	-	1-2
Total anions for anion/cation balance check	Calculation: sum of anions as mEquiv/L calculated from Alkalinity (bicarbonate), Chloride and Sulphate. Nitrate-N, Nitrite-N. Fluoride, Dissolved Reactive Phosphorus and Cyanide also included in calculation if available. APHA 1030 E 22nd ed. 2012.	0.07 meq/L	1-2
Total cations for anion/cation balance check	Sum of cations as mEquiv/L calculated from Sodium, Potassium, Calcium and Magnesium. Iron, Manganese, Aluminium, Zinc, Copper, Lithium, Total Ammoniacal-N and pH (H^+) also included in calculation if available. APHA 1030 E 22nd ed. 2012.	0.05 meq/L	1-2
pH	pH meter. APHA 4500-H^+ B 22nd ed. 2012. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field.	0.1 pH Units	1-2
Total Acidity (pH 8.3)	Titration to pH 8.3 with standard sodium hydroxide solution, phenolphthalein indicator. APHA 2310 B 22nd ed. 2012.	1.0 g/m³ as $CaCO_3$	1-2
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (Modified for alk <20) 22nd ed. 2012.	1.0 g/m³ as $CaCO_3$	1-2
Bicarbonate	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO_2 D 22nd ed. 2012.	1.0 g/m³ at 25°C	1-2
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 22nd ed. 2012.	1.0 g/m³ as $CaCO_3$	1-2
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 22nd ed. 2012.	0.1 mS/m	1-2
Dissolved Calcium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.05 g/m³	1-2
Dissolved Magnesium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m³	1-2
Dissolved Potassium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.05 g/m³	1-2
Dissolved Sodium	Filtered sample, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.02 g/m³	1-2

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Chloride	Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500 Cl^- E (modified from continuous flow analysis) 22nd ed. 2012.	0.5 g/m³	1-2
Total Ammoniacal-N	Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH_4-N = NH_4+-N + NH_3-N). APHA 4500-NH_3 F (modified from manual analysis) 22nd ed. 2012.	0.010 g/m³	1-2
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I 22nd ed. 2012 (modified).	0.002 g/m³	1-2
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House.	0.0010 g/m³	1-2
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I 22nd ed. 2012 (modified).	0.002 g/m³	1-2
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D. (modified) 4500 NH_3 F (modified) 22nd ed. 2012.	0.10 g/m³	1-2
Sulphide Distillation	Acid distillation of sample into alkaline trapping solution using Simple Distillation system. APHA 4500-S^{2-} I 22nd ed. 2012.	-	1-2
Total Sulphide	Sulphide distillation. Automated methylene blue colorimetry, discrete analyser. APHA 4500-S^{2-} I (modified) 22nd ed. 2012.	0.002 g/m³	1-2
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B 22nd ed. 2012.	0.5 g/m³	1-2
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, dilutions, seeded. Analysed at Hill Laboratories - Microbiology; 1 Clow Place, Hamilton. APHA 5210 B (modified) 22nd ed. 2012.	2 g O_2/m³	1-2
Chemical Oxygen Demand (COD), High range Hach	Dichromate/sulphuric acid digestion, colorimetry. Screen Level method. APHA 5220 D 22nd ed. 2012.	40 g O_2/m³	1-2

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental

Groundwater Monitoring Between 14/07/2016 and 09/08/2016

Table D1 Groundwater Monitoring Results

BORE	BH2007A (SWL mRL)	BH2007B (SWL mRL)	BH2008 (SWL mRL)	BHCAP302 (SWL mRL)	Comment
RL ToC (Note 1)	26.82	26.82	32.28	46.35	
14/07/2016	24.4	23.8	26.7		PDP Collected Data
25/07/2016	24.5	23.9	27.9		
09/08/2016				40.0	
1. Survey data from ESL Drawing 1251411-94A					