Appendix B

ESCP Calculations

USLE Caluclation - Cut to Fill SH18

Project: North Harbour No. 2 Watermain

Subject	**Universal Soil Loss Equation (USLE) Calculations**	By	**Kristina Healy**	Date	10-Dec-15
File Ref	**42073300**	Checked		Date	

Reference: ARC Land Fact Sheet 8
Estimating Sediment Yield, Universal Soil Loss Estimation (USLE)

The general form of the equation is:

A = R x K x (LS) x C x P

Where

A	=	soil loss (tons/hectare/year)
R	=	rainfall erosion index (J/hectare)
K	=	soil erodibility factor (tonnes/unit of R)
LS	=	slope length and steepness factor (dimensionless)
C	=	vegetation cover factor (dimensionless)
P	=	erosion control practice factor (dimensionless)

In addtion, the following factors are taken into account

Sediment delivery ratio = Ratio of sediment that is deopsited on site prior to runoff being treated by sediment retention measures. Assumed to be 0.75

Sediment containment efficiency = Efficiency of sediment control measures. Assumed to be 50%

Staging / timing

The works will be undertaken in discrete sections and for this analysis it is assumed that bare soil will be exposed for a maximum of 2 months for the first 2 sections and 1 month for the last.

SUMMARY CALCULATION:

Staged Site Construction

Component	Area of Earthwork (m2)	Rainfall Factor R	Soil Erodability K	Slope Length m	Slope %	Slope Grad Factor LS	Vegetation Factor C	Rough Factor P	Worked Period (years)	Unmitigated Soil Loss (tons)	Sediment Delivery Ratio	Sed Cont Eff	Mitigated Soil Loss (tons)
West GB Ch21075 to Ch21800	3000	77	0.26	750	2.7	0.67	0.1	1	0.2	0.068	0.75	50%	0.026
Kimberley Grove to Olwyn Place C	2840	77	0.30	710	4.2	1.50	0.1	1	0.2	0.199	0.75	50%	0.075
112 George Deane Pl to 30 Wicklar	1680	77	0.30	420	2.4	0.51	0.1	1	0.1	0.020	0.75	50%	0.008
Total	**7,520 m2**												
	0.75 ha									**TOTAL (tons)**	**0.29**		**0.11**

USLE Caluclation - Cut to Fill SH18

Constant R = Rainfall erosion index (J/hectare)

Reference: HIRDS Rainfall Data - National Institute of Water and Atmospheric Research (NIWA)

R = 0.00828 * P^2.2 * 1.7

Where: P = Rainfall for 6hr 2 year ARI storm event = 50.1
Multiplier to convert from imperial to metric units = 1.7

=> R = 77

Rainfall depths (mm)

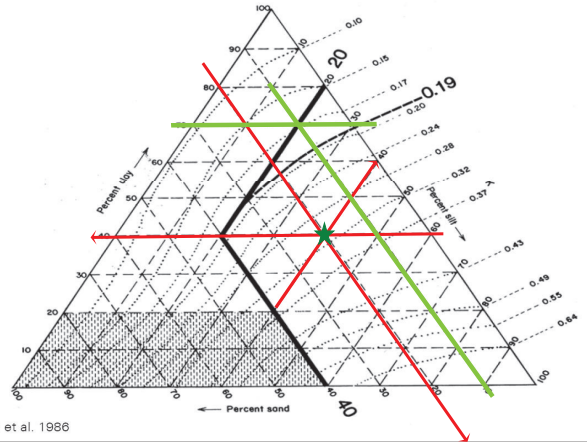
		Duration									
ARI (y)	aep	10m	20m	30m	60m	2h	6h	12h	24h	48h	72h
1.58	0.633	9.8	14.0	17.3	24.7	31.5	46.4	59.1	75.4	87.2	94.8
2.00	0.500	10.5	15.0	18.5	26.5	33.9	50.1	64.2	82.1	94.8	103.2
5.00	0.200	13.1	18.7	23.0	32.9	42.5	63.8	82.4	106.4	122.9	133.8
10.00	0.100	15.1	21.6	26.6	38.0	49.4	74.9	97.3	126.4	146.0	158.8
20.00	0.050	17.3	24.8	30.5	43.7	57.1	87.2	114.0	149.0	172.2	187.3
30.00	0.033	18.7	26.8	33.0	47.3	62.0	95.3	124.9	163.9	189.3	205.9
40.00	0.025	19.8	28.3	34.9	50.0	65.7	101.4	133.3	175.2	202.4	220.2
50.00	0.020	20.7	29.6	36.5	52.2	68.7	106.4	140.1	184.5	213.1	231.8
60.00	0.017	21.4	30.6	37.8	54.1	71.3	110.6	145.9	192.4	222.3	241.8
80.00	0.012	22.6	32.4	39.9	57.1	75.5	117.6	155.5	205.7	237.5	258.4
100.00	0.010	23.6	33.8	41.7	59.6	79.0	123.4	163.4	216.5	250.0	272.0

USLE Caluclation - Cut to Fill SH18

K = Soil erodibility factor (tonnes/unit of R)

Soil type:	Silty Clay	West GB Ch21075 to Ch21800		Clayey Sill
Estimated soil composition:				
Test Pit	From discussion with Geologist			
Clay	40 %			70
Silt	40 %			30
Sand	20 %			10
Estimated K value	0.30	(imperial)		0.17
Organic Content:	4 %			1
Correction factor:	-0.10		Refer to table below	0.06
Corrected K value	0.20	(imperial)		0.23
Convert to metric: (x1.32)	**0.26**			**0.30**

Figure 1: Triangular Nomograph for Estimating K Values



Goldman et al. 1986

Table 1: Correction Factor

Correction factor when percent organic matter is					
K value	0% (clay)	1%	2%	3%	4% (topsoil)
Greater than 0.40	+0.14	+0.07	0	-0.07	-0.14
0.20 - 0.40	+0.10	+0.05	0	-0.05	-0.1
Less than 0.20	+0.06	+0.03	0	-0.03	-0.06

USLE Caluclation - Cut to Fill SH18

LS = slope length and steepness factor (dimensionless)

Can use the following equation:

$$LS = \left(\frac{65.41 \times s^2}{s^2 + 10{,}000} + \frac{4.56 \times s}{\sqrt{s^2 + 10{,}000}} + 0.065\right) \times \left(\frac{l}{72.5}\right)^m$$

LS= topographic factor
l = Slope length, m
s = Slope steepness
m = Exponent dependent on slope steepness
0.2 for slopes<1%, 0.3 for slopes 1-3%. 0.4 for slopes 3.5-4.5%, and 0.5 for slopes > 5%)

LS Calculator:

Slope length (m)	750
Slope (%)	2.7
Slope Gradient Factor	**0.67**

Clarks Lane to Squadron Drive

Or use the following table based on the above equation:

Slope Ratio s, %	Slope Length, m												
	10	25	50	75	100	125	150	175	200	225	250	275	300
0.5	0.08	0.09	0.11	0.11	0.12	0.13	0.13	0.14	0.14	0.14	0.15	0.15	0.15
1.0	0.09	0.12	0.15	0.17	0.18	0.20	0.21	0.22	0.23	0.23	0.24	0.25	0.26
2.0	0.14	0.19	0.23	0.26	0.29	0.31	0.32	0.34	0.35	0.37	0.38	0.39	0.40
3.0	0.21	0.27	0.33	0.38	0.41	0.44	0.46	0.48	0.50	0.52	0.54	0.56	0.57
4.0	0.26	0.37	0.49	0.57	0.64	0.70	0.76	0.80	0.85	0.89	0.93	0.96	1.00
5.0	0.31	0.48	0.69	0.84	0.97	1.08	1.19	1.28	1.37	1.45	1.53	1.61	1.68
6.0	0.39	0.61	0.86	1.06	1.22	1.36	1.49	1.61	1.72	1.83	1.93	2.02	2.11
7.0	0.47	0.75	1.06	1.29	1.49	1.67	1.83	1.98	2.11	2.24	2.36	2.48	2.59
8.0	0.67	0.90	1.27	1.56	1.80	2.01	2.20	2.38	2.54	2.70	2.84	2.98	3.11
9.0	0.67	1.06	1.50	1.84	2.13	2.38	2.60	2.81	3.01	3.19	3.36	3.35	3.68
10.0	0.78	1.24	1.75	2.15	2.48	2.77	3.04	3.28	3.51	3.72	3.92	4.11	4.30
11.0	0.91	1.43	2.02	2.48	2.86	3.20	3.51	3.79	4.05	4.29	4.53	4.75	4.96
12.5	1.10	1.74	2.46	3.02	3.48	3.89	4.26	4.61	4.92	5.22	5.51	5.77	6.03
15.0	1.47	2.32	3.28	4.02	4.64	5.19	5.68	6.14	6.56	6.96	7.34	7.69	8.04
16.7	1.74	2.76	3.90	4.77	5.51	6.16	6.75	7.29	7.79	8.27	8.71	9.14	9.55
20.0	2.34	3.70	5.23	6.40	7.39	8.26	9.05	9.78	10.45	11.09	11.69	12.26	12.80
22.0	2.73	4.32	6.11	7.49	8.65	9.67	10.59	11.44	12.23	12.97	13.67	14.34	14.98
25.0	3.38	5.34	7.55	9.25	10.68	11.94	13.08	14.12	15.10	16.01	16.88	17.70	18.49
30.0	4.56	7.21	10.19	12.48	14.41	16.12	17.95	19.07	20.39	21.62	22.79	23.90	24.97
33.3	5.41	8.55	12.09	14.80	17.09	19.11	20.93	22.61	24.17	25.64	27.03	28.34	29.61
35.0	5.86	9.26	13.10	16.05	18.53	20.71	22.69	24.51	26.20	27.79	29.30	30.73	32.09
40.0	7.25	11.47	16.22	19.86	22.93	25.64	28.09	30.34	32.43	34.40	36.26	38.03	39.72
45.0	8.71	13.78	19.48	23.86	27.55	30.80	33.74	36.45	38.96	41.33	43.56	45.69	47.72
50.0	10.22	16.16	22.84	27.98	32.31	36.12	39.57	42.74	45.69	48.46	51.08	53.57	55.95
55.0	11.74	18.56	26.25	32.15	37.13	41.51	45.47	49.12	52.51	55.69	58.71	61.57	64.31
57.0	12.35	19.53	27.62	33.83	39.06	43.67	47.84	51.68	55.24	58.60	61.77	64.78	67.66
60.0	13.27	20.98	29.67	36.34	41.96	46.91	51.39	55.51	59.34	62.94	66.35	69.59	72.68
66.7	15.29	24.18	34.20	41.88	48.36	54.07	59.23	63.98	68.40	72.55	76.47	80.20	83.77
70.0	16.27	25.73	39.63	44.57	51.46	57.53	63.03	68.08	72.78	77.19	81.37	85.34	89.13
75.0	17.72	28.03	39.63	48.54	56.05	62.67	68.65	74.15	79.27	84.08	88.62	92.95	97.08
80.0	19.13	30.25	42.78	52.39	60.50	67.64	74.10	80.03	85.56	90.75	95.66	100.33	104.79
85.0	20.49	32.39	45.81	56.11	64.78	72.43	79.34	85.70	91.62	97.18	102.43	107.43	112.21
90.0	21.79	34.45	48.72	59.67	68.90	77.03	84.38	91.14	97.43	103.35	108.94	114.25	119.33
95.0	23.03	36.41	51.50	63.07	72.83	81.42	89.19	96.34	102.99	109.24	115.15	120.77	126.14
100.0	24.21	38.28	54.14	66.31	76.57	85.61	93.78	101.29	108.29	114.85	121.07	126.98	132.62

Slope length (m)	710
Slope (%)	4.2
Slope Gradient Factor	**1.50**

Kimberely Grove to Olwyn Place

Slope length (m)	420
Slope (%)	2.4
Slope Gradient Factor	**0.51**

112 George Deane Place to 30 Wicklam Lane

USLE Caluclation - Cut to Fill SH18

Constants C & P

C = Cover factor
Ratio of soil loss under specified conditions to that of a bare site
C factor is reduced when soil is protected against erosion

P = Erosion Control Practice Factor
Reflects the roughness of the earthworks surface

Treatment	C factor	P factor
Bare soil		
- compacted and smooth	1.0	1.3
- tracked walked on contour	1.0	1.2
- rough irregular surface	1.0	0.9
- disked to 250mm depth	1.0	0.8
Native vegetation (undisturbed)	0.0	1.0
Pasture (undisturbed)	0.0	1.0
Temporary grass	0.1	1.0
Temporary cover crop	0.5	1.0

* Reference:
Modified from Goldman SJ, Jackson K, Bursztynsky T 1986. Erosion and Sediment Control Handbook.

TP108 Peak Flow Rate Calculations

TP108 Worksheet

Project: North Harbour No.2 Watermain

Project No.: 42073300

Task: Run-off Calculations for pipe bridge - Oratia Stream

Calculated: W. Ouyang **Signature:** **Date:** 25-Nov-15

Reviewed By: K. Healy **Signature:** **Date:**

Approved By: **Signature:** **Date:**

A) Runoff Parameters and Time of Concentration

1. Catchment Details

Total Area (ha)	1636.44	Ref Data Sheet
Pervious Area (ha)	1334.87	Ref Data Sheet
Impervious Area (ha)	301.57	Ref Data Sheet
Channel^{n} factor **C**	0.80	0.60 - Piped System , 0.80 - Grass Channel
Catchment length **L** (km)	5.393	Refer Sc Calc Sheet
Catchment slope **Sc**	0.041	Refer Sc Calc Sheet

Assumptions (if any):
MPD Scenario
tc - changed - used tc from Mike 11 Model
Rainfall values changed as per those used in model 10yr-124, 50yr-169, 100yr-189.

2. Runoff Curve Number (CN) and Initial Abstraction (Ia)

Soil Name and Classific.	Area identifier, cover description (cover type, treatment and hydrological condition)	Curve number CN*	Area	Product CN x Area
A	1 - Impervious	98	301.57	29,553.4
A	2 - Pervious	39	1334.87	52,060.1
	* from Appendix B	**Total**	**1636.44**	**81,613.5**

CN (weighted) = $\frac{\text{total CN x A}}{\text{total area}} = \frac{81,613.5}{1,636.4388} =$ **49.9**

Ia (weighted) = $\frac{\text{5 x pervious area}}{\text{total area}} = \frac{6,674.4}{1,636.4388} =$ **4.1**

3. Time of Concentration

Runoff Factor = $\frac{CN}{200 - CN} = 0.332$

tc = 0.14C x L0.66 x [CN/(200-CN)]-.55 x Sc-0.30 = **1.627** hrs Note: tc = 10 min = 0.17hrs

SCS Lag for HEC-HMS "tp" = 2/3 x tc = 1.085 hrs

TP108 Peak Flow Rate Calculations

B) Graphical Peak Flow Rate

1. **Catchment Area** (km^2) = 16.364388

2. **Calc storage, S** = 25.4 x [(1000/CN - 10)] = 255.298

3. Annual Recurrence Interval (ARI)	2year	10year	20year	100year
4. 24 hour rainfall depth, P_{24} (mm)	80	121	142	204
5. Compute c* = $\frac{P_{24} - 2Ia}{P_{24} - 2Ia + 2S}$ (mm)	0.123	0.181	0.208	0.278
6. Specific flow rate q* (from Fig. 6.1 below)	0.014	0.020	0.022	0.030
7. Peak flow rate, $q_p = q^* A P_{24}$ (m^3/sec)	18.236	39.635	51.194	100.346
8. Runoff depth, $Q_{24} = \frac{(P_{24} - Ia)^2}{(P_{24} - Ia) + S}$ (mm)	17.2	36.8	48.5	88.1
9. Runoff Volume, V_{24} = 1000 x $Q_{24}A$ (m^3)	282,130	601,887	793,536	1,441,294

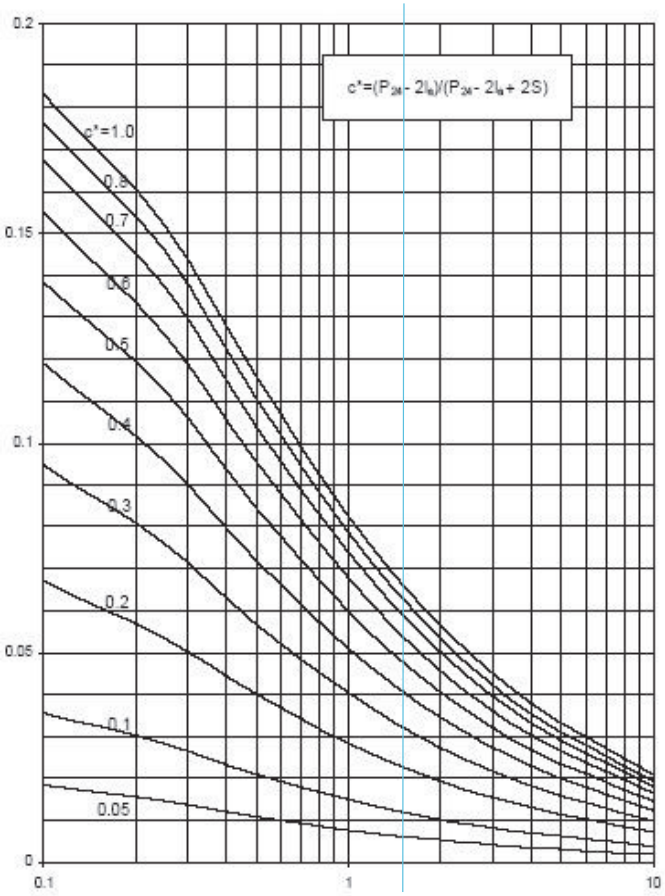


Figure 6.1, from TP10

TP108 Peak Flow Rate Calculations

TP108 Worksheet

Project: North Harbour No.2 Watermain

Project No.: 42073300

Task: Run-off Calculations for pipe bridge - Opanuku Stream

Calculated: W. Ouyang **Signature:** **Date:** 25-Nov-15

Reviewed By: K. Healy **Signature:** **Date:**

Approved By: **Signature:** **Date:**

A) Runoff Parameters and Time of Concentration

1. Catchment Details

Total Area (ha)	2225.30	Ref Data Sheet
Pervious Area (ha)	2080.21	Ref Data Sheet
Impervious Area (ha)	145.09	Ref Data Sheet
Channel^{n} factor **C**	0.80	0.60 - Piped System , 0.80 - Grass Channel
Catchment length **L** (km)	3.543	Refer Sc Calc Sheet
Catchment slope **Sc**	0.038	Refer Sc Calc Sheet

Assumptions (if any):
MPD Scenario
tc - changed - used tc from Mike 11 Model
Rainfall values changed as per those used in model 10yr-124, 50yr-169, 100yr-189.

2. Runoff Curve Number (CN) and Initial Abstraction (Ia)

Soil Name and Classific.	Area identifier, cover description (cover type, treatment and hydrological condition)	Curve number CN*	Area	Product CN x Area
A	1 - Impervious	98	145.09	14,218.8
A	2 - Pervious	39	2080.21	81,128.1
	* from Appendix B	**Total**	**2225.30**	**95,346.9**

CN (weighted) = $\frac{\text{total CN x A}}{\text{total area}} = \frac{95,346.9}{2,225.2968} =$ **42.8**

Ia (weighted) = $\frac{5 \text{ x pervious area}}{\text{total area}} = \frac{10,401.0}{2,225.2968} =$ **4.7**

3. Time of Concentration

Runoff Factor = $\frac{CN}{200 - CN} =$ 0.273

tc = 0.14C x L0.66 x [CN/(200-CN)]-.55 x Sc-0.30 = **1.406** hrs Note: tc = 10 min = 0.17hrs

SCS Lag for HEC-HMS "tp" = 2/3 x tc = 0.937 hrs

TP108 Peak Flow Rate Calculations

B) Graphical Peak Flow Rate

1. Catchment Area (km^2) = 22.252968

2. Calc storage, S = 25.4 x [(1000/CN - 10)] = 338.810

3. Annual Recurrence Interval (ARI)	**2year**	**10year**	**20year**	**100year**
4. 24 hour rainfall depth, P_{24} (mm)	80	121	142	204
5. Compute c* = $\frac{P_{24} - 2Ia}{P_{24} - 2Ia + 2S}$ (mm)	0.094	0.141	0.164	0.224
6. Specific flow rate q* (from Fig. 6.1 below)	0.012	0.018	0.020	0.028
7. Peak flow rate, q_p = q^*AP_{24} (m^3/sec)	21.229	48.467	63.243	127.358
8. Runoff depth, Q_{24} = $\frac{(P_{24} - Ia)^2}{(P_{24} - Ia) + S}$ (mm)	13.5	29.7	39.7	74.1
9. Runoff Volume, V_{24} = 1000 x $Q_{24}A$ (m^3)	301,214	661,608	882,478	1,648,324

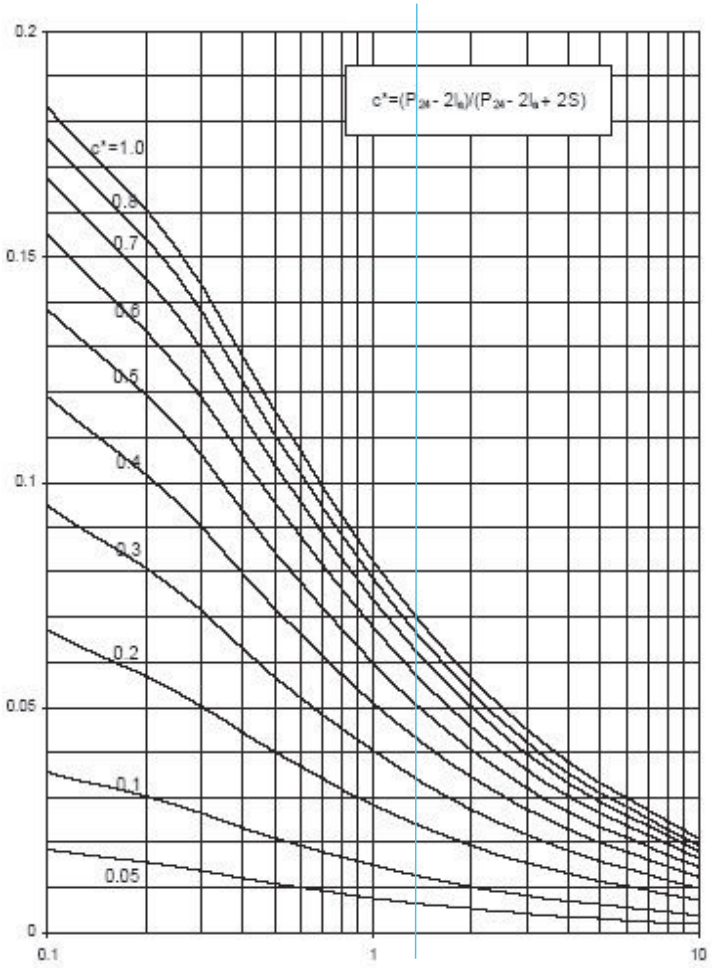


Figure 6.1, from TP10

TP108 Peak Flow Rate Calculations

TP108 Worksheet

Project: North Harbour No.2 Watermain

Project No.: 42073300

Task: Run-off Calculations for pipe bridge - Paremuka Stream

Calculated: W. Ouyang **Signature:** **Date:** 25-Nov-15

Reviewed By: K. Healy **Signature:** **Date:**

Approved By: **Signature:** **Date:**

A) Runoff Parameters and Time of Concentration

1. Catchment Details

Total Area (ha)	232.44	Ref Data Sheet
Pervious Area (ha)	130.07	Ref Data Sheet
Impervious Area (ha)	102.37	Ref Data Sheet
Channel^{n} factor **C**	0.80	0.60 - Piped System , 0.80 - Grass Channel
Catchment length **L** (km)	1.948	Refer Sc Calc Sheet
Catchment slope **Sc**	0.039	Refer Sc Calc Sheet

Assumptions (if any):
MPD Scenario
tc - changed - used tc from Mike 11 Model
Rainfall values changed as per those used in model 10yr-124, 50yr-169, 100yr-189.

2. Runoff Curve Number (CN) and Initial Abstraction (Ia)

Soil Name and Classific.	Area identifier, cover description (cover type, treatment and hydrological condition)	Curve number CN*	Area	Product CN x Area
A	1 - Impervious	98	102.37	10,032.7
A	2 - Pervious	39	130.07	5,072.7
	* from Appendix B	**Total**	**232.44**	**15,105.4**

CN (weighted) = $\frac{\text{total CN x A}}{\text{total area}} = \frac{15,105.4}{232.4440} =$ **65.0**

Ia (weighted) = $\frac{5 \text{ x pervious area}}{\text{total area}} = \frac{650.3}{232.4440} =$ **2.8**

3. Time of Concentration

Runoff Factor = $\frac{CN}{200 - CN} = 0.481$

tc = 0.14C x L0.66 x [CN/(200-CN)]-.55 x Sc-0.30 = **0.687** hrs Note: tc = 10 min = 0.17hrs

SCS Lag for HEC-HMS "tp" = 2/3 x tc = 0.458 hrs

TP108 Peak Flow Rate Calculations

B) Graphical Peak Flow Rate

1. Catchment Area (km^2) = 2.32444

2. Calc storage, S = 25.4 x [(1000/CN - 10)] = 136.858

3. Annual Recurrence Interval (ARI)	**2year**	**10year**	**20year**	**100year**
4. 24 hour rainfall depth, P_{24} (mm)	80	122	143	206
5. Compute c* = $\frac{P_{24} - 2Ia}{P_{24} - 2Ia + 2S}$ (mm)	0.215	0.299	0.335	0.423
6. Specific flow rate q* (from Fig. 6.1 below)	0.038	0.049	0.054	0.066
7. Peak flow rate, q_p = q^*AP_{24} (m^3/sec)	7.102	13.918	18.000	31.603
8. Runoff depth, Q_{24} = $\frac{(P_{24} - Ia)^2}{(P_{24} - Ia) + S}$ (mm)	28.1	55.6	71.2	121.4
9. Runoff Volume, V_{24} = 1000 x $Q_{24}A$ (m^3)	65,271	129,319	165,616	282,240

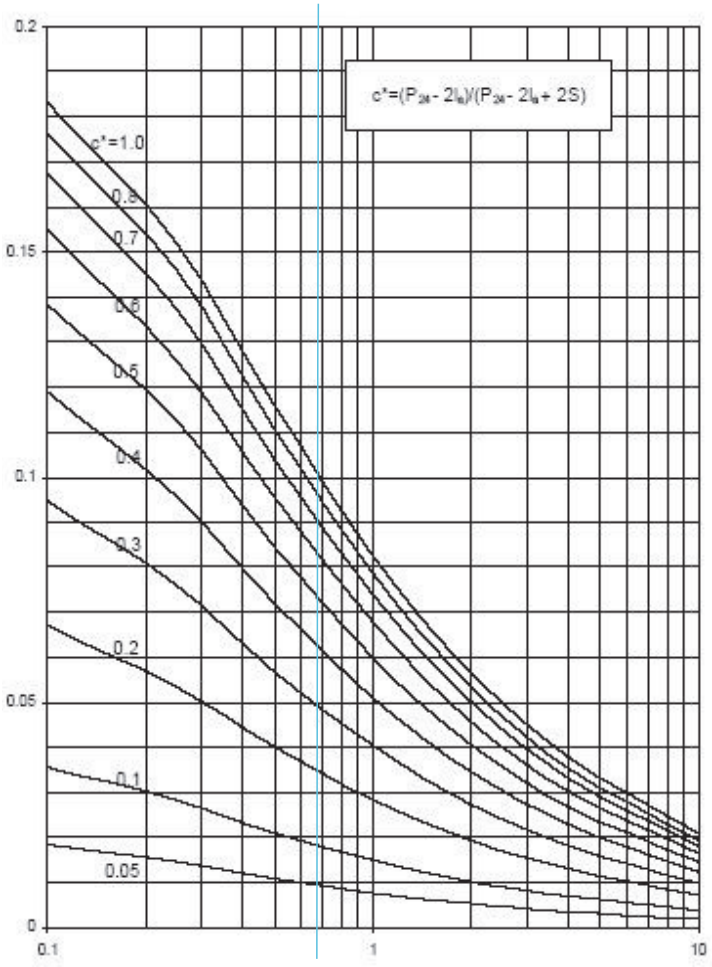


Figure 6.1, from TP10

TP108 Peak Flow Rate Calculations

TP108 Worksheet

Project: North Harbour No.2 Watermain

Project No.: 42073300

Task: Run-off Calculations for pipe bridge - Oteha Stream

Calculated: W. Ouyang **Signature:** **Date:** 25-Nov-15

Reviewed By: K. Healy **Signature:** **Date:**

Approved By: **Signature:** **Date:**

A) Runoff Parameters and Time of Concentration

1. Catchment Details

Total Area (ha)	962.70	Ref Data Sheet
Pervious Area (ha)	735.33	Ref Data Sheet
Impervious Area (ha)	227.38	Ref Data Sheet
Channel^{n} factor **C**	0.80	0.60 - Piped System , 0.80 - Grass Channel
Catchment length **L** (km)	3.282	Refer Sc Calc Sheet
Catchment slope **Sc**	0.035	Refer Sc Calc Sheet

Assumptions (if any):
MPD Scenario
tc - changed - used tc from Mike 11 Model
Rainfall values changed as per those used in model 10yr-124, 50yr-169, 100yr-189.

2. Runoff Curve Number (CN) and Initial Abstraction (Ia)

Soil Name and Classific.	Area identifier, cover description (cover type, treatment and hydrological condition)	Curve number CN*	Area	Product CN x Area
A	1 - Impervious	98	227.38	22,283.2
A	2 - Pervious	39	735.33	28,677.7
	* from Appendix B	**Total**	**962.70**	**50,960.9**

CN (weighted) = $\frac{\text{total CN x A}}{\text{total area}} = \frac{50,960.9}{962.7048} =$ **52.9**

Ia (weighted) = $\frac{\text{5 x pervious area}}{\text{total area}} = \frac{3,676.6}{962.7048} =$ **3.8**

3. Time of Concentration

Runoff Factor = $\frac{CN}{200 - CN} = 0.360$

tc = 0.14C x L0.66 x [CN/(200-CN)]-.55 x Sc-0.30 = **1.176** hrs Note: tc = 10 min = 0.17hrs

SCS Lag for HEC-HMS "tp" = 2/3 x tc = 0.784 hrs

TP108 Peak Flow Rate Calculations

B) Graphical Peak Flow Rate

1. Catchment Area (km^2) = 9.627048

2. Calc storage, S = 25.4 x [(1000/CN - 10)] = 225.833

3. Annual Recurrence Interval (ARI)	**2year**	**10year**	**20year**	**100year**
4. 24 hour rainfall depth, P_{24} (mm)	87	134	158	230
5. Compute c* = $\frac{P_{24} - 2Ia}{P_{24} - 2Ia + 2S}$ (mm)	0.149	0.218	0.249	0.329
6. Specific flow rate q* (from Fig. 6.1 below)	0.020	0.030	0.034	0.043
7. Peak flow rate, q_p = q^*AP_{24} (m^3/sec)	16.655	38.556	51.586	95.005
8. Runoff depth, Q_{24} = $\frac{(P_{24} - Ia)^2}{(P_{24} - Ia) + S}$ (mm)	22.2	47.3	62.3	112.8
9. Runoff Volume, V_{24} = 1000 x $Q_{24}A$ (m^3)	213,319	455,395	599,730	1,085,955

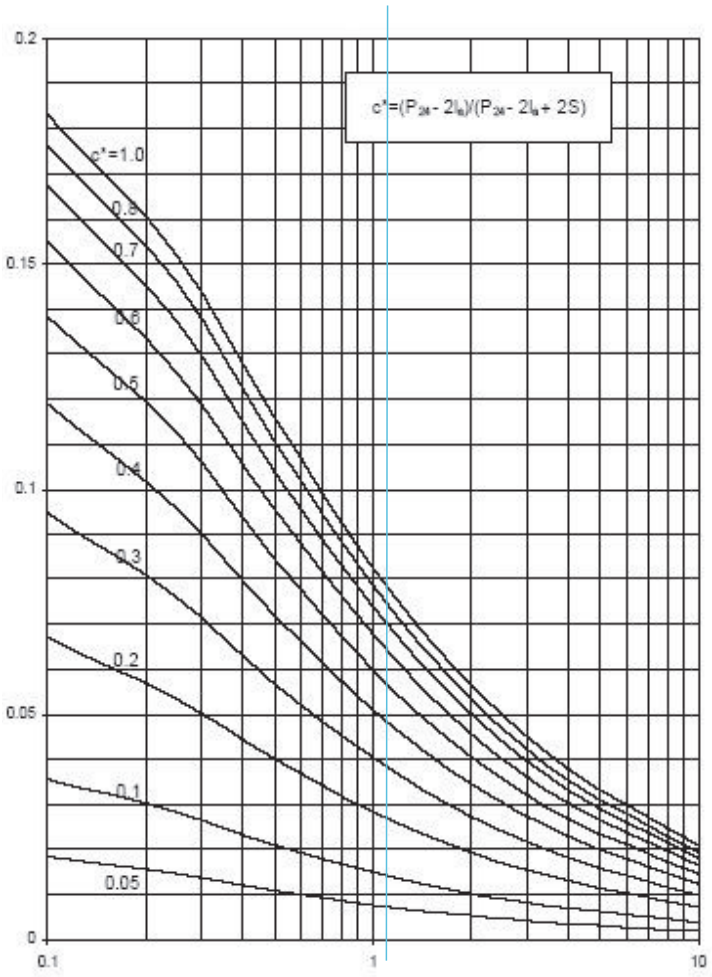


Figure 6.1, from TP10

North Harbour 2 Watermain and Northern Interceptor in Shared Corridor

VOLUME TWO

TECHNICAL REPORT B

SOIL AND GROUNDWATER CONTAMINATION ASSESSMENT

May 2016

Watercare
An Auckland Council Organisation

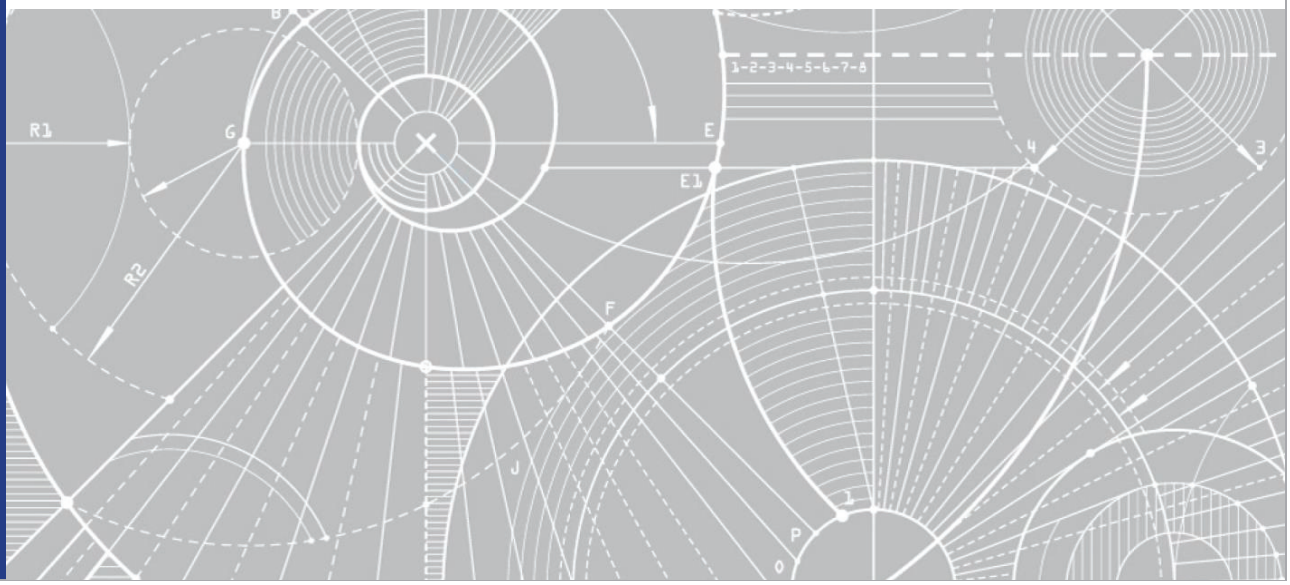
North Harbour 2 Watermain and Northern Interceptor in Shared Corridor

WATERCARE SERVICES LIMITED

Technical Report B- Soil and Groundwater Contamination Assessment

IZ018400-CL-RP-001 | 4

18 April 2016



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North Harbour 2 Watermain and Northern Interceptor in Shared Corridor

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4	18/04/2016	Final including Watercare comments	Walter Starke	Karyn Sinclair	Alan Hockey

Contents

Executive Summary

This technical report presents the findings of the potential soil and groundwater contamination effects related to the construction, operation and maintenance of Watercare Services Limited's (Watercare) proposed North Harbour 2 Watermain (NH2) Project between Titirangi and Albany and the land use effects of that part of the Northern Interceptor (NI) Project between Westgate and Hobsonville, where a shared corridor is proposed for both water and wastewater infrastructure.

This technical report supports the North Harbour 2 Watermain and Northern Interceptor Shared Corridor Assessment of Effects on the Environment (the AEE report) prepared by AECOM Consulting Services (NZ) Limited (AECOM) and Jacobs New Zealand Limited.

This report provides the following:

a) A desk top study to assess if current or historical activities at or near the Project area have or had the potential to cause ground contamination, including a drive-by pipe alignment assessment;

b) A review of the Auckland Council (Council) site files identified from the desk top study;

c) An assessment of the existing soil contamination investigation data for the NI alignment in the northern part of the Project area;

d) An estimate for the potential of contamination based on the outcome of the desk top study, Council site file review and NI soil contamination report review (T&T, 2015);

e) Outline of the statutory framework relevant to soil and groundwater contamination including adopted soil and groundwater contamination criteria for the Project;

f) Limited fieldwork and laboratory testing of the soil and groundwater to provide an environmental baseline for the part of the NH2 alignment;

g) An analysis of the soil and groundwater test results using the adopted contamination criteria;

h) An assessment of the actual or potential effects on human health and the environment (construction, operation and maintenance);

i) Options for spoil disposal based on the various methods of trenched and trenchless excavation works;

j) A Project contamination regulatory assessment; and

k) Conclusions.

It is concluded that:

a) A historical aerial photograph review, Council Site Contamination Enquiry, Council site file review and site drive-by pipe alignment assessment indicated that the potential for soil and groundwater contamination is categorised as typically low, occasionally low-medium and medium to high.

b) A limited soil contamination investigation has shown that all soil test results are below:

   i. the Soil Contamination Standards for commercial/industrial land use as referenced in the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NES Soil); and

ii. the Schedule 10 criteria listed in the Auckland Council Regional Plan: Air, Land & Water (ACRP:ALW).

c) A limited groundwater contamination investigation has shown that most test results are less than the laboratory limit of detection and all test results are less than the Permitted Activity criteria for freshwater, i.e. less than the 95 percent trigger values for freshwater (groundwater) specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality;

d) The limited soil and limited groundwater testing have shown that the potential risk to the receptors, in particular the construction workers, general public and future site users during and following the proposed works (in the areas where soil and groundwater testing was carried out) will be less than minor;

e) A conservative approach to manage unforeseen/unknown ground contamination is to use protocols that are designed to avoid, mitigate and remedy the potential for adverse effects on the environment, for example, an Erosion and Sediment Control Plan and a Contaminated Land Management Plan (CLMP);

f) Spoil disposal options for the future excavation works are either at a licensed managed fill site or a licensed cleanfill site;

g) A Discretionary Activity resource consent is required under the NES Soil since the rules for a Permitted Activity, Controlled Activity or Restricted Discretionary Activity cannot be met, in particular, the requirement for a Detailed Site Investigation report cannot be met;

h) No resource consent is required under the contaminated land rules of the ACRP:ALW for the following reasons:

i. Limited soil testing shows that the Project site does not fall into the category of land containing elevated levels of contaminants, i.e. all soil test results are below the soil contaminant criteria of Rule 5.5.41;

ii. For the large part of the Project site where no soil contamination testing was carried out it is considered that there is a low risk of encountering soil contamination, more specifically, that there is a low risk of encountering land containing elevated levels of contamination;

iii. Limited groundwater testing shows that there is no groundwater contamination and that the test results meet the Permitted Activity criteria under Rule 5.5.47;

iv. Separate phase hydrocarbons were not encountered during the limited field investigation and the risk of encountering separate phase hydrocarbons in considered low;

v. All spoil generated by the future excavation works will be disposed off-site at a licensed landfill, i.e. a licensed managed fill site or a licensed cleanfill site (except for the Asbestos Containing Material present near Brigham Creek Road, this is likely to require off-site disposal to a licensed solid waste landfill); and

vi. A CLMP can appropriately manage unforeseen ground contamination discovered during the proposed excavation works for the Project.

i) No resource consent is required under the Proposed Auckland Unitary Plan (PAUP) for the following reasons:

i. the PAUP refers to land containing elevated levels of contaminants, similar to the ACRP:ALW;

ii. Limited soil testing shows that the Project site does not fall into the category of land containing elevated levels of contaminants, i.e. all soil test results are below the soil contaminant criteria of Provision H4.5.2.1.3; and

iii. For the large part of the Project site where no soil contamination testing was carried out it is considered that there is a low risk of encountering soil contamination, more specifically, that there is a low risk of encountering land containing elevated levels of contamination.

1. Introduction

Jacobs New Zealand Limited (Jacobs) has been commissioned by Watercare Services Limited (Watercare) to assess the potential soil and groundwater contamination effects related to the construction, operation and maintenance of Watercare's proposed North Harbour 2 Watermain (NH2) Project between Titirangi and Albany, and the land use effects associated with the construction, operation and maintenance of the Northern Interceptor (NI) Project between Westgate and Hobsonville, where a shared corridor is proposed for both water and wastewater infrastructure.

The NH2 will convey potable water from storage reservoirs in Titirangi, via west Auckland and North Shore to storage reservoirs in Albany (a length of approximately 33kms). Its purpose will be to increase capacity and resilience of the water supply network to western and northern Auckland.

The NH2 Project incorporates:

- Pipeline installation, operation and maintenance of a new watermain of 1200 mm (west of Greenhithe Bridge) and 900mm (east of Greenhithe Bridge) nominal diameters (DN);
- Pipeline length of approximately 33 km mostly within public road reserve; and
- Other features including valve chambers, scour valves, air valves, line valves, bulk supply points, pipe bridges, and associated works.

Most of the watermain will be constructed by open trenching, micro tunnelling or bored tunnel (the latter two referred to as "trenchless technology") within a typical construction corridor of approximately 12 – 22 m in width with additional areas required for erosion and sediment control devices, traffic management, construction yards and storage areas at intervals along the pipe alignment for construction purposes.

The NI Project comprises of a new wastewater pipeline and associated activities to convey flows from north-west Auckland to the Hobsonville Pump Station, and then to the Rosedale Wastewater Treatment Plant (WWTP).

The proposed NI Project in the shared corridor begins in the vicinity of Hobsonville Road (West Harbour), near the intersection of the Upper Harbour and North Western Motorways (SH18 and SH16). From this location, the alignment follows the southern side of the SH18, continuing northeast to the Hobsonville Pump Station. Future phases of the NI Project will also include new pipelines between the Hobsonville Pump Station and the SH18 causeway.

Within the shared corridor, the NI Project incorporates the following:

- A new 5km wastewater pipeline of 2100mm DN;
- 16 pits / shafts for trenchless technology construction purposes. Five of these will be permanent manholes (MT Pits 2, 7, 11, 13 & 17) while the others (MT Pits 3, 4, 5, 6, 8, 9, 10, 12, 14, 15 and 16) will be temporary only until construction / testing is completed;
- MT Pit 7 will be a drop structure with permanent access, to allow for a future wastewater pipeline connection across SH18;
- A new 50m long wastewater pipeline and manholes connecting the 2100mm ND pipeline to the existing pump station;
- A new 1750 l/s Pump Station with future capacity across the site of 3,500l/s;

- Wastewater storage (within pipeline);
- Two 800m 1500mm DN rising mains (length to the causeway); and
- A 2100mm DN pipe installed by trenchless technology at SH18.

The proposed alignment of NH2 and the location of the NI Project are shown in Figure 1 below.

A full description of the proposed works and construction methodology is included in in the North Harbour 2 Watermain and Northern Interceptor Shared Corridor Assessment of Effects on the Environment (the AEE report) prepared by AECOM Consulting Services (NZ) Ltd (AECOM) and Jacobs.

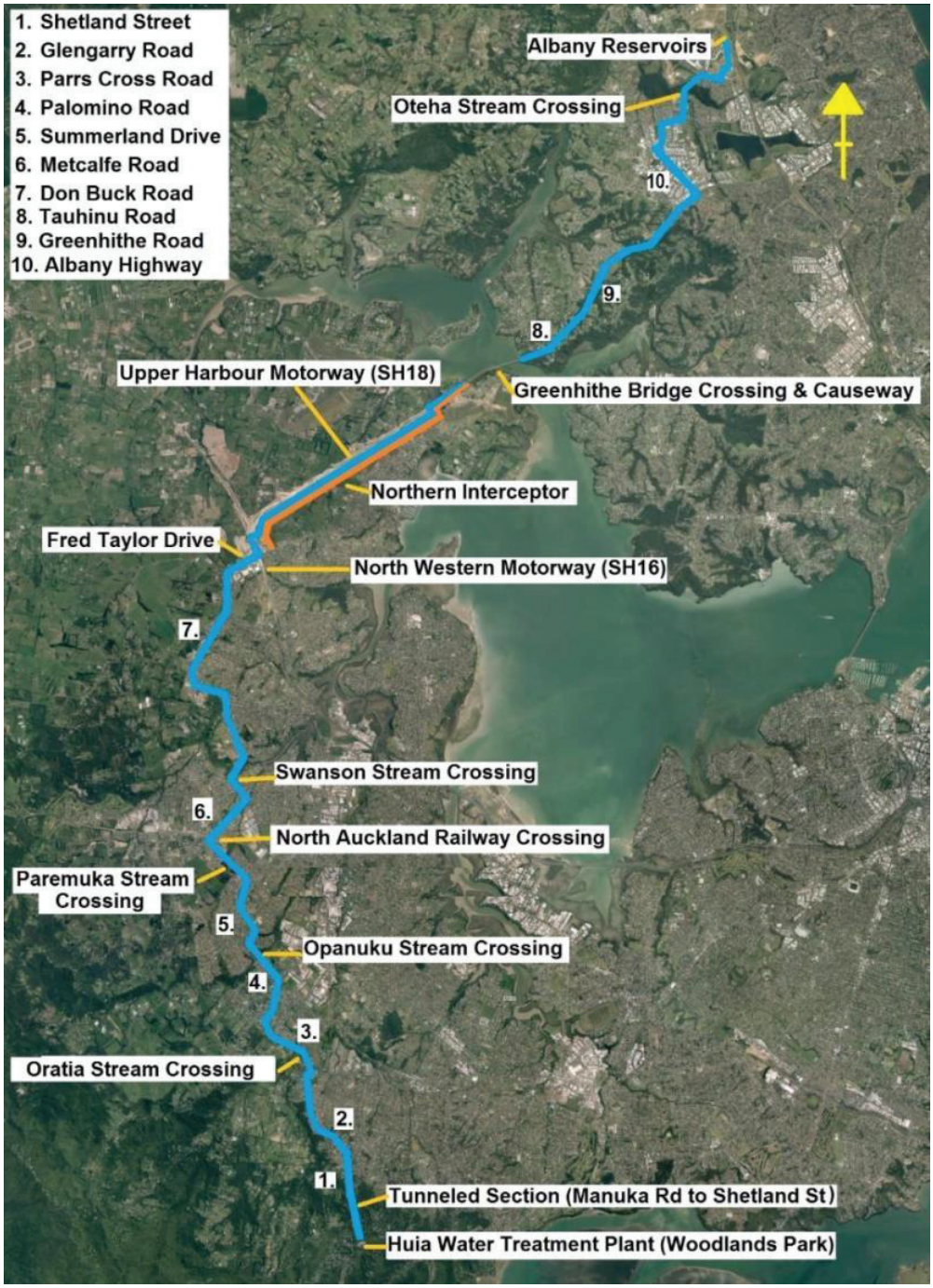

Figure 1 – Blue line is the proposed NH2 pipe alignment and Orange line is NI section within shared corridor

Watercare is proposing to designate land for the NH2 Project between Titirangi and Albany and the NI Project between Westgate and Hobsonville, and will also be seeking various resource consents for NH2 under the Resource Management Act 1991 (RMA). This technical report provides specialist input for the AEE which supports the Notices of Requirement for designation (NOR) and the resource consent applications. The alignment drawings referred to in this report are contained within Volume 3 of the AEE. Resource consents required for works associated with the NI Project will be sought by Watercare at a later date, nearer to the proposed date of construction.

This report provides the following:

a) A description of the proposed works including the anticipated methods of excavation such a trenched excavation works and trenchless works (Section 2);

b) The objectives and scope of work for the soil and groundwater contamination assessment in relation to the Project (Section 3);

c) A desk top study to assess if current or historical activities at or near the Project area have or had the potential to cause ground contamination, including a drive-by pipe alignment assessment (Section 4);

d) A review of the Auckland Council (Council) site files identified from the desk top study and an assessment of the existing soil contamination investigation data for the NI alignment in the northern part of the Project area (Section 5);

e) An estimate for the potential of contamination based on the outcome of the desk top study, Council site file review and NI soil contamination report review (Section 6);

f) Outline of the statutory framework relevant to soil and groundwater contamination including adopted soil and groundwater contamination criteria for the Project (Section 7);

g) Limited fieldwork and laboratory testing of the soil and groundwater to provide an environmental baseline for the part of the Project area (Sections 8 and 9);

h) An analysis of the soil and groundwater test results using the adopted contamination criteria (Section 10);

i) An assessment of the actual or potential effects on human health and the environment (construction, operation and maintenance) (Section 11);

j) Options for spoil disposal based on the various methods of trenched and trenchless excavation works (Section 12);

k) A Project contamination regulatory assessment (Section 13); and

l) Conclusions (Section 14).

2. Description of NH2 Proposed Works

A series of plans of the alignments of NH2 and NI within the shared corridor is included in the drawing set in Volume 3 of the AEE. Key route features are identified below.

2.1 Titirangi through to end of Fred Taylor Drive (NOR1)

Key route features for this section are:

a) The NH2 will begin with a bored tunnel approximately 800m long through a ridge and under private land at Konini Road, Scenic Drive and a unnamed paper road reserve adjacent to Tawini Road Titirangi;

b) Conventional open-cut trenching within existing road corridor from Shetland Street in the south to Fred Taylor Drive in the north;

c) Option to cross the railway line at Metcalfe Road via open cut trenching or trenchless technology; and

d) Pipe bridges over Oratia Stream, Opanuku Stream, Paremuka Stream, and Swanson Stream.

The section along Fred Taylor Drive from Don Buck Road to SH16 has already been constructed in collaboration with Auckland Transport's roading upgrade Project.

2.2 Eastern End of Fred Taylor Drive to Western End of the Greenhithe Bridge Causeway (the shared corridor) (NOR3)

Key route features that the NH2 and NI will be located within are:

a) NH2: Conventional open-cut trenching immediately south of SH18 and within the SH18 corridor;

b) NI: largely trenchless technology from access shafts with approximately 900 m long open-cut trenching from Microtunnel Pit 2, located north of Hobsonville Pump Station, in a westerly direction to the causeway widened embankment;

c) Trenchless technology for both pipelines to pass under SH16 and SH18; and

d) Connection to advanced works along Fred Taylor Drive.

2.3 Eastern End of Greenhithe Bridge to Albany reservoir (NOR2)

Key route features for this section are:

a) The majority of the NH2 to be constructed within roads or road berms via open cut trenching:

b) Option for pipe bridge or trenchless technology at Oteha Stream, Bushlands Park Reserve, and

c) Trenchless technology to pass beneath the intersection of Tauhinu Road and SH18 and Greenhithe Road near SH18, Albany Highway and Albany Expressway as well as a number of other shorter lengths along SH18.

Further detail about construction methodology for both NH2 and NI is provided in section 2 of the AEE.

3. Objectives and Scope of Work

3.1 Objectives

The objectives of the soil and groundwater contamination assessment are to:

a) Assess the potential effects that construction, operation and maintenance of the Project may have on soil and groundwater contamination; and

b) Identify appropriate control measures to minimise potential risks associated with soil and groundwater contamination on construction, operation and maintenance of the Project.

This report is one of a series of technical reports which supports the AEE for the Project.

3.2 Scope of Work

The scope of the Phase 1 soil and groundwater contamination assessment comprised of:

a) Providing a summary of the geology and hydrogeology using borehole information at or close to the alignments (NH2 and NI in the shared corridor);

b) Carrying out a site drive-by assessment of the alignment (where accessible) to document sites that have the potential to cause ground contamination adversely affecting the alignment (NH2 and NI in the shared corridor);

c) Reviewing the readily accessible historical aerial photographs to assess if former site activities or industries that are considered likely to cause land contamination resulting from hazardous substance use, storage or disposal, were present at or near the proposed NH2 and NI alignments. These activities and industries are listed within the Ministry for the Environment (MfE) document titled “Hazardous Activities and Industries List (HAIL)” (MfE, 2011);

d) Conducting a Site Contamination Enquiry (SCE) with Council (NH2);

e) Reviewing the relevant Council site/property files based on the outcome of items b) to d) above;

f) Assessing existing soil and groundwater data presented in the report titled *Northern Interceptor Phase 1 Ground Contamination Assessment*, prepared by Tonkin & Taylor Limited (T&T) on behalf of Watercare (T&T, 2015), for part of the NOR2 and NOR3 areas of the alignment;

g) Soil sampling where the NH2 alignment traverses five stream crossings (NH2);

h) Groundwater sampling at one of the five stream crossings of the alignment (NH2);

i) Laboratory testing of soil samples and a groundwater sample for a range of organic and inorganic parameters (NH2);

j) Assessing the soil and groundwater test results against relevant regulatory and off-site disposal requirements (NH2); and

k) Preparing this report (NH2 and NI in shared corridor).

3.2.1 Important note about your report

Sampling techniques, by definition, cannot determine the conditions between the sample points and so this report cannot be taken to be a full representation of the sub-surface conditions. This report only provides an indication of the likely sub-surface conditions.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by Watercare and from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

3.3 Other Relevant Reports

This report should be read in conjunction with the following reports:

a) AEE- North Harbour 2 Watermain and Northern Interceptor Shared Corridor, Volume 1;

b) Technical Report A – Earthworks, Erosion and Sediment Generation, North Harbour 2 Watermain and Northern Interceptor Shared Corridor, Volume 2;

c) Technical Report C – Groundwater, North Harbour 2 Watermain and Northern Interceptor Shared Corridor, Volume 2; and

d) AEE- North Harbour 2 Watermain and Northern Interceptor Shared Corridor, Volume 3 – Drawings.

4. Site Description

4.1 Proposed Alignment

The proposed alignment is divided into three sections as follows:

a) NOR1: A corridor for NH2 travelling from Titirangi to the eastern end of Fred Taylor Drive;

b) NOR2: A corridor for NH2 travelling from the eastern side of the Greenhithe Bridge to the Albany Reservoir; and

c) NOR3: This will be a "shared corridor" for both NH2 and a section of NI that will travel along SH18 from the eastern end of Fred Taylor Drive to the western side of the Greenhithe Bridge Causeway.

The whole alignment is generally located within the public road reserve except at the stream crossings and some reserves/Council park land.

The surrounding land uses of the alignment is a combination of residential, commercial and semi-rural as summarised in Table 1 below:

Table 1: Surrounding Land Use of NH2 Alignment and NI in the Shared Corridor (NOR3)

Area	Location
NOR1	Largely residential, limited horticultural (vineyard) for a small section along Parrs Cross Road at the Oratia Stream crossing, becoming commercial and residential along Fred Taylor Drive until the SH16 crossing.
NOR2	North of Greenhithe Bridge until William Pickering Lane the NH2 pipe will be located within the northern boundary of the SH18 reserve and immediately north of this is a reserve, residential properties and commercial land use. From William Pickering Drive to Albany reservoir the surrounding land use is largely commercial and it crosses the Oteha Stream at Bush Road.
NOR3	Largely within the southern section of the SH18 motorway reserve, following a similar alignment to the proposed NI pipeline. NH2 crosses SH18 from the south to the northern SH18 motorway reserve approximately opposite Olive Stone Lane until it meets the western boundary of the Greenhithe Bridge Watermain Duplication and Causeway Project. This area outside the SH18 reserve is largely semi-rural. The NI alignment is on the southern side of SH18 until Hobsonville pump station, then it crosses SH18 on the eastern side of the pump station, then the NI and NH2 alignments are both located within the northern berm of SH18 reserve to the causeway widened embankment.

4.2 Geology

4.2.1 Regional Geology

The Geology of the Auckland Area geological map (Institute of Geological and Nuclear Sciences, 2001) indicates the geological deposits likely be encountered along the proposed alignment from oldest to youngest include:

- **East Coast Bays Formation (ECBF)**. Early Miocene age flysch, a greenish grey, alternating muddy sandstone and mudstone, with occasional interbedded harder grit lenses (Parnell Grit). The weathered rocks of the ECBF weathers at the surface to brown and grey colour variations of soft to stiff, low to moderate plasticity clayey silt, soft to firm, non-plastic to high plasticity sandy silt, and very loose to very dense fine to medium sand;

- **Cornwallis Formation.** Early Miocene age volcanogenic flysch (alternating layers mudstone and sandstone) of the Waitemata Group, comprising grey brown, alternating, thick bedded sandstone and thin bedded mudstone;
- **Albany Conglomerate.** Early Miocene age well rounded pebbles and boulders in a medium to very coarse grained sandy matrix;
- **Piha Formation.** Coarse volcaniclastics, dominated by stratified, andesitic boulder-bearing, cobble-pebble breccia and conglomerate, locally interbedded with volcaniclastic granular sandstone;
- **Nihotupu Formation.** Early Miocene age fine grained volcaniclastic sandstone which can include beds of reworked tuffaceous and pumiceous material and tuff breccia debris flows;
- **Puketoka Formation**. Pleistocene age fluvially deposited pumiceous deposits of light grey to orange brown pumiceous mud, sand and gravel with black muddy peat and lignite; and
- **Alluvium.** Holocene age clays, silts and sands, muddy peat and unconsolidated organic-rich sediments.

Appendix A contains a site plan showing the surface geology of land within the 3 designation corridors proposed along the pipeline alignments. The main geological units occurring within these NOR are listed in Table 2 below:

Table 2: Regional Geology of the Pipe Alignment

Area	Location
NOR1	The proposed alignment geology is dominated mainly by the ECBF and the Puketoka Formation with some alluvial sediments in the northern part of this area. However, the south of this area (e.g. through the tunnelled section from Manuka Rd to Shetland St) is dominated by the Cornwallis Formation, the Piha Formation and the Nihotupu Formation.
NOR2	The proposed alignment goes through the ECBF and the Puketoka Formation within this area. There are some localised areas of Albany Conglomerate occurring about 1km west of the proposed alignment.
NOR3	Within this area the proposed alignment geology is dominated by the ECBF and the Puketoka Formation. Some alluvial sediments may be associated to the Puketoka Formation and this is evident in some patches towards the north of this area.

4.2.2 Local Geology

Information about the local geology is available at limited locations along the alignment and it confirms the regional geology obtained from the geological maps described in Section 4.2.1 above.

Table 3 below provides a summary of the local geology at the selected locations along the pipe alignment and provides a reference to the appendices containing the borehole logs describing the ground conditions. The locations of the boreholes are provided on Drawings Nos. 2010673.872 to 875 or in the appendices referenced in Table 3 below.

Table 3: Local Geology of the Pipe Alignment

Area	Location	Geological Unit	Unit Thickness	Soil Description Reference
NOR1	Oratia Stream Crossing	Fill Alluvium [1] ECBF [2]	4.8 m 1.0 m to 5 m >15 m	BH251, BH252 (see Appendix B)
	Opanuku Stream Crossing	Fill Alluvium ECBF	6 m to 8 m 0 m – 1 m >11 m	BH253, BH256, HA254, HA255 (see Appendix B)
	Parekumu Stream Crossing	Fill Alluvium ECBF	0 m – 6 m 0 m – 6 m >11 m	BH257, BH258, BH261, BH268, HA259, HA260, HA262 (see Appendix B)
	Swanson Stream Crossing	Fill Alluvium ECBF	0.8 m – 1.5 m 4.2 m – 4.5 m >7 m	BH263, BH264 (see Appendix B)
NOR2	West end near GBWD works	Fill ECBF	2 m >20 m	BH204 (see Appendix B)
	Corner William Pickering Drive and Piedmark Drive	Fill Alluvium ECBF	0.4 m – 2.4 m 0 m – 1 m >14 m	BH-t13,[1] BH-t14,[1] HA24, HA25 (see Appendix C)
	Oteha Stream Crossing	Fill Alluvium ECBF	0.2 m 0 m – 3.4 m >9 m	BH265, HA266, HA267 (see Appendix B)
NOR3	East end near GBWD works	Marine sediments Fill Alluvium ECBF	0 m – 0.8 m 0 m – 3.8 m 0 m – 0.8 m >14 m	BH201, BH202, HA201-206A (see Appendix B) BH-t1,[3] BH-t2,[3] HA01-HA-03 (see Appendix C)

Notes:

[1] Alluvium is the Puketoka Formation.

[2] ECBF is the East Coast Bays Formation.

[3] Borehole BH-t1, is labelled on a site plan as BH1 but the borehole logs is labelled as BH-t1, see Appendix C.

4.3 Hydrogeology

The depth to groundwater has been obtained from the borehole logs referenced in Section 4.2 and is summarised in Table 4 below. We note that these groundwater depths are approximate only since they have been obtained from the borehole logs rather than from regular monitoring of the piezometers post borehole or piezometer construction, except for BHs 201, 202 and 204.

Table 4: Groundwater Depths along the Pipe Alignment

Area	Location	Depth to Groundwater (m bgl)
NOR1	Oratia Stream Crossing (BH252)	4.0
	Opanuku Stream Crossing (BH253)	4.9
	Parekumu Stream Crossing (BH257)	3.8
	Swanson Stream Crossing (BH263)	2.3
NOR2	East end near GBWD works (BH204)	4.0
	Oteha Stream Crossing (BH265)	2.0
NOR3	West end near GBWD works (BH201 & BH202)	3.0

4.4 Project Drive-By Pipe Alignment Assessment

A drive-by assessment of the pipe alignment (where accessible) was carried out by the writer of this report in October 2015 to view sites that have the potential to cause ground contamination during the future construction of the pipe alignment. A summary of the key features noted during the site drive-by pipe alignment assessment are presented in Table 5 below.

Table 5: Project Drive-By Pipe Alignment Assessment - Summary of Sites of Interest

Area	Industry/Activity	Location
NOR1	Petrol/service station	- Gull Henderson, 150 Henderson Valley Rd (= 1-3 Forest Hill Road). - Mobil Don Buck, 393-395 Don Buck Road. - Challenge Massey, 2 Triangle Lane. - Z Energy- Massey North, 1 Asti Lane (corner Asti Lane & Fred Taylor Drive).
	Small electrical transformers (1)	- Forty-five small transformers are located in the road reserve.
	Timber storage	- Henderson Timbers, timber frame and truss manufacturing site, 42-52 Munroe Road. - Placemakers Westgate, yard storing timber, 547-557 Don Buck Road.
	Industrial site (2)	- Former Poultrymen's Co-operative Society Limited site, 3-5 Red Hills Road.
	Telecom site (3)	- Telecommunication site- diesel sign on fence, 142-144 Don Buck Road, Massey.
	Railway land	- Railway crossing on Metcalfe Road, near Ranui railway station.
NOR2	Small transformers (1)	- Twelve small transformers are located in the road reserve.
	Timber storage	- Albany ITM, yard storing timber, 66 Bush Road, Albany.

Area	Industry/Activity	Location
NOR3	Small transformers (1) pump station	- One small transformer located between the Fred Taylor Drive north-bound on-ramp to SH18 and Gunton Drive. - The Hobsonville pump station is located at 2 Buckley Ave and within the NI alignment in the shared corridor.

[1] These transformers were relatively small, located on pad foundations and there were no obvious transformer oil stains on the ground surrounding these transformers. Photograph of typical transformers are presented in Appendix D. The locations of the fifty-eight transformers are tabulated in Appendix E.

[2] This site is on the corner of Red Hills Road and Don Buck Road in Massey, all former buildings and structures were removed from the site and an advertising sign showed that this site was targeted for commercial / residential redevelopment (Red Hills convenience centre, see photograph in Appendix D). Note: PCL Mainfeeds Limited or Poultrymen's Co-operative Society Limited, used to operate on this site and the site used to contain a diesel fuelled boiler, see site contamination enquiry discussed in Section 4.6 below. It appears that there is a groundwater monitoring bore / piezometer at on this site near Don Buck Road, see photograph in Appendix D.

[3] At this site there is a building with a sign at the entrance stating “Hazchem- Diesel”, see photographs in Appendix D. It is understood that this building is used for telecommunication purposes and that it may contain a diesel generator for backup power generation.

4.5 Site History

A review of the readily accessible historical aerial photographs was undertaken to assess if former site activities or industries that are considered likely to cause land contamination resulting from hazardous substance use, storage or disposal were present at or near the pipe alignment. These activities and industries are presented on the HAIL (MfE, 2011c).

The following two sources were used:

a) Council Geographical Information System (GIS), using their publicly available website; and

b) The aerial photographic archive held by T&T at their offices in Newmarket, Auckland.

The historical aerial photographs reviewed covered the period 1940, 1950, 1960, 1970, 1980, 1990 and 2000. Appendix F contains the historical aerial photograph review. In summary we note that:

a) The pipe alignment largely follows established roads;

b) In the NOR1 area the 1940 and 1959 historical aerial photographs show that the alignment covering part of Glengarry Road, Border Road, Palomino Drive and Summerland Drive may have had horticultural activities;

c) The existing Hobsonville pump station contains a former sludge disposal bed (from the NZDF) that has been remediated, see Sections 5.3.5 and 5.3.6; and

d) No other land uses or activities were identified that could have the potential to show significant ground contamination that would adversely affect the construction of the NH2 and NI.

4.6 Council Site Contamination Enquiry

A SCE was lodged with Council on 26 February 2014 and Council’s response to the enquiry is contained in Appendix G. The enquiry provides information held by Council from two primary sources:

a) *"…Site specific files and pollution incident files available for the subject sites …"* as detailed in attachment A of Appendix G; and

b) *'The former Auckland Regional Council and current Natural Resources and Specialist Input Unit databases for records of landfill, bore, air discharge, industrial and trade process consents, contaminated site discharge consents and environmental assessments for the properties adjacent to the sites…"* as detailed in attachment B of Appendix G.

A summary of the eleven sites/items of the Council SCE are presented in Table 6 below. We note that many of the incidents / items listed in the SCE are located relatively far from the NH2 pipe alignment and have therefore not been considered further in this assessment.

A request was made to Auckland Council to view ten sites / items of interest and the writer of this report viewed the available items on 05 November 2015. This is further discussed in Section 5 below. The NZDF sludge bed remediation file was not reviewed as this was done by T&T in 2015, see Section 6.

Table 6: Council Site Contamination Enquiry- Eleven Sites/Items of Interest

Area	Date/consent no/file ref.	Description
NOR1	14/11/06	1-3 Forest Hill Rd: diesel in stormwater ditch, outside petrol station.
	26/03/09	Corner Don Buck Rd and Triangle Rd: diesel spill, small amount of 91 petrol having potentially entered the stormwater system.
	5-21-3869	1-3 Forest Hill Rd: Investigation of Gull site with previous pollution incident hydrocarbons entering stormwater system (this item is probably related to the item dated 14/11/06
	C512-12-3378	Nth Akl railway, Metcalfe Rd: install eight boreholes to 6 m depth for groundwater monitoring.
	31216	NZ Railway Co, Ranui Fill site, discharge of contaminants when operating an earth fill site.
	5-10-2564	397 Don Buck Rd: underground storage tank replacement, site remain as services station.
	C-512-12-1604	Don Buck Rd & Triangle Rd: install three piezos for groundwater level and chemistry monitoring.
NOR2	18/09/98	70 Upper Harbour Drive: *"Spill of 2000 litres of diesel while fill"*.
NOR3	20865	12 Kedgley Drive: discharge of contaminants to groundwater or surface water from a closed solid waste landfill, opposite Westgate shopping centre, SH16 and Kedgley Drive.
	32584	New Zealand Defence Force (NZDF) sludge bed remediation- this is further discussed in Section 6 below.
	40426	1 Squadron Dr: discharge of contaminants with the development of a retirement village.

The SCE also listed a resource consent, held by PCL- Mainfeeds Limited, for *"the discharge of contaminants to air from an animal feed mill and an 11.25 kW diesel fuel boiler"*, see item 4 in attachment B in Appendix G. However, as this is a discharge to air consent this is unlikely to have caused the potential for ground contamination, and the main item of interest is the *"diesel fuel boiler"*.

5. Council Site File Review & Review of Existing Soil Contamination Information (T&T, 2015)

This section discusses the following:

a) A review of the Council site files of the ten sites/items of interest carried out on 05 November 2015, following the SCE discussed in Section 4.6 above; and

b) A review of an existing soil contamination investigation report titled *Northern Interceptor- Phase 1 Ground Contamination Assessment*, prepared for Watercare by T&T in March 2015 (T&T, 2015). The existing soil contamination report covers part of the NOR2 and NOR3 area and it includes a site plan of the NI pipe alignment, contained in Appendix C.

In addition a property file was requested from Council for the 142-144 Don Buck Road property. A property file for the Mobil petrol station located at 1 Asti Lane (see Section 4.4) could not be obtained since this site address is not correct for the Mobil petrol station site and the correct site address is unknown at the time of writing this report.

5.1 NOR1

5.1.1 Gull Petrol Station: 1-3 Forest Hill Road (= 150 Henderson Valley Road)

In 2007 Andrew Stewart Limited (ASL) prepared a preliminary soil contamination report for Gull New Zealand Limited (Gull) (ASL, 2007). The investigation discovered soil contamination in the triangular grassed area between Forest Hill Road and Henderson Valley Road and north of the petrol station. ASL postulated that the soil contamination arose from leaking product of old fuel lines.

ASL reports that vertical migration of contamination from the leaking product of old fuel lines is unlikely due to the confining nature of the clay soils (at a depth of around 0.5 m below ground level), and that *" …during periods of high rainfall and corresponding higher water tables (groundwater/perched water has reportedly been observed at 200 mm depth at the site) migration and entry of petroleum hydrocarbons through the break in the stormwater pipe is conceivable."*

There is a low to medium risk of encountering ground contamination associated with the 1-3 Forest Hill Road site adversely impacting the proposed excavation works for the NH2 pipe line since the soil contamination encountered in the abovementioned triangular grassed area is located within 10-15 m of the anticipated NH2 pipe alignment.

Unforeseen ground contamination can be appropriately managed via a Contaminated Land Management Plan (CLMP), and a conservative assumption would be to assume that all soil and shallow groundwater within a 20 m distance of the Gull site is contaminated.

The CLMP should include site management procedures that avoid stockpiling or double handling of spoil in this area, that all spoil within be disposed off-site to a licensed solid waste landfill and that all groundwater or surface water that has come into contact with the site soils should be disposed of as contaminated groundwater (either removed via sucker truck and disposed of as liquid waste or dispose of to the local sewer, with prior permission of Watercare).

An alternative option is as follows:

a) Carry out a soil and groundwater contamination investigation prior to NH2 construction by excavating boreholes and installing groundwater monitoring wells at the proposed NH2 pipe location or between the NH2 pipe and the Gull petrol station and test both the soil and groundwater for hydrocarbon contamination; and

b) If the soil and groundwater is not contaminated then the soils / spoil and groundwater within a 20 m distance of the Gull site can be disposed of off-site in a similar manner as for other part for NH2 pipe alignment (discussed in Section 12), i.e. the soils / spoil and groundwater does not have to be treated as contaminated.

5.1.2 Metcalf Road Railway Crossing- Ranui Fill Site- NZ Railway Company

The SCE identified that the Ranui fill site holds resource consent to discharge contaminants to ground and that eight boreholes were installed for groundwater monitoring purposes.

The site file review identified several reports by T&T, on behalf of Ontrack Limited and / or KiwiRail Holdings Limited, showing that the Ranui fill site is located approximately 350 m east of the Metcalf Road railway crossing, i.e. the location of the NH2 pipe alignment (T&T, 2010).

The reports show that the groundwater flow is towards the east, i.e. away from the Metcalf Road railway crossing.

It is considered that there is a low risk of encountering ground contamination associated with the Ranui fill site adversely impacting the proposed excavation works for the NH2 pipe line.

5.1.3 Mobil Petrol Station: 397 Don Buck Road

The SCE identifies that underground storage tanks (UST) were replaced when the site was to remain as a service station.

Council file 5-10-2564 provides a UST removal report, dated October 2005, prepared by URS New Zealand Limited (URS) on behalf of Mobil Oil New Zealand Limited. The report is labelled *"privileged and confidential"* and therefore no copies can be presented as part of this report.

The report was reviewed by the writer of this report and it is considered that there is a low risk of encountering ground contamination associated with the 397 Don Buck Road site adversely impacting the proposed excavation works for the NH2 pipe line.

5.1.4 17-19 Fred Taylor Drive- Former Horticultural Land

The SCE did not identify the property located at 17-19 Fred Taylor Drive, however, soil contamination information for this property was located when reviewing the Council site files on 05 November 2015. The proposed development was for a Pak 'n' Save building with associated car parking and the soil contamination investigation work was carried out by Babbage Consultants Ltd in 2012 (Babbage, 2012).

The Babbage report provides a site plan with environmental (soil) sampling locations, soil contamination test results and borehole logs. The soil contamination test results largely show low contaminant levels, although at sample location HA-G4, the soil-lead concentration was elevated (326 mg/kg, compared to the Council criteria of 250 mg/kg) and HA-G4 is located approximately 10 m from Fred Taylor Drive.

Since the proposed NH2 pipe alignment is located underneath the carriageway and since soil-lead is a relatively immobile contaminant it is considered that there is a low risk of encountering ground contamination associated with the 17-19 Fred Taylor Drive site adversely impacting the proposed excavation works for the NH2 pipe line.

5.1.5 142-144 Don Buck Road- Telecommunications Site

The Project drive-by pipe alignment assessment identified a site with the HAZCHEM sign at the 142-144 Don Buck Road site entrance and since this property was not identified in the SCE a property file for this site was requested from Council on 30 October 2015. The property file did not contain any information relating to the storage of diesel or other hazardous substances on site.

It is considered that there is a low risk of encountering ground contamination associated the 142-144 Don Buck Road site adversely impacting the proposed excavation works for the NH2 pipe line.

5.2 NOR2

5.2.1 70 Upper Harbour Corridor- Diesel Spill

The SCE reports a *"spill of 2000 litres of diesel while fill"* at 70 Upper Harbour Drive in 1998. The Council site file could not be located, however, it is considered that there is a low risk of encountering ground contamination during the proposed excavation works within the SH18 corridor since:

a) The 70 Upper Harbour Corridor site is located approximately 80 m from the proposed NH2 pipe alignment which is located on the northern side of SH18; and

b) The diesel spill occurred in 1998 and ground contamination would have been observed and removed during the earthworks for SH18.

In addition it is considered that any residual soil and / or groundwater contamination related to the 1998 diesel spill can be appropriately managed via a CLMP.

5.2.2 NI Soil Contamination Data Relevant to NOR2 Area (T&T, 2015)

In the NOR2 area the proposed NI pipe alignment crosses the NH2 pipe alignment once at the intersection of William Pickering Drive and Piedmark Drive, as previously discussed in Table 3, Section 4.2.2.

Figure 7 of the T&T report provides the borehole locations in this area and a copy of the four relevant borehole logs and soil contamination test results are presented in Appendix C. The borehole logs do not report any visual or olfactory evidence of soil contamination.

The soil contamination test results show that at borehole location HA25 and BH14 the soils up to a depth of 0.5 m contain elevated levels of organic compounds (PaHs) and that this soil should not be classified as cleanfill but as slightly contaminated material and require off-site disposal to a licensed managed fill site or licensed solid waste landfill. The regulatory criteria will be discussed in more detail in Section 7 of this report.

5.3 NOR3

5.3.1 1/2A Kedgley Drive- Closed Solid Waste Landfill

The SCE lists that a consent was issued *"to authorise approximately the discharge of contaminants to groundwater and surface water from a closed solid waste landfill at 1/2A Kedgley Drive, associated with a proposed town centre, State Highway 16 and Kedgley Drive, (opposite Westgate Shopping)."*

In the period 2008-2009 SKM, now part of Jacobs, and the writer of this report was closely involved in the investigation and preparation of a Remedial Action Plan (RAP) for the closed solid waste landfill or uncontrolled fill area (SKM, 2009). A site plan of unauthorised fill area contained within the RAP shows that the proposed NH2 and NI in the shared corridor are located approximately 350 m south-east from the uncontrolled fill area.

In addition, groundwater and surface water from the closed landfill discharges in a northerly direction. Since the NH2 pipe alignment and NI in the shared corridor are located south-east of the uncontrolled fill area, future construction activities associated with the NH2 and NI in the shared corridor should not be affected by discharges from the uncontrolled fill area.

It is considered that there is a low risk of encountering ground contamination associated with the uncontrolled fill area adversely impacting the proposed excavation works for the NH2 and NI pipe lines.

5.3.2 1 Squadron Drive- Discharge of Contaminants for Retirement Village Development

The SCE lists that a consent was granted *"to discharge contaminants associated with the development and operation of a retirement village"* for the site located at 22-24 Upper Harbour Drive, Hobsonville, also known as 1-2 Squadron Drive, Hobsonville.

Riley Consultants Limited (Riley), on behalf of Summerset Retirement Villages, carried out an environmental site assessment, environmental detailed intrusive site investigation, RAP and site validation reporting (SVR) for proposed development (Riley, 2013 & Riley, 2015).

A site plan contained in the RAP shows that the proposed NH2 pipe alignment and proposed NI in the shared corridor will be located immediately south of the 1-2 Squadron Drive property.

Three areas of surface soil contamination were identified by Riley and at least one area has been remediated as described in the SVR. It is unknown if the other two areas have been remediated, however, the area closest to the NH2 pipe alignment, an orchard with elevated arsenic, is located approximately 50 m north of both the proposed NH2 pipe alignment and proposed NI in the shared corridor.

It is considered that there is a low risk of encountering ground contamination associated with the 1-2 Squadron Drive site adversely impacting the proposed excavation works for both the NH2 pipe alignment and NI in the shared corridor.

5.3.3 Hobsonville Road East- Preliminary Soil Contamination Investigation

The SCE did not identify the Hobsonville Road East- Preliminary Soil Contamination Investigation report, however, it was located when reviewing the Council site files on 05 November 2015. The investigation was carried out by GHD Limited (GHD) for Waitakere City Council for the Northern Strategic Growth Area (NorSGA) transport infrastructure project in 2010-2011 (GHD, 2011).

The investigation area covers a large part of Hobsonville Road as detailed on the site plan contained in the GHD report. The test results largely show low levels of soil contamination, typically with the Auckland background levels, except for chromium and copper concentrations where the 95% Upper Confidence Limit (UCL) of the mean was calculated and these were above the background concentrations.

The investigation work was carried out prior to the construction of SH18 which is located north of Hobsonville Road.

By locating the proposed NH2 and NI pipe alignments within the SH18 corridor, it is reasonable to assume that all potentially contaminated soil, probably surface soils such as topsoil, would have been removed as part of the SH18 construction activity.

It is considered that there is a low risk of encountering ground contamination associated with that reported in the Hobsonville Road East, Preliminary Soil Contamination Investigation report, adversely impacting the proposed excavation works for both the NH2 pipe and NI in the shared corridor.

5.3.4 Brigham Creek Road- Pond 1 & Pond 2 Soil Quality Investigation

The SCE did not identify the Brigham Creek Road- Pond 1 & 2 Soil Quality Investigation report, however, it was located when reviewing the Council site files on 05 November 2015. The investigation was carried out by GHD for Auckland Transport for the NorSGA transport infrastructure project in 2012 (GHD, 2012).

A site plan showing the pond quality investigation area is presented in the GHD report and shows that both the proposed NH2 pipe alignment and NI in the shared corridor cover this area.

The report concludes that soil contamination levels are above background levels in some areas and that *"… it is possible that Auckland Council may deem the soil unsuitable for reuse from a contaminant perspective."*

The report also noted some Asbestos Containing Materials (ACM) and that the ACM appeared to be confined to a discrete area. GHD recommended that an asbestos management plan be developed, including the removal of the ACM using a person with a certificate of competence under the Asbestos Regulations.

We agree that the ACM and any possible soil contaminated with asbestos fibres should be removed by a competent person and provided that this work will be done it is considered that there is a low risk of encountering ground contamination associated with that reported in the Brigham Creek Road- Pond 1 & Pond 2 Soil Quality Investigation report, adversely impacting the proposed excavation works for both the NH2 pipe and NI in the shared corridor.

5.3.5 NI Soil Contamination Data Relevant to NOR Area (T&T, 2015)

In the eastern part of the NOR3 area the NI alignment follows the NH2 alignment until the area opposite the Hobsonville pump station where the NI alignment crosses SH18 and immediately east of the pump station as indicated on Figure 3 contained in Appendix C. The NH2 pipe alignment crosses SH18 near Sinton Road.

Figure 3 of the T&T report provides the locations of the boreholes in the NOR3 area and also shows the locations of three HAIL sites:

a) A former airstrip located near the Squadron Drive onramp to SH18 and near borehole location HA3;

b) A former horticultural site also located near borehole HA3 (previously discussed in Section 5.3.2); and

c) The former New Zealand Defence Force (NZDF) sludge disposal bed and WWTP, now part of the Hobsonville pump station. This is further discussed in Section 5.3.6 below.

The potential for contamination at these three HAIL sites is discussed in Table 7 in Section 7 below.

Copies of the five relevant T&T borehole logs and soil contamination test results of the NOR3 area are also contained in Appendix C.

The borehole logs do not report any visual or olfactory evidence of soil contamination.

The soil contamination test results show that the soil is not contaminated, i.e. all test results meet Auckland Council published background values (ARC, 2001).

5.3.6 Hobsonville Pump Station

The T&T report (T&T, 2015) discusses the soil remediation work at the Hobsonville pump station, carried out in 2008 by Fraser Thomas Limited and discussed in their Site Validation Report (SVR) titled *"Hobsonville Sewage Treatment Plant: Environmental Remediation of Sludge Drying Bed: Site Validation Report"*, version 2, prepared for NZDF, October 2008, project number 31478, as follows:

"Remediation of the former sludge bed at the former Hobsonville WWTP (now the Hobsonville pump station site) was undertaken during 2008. Following the remedial works, Fraser Thomas produced a SVR. The validation report indicates the following regarding residual levels of contamination on the site the following remediation:

- *A number of samples from within soils at the base and sides of the excavation show levels of metals (arsenic and zinc) above published background concentrations, but below levels that have the potential to pose a risk to underlying groundwater and the receiving environment.*

- *Relative high ammonia nitrogen levels are indicated in soils at the north eastern wall of the excavation (location indicated to be on the eastern boundary of the site).*

- *Sampling taken 1 m outside the eastern face of the excavation using a hand auger, also indicated relatively high ammonia nitrogen levels. The depth at which the sample was taken is not indicated in the SVR.*

- *Groundwater monitoring following completion of the remediation was undertaken downstream of the former sludge bed. Results indicated that the levels of ammonia-nitrogen and number of metals in the groundwater exceeded the ANZECC 80% marine and freshwater trigger. Groundwater tested at an up-gradient location, was within the ANZECC 80% (marine and freshwater) trigger levels.*

- *The excavation was backfilled with tested cleanfill material.*

Correspondence reviewed indicated that discussions were held regarding elevated nitrogen and isolated zinc results in validation samples. ARC agreed with NZDF that further excavations would not be practical, but requested that NZDF undertake further groundwater monitoring. No records of further groundwater monitoring or preparation of a Long Term Management Plan (LTMP) were indicated in the property file."

It is considered that there is a medium risk of encountering ground contamination associated with residual sludge from the former NZDF operations sludge adversely impacting the proposed excavation works for the NI pipe lines.

In addition, for future works associated with the NI in the shared corridor in the area near the Hobsonville pump station, it is recommended that groundwater contamination monitoring is carried out to assess suitable groundwater disposal options (assuming that temporary groundwater lowering is required during the future works).

6. Potential for Contamination

The potential for contamination at or adjacent to the pipe alignments is assessed from the presence of HAIL sites, known contaminated sites and existing soil contamination data. This assessment was based on, respectively, the Project drive-by pipe alignment assessment (Section 4.4), the site history review (Section 4.5), the Council SCE (Section 4.6), a review of the relevant Council site files based on the SCE and the existing soil contamination information from the NI pipe alignment in the NOR2 and NOR3 areas (Section 5).

The potential for contamination affecting the pipe alignments depends on a number of factors including the type of HAIL site and location of hazardous substance within the HAIL site. Two examples of this are provided below:

a) Horticultural sites such as orchards typically used pesticides and insecticide sprays comprising largely inorganic contaminants over large areas. The sprays consisted of inorganic contaminants, typically Arsenic, Copper, Lead and organochlorine pesticides such as DDT (dichloro diphenyl trichloroethane) and these contaminants were relatively immobile in the soil and are typically found in the upper soil horizon (topsoil) and up to a depth of 0.4 m.

   The NH2 pipe alignment traverses through a number of older horticultural sites (see site history in Section 4.5) and it is considered reasonable to assume that the topsoil layer, i.e. the potentially contaminated layer, was removed prior to road construction to provide a good road subgrade. Therefore the potential to find soil contamination adversely affecting the pipe alignments is considered low.

   Horticultural sites also used mixing and / or storage sheds or a diesel fired boiler in the case of glasshouses and market garden sites. However, glasshouses were not observed within the pipe alignments so the likelihood of encountering organic contamination from a diesel horticultural use is considered low. The potential for encountering ground contamination associated with horticultural mixing and / or storage sheds is also relatively low since again it is reasonable to assume that such sheds and surface soils were removed as part of the road construction process. However, it is anticipated that a contingency plan such as a CLMP to deal with unforeseen ground contamination during future construction works will form part of a resource consent condition for the Project works.

b) Petrol stations store large amounts of organic contaminants such as petrol, diesel and the heavier oils such as lubricating oils. The risk of contamination adversely affecting the pipe alignment is the migration of these hazardous substances, so therefore the location of these hazardous substances, for example, the location of USTs and underground pipework from the USTs to the dispensing bowsers, in relation to the pipe alignment is important.

Table 7 below presents the results of our assessment for the potential for contamination in terms of low, medium and high risk, for the sites identified in Sections 4.4-4.6 and 5.

In Table 7 we have added a low risk of potential contamination for the presence of contaminated fill located below existing road, for the whole NH2 pipe alignment. Based on the information gathered during desk top study and Project drive-by pipe alignment assessment there is no reason to suspect that there are large areas of contaminated fill located below the existing roads.

Granular volcanic basecourse will probably exist below the roads and the inorganic contaminant concentration of volcanic material is likely to be greater that soils derived from non-volcanic soils in the Auckland area (ARC, 2001). However, it terms of encountering soil contamination during the future pipe construction works this is not considered to be an issue, both in terms of on-site reuse or off-site disposal of volcanic soils.

Table 7: Potential for Contamination: Risk Category Low, Medium & High

Area	Industry/Activity	Location	HAIL reference	Preliminary Assessment of Risk of Potential of Contamination
NOR 1	Gull petrol station	1-3 Forest Hill Road	Activity H	**Low to Medium**: site located adjacent to pipe alignment, see Section 5.1.1, potential for hydrocarbon contamination, TPH, PaH, BTEX
	Mobil petrol station	393-395 Don Buck Rd	Activity H	**Low**: site located adjacent to pipe alignment, see Section 5.1.3, potential for hydrocarbon contamination, TPH, PaH, BTEX
	Challenge petrol station	2 Triangle Rd	Possibly Activity H	**Low**: site located adjacent approx. 50 m from pipe alignment, potential for hydrocarbon contamination, TPH, PaH, BTEX
	Z-Energy petrol station	1 Asti Ln	Activity H	**Low**: site located adjacent to pipe alignment, potential for hydrocarbon contamination, TPH, PaH, BTEX
	Small electrical transformers	45 (see Appendix D)	Activity B2 or H	**Low:** no spills of oil observed, oil relative immobile contaminant so any contamination would be localised around the transformer itself, reasonable to assume that Vector would have cleaned up local oil spills
	Timber storage	42-52 Munroe Rd	Possibly Activity H	**Low**: possible treated timber stored on site but any soil contamination unlikely to have migrate to pipe alignment
	Timber storage	547-557 Don Buck Rd	Possibly Activity H	**Low**: possible treated timber stored on site but any soil contamination unlikely to have migrate to pipe alignment
	Industrial site	3-5 Red Hills Rd	Possibly Activity H	**Low**: contaminant diesel, see Table 5 in Section 4.4, however, redevelopment of site likely to have removed any hazardous substance
	Telecom site	142-144 Don Buck Rd	Possibly Activity H	**Low**: contaminant diesel, see Table 5 in Section 4.4, however, unknown if this is an above ground tank or UST, no pollution incidents reported on Council site contamination enquiry (see Section 5), and nothing reported on property file (see Section 5.1.5)
	Railway land	Railway crossing on Metcalfe Road, near Ranui railway station	Activity F6	**Low**: see Section 5.2
NOR 2	Small electrical transformers	12 (see Appendix D)	Activity B2 or H	**Low**: no spills of oil observed, oil relative immobile contaminant so any contamination would be localised around the transformer itself, reasonable to assume that Vector would have cleaned up local oil spills
	Timber storage	66 Bush Road	Possibly Activity H	**Low**: possible treated timber stored on site but any soil contamination unlikely to have migrate to pipe alignment- no groundwater contamination reported in Oteha Stream located hydraulically downgradient of 66 Bush Road (see Section 10.2)
	Diesel spill	70 Upper Harbour Dr	Possibly Activity H	**Low**: see Section 5.2.1
NOR 3	Closed landfill	12 Kedgley Drive	Activity G3	**Low**: see Section 5.3.1
	Small electrical transformer	Fred Taylor Dr north-bound on-ramp SH18 and Gunton Drive	Activity B2 or H	**Low**: no spills of oil observed, oil relative immobile contaminant so any contamination would be localised around the transformer itself, reasonable to assume that Vector would have cleaned up local oil spills
	Retirement village	1 Squadron Dr	Possibly Activity H	**Low**: see Section 5.3.2

Area	Industry/Activity	Location	HAIL reference	Preliminary Assessment of Risk of Potential of Contamination
	Former airstrip	Near Squadron Dr- see Section 5.2	Activity H	**Low**: *"the airstrip is located on land adjacent to the proposed alignment. If present, contamination is likely confined to shallow surface soils where the airstrip was located. The potential for migration is low. In addition, site observations where a former airstrip may have been located indicates that significant earthworks and soil removal has occurred associated with construction of the Upper-Harbour Highway. It is likely that contaminated soil that may have been present has been removed during earthworks."* (T&T, 2015)
	NZDF sludge	2A Buckley Ave, see Section 5.2	Activity H	**Low for NH2**: *"sludges were previously disposed onto land within the WWTP operated by NZDF. The sludge disposal area was remediated in 2010. Minor contaminants remain at the boundaries of the disposal area. Groundwater monitoring shows low metal concentrations. The sludge bed and WWTP facility is located at least 20 m from the proposed Phase 1 alignment. The risk for these facilities to affect soil and groundwater in the vicinity of the proposed alignment is low because of the low permeability ground conditions in this area."* (T&T, 2015). We note that the NH2 pipe alignment is located north of SH18 and therefore approximately 100 m from the former sludge areas, thereby reducing the risk from low to negligible. **Medium to High for NI in NOR3**: The T&T report (T&T, 2015) describes the following:: *"Sludges were previously disposed onto land within the WWTP operated by NZDF. If significant spills/overtopping of the sludge bed has occurred (during operation of the sludge drying bed), there is potential for soil down gradient of the former sludge bed to be impacted. The former NZDF sludge bed was remediated in 2008 and a validation report prepared by Fraser Thomas Ltd. The sludge and some soil surrounding the sludge bed was excavated and disposed to landfill. Material used to backfill the remediation excavation was tested and reported in the Fraser Thomas SVR to be within cleanfill criteria. Validation testing of soil downgradient of the sludge bed is indicated to contain levels of metals (arsenic and zinc) above published background concentrations, but below levels that have the potential to pose a risk to human health. The proposed Phase 1 alignment is indicated to pass approximately 10m east (down-gradient) of the former sludge bed. Available groundwater monitoring data indicate that water quality has been impacted downgradient of the sludge bed."* Note: the 'medium to high' assessment of risk is for the likelihood of encountering contamination in this area since the validation testing shows levels of some contaminants above background values but below levels that have the potential to pose a risk to human health. Therefore the risk of this 'low level' contamination causing adverse effects to human health and the environment is considered to be low to medium provided this risk is managed during future construction works in the this area using a Contaminated Land Management Plan.
NOR 1-3	Horticultural sites	Mainly NOR1, limited along NOR2 & NOR3	Activity A10	**Low**: Any contaminated soil likely to be removed prior to road construction, as described in Section 6 above.
	Potentially contaminated fill imported for road construction		Activity I	**Low, possibly medium**: *"the fill used to construct roads are most likely to be locally derived source, and is highly unlikely to have been imported from an industrial site. If contaminants are present there are likely confined to fill material."* (T&T, 2015)

7. Statutory Requirements: Contaminated Land Assessment Criteria

This section discusses the applicable national and regional assessment criteria, in terms of soil and groundwater.

7.1 National and Regional Criteria

The contaminated land assessment criteria are derived from:

a) The Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011, commonly referred to as the NES Soil;

b) The Auckland Council Regional Plan: Air, Land & Water (ACRP:ALW); and

c) The Proposed Auckland Unitary Plan (PAUP).

The PAUP was notified on 30 September 2013. The PAUP is currently going through the public notification and submissions process. The existing district and regional plans remain operative until superseded by the provisions of the PAUP as they are made operative.

However, section 86B(3) of the RMA states that a rule in a proposed plan has immediate legal effect from the date of notification if the rule:

a) protects or relates to water, air, or soil (for soil conservation); or

b) protects areas of significant indigenous vegetation; or

c) protects areas of significant habitats of indigenous fauna; or

d) protects historic heritage; or

e) provides for or relates to aquaculture activities.

A number of rules in the PAUP have immediate legal effect as at 30 September 2013, and thus must be considered in relation to the proposed works, along with the operative plans. The contaminated soil, groundwater and landfill rules under the PAUP are very similar to those in the ACRP:ALW, and the Permitted Activity (PA) soil acceptance criteria in provision H.4.5.2.1.3 are the same as the Schedule 10 levels in the ACRP:ALW. PAUP rule H.4.5.2.3.1 is further discussed in Section 7.4.

7.2 NES Soil

The NES Soil came into effect on 1st January 2012. All territorial authorities (district and city councils) are required to give effect to and enforce the requirements of the NES.

Section 4 of the NES sets out the relationship of the regulations with territorial and regional council functions. The NES Soil relates to territorial authority functions (as set out in section 31 of the RMA), but does not apply to regional council functions under section 30 of the RMA.

The policy objective of the NES Soil is to ensure land affected by contaminants in soils is appropriately identified and assessed when soil disturbance and / or land development activities take place and, if necessary, remediated or the contaminant contained to make the land safe for human use.

The NES Soil achieves its objectives through a mix of policy allowing and controlling certain activities on land affected or potentially affected by soil contaminants. Under the regulations, land is considered to be actually or potentially contaminated if an activity or industry on the HAIL has been, is, or is more likely than not to have been, undertaken on that land.

It is considered that the requirements of the NES Soil apply to the Project since:

a) Soil disturbance, an activity under the NES Soil, will be undertaken; and

b) The soil disturbance will be undertaken where *" … an activity or industry on the HAIL has been, is, or is more likely than not to have been undertaken on that land."* This assessment was made in Table 7, see Section 6.

7.2.1 Soil Disturbance (NES Soil)

Soil disturbance under the NES Soil may either be a Permitted, Controlled, Restricted Discretionary or Discretionary Activity. The various rules for these activities are described below.

7.2.1.1 Permitted Activity

Rule 8(3) provides the Permitted Activity rules for soil disturbance.

The Project works will not meet the Permitted Activity rule requirements since it is anticipated that the volume of earthworks will be greater than 25 m^3 per 500 m^2 (assuming that the whole pipe alignment is regarded as one 'site' or 'piece of land'), the off-site spoil disposal will be greater than 5 m^3 per 500 m^2 (assuming that the majority of the spoil requires off-site disposal since the backfill material for the pipe trench is likely to require an engineered specification that the current/existing soil may not be able to fulfil), and the duration of the Project works will be longer than two months.

7.2.1.2 Controlled Activity

Rule 9(1) provides the Controlled Activity rules for soil disturbance.

The Project works will not meet the Controlled Activity rule requirements since a detailed site investigation (DSI) report does not exist. This report is a Phase 1 soil and groundwater contamination assessment and some areas of potential concern, identified as "low to medium risk" in Table 7 in Section 6, have not been investigated.

7.2.1.3 Restricted Discretionary Activity

Rule 10(1) provides the Restricted Discretionary Activity rules for soil disturbance and in summary assumes that a DSI report exists and that the soil contamination exceeds the applicable guideline values for the proposed land use (see Section 7.2.2 below).

Since a DSI report does not exist, as discussed in Section 7.2.1.2 above, it is considered that the Project works do not meet the Restricted Activity rule requirements.

7.2.1.4 Discretionary Activity

Rule 11(1) provides the Discretionary Activity rules for soil disturbance and states that

"1) This regulation applies to an activity described in any of regulation 5(2) to (6) on a piece of land described in regulation 5(7) or (8) that is not a permitted activity, controlled activity, or restricted discretionary activity."

It is considered that the Discretionary Activity regulation should be applied to the Project.

7.2.2 Soil Guideline Values

The NES Soil provides selected soil guideline values (SGVs) for human health protection for a range of land uses and these SGVs are derived from the NES Soil soil contamination standards (SCSs) for 12 priority contaminants or other referenced guidelines for non-priority contaminants.

Nine of the 12 priority contaminants have been assessed in specific parts of the pipe alignments. The remaining three contaminants, Boron, Pentachlorophenol and Dioxin, were not considered a contaminant of potential concern. The soil laboratory test results have been assessed against the appropriate SGVs in Section 11.

7.3 ACRP:ALW

The ACRP:ALW contains a number of contaminated land rules, Rules 5.5.40 to 5.5.45, that specify whether earthworks or soil disturbing activities are a Permitted Activity, Controlled Activity, Restricted Discretionary Activity or a Discretionary Activity.

There are two Permitted Activity Rules relevant to the Project, Rule 5.5.41 (for soil) and Rule 5.5.57 (for temporary discharge of uncontaminated groundwater).

7.3.1 Rule 5.5.41- Soil

Rule 5.5.41 allows for soil contaminant levels to be less than 95% of the UCL, as described in the MfE document *Contaminated Land Management Guidelines No. 5- Site Investigation and Analysis of Soils* (MfE, 2011a) using the greater of (i) or (ii) below:

i. For in situ soil and material imported and / or deposited onto the land:

   1. The criteria specified in Schedule 10 of the ACRP:ALW. Note, the discharge values have been applied in this report and it is understood that the human health values in Schedule 10 are superseded by the SGVs in the NES. For contaminants not included in Schedule 10;

   2. The Tier 1 soil acceptance criteria for the current land use or, in the case of a proposed change in land use, the proposed land use for the more stringent of either the protection of human health or sensitive groundwater specified in the MfE document *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand* (MfE, 1999), or for contaminants not included in Schedule 10 or the Petroleum Hydrocarbon guidelines;

   3. The soil quality guidelines for the current land use or, in the case of a proposed change in land use, the proposed land use in *the Canadian Environmental Quality Guidelines*, prepared by the Canadian Council of Ministers of the Environment (CCME, 1991), updated 2002, for the currently zoned land use, or for contaminants not included in Schedule 10, the Petroleum Hydrocarbon guidelines or the CCME guidelines; and

   4. For dieldrin and lindane only, the soil quality guidelines in the MfE document *Identifying, Investigating and Managing Risks Associated with Former Sheep-Dip Sites- A Guide for Local Authorities* (MfE, 2006).

ii. For in situ soil and material imported and / or deposited onto the land the natural background levels for that soil or material or the relevant background levels specified in the Auckland Regional Council (ARC) Technical Publication (TP) *Background concentrations of inorganic elements in soils from the Auckland region* (TP153) (ARC, 2001).

Rule 5.5.41 also requires that soil or material historically imported shall not contain separate phase liquid contaminants including separate phase hydrocarbons.

7.3.2 Rule 5.5.47- Groundwater

In terms of assessing the contaminants in the groundwater for the Project it is considered that Rule 5.5.57 applies:

> *"The discharge of water from the following is a Permitted Activity: ……*
>
> *e) Temporary and permanent discharge of diverted uncontaminated groundwater;"*

Uncontaminated groundwater, in terms of its contaminant level is defined in Rule 5.5.58 which states that:

> *"The activities in Rule 5.5.47 are subject to the following conditions: ….*
>
> *c) "The contaminants discharged shall not either by itself or in combination with other contaminants after reasonable mixing exceed the greater of the 95 percent trigger values for freshwater (groundwater) specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000), or the natural background level, with the exception …"*

It is understood that with respect to the term 'reasonable mixing' Auckland Council can accept up to ten times (10x) the threshold criteria, i.e. the ANZECC 95% protection trigger level multiplied by ten.

7.4 PAUP

7.4.1 Provision H.4.5.2.1.3

Provision H.4.5 of the PAUP (contaminated land), an activity table is provided for discharge rules under Section 15 of the RMA. The table *"specifies the activity status for the discharge of contaminants to land and/or water from containing elevated levels of contaminants."*

Within the PAUP table it is considered that the activity described as *"Discharges of contaminants from land not used for primary production"* is most relevant to the Project works, and the PAUP table classifies this as a Permitted Activity.

Auckland Council manages the potential discharges from a Permitted Activity with a number of controls and the controls applicable to the *"Discharges of contaminants from land not used for primary production"* are specified in provision H.4.5.2.1.3 of the PAUP. Therefore the controls of provision H.4.5.2.1.3 of the PAUP are, in terms of maximum allowable soil contaminant criteria, the same as those specified in Rule 5.5.41 of the ACRP:ALW (see Section 7.3.1).

7.4.2 Provision H.4.18.2.1.1.2

Provision H.4.18 of the PAUP allows for *" …discharges of contaminants onto or into land that are not otherwise covered by the plan, and that are identified as occurring or needing to occur for recognised purposes."*

An activity table is provided for provision H.4.18 and the activity described as *"discharge of water from … temporary and permanent discharge of diverted uncontaminated groundwater.."* has a Permitted Activity status.

The controls relevant to contaminant criteria relevant to a Permitted Activity are specified in provision H.4.18.2.1.1.2 of the PAUP and are paraphrased below:

> *"The contaminant discharged must not either by itself or in combination with other contaminants after reasonable mixing exceed the greater of the 95 percent trigger values for freshwater (groundwater) specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000), or the natural background level".*

Therefore the controls of provision H.4.18.2.1.1.2 of the PAUP are the same as those specified in Rule 5.5.58(c) of the ACRP:ALW (see Section 7.3.2).

7.5 Adopted Site Assessment Criteria

7.5.1 Soil: Adopted Site Assessment Criteria

Based on the NES Soil, ACRP:ALW and PAUP soil guideline values described above, the soil contamination values adopted for this assessment are presented in Table 8 below.

Table 8: Soil- Adopted Site Assessment Criteria

Parameter	ACRP:ALW Permitted Activity Limits		SCS commercial/industrial outdoor worker/maintenance	TP153 (cleanfill criteria)	
	Schedule 10	Other discharge		Non-volcanic	Volcanic
Arsenic	100	-	70	12	12
Cadmium	7.5	-	1300 (at pH =5)	0.65	0.65
Chromium	400	-	6300	55	125
Copper	325	-	>10,000	45	90
Lead	250	-	3300	65	65
Mercury	0.75	-	4200[7]	0.45	0.45
Nickel	105	-	1500[3]	35	320
Zinc	400	-	23000[3]	180	1160
Naphthalene	-	69[4]	-	-	-
BaP (equiv)	2.15		35	-	-
Pyrene	-	1.3[4] – 1600[4]	-	-	-
C7 – C9	-	710[4] – 2700[4]	-	-	-
C10 – C14	-	560[4] – 1500[4]	-	-	-
C15 – C36	-	>20000[4]	-	-	-
DDT- total	0.7[6]	-	1000	-	-
Dieldrin	-	190[5]	160	-	-
Lindane		14,000[5]	-	-	-

Notes:

[1] MfE, 2011, Tables 54 & 55, Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health.

[2] ACRP:ALW (Operative in Part, 21 October 2010). It may be inferred from Note 3 of Schedule 10 that where the heavy metal limit for human health is not shown then the limit is equal or higher than the discharge limit.

[3] United States Environmental Protection Agency (USEPA), Human Health Medium – Regional Screening Levels (RSL, May 2013) – International risk – based SGVs for residential land use, non-cancer endpoint, all pathways.

[4] MfE, Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand (Revised 2011) Module 4 – Tier 1 Soil Screening Criteria Residential land use, all pathways, for silty clay soil with surface (<1m) depth of contamination (Table 4.10) and for the protection of groundwater quality for potable use (Table 4.20) with surface contamination (<1 m) and depth to groundwater as 4 m.

[5] MfE, Identifying, Investigating and Managing Risks Associated with Former Sheep-dip Sites, November 2006 – SGVs for human health for commercial / industrial (unpaved) land use (Table 4).

[6] Note 2 of Schedule 10 states that this value applies to the redevelopment phase. Upon completion of the land development the PA limit is 12 mg/kg, which is the same value as in the PAUP permitted activity criteria, see Section 7.4.1.

[7] Inorganic mercury compounds.

[8] ARC (2001), Background concentrations of inorganic elements in soils from the Auckland region, TP 153.

7.5.2 Groundwater: Adopted Site Assessment Criteria

The guideline values adopted for this groundwater contamination assessment are presented in Table 9 below and were used to assess groundwater at the site. These values are based on Rules 5.5.57(e) and 5.5.58 (c) of the ACRP:ALW, and controls of provision H.4.18.2.1.1.2 of the PAUP, see Section 7.4.2. We note that the marine values are presented for comparative purposes as Rule 5.5.42A (i) refers to freshwater trigger level, however, as part of the site is located near the CMA and the groundwater is likely to discharge to the marine environment and therefore the marine values may be considered.

Table 9: Groundwater- Adopted Site Assessment Criteria

Parameter	95% Level of Protection of Species, ANZECC (2000)		Adopted Groundwater Site Assessment Criteria
	Freshwater	Marine	
Arsenic	0.024	ID [2]	0.240
Cadmium	0.0002	0.0055	0.055
Chromium	0.001	0.0044	0.044
Copper	0.0014	0.0013	0.013
Lead	0.0034	0.0044	0.044
Mercury	0.0006	0.0004	0.004
Nickel	0.011	0.070	0.7
Zinc	0.008	0.015	0.150
Naphthalene	0.016	0.070	0.7
BaP (equiv)	0.0002 [3]	ID	0.002
Pyrene	-	-	-
C7 – C9	-	-	-
C10 – C14	-	-	-
C15 – C36	-	-	-

Notes:

[1] All units are in mg/L (=g/m^3).

[2] ID means insufficient data to derive a reliable trigger value.

[3] A low reliability trigger value of 0.2 µg/L was derived for benzo[a]pyrene using the statistical distribution method (95% protection). This chemical has the potential to bio-accumulate but this has not been accounted for in this figure. Alternative protection levels were 99% 0.1 µg/L, 90% 0.4 µg/L, 80% 0.7 µg/L. The 99% figure is recommended if no data are available on bioaccumulation effects at specific sites. This is applicable to both fresh and marine waters and should only be used as an indicative interim working level. Australian and New Zealand Guidelines for Fresh and Marine Water Quality Volume 2 Aquatic Ecosystems - Rationale and Background Information (Chapter 8) October 2000.

8. Site Investigation Works

In the period May to June 2014 site investigation works were carried out at:

a) The five stream crossings: four located in the NOR1 area and one located in the NOR2 area, see Table 3 in Section 4.2.2; and

b) In the area of the Greenhithe Bridge: in the western side of the NOR2 area and the eastern side of the NOR3 area.

The works were carried out for geotechnical and contaminated land assessment purposes and comprised of machined drilled boreholes and hand augered boreholes.

The site investigation works for the Greenhithe Bridge area have been previously presented in report titled *Technical Report B- Soil, Sediment and Groundwater Contamination, Greenhithe Bridge Watermain Duplication and Causeway*, for Watercare, prepared by Jacobs, reference AE04521, revision 6, dated June 2015 (Jacobs, 2015). The relevant information from that report, such as borehole logs and soil contamination test results, has been reproduced in this report in Appendix B.

8.1 Objective

The objective of the site investigation works was to assess the soil and groundwater contaminant levels at the five stream crossings and in the area near the Greenhithe Bridge that would be disturbed during the earthworks. The data obtained from the site investigation works, and field observations in terms of visual or olfactory evidence of ground contamination, would be used to establish the implications of the proposed works.

8.2 Sampling Methodology: Soil, Sediment and Groundwater

Watercare engaged Jacobs to prepare a sampling methodology for soil, groundwater and sediment sampling in April 2014. The sampling methodology provided Watercare's site investigation contractor Opus International Consultants Ltd (Opus) with the proposed sample locations and method of obtaining samples. A copy of the sampling methodology is presented in Appendix H. The sampling methodology also included that for the Greenhithe Bridge Watermain Duplication and Causeway area (Jacobs, 2015) and therefore included sediment sampling.

8.3 Fieldwork

The fieldwork was undertaken by Opus in accordance with the sampling methodology, see Appendix H, in the period May to June 2014.

The locations of the soil, sediment and groundwater samples obtained within the site are presented in Table 1 of the report *Environmental Sampling and Testing Report, NH2 Watermain, Greenhithe and Stream Crossings*, reference GS14/091 (Opus, 2014). A copy of this report is contained within Appendix I.

All samples were couriered to R J Hills Laboratory Limited (Hills Laboratory) by Opus using appropriate contaminated land documentation such as chain of custody and request for analysis forms.

Copies of the borehole logs of the environmental sampling locations are contained within Appendix B (note, these borehole logs are also contained within Appendix B of the Opus Geotechnical Factual Report GS14/089).

None of the boreholes recorded visual or olfactory evidence of ground contamination.

9. Laboratory Testing

The laboratory testing comprised the testing of soil and groundwater samples for the following parameters:

a) Suite of heavy metals: Arsenic, Cadmium, Chromium (total), Copper, Lead, Nickel, Zinc and Mercury;

b) Total Petroleum Hydrocarbons (TPH) and Polycyclic Aromatic Hydrocarbons (PaH); and

c) Organochlorine Pesticides (OCP).

For the May to June 2014 fieldwork the samples tested and laboratory testing regime is presented in Table 3 of the environmental sampling and testing report contained in Appendix I. The information contained in Appendix I includes Greenhithe Bridge Watermain Duplication and Causeway area and for clarity the sampling and testing regime for relevant to the NOR1-NOR3 area has been reproduced in Table 10 (soil) and Table 11 (groundwater) below.

An assessment of the soil and groundwater test results is presented in Section 11 of this report.

Table 10: Summary of Laboratory Testing Regime: Soil

Area	Location	Borehole/Hand Auger	Depth (m)	Parameter Tested			
				Metals	TPH	PaH	OCP
NOR1	Oratia Stream Crossing	BH251	0.0-0.2	✓	✓	✓	✓
	Opanuku Stream Crossing	HA254	0.0-0.2	✓	✓	✓	✓
			0.9-1.1	✓	✓	✓	✓
		HA255	0.0-0.2	✓	✓	✓	✓
	Parekumu Stream Crossing	HA259	0.0-0.2	✓	✓	✓	✓
		HA260	0.0-0.2	✓	✓	✓	✓
			0.9-1.1	✓	✓	✓	✓
	Swanson Stream Crossing	BH263	0.0-0.2	✓	✓	✓	✓
NOR2	West end near GBWD works	BH204	0.0-0.2	✓	✓	✓	✓
			0.9-1.1	✓	✓	✓	✓
NOR3	East end near GBWD works	BH201	0.0-0.2	✓	✓	✓	✓
			0.9-1.1	✓	✓	✓	-
		BH202	0.0-0.2	✓	✓	✓	✓
			0.9-1.1	✓	✓	✓	-

Table 11: Summary of Laboratory Testing Regime: Groundwater

Area	Location	Borehole	Parameters Tested		
			Metals	TPH	PaH
NOR2	Oteha Stream Crossing	BH265	✓	✓	✓
NOR3	East end near GBWD works	BH201	✓	✓	✓

10. Assessment of Site Test Results

The assessment of the site test results has been made against national and Auckland regulatory criteria previously discussed in Section 7, and against the off-site disposal criteria, for soil and groundwater. This is discussed in Sections 10.1 and 10.2 below.

10.1 Soil Contamination Assessment

The table in Appendix J provides an assessment of the 14 soil samples against the SGVs from the NES, the Schedule 10 criteria of the ACRP:ALW and the TP 153 Auckland cleanfill criteria. A summary of the test results against the regulatory criteria for each of the three sections of the pipe alignments is presented in Table 12 below. The notes below Table 12 indicate where other soil contamination test results are available.

Table 12: Summary of Assessment of Test Results Against Regulatory Criteria

Area	Are the site test results below the following criteria?			
	NES- SCS [1]	ACRP:ALW-Schedule 10 [2]	TP153	
			Non-volcanic soil [3]	Volcanic soil
NOR1	Yes	yes	no	yes
NOR2 [4]	Yes	yes	yes	yes
NOR3 [5]	Yes	yes	yes	yes

Notes:

[1] NES- SCS for commercial / industrial outdoor worker/maintenance, as per Table 8 in Section 7.5.1.

[2] The ACRP:ALW Schedule 10 criteria determine the contaminant levels meet the permitted activity criteria. The Schedule 10 contaminant criteria are often used by managed fill sites as maximum allowable contaminant criteria.

[3] The TP153 (non-volcanic soil) levels are typically used to assess if spoil from a site disposed off-site as cleanfill.

[4] Soil contamination data from the NI Project (T&T, 2015), previously discussed in Section 5, indicate that the soils up to a depth of 0.5 m contain elevated levels of organic compounds (PaHs) and that this soil should not be classified as cleanfill but as slightly contaminated material and require off-site disposal to a licensed managed fill site or licensed solid waste landfill.

[5] Soil contamination data from the NI Project (T&T, 2015), previously discussed in Section 5, indicate that the soil is not contaminated, i.e. all test results meet Auckland Council published background values (ARC, 2001).

10.2 Groundwater Contamination Assessment

The groundwater test results from boreholes BH201 and BH265 have been presented in Table 13, together with the assessment criteria from Section 7.5.2.

Table 13 shows that most test results are less than the laboratory limit of detection (LOD) and all test results are less than the PA criteria for freshwater and less than the PA criteria for marine water.

If it is required to temporarily remove groundwater during the construction works at the receiving pit located south of SH18 (BH201) or for the Oteha Stream crossing works (BH264), it may be discharged to the stormwater system.

For the remainder of the pipe alignment there is no information on the groundwater quality. Conservatively it is assumed that if temporary groundwater lowering is required for the construction works it may be disposed of at the local sewer, with prior permission from Watercare. If during the excavation works visual and / or olfactory

evidence of groundwater is encountered, the groundwater shall be sampled and tested prior to sewer disposal, and procedures for this event shall be documented in the CLMP. Alternatively pre-construction groundwater quality monitoring may be carried out at key locations where groundwater diversion is likely to be required and identified in *Technical Report C – Groundwater, North Harbour 2 Watermain and Northern Interceptor Shared Corridor, Volume 2*.

Table 13: Groundwater Test Results and Adopted Groundwater Criteria

Parameter	BH201	BH265	95% Level of Protection of Species, ANZECC (2000)		Adopted Groundwater Site Assessment Criteria
			Freshwater	Marine	
Arsenic	<0.011	<0.0011	0.024	ID [2]	0.240
Cadmium	<0.00053	<0.000053	0.0002	0.0055	0.055
Chromium	<0.0053	<0.00053	0.001	0.0044	0.044
Copper	<0.0053	<0.00053	0.0014	0.0013	0.013
Lead	<0.0011	<0.00011	0.0034	0.0044	0.044
Mercury	<0.00008	<0.00008	0.0006	0.0004	0.004
Nickel	<0.0053	0.00142	0.011	0.070	0.7
Zinc	<0.011	0.0011	0.008	0.015	0.150
Naphthalene	<0.0005	<0.0005	0.016	0.070	0.7
BaP (equiv)	<0.00010	<0.00010	0.0002 [3]	ID	0.002
Pyrene	<0.0002	<0.0002	-	-	-
C7 – C9	<0.10	<0.10	-	-	-
C10 – C14	<0.2	<0.2	-	-	-
C15 – C36	<0.4	<0.4	-	-	-

Notes:

[1] All units are in mg/L (=g/m^3, as reported by Hill Laboratories, see Appendix I).

[2] ID means insufficient data to derive a reliable trigger value.

[3] A low reliability trigger value of 0.2 µg/L was derived for benzo[a]pyrene using the statistical distribution method (95% protection). This chemical has the potential to bio-accumulate but this has not been accounted for in this figure. Alternative protection levels were 99% 0.1 µg/L, 90% 0.4 µg/L, 80% 0.7 µg/L. The 99% figure is recommended if no data are available on bioaccumulation effects at specific sites. This is applicable to both fresh and marine waters and should only be used as an indicative interim working level. Australian and New Zealand Guidelines for Fresh and Marine Water Quality Volume 2 Aquatic Ecosystems - Rationale and Background Information (Chapter 8) October 2000.

11. Assessment of Environmental Effects

11.1 Conceptual Model Development

A typical conceptual model for soil and groundwater contamination includes three items and their linkages:

a) Sources;

b) Pathways; and

c) Receptors.

The conceptual Project risk model comprises a review of available data collected in the preparation of this report to determine on a qualitative basis the potential exposure sources of receptors to the contaminants sources (soil and groundwater) identified from the site history.

The conceptual model establishes the presence and nature of potential contamination sources, and determines who the potential receptors are i.e. who could be exposed to the contamination and the potential pathways (ingestion, inhalation, and direct contact) from contamination source to the receptors. The Project is then examined as a whole to determine whether complete source, pathway, and receptor pollutant linkages are present and as such does an exposure risk to humans exist.

11.2 Sources

The conceptual site model source including the contaminants of concern, can be classified into one of three groups:

a) Known contamination (including potentially contaminated sites);

b) Unknown contamination; and

c) Future Project construction activity related contamination.

Known contamination areas have not been identified for the Project site, both in terms of the desktop study (see Sections 4 and 5) and the actual soil and groundwater testing at the site (see Section 9).

Approximately 20 areas/sites of potential contamination have been presented in Table 7, Section 6, including an estimate of their risk level (low, medium and high) to the Project. None of the areas/sites are considered a high risk and all but one site are categorised a low risk. The two sites that are not categorised a low risk are categorised a low to medium risk (the Gull petrol station, located at 1-3 Forest Hill Road in Henderson) and medium to high risk (the Hobsonville pump station, located at 2A Buckley Ave).

It is anticipated that unforeseen ground contamination discovered during future excavation works for the NH2 pipe and NI in the shared corridor can be managed via a CLMP, see Section 11.5 below.

Unknown contamination areas are those that may be discovered during future excavation works associated with the Project, both in trench excavation and micro-tunnelling. Unknown contamination will also be addressed in the CLMP.

11.3 Pathways

Pathways are the routes that move contaminants from the source to the receptors. Exposure routes are also considered pathways.

Contaminant pathways that have been considered in the preparation of this report are:

a) Ingestion of soil;

b) Dermal contact with soil;

c) Inhalation of vapours and dust;

d) Groundwater movement; and

e) Overland flow of contaminated water.

11.4 Receptors

Receptors are the elements that could be adversely affected by the contaminants and include:

a) People, in particular excavation and construction workers for the Project;

b) Ecological receptors, such as flora and fauna;

c) Groundwater; and

d) Surface water.

11.5 Plausible Contaminant Linkages

Table 14 below provides a summary of the Project-specific Plausible Contaminant Linkages (PCL) based on historic activities identified along the NH2 pipe alignment and NI in the shared corridor, the contaminants of concern, the results of the investigations undertaken and the potential receptors. Within this table, the plausibility of contaminant linkages is indicated as per below:

✓ Plausible contaminant linkage; and

X No plausible contaminant linkage.

Table 14: Plausible Contaminant Linkages

Source	Pathway	Receptor	Comment	PCL
Contamination in made ground, i.e. fill material	Ingestion, direct contact (dermal), inhalation of dust	Future site users	Possible residual hydrocarbons and heavy metal contamination at some sites	X
	Uptake by vegetables	Future site users		X
	Ingestion, direct contact (dermal), inhalation of dust	Construction workers		✓
	Ingestion, direct contact (dermal), inhalation of dust	General public		X
	Migration of leachable fraction	Groundwater & surface water		✓
Contamination in natural soil	Ingestion, direct contact (dermal), inhalation of dust	Future site users	No known area of contamination	X
	Uptake by vegetables	Future site users		X

Source	Pathway	Receptor	Comment	PCL
	Ingestion, direct contact (dermal), inhalation of dust	Construction workers		X
	Ingestion, direct contact (dermal), inhalation of dust	General public		X
	Migration of leachable fraction	Groundwater & surface water		X
Contamination in groundwater	Ingestion, direct contact (dermal)	Future site users	No known area of contamination	X
	Ingestion, direct contact (dermal),	Construction workers		X
	Off-site migration	Groundwater & surface water		X
Contamination in surface water	Ingestion, direct contact (dermal)	Future site users	No known area of contamination	X
	Ingestion, direct contact (dermal),	Construction workers		X
	Off-site migration	Groundwater & surface water		X
	Direct contact	Building materials		X

Based on the plausible contaminant linkages model the main risk potential posed as a result of residual soil contamination is to construction workers if they do not handle the material using appropriate methods controls. The level of risk to site workers, the general public and the environment as a result of potential soil contamination is very low to negligible and this is borne out by the results of the initial soil sampling conducted as part of preparing this report.

11.6 Conclusion: Assessment of Human Health and Environmental Effects

The linkages between source, target and receptor are important in assessing the ground contamination risk during the construction of the proposed pipelines, both in terms of human health and environmental risks.

Limited soil and limited groundwater testing have shown that the potential risk to the receptors, in particular the construction workers, general public and future site users during and following the proposed works (in the areas where soil and groundwater testing was carried out) will be less than minor.

A conservative approach to manage unforeseen / unknown ground contamination is to use protocols that are designed to avoid, mitigate and remedy the potential for adverse effects on the environment, for example, the Project erosion and sediment control plan (ESCP) and the CLMP.

The CLMP will be prepared once the contractor has been appointed and it will be submitted to Council prior to construction. It should include, as a minimum:

a) Guidance for site staff on how to recognise ground contamination during excavation works;

b) Procedures on how to deal with unforeseen ground contamination such as discovery protocols; and

c) Potential ground contamination resulting from construction activities such as inadvertent spillages of fuel while refuelling construction plant and equipment.

It is therefore considered that potential adverse effects on the environment arising from unforeseen/unknown ground contamination at the Project site can be avoided, mitigated and remedied provided that the contractor adheres to the protocols listed in the ESCP and the CLMP.

12. Spoil Disposal

It is anticipated that all spoil generated by the Project will require off-site disposal since there is limited space within the Project works area (typically the road reserve), where the spoil can be efficiently stockpiled and reused for the Project works.

For simplicity the spoil generated by the Project excavation works has been categorised into four groups based on the type of excavation method and depth of excavation:

a) Open trench excavation works;

b) Shafts for trenchless excavations;

c) Micro tunnelling and pipe jacking; and

d) Foundations for pipe bridge crossing.

The spoil generated by these four groups, the potential for the spoil to be contaminated and the recommended spoil disposal options are presented in Sections 12.1 to 12.4 below. Table 15 in Section 12.5 provides a summary of the spoil disposal options for the NOR1 to NOR3 areas.

12.1 Trench Excavation Works

12.1.1 NOR1 and Northern Part of NOR2

The majority of the Project works in the NOR1 area and northern part of the NOR2 area (from William Pickering Drive north) involves trench excavation below the existing road carriageway as shown in the Project drawings 2010673.510 to 2010673.532.

The desk-top study and drive-by pipe alignment assessment has shown that parts of the trench excavation works are located near HAIL sites, for example petrol stations. However, it is considered that the risk of ground contamination at the pipe alignment originating from these HAIL sites is typically considered low, as previously discussed in Table 7 in Section 6.

An existing carriageway is anticipated to comprise the following four layers (from top to bottom): asphalt, basecourse, subbase and subgrade, the latter often being the in-situ soil that is compacted or reworked. The depth of these four layers is expected to range, in broad terms, between 0.5 m and 1 m. Within the existing carriageway it is considered reasonable to assume that these four layers are uncontaminated.

Within the road berm it is possibly that the upper 0.5 m may contain slightly elevated levels of contaminants, for example PaHs, as show in the NI investigation in NOR3, previously discussed in Section 5. We note that many other soil / fill test results in the upper 0.5 m layer did not report elevated levels of contamination and that the soil test results comply with cleanfill criteria (see Appendix C).

It is considered that a conservative assumption would be assume that all soil / fill up to a 0.5 m depth is marginally contaminated and requires off-site disposal to a licensed managed fill site, and that all soils below a depth of 0.5 m can be disposed off-site as cleanfill.

12.1.2 Southern Part of NOR2

In the southern part of the NOR2 area the trench excavation works excavation are within the berm of the SH18 motorway.

The desk-top study and drive-by pipe alignment assessment have shown that there is a low risk of ground contamination at the pipe alignment caused by HAIL sites located adjacent or near the pipe alignment.

Typical cross sections details of the proposed SH18 construction section are presented on Drawing 2010674.351. These sections show that the proposed pipe will be cut into the existing SH18 berm and that the spoil from these cutting works may be used as fill in other areas of the SH18 section.

There is no reason to suspect that contaminated soil was used in the construction of the berm of SH18 and it is therefore considered reasonable to assume that the future spoil from this area can be disposed of as cleanfill.

12.1.3 NOR3

In the eastern part of the NOR3 area, the future excavation works for both the NH2 pipe and NI in the shared corridor are located within the northern berm of the SH18 motorway corridor. The NI in the shared corridor crosses SH18 from the northern berm to the southern berm at the Hobsonville pump station whereas the NH2 alignment crosses SH18 in the area of Sinton Road.

In the central and western part of the NOR3 area, the future excavation works are typically within the southern part of the SH18 corridor.

The desk-top study and drive-by pipe alignment assessment have shown that there is a low risk of ground contamination caused by HAIL sites located adjacent at or near the NH2 alignment and NI in the shared corridor, except at the following two areas:

a) Near Brigham Creek Road, see Section 5.3.4; and.

b) Near Hobsonville pump station, see Section 5.4.6.

For the NH2 works typical cross section details of the proposed SH18 construction section are presented on Drawing 2010674.351. These sections show that the proposed pipe will be cut into the existing SH18 berm and that the spoil form these cutting works may be used as fill in other areas of the SH18 section. The excavation works for the NI in the shared corridor largely comprise access shafts for a trenchless technology (see Section 2.1.2).

The soil contamination testing in the eastern part of the NOR3 area shows that the soil contaminant levels are low and that the soil can be regarded as cleanfill. However, in the area of Brigham Creek Road (see Section 5.3.4) and the western part of NOR3 (through former farmland) a conservative assumption would be to assume that the top 0.5 m depth of soil contains low level contamination. In the area of the current Hobsonville pump station it is considered appropriate that the soil up to a depth of 1 m contains low level contamination

For the NOR 3 area it is considered that a conservative assumption would be to assume that all soil / fill up to a 0.5 m depth is marginally contaminated and requires off-site disposal to a licensed managed fill site, and that all soils below a depth of 0.5 m can be disposed off-site as cleanfill, except for the soils in the Hobsonville pump station area where soil up to a depth of 1 m should be disposed of to a licensed managed fill site.

12.2 Shafts for Trenchless Excavations

The NH2 Project shafts for trenchless excavations are shown on Drawing numbers 2010674.301, .302, .316, .321-.327, .331 and .332. These shafts are identified on the drawings as temporary jacking pits and receiving pits.

The NI Project in the shared corridor the shafts for trenchless excavations are shown on Drawing numbers 2011119.004 and Drawing number 2011120.001 to .017.

The desk-top study and drive-by pipe alignment assessment have not identified HAIL sites at or adjacent to the proposed shaft locations, except for:

a) The proposed shaft for Microtunnel Pit 13 for the NI in the shared corridor as shown on Drawing number 2011120.013. The proposed Microtunnel Pit 13 is located immediately west of the Pond 1 area investigated by GHD in 2012 (GHD, 2012). The GHD report shows that no actual soil sampling and testing was carried out at the proposed Microtunnel Pit 13 location and from aerial photographs it appears that the area at and around Microtunnel Pit 13 has been subjected to earthworks, probably earthworks associated with the Birmingham Creek Road off-ramp and construction of the nearby roundabout. It is therefore concluded that there is a low risk of encountering soil contamination at the Microtunnel Pit 13 location.

b) The proposed shaft for Microtunnel Pit 17 for the NI in the shared corridor as shown on Drawing number 2011120.017. The proposed Microtunnel Pit 17 is located west of the Hobsonville Pump station and the former NZDF sludge bed and sludge bed remediation works were carried out east of the pump station (see Section 5.4.6). A conservative assumption would be to assume that the soils up to a depth of 1 m would contain low level contamination and require off-site disposal to a licensed managed fill site.

It is reasonable to assume that the future spoil from these shaft areas can be disposed of as cleanfill, except for the spoil from the Microtunnel Pit 17, see item b) above.

12.3 Micro Tunnelling and Pipe Jacking

For the NH2 Project all micro tunnelling and pipe jacking operations will be carried out at depth and into the natural ground, see also Drawing numbers 2010674.301, .302, .316, .321-.327, .331 and .332.

For the NI Project in the shared corridor the micro tunnelling excavations will also be carried out at depth and into the natural ground, see Drawing numbers 2011119.004 and Drawing number 2011120.001 to .017.

Since these works are carried out in natural ground it is reasonable to assume that the spoil derived from these trenchless excavation works is not contaminated and that the spoil can be removed off-site as cleanfill.

12.4 Foundations for Pipe Bridge Crossings

The pipe alignment crosses five streams as previously discussed in Table 3 in Section 4.2.2. Piled foundations are proposed for the pipe bridge crossings as shown on Drawing numbers 2010673.881 to .885 and Drawing numbers 2010675.211, .211, .221, 2.31 and .241.

Geotechnical and soil contamination investigations were carried out at all five stream crossing and show that:

a) At the Oratia and Oteha Stream Crossings the soil contaminant levels showed marginally elevated levels of one or more heavy metals. Spoil from piled foundation excavations up to 0.5 m depth should be disposed of as managed fill and spoil below 0.5 m depth as cleanfill; and

b) At the Opanuku, Parekumu and Swanson Stream Crossings the soil contaminant levels were all below the Auckland background values for non- volcanic soils. All spoil from piled foundation excavations may be disposed of as cleanfill.

12.5 Spoil Disposal Options for Areas NOR1-NOR3

The spoil disposal options for areas NOR1 to NOR3 and based on the four excavation groups and excavation depths as discussed in Sections 12.1 to 12.4 above are presented in Table 15 below.

Table 15: Summary of Off-Site Spoil Disposal Options based on Type of Excavation and Depth of Excavation

Area	Type of excavation	Depth (m bgl)	Off-site disposal option	
			Cleanfill	Managed Fill
NOR1	Open trenches:	0.0 - 0.5		✓
		> 0.5	✓	
	Shafts / pits	All depths	✓	
	Micro tunnel or pipe jacking	All depths	✓	
	Oratia stream crossing	0.0 - 0.5		✓
		> 0.5	✓	
	Opanuku, Parekumu & Swanson stream crossings	All depths	✓	
NOR2	Open trenches: from William Pickering Dr north	0.0 - 0.5		✓
		> 0.5	✓	
	Open trench: from William Pickering Dr south	All depths	✓	
	Shafts / pits	All depths	✓	
	Micro tunnel or pipe jacking	All depths	✓	
	Oteha stream crossing	0.0 - 0.5		✓
NOR3	Open trenches (except near Brigham Creek Road)	0.0 - 0.5		✓
		> 0.5	✓	
	Open trenches near Brigham Creek Road [1]			✓
	Shafts / pits- except Microtunnel Pit 17	All depths	✓	
	Microtunnel Pit 17	0.0 – 1.0		✓
		> 1.0	✓	
	Micro tunnel or pipe jacking	All depths	✓	

Note: [1] See Section 5.3.4: The presence of ACM and any possible soil contaminated with asbestos fibres should be removed by a competent person and this material is likely to require off-site disposal to a licensed solid waste landfill.

13. Project Contamination Regulatory Assessment

13.1 NES Soil

It is considered that the requirements of the NES Soil apply to the Project since:

a) Soil disturbance, an activity under the NES Soil, will be undertaken; and

b) The soil disturbance will be undertaken where *" … an activity or industry on the HAIL has been, is, or is more likely than not to have been undertaken on that land."* This assessment was made in Table 7, see Section 6.

It is considered that Discretionary Activity resource consent is required under the NES Soil since the rules for a Permitted Activity, Controlled Activity or Restricted Discretionary Activity cannot be met, in particular, the requirement for a DSI report cannot be met.

This report is a soil and groundwater contamination assessment and is essentially a combination of a Preliminary Site Investigation report with limited soil and groundwater quality testing.

This report shows that there is a low risk of encountering ground contamination during the future excavation work and recommends that unforeseen ground contamination discovered during future earthworks can be appropriately managed via a CLMP.

13.2 ACRP:ALW

It is considered that no resource consent is required under the contaminated land rules of the ACRP:ALW for the following reasons:

a) Limited soil testing shows that the Project site does not fall into the category of land containing elevated levels of contaminants, i.e. all soil test results are below the soil contaminant criteria of Rule 5.5.41, see Section 10.1;

b) For the large part of the Project site where no soil contamination testing was carried out it is considered that there is a low risk of encountering soil contamination (see Section 6). More specifically, that there is a low risk of encountering land containing elevated levels of contamination;

c) Limited groundwater testing shows that there is no groundwater contamination and that the test results meet the Permitted Activity criteria under Rule 5.5.47, see Section 10.2;

d) Separate phase hydrocarbons were not encountered during the limited field investigation and the risk of encountering separate phase hydrocarbons in considered low. (See Section 6 where former ARC files have been reviewed for petrol station sites);

e) All spoil generated by the future excavation works will be disposed off-site at a licensed landfill, i.e. a licensed managed fill site or a licensed cleanfill site, see Section 12 (except for the ACM present near Brigham Creek Road, this is likely to require off-site disposal to a licensed solid waste landfill); and

f) A CLMP can appropriately manage unforeseen ground contamination discovered during the proposed excavation works for the Project.

13.3 PAUP

It is considered that no resource consent is required under the PAUP since:

a) The PAUP refers to land containing elevated levels of contaminants;

b) Limited soil testing shows that the Project site does not fall into the category of land containing elevated levels of contaminants, i.e. all soil test results are below the soil contaminant criteria of Provision H4.5.2.1.3, see Section 7.4.1; and

c) For the large part of the Project site where no soil contamination testing was carried out it is considered that there is a low risk of encountering soil contamination (see Section 6). More specifically, that there is a low risk of encountering land containing elevated levels of contamination.

14. Conclusions

It is concluded that:

a) A historical aerial photograph review, Council SCE, Council site file review and site drive-by pipe alignment assessment indicated that the potential for soil and groundwater contamination is categorised as typically low and occasionally low-medium (see Section 6);

b) A limited soil contamination investigation has shown that all soil test results are below the NES Soil SCS for commercial/industrial land use and below the ACRP:ALW Schedule 10 criteria (see Section 10.1);

c) A limited groundwater contamination investigation has shown that that most test results are less than the laboratory limit of detection (LOD) and all test results are than the PA criteria for freshwater and less than the PA criteria for marine water (see Section 10.2);

d) The limited soil and limited groundwater testing have shown that the potential risk to the receptors, in particular the construction workers, general public and future site users during and following the proposed works (in the areas where soil and groundwater testing was carried out) will be less than minor (see Section 11.6);

e) A conservative approach to manage unforeseen/unknown ground contamination is to use protocols that are designed to avoid, mitigate and remedy the potential for adverse effects on the environment, for example, the ESCP and the CLMP (see Section 11.6);

f) Spoil disposal options for the future excavation works are either at a licensed managed fill site or a licensed cleanfill site as presented in Table 15 in Section 12.5;

g) A Discretionary Activity resource consent is required under the NES Soil since the rules for a Permitted Activity, Controlled Activity or Restricted Discretionary Activity cannot be met, in particular, the requirement for a DSI report cannot be met (see Section 13.1);

h) No resource consent is required under the contaminated land rules of the ACRP:ALW for the reasons listed in Section 13.2; and

i) No resource consent is required under the PAUP for the reasons listed in Section 13.3.

15. References & Bibliography

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c) Babbage, 2012, selected pages copied from the site file viewed on 05 November 2015 (see Section 5), client/project *MB82 Due Diligence Study*.

d) GHD, 2011, *Report for NorSGA- Hobsonville Road East- Preliminary Soil Contamination Investigation*, prepared for Auckland Council, by GHD Limited, January 2011, reference 51/28664/12.

e) GHD, 2012, *Report for NorSGA- Brigham Creek Road- Pond 1 & 2 Soil Quality Investigation*, prepared for Auckland Transport, by GHD Limited, March 2012, reference 51/28664/44.

f) Jacobs (2014), *Sampling Methodology- Ground Contamination- North Harbour No. 2 Watermain*, for Watercare Services Ltd, by Jacobs/SKM, revision 1 final, 05 May 2014, ref. AE04521.

g) Kermode (1992), Sheet R11, Geology of the Auckland urban area, scale 1:50,000.

h) MfE, 2011a, *Contaminated Land Management Guidelines No. 5- Site Investigation and Analysis of Soils (revised 2011)*, produced by MfE, February 2004, publication reference ME 1073.

i) MfE, 2011b, *Contaminated Land Management Guidelines No. 1- Reporting on Contaminated Sites in New Zealand (revised 2011)*, produced by MfE, February 2004, publication reference ME 1073.

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k) Opus, 2014a, *Environmental Sampling & Testing Report- NH2 Watermain Greenhithe and Stream Crossings*, for Watercare Services Ltd, by Opus International Consultants Ltd, August 2014, reference GS14/091.

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m) Riley, 2013, *Remediation Action Plan, Proposed Retirement Village, Monterey Park Hobsonville*, prepared for Retirement Villages (Hobsonville) Limited, by Riley Consultants Limited, 23 August 2013, reference 11255/1-I.

n) Riley, 2015, *Site Validation Report, Summerset Retirement Village- Stage 1, 1 Squadron Drive, Hobsonville*, prepared for Summerset Retirement Villages, by Riley Consultants Limited, 16 February 2015, reference 11255/3-AK.

o) Schofield, 1998, Sheets Q10 & R10- Helensville and Whangaparoa, Geological map of New Zealand 1:50,000, Map (2 sheets) and notes, Wellington, New Zealand, Department of Scientific and Industrial Research.

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q) T&T, 2010, *2009 Annual Groundwater Monitoring Report for Ranui Fill Site, Resource Consent 31216*, prepared for Auckland Regional Council, by Tonkin & Taylor Limited, 17 February 2010, reference 23561.600.

r) T&T, 2015, *Northern Interceptor- Phase 1 Ground Contamination Assessment*, for Watercare Services Ltd, by Tonkin & Taylor Ltd, Job No. 28773.34.v1, March 2015.

16. Abbreviations

- AECOM: AECOM Limited
- AEE: Assessment of Environmental Effects
- ACRP:ALW: Auckland Council Regional Plan: Air, Land & Water
- ANZECC: (2000 version) Australian and New Zealand Guidelines for Fresh and Marine Water Quality Guidelines
- ARC: Auckland Regional Council (now part of Council)
- ASL: Andrew Stewart Limited
- Babbage: Babbage Consultants Limited
- BaP_{equiv}: Benzo(a)pyrene equivalent
- BH: Borehole
- BTEX: Benzene, Toluene, Ethylbenzene, Xylenes
- $C_7 - C_9$: Carbon range
- CLMP: Contaminated Land Management Plan
- Council: Auckland Council
- DSI: Detailed Site Investigation
- ECBF: East Coast Bays Formation
- ESCP: Erosion Sediment Control Plan
- GBWD: Greenhithe Bridge Watermain Duplication
- GHD: GHD Limited
- GIS: Geographical Information System
- Gull: Gull New Zealand
- g/m^3: grams per cubic metre (= µg/L)
- HA: Hand-augered borehole
- HAIL: Hazardous Activities and Industries List
- HM: Heavy Metals
- Jacobs: Jacobs New Zealand Limited
- km: kilometre.

- LOD: Limit of Detection (laboratory analytical testing)
- m: metre
- m bgl: metres below ground level
- MfE: Ministry for the Environment
- µg/L: microgram per litre (= g/m^3)
- mm: millimetre
- Mobil: Mobil Oil New Zealand Limited
- NES Soil: Resource Management (National Environmental Standard for Assessing & Managing Contaminants in Soil to Protect Human Health) Regulations 2011
- NH2: North Harbour No. 2 Watermain
- NI: Northern Interceptor
- no.: number
- NorSGA: Northern Strategic Growth Area
- OCP: Organochlorine Pesticides
- Opus: Opus International Consultants Limited
- PA: Permitted Activity
- PaH Polycyclic Aromatic Hydrocarbons
- PAUP: Proposed Auckland Unitary Plan
- PCL: Plausible Contaminant Linkages
- PSI: Preliminary Site Investigation
- RAP: Remedial Action Plan
- Riley: Riley Consultants Limited
- RMA: Resource Management Act
- RNZAF: Royal New Zealand Air Force
- SCE: Site Contamination Enquiry
- SCS: Soil Contaminant Standard
- SH: State Highway
- SGV: Soil Guideline Value

- SKM: Sinclair Knight Merz Ltd (now part of Jacobs)
- SVR: Site Validation Report
- T&T: Tonkin & Taylor Limited
- TOC: Total Organic Carbon
- TP: Technical Publication
- TPH: Total Petroleum Hydrocarbons
- UCL: Upper Confidence Limit (as per MfE Guideline No. 5, 2004)
- URS: URS New Zealand Limited
- UST: Underground Storage Tank
- Watercare: Watercare Services Limited
- WWTP: Wastewater Treatment Plant

Appendix A. Site Plan: Regional Geology and NH2 Pipe Alignment

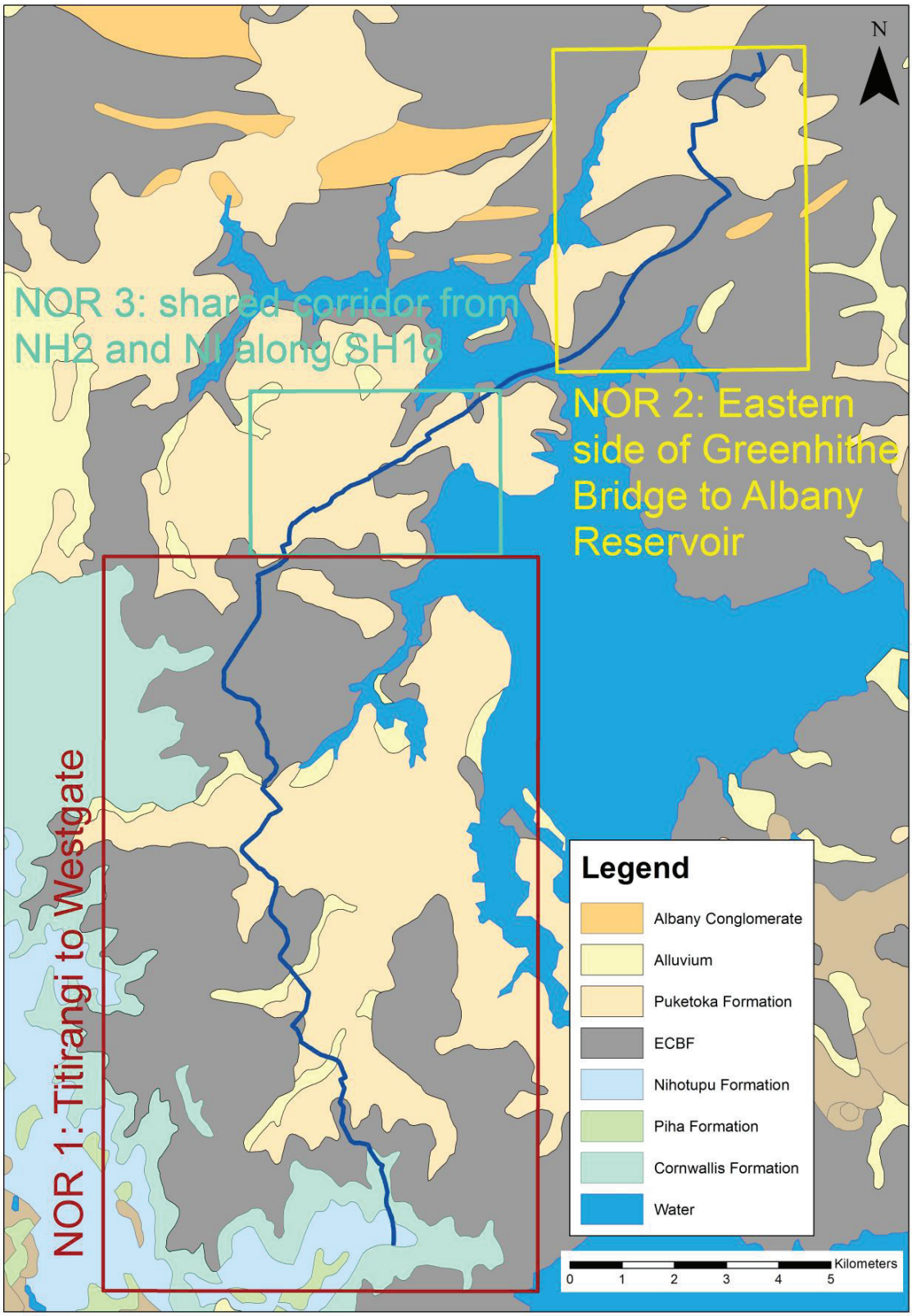

Figure 2. Geology along the route of the proposed alignment

Appendix B. Borehole Logs: Geotechnical Factual Report (Opus, 2014b)

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