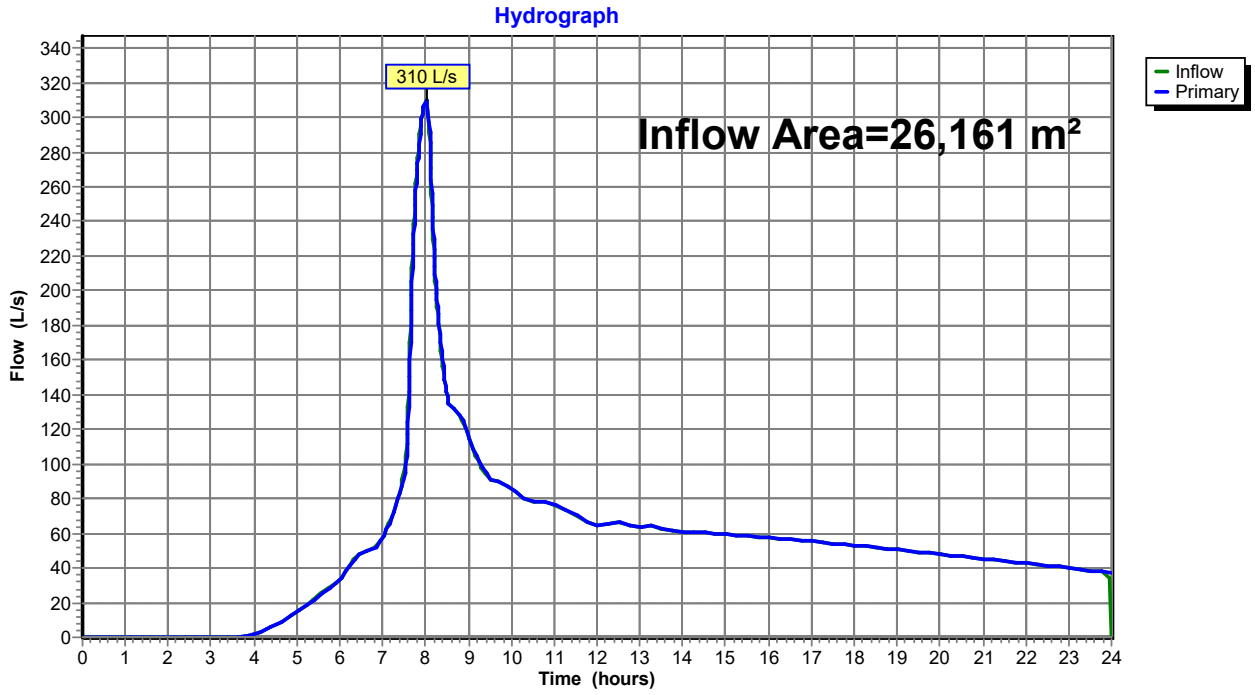
Summary for Link 30L: (new Link)

Inflow Area = 26,161 m², 0.00% Impervious, Inflow Depth > 175 mm for Type 1A-100yr event
Inflow = 310 L/s @ 8.01 hrs, Volume= 4,581 m³
Primary = 310 L/s @ 8.02 hrs, Volume= 4,581 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 30L: (new Link)

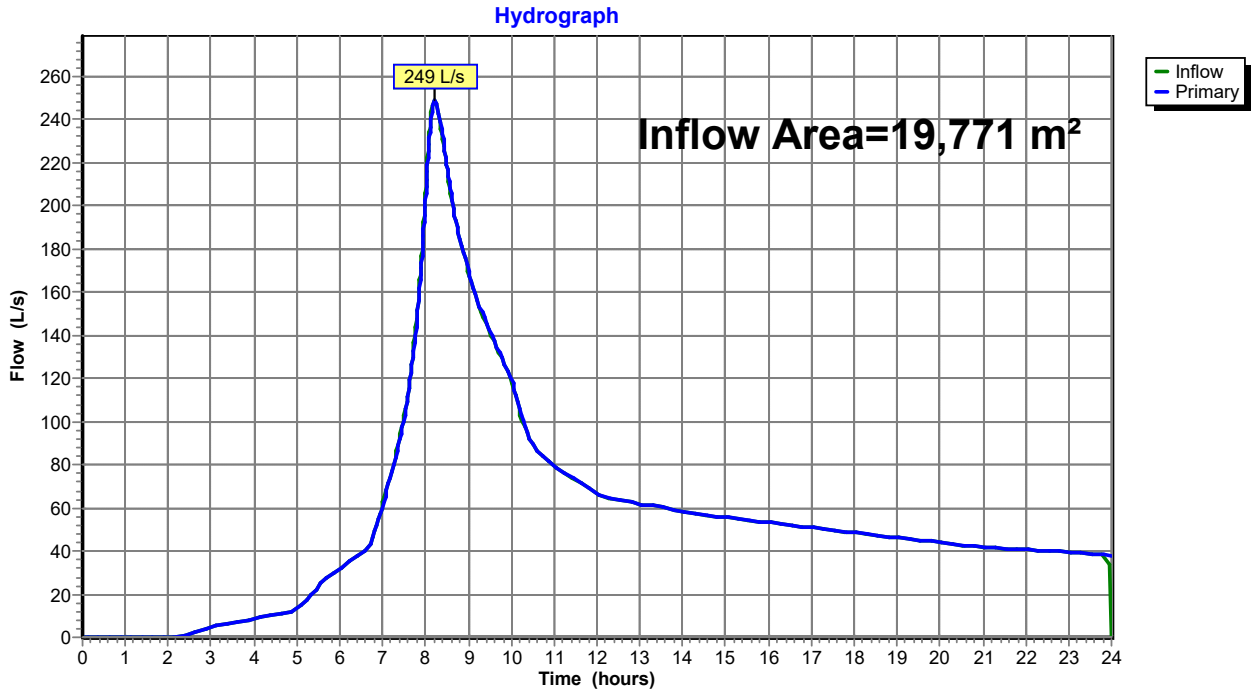


Summary for Link 31L: (new Link)

Inflow Area = 19,771 m², 0.00% Impervious, Inflow Depth > 238 mm for Type 1A-100yr event
Inflow = 249 L/s @ 8.20 hrs, Volume= 4,708 m³
Primary = 249 L/s @ 8.21 hrs, Volume= 4,708 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 31L: (new Link)



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Sim-Route method - Pond routing by Sim-Route method

Subcatchment 24S: Proposed Runoff Area=19,771 m² 0.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=85 Runoff=222 L/s 3,086 m³

Subcatchment 30S: Predevelopment Runoff Area=26,161 m² 0.00% Impervious Runoff Depth>86 mm
Tc=10.0 min CN=61 Runoff=137 L/s 2,254 m³

Pond 23P: Detention pond D (7m Peak Elev=76.75 m Storage=668 m³ Inflow=222 L/s 3,086 m³
Outflow=129 L/s 2,748 m³

Link 30L: (new Link) Inflow=137 L/s 2,253 m³
Primary=137 L/s 2,253 m³

Link 31L: (new Link) Inflow=129 L/s 2,747 m³
Primary=129 L/s 2,747 m³

Total Runoff Area = 45,932 m² Runoff Volume = 5,340 m³ Average Runoff Depth = 116 mm
100.00% Pervious = 45,932 m² 0.00% Impervious = 0 m²

Summary for Subcatchment 24S: Proposed eastern yarding (option 3-B)

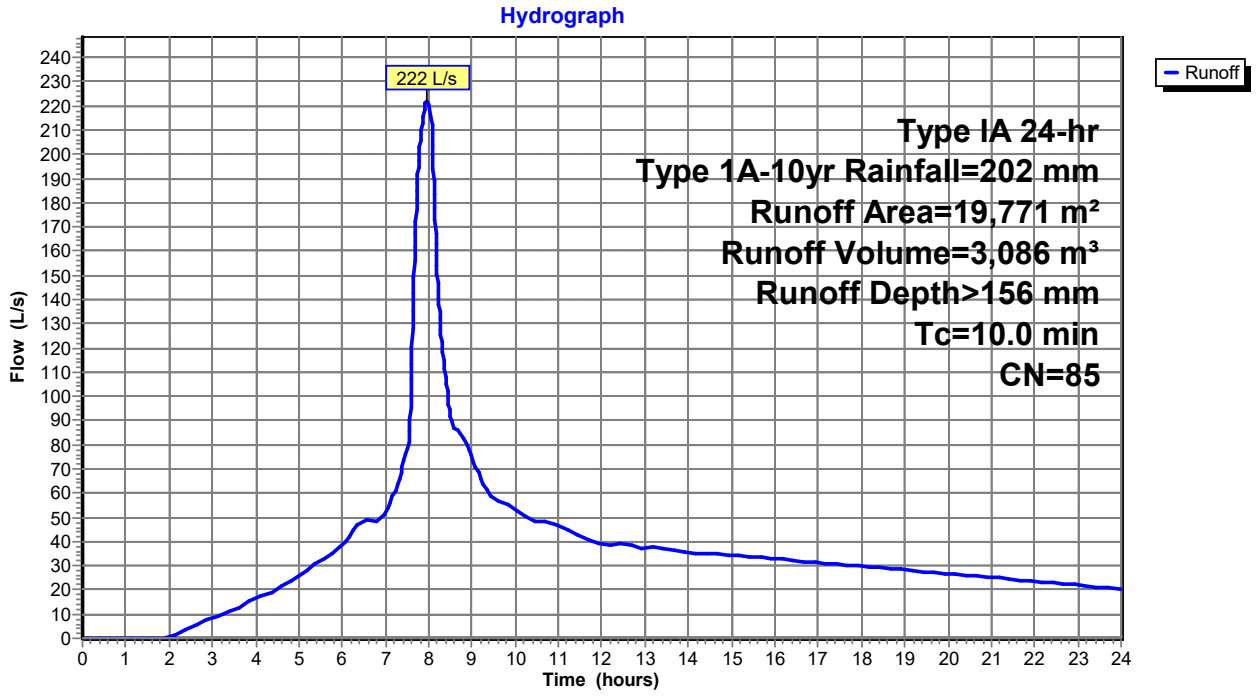
Runoff = 222 L/s @ 7.97 hrs, Volume= 3,086 m³, Depth> 156 mm
Routed to Pond 23P : Detention pond D (7m x103.3m)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr Type 1A-10yr Rainfall=202 mm

	Area (m²)	CN	Description
*	19,771	85	Gravel
	19,771		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 24S: Proposed eastern yarding (option 3-B)



Summary for Subcatchment 30S: Predevelopment eastern yarding (Option 3-B)

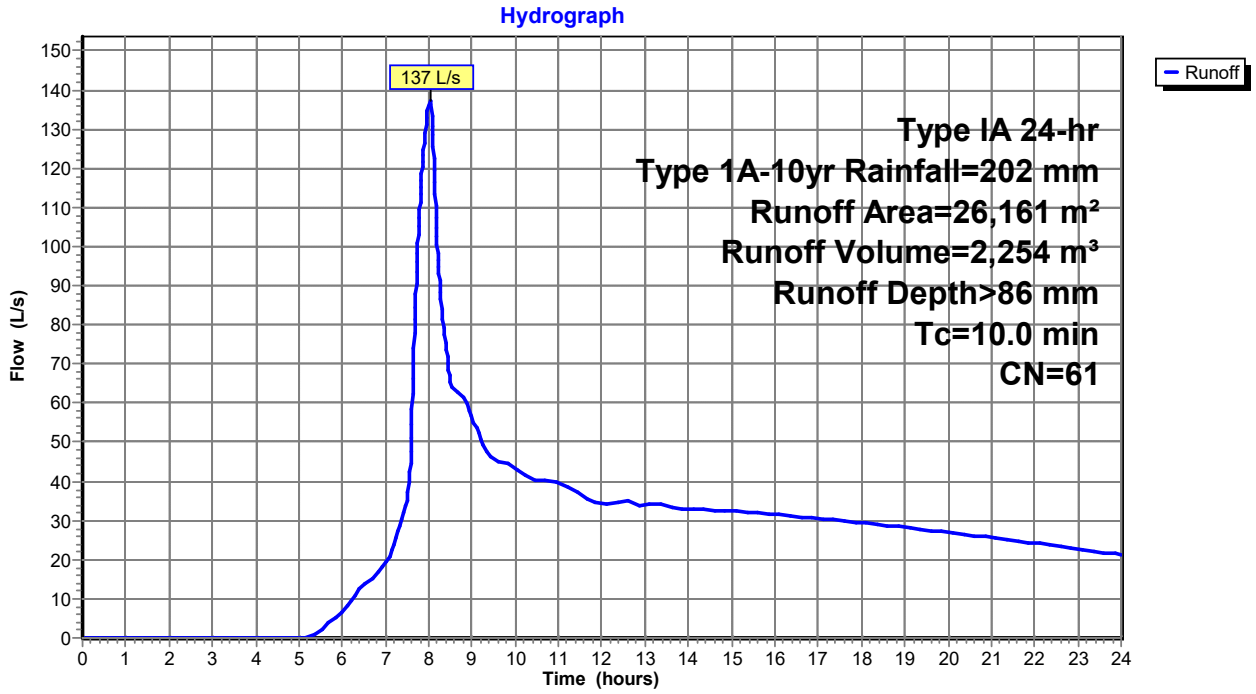
Runoff = 137 L/s @ 8.03 hrs, Volume= 2,254 m³, Depth> 86 mm
Routed to Link 30L : (new Link)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr Type 1A-10yr Rainfall=202 mm

	Area (m²)	CN	Description
*	19,771	61	Grass
*	2,620	61	Grass (Boron Plant)
*	3,770	61	Grass (carparks, road)
	26,161	61	Weighted Average
	26,161		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 30S: Predevelopment eastern yarding (Option 3-B)



Summary for Pond 23P: Detention pond D (7m x103.3m)

Inflow Area = 19,771 m², 0.00% Impervious, Inflow Depth > 156 mm for Type 1A-10yr event
Inflow = 222 L/s @ 7.97 hrs, Volume= 3,086 m³
Outflow = 129 L/s @ 8.28 hrs, Volume= 2,748 m³, Atten= 42%, Lag= 18.7 min
Primary = 129 L/s @ 8.28 hrs, Volume= 2,748 m³
Routed to Link 31L : (new Link)

Routing by Sim-Route method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 76.75 m @ 8.28 hrs Surf.Area= 1,063 m² Storage= 668 m³

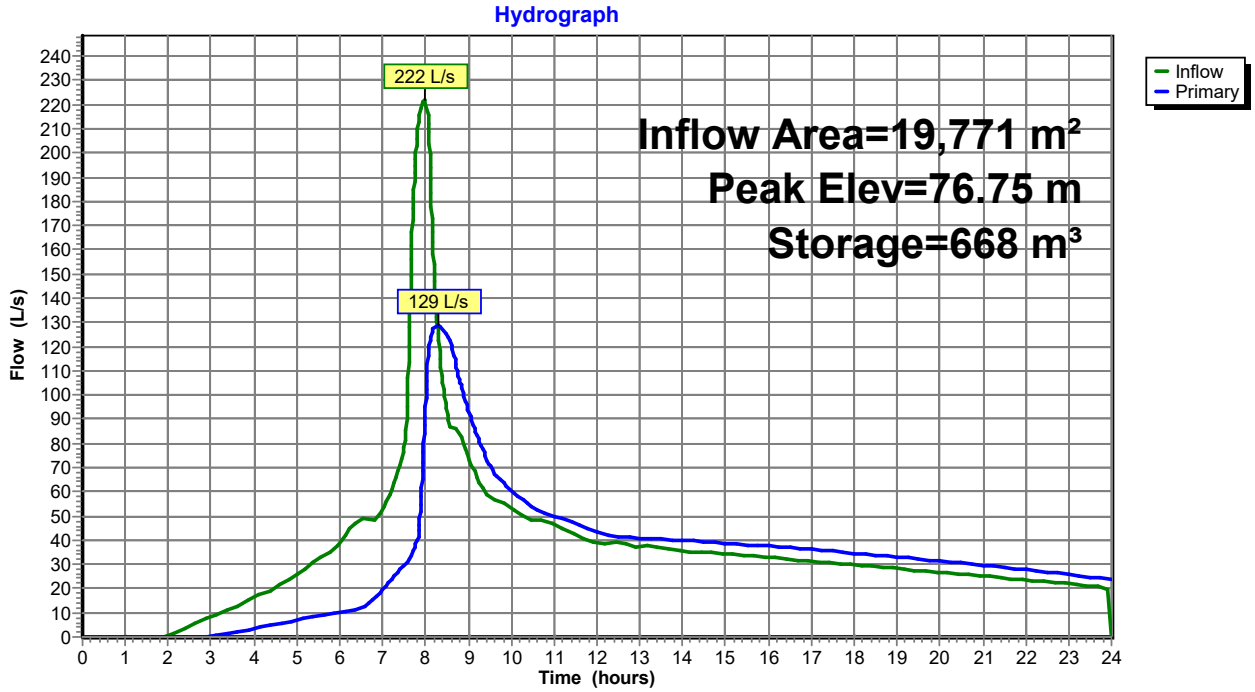
Plug-Flow detention time= 168.8 min calculated for 2,747 m³ (89% of inflow)
Center-of-Mass det. time= 95.5 min (814.2 - 718.7)

Volume	Invert	Avail.Storage	Storage Description
#1	76.00 m	949 m³	**7.00 mW x 103.30 mL x 1.00 mH Prismatoid Z=2.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	76.00 m	**100 mm Vert. Orifice/Grate 2yr** C= 0.650 Limited to weir flow at low heads
#2	Primary	76.30 m	**150 mm Vert. Orifice/Grate** C= 0.650 Limited to weir flow at low heads
#3	Primary	76.60 m	**300 mm Horiz. Orifice/Grate - Horizontal** C= 0.650 Limited to weir flow at low heads
#4	Primary	76.80 m	**0.15 m long + 2.0 m/m SideZ x 0.50 m breadth Broad-Crested Rectangular W** Head (meters) 0.06 0.12 0.18 0.24 0.30 0.37 0.43 0.49 0.55 0.61 0.76 0.91 1.07 Coef. (Metric) 1.43 1.45 1.45 1.47 1.50 1.55 1.59 1.67 1.67 1.64 1.78 1.81 1.83

Primary OutFlow Max=129 L/s @ 8.28 hrs HW=76.75 m TW=0.00 m (Dynamic Tailwater)
- **1=Orifice/Grate 2yr** (Orifice Controls 19 L/s @ 2.41 m/s)
- **2=Orifice/Grate** (Orifice Controls 31 L/s @ 1.76 m/s)
- **3=Orifice/Grate - Horizontal** (Orifice Controls 79 L/s @ 1.11 m/s)
- **4=Broad-Crested Rectangular Weir** (Controls 0 L/s)

Pond 23P: Detention pond D (7m x103.3m)

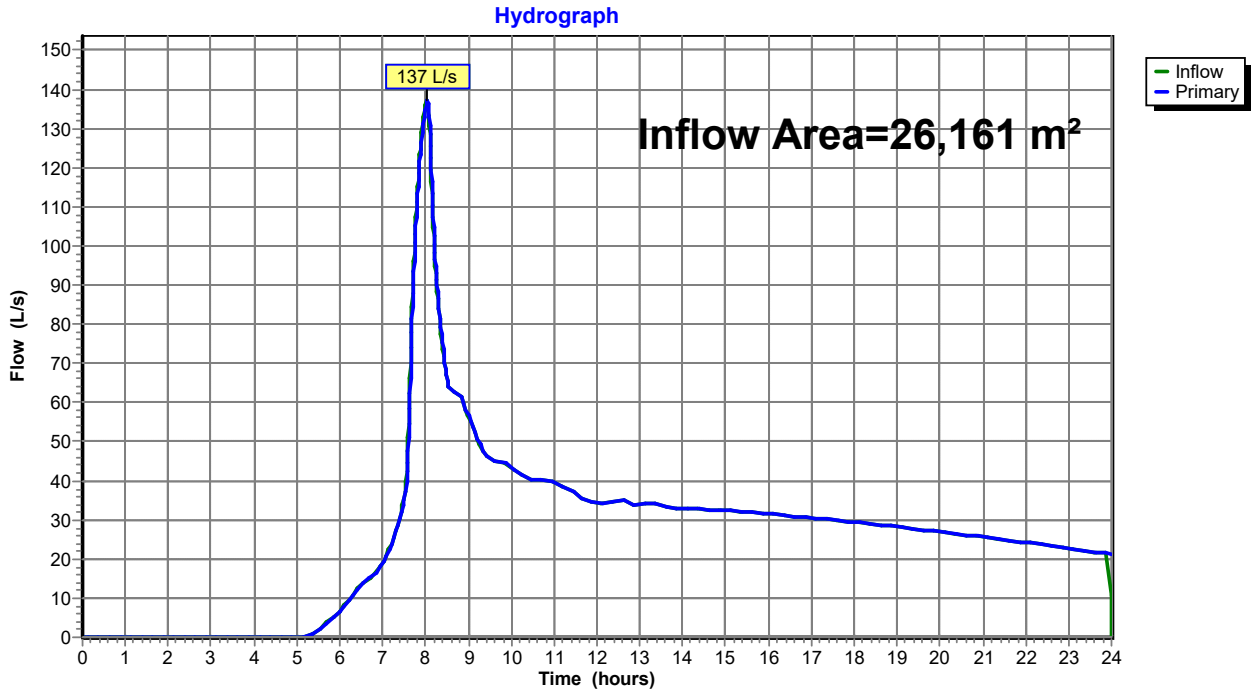


Summary for Link 30L: (new Link)

Inflow Area = 26,161 m², 0.00% Impervious, Inflow Depth > 86 mm for Type 1A-10yr event
Inflow = 137 L/s @ 8.03 hrs, Volume= 2,253 m³
Primary = 137 L/s @ 8.04 hrs, Volume= 2,253 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 30L: (new Link)

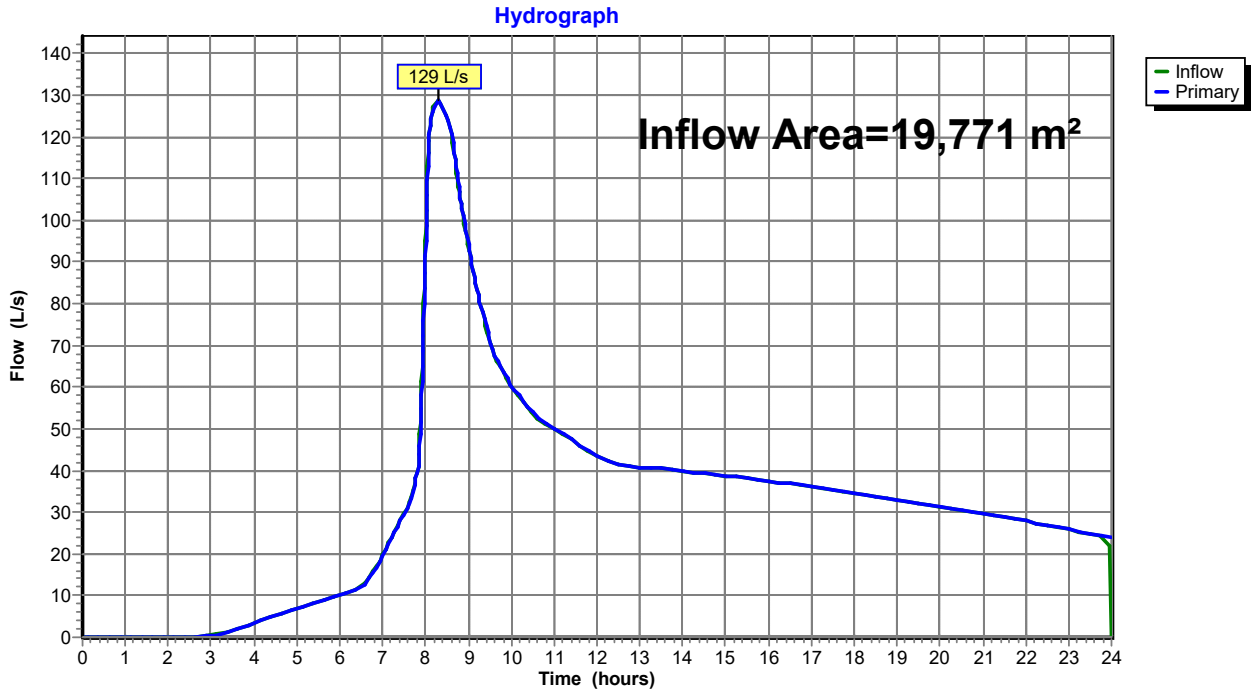


Summary for Link 31L: (new Link)

Inflow Area = 19,771 m², 0.00% Impervious, Inflow Depth > 139 mm for Type 1A-10yr event
Inflow = 129 L/s @ 8.28 hrs, Volume= 2,747 m³
Primary = 129 L/s @ 8.29 hrs, Volume= 2,747 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 31L: (new Link)



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Sim-Route method - Pond routing by Sim-Route method

Subcatchment 24S: Proposed eastern Runoff Area=19,771 m² 0.00% Impervious Runoff Depth>87 mm
Tc=10.0 min CN=85 Runoff=122 L/s 1,721 m³

Subcatchment 30S: Predevelopment Runoff Area=26,161 m² 0.00% Impervious Runoff Depth>36 mm
Tc=10.0 min CN=61 Runoff=43 L/s 936 m³

Pond 23P: Detention pond D (7m Peak Elev=76.53 m Storage=442 m³ Inflow=122 L/s 1,721 m³
Outflow=35 L/s 1,444 m³

Link 30L: (new Link) Inflow=43 L/s 935 m³
Primary=43 L/s 935 m³

Link 31L: (new Link) Inflow=35 L/s 1,443 m³
Primary=35 L/s 1,443 m³

Total Runoff Area = 45,932 m² Runoff Volume = 2,657 m³ Average Runoff Depth = 58 mm
100.00% Pervious = 45,932 m² 0.00% Impervious = 0 m²

Summary for Subcatchment 24S: Proposed eastern yarding (option 3-B)

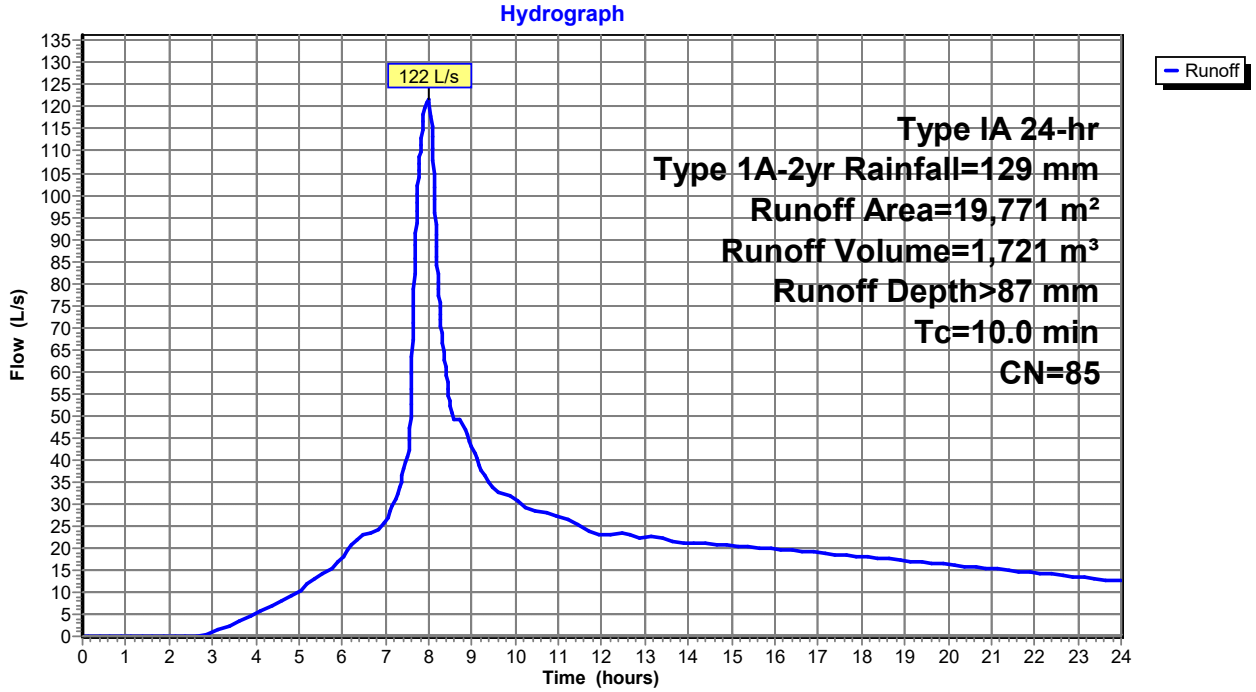
Runoff = 122 L/s @ 7.99 hrs, Volume= 1,721 m³, Depth> 87 mm
Routed to Pond 23P : Detention pond D (7m x103.3m)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr Type 1A-2yr Rainfall=129 mm

	Area (m²)	CN	Description
*	19,771	85	Gravel
	19,771		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 24S: Proposed eastern yarding (option 3-B)



Summary for Subcatchment 30S: Predevelopment eastern yarding (Option 3-B)

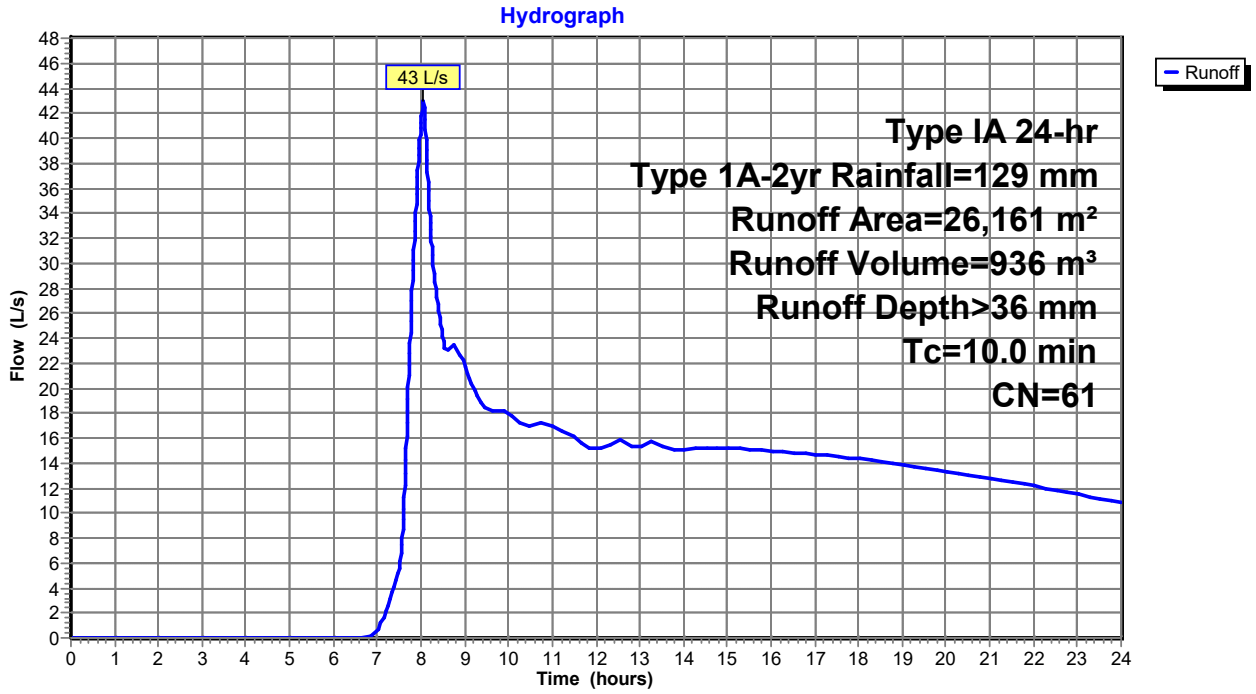
Runoff = 43 L/s @ 8.06 hrs, Volume= 936 m³, Depth> 36 mm
Routed to Link 30L : (new Link)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr Type 1A-2yr Rainfall=129 mm

	Area (m²)	CN	Description
*	19,771	61	Grass
*	2,620	61	Grass (Boron Plant)
*	3,770	61	Grass (carparks, road)
	26,161	61	Weighted Average
	26,161		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 30S: Predevelopment eastern yarding (Option 3-B)



Summary for Pond 23P: Detention pond D (7m x103.3m)

Inflow Area = 19,771 m², 0.00% Impervious, Inflow Depth > 87 mm for Type 1A-2yr event
Inflow = 122 L/s @ 7.99 hrs, Volume= 1,721 m³
Outflow = 35 L/s @ 9.35 hrs, Volume= 1,444 m³, Atten= 71%, Lag= 81.7 min
Primary = 35 L/s @ 9.35 hrs, Volume= 1,444 m³
Routed to Link 31L : (new Link)

Routing by Sim-Route method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 76.53 m @ 9.35 hrs Surf.Area= 960 m² Storage= 442 m³

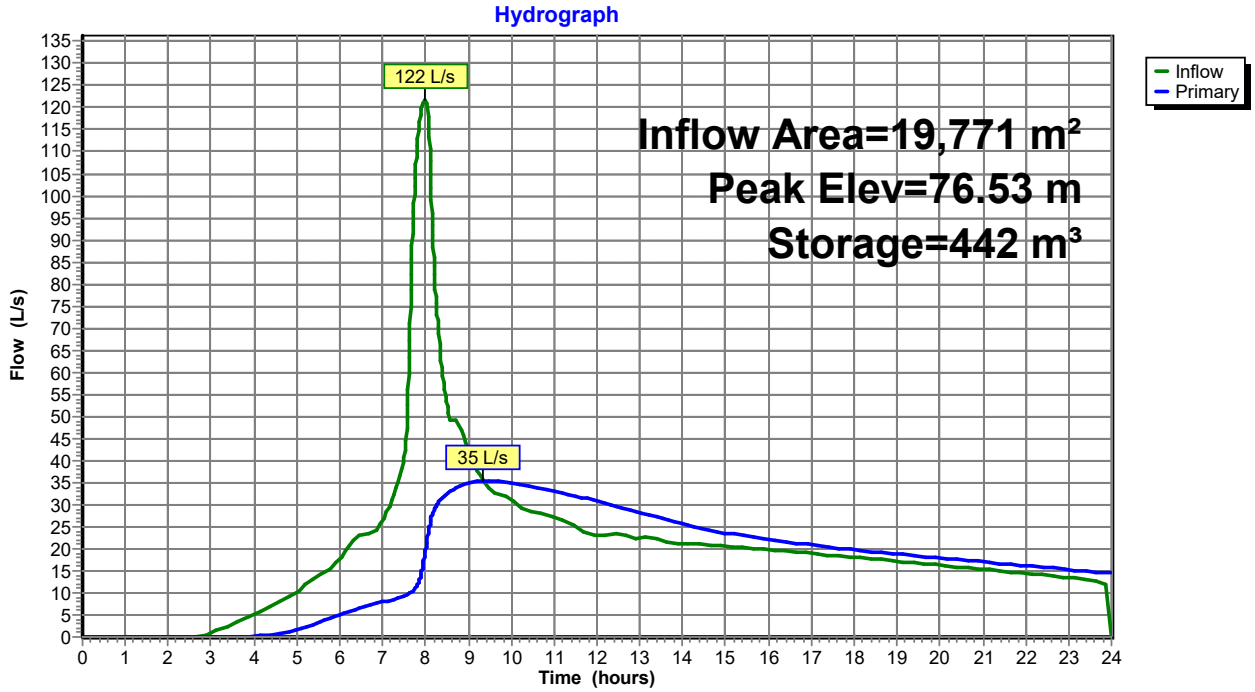
Plug-Flow detention time= 213.2 min calculated for 1,444 m³ (84% of inflow)
Center-of-Mass det. time= 111.8 min (860.0 - 748.2)

Volume	Invert	Avail.Storage	Storage Description
#1	76.00 m	949 m³	**7.00 mW x 103.30 mL x 1.00 mH Prismatoid Z=2.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	76.00 m	**100 mm Vert. Orifice/Grate 2yr** C= 0.650 Limited to weir flow at low heads
#2	Primary	76.30 m	**150 mm Vert. Orifice/Grate** C= 0.650 Limited to weir flow at low heads
#3	Primary	76.60 m	**300 mm Horiz. Orifice/Grate - Horizontal** C= 0.650 Limited to weir flow at low heads
#4	Primary	76.80 m	**0.15 m long + 2.0 m/m SideZ x 0.50 m breadth Broad-Crested Rectangular W** Head (meters) 0.06 0.12 0.18 0.24 0.30 0.37 0.43 0.49 0.55 0.61 0.76 0.91 1.07 Coef. (Metric) 1.43 1.45 1.45 1.47 1.50 1.55 1.59 1.67 1.67 1.64 1.78 1.81 1.83

Primary OutFlow Max=35 L/s @ 9.35 hrs HW=76.53 m TW=0.00 m (Dynamic Tailwater)
- **1=Orifice/Grate 2yr** (Orifice Controls 16 L/s @ 1.99 m/s)
- **2=Orifice/Grate** (Orifice Controls 20 L/s @ 1.12 m/s)
- **3=Orifice/Grate - Horizontal** (Controls 0 L/s)
- **4=Broad-Crested Rectangular Weir** (Controls 0 L/s)

Pond 23P: Detention pond D (7m x103.3m)

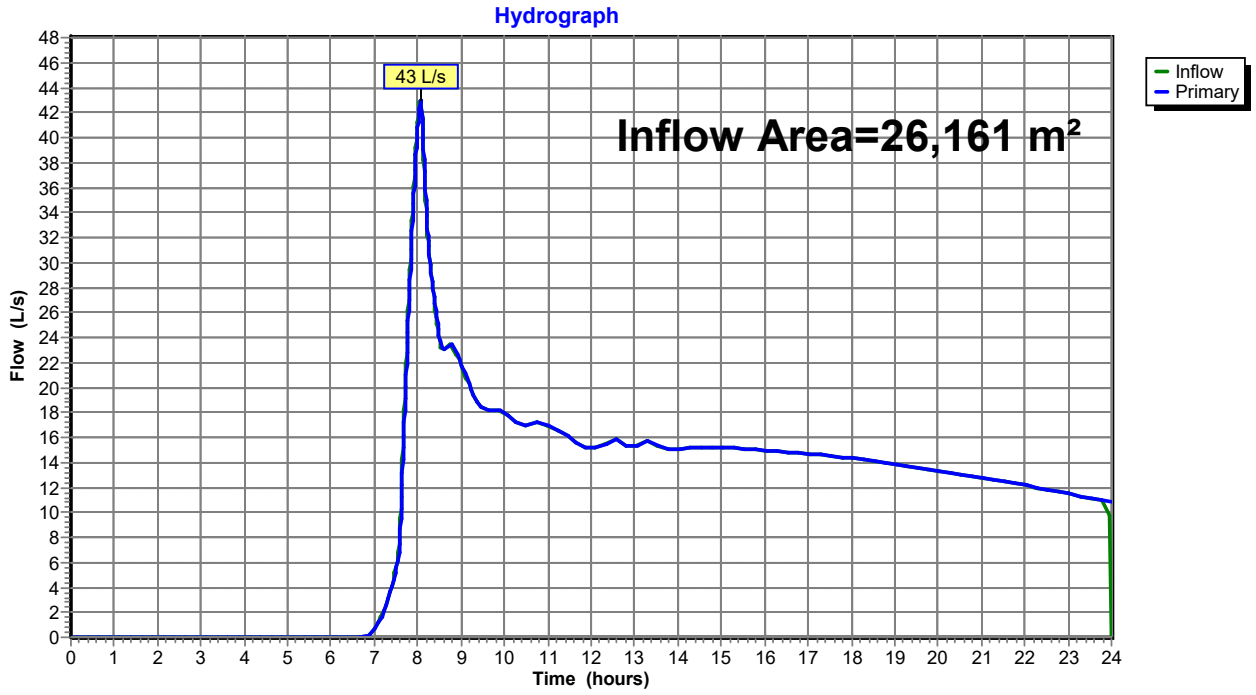


Summary for Link 30L: (new Link)

Inflow Area = 26,161 m², 0.00% Impervious, Inflow Depth > 36 mm for Type 1A-2yr event
Inflow = 43 L/s @ 8.06 hrs, Volume= 935 m³
Primary = 43 L/s @ 8.07 hrs, Volume= 935 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 30L: (new Link)

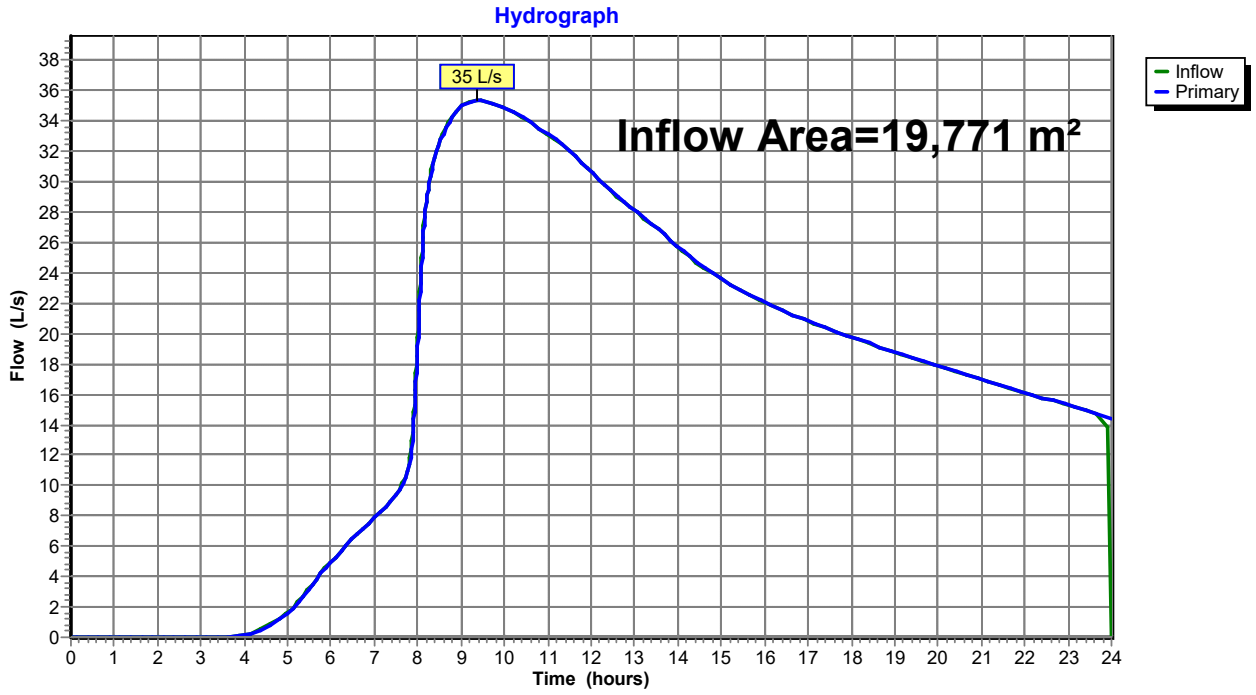


Summary for Link 31L: (new Link)

Inflow Area = 19,771 m², 0.00% Impervious, Inflow Depth > 73 mm for Type 1A-2yr event
Inflow = 35 L/s @ 9.35 hrs, Volume= 1,443 m³
Primary = 35 L/s @ 9.36 hrs, Volume= 1,443 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 31L: (new Link)



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Sim-Route method - Pond routing by Sim-Route method

Subcatchment 24S: Proposed Runoff Area=19,771 m² 0.00% Impervious Runoff Depth>126 mm
Tc=10.0 min CN=85 Runoff=179 L/s 2,500 m³

Subcatchment 30S: Predevelopment Runoff Area=26,161 m² 0.00% Impervious Runoff Depth>63 mm
Tc=10.0 min CN=61 Runoff=94 L/s 1,659 m³

Pond 23P: Detention pond D (7m Peak Elev=76.68 m Storage=591 m³ Inflow=179 L/s 2,500 m³
Outflow=81 L/s 2,188 m³

Link 30L: (new Link) Inflow=94 L/s 1,659 m³
Primary=94 L/s 1,659 m³

Link 31L: (new Link) Inflow=81 L/s 2,187 m³
Primary=81 L/s 2,187 m³

Total Runoff Area = 45,932 m² Runoff Volume = 4,160 m³ Average Runoff Depth = 91 mm
100.00% Pervious = 45,932 m² 0.00% Impervious = 0 m²

Summary for Subcatchment 24S: Proposed eastern yarding (option 3-B)

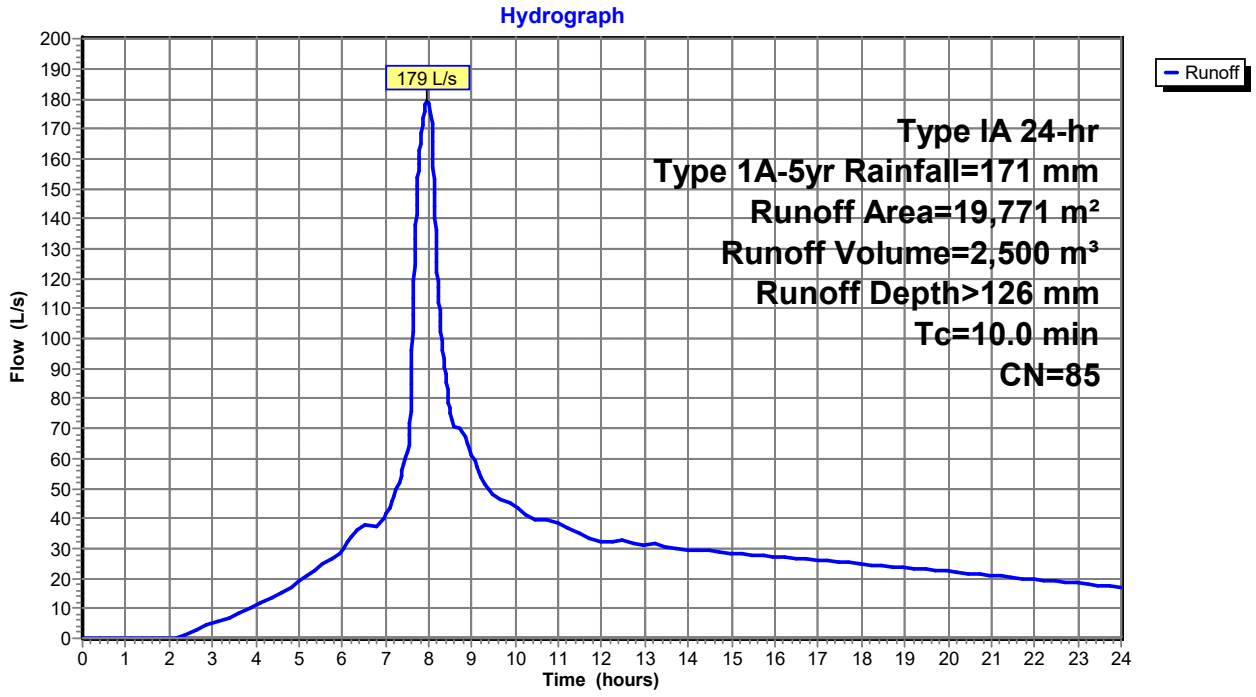
Runoff = 179 L/s @ 7.97 hrs, Volume= 2,500 m³, Depth> 126 mm
Routed to Pond 23P : Detention pond D (7m x103.3m)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr Type 1A-5yr Rainfall=171 mm

	Area (m²)	CN	Description
*	19,771	85	Gravel
	19,771		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 24S: Proposed eastern yarding (option 3-B)



Summary for Subcatchment 30S: Predevelopment eastern yarding (Option 3-B)

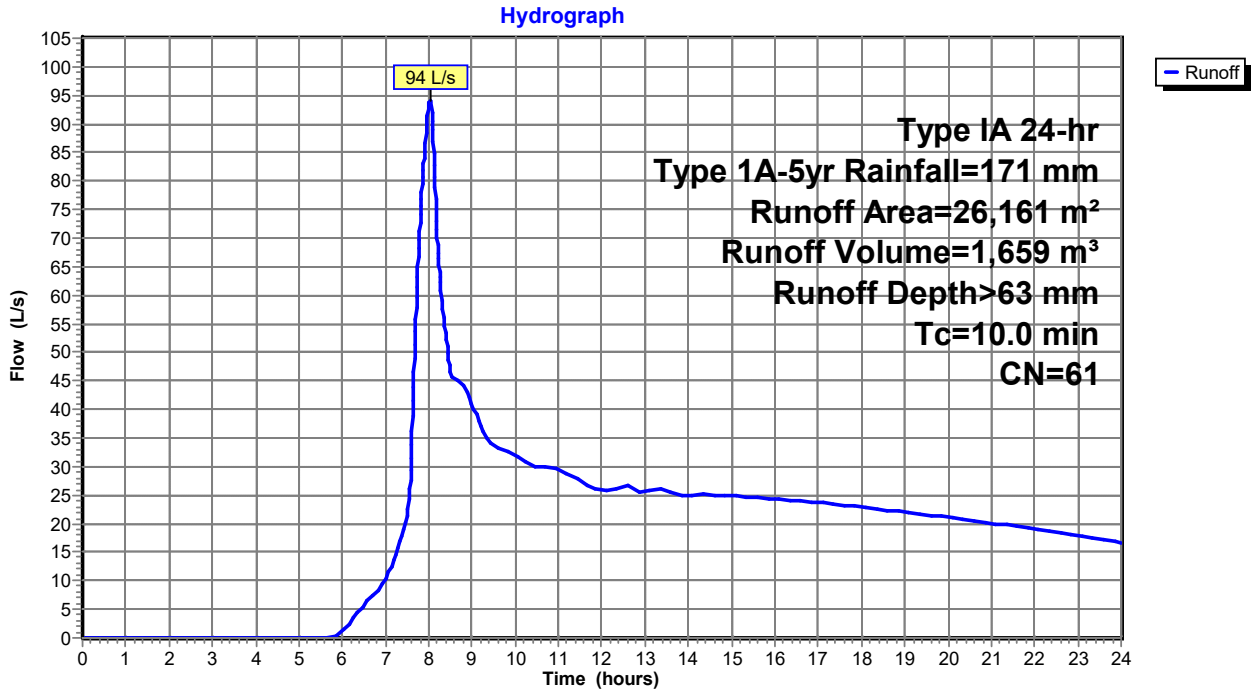
Runoff = 94 L/s @ 8.04 hrs, Volume= 1,659 m³, Depth> 63 mm
Routed to Link 30L : (new Link)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr Type 1A-5yr Rainfall=171 mm

	Area (m²)	CN	Description
*	19,771	61	Grass
*	2,620	61	Grass (Boron Plant)
*	3,770	61	Grass (carparks, road)
	26,161	61	Weighted Average
	26,161		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 30S: Predevelopment eastern yarding (Option 3-B)



Summary for Pond 23P: Detention pond D (7m x103.3m)

Inflow Area = 19,771 m², 0.00% Impervious, Inflow Depth > 126 mm for Type 1A-5yr event
Inflow = 179 L/s @ 7.97 hrs, Volume= 2,500 m³
Outflow = 81 L/s @ 8.45 hrs, Volume= 2,188 m³, Atten= 55%, Lag= 28.7 min
Primary = 81 L/s @ 8.45 hrs, Volume= 2,188 m³
Routed to Link 31L : (new Link)

Routing by Sim-Route method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 76.68 m @ 8.45 hrs Surf.Area= 1,028 m² Storage= 591 m³

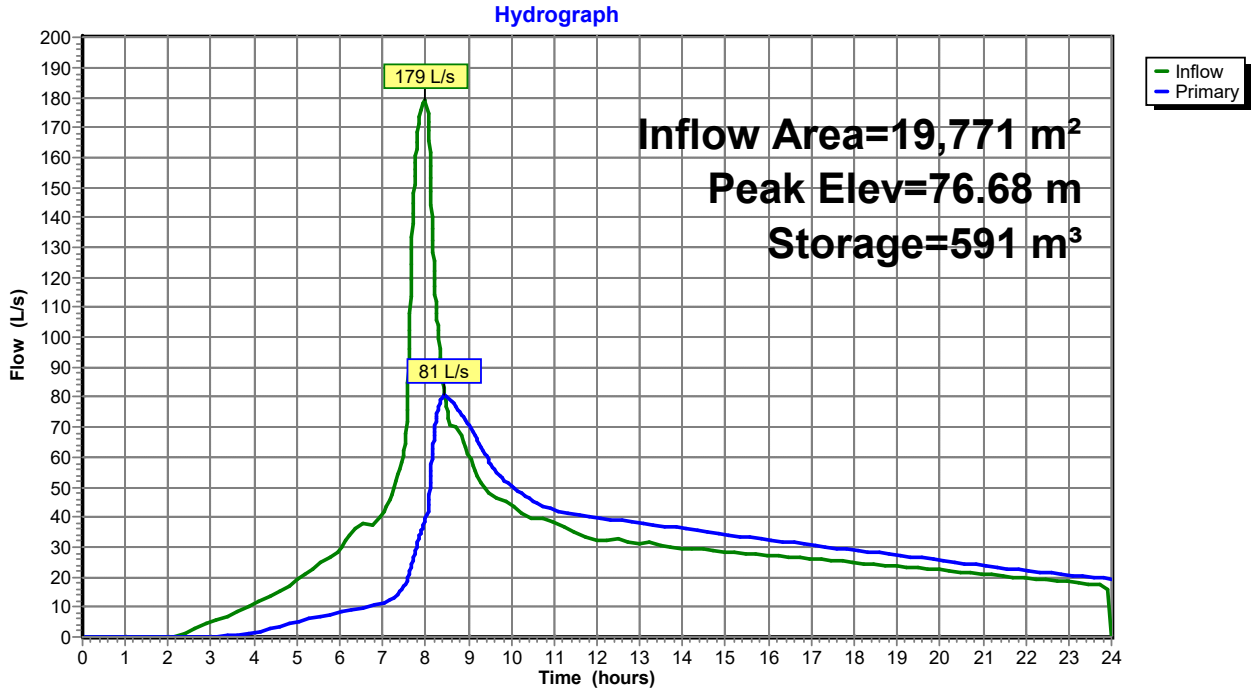
Plug-Flow detention time= 186.0 min calculated for 2,187 m³ (87% of inflow)
Center-of-Mass det. time= 104.3 min (833.2 - 728.9)

Volume	Invert	Avail.Storage	Storage Description
#1	76.00 m	949 m³	**7.00 mW x 103.30 mL x 1.00 mH Prismatoid Z=2.0**

Device	Routing	Invert	Outlet Devices
#1	Primary	76.00 m	**100 mm Vert. Orifice/Grate 2yr** C= 0.650 Limited to weir flow at low heads
#2	Primary	76.30 m	**150 mm Vert. Orifice/Grate** C= 0.650 Limited to weir flow at low heads
#3	Primary	76.60 m	**300 mm Horiz. Orifice/Grate - Horizontal** C= 0.650 Limited to weir flow at low heads
#4	Primary	76.80 m	**0.15 m long + 2.0 m/m SideZ x 0.50 m breadth Broad-Crested Rectangular W** Head (meters) 0.06 0.12 0.18 0.24 0.30 0.37 0.43 0.49 0.55 0.61 0.76 0.91 1.07 Coef. (Metric) 1.43 1.45 1.45 1.47 1.50 1.55 1.59 1.67 1.67 1.64 1.78 1.81 1.83

Primary OutFlow Max=81 L/s @ 8.45 hrs HW=76.68 m TW=0.00 m (Dynamic Tailwater)
- **1=Orifice/Grate 2yr** (Orifice Controls 18 L/s @ 2.28 m/s)
- **2=Orifice/Grate** (Orifice Controls 28 L/s @ 1.58 m/s)
- **3=Orifice/Grate - Horizontal** (Weir Controls 35 L/s @ 0.50 m/s)
- **4=Broad-Crested Rectangular Weir** (Controls 0 L/s)

Pond 23P: Detention pond D (7m x103.3m)

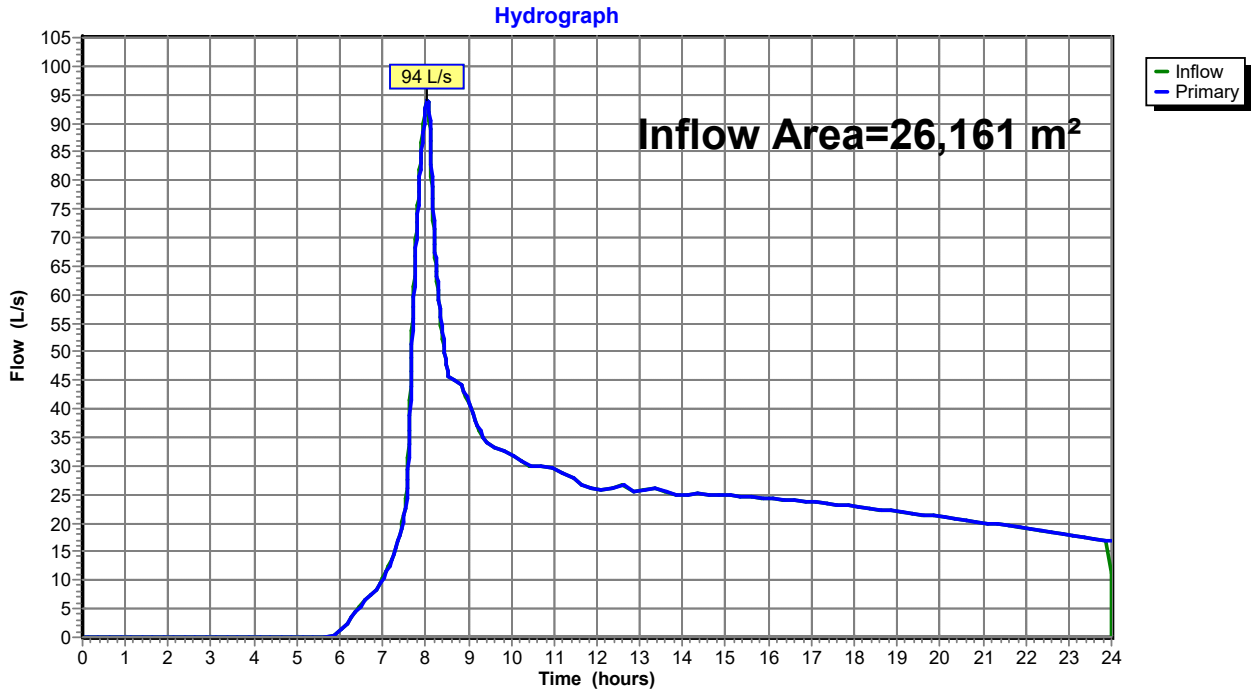


Summary for Link 30L: (new Link)

Inflow Area = 26,161 m², 0.00% Impervious, Inflow Depth > 63 mm for Type 1A-5yr event
Inflow = 94 L/s @ 8.04 hrs, Volume= 1,659 m³
Primary = 94 L/s @ 8.05 hrs, Volume= 1,659 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 30L: (new Link)

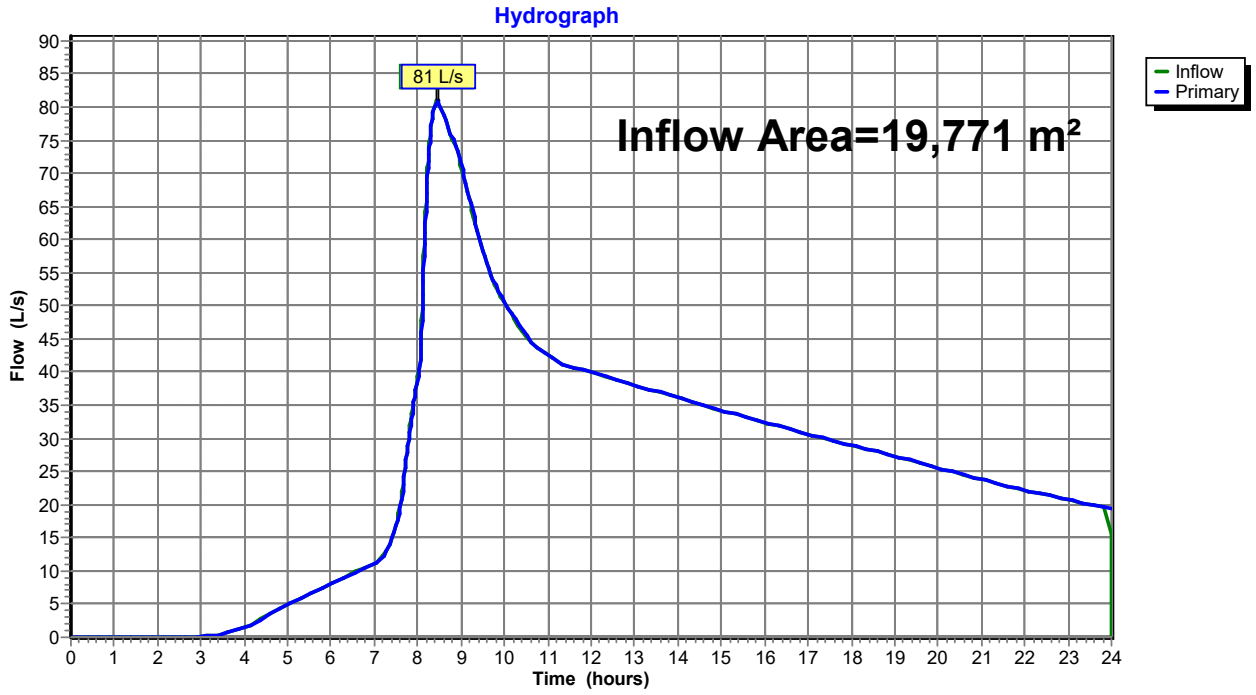


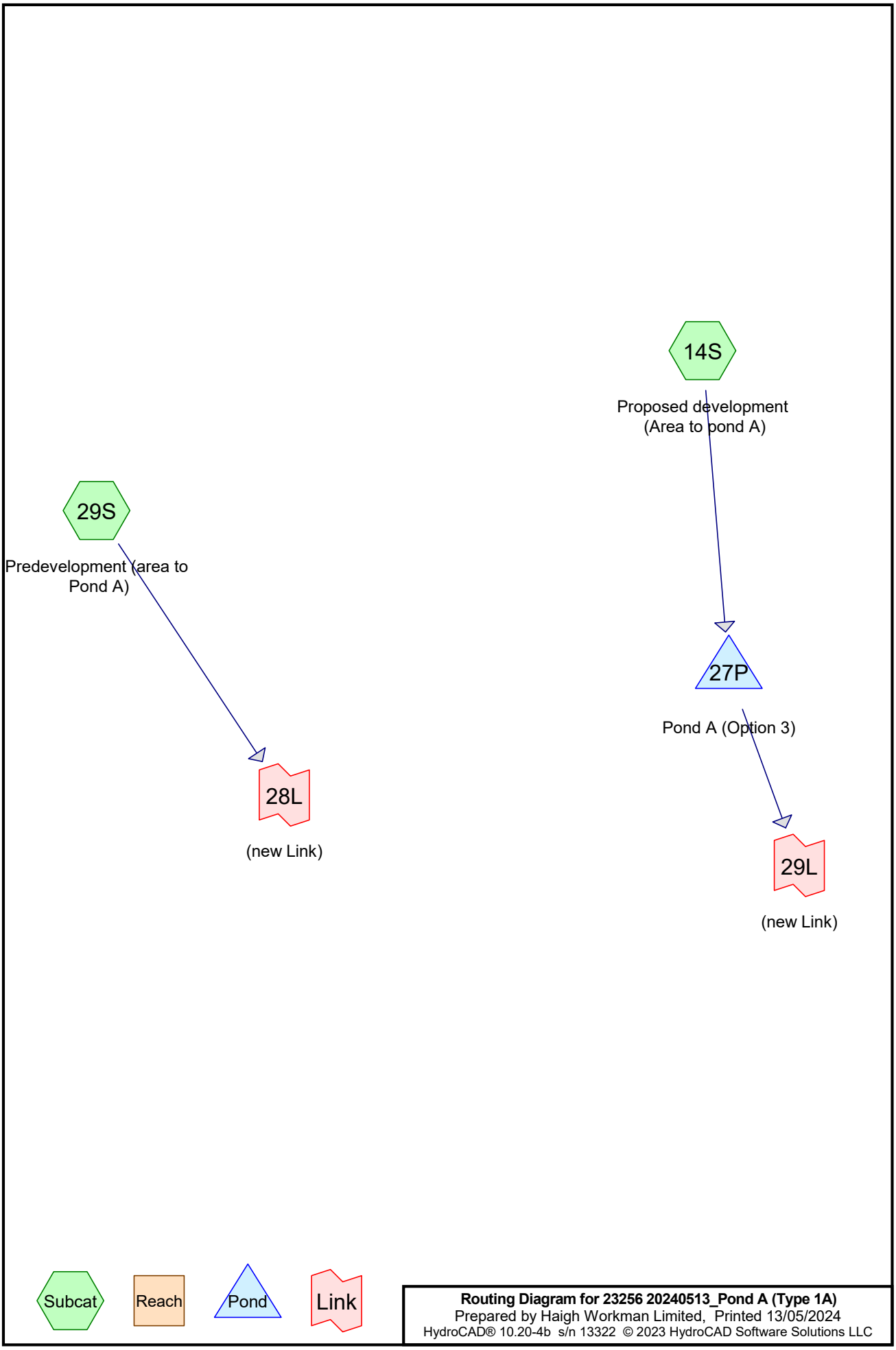
Summary for Link 31L: (new Link)

Inflow Area = 19,771 m², 0.00% Impervious, Inflow Depth > 111 mm for Type 1A-5yr event
Inflow = 81 L/s @ 8.45 hrs, Volume= 2,187 m³
Primary = 81 L/s @ 8.46 hrs, Volume= 2,187 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 31L: (new Link)





Routing Diagram for 23256 20240513_Pond A (Type 1A)
Prepared by Haigh Workman Limited, Printed 13/05/2024

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (mm)	AMC
1	Type 1A-100yr	Type IA 24-hr		Default	24.00	1	311	2
2	Type 1A-10yr	Type IA 24-hr		Default	24.00	1	202	2
3	Type 1A-2yr	Type IA 24-hr		Default	24.00	1	129	2
4	Type 1A-5yr	Type IA 24-hr		Default	24.00	1	171	2

Area Listing (selected nodes)

Area (sq-meters)	CN	Description (subcatchment-numbers)
69,048	61	>75% Grass cover, Good, HSG B (29S)
6,715	98	Concrete (14S)
14,566	98	Existing Roofs (14S)
5,129	61	Grass (14S)
44,375	85	Gravel (14S)
1,833	61	Pond (14S)
2,870	98	Proposed Roofs (14S)
144,536	**75**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (sq-meters)	Soil Group	Subcatchment Numbers
0	HSG A	
69,048	HSG B	29S
0	HSG C	
0	HSG D	
75,488	Other	14S
144,536		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (sq-meters)	HSG-B (sq-meters)	HSG-C (sq-meters)	HSG-D (sq-meters)	Other (sq-meters)	Total (sq-meters)	Ground Cover	Subca Numbe
0	69,048	0	0	0	69,048	>75% Grass cover, Good	
0	0	0	0	6,715	6,715	Concrete	
0	0	0	0	14,566	14,566	Existing Roofs	
0	0	0	0	5,129	5,129	Grass	
0	0	0	0	44,375	44,375	Gravel	
0	0	0	0	1,833	1,833	Pond	
0	0	0	0	2,870	2,870	Proposed Roofs	
0	**69,048**	**0**	**0**	**75,488**	**144,536**	**TOTAL AREA**	

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Sim-Route method - Pond routing by Sim-Route method

Subcatchment 14S: Proposed Runoff Area=75,488 m² 31.99% Impervious Runoff Depth>268 mm
Tc=15.0 min CN=87 Runoff=1,419 L/s 20,257 m³

Subcatchment 29S: Predevelopment Runoff Area=69,048 m² 0.00% Impervious Runoff Depth>174 mm
Tc=20.0 min CN=61 Runoff=767 L/s 12,041 m³

Pond 27P: Pond A (Option 3) Peak Elev=77.98 m Storage=4,095 m³ Inflow=1,419 L/s 20,253 m³
Outflow=1,337 L/s 16,939 m³

Link 28L: (new Link) Inflow=767 L/s 12,037 m³
Primary=767 L/s 12,037 m³

Link 29L: (new Link) Inflow=1,337 L/s 16,934 m³
Primary=1,337 L/s 16,934 m³

Total Runoff Area = 144,536 m² Runoff Volume = 32,298 m³ Average Runoff Depth = 223 mm
83.29% Pervious = 120,385 m² 16.71% Impervious = 24,151 m²

Summary for Subcatchment 14S: Proposed development (Area to pond A)

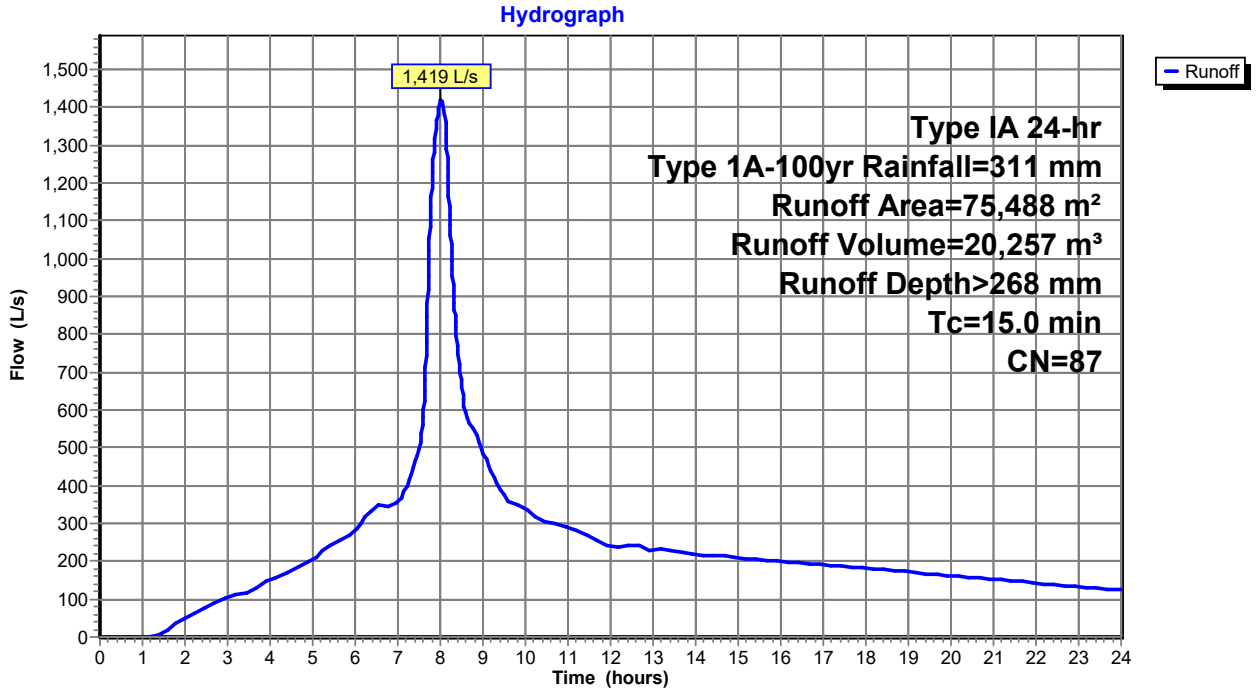
Runoff = 1,419 L/s @ 8.02 hrs, Volume= 20,257 m³, Depth> 268 mm
Routed to Pond 27P : Pond A (Option 3)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr Type 1A-100yr Rainfall=311 mm

	Area (m²)	CN	Description
*	14,566	98	Existing Roofs
*	2,870	98	Proposed Roofs
*	6,715	98	Concrete
*	1,833	61	Pond
*	5,129	61	Grass
*	44,375	85	Gravel
	75,488	87	Weighted Average
	51,337		68.01% Pervious Area
	24,151		31.99% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
15.0					**Direct Entry,**

Subcatchment 14S: Proposed development (Area to pond A)



Summary for Subcatchment 29S: Predevelopment (area to Pond A)

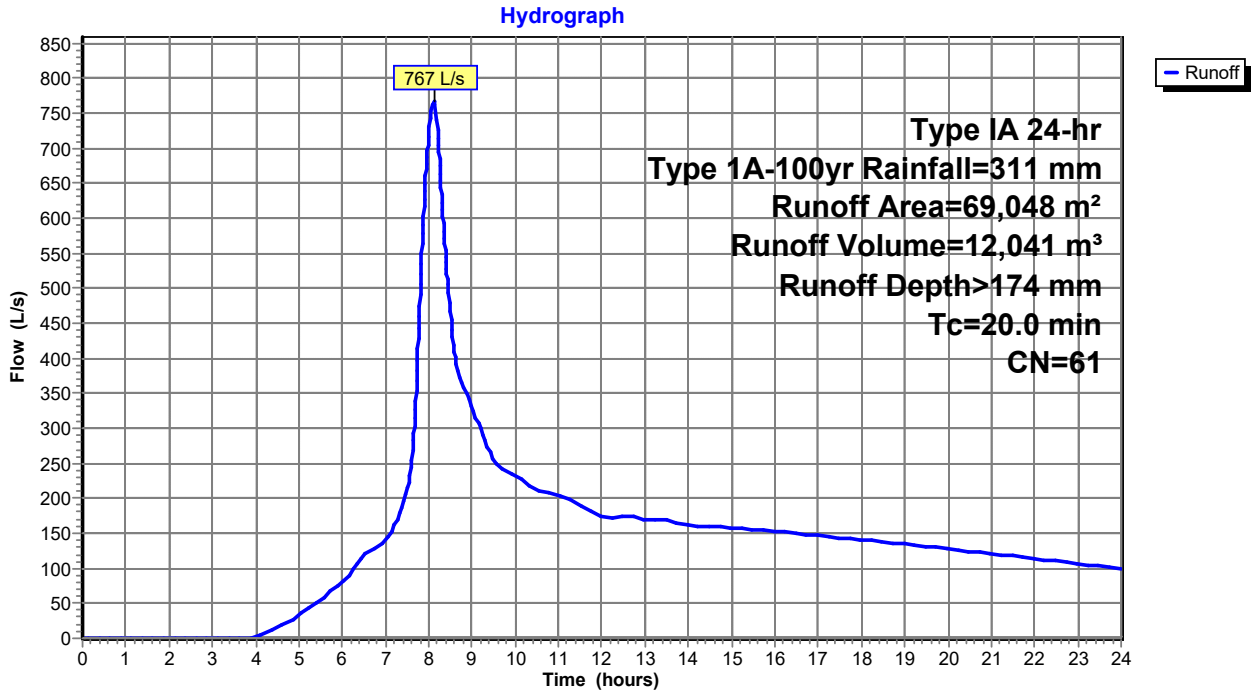
Runoff = 767 L/s @ 8.11 hrs, Volume= 12,041 m³, Depth> 174 mm
Routed to Link 28L : (new Link)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr Type 1A-100yr Rainfall=311 mm

Area (m²)	CN	Description
69,048	61	>75% Grass cover, Good, HSG B
69,048		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
20.0					**Direct Entry,**

Subcatchment 29S: Predevelopment (area to Pond A)



Summary for Pond 27P: Pond A (Option 3)

Inflow Area = 75,488 m², 31.99% Impervious, Inflow Depth > 268 mm for Type 1A-100yr event
Inflow = 1,419 L/s @ 8.02 hrs, Volume= 20,253 m³
Outflow = 1,337 L/s @ 8.13 hrs, Volume= 16,939 m³, Atten= 6%, Lag= 6.6 min
Primary = 1,337 L/s @ 8.13 hrs, Volume= 16,939 m³
Routed to Link 29L : (new Link)

Routing by Sim-Route method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 77.98 m @ 8.13 hrs Surf.Area= 3,354 m² Storage= 4,095 m³

Plug-Flow detention time= 188.5 min calculated for 16,932 m³ (84% of inflow)
Center-of-Mass det. time= 80.0 min (772.3 - 692.3)

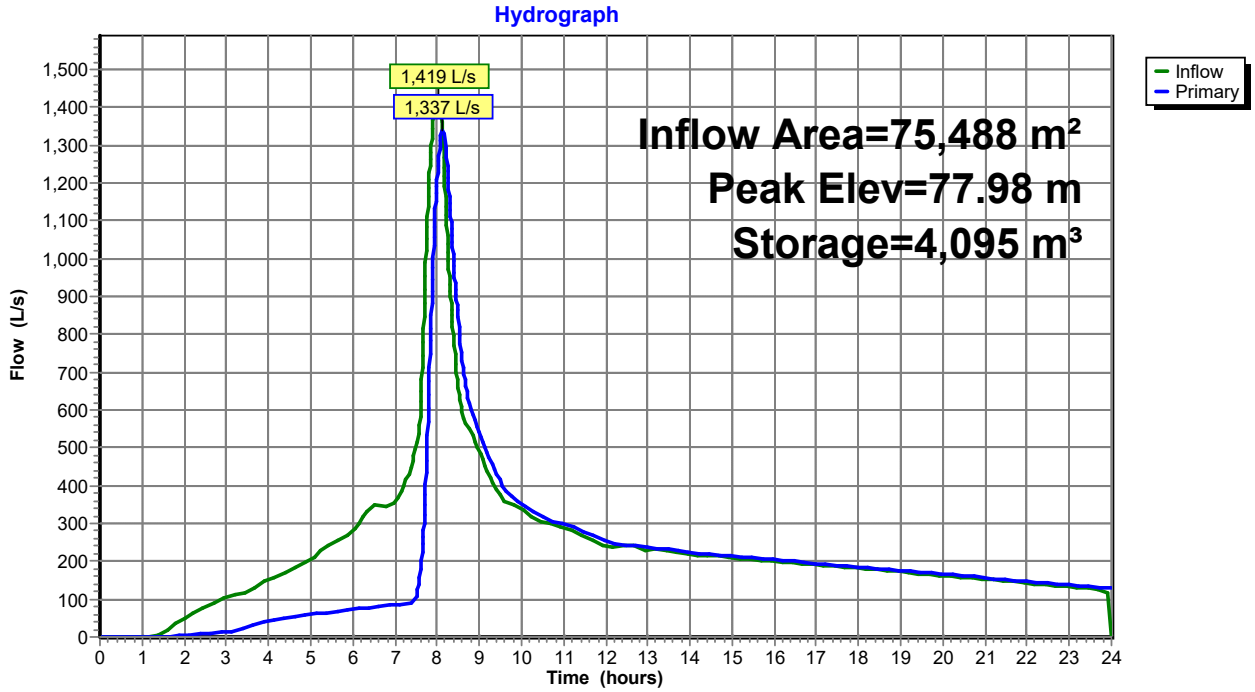
Volume	Invert	Avail.Storage	Storage Description
#1	75.80 m	4,171 m³	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (meters)	Surf.Area (sq-meters)	Inc.Store (cubic-meters)	Cum.Store (cubic-meters)
75.80	665	0	0
76.00	802	147	147
76.20	980	178	325
76.40	1,190	217	542
76.60	1,433	262	804
76.80	1,708	314	1,118
77.00	1,994	370	1,489
77.20	2,268	426	1,915
77.40	2,542	481	2,396
77.60	2,817	536	2,932
77.80	3,094	591	3,523
78.00	3,387	648	4,171

Device	Routing	Invert	Outlet Devices
#1	Primary	75.80 m	**100 mm Vert. 100mm DIA Orifice/Grate** C= 0.650 Limited to weir flow at low heads
#2	Primary	76.20 m	**150 mm Vert. 150mm DIA Orifice/Grate** C= 0.650 Limited to weir flow at low heads
#3	Primary	77.70 m	**1,050 mm Horiz. 1,050mm DIA Manhole** C= 0.650 Limited to weir flow at low heads
#4	Primary	77.80 m	**3.00 m long + 2.0 m/m SideZ x 5.00 m breadth Broad-Crested Rectangular W** Head (meters) 0.06 0.12 0.18 0.24 0.30 0.37 0.43 0.49 Coef. (Metric) 1.48 1.49 1.49 1.46 1.45 1.46 1.46 1.45

Primary OutFlow Max=1,336 L/s @ 8.13 hrs HW=77.98 m TW=0.00 m (Dynamic Tailwater)
- **1=100mm DIA Orifice/Grate** (Orifice Controls 33 L/s @ 4.20 m/s)
- **2=150mm DIA Orifice/Grate** (Orifice Controls 66 L/s @ 3.76 m/s)
- **3=1,050mm DIA Manhole** (Weir Controls 871 L/s @ 0.95 m/s)
- **4=Broad-Crested Rectangular Weir** (Weir Controls 366 L/s @ 0.61 m/s)

Pond 27P: Pond A (Option 3)

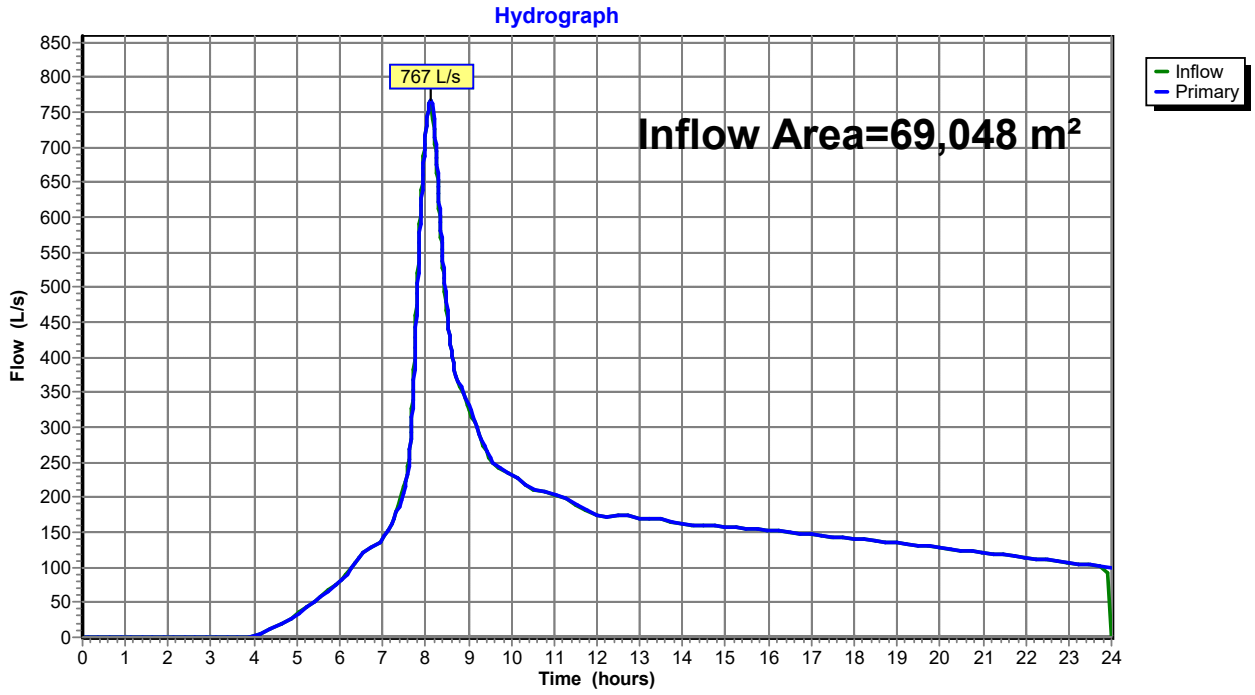


Summary for Link 28L: (new Link)

Inflow Area = 69,048 m², 0.00% Impervious, Inflow Depth > 174 mm for Type 1A-100yr event
Inflow = 767 L/s @ 8.11 hrs, Volume= 12,037 m³
Primary = 767 L/s @ 8.12 hrs, Volume= 12,037 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 28L: (new Link)

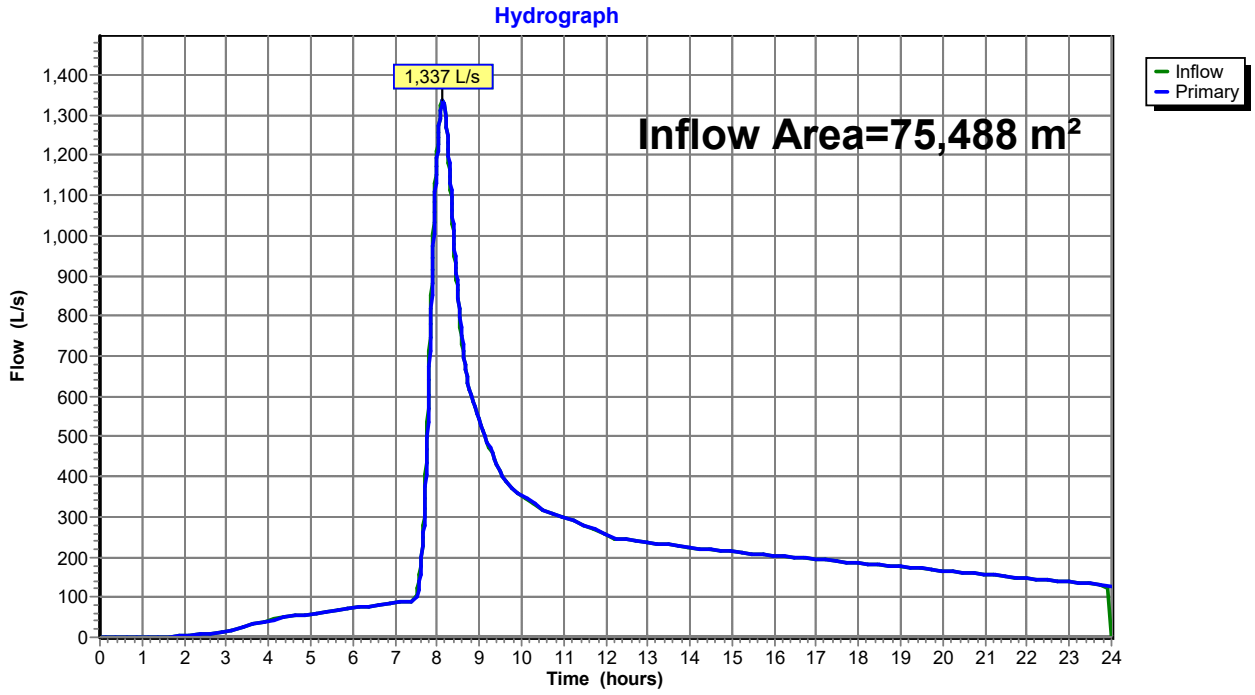


Summary for Link 29L: (new Link)

Inflow Area = 75,488 m², 31.99% Impervious, Inflow Depth > 224 mm for Type 1A-100yr event
Inflow = 1,337 L/s @ 8.13 hrs, Volume= 16,934 m³
Primary = 1,337 L/s @ 8.14 hrs, Volume= 16,934 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 29L: (new Link)



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Sim-Route method - Pond routing by Sim-Route method

Subcatchment 14S: Proposed Runoff Area=75,488 m² 31.99% Impervious Runoff Depth>162 mm
Tc=15.0 min CN=87 Runoff=862 L/s 12,214 m³

Subcatchment 29S: Predevelopment Runoff Area=69,048 m² 0.00% Impervious Runoff Depth>86 mm
Tc=20.0 min CN=61 Runoff=334 L/s 5,917 m³

Pond 27P: Pond A (Option 3) Peak Elev=77.81 m Storage=3,561 m³ Inflow=862 L/s 12,212 m³
Outflow=325 L/s 9,024 m³

Link 28L: (new Link) Inflow=334 L/s 5,915 m³
Primary=334 L/s 5,915 m³

Link 29L: (new Link) Inflow=325 L/s 9,021 m³
Primary=325 L/s 9,021 m³

Total Runoff Area = 144,536 m² Runoff Volume = 18,131 m³ Average Runoff Depth = 125 mm
83.29% Pervious = 120,385 m² 16.71% Impervious = 24,151 m²

Summary for Subcatchment 14S: Proposed development (Area to pond A)

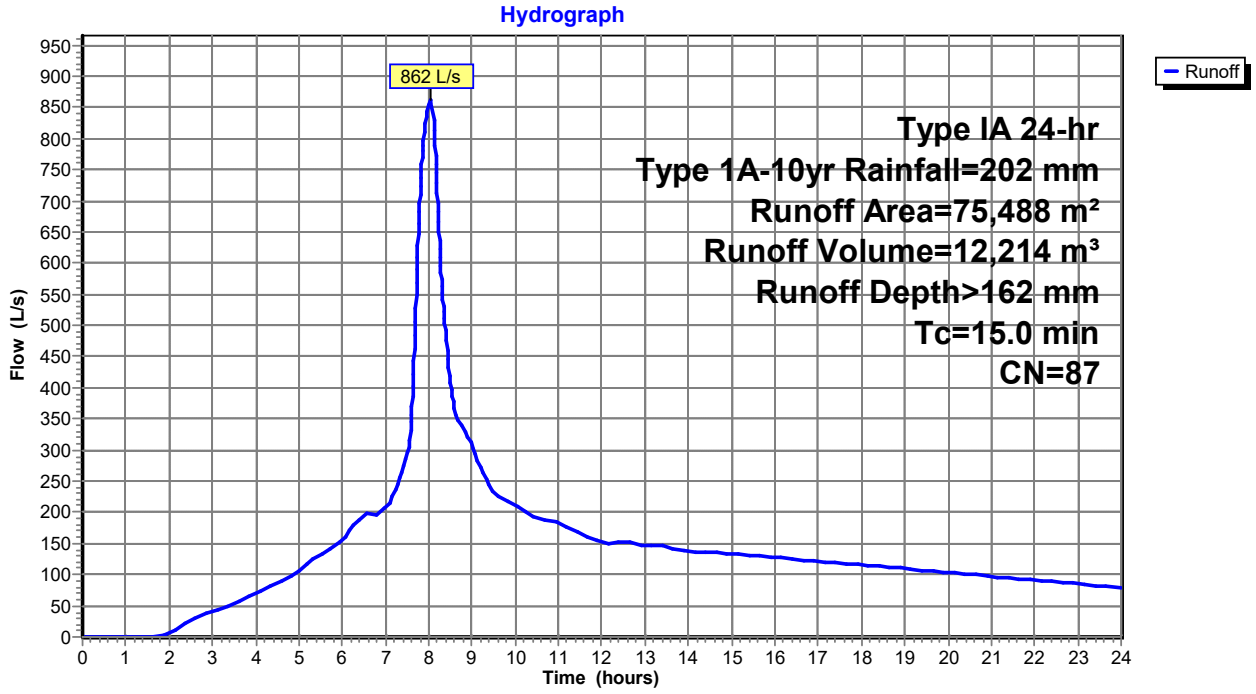
Runoff = 862 L/s @ 8.04 hrs, Volume= 12,214 m³, Depth> 162 mm
Routed to Pond 27P : Pond A (Option 3)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr Type 1A-10yr Rainfall=202 mm

	Area (m²)	CN	Description
*	14,566	98	Existing Roofs
*	2,870	98	Proposed Roofs
*	6,715	98	Concrete
*	1,833	61	Pond
*	5,129	61	Grass
*	44,375	85	Gravel
	75,488	87	Weighted Average
	51,337		68.01% Pervious Area
	24,151		31.99% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
15.0					**Direct Entry,**

Subcatchment 14S: Proposed development (Area to pond A)



Summary for Subcatchment 29S: Predevelopment (area to Pond A)

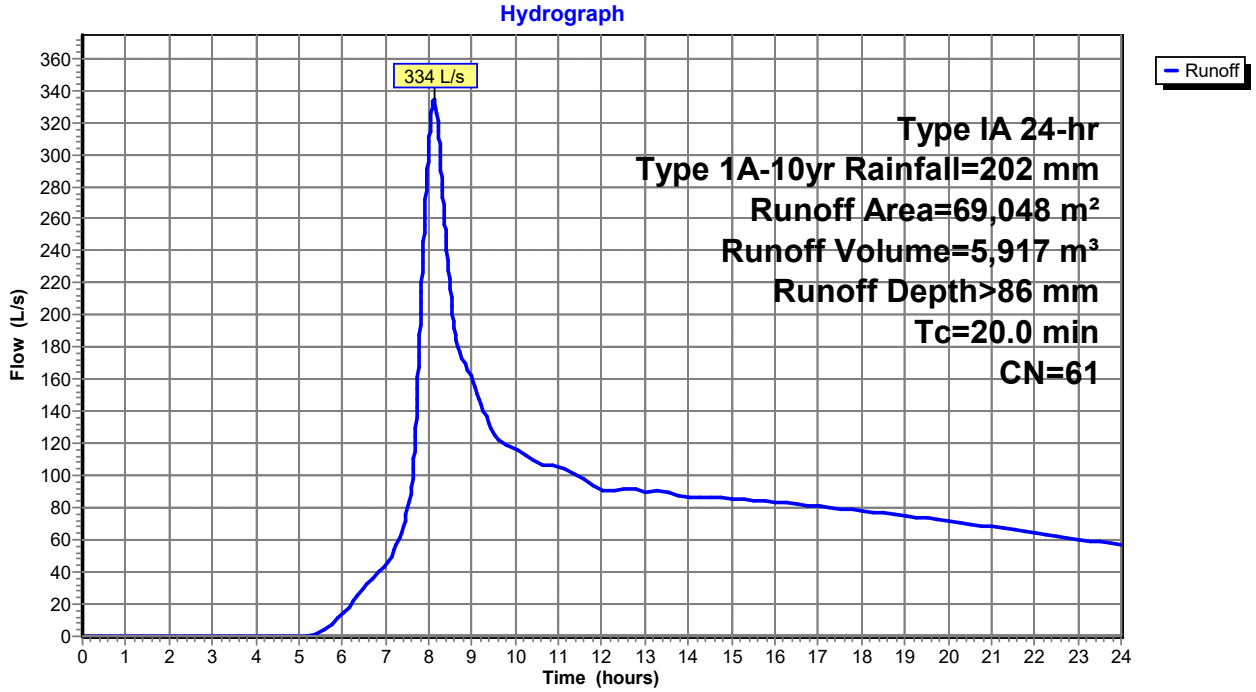
Runoff = 334 L/s @ 8.13 hrs, Volume= 5,917 m³, Depth> 86 mm
Routed to Link 28L : (new Link)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr Type 1A-10yr Rainfall=202 mm

Area (m²)	CN	Description
69,048	61	>75% Grass cover, Good, HSG B
69,048		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
20.0					**Direct Entry,**

Subcatchment 29S: Predevelopment (area to Pond A)



Summary for Pond 27P: Pond A (Option 3)

Inflow Area = 75,488 m², 31.99% Impervious, Inflow Depth > 162 mm for Type 1A-10yr event
Inflow = 862 L/s @ 8.04 hrs, Volume= 12,212 m³
Outflow = 325 L/s @ 8.89 hrs, Volume= 9,024 m³, Atten= 62%, Lag= 50.7 min
Primary = 325 L/s @ 8.89 hrs, Volume= 9,024 m³
Routed to Link 29L : (new Link)

Routing by Sim-Route method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 77.81 m @ 8.89 hrs Surf.Area= 3,112 m² Storage= 3,561 m³

Plug-Flow detention time= 283.3 min calculated for 9,024 m³ (74% of inflow)
Center-of-Mass det. time= 123.4 min (836.1 - 712.7)

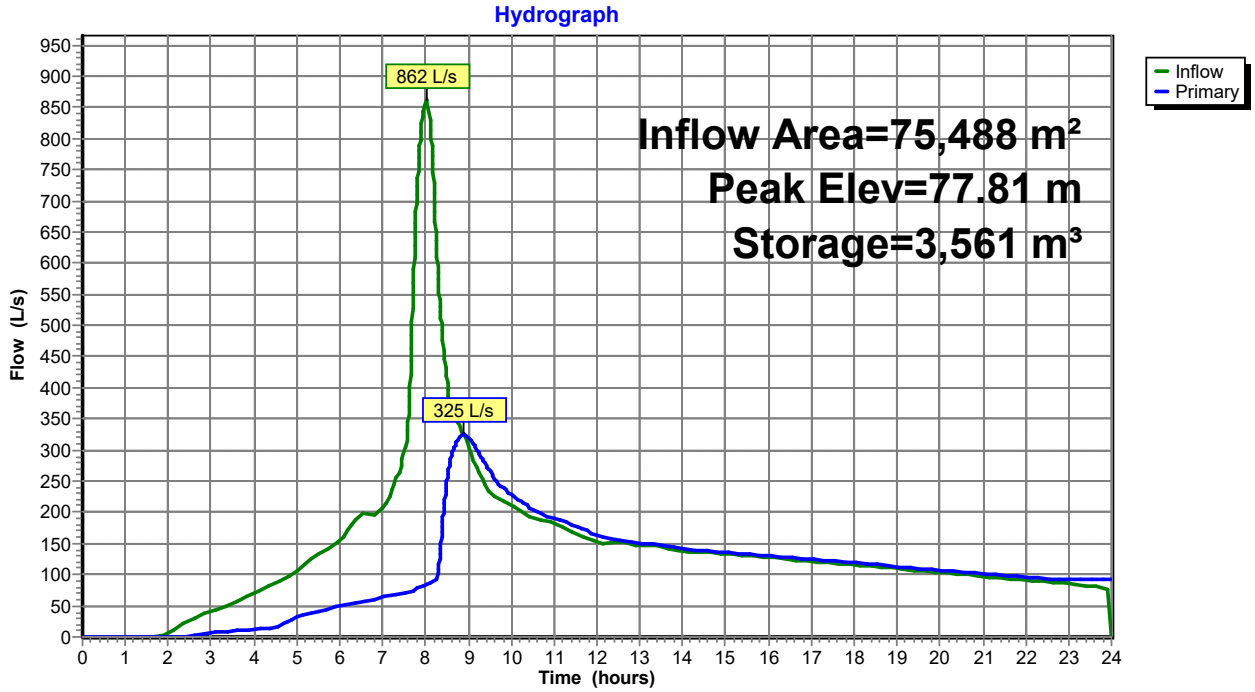
Volume	Invert	Avail.Storage	Storage Description
#1	75.80 m	4,171 m³	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (meters)	Surf.Area (sq-meters)	Inc.Store (cubic-meters)	Cum.Store (cubic-meters)
75.80	665	0	0
76.00	802	147	147
76.20	980	178	325
76.40	1,190	217	542
76.60	1,433	262	804
76.80	1,708	314	1,118
77.00	1,994	370	1,489
77.20	2,268	426	1,915
77.40	2,542	481	2,396
77.60	2,817	536	2,932
77.80	3,094	591	3,523
78.00	3,387	648	4,171

Device	Routing	Invert	Outlet Devices
#1	Primary	75.80 m	**100 mm Vert. 100mm DIA Orifice/Grate** C= 0.650 Limited to weir flow at low heads
#2	Primary	76.20 m	**150 mm Vert. 150mm DIA Orifice/Grate** C= 0.650 Limited to weir flow at low heads
#3	Primary	77.70 m	**1,050 mm Horiz. 1,050mm DIA Manhole** C= 0.650 Limited to weir flow at low heads
#4	Primary	77.80 m	**3.00 m long + 2.0 m/m SideZ x 5.00 m breadth Broad-Crested Rectangular W** Head (meters) 0.06 0.12 0.18 0.24 0.30 0.37 0.43 0.49 Coef. (Metric) 1.48 1.49 1.49 1.46 1.45 1.46 1.46 1.45

Primary OutFlow Max=325 L/s @ 8.89 hrs HW=77.81 m TW=0.00 m (Dynamic Tailwater)
- **1=100mm DIA Orifice/Grate** (Orifice Controls 32 L/s @ 4.03 m/s)
- **2=150mm DIA Orifice/Grate** (Orifice Controls 63 L/s @ 3.57 m/s)
- **3=1,050mm DIA Manhole** (Weir Controls 224 L/s @ 0.61 m/s)
- **4=Broad-Crested Rectangular Weir** (Weir Controls 6 L/s @ 0.16 m/s)

Pond 27P: Pond A (Option 3)

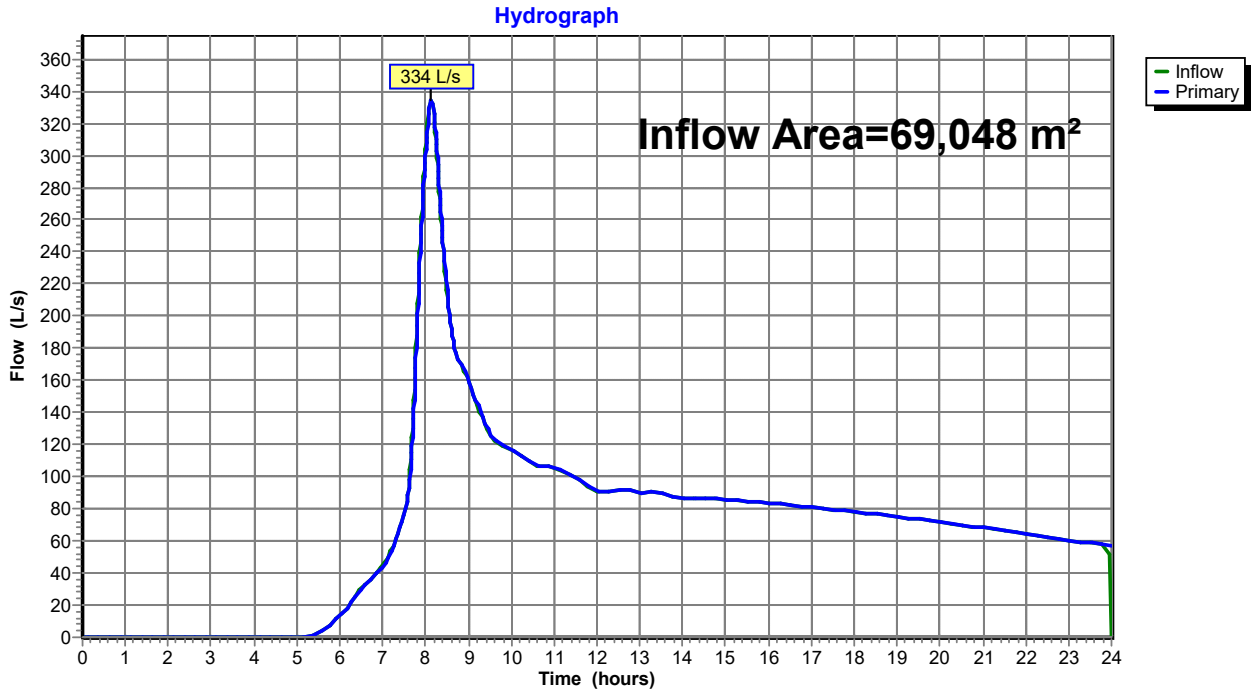


Summary for Link 28L: (new Link)

Inflow Area = 69,048 m², 0.00% Impervious, Inflow Depth > 86 mm for Type 1A-10yr event
Inflow = 334 L/s @ 8.13 hrs, Volume= 5,915 m³
Primary = 334 L/s @ 8.14 hrs, Volume= 5,915 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 28L: (new Link)

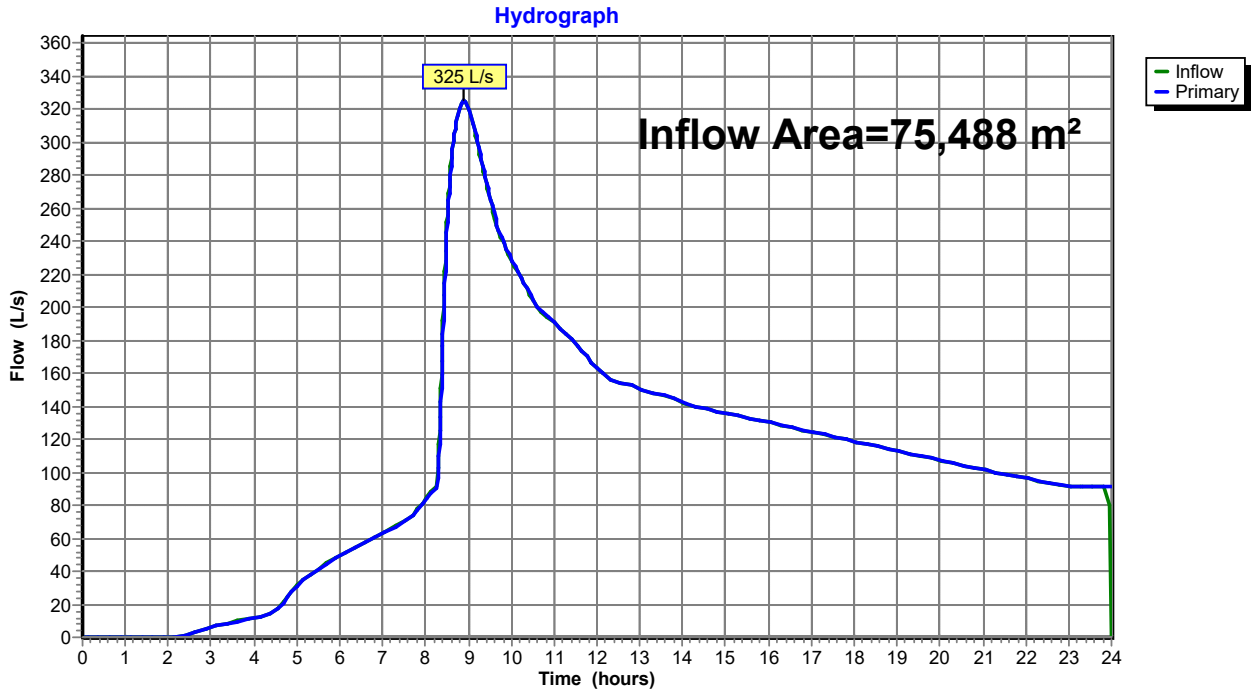


Summary for Link 29L: (new Link)

Inflow Area = 75,488 m², 31.99% Impervious, Inflow Depth > 119 mm for Type 1A-10yr event
Inflow = 325 L/s @ 8.89 hrs, Volume= 9,021 m³
Primary = 325 L/s @ 8.90 hrs, Volume= 9,021 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 29L: (new Link)



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Sim-Route method - Pond routing by Sim-Route method

Subcatchment 14S: Proposed Runoff Area=75,488 m² 31.99% Impervious Runoff Depth>92 mm
Tc=15.0 min CN=87 Runoff=486 L/s 6,943 m³

Subcatchment 29S: Predevelopment Runoff Area=69,048 m² 0.00% Impervious Runoff Depth>36 mm
Tc=20.0 min CN=61 Runoff=101 L/s 2,453 m³

Pond 27P: Pond A (Option 3) Peak Elev=77.43 m Storage=2,466 m³ Inflow=486 L/s 6,941 m³
Outflow=83 L/s 4,973 m³

Link 28L: (new Link) Inflow=101 L/s 2,452 m³
Primary=101 L/s 2,452 m³

Link 29L: (new Link) Inflow=83 L/s 4,970 m³
Primary=83 L/s 4,970 m³

Total Runoff Area = 144,536 m² Runoff Volume = 9,396 m³ Average Runoff Depth = 65 mm
83.29% Pervious = 120,385 m² 16.71% Impervious = 24,151 m²

Summary for Subcatchment 14S: Proposed development (Area to pond A)

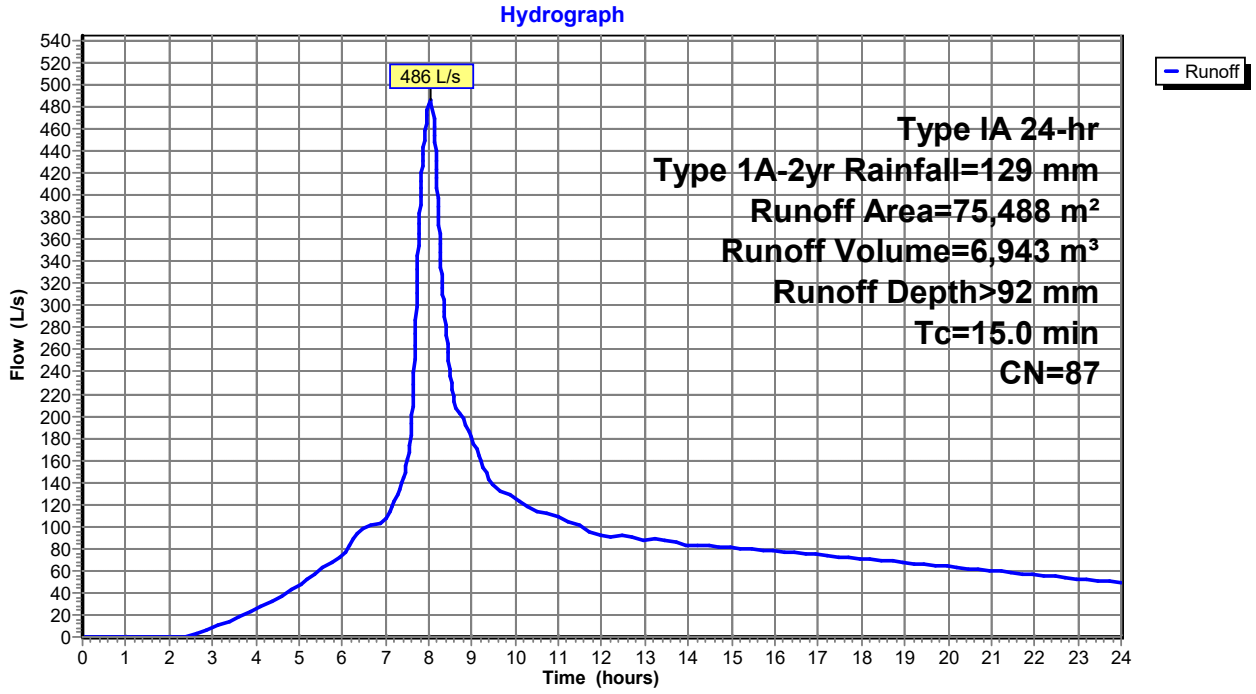
Runoff = 486 L/s @ 8.05 hrs, Volume= 6,943 m³, Depth> 92 mm
Routed to Pond 27P : Pond A (Option 3)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr Type 1A-2yr Rainfall=129 mm

	Area (m²)	CN	Description
*	14,566	98	Existing Roofs
*	2,870	98	Proposed Roofs
*	6,715	98	Concrete
*	1,833	61	Pond
*	5,129	61	Grass
*	44,375	85	Gravel
	75,488	87	Weighted Average
	51,337		68.01% Pervious Area
	24,151		31.99% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
15.0					**Direct Entry,**

Subcatchment 14S: Proposed development (Area to pond A)



Summary for Subcatchment 29S: Predevelopment (area to Pond A)

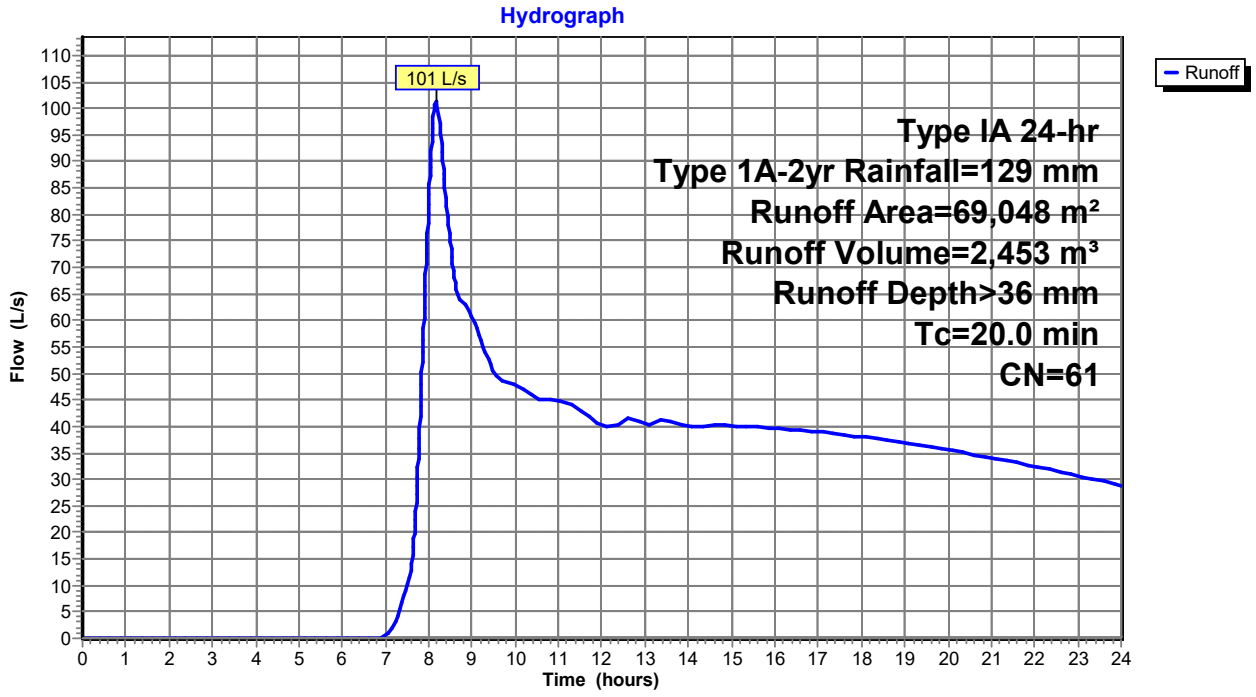
Runoff = 101 L/s @ 8.16 hrs, Volume= 2,453 m³, Depth> 36 mm
Routed to Link 28L : (new Link)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr Type 1A-2yr Rainfall=129 mm

Area (m²)	CN	Description
69,048	61	>75% Grass cover, Good, HSG B
69,048		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
20.0					**Direct Entry,**

Subcatchment 29S: Predevelopment (area to Pond A)



Summary for Pond 27P: Pond A (Option 3)

Inflow Area = 75,488 m², 31.99% Impervious, Inflow Depth > 92 mm for Type 1A-2yr event
Inflow = 486 L/s @ 8.05 hrs, Volume= 6,941 m³
Outflow = 83 L/s @ 14.36 hrs, Volume= 4,973 m³, Atten= 83%, Lag= 378.8 min
Primary = 83 L/s @ 14.36 hrs, Volume= 4,973 m³
Routed to Link 29L : (new Link)

Routing by Sim-Route method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 77.43 m @ 14.36 hrs Surf.Area= 2,580 m² Storage= 2,466 m³

Plug-Flow detention time= 351.4 min calculated for 4,971 m³ (72% of inflow)
Center-of-Mass det. time= 183.1 min (922.9 - 739.7)

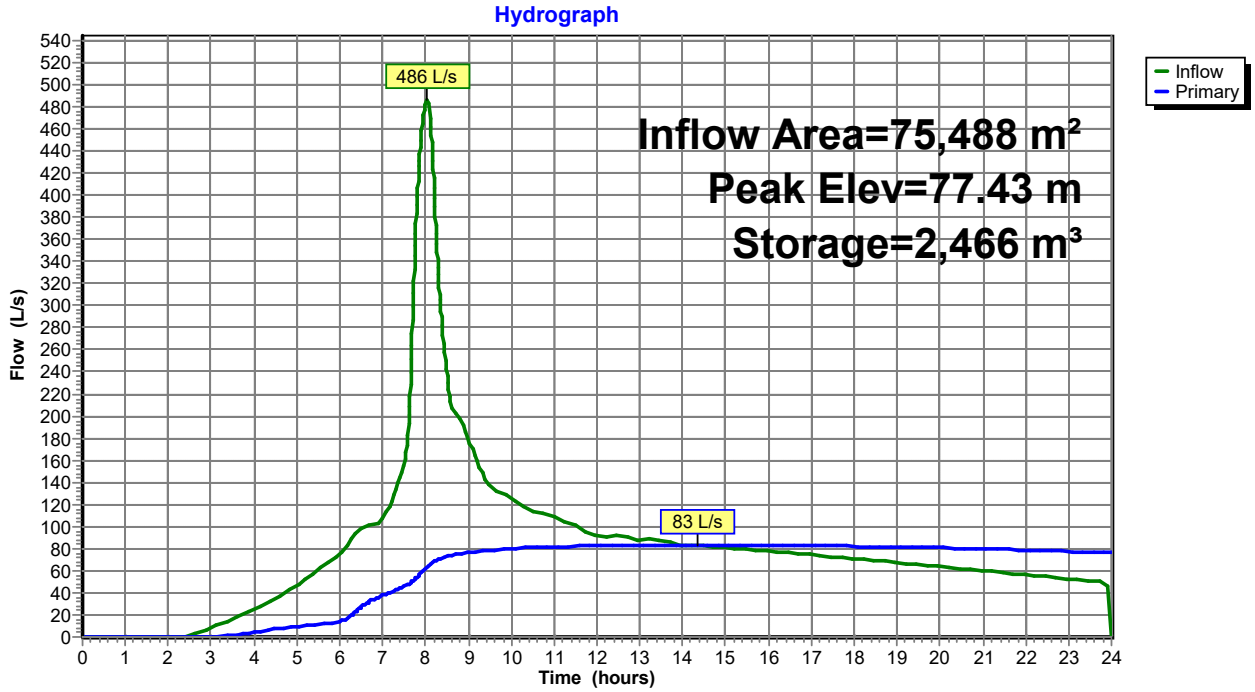
Volume	Invert	Avail.Storage	Storage Description
#1	75.80 m	4,171 m³	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (meters)	Surf.Area (sq-meters)	Inc.Store (cubic-meters)	Cum.Store (cubic-meters)
75.80	665	0	0
76.00	802	147	147
76.20	980	178	325
76.40	1,190	217	542
76.60	1,433	262	804
76.80	1,708	314	1,118
77.00	1,994	370	1,489
77.20	2,268	426	1,915
77.40	2,542	481	2,396
77.60	2,817	536	2,932
77.80	3,094	591	3,523
78.00	3,387	648	4,171

Device	Routing	Invert	Outlet Devices
#1	Primary	75.80 m	**100 mm Vert. 100mm DIA Orifice/Grate** C= 0.650 Limited to weir flow at low heads
#2	Primary	76.20 m	**150 mm Vert. 150mm DIA Orifice/Grate** C= 0.650 Limited to weir flow at low heads
#3	Primary	77.70 m	**1,050 mm Horiz. 1,050mm DIA Manhole** C= 0.650 Limited to weir flow at low heads
#4	Primary	77.80 m	**3.00 m long + 2.0 m/m SideZ x 5.00 m breadth Broad-Crested Rectangular W** Head (meters) 0.06 0.12 0.18 0.24 0.30 0.37 0.43 0.49 Coef. (Metric) 1.48 1.49 1.49 1.46 1.45 1.46 1.46 1.45

Primary OutFlow Max=83 L/s @ 14.36 hrs HW=77.43 m TW=0.00 m (Dynamic Tailwater)
- **1=100mm DIA Orifice/Grate** (Orifice Controls 28 L/s @ 3.62 m/s)
- **2=150mm DIA Orifice/Grate** (Orifice Controls 55 L/s @ 3.09 m/s)
- **3=1,050mm DIA Manhole** (Controls 0 L/s)
- **4=Broad-Crested Rectangular Weir** (Controls 0 L/s)

Pond 27P: Pond A (Option 3)

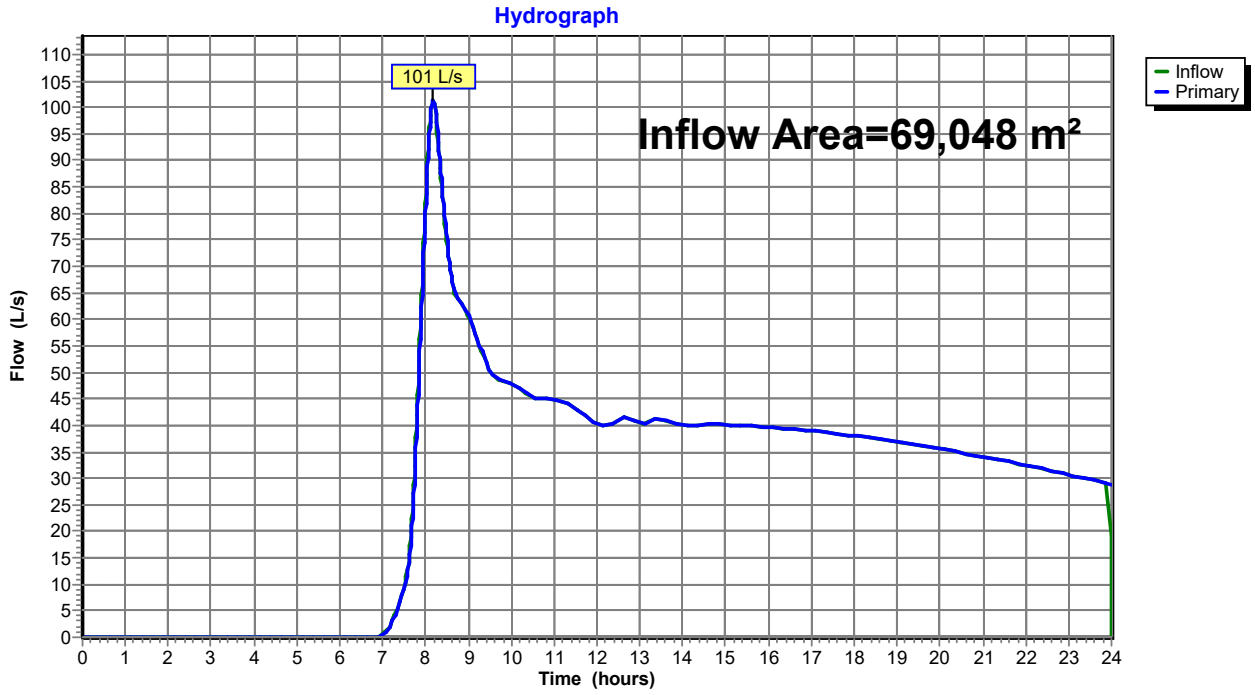


Summary for Link 28L: (new Link)

Inflow Area = 69,048 m², 0.00% Impervious, Inflow Depth > 36 mm for Type 1A-2yr event
Inflow = 101 L/s @ 8.16 hrs, Volume= 2,452 m³
Primary = 101 L/s @ 8.17 hrs, Volume= 2,452 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 28L: (new Link)

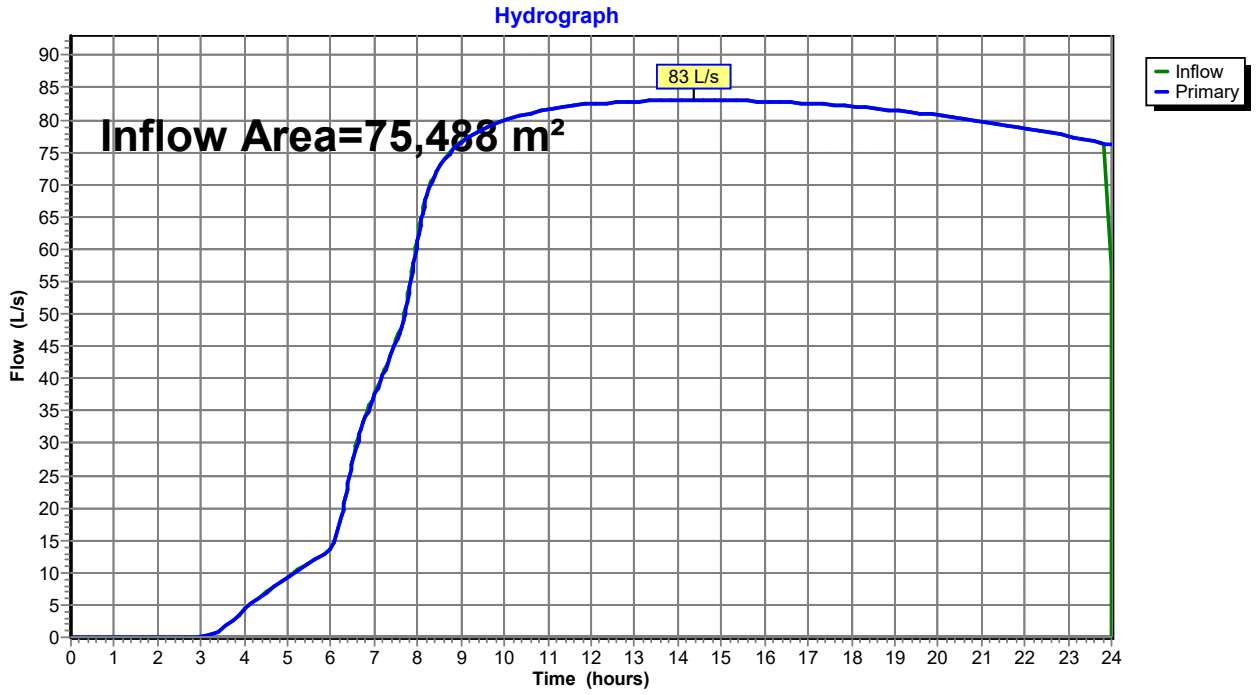


Summary for Link 29L: (new Link)

Inflow Area = 75,488 m², 31.99% Impervious, Inflow Depth > 66 mm for Type 1A-2yr event
Inflow = 83 L/s @ 14.36 hrs, Volume= 4,970 m³
Primary = 83 L/s @ 14.37 hrs, Volume= 4,970 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 29L: (new Link)



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Sim-Route method - Pond routing by Sim-Route method

Subcatchment 14S: Proposed Runoff Area=75,488 m² 31.99% Impervious Runoff Depth>132 mm
Tc=15.0 min CN=87 Runoff=702 L/s 9,957 m³

Subcatchment 29S: Predevelopment Runoff Area=69,048 m² 0.00% Impervious Runoff Depth>63 mm
Tc=20.0 min CN=61 Runoff=227 L/s 4,354 m³

Pond 27P: Pond A (Option 3) Peak Elev=77.75 m Storage=3,382 m³ Inflow=702 L/s 9,954 m³
Outflow=168 L/s 6,936 m³

Link 28L: (new Link) Inflow=227 L/s 4,353 m³
Primary=227 L/s 4,353 m³

Link 29L: (new Link) Inflow=168 L/s 6,933 m³
Primary=168 L/s 6,933 m³

Total Runoff Area = 144,536 m² Runoff Volume = 14,311 m³ Average Runoff Depth = 99 mm
83.29% Pervious = 120,385 m² 16.71% Impervious = 24,151 m²

Summary for Subcatchment 14S: Proposed development (Area to pond A)

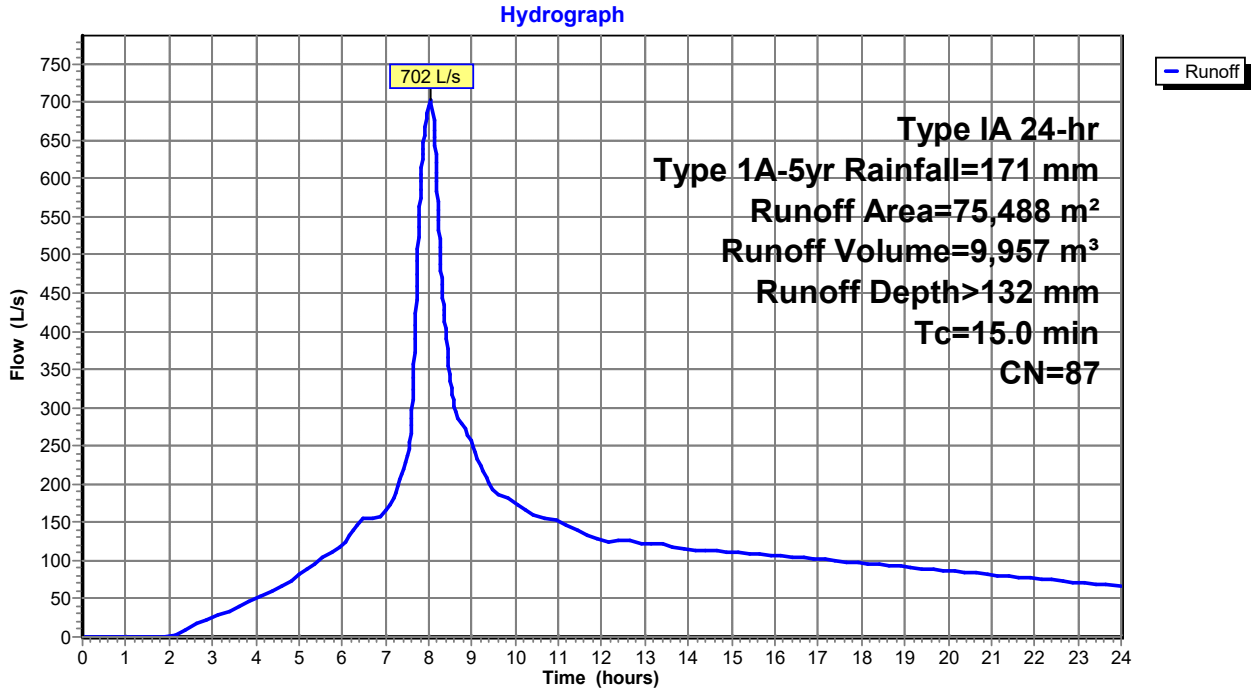
Runoff = 702 L/s @ 8.05 hrs, Volume= 9,957 m³, Depth> 132 mm
Routed to Pond 27P : Pond A (Option 3)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr Type 1A-5yr Rainfall=171 mm

	Area (m²)	CN	Description
*	14,566	98	Existing Roofs
*	2,870	98	Proposed Roofs
*	6,715	98	Concrete
*	1,833	61	Pond
*	5,129	61	Grass
*	44,375	85	Gravel
	75,488	87	Weighted Average
	51,337		68.01% Pervious Area
	24,151		31.99% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
15.0					**Direct Entry,**

Subcatchment 14S: Proposed development (Area to pond A)



Summary for Subcatchment 29S: Predevelopment (area to Pond A)

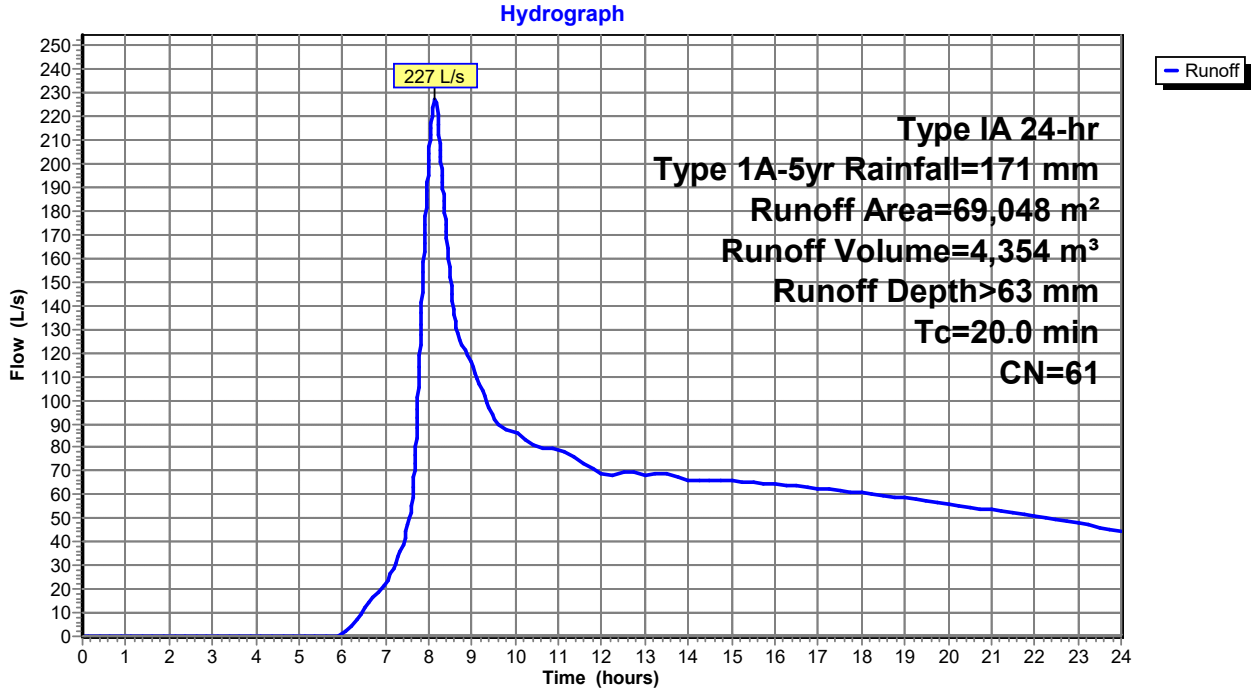
Runoff = 227 L/s @ 8.15 hrs, Volume= 4,354 m³, Depth> 63 mm
Routed to Link 28L : (new Link)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type IA 24-hr Type 1A-5yr Rainfall=171 mm

Area (m²)	CN	Description
69,048	61	>75% Grass cover, Good, HSG B
69,048		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
20.0					**Direct Entry,**

Subcatchment 29S: Predevelopment (area to Pond A)



Summary for Pond 27P: Pond A (Option 3)

Inflow Area = 75,488 m², 31.99% Impervious, Inflow Depth > 132 mm for Type 1A-5yr event
Inflow = 702 L/s @ 8.05 hrs, Volume= 9,954 m³
Outflow = 168 L/s @ 10.18 hrs, Volume= 6,936 m³, Atten= 76%, Lag= 128.3 min
Primary = 168 L/s @ 10.18 hrs, Volume= 6,936 m³
Routed to Link 29L : (new Link)

Routing by Sim-Route method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 77.75 m @ 10.18 hrs Surf.Area= 3,031 m² Storage= 3,382 m³

Plug-Flow detention time= 338.4 min calculated for 6,933 m³ (70% of inflow)
Center-of-Mass det. time= 158.5 min (880.5 - 722.0)

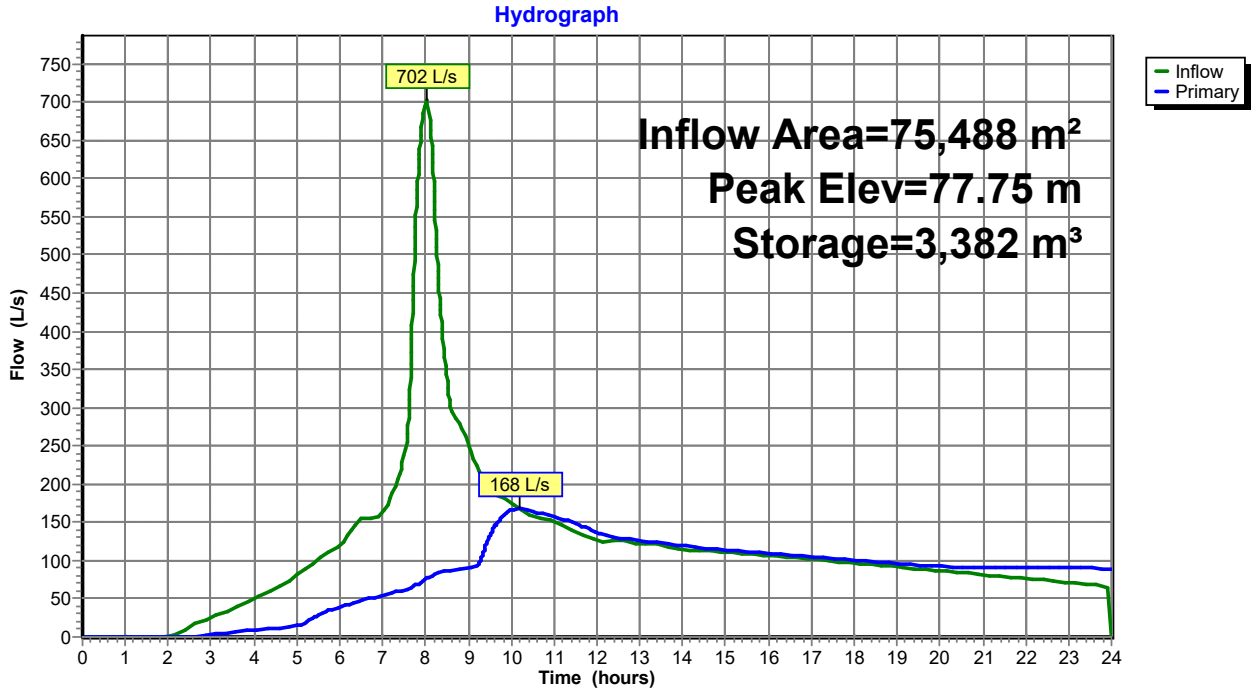
Volume	Invert	Avail.Storage	Storage Description
#1	75.80 m	4,171 m³	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (meters)	Surf.Area (sq-meters)	Inc.Store (cubic-meters)	Cum.Store (cubic-meters)
75.80	665	0	0
76.00	802	147	147
76.20	980	178	325
76.40	1,190	217	542
76.60	1,433	262	804
76.80	1,708	314	1,118
77.00	1,994	370	1,489
77.20	2,268	426	1,915
77.40	2,542	481	2,396
77.60	2,817	536	2,932
77.80	3,094	591	3,523
78.00	3,387	648	4,171

Device	Routing	Invert	Outlet Devices
#1	Primary	75.80 m	**100 mm Vert. 100mm DIA Orifice/Grate** C= 0.650 Limited to weir flow at low heads
#2	Primary	76.20 m	**150 mm Vert. 150mm DIA Orifice/Grate** C= 0.650 Limited to weir flow at low heads
#3	Primary	77.70 m	**1,050 mm Horiz. 1,050mm DIA Manhole** C= 0.650 Limited to weir flow at low heads
#4	Primary	77.80 m	**3.00 m long + 2.0 m/m SideZ x 5.00 m breadth Broad-Crested Rectangular W** Head (meters) 0.06 0.12 0.18 0.24 0.30 0.37 0.43 0.49 Coef. (Metric) 1.48 1.49 1.49 1.46 1.45 1.46 1.46 1.45

Primary OutFlow Max=168 L/s @ 10.18 hrs HW=77.75 m TW=0.00 m (Dynamic Tailwater)
- **1=100mm DIA Orifice/Grate** (Orifice Controls 31 L/s @ 3.97 m/s)
- **2=150mm DIA Orifice/Grate** (Orifice Controls 62 L/s @ 3.50 m/s)
- **3=1,050mm DIA Manhole** (Weir Controls 75 L/s @ 0.42 m/s)
- **4=Broad-Crested Rectangular Weir** (Controls 0 L/s)

Pond 27P: Pond A (Option 3)

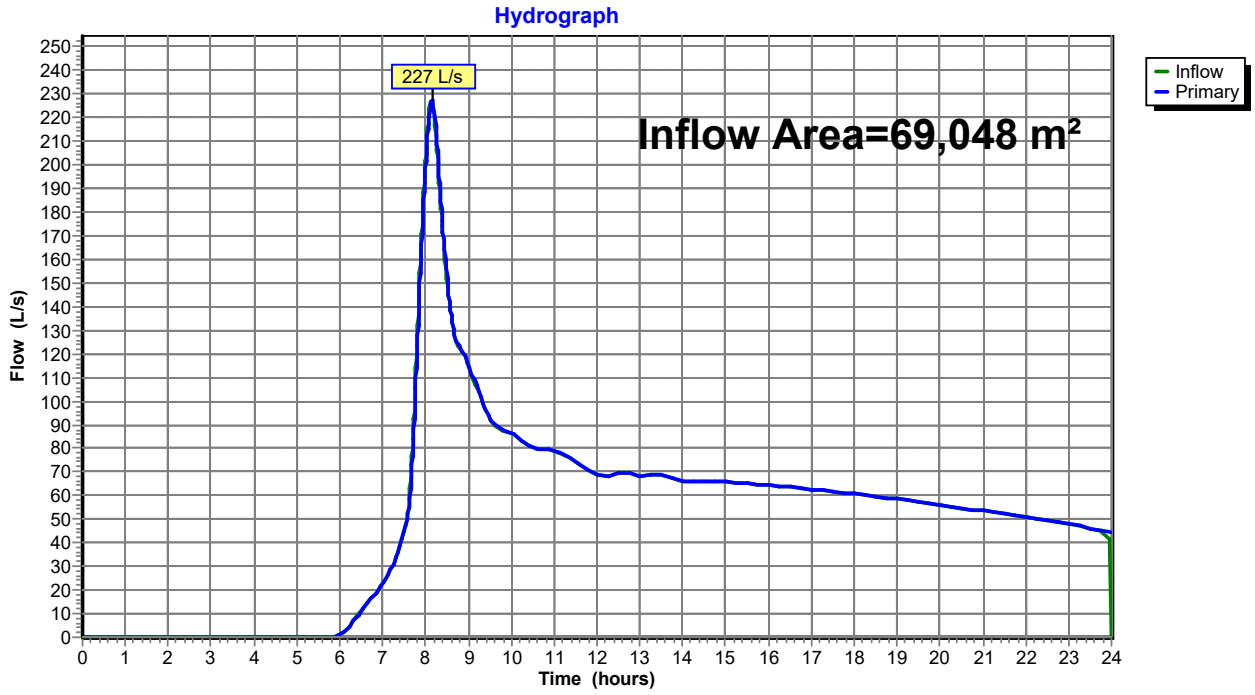


Summary for Link 28L: (new Link)

Inflow Area = 69,048 m², 0.00% Impervious, Inflow Depth > 63 mm for Type 1A-5yr event
Inflow = 227 L/s @ 8.15 hrs, Volume= 4,353 m³
Primary = 227 L/s @ 8.16 hrs, Volume= 4,353 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 28L: (new Link)

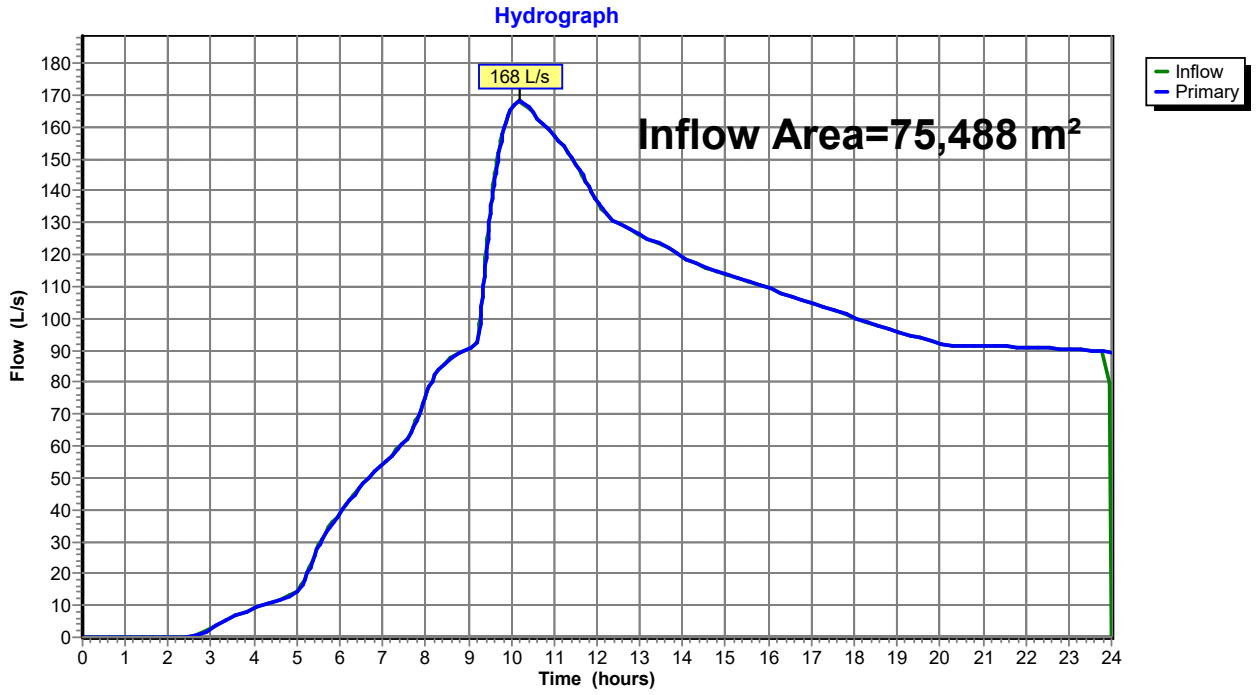


Summary for Link 29L: (new Link)

Inflow Area = 75,488 m², 31.99% Impervious, Inflow Depth > 92 mm for Type 1A-5yr event
Inflow = 168 L/s @ 10.18 hrs, Volume= 6,933 m³
Primary = 168 L/s @ 10.19 hrs, Volume= 6,933 m³, Atten= 0%, Lag= 0.6 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link 29L: (new Link)



Appendix D – Wastewater Checklist

FAR NORTH DISTRICT COUNCIL
Appendix E TP58
On-site Wastewater Disposal Site Evaluation
Investigation Checklist

Part A –Owners Details

1. Applicant Details:

Applicant Name	*Waipapa Pine Ltd*	
Company Name		
	First Name(s)	Surname
Property Owner Name(s)		

Nature of Applicant*	*Owner*

*(*i.e. Owner, Leasee, Prospective Purchaser, Developer)*

2. Consultant / Site Evaluator Details:

Consultant/Agent Name	*Haigh Workman*			
Site Evaluator Name	*John Papesch*			
Postal Address	*PO Box 89*			
	Kerikeri			
Phone Number	Business	*407 8327*	Private	
	Mobile		Fax	
Name of Contact Person				
E-mail Address	*johnp@haighworks.co.nz*			

3. Are there any previous existing discharge consents relating to this proposal or other waste discharge on this site?

Yes		No	✓	(Please tick)
If yes, give Reference Numbers and Description				

4. List any other consent in relation to this proposal site and indicate whether or not they have been applied for or granted
If so, specify Application Details and Consent No.
(eg. LandUse, Water Take, Subdivision, Earthworks Stormwater Consent)

This assessment is to accompany a resource consent application

Part B- Property Details

1. Property for which this application relates:

Physical Address of Property	*1945B State Highway 10, Waipapa*
Territorial Local Authority	FAR NORTH DISTRICT COUNCIL
Regional Council	NORTHLAND REGIONAL COUNCIL
Legal Status of Activity	Permitted: Controlled: Discretionary: ✓
Relevant Regional Rule(s) (Note 1)	
Total Property Area (m²)	*107,500*
Map Grid Reference of Property If Known	

2. Legal description of land (as shown on Certificate of Title)

Lot 1	*DP 376253*		CT No.	
Lot 2	*DP 343062*			
Lot 3	*DP 343062*			
Other (specify)				

Please ensure copy of Certificate of Title is attached

PART C: Site Assessment - Surface Evaluation

(Refer TP58 - Sn 5.1 General Purpose of Site Evaluation and Sn 5.2.2(a) Site Surface Evaluation)
Note: Underlined terms defined in Table 1, attached

Has a relevant property history study been conducted?

Yes	✓	No	

(Please tick one)

If yes, please specify the findings of the history study, and if not please specify why this was not considered necessary.

Haigh Workman designed the existing wastewater system
Meter readings have been carried out to verify design flows

1. Has a Slope Stability Assessment been carried out on the property?

Yes		No	✓	Please tick

If No, why not?

Site is flat. .

If Yes, please give details of report (and if possible, please attach report):

Author	
Company/Agency	
Date of Report	
Brief Description of Report Findings:-	

2. Site Characteristics (See Table 1 attached):

Provide descriptive details below:
Performance of Adjacent Systems:
No problems known
Estimated Rainfall and Seasonal Variation:
1600 mm per year. 900 mm winter, 700 mm summer
Vegetation / Tree Cover:
Rough pasture
Slope Shape: (Please provide diagrams)
Flat
Slope Angle:
5 degrees for proposed effluent field
Surface Water Drainage Characteristics:
Sheet flow
Flooding Potential: YES/NO
No – elevated disposal field located above 100 year ARI + CC flood level
.
If yes, specify relevant flood levels on appended site plan, I.e. one in 5 years and/or 20 year and/or 100 year return period flood level, relative to disposal area.
Surface Water Separation:
See table
Site Characteristics: or any other limitation influencing factors

3. Site Geology **Check Rock Maps**

lluvium:overlaying rugged surfaces of lava flows

Geological Map Reference Number	*NZMS 290 rock and soils maps*

4. What Aspect(s) does the proposed disposal system face? (please tick)

North	✓	**West**	
North-West		**South-West**	
North-East		**South-East**	
East		**South**	

5. Site clearances,(Indicate on site plan where relevant)

Separation Distance from	Treatment Separation Distance	Disposal Field Separation Distance	NRC minimum
Boundaries	*>50 m*	*>3 m*	1.5 m
Rivers, lakes, ponds, wetlands, CMA	*na*	*>15 m*	15 m
Stormwater flow path	*na*	*>3 m*	5 m
Groundwater	*na*	*>1 m*	0.6 m
Stands of Trees/Shrubs	*na*	*na*	na
Wells, water bores	*na*	*>100 m*	20 m
Rivers, lakes, wetlands, CMA (FNDC)	*>150 m*	*>300 m*	30 m

PART D: Site Assessment - Subsoil Investigation

(Refer TP58 - Sn 5.1 General Purpose of Site Evaluation, and Sn 5.2.2(a) Site Surface Evaluation and Sn 5.3 Subsurface Investigations)

Note: Underlined terms defined in Table 2, attached

1. Please identify the soil profile determination method:

Test Pit		(Depth____*1.4* _____m	No of Test Pits	*3*
Bore Hole		(Depth__	No of Bore Holes	
Other (specify):				

Soil Report attached?

Yes	✓	No		Please tick

2. Was fill material intercepted during the subsoil investigation?

Yes		No	✓	Please tick

If yes, please specify the effect of the fill on wastewater disposal

3. percolation testing (mandatory and site specific for trenches in soil type 4 to 7)

Please specify the method					
Not required – trickle irrigation proposed					
Test Report Attached?	Yes		No	✓	Please tick

4. Are surface water interception/diversion drains required?

Yes	✓	No		Please tick

If yes, please show on site plan

4a Are subsurface drains required

Yes		No	✓	Please tick

If yes, please provide details

5. Please state the depth of the seasonal water table:

Winter	*1.0*	m	Measured		Estimated	✓
Summer	*>1.0*	m	Measured	✓	Estimated	

6. Are there any potential storm water short circuit paths?

Yes		No	✓	Please tick

If the answer is yes, please explain how these have been addressed

7. Based on results of subsoil investigation above, please indicate the disposal field soil category
(Refer TP58 Table 5.1)

Is Topsoil Present?	*Yes*	If so, Topsoil Depth?	*0.2* (m)

Soil Category	Description	Drainage	Tick One
1	Gravel, coarse sand	Rapid draining	
2	Coarse to medium sand	Free draining	
3	Medium-fine & loamy sand	Good drainage	
4	Sandy loam, loam & silt loam	Moderate drainage	✓
5	Sandy clay-loam, clay loam & silty clay-loam	Moderate to slow drainage	
6	Sandy clay, non-swelling clay & silty clay	Slow draining	
7	Swelling clay, grey clay, hardpan	Poorly or non-draining	

Reasons for placing in stated category

Soil map classification, soil colour and texture

PART E: Discharge Details

1. Water supply source for the property (please tick):

Rainwater (roof collection)	✓
Bore/well	✓
Public supply	

2. Calculate the maximum daily volume of wastewater to be discharged, unless accurate water meter readings are available

(Refer TP58 Table 6.1 and 6.2)

Number of Bedrooms	*0*			
Design Occupancy	*104*			(Number of People)
Per capita Wastewater Production	140	160	180	(tick) (Litres per person per day)
Other - specify	200	220		
Day workers	*40✓*			Litres per person per day
				Litres per person per day
Total Daily Wastewater Production	*4,160*			(litres per day)

3. Do any special conditions apply regarding water saving devices

a) Full Water Conservation Devices?	Yes		No	✓	(Please tick)
b) Water Recycling - what %?	%				(Please tick)

If you have answered yes, please state what conditions apply and include the estimated reduction in water usage

Dual flush toilets, low water use dishwasher, no garbage grinders

4. Is Daily Wastewater Discharge Volume more than 2000 litres:

Yes	✓	(Please tick)
No		(Please tick)

Note if answer to the above is yes, an N.R.C wastewater discharge permit may be required

5. Gross Lot Area to Discharge Ratio:

Gross Lot Area	*107,500*	m^2
Total Daily Wastewater Production	*4,160*	(Litres per day)(from above)
Lot Area to Discharge Ratio	*26*	

7. Does this proposal comply with a Gross Lot Area to Discharge Ratio of greater than 3?

Yes	✓	No		Please tick

8. Is a Northland Regional Council Discharge Consent Required?

Yes	✓	No		(Please tick)

PART F: Primary Treatment *(Refer TP58 Section 7.2)*

1. Please indicate below the no. and capacity (litres) of all septic tanks including type (single/dual chamber grease traps) to be installed or currently existing: If not 4500 litre, duel chamber explain why not

Number of Tanks	Type of Tank	Capacity of Tank (Litres)
VBB C 3000 twin – at office block		
VBB C 2200 – at Boron plant		
pump chamber – at Boron plant		
	Total Capacity	

2. Type of Septic Tank Outlet Filter to be installed?

Not applicable

PART G: Secondary and Tertiary Treatment

(Refer TP58 Section 7.3, 7.4, 7.5 and 7.6)

1. Please indicate the type of additional treatment, if any, proposed to be installed in the system: (please tick)

Secondary Treatment	✓		
Home aeration plant			
Commercial aeration plant			
Intermediate sand filter			
Recirculating sand filter			
Recirculating textile filter			
Clarification tank			
Tertiary Treatment			
Ultraviolet disinfection			
Chlorination			
Other		Specify	

PART H: Land Disposal Method

(Refer TP58 Section 8)

1. Please indicate the proposed loading method: (please tick)

Gravity	
Dosing Siphon	
Pump	✓

2.High water level alarm to be installed in pump chambers

Yes✓	No

If not to be installed, explain why

3. If a pump is being used, please provide the following information:

Total Design Head	*Refer supplier information*	(m)
Pump Chamber Volume		(Litres)
Emergency Storage Volume		(Litres)

4. Please identify the type(s) of land disposal method proposed for this site: (please tick)
(Refer TP58 Sections 9 and 10)

Surface Dripper Irrigation	✓		
Sub-surface Dripper irrigation			
Standard Trench			
Deep Trench			
Mound			
Evapo-transpiration Beds			
Other		Specify	

5. Please identify the loading rate you propose for the option selected in Part H, Section 4 above, stating the reasons for selecting this loading rate:

Loading Rate	*4*		(Litres/m^2/day)
Disposal Area	Design	*1040*	(m^2)
	reserve	*312*	(m^2)

Explanation *(Refer TP58 Sections 9 and 10)*

Loading rate adopted for secondary treated effluent in category 4 soils refer table 9.2 in TP58

6. What is the available reserve wastewater disposal area *(Refer TP58 Table 5.3)*

Reserve Disposal Area (m²)	*312*
Percentage of Primary Disposal Area (%)	*30*

7. Please provide a detailed description of the design and dimensions of the disposal field and attach a detailed plan of the field relative to the property site:

Description and Dimensions of Disposal Field:

Form a raised topsoil mound 135 m long x 10 m wide with a 5 degree northwards slope.					
Disposal area comprises 10x dripper lines x 1 m apart x 104 m long each.					
Lines to be pinned to the ground surface and covered with bark mulch and densely planted					
Plan Attached?	*Yes*	✓	*No*		*(Please tick)*

If not, explain why not

PART I: Maintenance & Management

(Refer TP58 Section 12.2)

1. Has a maintenance agreement been made with the treatment and disposal system suppliers?

Yes	✓	No		(Please tick)

Name of Suppliers

Waterflow NZ

PART J: Assessment of Environmental Effects

1. Is an assessment of environmental effects (AEE) included with application?

(Refer TP58 section 5. Ensure all issues concerning potential effects addressed)

Yes	✓	No		(Please tick)

If Yes, list and explain possible effects

PART K: Is Your Application Complete?

1. In order to provide a complete application you have remembered to:

Fully Complete this Assessment Form	✓
Include a *Location Plan* and *Site Plan* (with Scale Bars)	✓
Attach an Assessment of Environmental Effects (AEE)	✓

1. Declaration

I hereby certify that, to the best of knowledge and belief, the information given in this application is true and complete.

Name	*John Papesch*	Signature	
Position	*Senior Civil Engineer*	Date	11/6/2024

Note

Any alteration to the site plan or design after RC approval may result in non compliance.

Appendix E – Testpit Logs

PO Box 89, 0245
6 Fairway Drive
Kerikeri, 0230
New Zealand

HAIGH WORKMAN LTD
Civil & Structural Engineers

Phone 09 407 8327
Fax 09 407 8378
www.haighworkman.co.nz
info@haighworkman.co.nz

Testpit Log - TP1

Hole Location: Refer to Site Plan

JOB No. 23 256

CLIENT: Waipapa Pine Ltd
Date Started: 12/03/2024
Date Completed: 12/03/2024
SITE:
DRILLING METHOD: Digger
HOLE DIAMETER (mm) 1mx0.6mx1.2m (deep)
LOGGED BY: LP
CHECKED BY: RH

Soil Description (Based on NZGS Logging Guidelines 2005)	Depth (m)	Geology	Graphic Log	Water Level	Sensitivity	Vane Shear and Remoulded Vane Shear Strengths (kPa)	Scala Penetrometer (blows/100mm)
TOPSOIL, SILT, dark grey, moist, rootlets	0.0	TS		Groundwater Not Encountered	V	0 0	0 5 10 15 20
Clayey SILT, brown and grey striations, moist, trace fine sand	0.5				V	0 0	
Silty CLAY, mottled brown and grey, moist to very moist, trace fine sand	1.0				V	0 0	
End of test pit at 1.2m Groundwater not encountered	1.5				V	0 0	
	2.0				V	0 0	
	2.5				V	0 0	
	3.0						
	3.5						
	4.0						
	4.5						

LEGEND

TOPSOIL | CLAY | SIL | SAND | GRAVEL | FILL

Corrected shear vane reading
Remoulded shear vane reading
Scala Penetrometer

Note: UTP = Unable To Penetrate. T.S. = Topsoil.
Scala penetrometer testing not undertaken.
Hand Held Shear Vane S/N:

PO Box 89, 0245
6 Fairway Drive
Kerikeri, 0230
New Zealand

HAIGH WORKMAN LTD
Civil & Structural Engineers

Phone 09 407 8327
Fax 09 407 8378
www.haighworkman.co.nz
info@haighworkman.co.nz

Testpit Log - TP2

Hole Location: Refer to Site Plan

JOB No. 23 256

CLIENT: Waipapa Pine Ltd
Date Started: 12/03/2024
Date Completed: 12/03/2024
SITE:
DRILLING METHOD: Digger
HOLE DIAMETER (mm) 1mx0.6mx1.4m (deep)
LOGGED BY: LP
CHECKED BY: RH

Soil Description (Based on NZGS Logging Guidelines 2005)	Depth (m)	Geology	Graphic Log	Water Level	Sensitivity	Vane Shear and Remoulded Vane Shear Strengths (kPa)	Scala Penetrometer (blows/100mm)
TOPSOIL, SILT trace clay, dark grey, dry to moist, rootlets	0.0	TS		Groundwater Not Encountered	V	0 0	0 5 10 15 20
SILT, trace fine sand and clay, brown and grey striations, moist, Silt Loam, grey/brown, moist some fine gravel, large roots	0.5				V	0 0	
Silty CLAY, mottled brown and grey, moist to very moist, trace fine sand SILT, grey, trace clay and fine gravel, largre roots, very moist to saturated	1.0				V	0 0	
saturated							
End of test pit at 1.4m Groundwater not encountered	1.5				V	0 0	
	2.0				V	0 0	
	2.5				V	0 0	
	3.0						
	3.5						
	4.0						
	4.5						

LEGEND

TOPSOIL | CLAY | SIL | SAND | GRAVEL | FILL

Corrected shear vane reading
Remoulded shear vane reading
Scala Penetrometer

Note: UTP = Unable To Penetrate. T.S. = Topsoil.
Scala penetrometer testing not undertaken.
Hand Held Shear Vane S/N:

PO Box 89, 0245
6 Fairway Drive
Kerikeri, 0230
New Zealand

HAIGH WORKMAN LTD
Civil & Structural Engineers

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www.haighworkman.co.nz
info@haighworkman.co.nz

Testpit Log - TP3

Hole Location: Refer to Site Plan

JOB No. 23 256

CLIENT: Waipapa Pine Ltd
Date Started: 12/03/2024
Date Completed: 12/03/2024
SITE:
DRILLING METHOD: Digger
HOLE DIAMETER (mm) 1mx0.6mx1.2m (deep)
LOGGED BY: LP
CHECKED BY: RH

Soil Description (Based on NZGS Logging Guidelines 2005)	Depth (m)	Geology	Graphic Log	Water Level	Sensitivity	Vane Shear and Remoulded Vane Shear Strengths (kPa)	Scala Penetrometer (blows/100mm)
TOPSOIL, SILT, dark grey, moist, trace fine gravel, rootlets	0.0	TS		Groundwater Not Encountered	V	0 0	0 5 10 15 20
Gravelly SILT, orangish brown,							
Clayey SILT, grey with brown striations, moist, roots							
	0.5				V	0 0	
very moist, roots							
	1.0				V	0 0	
SILT, light greenish grey, very moist to saturated, trace fine sand							
End of test pit at 1.4m					V	0 0	
Groundwater not encountered	1.5						
	2.0				V	0 0	
	2.5				V	0 0	
	3.0						
	3.5						
	4.0						
	4.5						

LEGEND

TOPSOIL | CLAY | SIL | SAND | GRAVEL | FILL

Corrected shear vane reading
Remoulded shear vane reading
Scala Penetrometer

Note: UTP = Unable To Penetrate. T.S. = Topsoil.
Scala penetrometer testing not undertaken.
Hand Held Shear Vane S/N:

Geotechnical Investigation Report

Boron Plant and Dispatch Yard

1945B State Highway 10, Waipapa

For

Waipapa Pine Limited

Haigh Workman reference 23 256

May 2024

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Revision History

Revision №	Issued By	Description	Date
A	Wayne Thorburn	First Issue	14 May 2024

Prepared By

Wayne Thorburn

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Approved By

John Papesch

Senior Civil / Geotechnical Engineer
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Executive Summary

Haigh Workman Ltd (Haigh Workman) has been commissioned by Waipapa Pine Limited (the Client) to undertake a geotechnical investigation for the proposed the expansion of the existing sawmill facility. Geotechnical investigations across the site have been undertaken across the site by Haigh Workman and others, including recent investigations in March 2024 by Haigh Workman, with investigation locations focused on the proposed Boron Treatment Plant location originally located approximately 50 m west of the revised location. All relevant testing by Haigh Workman and others has been included within this report during out assessment of the subsoils.

The results of the geotechnical investigations carried out are generally consistent with the published geology maps indicating the proposed Boron Treatment Plant site is underlain by a veneer of Tauranga Group alluvial deposits, underlain with rubbly basaltic rock from the Kerikeri Volcanic Group. A topsoil mound for the wastewater dispersal field is located over the northern side of the proposed building.

A preliminary settlement analysis was undertaken based on the proposed FGL and the layout provided within the concept plans. The existing site will require earthworks across the proposed building platform and surrounding dispatch yard, comprising removal of the existing wastewater dispersal bund and raising the ground level elsewhere. Based on the required FGL and site topography, up to 1.4 m of fill will be required across the building platform area. The current concept plan indicates the Boron Treatment Plant will comprise a 40 m x 58 m warehouse building, with storage tanks and loading dock located under a canopy on the southern side of the building (approximately 10.5 m x 10 m). We have assumed a floor loading of 30 kPa.

Based on the preliminary settlement assessment, differential settlement across the building platform is estimated to be in the order of 75 mm (south-eastern corner to centre of slab). Differential settlement across the slab can be mitigated by preloading the site, e.g., importing fill to raise the ground to FGL (78.7 mRL), and monitoring for at least 3 months prior to building. To further mitigate the effects of settlement, the settlement preload can include a surcharge above the FGL to replicate the building loads e.g., 30 kPa UDL would be in the order of 1.5 m of additional fill above the FGL, resulting in a greater magnitude of settlement occurring in a quicker timeframe, i.e., the aim of the settlement and preload surcharge is to achieve the total maximum settlement (estimated at 100 mm) within 3-6 months. A separate analysis was undertaken where the structural loads are supported on individual pad foundations, with a design bearing capacity of 100 kPa available for a maximum pad foundation size of 1.2 m x 1.2 m (size chosen to keep settlements below 25 mm for conventional foundation elements), and strip footings are limited to 0.60 m width.

Geotechnical risk has been evaluated and is considered minor, provided the recommendations detailed within this report are followed. A summary of the geotechnical risks are as follows:

- Undercuts across the site may be required to remove unsuitable material. This includes the possibility of old field drains and non-certified filling.
- Groundwater level across the site is shallow. We recommend excavations be kept to a minimum and should not go any deeper than the groundwater level to reduce the risk of any groundwater drawdown induced settlements.

- Bearing capacity has been assessed in accordance with the methods presented in the New Zealand Building Code (B1/VM4). Recommended ultimate bearing capacity is 200 kPa (based on thickening the crustal layer and preloading the soils). The bearing capacity is limited to 1.2 x 1.2 m pad foundations and 0.6 m strip footings. The bearing capacity value is appropriate for vertical loads only, and do not allow for any imposed horizontal shear or moment actions and will require confirmation during specific design. A geotechnical strength reduction factor of 0.5 can be adopted for limit state design.

- Settlement – settlement analyses have been based on the concept drawings and FGL provided, the final foundation dimensions and final ground levels are to be confirmed and further assessment will be required. Section 5 presents the settlement estimates based on the assumed loads and load breakdown, e.g., spread footings and slab UDL. To limit consolidation settlement to 25mm, 0.60m wide strip footings should be adopted in design and maximum pad foundations of 1.2m x 1.2m, adopting a design bearing pressure of 100 kPa for limit state design (200 kPa x 0.5 = 100 kPa). Deflections have been estimated for floor slab loadings of 30 kPa and maximum 1400 mm of fill placed (approximately 60 kPa). Based on the estimated settlements, we recommend that a settlement preload trial is undertaken and monitored prior to building.

- Liquefaction – A liquefaction assessment was undertaken, indicating liquefaction damage is unlikely based on 'Planning and engineering guidance for potentially liquefaction-prone land, MBIE, September 2017. Based on our assessment we consider liquefaction induced ground damage is less than minor to minor . We consider the effects from excess pore pressure and liquefaction to be between insignificant (L0) to moderate (L2) in accordance with Table 5.1 (Module 3), with relatively small differential settlements across the site due to limited excess pore water pressures. The risk of lateral spreading toward the Whiriwhiritoa Stream is considered negligible due to the low likelihood of liquefaction and distance to the free face being over 300 m.

- Expansivity – The subsoils at this site are considered moderately expansive. Foundations should be designed under AS 2870 expansive site class of M (moderately) and adopting the recent Building Code revisions (B1/AS1) for surface movement. Strip and pad foundations shall be embedded a minimum 600 mm below finished ground level.

- Floor Slab design – Modulus of Subgrade Reaction values can be estimated once the final load breakdown is available and settlement preload trial undertaken.

- A geogrid (minimum 40 kN strength) and geotextile (BIDIM A-39) is recommended at the subgrade level prior to the settlement preload trial.

- All earthworks to be supervised by a CPEng (Geotechnical) familiar with the contents of this report and the ground conditions, including preload filling and monitoring.

- Concentrated stormwater flows – Must be collected and carried in sealed pipes to an approved outfall or other means of disposal and must not be allowed to saturate the subgrade soils to ensure the stability of the foundations is maintained.

- A design CBR of 2.0% should be adopted for pavement design purposes. Localised soft zones are expected and will need to be undercut and removed during construction. A minimum undrained shear strength of 50 kPa in the upper 1.0 m is required for pavement design. We recommend a geotextile and geogrid is installed between subgrade and pavement to minimise the ingress of fines into the pavement from dynamic loading.

1 Introduction

1.1 Project Brief and Scope

Haigh Workman Ltd (Haigh Workman) has been commissioned by Waipapa Pine Limited (the Client) to undertake a geotechnical investigation for the proposed the expansion of the existing sawmill facility. The expansion includes a Boron Treatment plant and dispatch yard. This report presents the information gathered during the site investigation, interpretation of data obtained and site-specific geotechnical recommendations relevant to the site. The investigation and report has been prepared to assess the subsoil conditions for foundation design and identify geotechnical constraints for the proposed development.

This report provides the following:

- A summary of the published geology with reference to the geotechnical investigations undertaken.
- Review of previous geotechnical investigation data.
- Analysis of the data obtained from site investigations and preparation of a geotechnical ground model.
- Foundation recommendations.
- Identification of any additional geotechnical risks and/or hazards.

1.2 Proposed Development

Waipapa Pine Limited propose to expand the site operations by creating a new dispatch yard near the entrance to the site, and construction of a warehouse building to accommodate a Boron treatment plant. The proposed Boron treatment plant building is partially located over an existing wastewater dispersal mound and will need to be decommissioned and the mound removed. Concept drawings provided by Waipapa Pine indicate a single storey warehouse with approximately 2320 m^2, and additional canopy and hardstand area of approximately 105 m^2 on the southern side to accommodate the Boron tanks. The land surrounding the warehouse building will comprise a dispatch yard covering approximately 15,000 m^2 and will be formed with granular hardfill.

This geotechnical investigation and report considers the geotechnical aspects for the proposed structures, with reference to the proposed development locations, (refer Figure 1 and Appendix A). Should the proposed development vary from the proposals described above and/or be relocated outside of the investigated area, further investigation and/or amendments to the recommendations made in this report may be required.

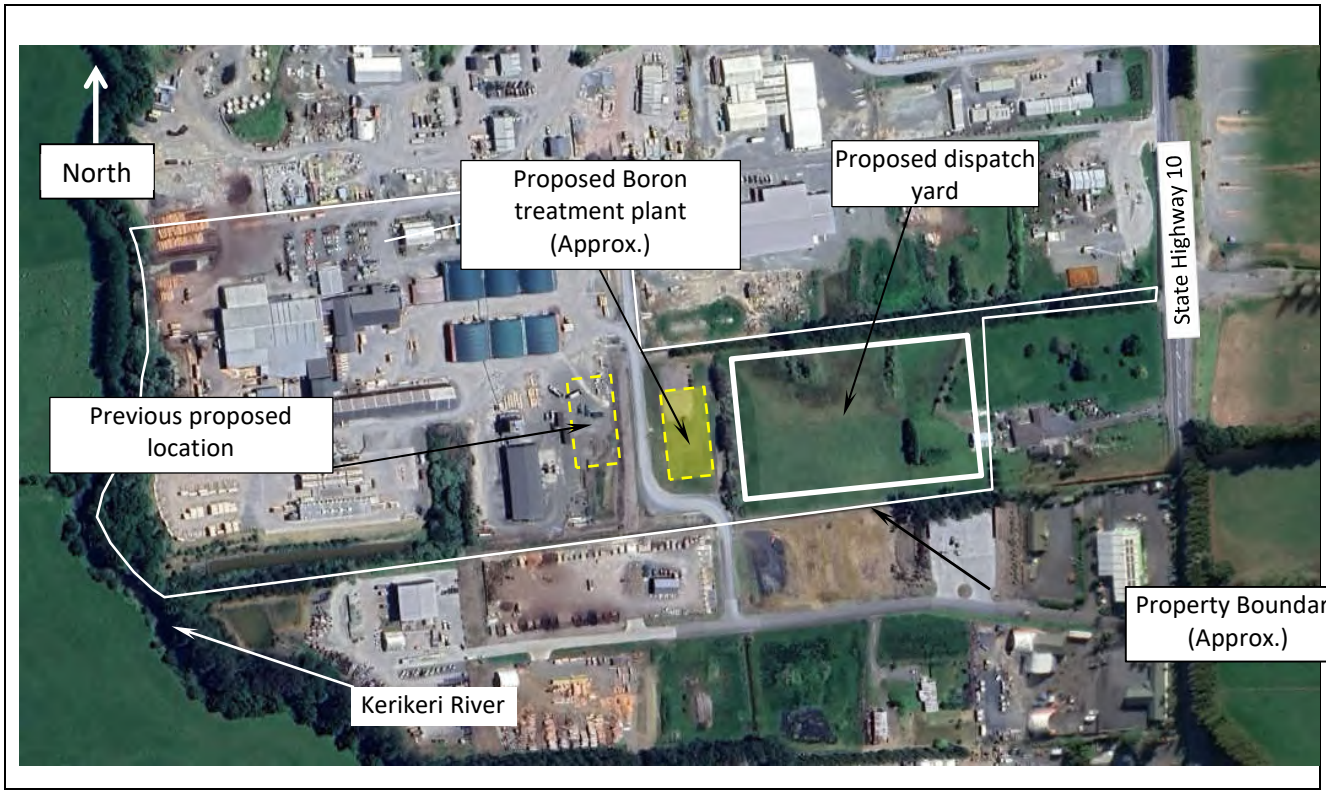


Figure 1 - Site location

1.3 Site Description

The Waipapa Pine sawmill is located over three lots (Lots 1-3, DP 376253), comprising an approximate land area of 10.75 hectares and irregular in plan shape. The sites are accessed through Industrial Way. The proposed development area is located near the access into the sawmill, near the southern and boundary. The southern boundary currently has an open drain running east and west from the existing site entrance.

The proposed Boron treatment plant location has changed following the geotechnical investigations. The revised location is an area where supplementary testing was undertaken for other purposes and will be used in this assessment. The approximate proposed building development locations are shown in .

The ground surface across the site is generally flat, with approximately 1.5 m of elevation change across the building platform. The change in elevation is exacerbated by the existing wastewater dispersal mound at the proposed building location.

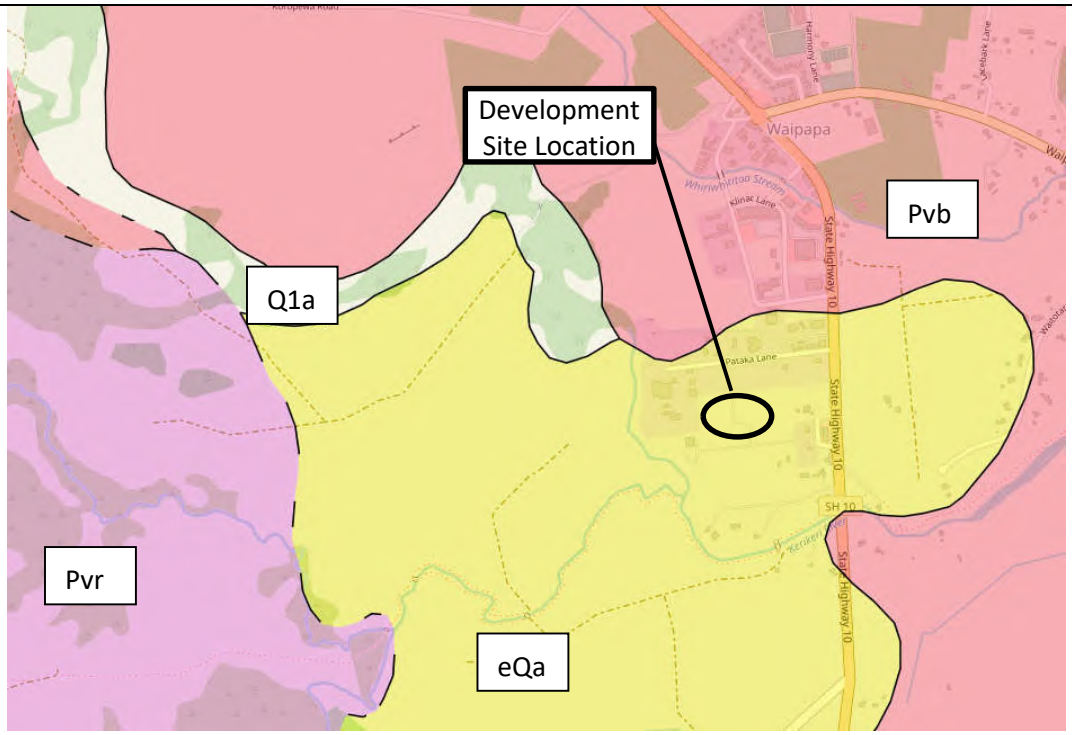
2 Desktop Study

2.1 Published Geology

Sources of Information:

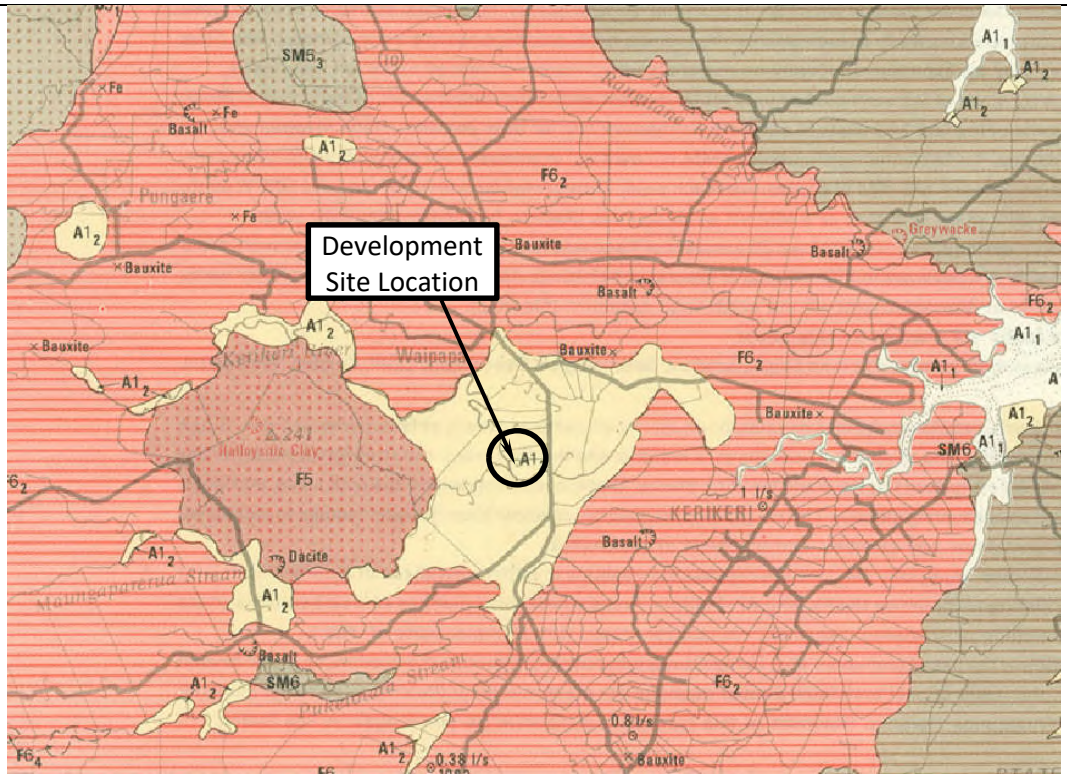
- Institute of Geological & Nuclear Sciences 1:250,000 Geological Map 2, 2009: "*Geology of the Whangarei area*"
- NZMS 290 Sheet P04/05, 1: 100,000 scale, 1982: *"Rock types map of the Whangaroa - Kaikohe area"*
- NZMS 290 Sheet P04/05, 1: 100,000 scale, 1980: *"Soil map of the Whangaroa - Kaikohe area"*

The site is within the bounds of the GNS Geological Map 2 "Geology of the Whangarei area", 1:250,000 scale*. The published geology shows the site to be located near a geological boundary of Kerikeri Volcanic Group and Tauranga Group alluvial soils. The Waipapa area, although mapped as Kerikeri Volcanic Group, typically is overlain by recent alluvial soils exhibiting variable strength. Further reference to the published New Zealand land inventory maps (Whangaroa-Kaikohe 1980) also indicates the site is underlain by alluvium ($A1_2$), forming riverbed and flood plain deposits, in places forming a thin veneer (1-3m) over rugged surfaces of lava flows.



Edbrooke, S.W.; Brook, F.J. Geology of the Whangarei Area, IGNS, 1:250,000

* Edbrooke, S.W; Brook, F.J. (compilers) 2009. Geology of the Whangarei area.



Kermode, L.O. 1982: Whangaroa – Kaikohe, NZMS 290, Sheet P04/05, 1:100,000

Figure 2 – Published geological maps

Table 1 - Geological Legend

Symbol	Unit Name	Description
Q1a / $A1_2$	Tauranga Group (Holocene)	Unconsolidated to poorly consolidated mud, sand, gravel, and peat deposits of alluvial, colluvial and lacustrine origins. Holocene river deposits.
eQa	Tauranga Group (Early to middle Pleistocene)	Partly consolidated mud, sand, gravel and peat or lignite of alluvial, colluvial, lacustrine, swamp and estuarine origins. Early Pleistocene – Middle Pleistocene estuary, river, and swamp deposits.
Pvb / $F6_2$	Kerikeri Volcanic Group (Late Miocene to early Pliocene)	Basalt lava, volcanic plugs, and minor tuff. Kerikeri Volcanic Group Late Miocene basalt of Kaikohe – Bay of Islands Volcanic Field.
Pvr / F5	Kerikeri Volcanic Group (Late Miocene to early Pliocene)	Alkaline and peralkaline rhyolite domes with some obsidian.

2.2 Historical Aerial Photograph (Retrolens)

A review of historical aerial photographs using Retrolens was undertaken. A tree-lined farm drain was identified in the 1953 aerial photograph south of the proposed treatment plant and was filled prior to 1981. Figure 3 shows the 1953 photograph and a recent 2023 Google Earth image.

1953

2023 (field drain marked as white dash)

Figure 3 - Historical and recent aerial photograph

3 Ground Investigations

3.1 Previous Investigations

Previous geotechnical investigations have been undertaken across the Waipapa Pine sawmill site as part of ongoing expansion projects. Relevant investigation results have been used in our assessment of the proposed Boron Treatment Plant facility.

- Haigh Workman Limited completed geotechnical investigations to support Pine Plant expansion located within the south-west of the site, the investigations comprised one hand auger (BH1) to 2.0 m below ground level, and 9 no. Scala penetrometer tests. A further 16 no. Scala penetrometer tests were completed in 2014-2015 to support the proposed workshop development located in the central of the site.
- Underground Investigation Limited completed 12 no. Cone Penetration Tests (CPT01-CPT12) to support detailed geotechnical assessment of a Bin Sorter Warehouse development located in the central area of the site.
- Pre-purchase geotechnical investigations were undertaken by Initia in November 2022 and comprised 12 no. CPTs (CPT101-CPT115) and 4 no. HAs (HA01-HA04). The investigation locations were selected to enable assessment of subsurface conditions and variability across the site and with consideration

to site access limitations. The investigations were focussed in the proposed future development area located in the south-eastern quadrant of the site.

Table 2 - Previous site investigations

Investigation ID	Coordinates (Mt Eden 2000, EPSG:2105)		Termination Depth (m BGL)
	Easting (m)	Northing (m)	
BH1	322625.58	984291.4	2.0
CPT01	322669.3	984325.1	5.4
CPT02	322677.18	984326.4	4.5
CPT03	322677.56	984316.4	4.8
CPT04	322670.68	984315.1	5.0
CPT05	322663.7	984313.9	4.1
CPT06	322644.46	984321.2	4.8
CPT07	322628.48	984319.6	4.5
CPT08	322627.93	984333.6	4.8
CPT09	322633.86	984309.8	4.5
CPT10	322618.88	984308.2	6.3
CPT11	322612.47	984320	5.5
CPT12	322612.07	984330.9	6.1
CPT101	322900.7	984347.2	2.2
CPT102	322973.4	984358.9	3.8
CPT103	322993.7	984263.5	2.3
CPT104	322925.8	984256.3	2.0
CPT105	322946.5	984314.3	2.0
CPT106	322783.2	984235.3	5.1
CPT107	322846.1	984346.8	7.0
CPT109	322692.2	984234.5	5.0
CPT111	322537.5	984233.1	5.1
CPT112	322500.6	984288.3	4.1
CPT114	322699.7	984434.3	5.7
CPT115	322809.1	984413	5.1
HA01	322907.3	984343.1	2.6
HA02	322973.1	984353.2	4.0
HA03	321233.6	1084274	2.4
HA04	322925.9	984253.3	2.2

3.2 Haigh Workman Investigations (2024)

Geotechnical investigations were undertaken by Haigh Workman in March 2024 and comprised 15 no. CPTs and 10 no. hand augers. The investigation locations were focused on the proposed Boron Treatment Plant location originally located approximately 50 m west of the revised location.

Table 3 - Haigh Workman subsoil investigations (2024)

Investigation ID	Coordinates (Mt Eden 2000, EPSG:2105)		Termination Depth (m BGL)
	Easting (m)	Northing (m)	
CPT2401	322639.5	984294.5	3.6
CPT2402	322637.9	984291.8	3.7
CPT2403	322652.6	984297.7	4.4
CPT2404	322779.4	984343.3	5.0
CPT2405	322785.8	984312.0	5.1
CPT2406	322784.9	984283.7	3.2
CPT2407	322804.4	984286.2	4.9
CPT2408	322792.9	984298.4	4.8
CPT2409	322802.3	984313.0	5.8
CPT2410	322791.4	984330.0	3.0
CPT2411	322800.1	984344.3	4.6
CPT2412	322847.0	984272.1	4.2
CPT2413	322877.9	984272.3	2.4
CPT2414	322877.5	984303.0	4.8
CPT2415	322847.0	984308.5	7.1
BH2401	322635.3	984294.3	3.75
BH2402	322642.8	984291.7	4.2
BH2403	322780.7	984326.5	2.2
BH2404	322793.5	984334.2	2.5
BH2405	322795.1	984309.6	3.3
BH2406	322803.7	984300.1	3.0
BH2407	322795.5	984283.2	3.4
BH2408	322846.7	984302.2	3.0
BH2409	322863.7	984269.0	2.9
BH2410	322877.6	984276.1	2.6

3.2.1 *Cone Penetration Tests*

CPTs were undertaken by Underground Investigation Limited under the supervision of engineering geologist from Haigh Workman Limited. Underground Investigation Limited provided a track mounted cone penetration rig to test and record ground information. CPT soundings are presented in Appendix B.

3.2.2 *Hand Augers*

Ten hand augered boreholes were undertaken by an engineering geologist and geotechnical engineer from Haigh Workman Limited. HAs were drilled to a maximum depth of 4.2 m or refusal on an obstruction, e.g., volcanic boulders. Hand auger logs are presented in Appendix B.

3.2.3 *Laboratory Testing*

Two disturbed bag samples were sent to Babbage Geotechnical Laboratory for Atterberg limits and linear shrinkage testing. Test results are provided in Figure 4, and Appendix B.

Borehole Number	Sample Number	Depth (m)	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Linear Shrinkage (%)*
BH05	Sample 1	0.40 – 0.80	72.0	115	62	53	20
BH10	Sample 2	1.00 – 1.40	71.7	72	43	29	12

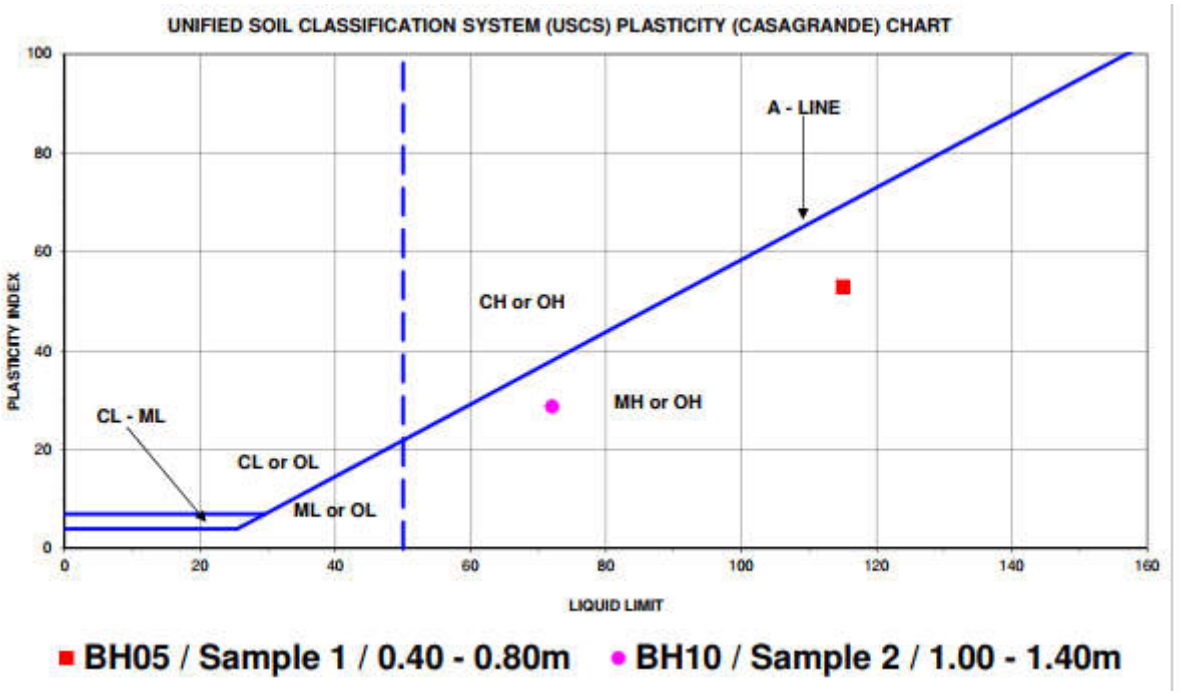


Figure 4 - Atterberg limit test results

4 Subsoil Conditions

4.1 General

The geotechnical model presented in this report is based on available information obtained from historical and recent geotechnical investigations completed by Haigh Workman and others. The nature and continuity of the subsoil conditions on the site have been interpolated between the boreholes and inferred from the data

available, therefore some variation between test positions is likely and may vary from the ground model presented within this report.

4.2 Site Stratigraphy

The results of the geotechnical investigation carried out by Haigh Workman are generally consistent with the published geology maps and historical investigation data, indicating the proposed Boron Treatment Plant site is underlain by the following geological units:

- Fill mound for the wastewater dispersal field.
- A veneer of Tauranga Group alluvial deposits of variable strength.
- Underlying the Tauranga Group alluvium is rubbly basaltic rock from the Kerikeri Volcanic Group. The presence of basalt rock has been inferred based on 'refusal' in both the hand augers and CPTs.

Table 4 below summarises the materials encountered at the proposed Boron Treatment Plant and dispatch area only, with depth to base of each unit provided.

Table 4 - Summary of test results (Proposed Boron Treatment Plant)

Test I.D.	Tauranga Group alluvial soils (mbgl)	Kerikeri Volcanic Group basalt (mbgl)	Groundwater level (mbgl)*
HA01	2.5	>2.5	0.9
HA04	2.2	>2.2	1.0
BH2408	>3.0	NE	1.2
BH2409	2.9	>2.9	1.0
BH2410	2.6	>2.6	0.6
CPT101	2.2	>2.2	0.3
CPT104	2.0	>2.0	0.5
CPT105	2.0	>2.0	0.2
CPT107	6.95	>7.0	0.3
CPT2412	4.2	>4.2	1.4
CPT2413	2.4	>2.4	1.1
CPT2414	4.8	>4.8	1.4
CPT2415	7.1	>7.1	1.4

NE Not Encountered
* Groundwater level measured from within test hole

4.2.1 *Fill*

The majority of the Waipapa Pine sawmill is covered in a compacted hardfill of variable thickness. The proposed Boron Treatment Plant is in an undeveloped part of the site to the south-east, and is partially located over the wastewater dispersal mound, which will comprise topsoil and has been designed as non-certified fill.

4.2.2 *Alluvium*

Alluvial soils were encountered at all locations. The thickness of the alluvial fan deposits varied from 2.0 m (CPT105) to 7.1 m (CPT2415) across the proposed building platform, with refusal on Kerikeri Volcanic Group typically in the upper 5.0 m.

CPT soundings and vane shear testing within the hand augers indicate a stiff crustal layer encountered in the upper 1.0 m across the site (undrained shear strength > 50 kPa), underlain by very soft to firm alluvium till refusal on Kerikeri Volcanic Group.

4.2.3 *Kerikeri Volcanic Group*

Kerikeri Volcanic Group was encountered at the base of the hand auger holes and CPT soundings across the proposed building platform. The sudden refusal within the HAs and CPTs has been inferred as the top of the basalt rock layer and has not been visually appraised by core sampling. The basalt thickness is expected to be variable across the site.

4.2.4 *Groundwater*

Groundwater level was measured within the test holes at the completion of testing, which typically indicated groundwater within 1.0 m from the existing ground surface. No further groundwater monitoring has been undertaken. Groundwater levels can and do fluctuate and higher groundwater levels may be encountered following periods of prolonged or heavy rainfall. For the purposes of geotechnical assessment for the proposed Boron Treatment Plant and dispatch yard, the groundwater level has been assumed at 1.0 m below existing ground level.

5 Geotechnical Assessment

5.1 General

Based on our site observations, geological appraisal, and the findings of our recent field investigations, we consider that the subject site is suitable for the proposed development. Based on the information provided, the proposed finished ground level (FGL) will be 78.7 mRL, giving an assumed finished floor level (FFL) of 79.0 mRL, the existing ground level varies from 77.4 mRL to 78.3 mRL.

The following geotechnical hazards have been identified and assessed within this report.

- Liquefaction susceptibility.
- Settlement risk due to fill required to raise ground to 78.7 mRL.
- Pavement design on soft soils.

5.2 Geotechnical Design Parameters

Geotechnical design parameters recommended in this report are based on in-situ test results, empirical relationships, and local experience. Refer Table 5 for recommended design parameters.

Table 5 – Geotechnical Design Parameters

Soil Unit	Bulk Unit Weight - γ (kN/m^3)	Peak undrained shear strength - S_u (kPa)	Effective cohesion – c' (kPa)	Effective friction angle - φ' (degrees)	Coefficient of volume compressibility - m_v (m^2/MN)
Alluvium - Stiff Crust	18	50 – 100	3	26	0.10
Alluvium - Soft to Firm	16	12.5 – 50	1	26	0.30
Kerikeri Volcanic Group – Basalt	20	>5000	50	35	N/A

5.2.1 *CPT Undrained Shear Strength*

The undrained shear strength has been assessed using the in-situ CPT data and vane shear strength. Data plots are presented in Figure 5.

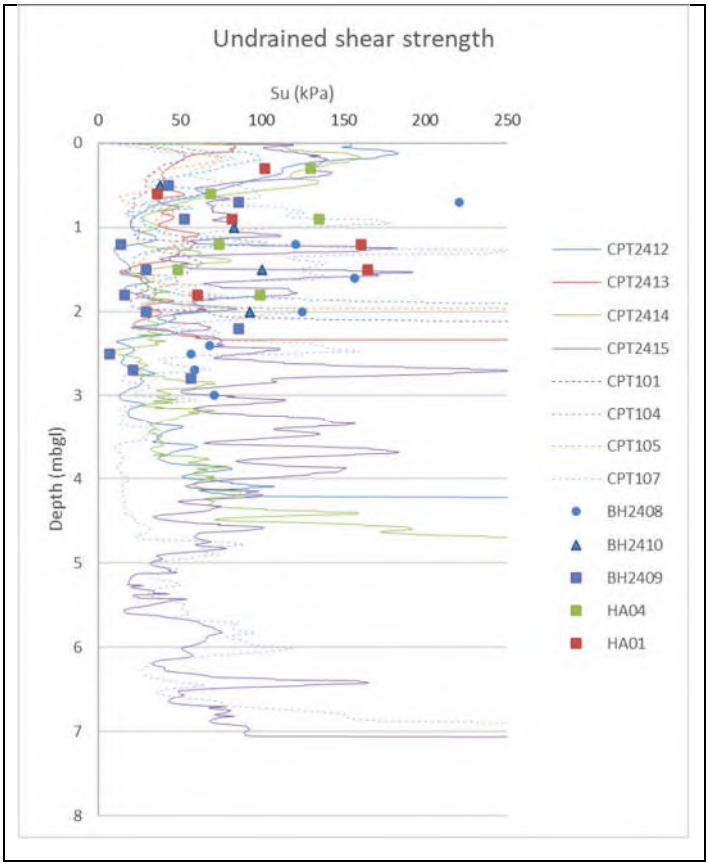


Figure 5 –CPT Plots (undrained shear strength)

5.3 Settlement Analysis

The natural ground conditions across the site were found to be variable, with depth to the basalt rock shelf varying from 2.0 m to 7.1 m. Refusal on basalt rock has been modelled to represent an incompressible layer, which has been confirmed with settlements preload trials undertaken on an nearby adjacent properties.

The existing site will require earthworks across the proposed building platform and surrounding dispatch yard, comprising removal of the existing wastewater dispersal bund and raising the ground level elsewhere. Based on the required FGL and site topography, up to 1.4 m of fill will be required across the building platform area.

The proposed development plan is currently in concept stage. The current concept plan indicates the Boron Treatment Plant will comprise a 40 m x 58 m warehouse building, with storage tanks and loading dock located under a canopy on the southern side of the building (approximately 10.5 m x 10 m). The building layout includes two access points for lay-up turning, pre-treatment area, wrap/strap area, and post-treatment area. We have assumed a floor loading of 30 kPa

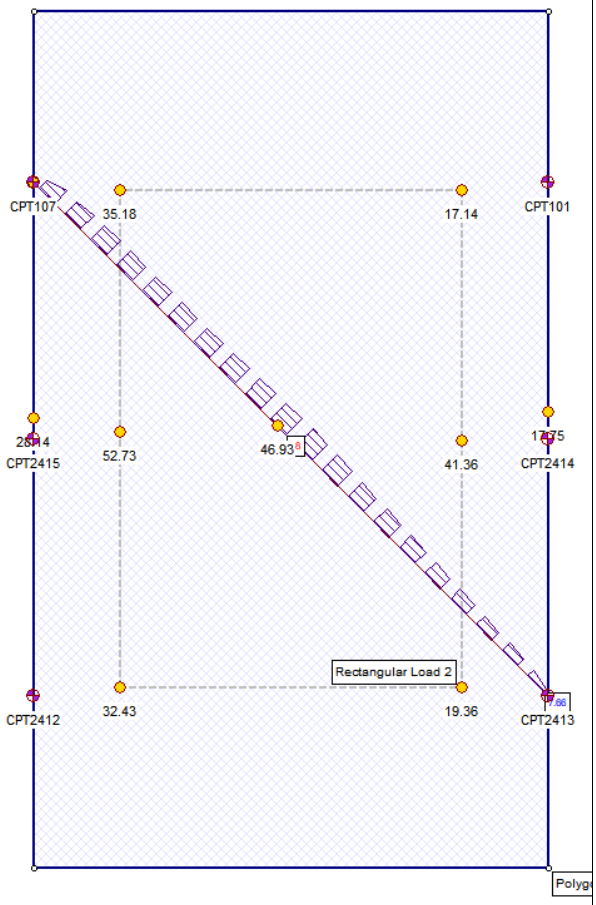
The following assumptions have been made to complete a preliminary settlement assessment:

- Uniformly distributed load (UDL) across the floor slab = 30 kPa

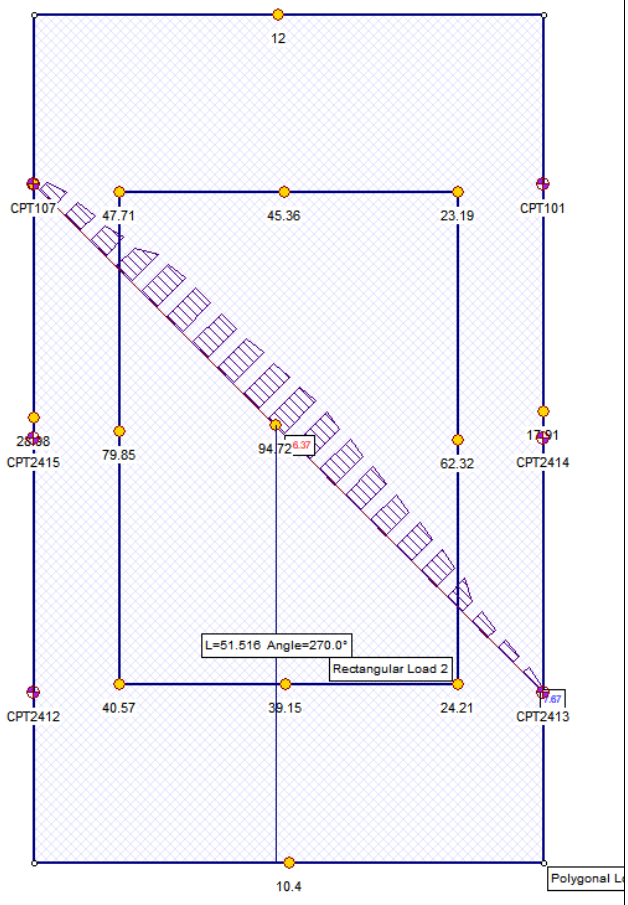
- Building dimensions = 40 m x 58 m
- Maximum fill required to raise the ground level to FGL = 1.4 m

Table 6 - Settlement prediction results

Loading Condition	Total max. settlement (mm)	Angular Distortion across building platform	Estimated time*
Raise ground level with granular fill to FFL (max. 30 kPa)	50	1:1250	< 3 months
UDL Floor Loading – 30 kPa	100	1:400	< 3 months



Filling across site (30 kPa)



Building (30 kPa)

* Rate of settlement based on nearby settlement trials undertaken by Haigh Workman. Preload and surcharge to be monitored using settlement plates and survey to confirm.

Based on the preliminary settlement assessment, differential settlement across the building platform is estimated to be in the order of 75 mm (south-eastern corner to centre of slab). Differential settlement across the slab can be mitigated by preloading the site, e.g., importing fill to surcharge the soils prior to building, and is recommended to mitigate the effects of angular distortion across the proposed building. If the fill beneath is placed prior to building (minimum three months), differential settlement across the building slab will reduce to approximately 45 mm (1:800). To further mitigate the effects of settlement, the settlement preload can include a surcharge above the FGL to replicate the building loads e.g., 30 kPa UDL would be in the order of 1.5 m of additional fill above the FGL. The additional fill surcharge will result in a greater magnitude of settlement occurring in a quicker timeframe, i.e., the aim of the settlement and preload surcharge is to achieve the total maximum settlement (estimated at 100 mm) within 3-6 months.

A separate analysis was undertaken where the structural loads are supported on individual pad foundations, with a design bearing capacity of 100 kPa available for a maximum pad foundation size of 1.2 m x 1.2 m (size chosen to keep settlements below 25 mm for conventional foundation elements), and strip footings are limited to 0.60 m width.

5.4 Bearing Capacity

Undrained shear strength has been assessed using the investigation data. Based on the available geotechnical investigation data, and the requirement to raise the site to achieve positive drainage (thickening the crustal layer and preloading the soils), we recommended an undrained shear strength (Su) of 40 kPa is adopted for bearing capacity calculations. An ultimate bearing capacity of 200 kPa can be adopted for preliminary design purposes of shallow spread foundations, and is vertical loads only, i.e., horizontal shear or moment actions have not been assessed and will require specific analyses. A geotechnical strength reduction factor of 0.5 shall be applied for limit state design.

If the site is preloaded, the bearing capacity and foundation dimensions will alter and can be confirmed at detailed design phase.

5.5 Shrink Swell Soil Characteristics

The New Zealand Building Code Clause (B1) outlines expansive soils are those with a liquid limit greater than 50% and a linear shrinkage greater than 15%. Atterberg limits test results indicate the site subsoils are expansive. The soil test results plot below the A-Line (Figure 4), we consider the soils are moderately expansive (Class M) and exhibit good engineering behaviour[‡].

[‡] Laurence, D. Wesley. Geotechnical Engineering in Residual Soils, 2010.

5.6 Seismic Considerations

5.6.1 *Site Subsoil Class*

The site conditions have been assessed to be consistent with seismic subsoil Class D (Deep or soft soil sites) in accordance with NZS1170.5:2004. For geotechnical design purposes, Site Class C (shallow soil site) has been adopted as it provides a more conservative assessment for peak ground acceleration estimates (PGA) and is more aligned to the MBIE geotechnical guidance, Module 1.

5.6.2 *Liquefaction Assessment*

The site geology is susceptible to liquefaction due the recent alluvial deposits and high groundwater level. However, the fine-grained clayey soils encountered during subsurface investigations are not considered susceptible to liquefaction as they are too plastic to liquefy. Laboratory testing of the near surface soils completed during investigations indicates a plasticity index (PI) of between 29 and 53, which is too plastic to liquefy (PI > 12). The sandy lenses are potentially susceptible to liquefy which may result in liquefaction induced settlement.

A qualitative liquefaction assessment has been undertaken for both SLS and ULS design seismic events using the site-specific CPT data. The analysis was undertaken using Cliq software and the Boulanger and Idriss (2014) assessment method. A groundwater level of 0.5m below current ground levels was assumed for the analysis. The liquefaction analysis results are presented in Appendix C. Design peak ground acceleration (PGA) and associated magnitude Mw for serviceability (SLS) and ultimate (ULS) limit states have been assessed in accordance with the MBIE Geotechnical Guidelines Module One.

The seismic coefficients for design are based on the NZTA Bridge Manual (NZBM), calculated based on the following formula:

$$PGA = C0.1000 * \frac{Ru}{1.3} * f * g$$

Un-weighted PGA coefficient for Class A/B	Return Period Factor (Ru = 1/500	Site subsoil class factor
$C_{0,1000}$ = 0.13	R_u = 1.0	f = 1.33

Peak ground acceleration (PGA) for the site is as follows:

- ULS – 0.13 g, Mw 5.8 earthquake.
- Lower bound ULS – 0.19 g, Mw 6.5 earthquake [used in analysis based on Module 1, NZGS & MBIE].

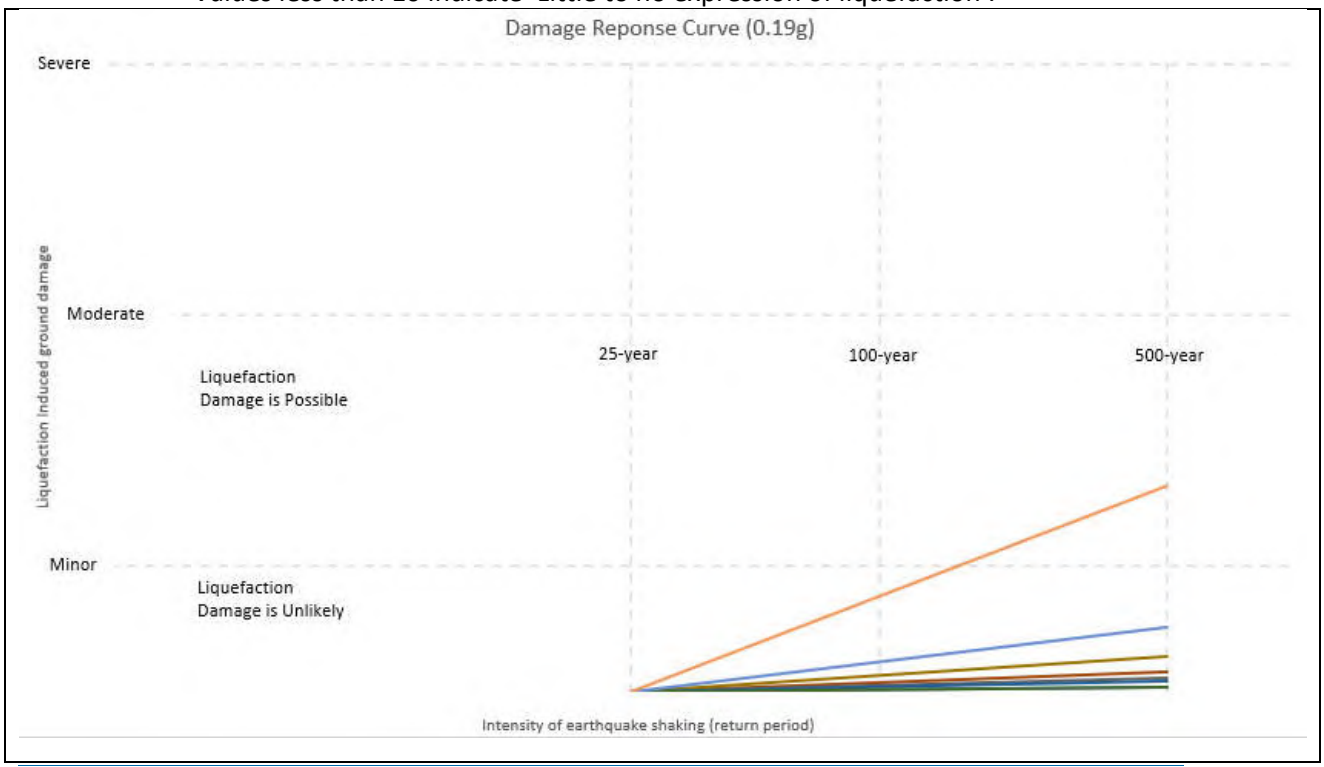
Results are summarised in Table 7, with detailed results presented in Appendix C. The analyses indicate that SLS levels of shaking are not likely to trigger liquefaction in the alluvial soils. Under ULS conditions, minor liquefaction within thin discrete layers is possible. The liquefaction potential index (LPI) and liquefaction severity number (LSN) have been used to assess the effects of liquefaction.

The assessed LPI ranges between 0 to 2.3, indicating an overall low risk of liquefaction for the site. The LSN for ranged between 0 to 16 indicating the effects of liquefaction, would be negligible to minor for structures bearing on the surface. Free field liquefaction induced settlements range from 0 to 60 mm, and typically less than 10 mm within the proposed development area. Analyses have been undertaken based on a minimum 750 mm granular hardfill being imported across the building platform area.

Table 7 - Summary of results (minimum 750 mm granular fill across building platform)

Test data	Liquefiable Zone (mbgl) – 0.19g, Mw 6.5	Estimated total vertical free field settlement (mm) – ULS	Liquefaction Severity Number (LSN) – ULS*	Liquefaction Potential Index
CPT101	2.05-2.1	<10	<10	Low risk
CPT104	1.8-1.9	<10	<10	Low risk
CPT105	1.65-1.7	<10	<10	Low risk
CPT107	2.4-2.5; 6.7-6.9	10	<10	Low risk
CPT2412	4.0-4.1	<10	<10	Low risk
CPT2413	n/a	<10	<10	Low risk
CPT2414	Variable below 2.8	25	<10	Low risk
CPT2415	Variable below 1.0	60	16 (minor expression)	Low risk

* Values less than 10 indicate 'Little to no expression of liquefaction'.



Based on our assessment we consider liquefaction induced ground damage is less than minor to minor and liquefaction damage is unlikely based on 'Planning and engineering guidance for potentially liquefaction-prone land, MBIE, September 2017). Based on the assessment, we consider the effects from excess pore pressure and liquefaction to be between insignificant (L0) to moderate (L2) in accordance with Table 5.1 (Module 3), with relatively small differential settlements across the site due to limited excess pore water pressures. The risk of lateral spreading toward the Kerikeri River is considered negligible due to the low likelihood of liquefaction and the distance to the free face being over 300 m.

5.6.3 *Other Considerations*

Cyclic softening is another seismically induced phenomenon that may occur at the site considering the underlying soft to firm cohesive alluvial silts and clays. An assessment of cyclic softening triggering was undertaken by Haigh Workman using the CPT data and the methods presented by Idriss and Boulanger (2008), with the magnitude scaling factor (MSF) adjusted accordingly for the fine-grained soils. The thin discrete layer within CPT2415 may exhibit cyclic softening and result in some minor settlement, but not expected to have an adverse effect on the proposed building or the overall bearing capacity of the site, refer Figure 6.

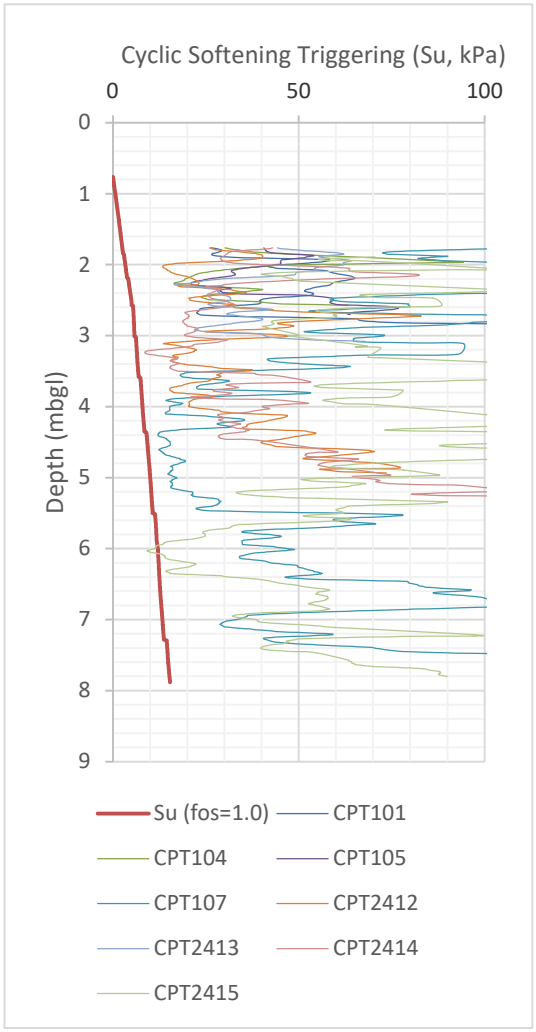


Figure 6 - Cyclic softening triggering

5.7 Pavement Design

Based on in-situ test results and the presence of fine-grained soils, we recommend a design CBR of 2.0% should be adopted for concept pavement design purposes, with the inclusion of a geogrid and textile at the subgrade level. Localised soft zones are expected and will need to be undercut and removed during construction. Subsoil drainage is also recommended across the site due to the high groundwater level.

A minimum undrained shear strength of 50 kPa in the upper 1.0 m is required for pavement design. We recommend the pavement is reinforced with geogrid to confine the subbase material. A geotextile (BIDIM A29 or equivalent) should be installed between subgrade and pavement to minimise the ingress of fines into the pavement during dynamic loading.

6 Foundation Recommendations

6.1 General

Concept drawings provided by Waipapa Pine indicate a single storey warehouse with approximately 2320 m^2, and additional canopy and hardstand area of approximately 105 m^2 on the southern side to accommodate the Boron tanks. The land surrounding the warehouse building will comprise a dispatch yard covering 15,000 m^2 and will be formed with granular hardfill. A uniformly distributed floor slab loading of 30 kPa has been provided by the Client.

The preferred foundation type for this proposed building is shallow spread foundations, due to the potential of down drag on piled foundations from filling and the probability of gaps forming beneath the concrete slab as a result of consolidation settlement and secondary creep occurring over a long time, e.g., a fully suspended floor slab will be required to mitigate this risk. Piled foundations could be considered for concentrated loads or areas sensitive to movement e.g., sensitive plant, and can comprise bored or driven piles to the top of basalt rock provided care is taken to not damage the surrounding foundations e.g., driven displacement piles can raise the surrounding ground damage shallow on-grade foundations.

6.2 Shallow Foundations

The subsoils comprised fine-grained alluvial soils, moderately susceptible to seasonal shrink-swell behaviour. The proposed FGL is 78.7 mRL and FFL 79.0 mRL. Consolidation settlement has been analysed based slab on grade construction with a uniformly distributed load of 30 kPa and raising the site prior to building. Based on the ground conditions, we consider concrete slab on grade foundations will be appropriate provided the site is subject to a monitored settlement preload of no less than three months.

For conventional spread foundation design, we recommend embedment for spread footings be 600 mm below FGL. The soils are variable across the site and adopting conventional spread foundations may encounter unsuitable ground conditions and high groundwater level. We recommend the following maximum dimensions to support concentrated loads, with an ultimate bearing capacity of 200 kPa (geotechnical strength reduction factor of 0.5 for limit state design) for concept design purposes and to be confirmed following completion of the settlement preload:

- Pad Foundations = 1200 x 1200 mm
- Continuous strip footing width = 600 mm

Larger foundation area can be adopted to spread the load. However, this will result in the pressure bulb deepening, reducing the ultimate bearing capacity and will require a detailed settlement analysis to predict settlement under the given loading scenario. The parameters given in Table 5 can be adopted for settlement analyses.

A preliminary consolidation settlement assessment has been undertaken based on the proposed building layout. Based on the required filling and a 30 kPa UDL, 75 mm differential settlement across the building is

anticipated. The differential settlement can be reduced to approximately 50 mm if filling is undertaken in advance (minimum three months), and further mitigated if surcharge is placed to replicate the building loads. The settlement predictions are subject to change based on building and floor loadings, and the required final level of the site. A settlement preload design will be required once the final building layout has been determined.

Confirmation of the stripped subgrade is recommended prior to preparing foundations to ensure all unsuitable material, e.g., topsoil or non-certified fill, has been removed. Where filling is required, compaction testing will be required to confirm the hardfill has been compacted to an engineered standard.

- Ultimate bearing capacity of 200kPa (based on the limiting foundation sizes as detailed within Section 5.2 and settlement preload being undertaken in advance).
- Geotechnical strength reduction factor – 0.5.
- Soil expansivity class – Site Class M (moderately reactive soils).
- Seismic class – Site Class D (deep or soft soil site).

Bearing capacity values included in this report are for vertical loads only and do not consider horizontal shear or moment.

Where foundation excavations expose soft/weak or otherwise unsuitable ground these materials should be undercut and replaced with GAP40 compacted to an engineered standard.

7 Construction

7.1 Earthworks Operation and Compaction Control

Based on the concept plans prepared, up to 1.4 m of imported granular fill will be raise the ground of existing level to FGL. Prior to the placement of any filling, it will be necessary to strip all topsoil. All filling across the site should be done at the same time, including the dispatch yard. A typical construction sequence is as follows:

- Strip the site of topsoil – [Subgrade check by Geotechnical Engineer]
- Geotextile – BIDIM A39 across the subgrade prior to filling (install min. 40 kN geogrid, e.g., CombiGrid®)
- Settlement monitoring pins to be added across the building platform.
- Import fill and start running in layer (200 mm loose for granular fill). Building platforms to be done first and overfilled a minimum 2.0 m from all edges of building. Fill up to FFL level.
- Surcharge the building platforms with fill to replicate the proposed building loads and other additional surcharge required to speed up the settlement i.e., decrease the time for settlement to occur. Settlement to be monitored. [Subject to settlement preload design and reporting]

- Once approved by the Engineer, surcharge fill can be removed and spread over other areas of the site to achieve the desired levels.

7.2 Earthworks

7.2.1 *Subgrade Preparation*

Due to the soil sensitivity at the site, site concrete or gravel surface protection is recommended under all perimeter or pad footings to provide a suitable working base when preparing foundations, this is particularly important if preparing foundations in wet weather or during winter, or during summer where exposure to the sun and heat will result in the soils becoming desiccated. Slab preparation should also be protected by granular hardfill or polythene immediately following site clearance.

7.2.2 *Filling*

The site can be raised with granular fill, subject to approval by the Engineer and preload monitoring. Our recommended control criteria are as follows:

Table 8 - Maximum dry density for granular fill

	Dy Density Percentage of N.Z. Standard Compaction Test	Water Content Allow variations from Optimum
GAP65/GAP40	95%	6% to 8%

Table 9 - Clegg Impact Value (CIV) testing on granular fill

Clegg Impact Value – 4.5kg Clegg	
Average value	25
Maximum single value	20

Note: Average value shall be determined over ten consecutive tests.

Table 10 - Proof roll testing on granular hardfill

Proof rolling observations	
Target elastic settlement beneath a fully loaded six-wheel truck or 10 tonne smooth drum roller	<5 mm

All filling shall be compacted in thin layers, approximately 200 mm loose, with compaction testing completed at every second layer by a CPEng (Geotechnical).

7.2.3 *Groundwater Control*

Groundwater level across the site is shallow and service installation will need to be aware of this during construction. The site will need to be built up as part of the site preparation and should be done well in advance of preparing the site for service installation. Where possible, all services should be installed during summer.

7.3 Subgrade Protection

We recommend that trafficking of the building platform and carparking areas are minimised and that subgrades are only trimmed to final levels immediately prior to covering with granular hardfill. The site should be shaped to avoid water ponding during rain, thereby limiting the need for additional undercutting and hard filling. Areas of trimmed subgrade shall not be left exposed to allow the ingress of water, nor should subgrade areas be trafficked prior to drying out after rain.

7.4 Stormwater Disposal

Stormwater from paved areas, roofs, driveways, and water storage tanks should be collected in sealed, flexible pipes and discharged in such a manner to not cause any instability or erosion. It is essential for the long-term stability of this site, that all storm water be piped away from any proposed building platform to avoid over saturation of the underlying natural soils.

Stormwater shall be piped away from any proposed building platform to avoid over saturation of the subsoils and to maintain stability across the site. All stormwater overflow drainages should be channelled away from the development platform and discharged in a controlled manner.

Uncontrolled stormwater discharges onto the ground surface can cause erosion and should not be permitted under any circumstances where stability could be compromised.

7.5 Services

At the time of writing, no known underground services cross beneath the proposed development area. Where it is intended for the installation of underground services, we recommend that all services are installed prior to foundation excavations and construction and that all services are designed to be outside the influence of foundation excavations. We recommend that any new services are accurately located on site and the depth to invert be determined prior to the commencement of foundation excavations.

7.6 Geotechnical Review

Haigh Workman Limited have only been provided with concept design drawings for the site. We therefore would like to be given the opportunity of reviewing the final civil and structural drawings for this development prior to Building Consent application to ensure that our recommendations relating to site works and foundation design have been interpreted as intended. Our involvement in the detailed design process is recommended.

7.7 Construction Observations

We consider the following specific items will need to be observed at the time of construction to ensure the foundation soils are consistent with the assumptions made in this geotechnical report:

1. Geotechnical drawing review to confirm the foundation design is as per the geotechnical recommendations.
2. Observe subgrade exposure prior to covering with hardfill protection.
3. Observe fill placement and confirmation fill has been placed to an engineered standard.
4. Review settlement monitoring results. Engineer to confirm removal of surcharge.
5. Observe all foundation excavations and exposure of foundation soils.
6. Observe pavement construction and testing at regular intervals.

Provision should be allowed for modifying the foundation solution at this time should unforeseen ground conditions be encountered.

8 Limitations

This report has been prepared for the use of Waipapa Pine Limited with respect to the brief outlined to us. This report is to be used by our Client and their Consultants and may be relied upon when considering geotechnical advice. Furthermore, this report may be utilised in the preparation of building and/or resource consent applications with local authorities. The information and opinions contained within this report shall not be used in other context for any other purpose without prior review and agreement by Haigh Workman Ltd.

The recommendations given in this report are based on site data from discrete locations. Inferences about the subsoil conditions away from the test locations have been made but cannot be guaranteed. We have inferred an appropriate geotechnical model that can be applied for our analyses. However, variations in ground conditions from those described in this report could exist across the site. Should conditions encountered differ to those outlined in this report we ask that we be given the opportunity to review the continued applicability of our recommendations.

Appendix A – Drawings

Drawing No.	Title
23 256/G01	Site Plan
23 256/G01	Site Investigation Plan
23 256/G03	Geological Section A-A

Rev	Date	Description	By	Checked
A	14/05/2024	GEO REPORT	LP	JP

DWG SITE PLAN

A3 Scale 1: 1500 (0 – 30 – 75)

Date 14/05/2024

Drawn WT | Checked JP | Approved JP

File C:\USERS\WAYNETHORBURN\HAIGH WORKMAN LIMITED\SUITEFILES - CLIENTS\WAIPAPA PINE LIMITED\JOBS\23 256 - WAIPAPA MILL -1945B STATE HIGHWAY 10, WAIPAPA\ENGINEERING\DRAWINGS\06 GEO SITE PLAN\23 256_20240508_GEO.DWG

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Project BORON PLANT AND DISPATCH YARD
WAIPAPA MILL - 1945B STATE HIGHWAY 10, WAIPAPA

Client WAIPAPA PINE LIMITED

Project No. 23 256

RC no.

Stage

Dwg No. G01

Sheet No. 1 OF 3

Rev	Date	Description	By	Checked
A	08/05/2024	DRAFT	LP	JP

DWG SITE INVESTIGATION PLAN

A3 Scale 1: 1000 (0, 20, 50)

Date 14/05/2024

Drawn WT | Checked JP | Approved JP

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Client WAIPAPA PINE LIMITED

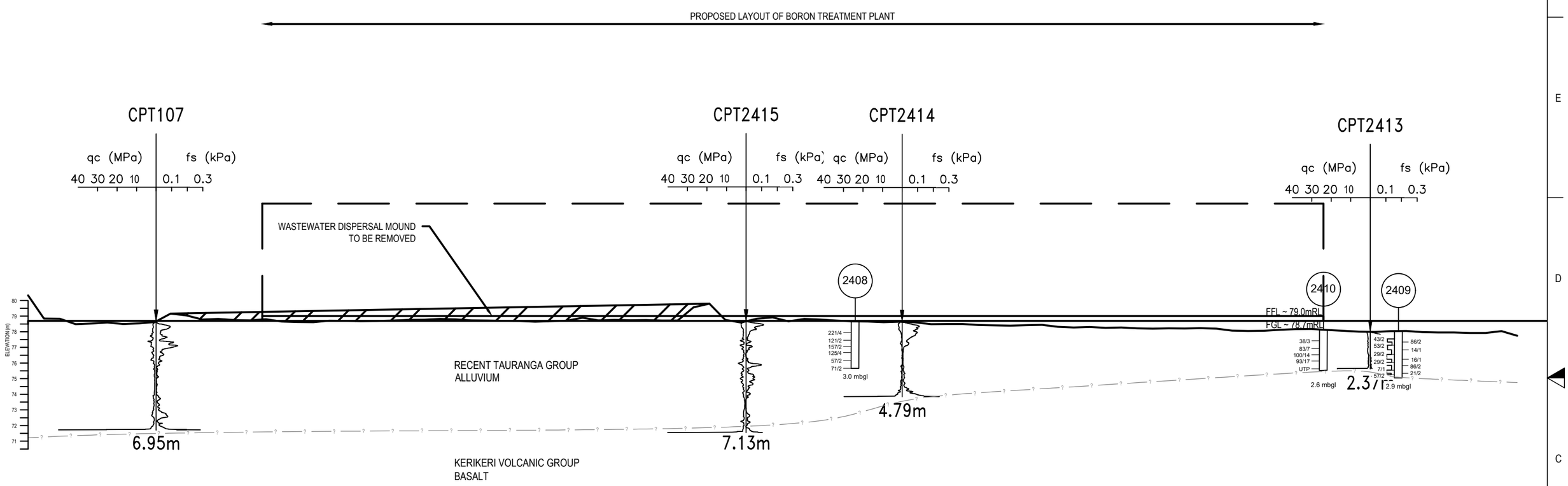
Project No. 23 256

RC no.

Stage

Dwg No. G02

Sheet No. 2 OF 3



Rev	Date	Description	By	Checked
A	08/05/2024	DRAFT	LP	JP

DWG GEOLOGICAL SECTION A-A

A3 Scale 1: 250 (0 5 13)

Date 14/05/2024

Drawn WT | Checked JP | Approved JP

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Project BORON PLANT AND DISPATCH YARD
WAIPAPA MILL - 1945B STATE HIGHWAY 10, WAIPAPA

Client WAIPAPA PINE LIMITED

Project No. 23 256

RC no.

Stage

Dwg No. G03

Sheet No. 3 OF 3

Appendix B – Site Investigation Logs

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Borehole Log - BH2401

Hole Location: Refer to Site Plan

JOB No. 23 256

CLIENT:	Waipapa Pine Limited	**SITE:**	Waipapa Mill - 1945B State Highway 10, Waipapa		
Date Started:	12/03/2024	**DRILLING METHOD:**	Hand Auger	**LOGGED BY:**	CN
Date Completed:	12/03/2024	**HOLE DIAMETER (mm)**	50mm	**CHECKED BY:**	WT

Soil Description

Based on NZGS Logging Guidelines 2005

GRAVEL *[HARDFILL]*

Silty **CLAY**, trace fine sand; brown, mottled dark greyish brown. Very stiff, moist, medium to high plasticity. *[TAURANGA GROUP - ALLUVIUM]*

SILT, some clay, trace fine to medium sand; light brownish grey. Very stiff, moist to wet, low plasticity.

From 1.3m: Trace clay. Wet, no to low plasticity.
From 1.4m: Some clay. Low plasticity.
From 1.5m: Trace clay, no to low plasticity.

From 1.7m: Minor fine sand.

At 2.0m: Trace fine gravel (weakly cemented clasts).
From 2.1m: Minor fine to medium sand.

SILT, some fine to medium sand; grey, mottled dark grey. Stiff, saturated, no plasticity.
From 2.7m: Minor fine to medium sand.

At 3.0m: Trace fine gravel (weakly cemented clasts).

From 3.2m: Trace fine to medium sand. Firm.
From 3.3m: No sand. Very soft.

From 3.6m: Becomes dark grey to grey. Firm to stiff.

End of hole at 3.75m (Unable to Penetrate - Obstruction)

Depth (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

Geology: H.FILL; TAURANGA GROUP - ALLUVIUM

Graphic Log

Water Level: Groundwater Seepage encountered at 1.3mbgl.

Sensitivity	Vane Shear and Remoulded Vane Shear Strengths (kPa)
	UTP
1 2	168 / 14
2 4	171 / 7
2 9	103 / 4
4 3	153 / 4
3 3	118 / 4
6 6	118 / 2
4 8	86 / 2
3 6	64 / 2
5 4	193 / 4
8	7 / 1
8	7 / 1
3 0	53 / 2
	UTP

Scala Penetrometer (blows/100mm): 0 5 10 15 20

LEGEND

TOPSOIL | CLAY | SILT | SAND | GRAVEL | FILL

Corrected shear vane reading
Remoulded shear vane reading
Scala Penetrometer

Note: UTP = Unable to penetrate. T.S. = Topsoil.
Hand Held Shear Vane S/N: DR1698
Scala penetrometer testing not undertaken. Groundwater seepage encountered at 1.3mbgl. Groundwater measured at 1.5mbgl at completion of drilling.

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Borehole Log - BH2402

Hole Location: Refer to Site Plan

JOB No. 23 256

CLIENT:	Waipapa Pine Limited	**SITE:**	1945B State Highway 10, Waipapa 0295		
Date Started:	12/03/2024	**DRILLING METHOD:**	Hand Auger	**LOGGED BY:**	JP
Date Completed:	12/03/2024	**HOLE DIAMETER (mm)**	50mm	**CHECKED BY:**	WT

Soil Description
Based on NZGS Logging Guidelines 2005

HARDFILL; Fine to coarse gravel with some cobbles and silt intermixed. Dense, dry. [FILL]

SILT, minor clay, trace fine gravel; brownish orange and light brown, mottled orange. Very stiff, moist, low plasticity. [Fill]

From 0.6m: Becomes brown to orangish brown.

SILT, some clay, trace fine gravel; brown, mottled orange. Very stiff, moist, low plasticity. [Tauranga Group Alluvium].

SILT, trace clay; brown to dark brownish grey. Stiff, moist, low plasticity.

From 1.0m: Becomes orange, mottled brownish orange. Very stiff.

SILT, minor fine sand, trace gravel; light brown to light grey. Stiff, wet, no plasticity.

From 1.4m: Trace clay, trace fine sand; light grey. No gravel.

SILT, minor fine gravel, minor fine to coarse sand, trace clay; grey, mottled dark grey. Stiff, saturated, no plasticity.

From 2.9m to 3.2m: Poor sample recovery. Hand auger dropped from 2.9m to 3.2m.

SILT, trace clay, trace fine sand, trace fine gravel; grey to bluish grey, streaked dark greenish grey. Very stiff, wet to saturated, no plasticity. Gravel: weakly cemented.

From 3.2m to 4.2m: Poor sample recovery.

From 3.6m: Becomes dark greenish grey, streaked grey.

End of Hole at 4.2m. (Target Depth)

Depth (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

Geology: FILL; TAURANGA GROUP ALLUVIUM

Water Level: Groundwater measured at 1.3mbgl.

Sensitivity: 8, 10, 4, 3

Vane Shear and Remoulded Vane Shear Strengths (kPa): UTP; 114, 14; 159, 7; 138, 14; 90, 21; 241; 76, 24; UTP; UTP

Scala Penetrometer (blows/100mm): 0 2 4 6 8 10

LEGEND

TOPSOIL | CLAY | SILT | SAND | GRAVEL | FILL

Corrected shear vane reading
Remoulded shear vane reading
Scala Penetrometer

Note: UTP = Unable To Penetrate. T.S. = Topsoil.
Scala penetrometer testing not undertaken.
Hand Held Shear Vane S/N: DR2278. Groundwater measured at 1.3m below ground level at completion of drilling.

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BH2402 - Soil Sample Photograph

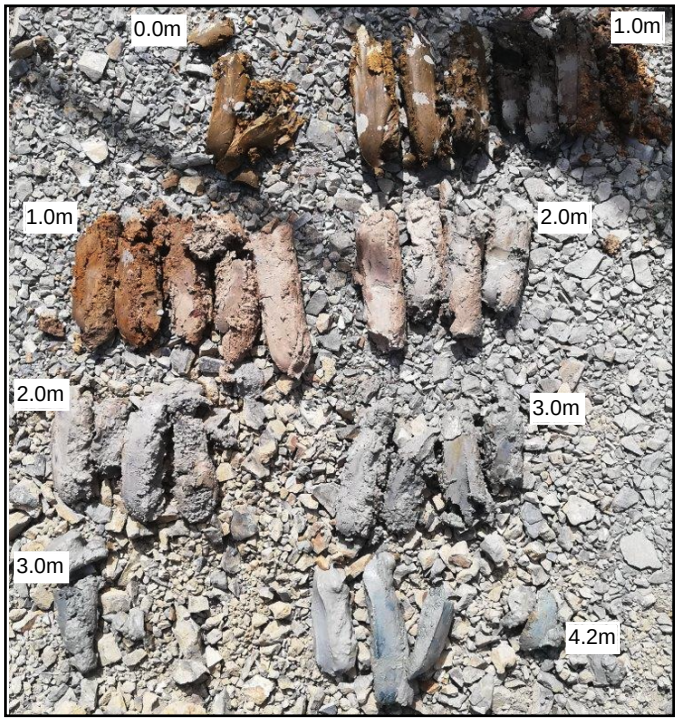
Hole Location: Refer to Site Plan

JOB No. 23 256

CLIENT:	Waipapa Pine Limited	**SITE:**	1945B State Highway 10, Waipapa 0295		
Date Started:	12/03/2024	**DRILLING METHOD:**	Hand Auger	**LOGGED BY:**	JP
Date Completed:	12/03/2024	**HOLE DIAMETER (mm)**	50mm	**CHECKED BY:**	WT

Soil Description

Based on NZGS Logging Guidelines 2005



Depth (m)	Geology	Graphic Log	Water Level	Sensitivity	Vane Shear and Remoulded Vane Shear Strengths (kPa)	Scala Penetrometer (blows/100mm)
0.0						0 2 4 6 8 10
0.5						
1.0						
1.5						
2.0						
2.5						
3.0						
3.5						
4.0						
4.5						

LEGEND

TOPSOIL | CLAY | SILT | SAND | GRAVEL | FILL

Corrected shear vane reading
Remoulded shear vane reading
Scala Penetrometer

Note:

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Borehole Log - BH2403

Hole Location: Refer to Site Plan

JOB No. 23 256

CLIENT:	Waipapa Pine Limited	**SITE:**	Waipapa Mill - 1945B State Highway 10, Waipapa		
Date Started:	12/03/2024	**DRILLING METHOD:**	Hand Auger	**LOGGED BY:**	CN
Date Completed:	12/03/2024	**HOLE DIAMETER (mm)**	50mm	**CHECKED BY:**	WT

Soil Description

Based on NZGS Logging Guidelines 2005

GRAVEL *[HARDFILL]*

Clayey **SILT**; brownish grey. Stiff, moist, medium to high plasticity.
[TAURANGA GROUP - ALLUVIUM]

Silty **CLAY**; light greyish brown. Stiff, moist, high plasticity.

From 1.1m: Trace fine sand.

SILT, minor clay, trace fine sand; light brownish grey to light grey, mottled brown and light orange. Stiff, wet, low plasticity.

From 1.4m: Some clay. Low to medium plasticity.

SILT, minor clay, trace fine sand; grey to bluish grey, mottled dark bluish grey. Very soft, saturated, low plasticity.

From 1.7m: Becomes soft to firm.

From 1.8m: Minor fine to medium sand, no clay. No to low plasticity.

From 2.0m: Becomes light brownish grey.

End of hole at 2.2m (Unable to Penetrate - Obstruction)

Depth (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

Geology: H.FILL; TAURANGA GROUP - ALLUVIUM

Graphic Log

Water Level: Groundwater Seepage Encountered at 1.2mbgl.

Sensitivity: 8; 3 7; 4 3; 6; 2 0; 2 0; 1 2

Vane Shear and Remoulded Vane Shear Strengths (kPa): 89, 11; 66, 2; 153, 4; 5, 1; 36, 2; 36, 2; 21, 2

Scala Penetrometer (blows/100mm): 0 5 10 15 20

LEGEND

TOPSOIL | CLAY | SILT | SAND | GRAVEL | FILL

Corrected shear vane reading
Remoulded shear vane reading
Scala Penetrometer

Note: UTP = Unable to penetrate. T.S. = Topsoil.
Hand Held Shear Vane S/N: DR1698
Scala penetrometer testing not undertaken. Groundwater seepage encountered at 1.2mbgl.

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Borehole Log - BH2404

Hole Location: Refer to Site Plan

JOB No. 23 256

CLIENT:	Waipapa Pine Limited	**SITE:**	1945B State Highway 10, Waipapa 0295		
Date Started:	12/03/2024	**DRILLING METHOD:**	Hand Auger	**LOGGED BY:**	JP
Date Completed:	12/03/2024	**HOLE DIAMETER (mm)**	50mm	**CHECKED BY:**	WT

Soil Description

Based on NZGS Logging Guidelines 2005

HARDFILL; Fine to coarse gravel with some cobbles and silt intermixed. Dense, dry. [FILL]

SILT, trace fine gravel; dark brown. Very stiff, dry to moist, no plasticity. [Fill]

SILT; dark brownish grey, streaked dark brown. Very stiff, dry to moist, no plasticity. Trace rootlets. [Tauranga Group Alluvium]

SILT, minor clay; brown, mottled dark brown. Very stiff, moist to wet, low plasticity. Trace rootlets.

SILT, some clay; brownish orange, streaked brown. Very stiff, moist, low to medium plasticity.

From 1.0m: Becomes brown, streaked dark brown, trace fine gravel (weakly cemented).

From 1.2m: Becomes light brown and brown, streaked dark brown.

SILT, trace fine gravel, trace clay; light brown and light grey, mottled light orange and brown. Stiff, moist to wet, no plasticity.

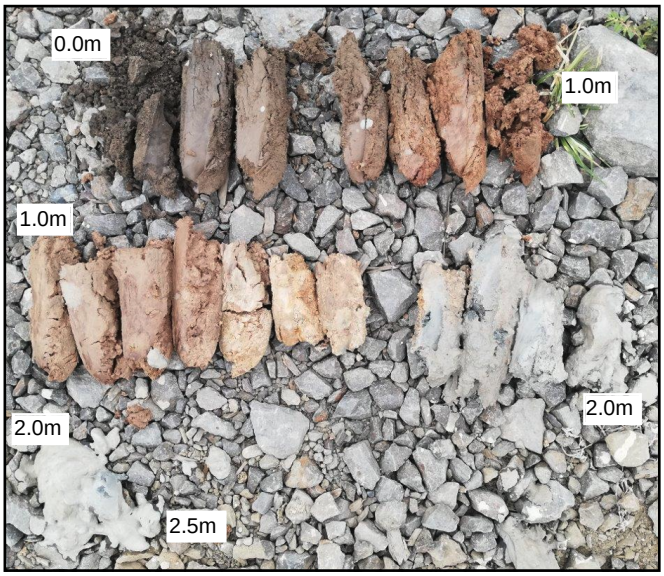
From 1.5m: Becomes light yellowish brown, streaked orange.

SILT, trace fine to coarse sand, trace fine gravel; bluish grey, streaked dark grey. Very stiff, wet, no plasticity.

SILT, trace fine sand, trace clay; light grey, speckled grey. Soft, saturated, no plasticity (dilatant).

From 2.2m to 2.5m: Poor sample recovery.

End of Hole at 2.5m. (Unable to Penetrate)



Depth (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

Geology: FILL; TAURANGA GROUP ALLUVIUM

Water Level: Groundwater measured at 0.8mbgl.

Sensitivity: 4, 9

Vane Shear and Remoulded Vane Shear Strengths (kPa): 207, 48, UTP, 152, 21, 31, 3, UTP

Scala Penetrometer (blows/100mm): 0 2 4 6 8 10

LEGEND

TOPSOIL | CLAY | SILT | SAND | GRAVEL | FILL

Corrected shear vane reading
Remoulded shear vane reading
Scala Penetrometer

Note: UTP = Unable To Penetrate. T.S. = Topsoil.
Scala penetrometer testing not undertaken.
Hand Held Shear Vane S/N: DR2278. Groundwater measured at 0.8m below ground level at completion of drilling.

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Borehole Log - BH2405

Hole Location: Refer to Site Plan

JOB No. 23 256

CLIENT:	Waipapa Pine Limited	**SITE:**	Waipapa Mill - 1945B State Highway 10, Waipapa		
Date Started:	12/03/2024	**DRILLING METHOD:**	Hand Auger	**LOGGED BY:**	CN
Date Completed:	12/03/2024	**HOLE DIAMETER (mm)**	50mm	**CHECKED BY:**	WT

Soil Description

Based on NZGS Logging Guidelines 2005

GRAVEL *[HARDFILL]*

SILT, some clay; greyish brown. Very stiff, moist, medium plasticity.

Silty **SAND**; brown. Loose, wet, no plasticity. Sand: fine to medium.
From 0.5m: Trace coarse sand. *[TAURANGA GROUP - ALLUVIUM]*

Sandy **SILT**, trace clay; light brownish grey. Stiff, wet, no to low plasticity.

SILT, some clay, trace fine to medium sand; light yellowish grey to light brownish grey. Very stiff, wet, low to medium plasticity.
From 1.0m: Minor clay, trace coarse sand. Low plasticity.

From 1.2m: No clay.

From 1.5m: Becomes very soft.

SILT, trace fine sand; light bluish grey to light grey. Very soft, saturated, low plasticity.

From 2.05m: Minor fine to medium sand. Firm.
At 2.1m: Very stiff.

Sandy **SILT**; dark bluish grey to dark grey. Stiff, saturated, no plasticity. Sand: fine to medium.

SILT, trace fine sand; light grey to light bluish grey. Stiff, saturated, no plasticity.

End of hole at 3.3m (Target Depth)
rod pushed down to rock - rock at 5.2mbgl.

Depth (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

Geology: H.FILL; TAURANGA GROUP - ALLUVIUM

Groundwater measured at 0.7mbgl.

Sensitivity	Vane Shear (kPa)	Remoulded Vane Shear (kPa)
2 8	150	5
7 2	128	2
4 0	71	2
1 0	9	1
6	5	1
9 9	182	2
1 1	20	2
5 2	93	2
2 6	46	2
2 3	125	5

Scala Penetrometer (blows/100mm): 0 5 10 15 20

LEGEND

TOPSOIL CLAY SILT SAND GRAVEL FILL

Corrected shear vane reading
Remoulded shear vane reading
Scala Penetrometer

Note: UTP = Unable to penetrate. T.S. = Topsoil.
Hand Held Shear Vane S/N: DR1698
Scala penetrometer testing not undertaken. Groundwater seepage encountered at 0.9mbgl. Groundwater measured at 0.7mbgl at completion of drilling.

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Borehole Log - BH2406

Hole Location: Refer to Site Plan

JOB No. 23 256

CLIENT:	Waipapa Pine Limited	**SITE:**	1945B State Highway 10, Waipapa 0295		
Date Started:	12/03/2024	**DRILLING METHOD:**	Hand Auger	**LOGGED BY:**	JP
Date Completed:	12/03/2024	**HOLE DIAMETER (mm)**	50mm	**CHECKED BY:**	WT

Soil Description
Based on NZGS Logging Guidelines 2005

HARDFILL; Fine to coarse gravel with some cobbles and silt intermixed. Dense, dry. [FILL]

SILT, some fine gravel, trace fine sand; brown to brownish orange, mottled orange, speckled black. Very stiff, moist, no plasticity. [Tauranga Group Alluvium].

From 0.6m: Becomes moist to wet.

SILT, trace fine gravel, trace coarse sand; light brown, mottled brownish grey. Very stiff, wet, no plasticity.

SILT, trace fine gravel; light brown to greyish brown, mottled dark brownish orange. Very stiff, moist to wet, no plasticity.

SILT, trace fine to medium sand, trace fine gravel; light yellowish brown to light grey. Very stiff, wet to saturated, no plasticity.

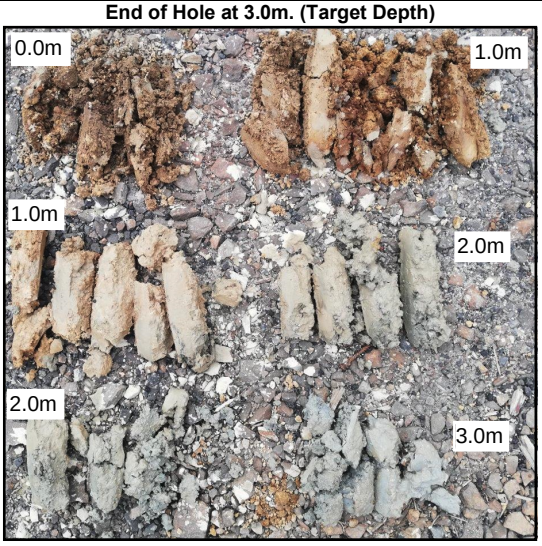
From 1.3m: Becomes dark grey, mottled dark greenish grey.

From 1.5m: Becomes light greenish grey, mottled dark green, speckled grey. Stiff.

SILT, trace fine gravel and fine to coarse sand; bluish grey, mottled dark grey. Very stiff, saturated, no plasticity. Poor Sample Recovery.

SILT, trace fine to medium sand; light bluish grey. Soft to firm, saturated, no plasticity (dilatant).

End of Hole at 3.0m. (Target Depth)



Depth (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

Geology: FILL; TAURANGA GROUP ALLUVIUM

Water Level: Groundwater measured at 0.6mbgl.

Sensitivity: 6, 13, 7

Vane Shear and Remoulded Vane Shear Strengths (kPa): 141, 24, 241, 69, 3, 179, 14, UTP, 24, 3

Scala Penetrometer (blows/100mm): 0 2 4 6 8 10

LEGEND

TOPSOIL | CLAY | SILT | SAND | GRAVEL | FILL

Corrected shear vane reading
Remoulded shear vane reading
Scala Penetrometer

Note: UTP = Unable To Penetrate. T.S. = Topsoil.
Scala penetrometer testing not undertaken.
Hand Held Shear Vane S/N: DR2278. Groundwater measured at 0.6m below ground level at completion of drilling.

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Borehole Log - BH2407

Hole Location: Refer to Site Plan

JOB No. 23 256

CLIENT:	Waipapa Pine Limited	**SITE:**	Waipapa Mill - 1945B State Highway 10, Waipapa		
Date Started:	12/03/2024	**DRILLING METHOD:**	Hand Auger	**LOGGED BY:**	CN
Date Completed:	12/03/2024	**HOLE DIAMETER (mm)**	50mm	**CHECKED BY:**	WT

Soil Description

Based on NZGS Logging Guidelines 2005

GRAVEL *[HARDFILL]* — 0.0 — H.FILL

Clayey **SILT**; greyish brown. Very stiff, moist, medium plasticity. *[TAURANGA GROUP - ALLUVIUM]* — 0.5

SILT, some clay, minor fine to medium sand; light brownish grey, mottled brownish orange. Stiff, moist to wet, low to medium plasticity.

Clayey **SILT**, trace fibrous organics; light greyish brown, mottled light brownish grey and dark brown. Stiff,wet, low to medium plasticity. — 1.0

SILT, some clay, trace fine sand; light greyish brown, mottled light brownish grey. Stiff, saturated, low plasticity.

SILT, minor fine to medium sand, minor clay; light grey, mottled light brownish grey. Stiff, saturated, no to low plasticity. — 1.5

SILT, some fine to medium sand, trace coarse sand, trace clay; grey to dark bluish grey. Stiff, saturated, no to low plasticity. — 2.0

From 2.4m: No clay. — 2.5

From 3.2m: Minor fine to medium sand. — 3.0

TAURANGA GROUP - ALLUVIUM

End of hole at 3.4m (Target Depth) — 3.5

4.0

4.5

Groundwater Seepage Encountered at 0.7mbgl.

Sensitivity	Vane Shear (kPa)	Remoulded Vane Shear (kPa)
10	103	11
12	86	7
16	111	7
58	103	2
58	103	2
48	86	2
16	57	4
52	93	2
23	82	4

Scala Penetrometer (blows/100mm): 0 5 10 15 20

LEGEND

TOPSOIL | CLAY | SILT | SAND | GRAVEL | FILL

Corrected shear vane reading
Remoulded shear vane reading
Scala Penetrometer

Note: UTP = Unable to penetrate. T.S. = Topsoil.
Hand Held Shear Vane S/N: DR1698
Scala penetrometer testing not undertaken. Groundwater seepage encountered at 1.0mbgl.

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Borehole Log - BH2408

Hole Location: Refer to Site Plan

JOB No. 23 256

CLIENT:	Waipapa Pine Limited	**SITE:**	Waipapa Mill - 1945B State Highway 10, Waipapa		
Date Started:	12/03/2024	**DRILLING METHOD:**	Hand Auger	**LOGGED BY:**	CN
Date Completed:	12/03/2024	**HOLE DIAMETER (mm)**	50mm	**CHECKED BY:**	WT

Soil Description

Based on NZGS Logging Guidelines 2005

SILT; brown. Very stiff, dry to moist, no plasticity. *[TOPSOIL]*

0.35m: **SILT**, some clay, minor medium sand to fine gravel; brown to greyish brown, mottled orange. Very stiff, dry to moist, low plasticity.

Clayey **SILT**, trace fine sand; orangish brown. Very stiff, moist, medium to high plasticity. *[TAURANGA GROUP - ALLUVIUM]*

SILT, trace clay, trace fine sand; light brownish grey, mottled dark grey. Very stiff, moist, no to low plasticity.

From 1.0m: Becomes mottled light brownish pink. Wet.

From 1.1m: Minor fine to coarse sand, trace fine gravel.

From 1.2m: Becomes saturated.

From 1.4m: Minor fine to medium sand, no fine gravel; light grey to brownish gr

From 1.5m: Some fine to medium sand.

From 2.0m: Becomes grey.

From 2.1m: Becomes firm to stiff.

From 2.4m: minor fine to medium sand. Poor sample recovery.

End of hole at 3.0m (Target Depth)

Depth (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

Geology: T.S. / TAURANGA GROUP - ALLUVIUM

Graphic Log

Water Level: Groundwater Encountered at 1.2mbgl.

Sensitivity	Vane Shear and Remoulded Vane Shear Strengths (kPa)
6 2	UTP / 221 / 4
6 8	UTP / 121 / 2
8 8	157 / 2
3 5	125 / 4
1 9	68 / 4
3 2	57 / 2
3 3	59 / 2
4 0	71 / 2

Scala Penetrometer (blows/100mm): 0 5 10 15 20

LEGEND

TOPSOIL | CLAY | SILT | SAND | GRAVEL | FILL

Corrected shear vane reading
Remoulded shear vane reading
Scala Penetrometer

Note: UTP = Unable to penetrate. T.S. = Topsoil.
Hand Held Shear Vane S/N: DR1698
Scala penetrometer testing not undertaken. Groundwater seepage encountered at 1.2mbgl. Groundwater measured at 1.3mbgl at completion of drilling.

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Borehole Log - BH2409

Hole Location: Refer to Site Plan

JOB No. 23 256

CLIENT:	Waipapa Pine Limited	**SITE:**	Waipapa Mill - 1945B State Highway 10, Waipapa		
Date Started:	12/03/2024	**DRILLING METHOD:**	Hand Auger	**LOGGED BY:**	CN
Date Completed:	12/03/2024	**HOLE DIAMETER (mm)**	50mm	**CHECKED BY:**	WT

Soil Description

Based on NZGS Logging Guidelines 2005

SILT; brown. Stiff, moist, no plasticity. *[TOPSOIL]*

0.25m: Clayey **SILT**; brownish grey. Stiff, moist, mediium plasticity. *[TAURANGA GROUP - ALLUVIUM]*

From 0.5m: Becomes moist to wet.

From 0.7m: Trace fine sand. Wet.

From 0.8m: Minor fine to medium sand.

SILT, some clay; light greyish brown. Firm, wet, low to medium plasticity.

1.15m: **SILT**, trace fine sand; light bluish grey and dark bluish grey. Soft, saturated, low plasticity.

From 1.5m: Becomes dark bluish grey. No to low plasticity.

From 1.7m: Minor fine to medium sand.

2.05m: **SILT**, trace fine sand; light bluish grey to light grey. Soft, saturated, no plasticity.

At 2.8m: Firm to stiff.

End of hole at 2.9m (Unable to Penetrate - Obstruction)

Depth (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

Geology: T.S. / TAURANGA GROUP - ALLUVIUM

Graphic Log

Water Level: Groundwater Seepage Encountered at 1.0mbgl.

Sensitivity	Vane Shear and Remoulded Vane Shear Strengths (kPa)
2 4	43 / 2
4 8	86 / 2
3 0	53 / 2
1 6	14 / 1
1 6	29 / 2
1 8	16 / 1
1 6	29 / 2
4 8	86 / 2
8	7 / 1
1 2	21 / 2
3 2	57 / 2
	UTP

Scala Penetrometer (blows/100mm): 0 5 10 15 20

LEGEND

TOPSOIL | CLAY | SILT | SAND | GRAVEL | FILL

Corrected shear vane reading
Remoulded shear vane reading
Scala Penetrometer

Note: UTP = Unable to penetrate. T.S. = Topsoil.
Hand Held Shear Vane S/N: DR1698
Scala penetrometer testing not undertaken. Groundwater seepage encountered at 1.0mbgl & groundwater measured at 1.0mbgl at completion of drilling.

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Borehole Log - BH2410

Hole Location: Refer to Site Plan

JOB No. 23 256

CLIENT:	Waipapa Pine Limited	**SITE:**	1945B State Highway 10, Waipapa 0295		
Date Started:	12/03/2024	**DRILLING METHOD:**	Hand Auger	**LOGGED BY:**	JP
Date Completed:	12/03/2024	**HOLE DIAMETER (mm)**	50mm	**CHECKED BY:**	WT

Soil Description
Based on NZGS Logging Guidelines 2005

SILT; brown to dark brown, streaked light grey, speckled orange. Stiff, moist, no plasticity. Trace rootlets.

SILT, minor clay; brown, streaked brownish grey. Stiff, moist, low plasticity. [Tauranga Group Alluvium]

SILT, minor clay, trace fine gravel; brown to light brown, streaked dark brown. Stiff, moist to wet, low plasticity.

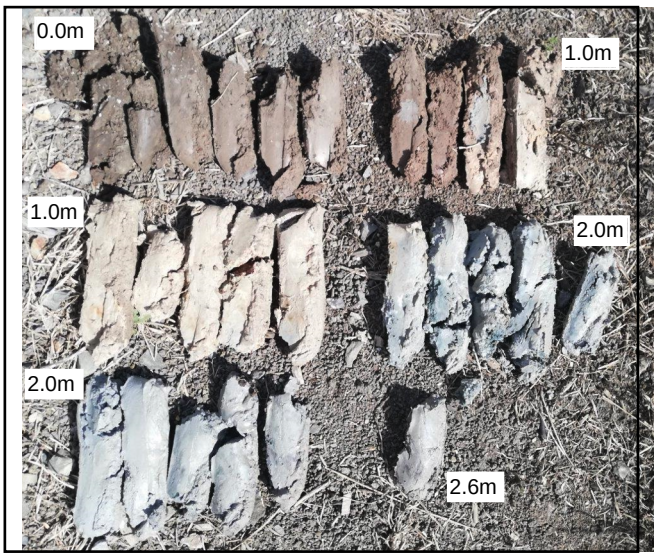
SILT, minor clay; light brownish grey, mottled orange. Stiff, moist to wet, low plasticity.

SILT, trace clay; light bluish grey, streaked light orange. Stiff, wet, low plasticity.

From 2.0m: Becomes light bluish grey.

SILT, minor clay, trace fine gravel; light bluish grey, mottled dark grey. Very stiff, moist, low plasticity.

End of Hole at 2.6m. (Unable to Penetrate)



Depth (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

Geology: T.S. / TAURANGA GROUP ALLUVIUM

Water Level: Groundwater measured at 0.6mbgl.

Sensitivity: 1, 12, 5

Vane Shear and Remoulded Vane Shear Strengths (kPa): 38, 3, 83, 7, 100, 14, 93, 17, UTP, UTP

Scala Penetrometer (blows/100mm): 0 2 4 6 8 10

LEGEND

TOPSOIL | CLAY | SILT | SAND | GRAVEL | FILL

Corrected shear vane reading
Remoulded shear vane reading
Scala Penetrometer

Note: UTP = Unable To Penetrate. T.S. = Topsoil.
Scala penetrometer testing not undertaken.
Hand Held Shear Vane S/N: DR2278. Groundwater measured at 1.0m below ground level at completion of drilling.

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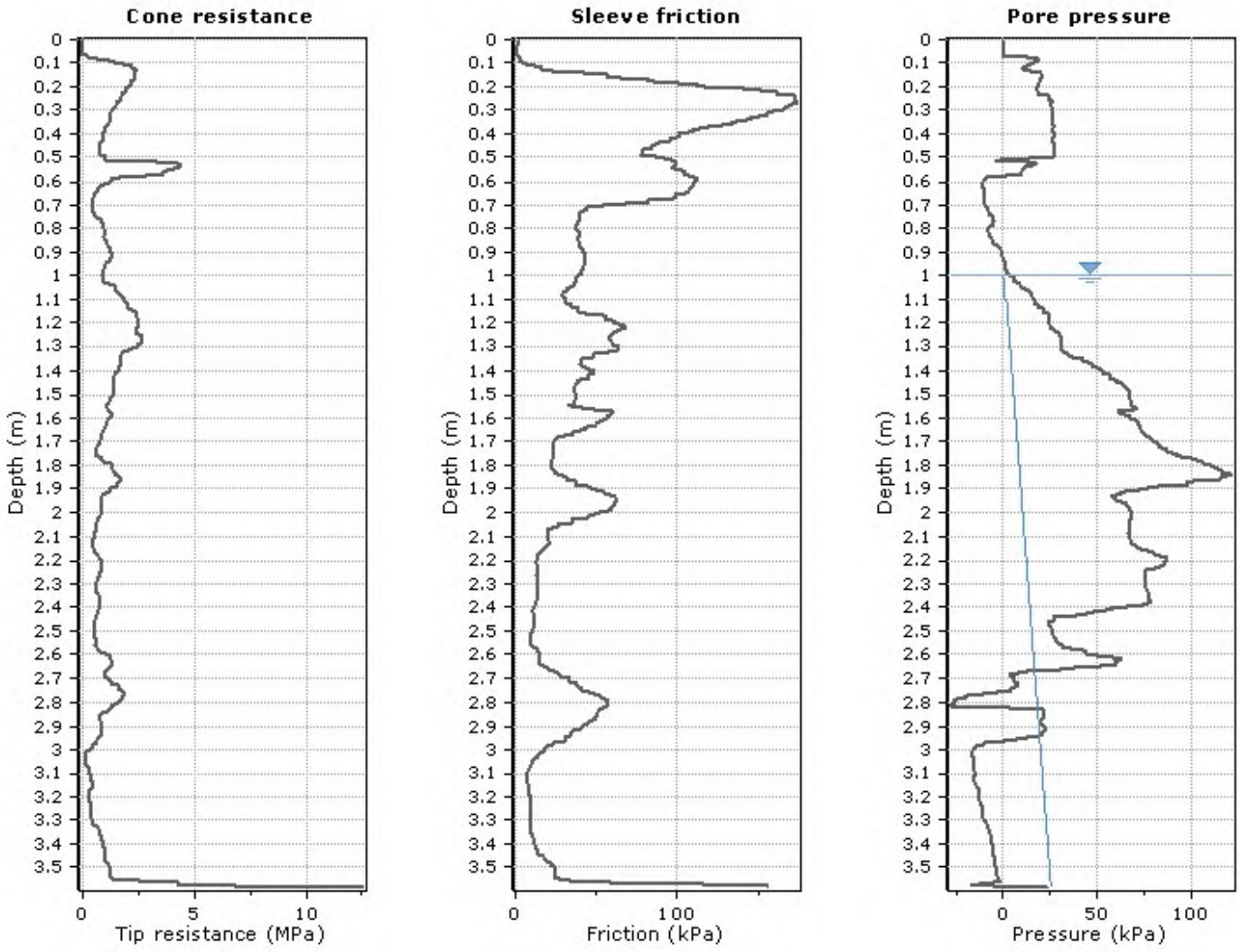
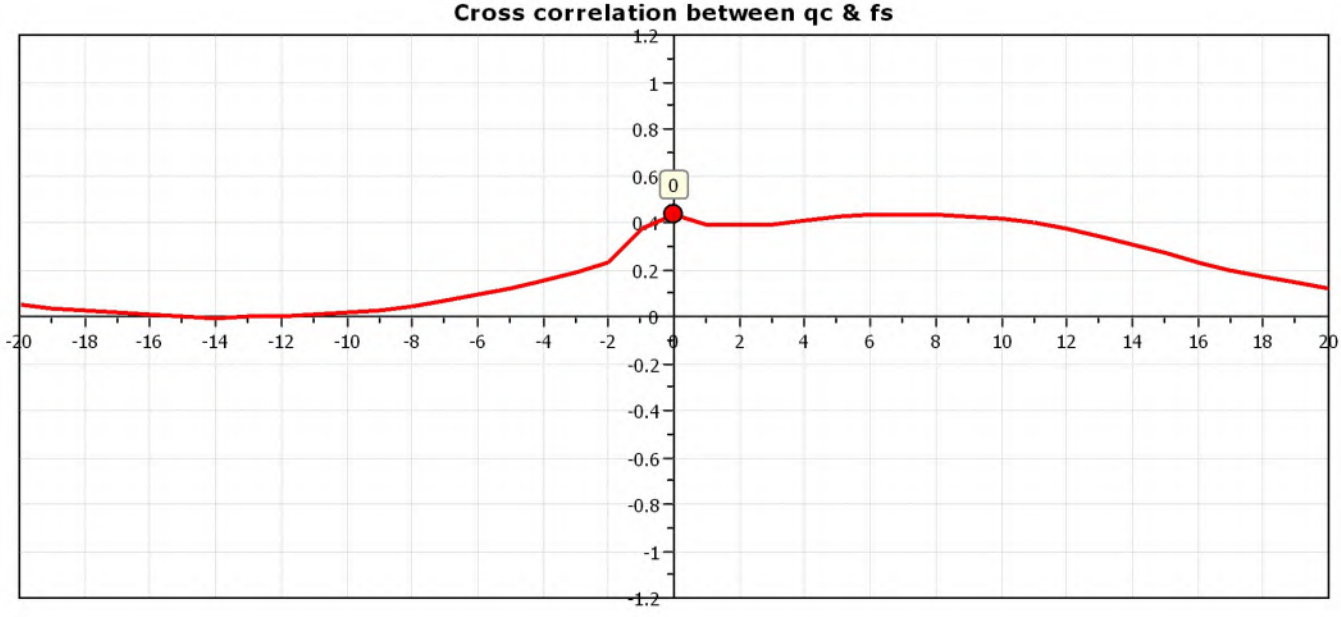
CPT: CPT2401
Total depth: 3.58 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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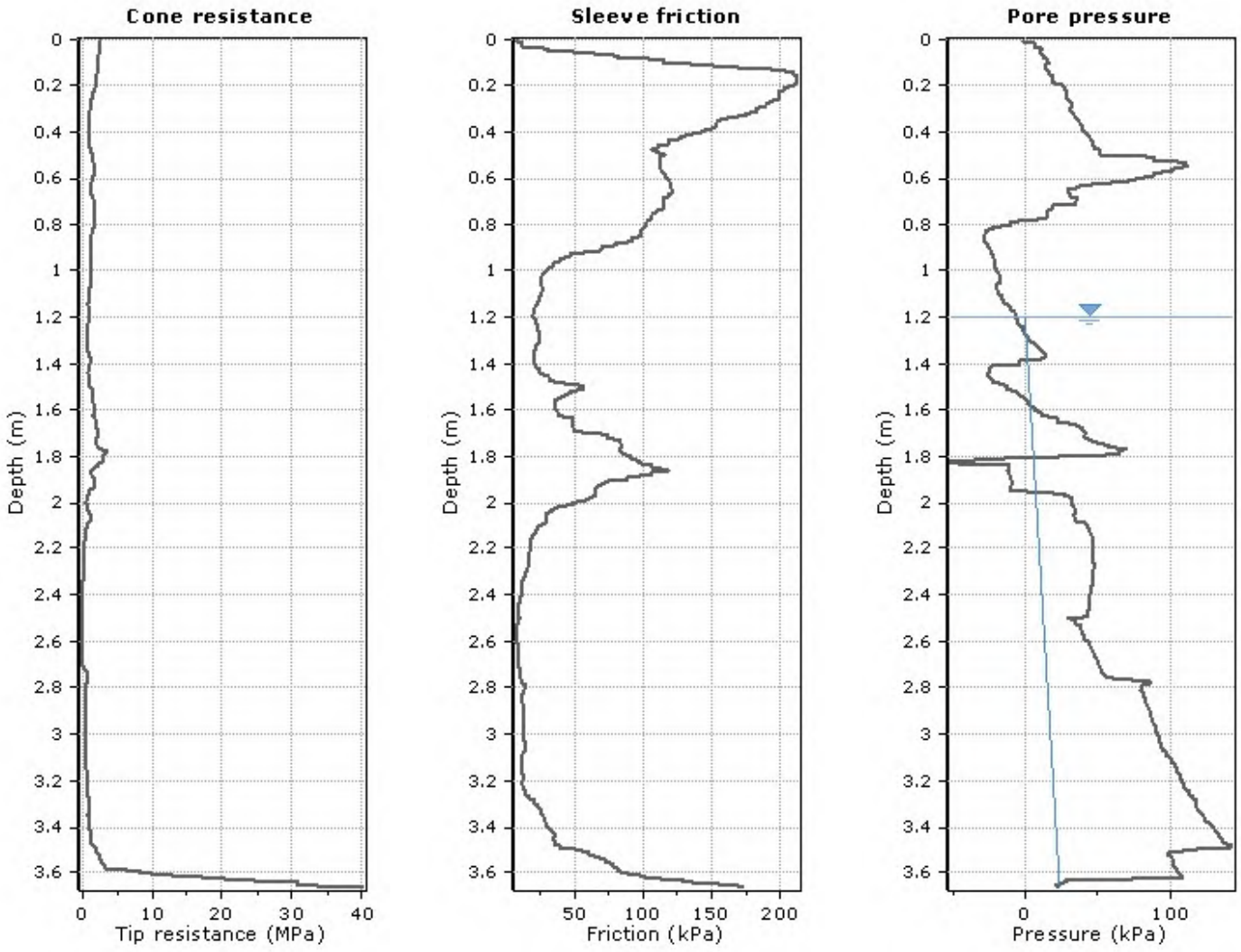
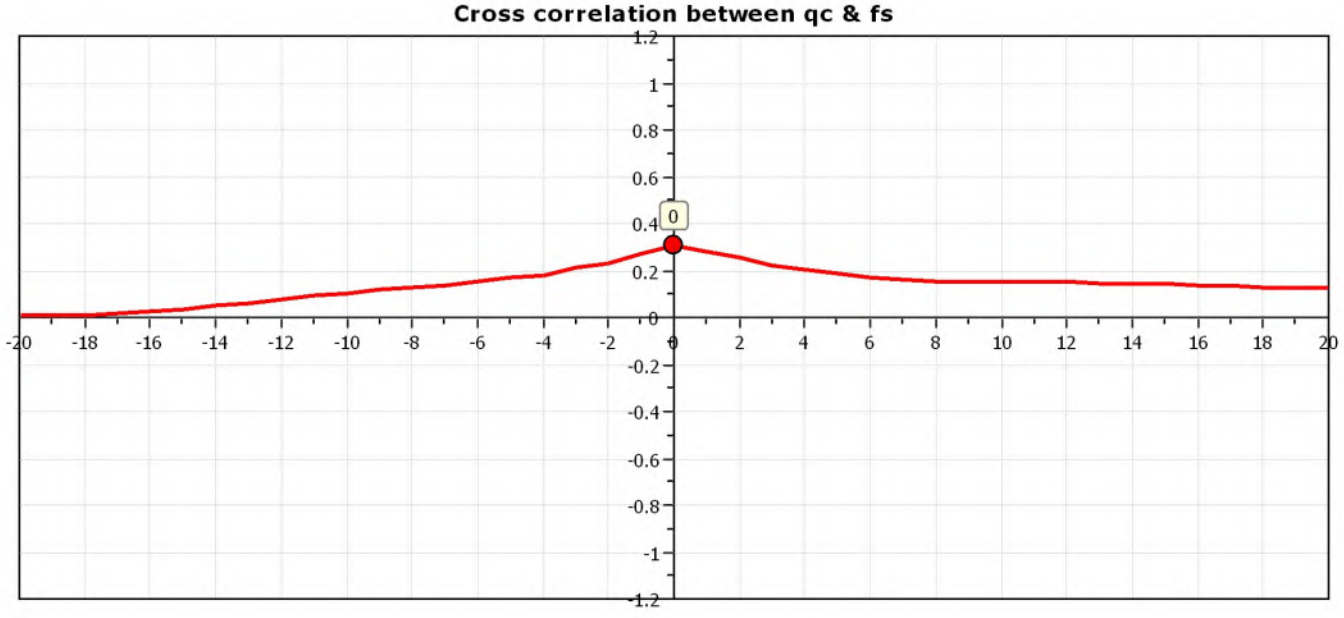
CPT: CPT2402
Total depth: 3.66 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



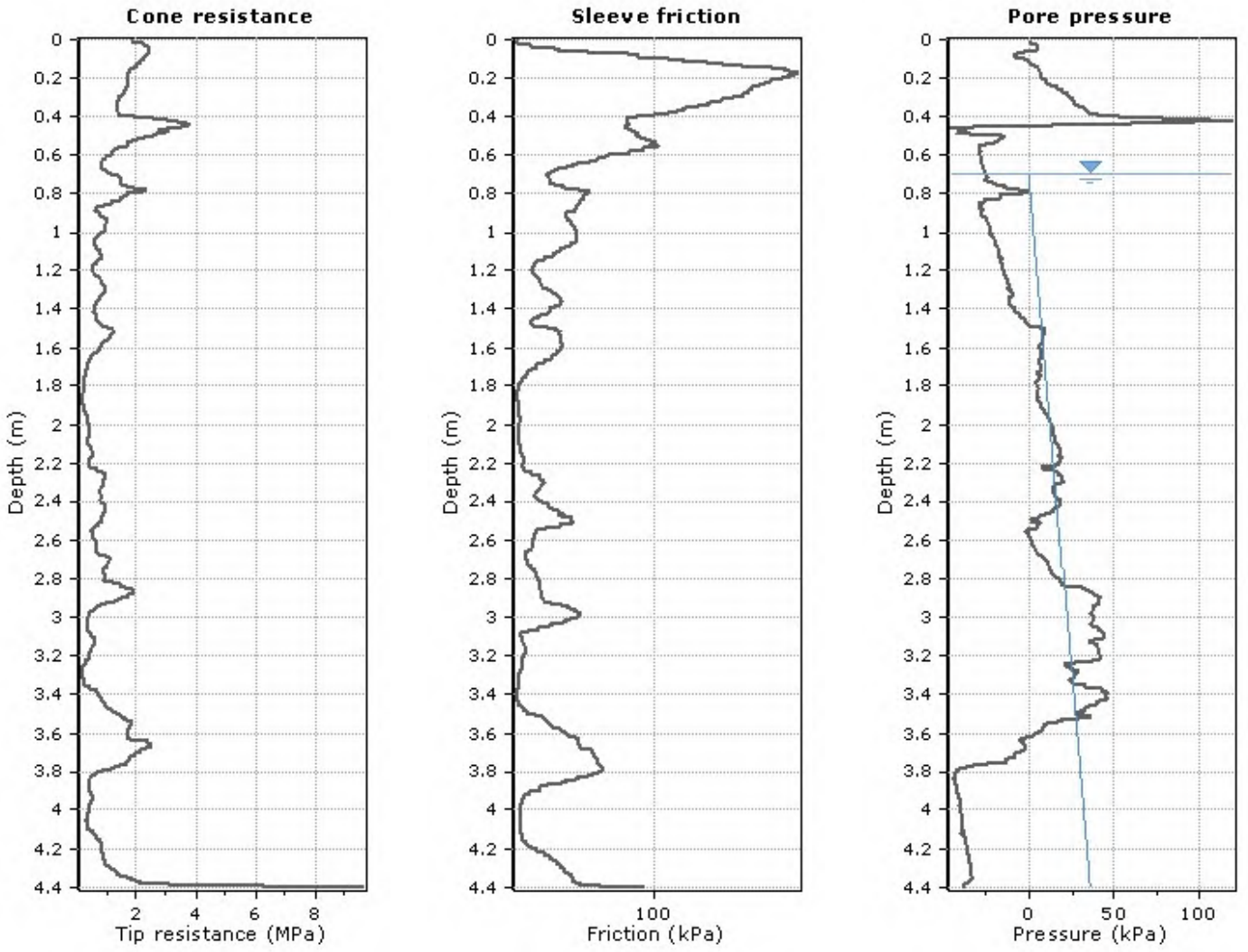
The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



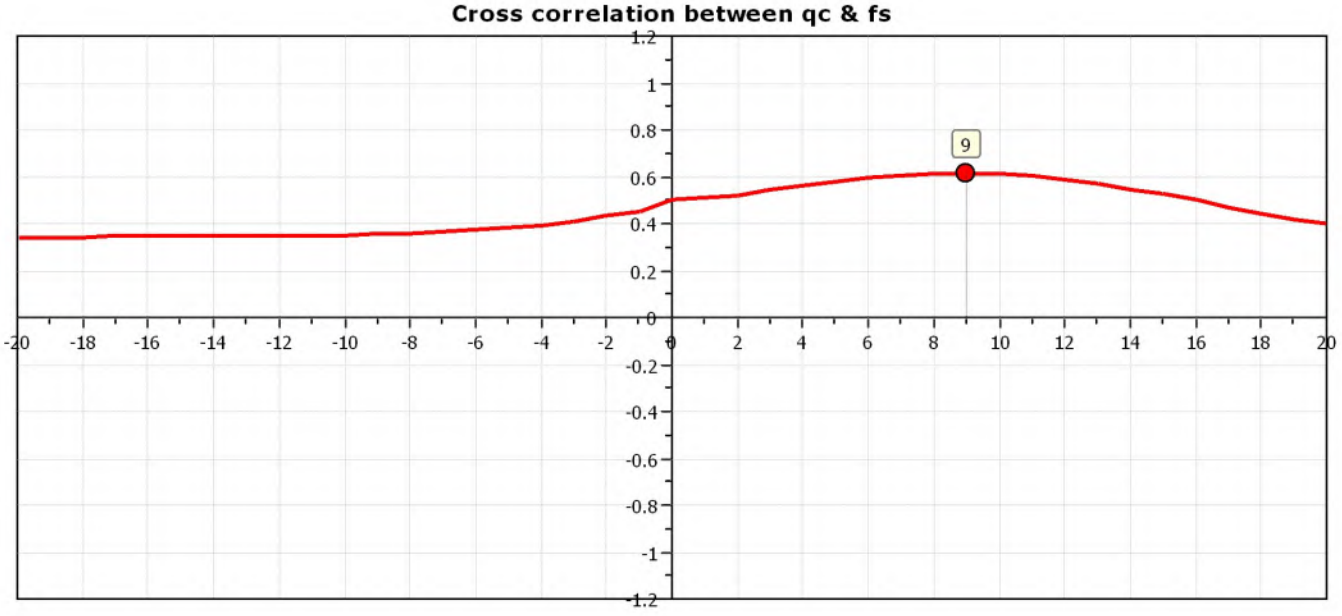
Underground Investigation Ltd
Cone Penetration Testing
craig@undergroundinvestigation.co.nz
+64211473249

CPT: CPT2403
Total depth: 4.40 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



Underground Investigation Ltd
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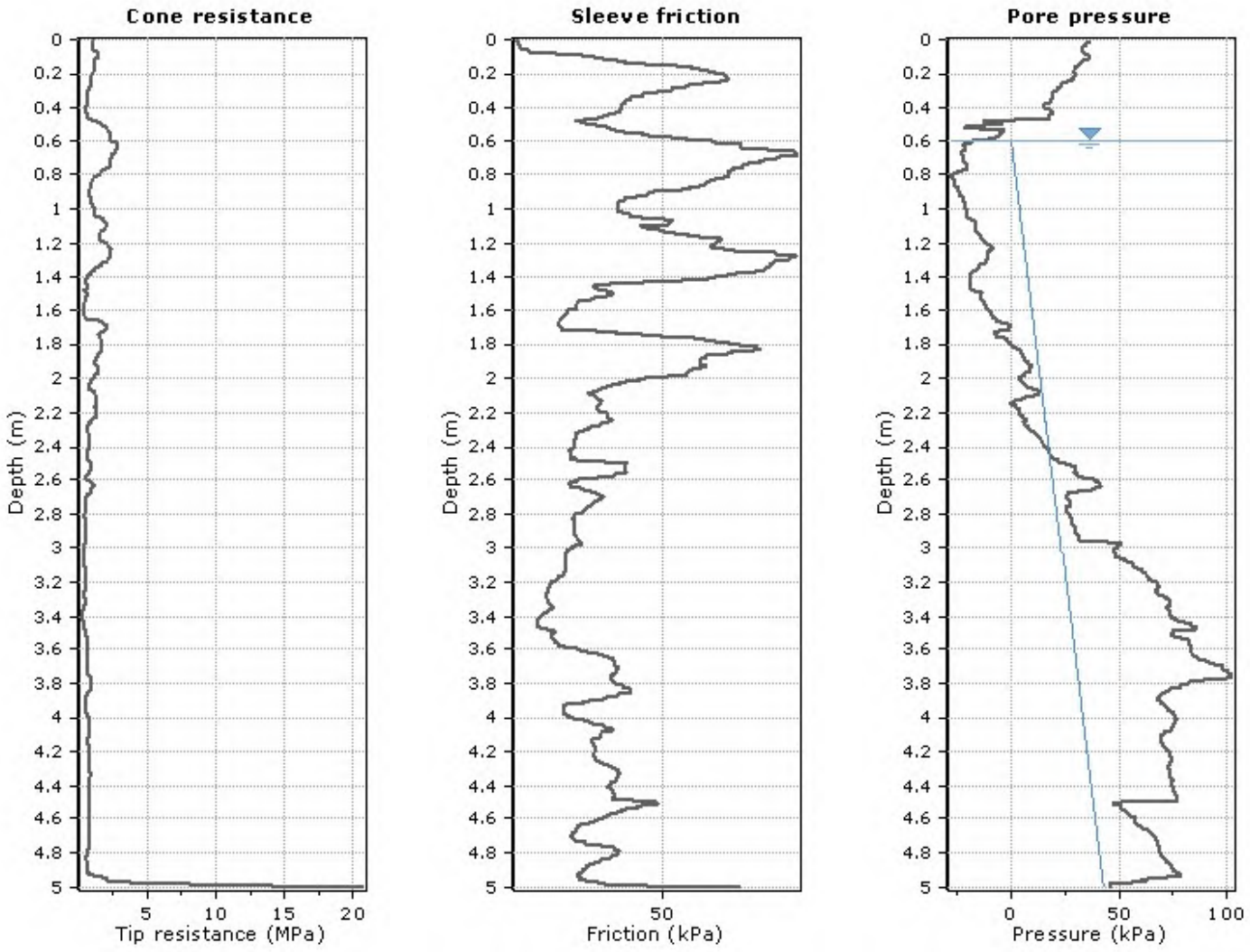
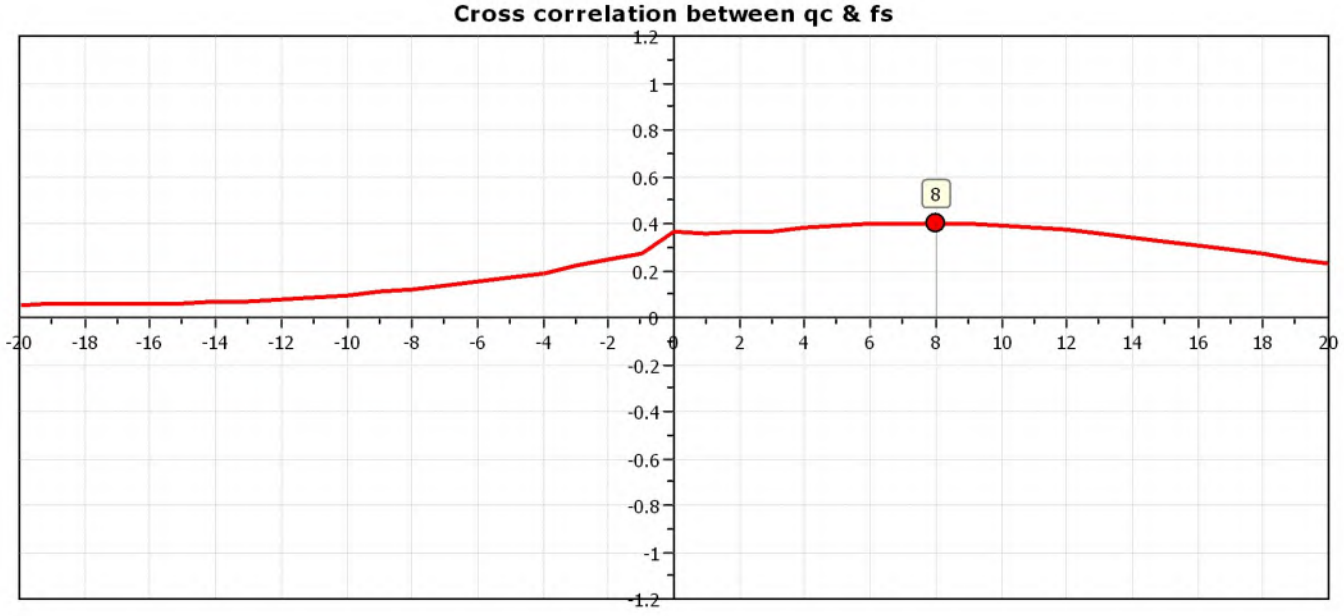
+64211473249

CPT: CPT2404
Total depth: 5.00 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



Underground Investigation Ltd
Cone Penetration Testing
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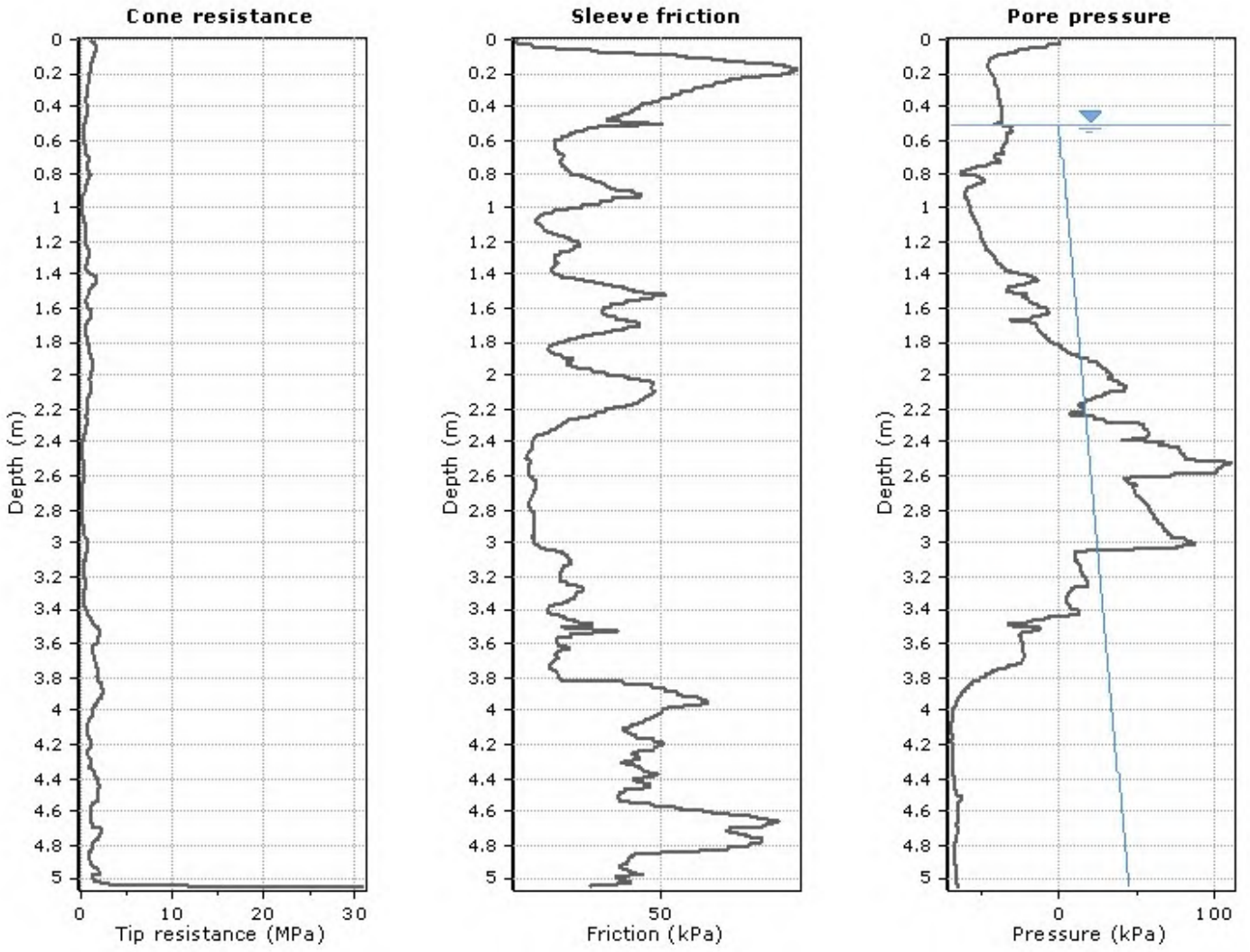
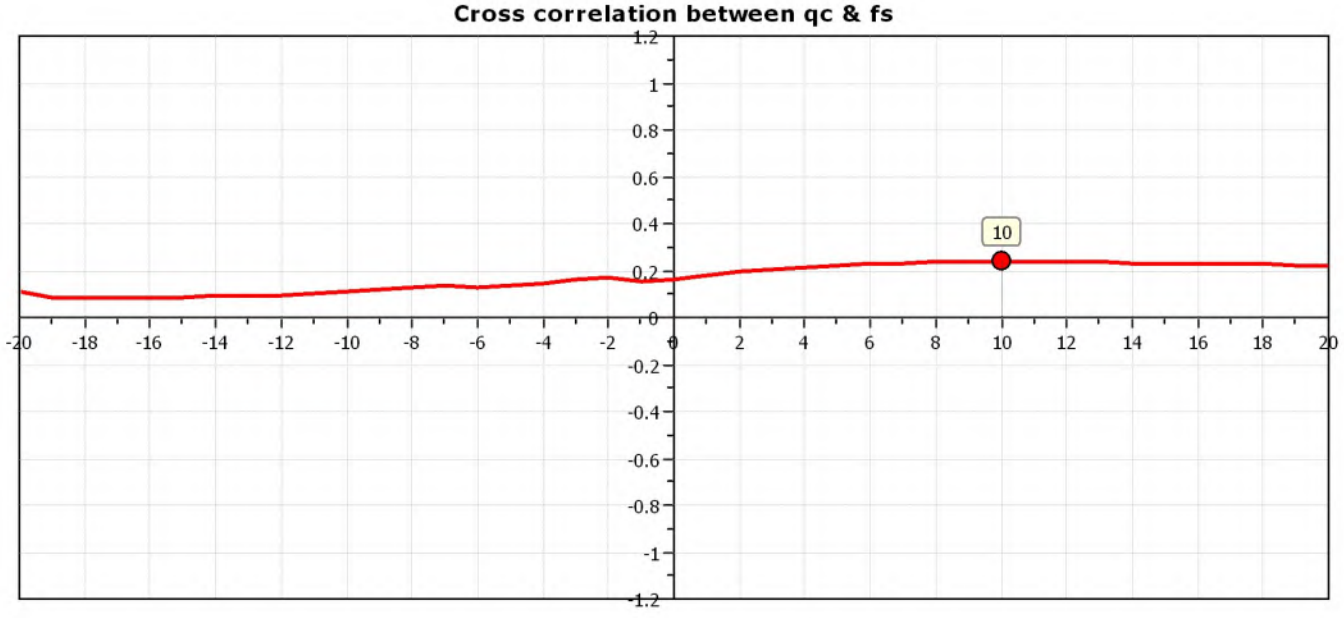
+64211473249

CPT: CPT2405
Total depth: 5.05 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



Underground Investigation Ltd
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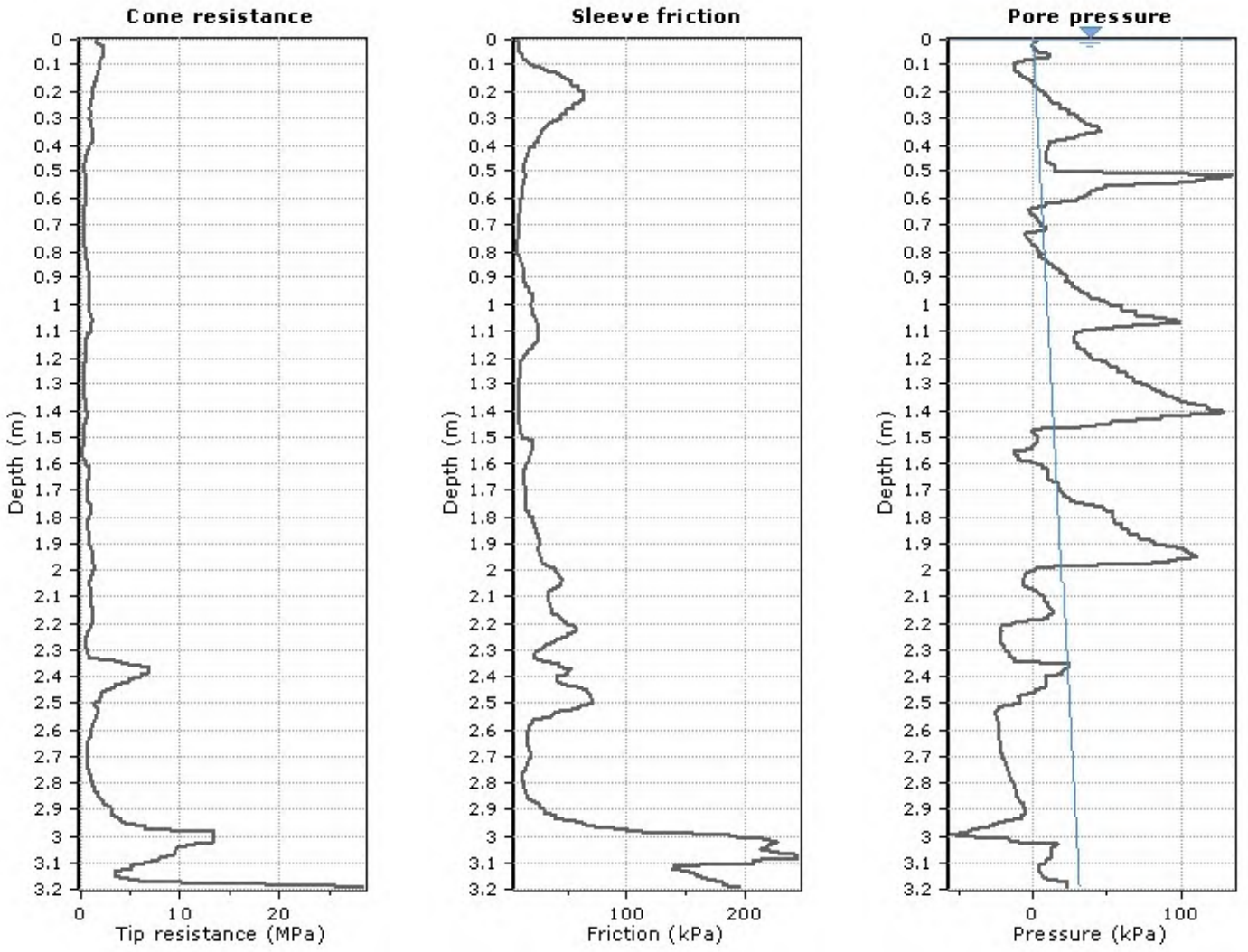
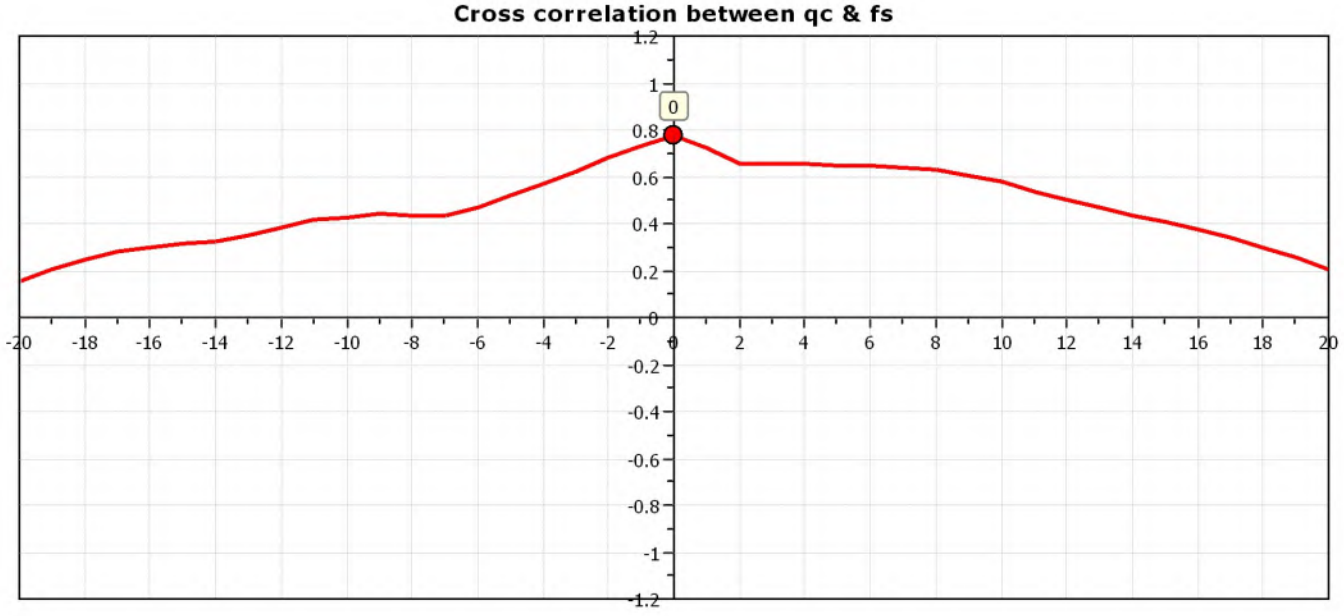
+64211473249

CPT: CPT2406
Total depth: 3.19 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



Underground Investigation Ltd
Cone Penetration Testing
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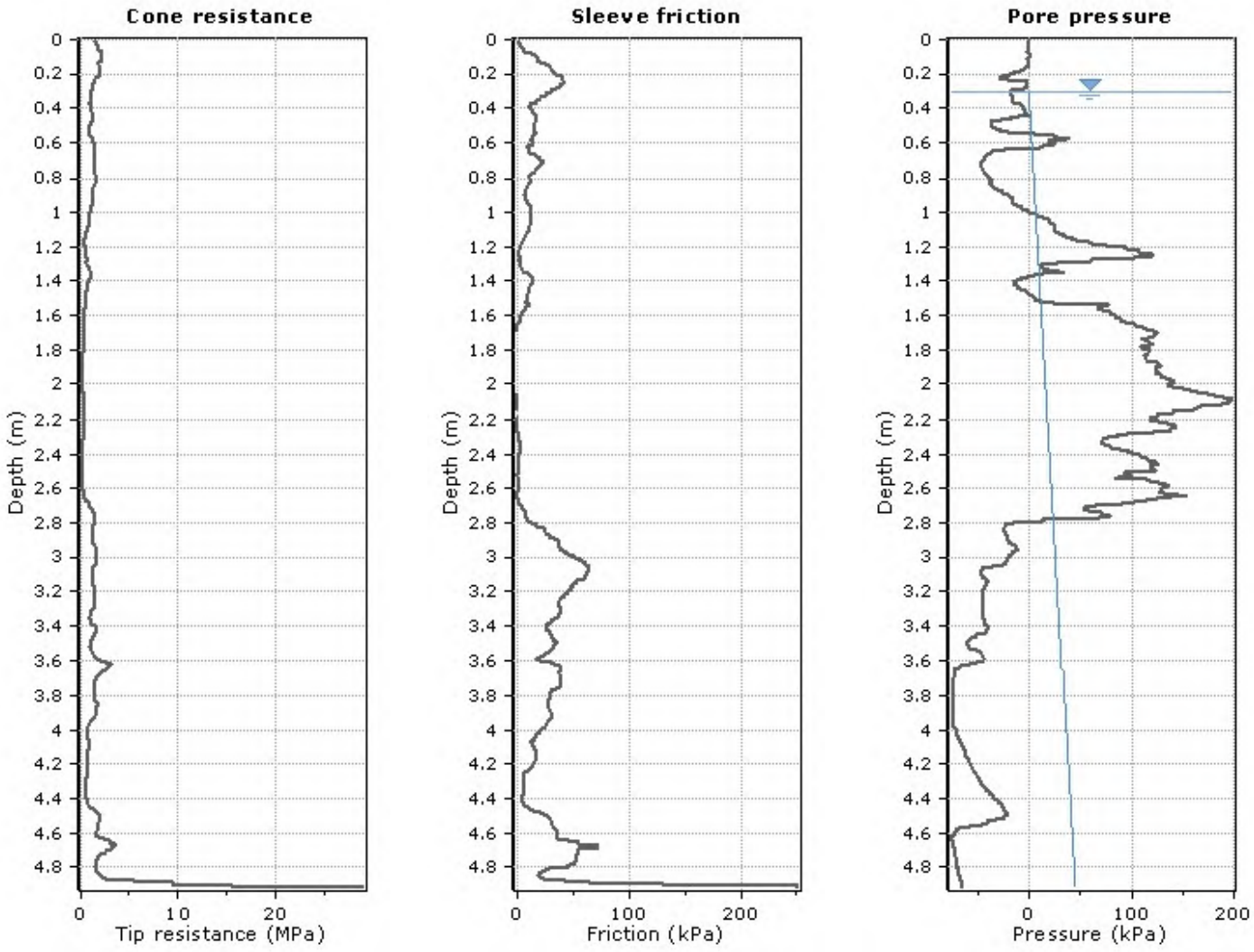
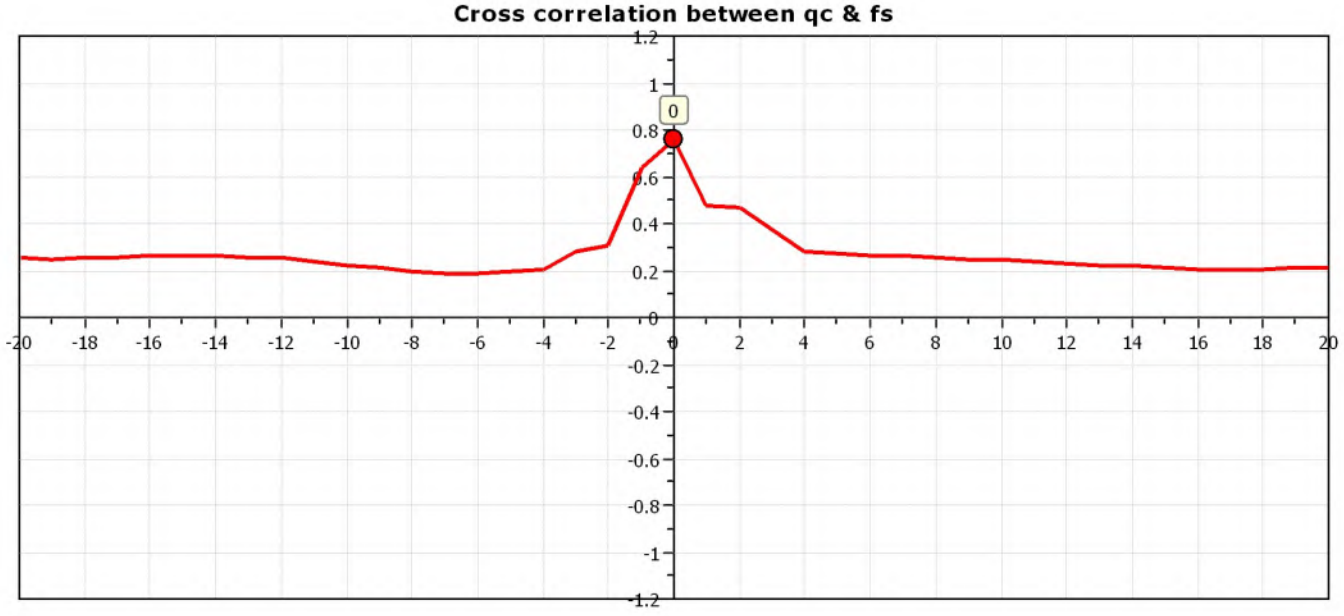
CPT: CPT2407
Total depth: 4.91 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



Underground Investigation Ltd
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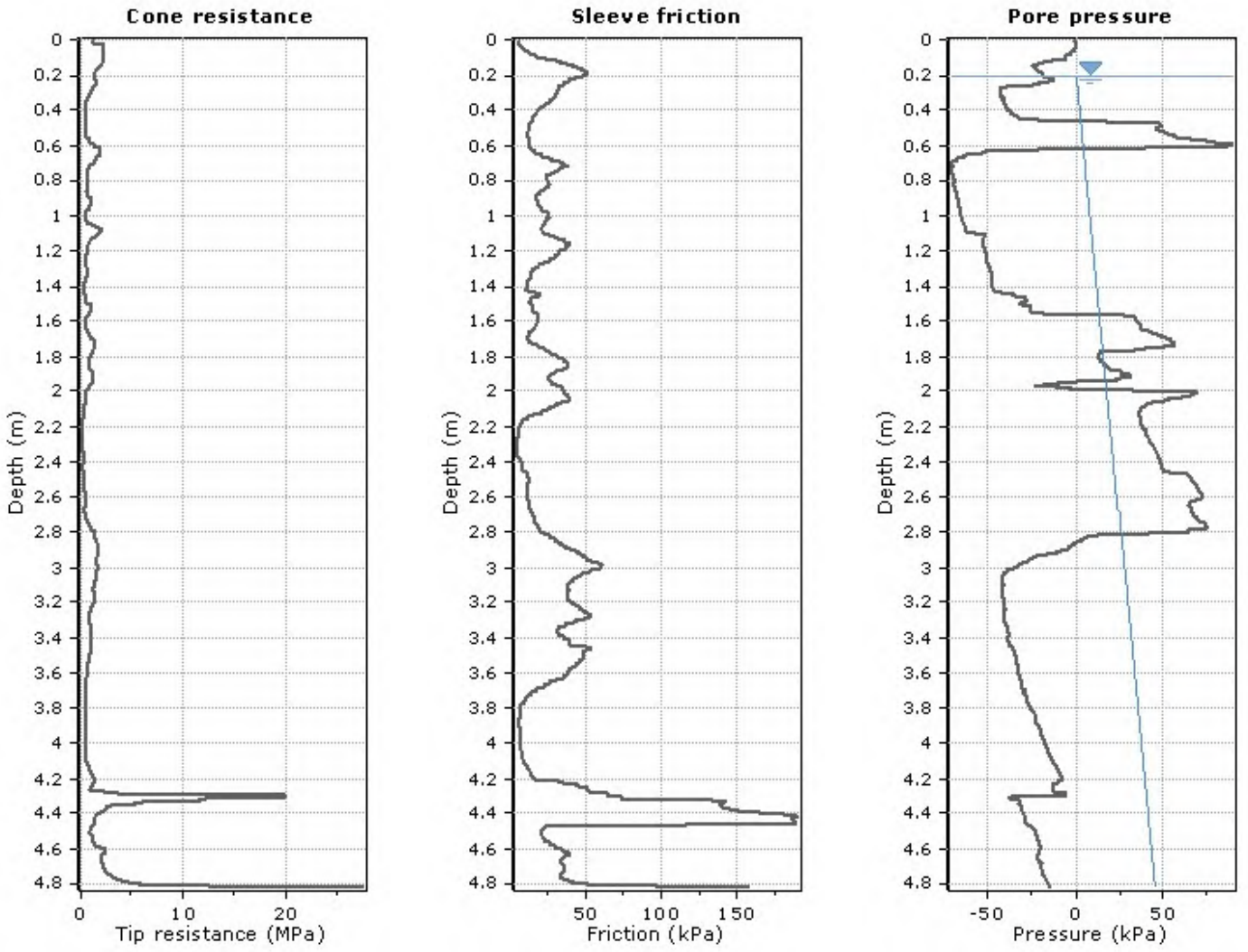
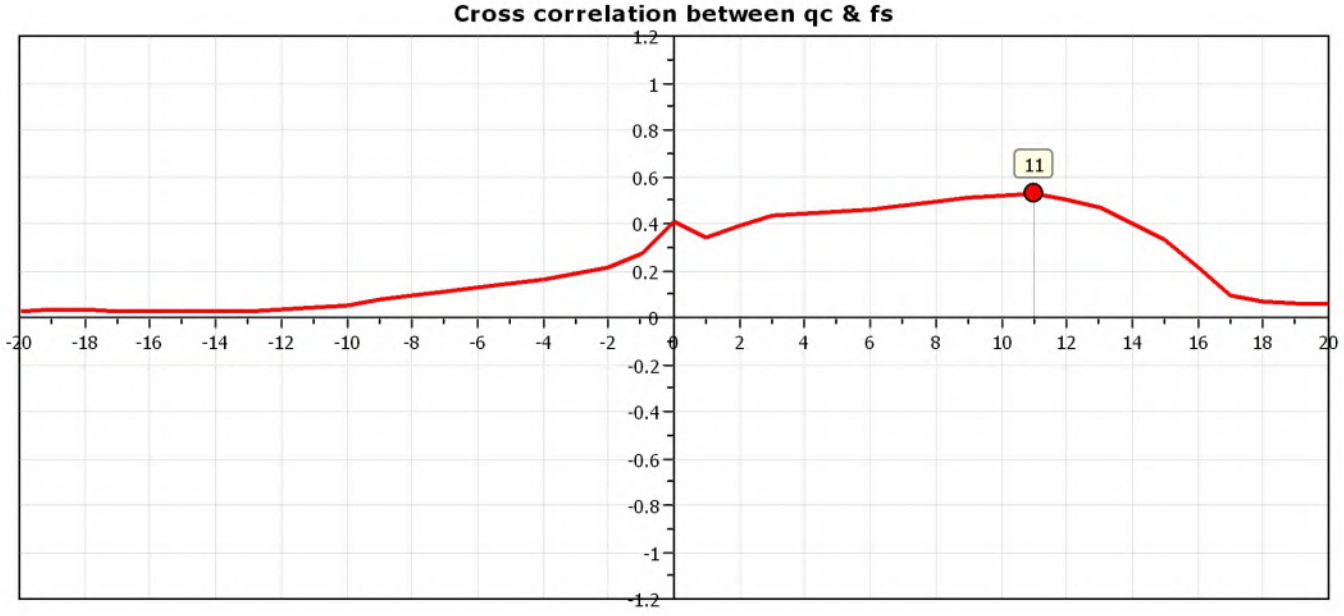
CPT: CPT2408
Total depth: 4.82 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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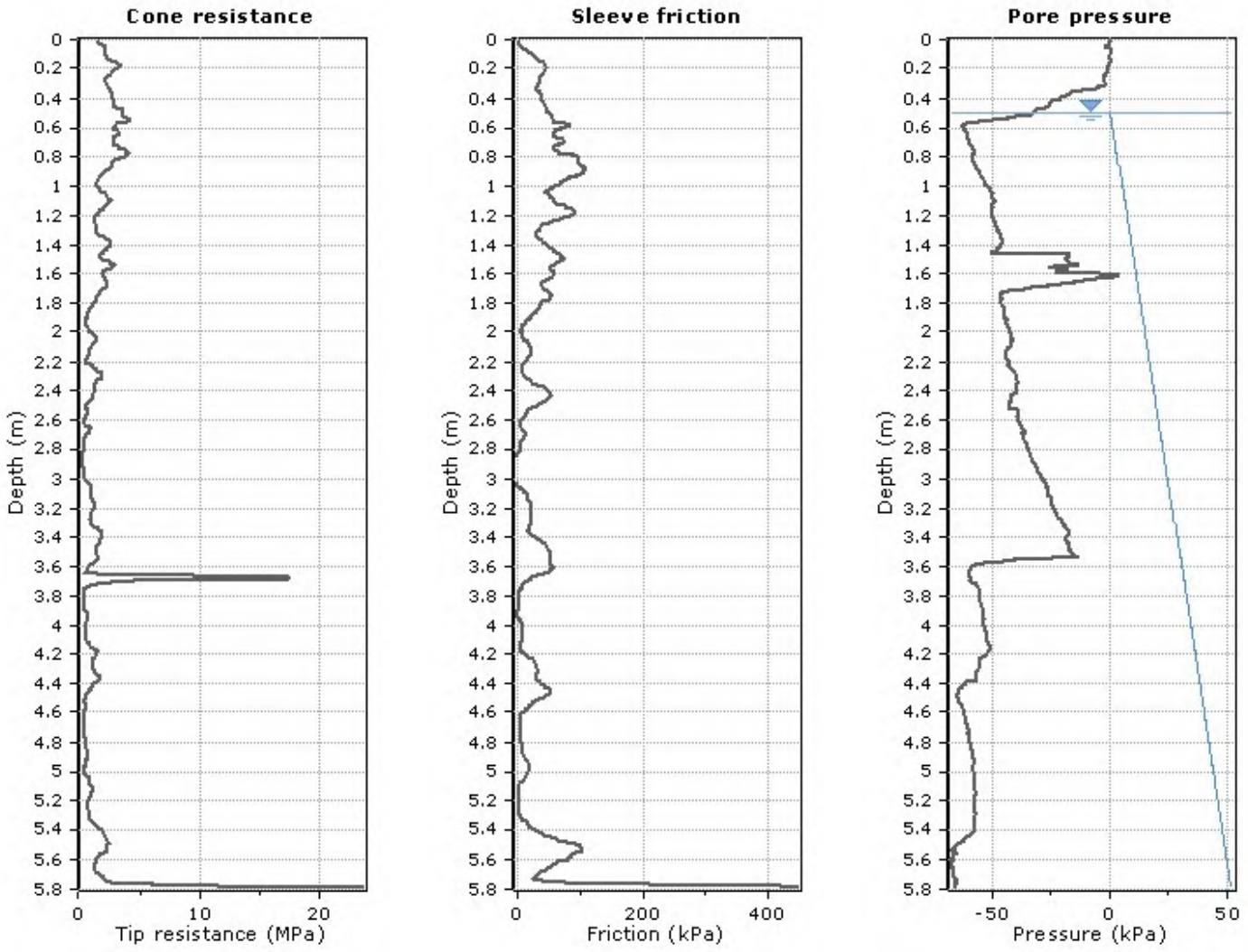
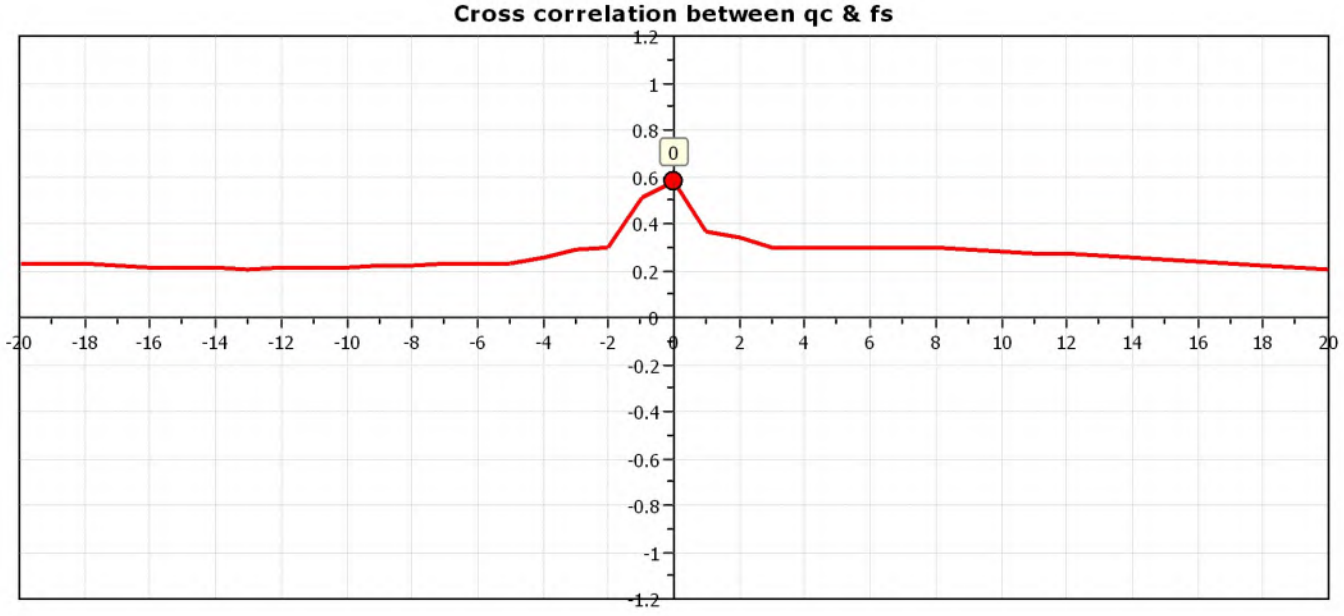
CPT: CPT2409
Total depth: 5.79 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



Underground Investigation Ltd
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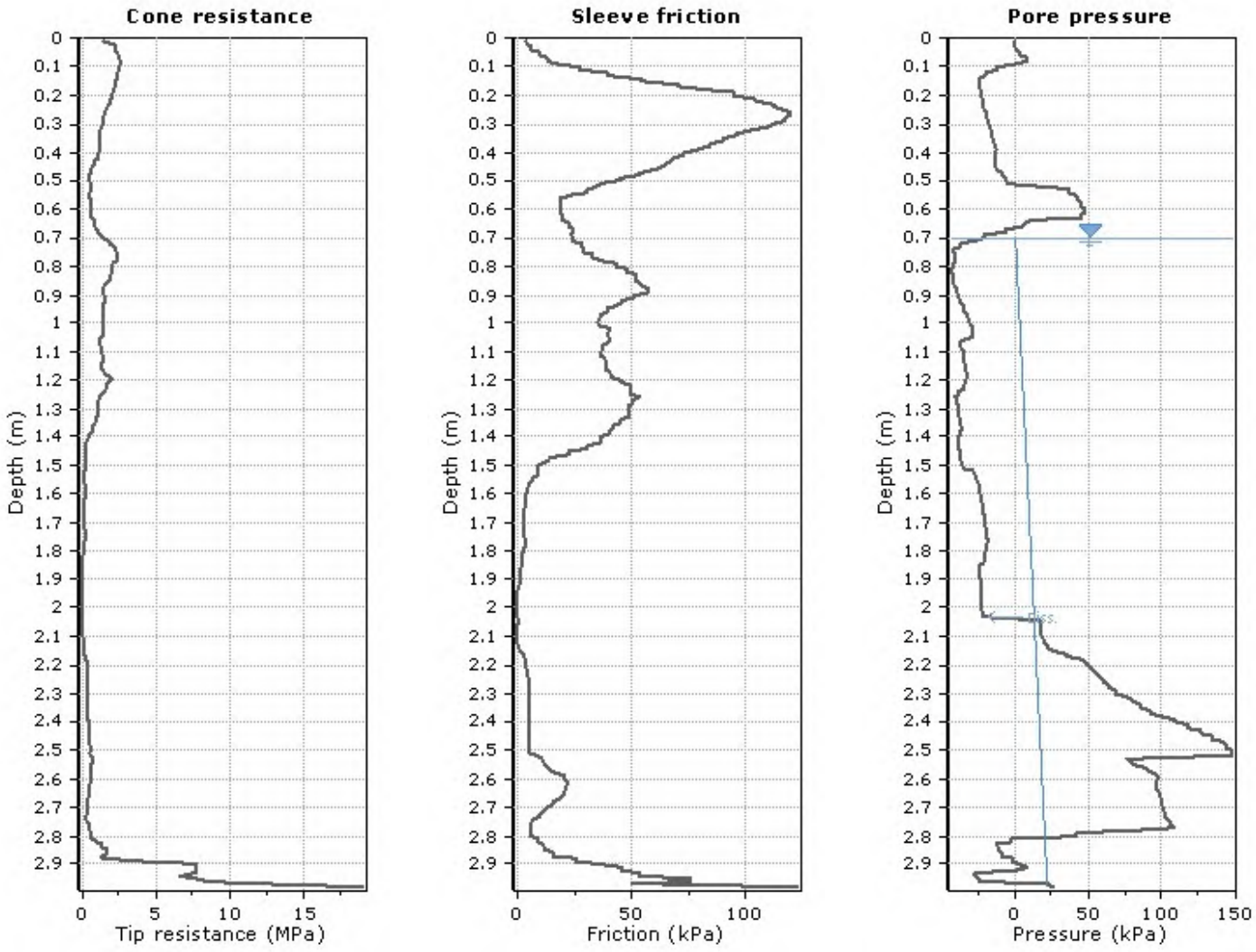
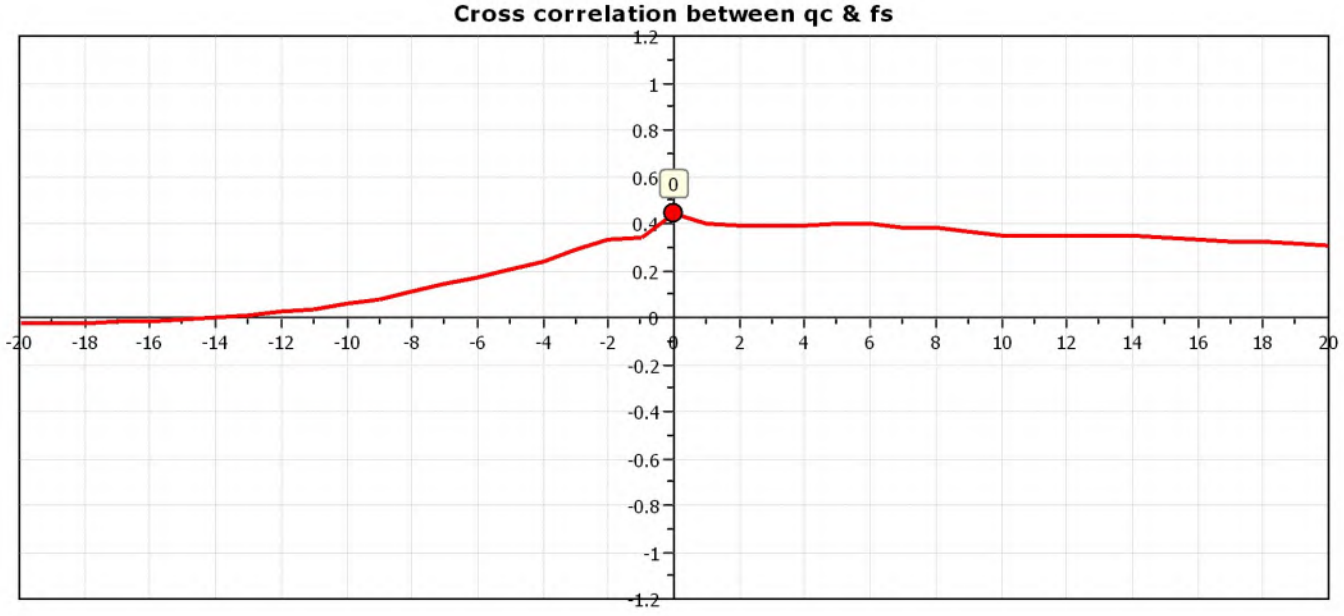
+64211473249

CPT: CPT2410
Total depth: 2.98 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



Underground Investigation Ltd
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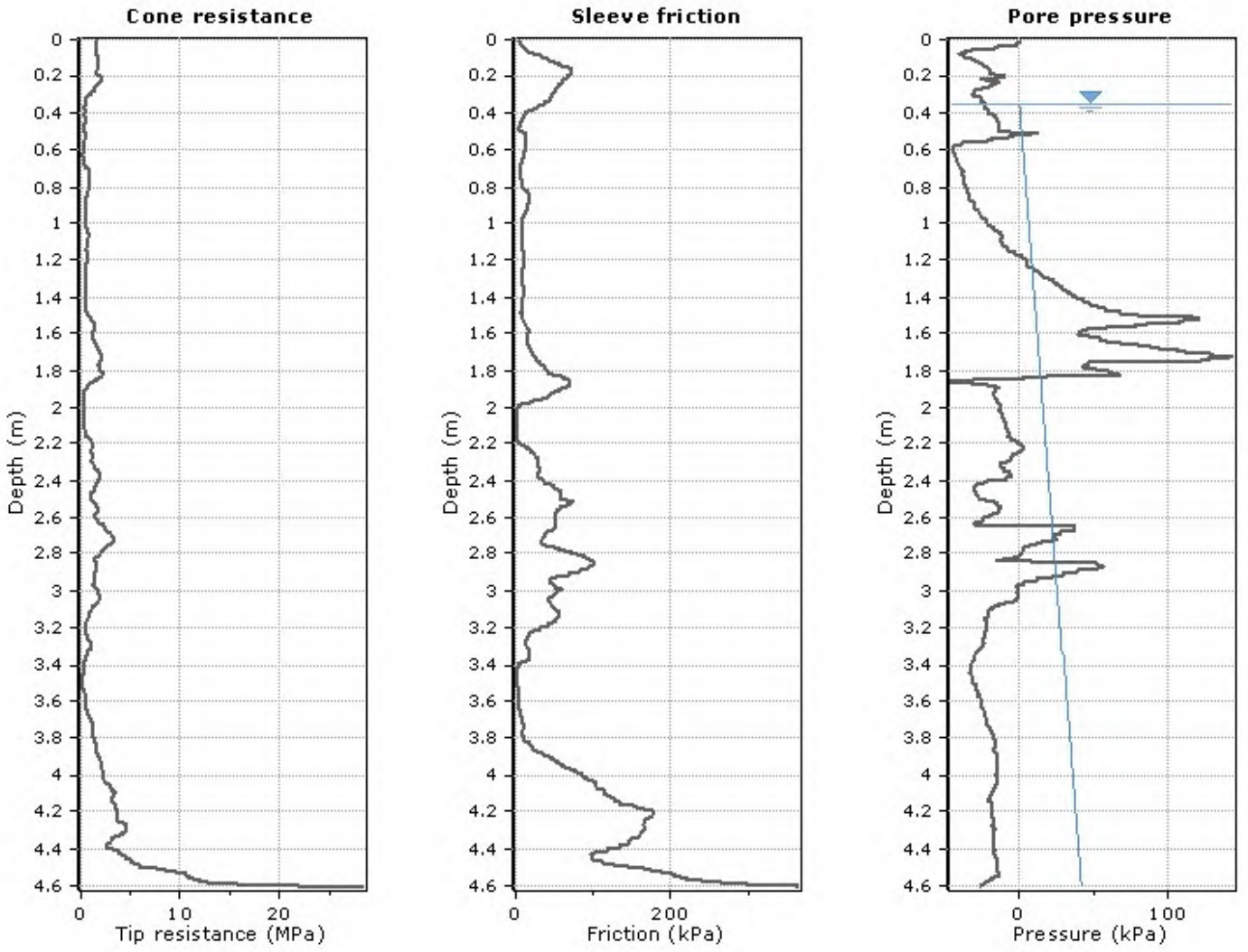
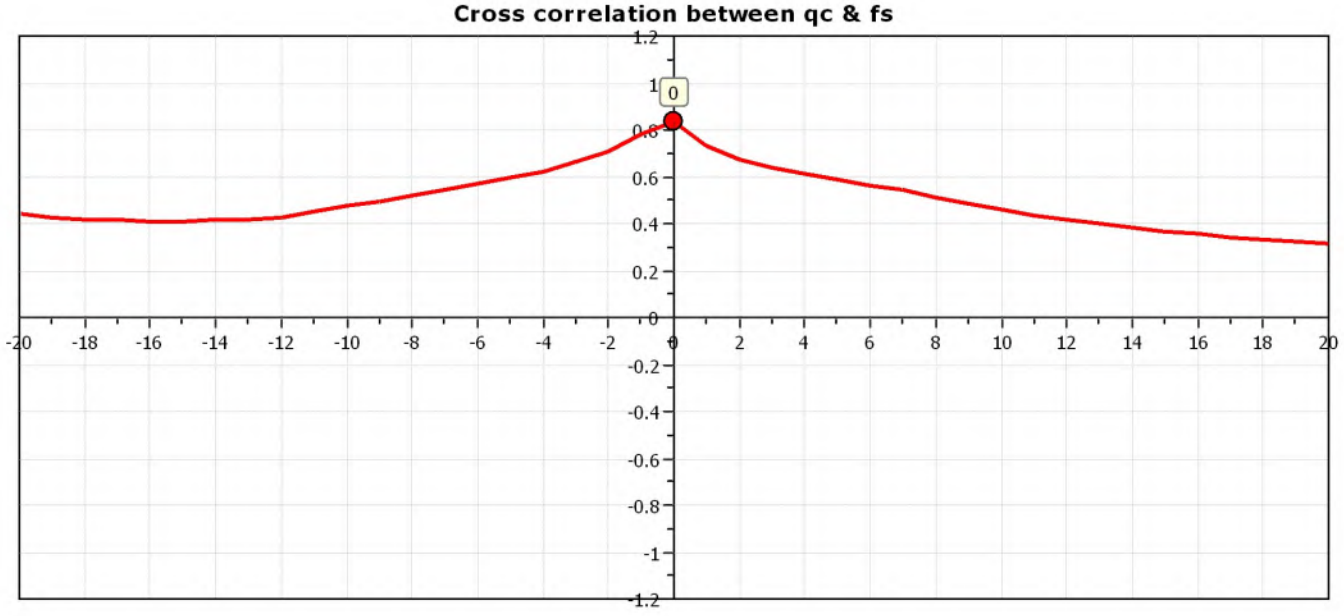
+64211473249

CPT: CPT2411
Total depth: 4.61 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



Underground Investigation Ltd
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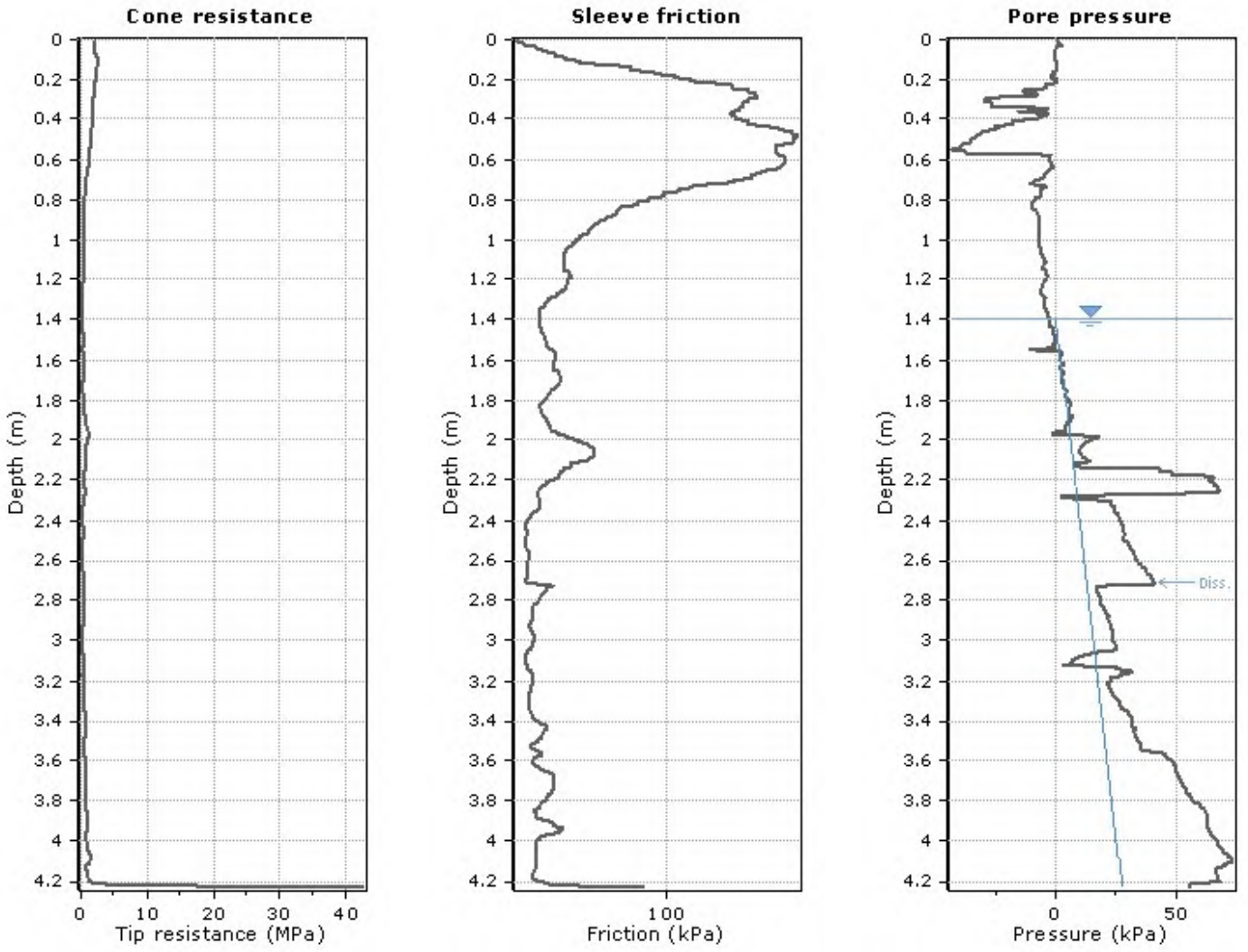
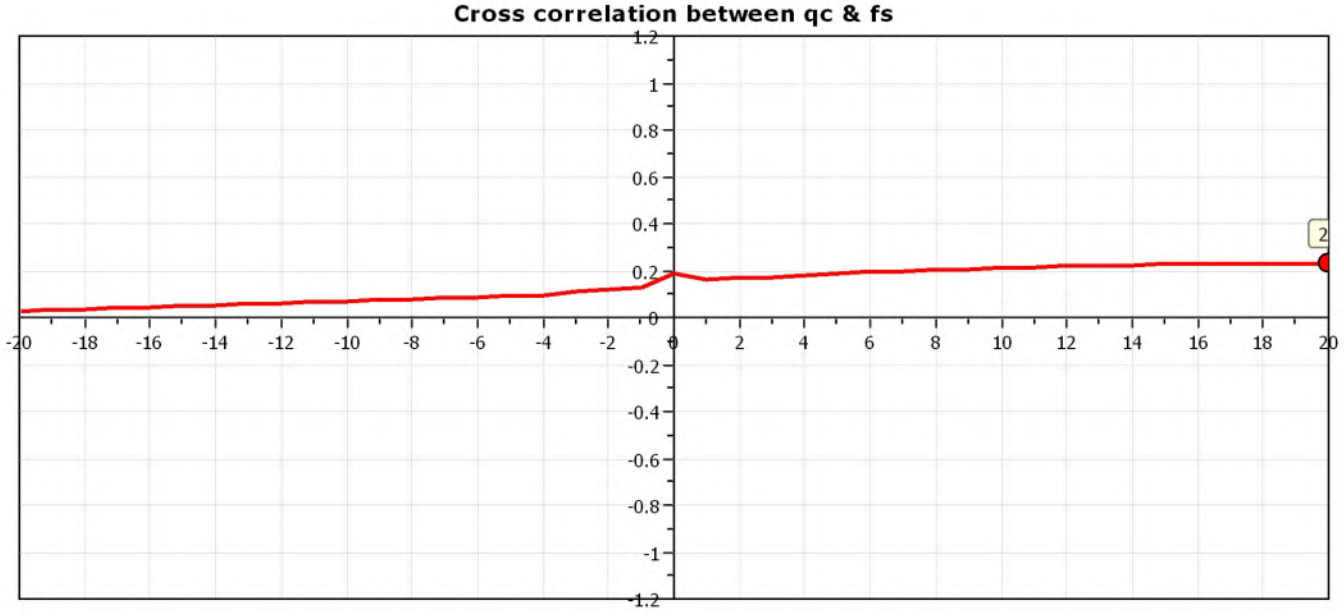
+64211473249

CPT: CPT2412
Total depth: 4.23 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



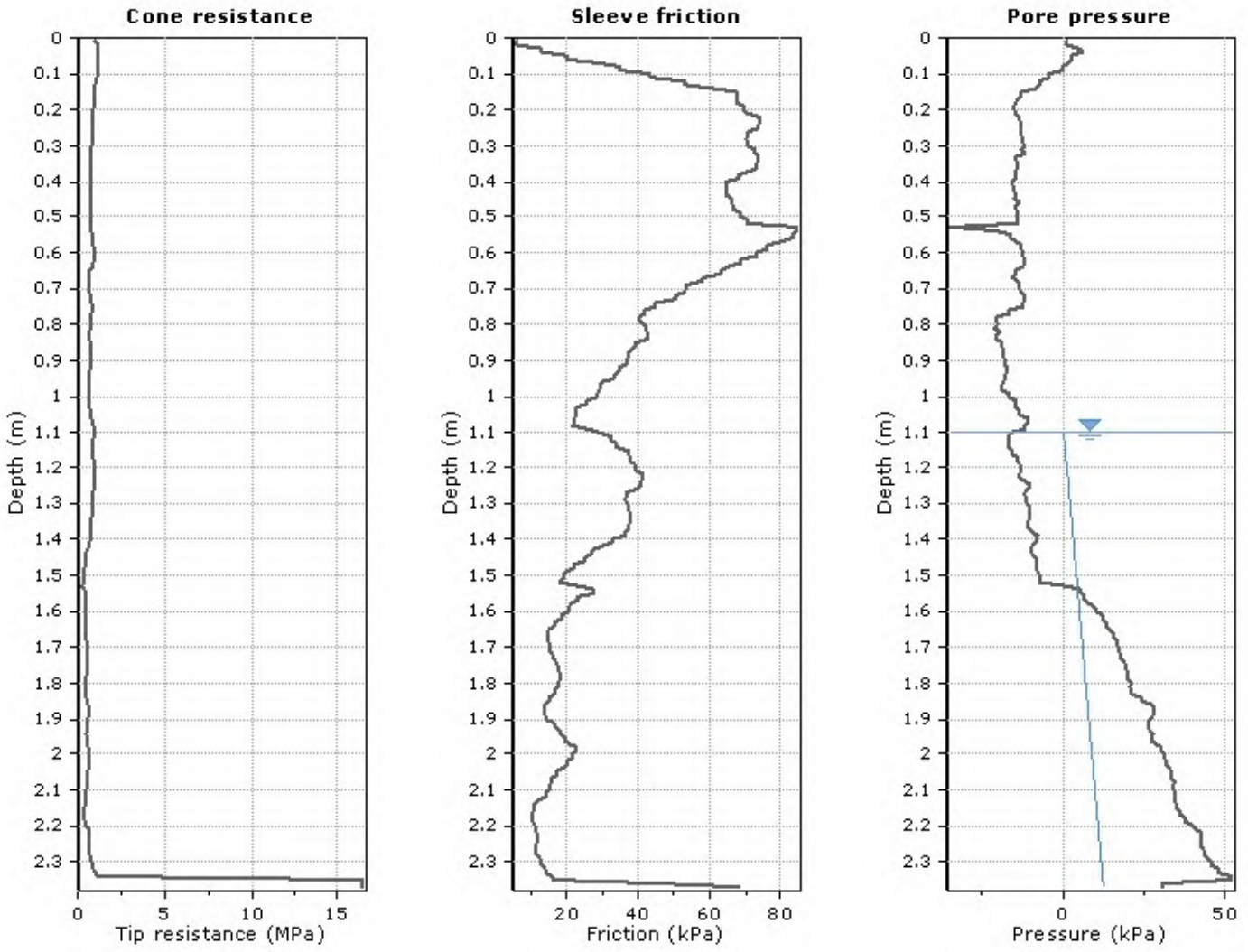
The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



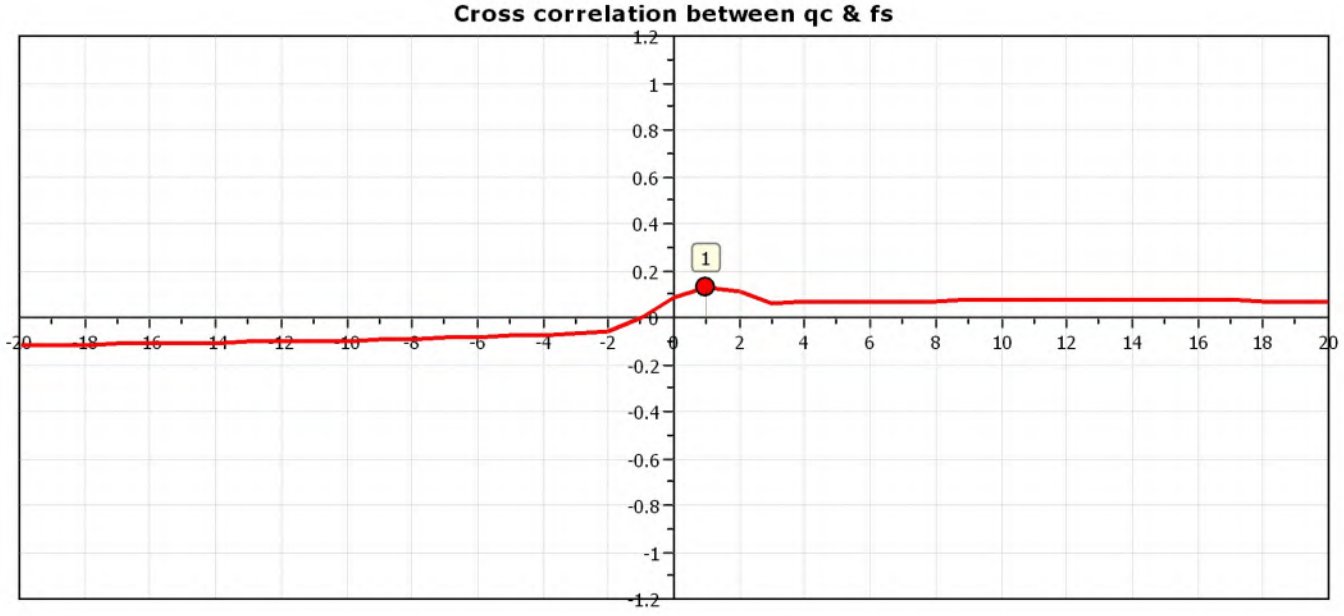
Underground Investigation Ltd
Cone Penetration Testing
craig@undergroundinvestigation.co.nz
+64211473249

CPT: CPT2413
Total depth: 2.37 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



Underground Investigation Ltd
Cone Penetration Testing
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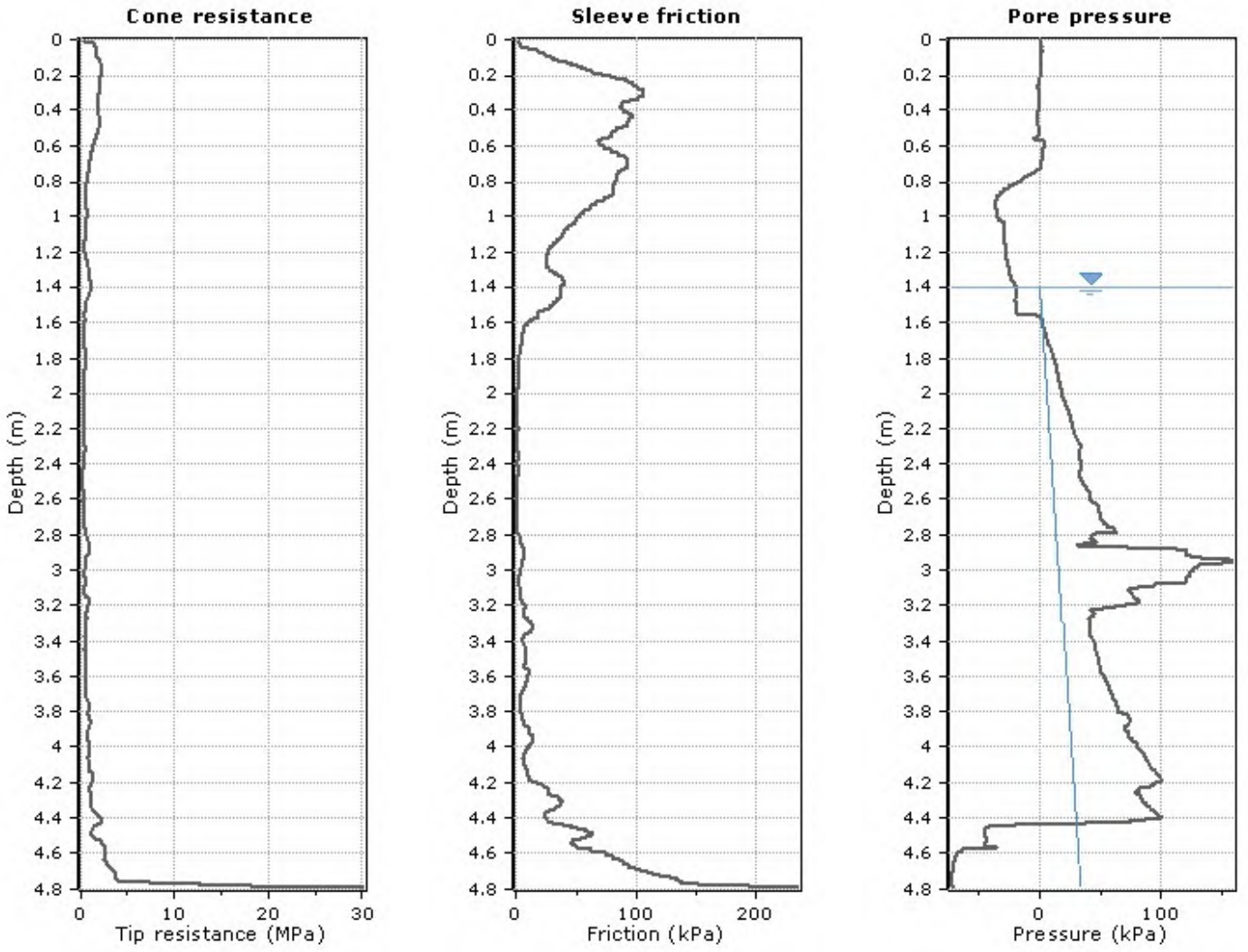
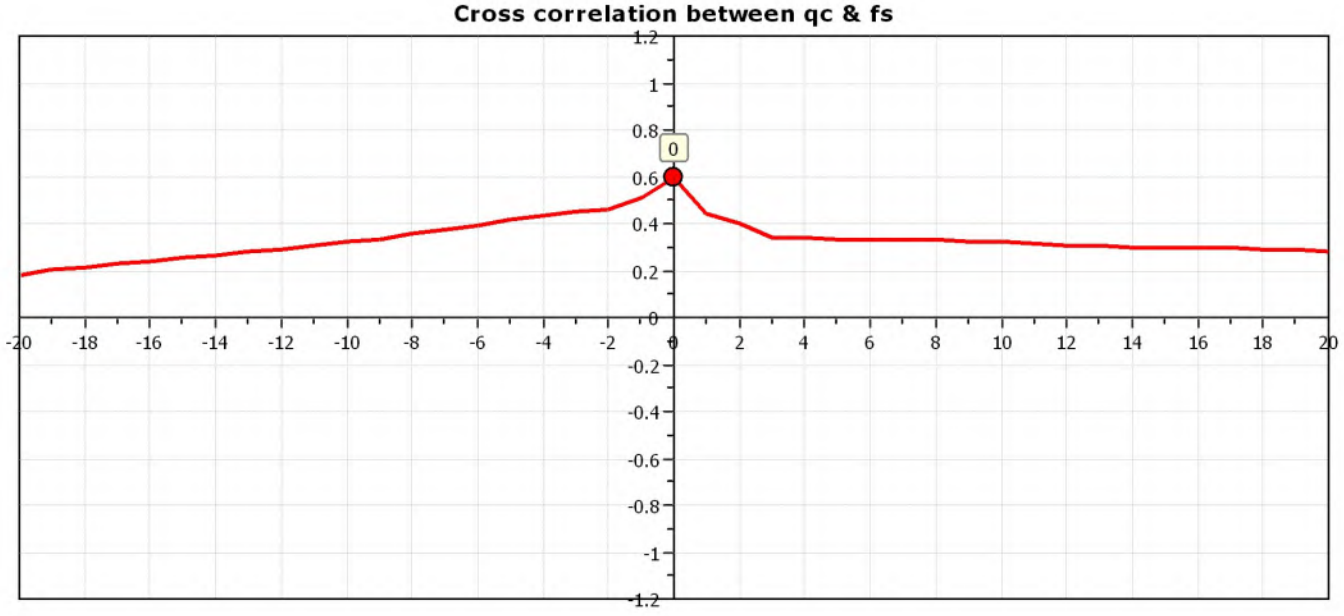
+64211473249

CPT: CPT2414
Total depth: 4.79 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



Underground Investigation Ltd
Cone Penetration Testing
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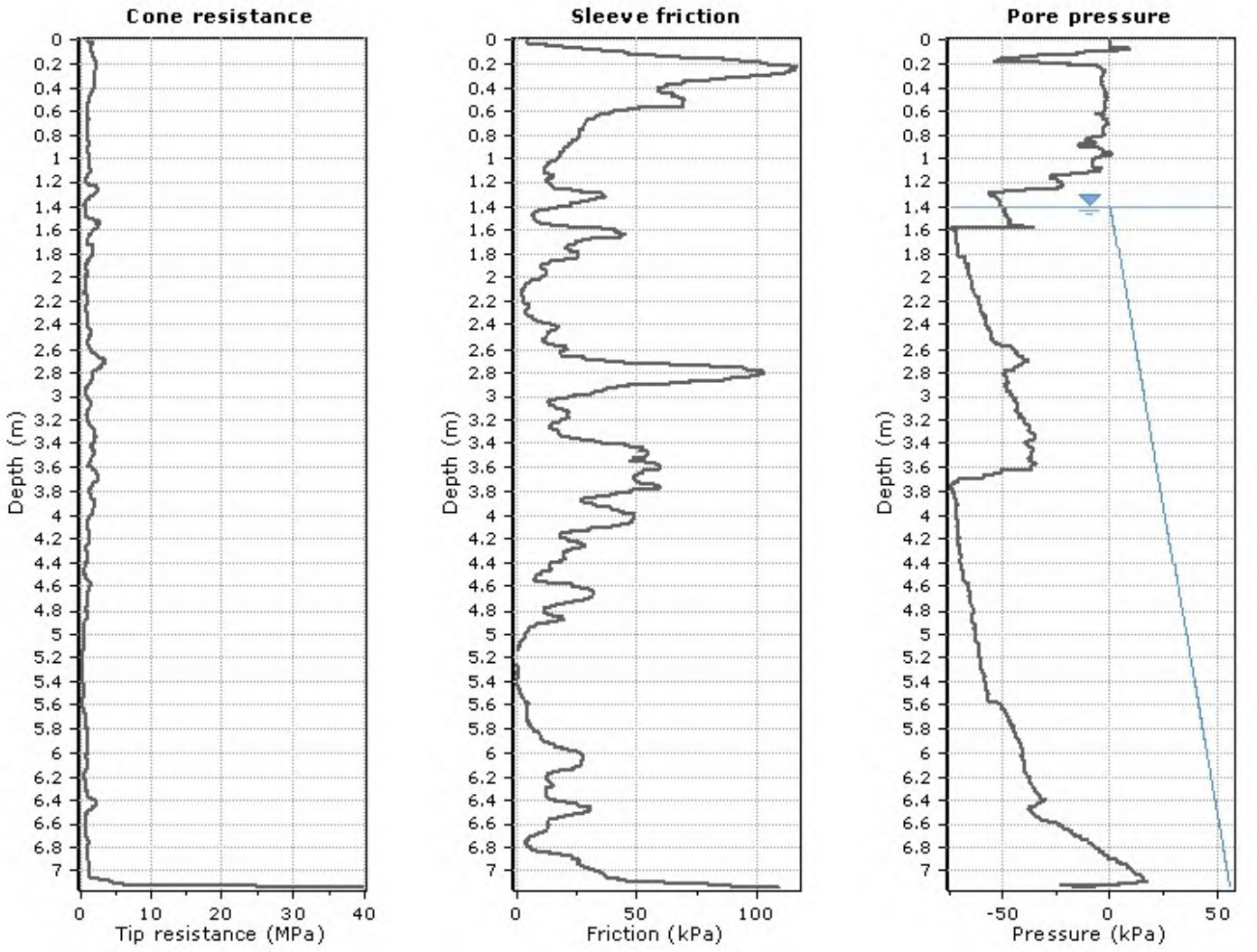
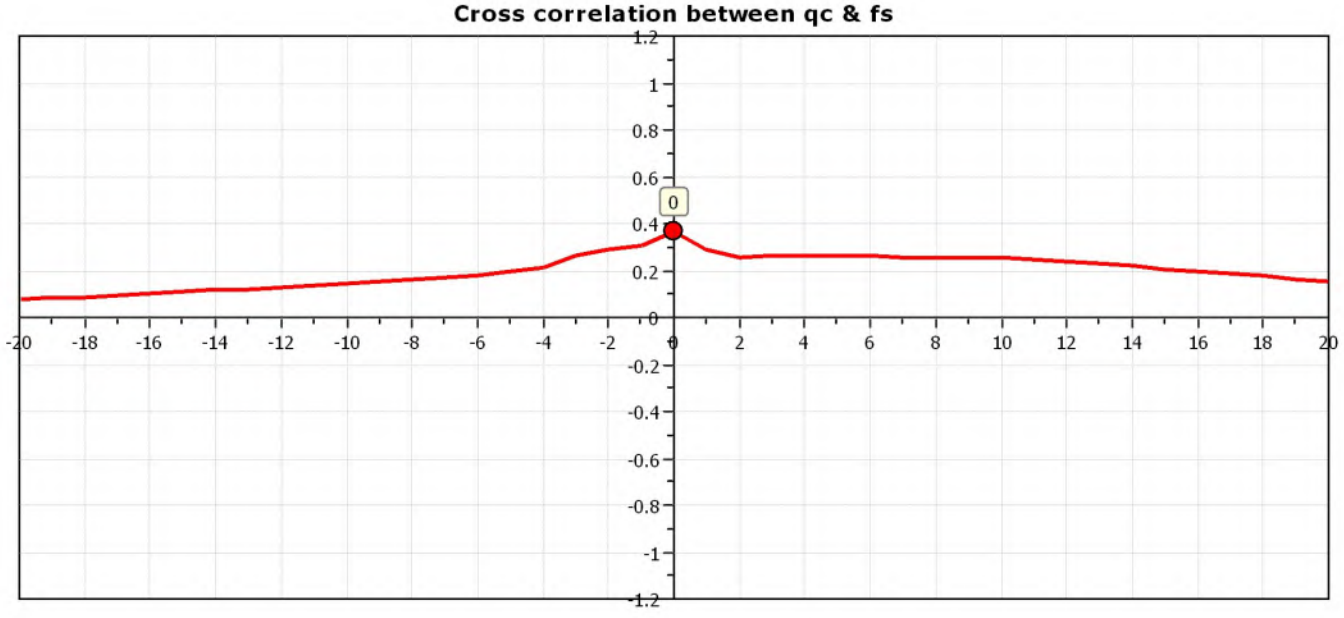
+64211473249

CPT: CPT2415
Total depth: 7.13 m, Date: 13/03/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine Sawmill**
Location: **Waipapa**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



HAND AUGER LOG

HOLE NO.: HA01

CLIENT: Fletcher Conc. & Infs. Ltd
PROJECT: Waipapa Pine
SITE LOCATION: 1945 State Highway 10, Waipapa
Project Ref.: P-001505

CO-ORDINATES: 1683493.00mE, 6102701.00mN
Co-ordinate system: NZTM
Location method: GPSH
ELEVATION: 77.3m
Datum: ONTPHT1964
Level method: CONTOUR
START DATE: 04/11/2022
END DATE: 04/11/2022
LOGGED BY: FPT
CHECKED BY: APK

UNIT	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH (m)
Topsoil	SILT, with some clay, with trace rootlets; dark brown. Stiff; low plasticity; moist.		0.0
Late Pleistocene River Deposits	SILT, with some clay; brownish grey. Firm; high plasticity; moist.		0.4
	0.70m - 1.00m: Not Recovered		0.6
	0.9m: Grades to stiff		1.0
	Clayey SILT, with minor organics; grey. Very stiff; high plasticity; saturated; organic odour present.		1.2
	1.50m - 2.30m: Not Recovered		1.6
	1.8m: Grades to stiff		1.8
	Sandy SILT; bluish grey. Very stiff; non-plastic; saturated; sand, fine to coarse.		2.4
	EOH: 2.55m		2.6

LEGEND

SCALA PENETROMETER (Blows / 50mm): 2 4 6 8 10 12 14 16 18; 20

VANE SHEAR STRENGTH (kPa) Vane: 3591: 50 100 150 200

Values
102
16
36
10
82
16
161
13
165
13
61
15
UTP
-

WATER: 04/11/2022

REMARKS

Practical Refusal at 2.50m. Scala bouncing. Inferred basalt rock.

Ground water measured at 0.90m immediately after testing.

WATER
- Standing Water Level
- Out flow
- In flow

INVESTIGATION TYPE
- [x] Hand Auger
- [ ] Test Pit

HAND AUGER LOG

HOLE NO.: HA02

CLIENT: Fletcher Conc. & Infs. Ltd
PROJECT: Waipapa Pine
SITE LOCATION: 1945 State Highway 10, Waipapa
Project Ref.: P-001505

CO-ORDINATES: 1683559.00mE, 6102710.00mN
Co-ordinate system: NZTM
Location method: GPSH
ELEVATION: 77.1m
Datum: ONTPHT1964
Level method: CONTOUR
START DATE: 04/11/2022
END DATE: 04/11/2022
LOGGED BY: FPT
CHECKED BY: APK

INITIA
GEOTECHNICAL SPECIALISTS

UNIT	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH (m)	LEGEND	SCALA PENETROMETER (Blows / 0mm)	VANE SHEAR STRENGTH (kPa) Vane: 3591	Values	WATER
Top soil	SILT, with minor clay, with trace rootlets; dark brown. Stiff; low plasticity; moist.		0.0	TS				
Late Pleistocene River Deposits	SILT, with minor clay; brownish grey. Very stiff; low plasticity; moist.		0.2				138	
			0.4				16	
			0.6				128	▼ 04/11/2022
			0.8				30	
			1.0				171	
			1.2				20	
	1.20m - 4.00m: Not Recovered			N/R			135	
			1.4				13	
	1.5m: Grades to stiff		1.6				82	
			1.8				20	
			2.0				72	
			2.2				43	
			2.4				86	
			2.6				20	
	2.7m: Grades to firm		2.8				49	
			3.0				13	
	3.0m: Grades to stiff		3.2				66	
			3.4				23	
	3.3m: Grades to very stiff		3.6				137	
			3.8				15	
	3.6m: Grades to stiff		4.0				72	
			4.2				18	
	EOH: 4.00m		4.4				82	
			4.6				23	
			4.8					

REMARKS

Target Depth Reached.

Ground water measured at 0.60m immediately after testing.

WATER

- ▼ Standing Water Level
- ◁ Out flow
- ▷ In flow

INVESTIGATION TYPE

- ☑ Hand Auger
- ☐ Test Pit

Checked By: APK

HAND AUGER LOG

INITIA
GEOTECHNICAL SPECIALISTS

HOLE NO.: HA03

CLIENT: Fletcher Conc. & Infs. Ltd
PROJECT: Waipapa Pine
SITE LOCATION: 1945 State Highway 10, Waipapa
Project Ref.: P-001505

CO-ORDINATES: 1683574.00mE, 6102617.00mN
Co-ordinate system: NZTM
Location method: GPSH
ELEVATION: 77.3m
Datum: ONTPHT1964
Level method: CONTOUR
START DATE: 04/11/2022
END DATE: 04/11/2022
LOGGED BY: FPT
CHECKED BY: APK

UNIT	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH (m)
Topsoil	Clayey SILT, with trace rootlets; dark brown. Stiff; low plasticity.		0.0
Late Pleistocene River Deposits	SILT, with minor clay and sand; greyish brown. Stiff; low plasticity; moist; sand, fine to medium.		0.0
	0.7m - 0.8m: Grades to greyish brown, speckled orange brown		0.7
	1.0m: Grades to grey, mottled black, some decomposed organic material 1.1m: Grades to saturated		1.0
	1.70m - 2.35m: Not Recovered		1.7
	1.8m: Grades to firm		1.8
	2.1m: Grades to very stiff		2.1
	EOH: 2.35m		2.35

SCALA PENETROMETER (Blows / 50mm): 2, 4, 6, 8, 10, 12, 14, 16, 18

VANE SHEAR STRENGTH (kPa) Vane: 3591: 50, 100, 150, 200

Values
95
23
82
13
63
10
148
16
128
23
46
20
119
56
UTP
-

WATER: 04/11/2022

REMARKS

Practical Refusal at 2.35m. Scala bouncing. Inferred basalt rock.

Ground water measured at 1.10m immediately after testing.

WATER
- Standing Water Level
- Out flow
- In flow

INVESTIGATION TYPE
- [x] Hand Auger
- [ ] Test Pit

HAND AUGER LOG

HOLE NO.: HA04

CLIENT: Fletcher Conc. & Infs. Ltd
PROJECT: Waipapa Pine
SITE LOCATION: 1945 State Highway 10, Waipapa
Project Ref.: P-001505

CO-ORDINATES: 1683510.00mE, 6102611.00mN
Co-ordinate system: NZTM
Location method: GPSH
ELEVATION: 77.4m
Datum: ONTPHT1964
Level method: CONTOUR
START DATE: 04/11/2022
END DATE: 04/11/2022
LOGGED BY: FPT
CHECKED BY: APK

INITIA
GEOTECHNICAL SPECIALISTS

UNIT	MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH (m)	LEGEND	SCALA PENETROMETER (Blows / 50mm)	VANE SHEAR STRENGTH (kPa) Vane: 3591	Values	WATER
Topsoil	SILT, with some clay, with trace rootlets; dark brown. Stiff; low plasticity; moist.		0.0	TS				
Late Pleistocene River Deposits	SILT, with minor clay, with trace sand; greyish brown. Very stiff; low plasticity; moist; sand, fine.		0.2				130	
	0.6m: Grades to stiff		0.4				20	
	Sandy SILT; grey brown, speckled white. Very stiff; low plasticity; wet; sand, fine to medium.		0.6				69	
	SILT, with some sand, with minor clay, with trace organic material; light grey, speckled black. Stiff; low plasticity; saturated; sand, fine to medium.		0.8				31	
	1.5m: Grades to firm		1.0				135	04/11/2022
	1.20m - 2.20m: Not Recovered		1.2	N/R			18	
	1.8m: Grades to stiff		1.4	N/R			74	
	EOH: 2.20m		1.6	N/R			16	
			1.8	N/R			49	
			2.0	N/R			16	
			2.2	N/R	20		99	
			2.4				18	
			2.6				UTP	
			2.8				-	
			3.0					
			3.2					
			3.4					
			3.6					
			3.8					
			4.0					
			4.2					
			4.4					
			4.6					
			4.8					

REMARKS

Practical Refusal at 2.20m. Scala bouncing. Inferred basalt rock.

Ground water measured at 1.00m immediately after testing.

WATER

- ▼ Standing Water Level
- ◁ Out flow
- ▷ In flow

INVESTIGATION TYPE

- ☑ Hand Auger
- ☐ Test Pit

Initia
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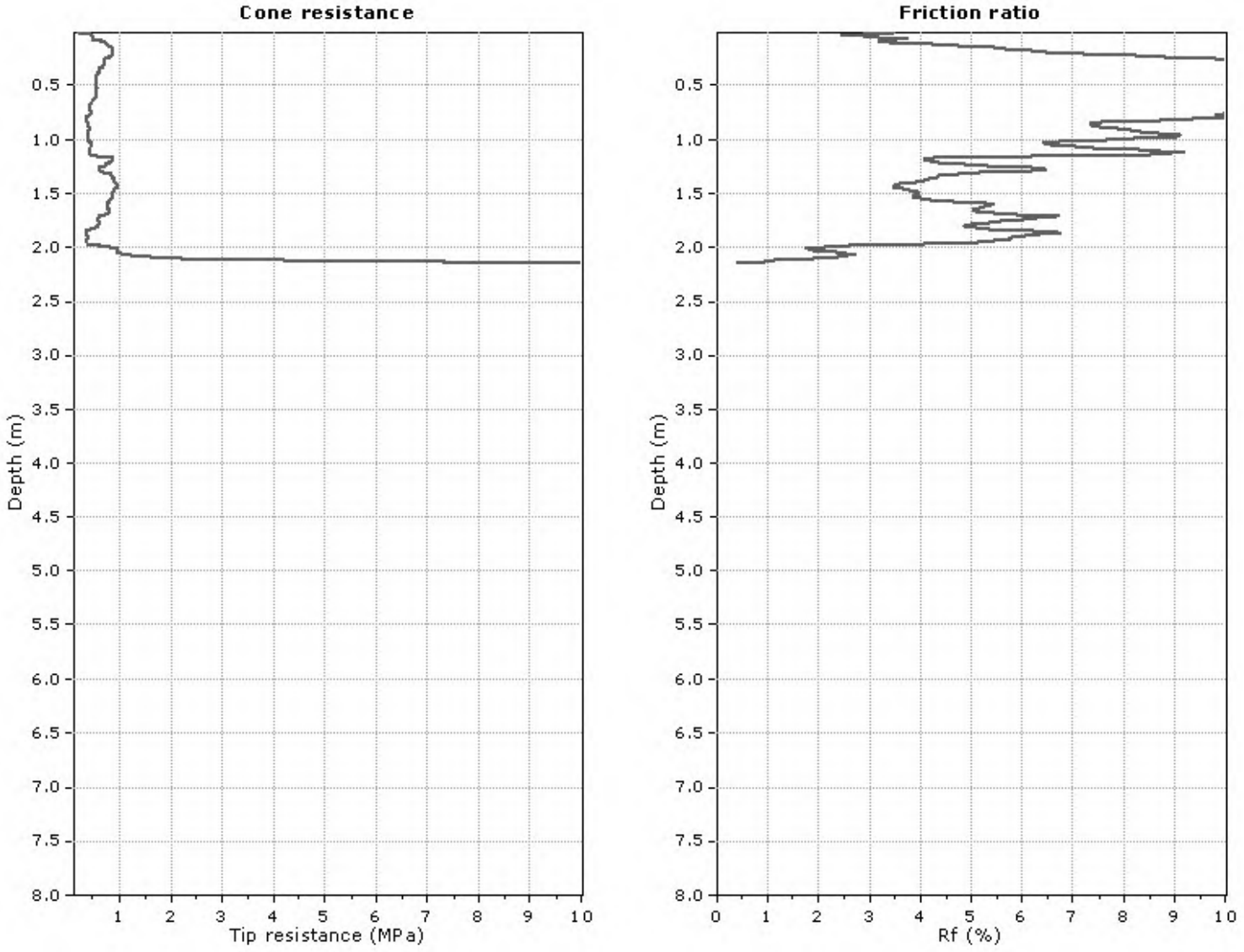
CPT: CPT101
Total depth: 2.15 m, Date: 22/11/2022
Surface Elevation: 85.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine**
Location: **1945 State Highway 10, Waipapa**



Initia
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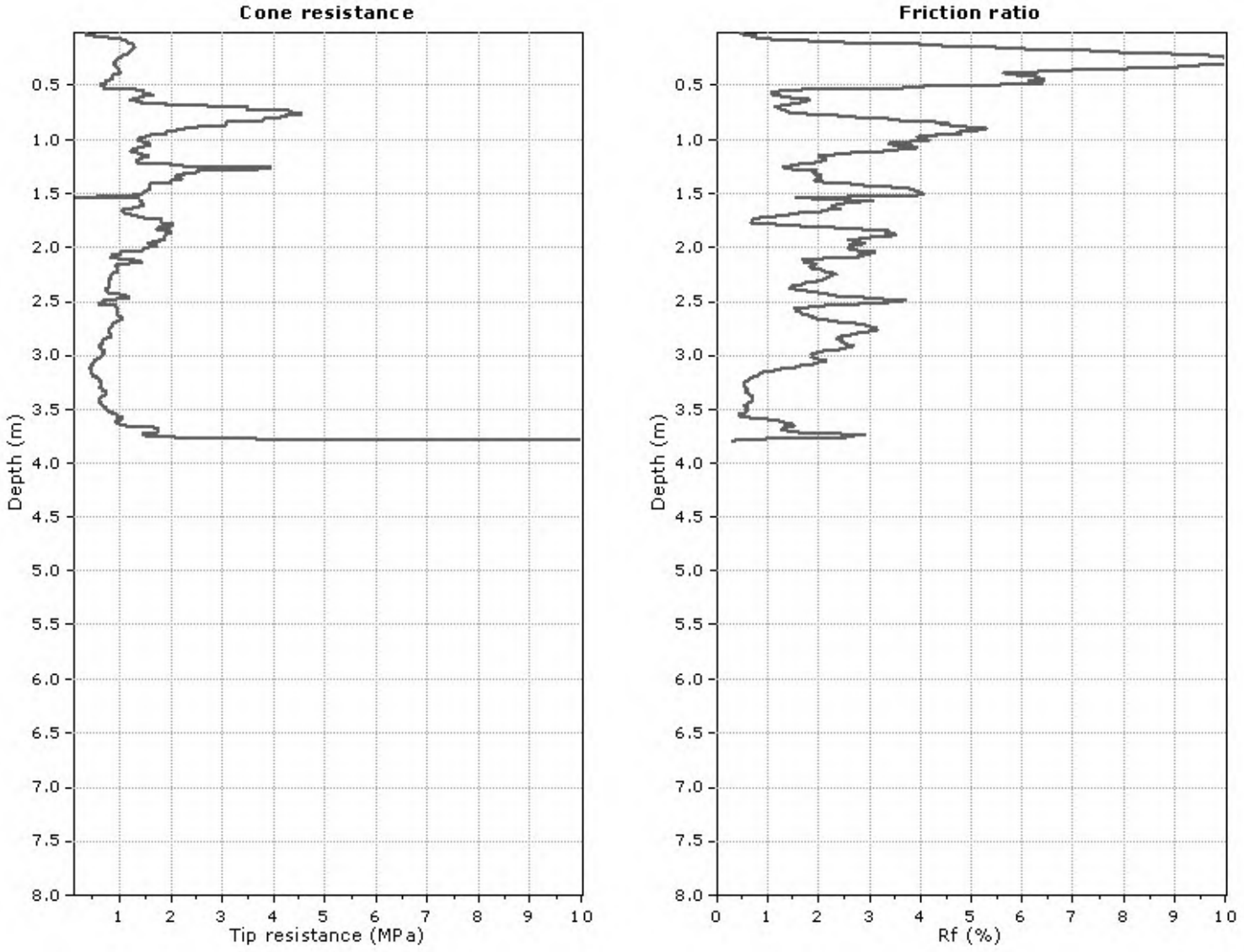
CPT: CPT102
Total depth: 3.79 m, Date: 22/11/2022
Surface Elevation: 84.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine**
Location: **1945 State Highway 10, Waipapa**



Initia
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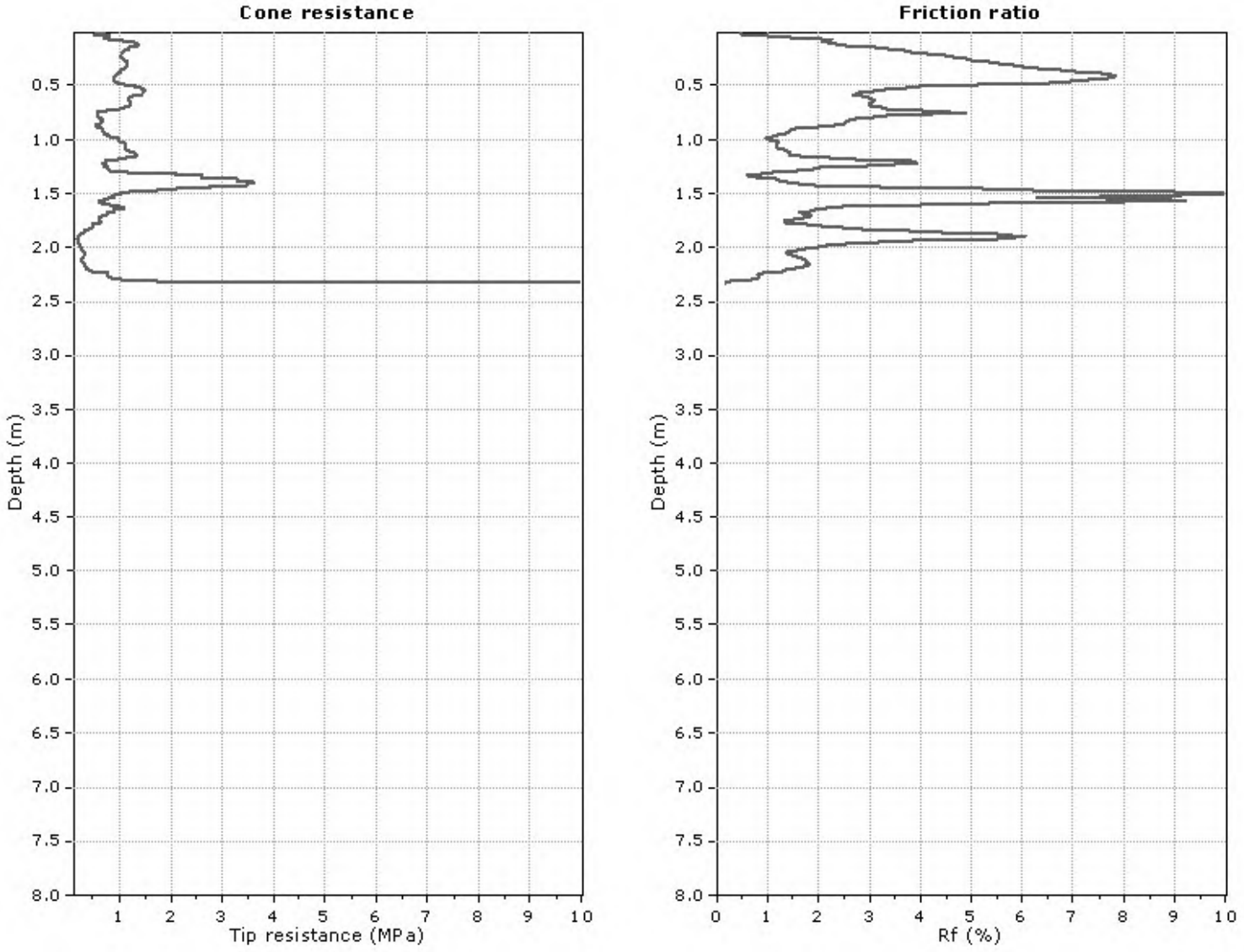
CPT: CPT103
Total depth: 2.32 m, Date: 22/11/2022
Surface Elevation: 86.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine**
Location: **1945 State Highway 10, Waipapa**



Initia
Geotechnical Specialists
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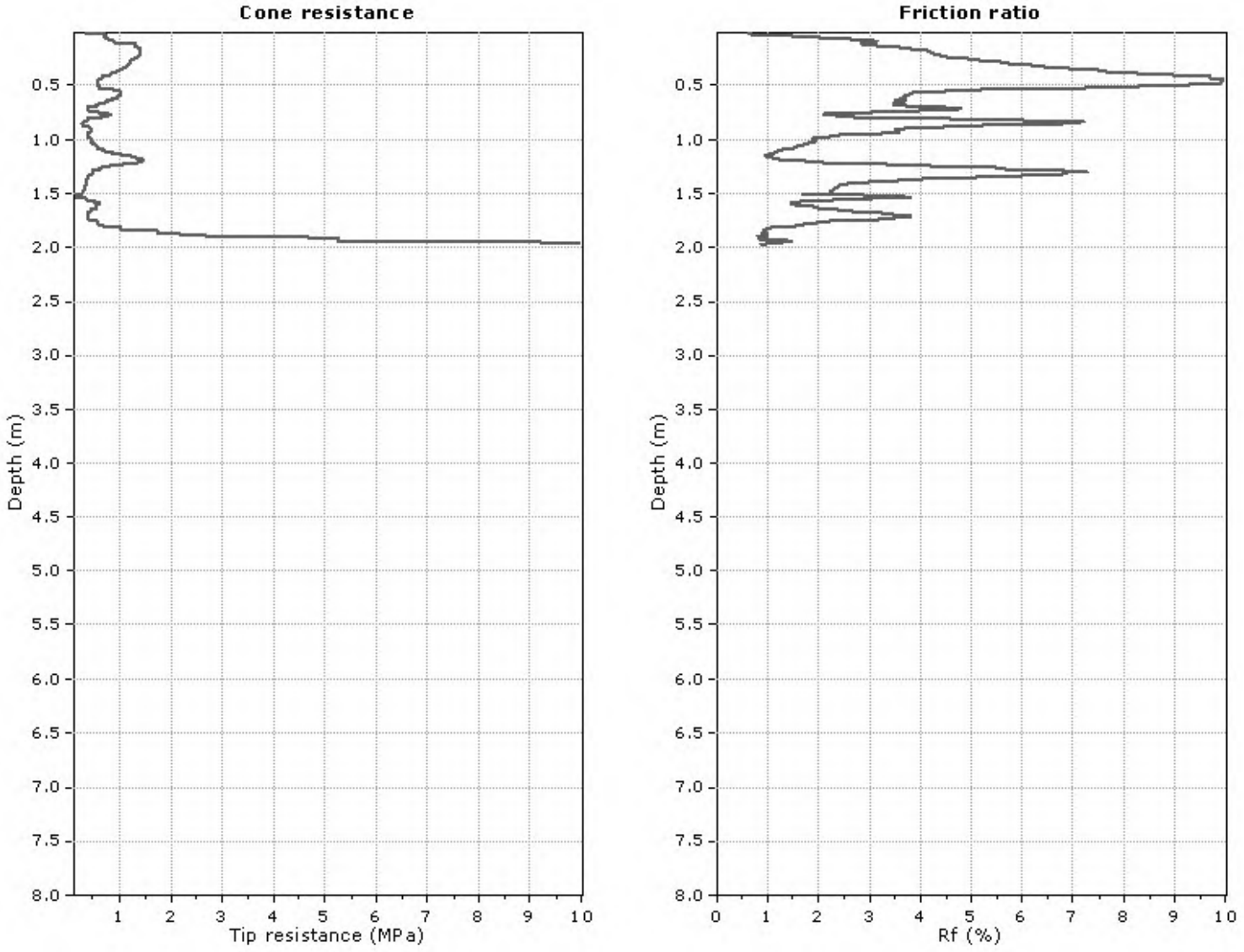
CPT: CPT104
Total depth: 1.98 m, Date: 22/11/2022
Surface Elevation: 86.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine**
Location: **1945 State Highway 10, Waipapa**



Initia
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114 St Georges Bay Road, Auckland
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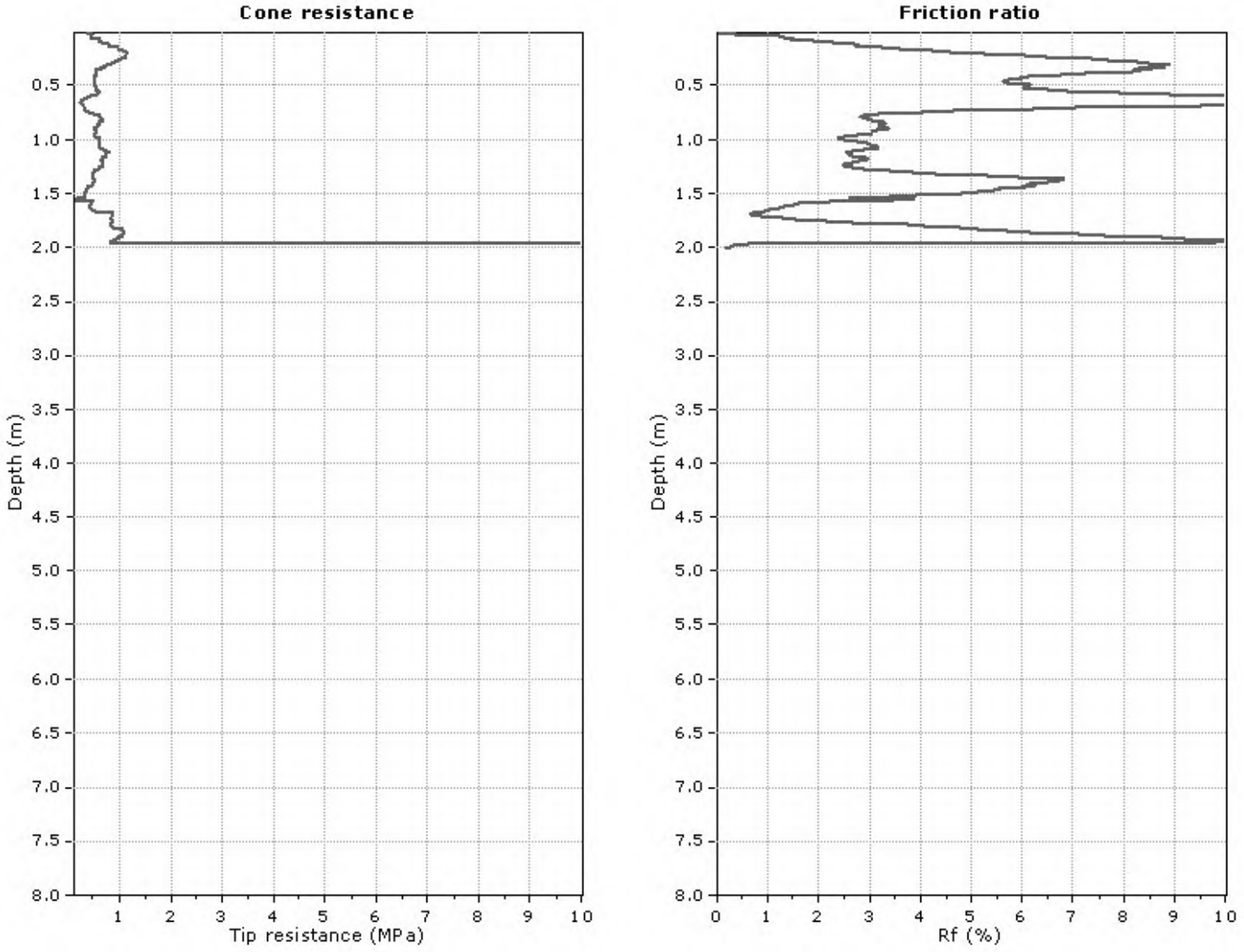
CPT: CPT105
Total depth: 2.01 m, Date: 22/11/2022
Surface Elevation: 81.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine**
Location: **1945 State Highway 10, Waipapa**



Initia
Geotechnical Specialists
114 St Georges Bay Road, Auckland
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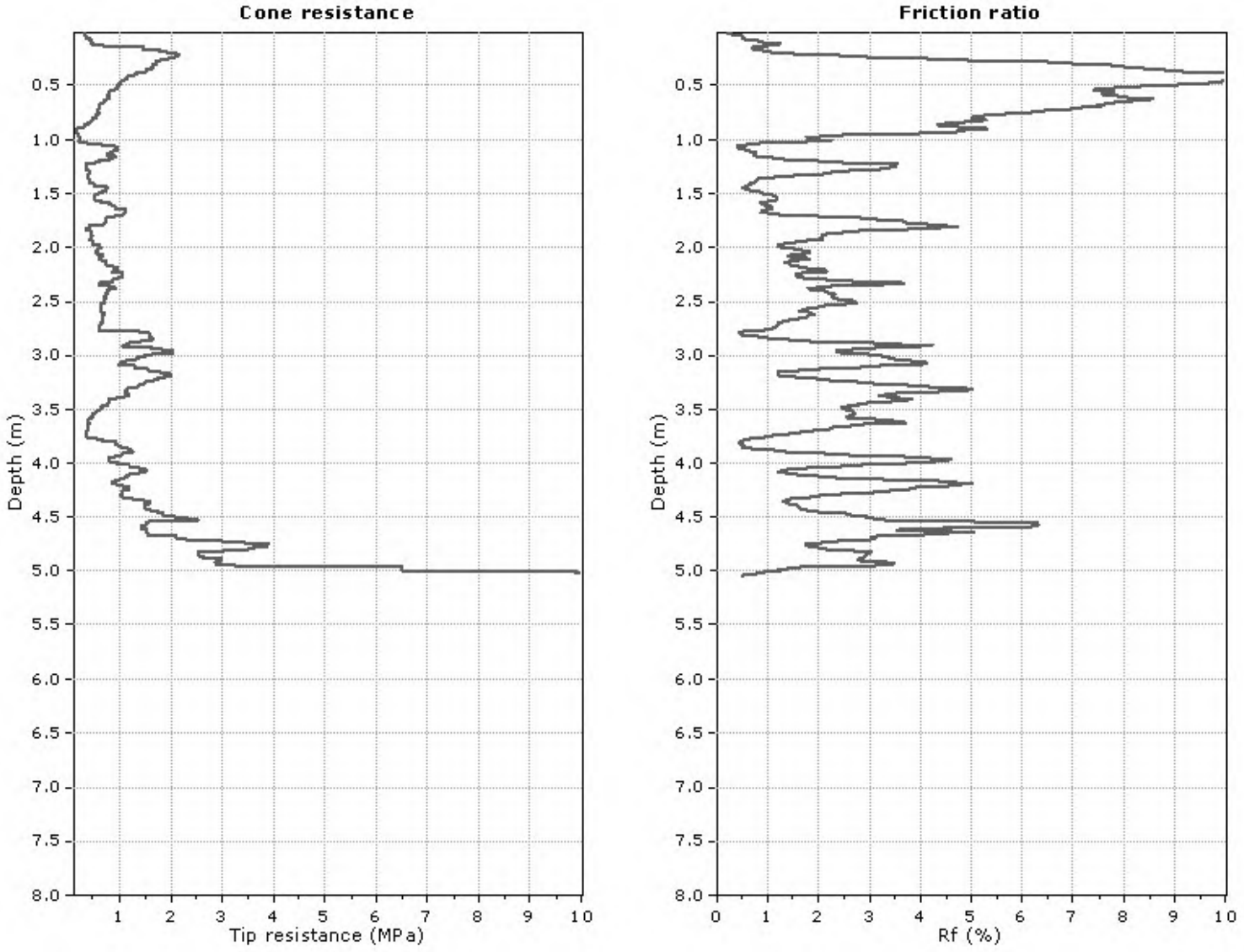
CPT: CPT106
Total depth: 5.04 m, Date: 22/11/2022
Surface Elevation: 92.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine**
Location: **1945 State Highway 10, Waipapa**



Initia
Geotechnical Specialists
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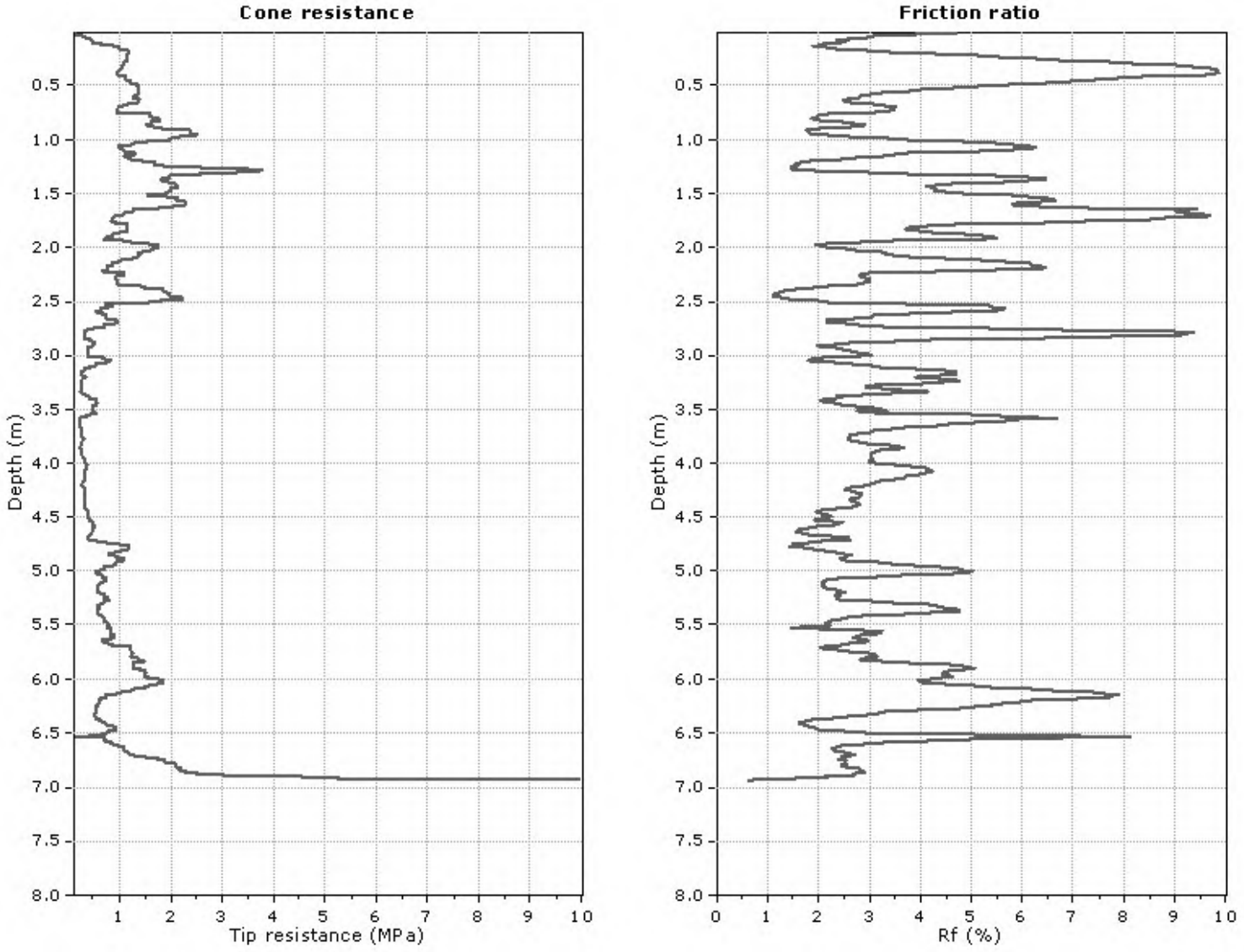
CPT: CPT107
Total depth: 6.94 m, Date: 22/11/2022
Surface Elevation: 87.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine**
Location: **1945 State Highway 10, Waipapa**



Initia
Geotechnical Specialists
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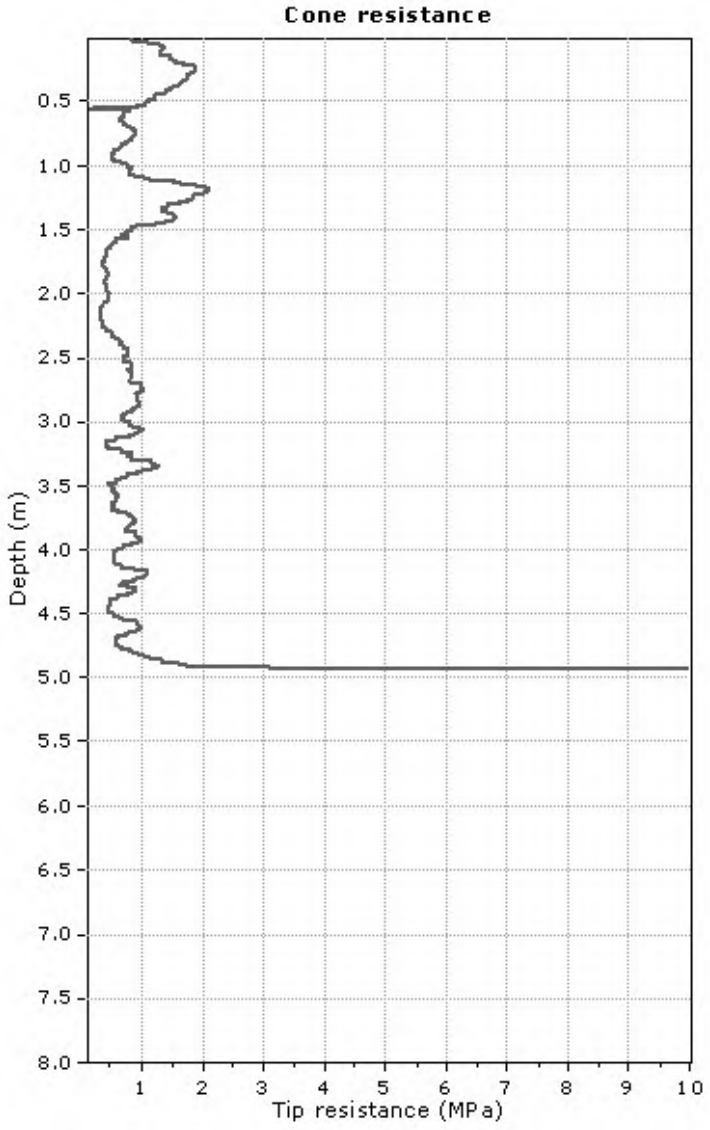
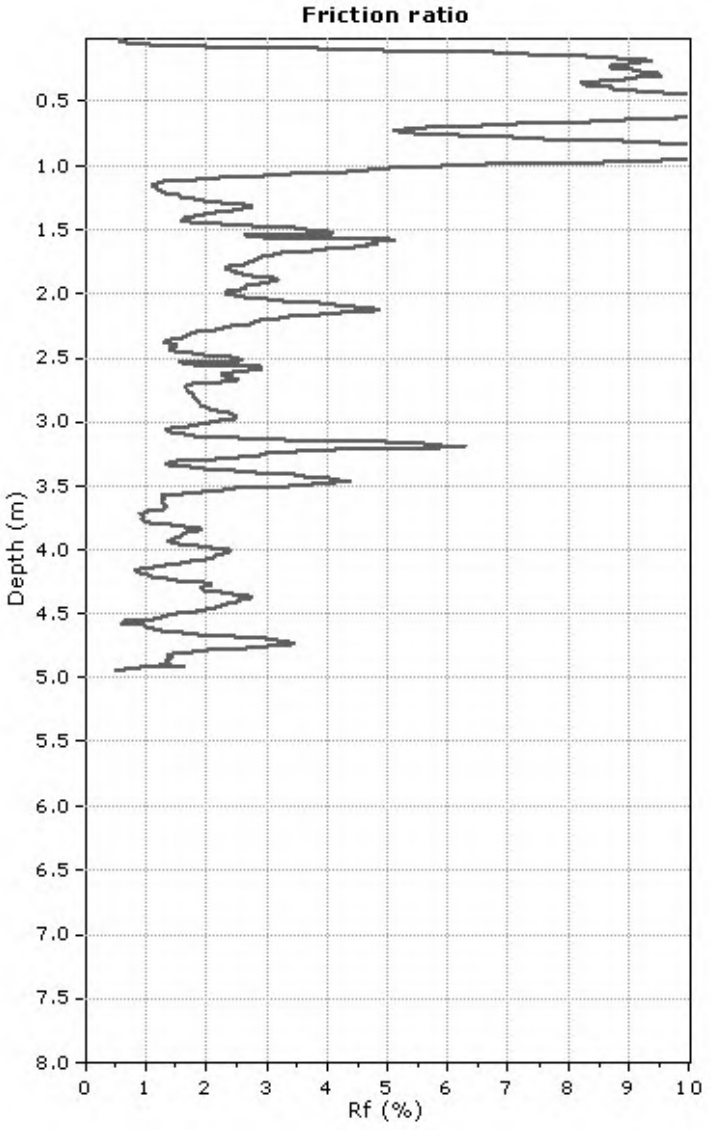
CPT: CPT109
Total depth: 4.94 m, Date: 22/11/2022
Surface Elevation: 84.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine**
Location: **1945 State Highway 10, Waipapa**





Initia
Geotechnical Specialists
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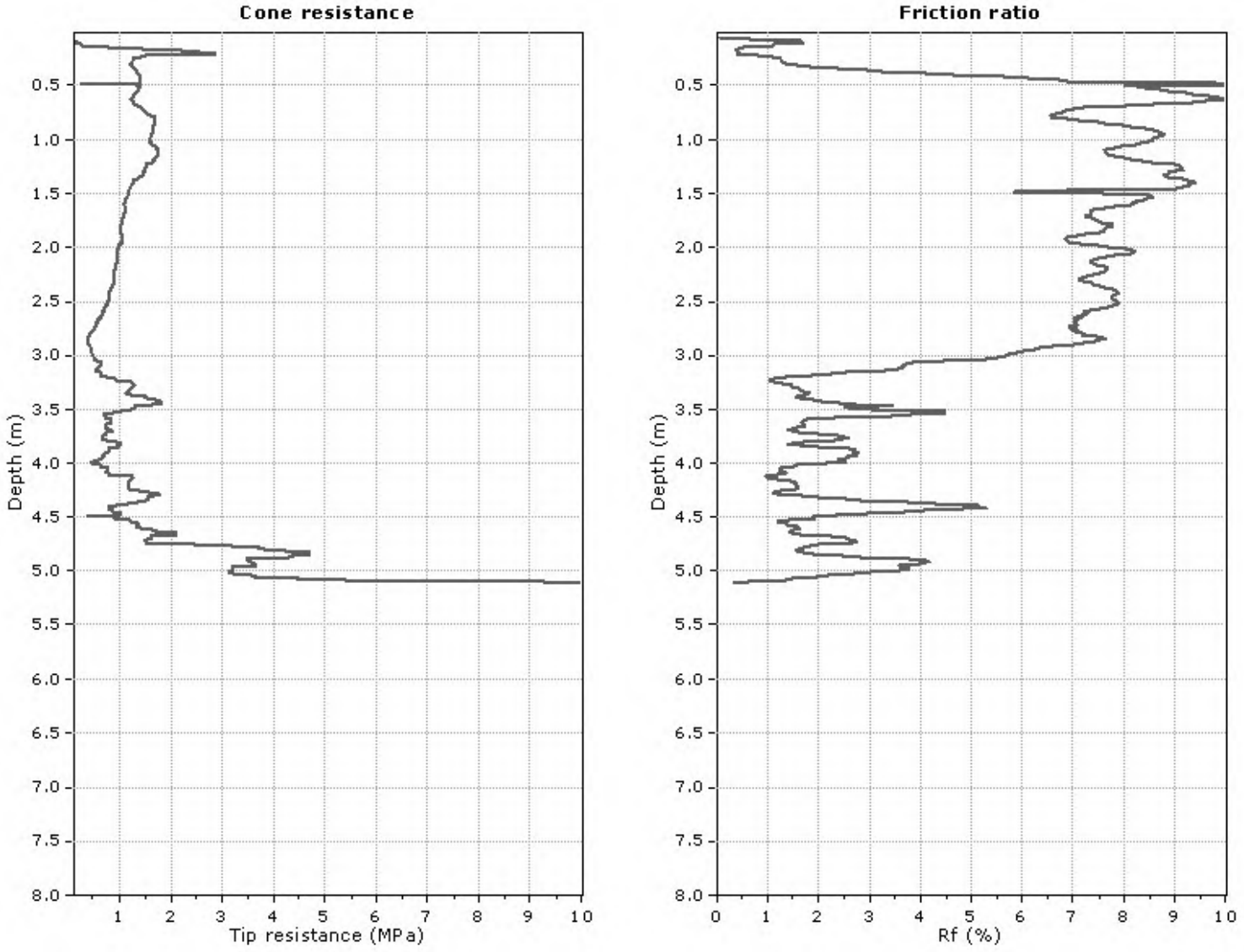
CPT: CPT111
Total depth: 5.11 m, Date: 22/11/2022
Surface Elevation: 87.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine**
Location: **1945 State Highway 10, Waipapa**



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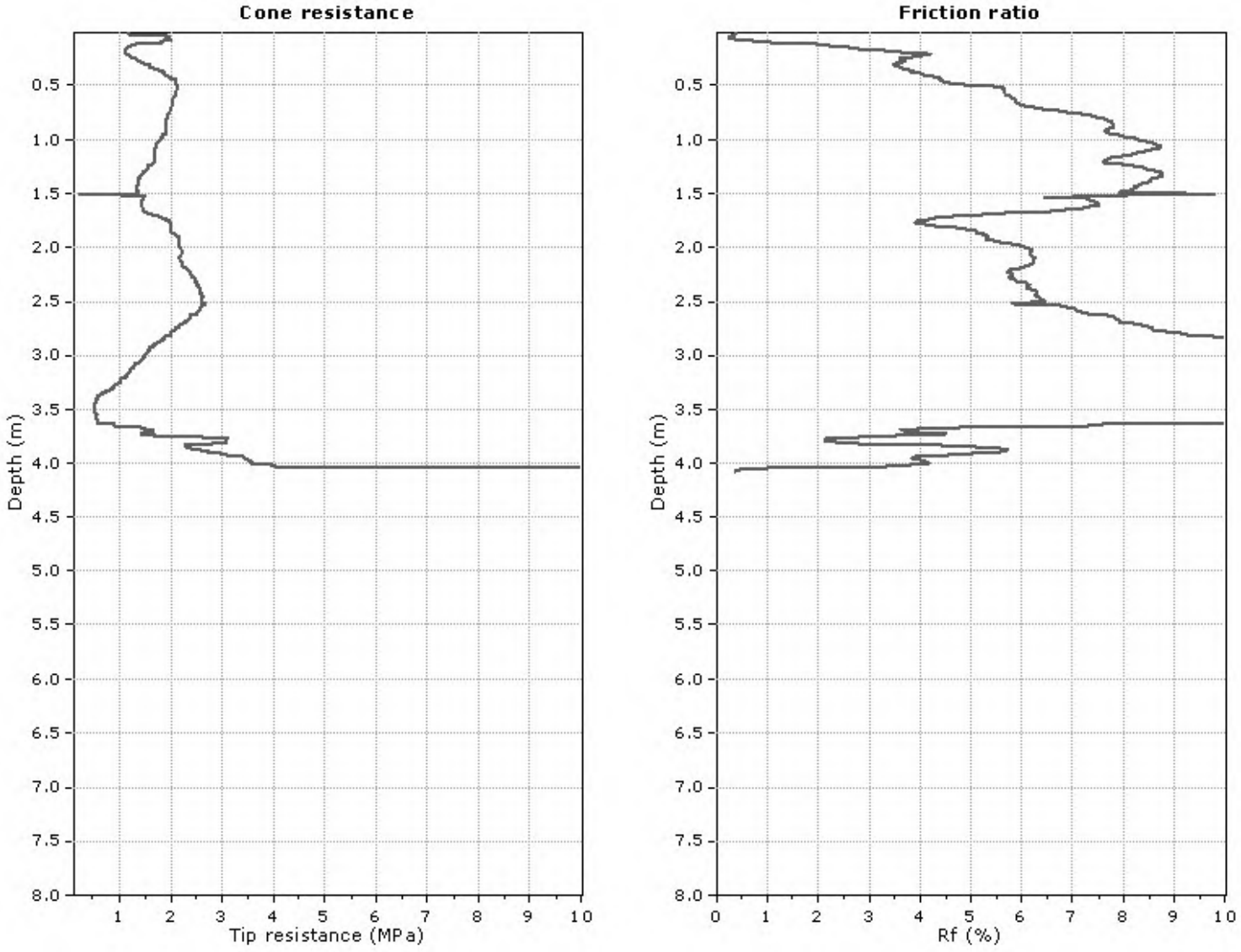
CPT: CPT112
Total depth: 4.07 m, Date: 22/11/2022
Surface Elevation: 92.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine**
Location: **1945 State Highway 10, Waipapa**



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Geotechnical Specialists
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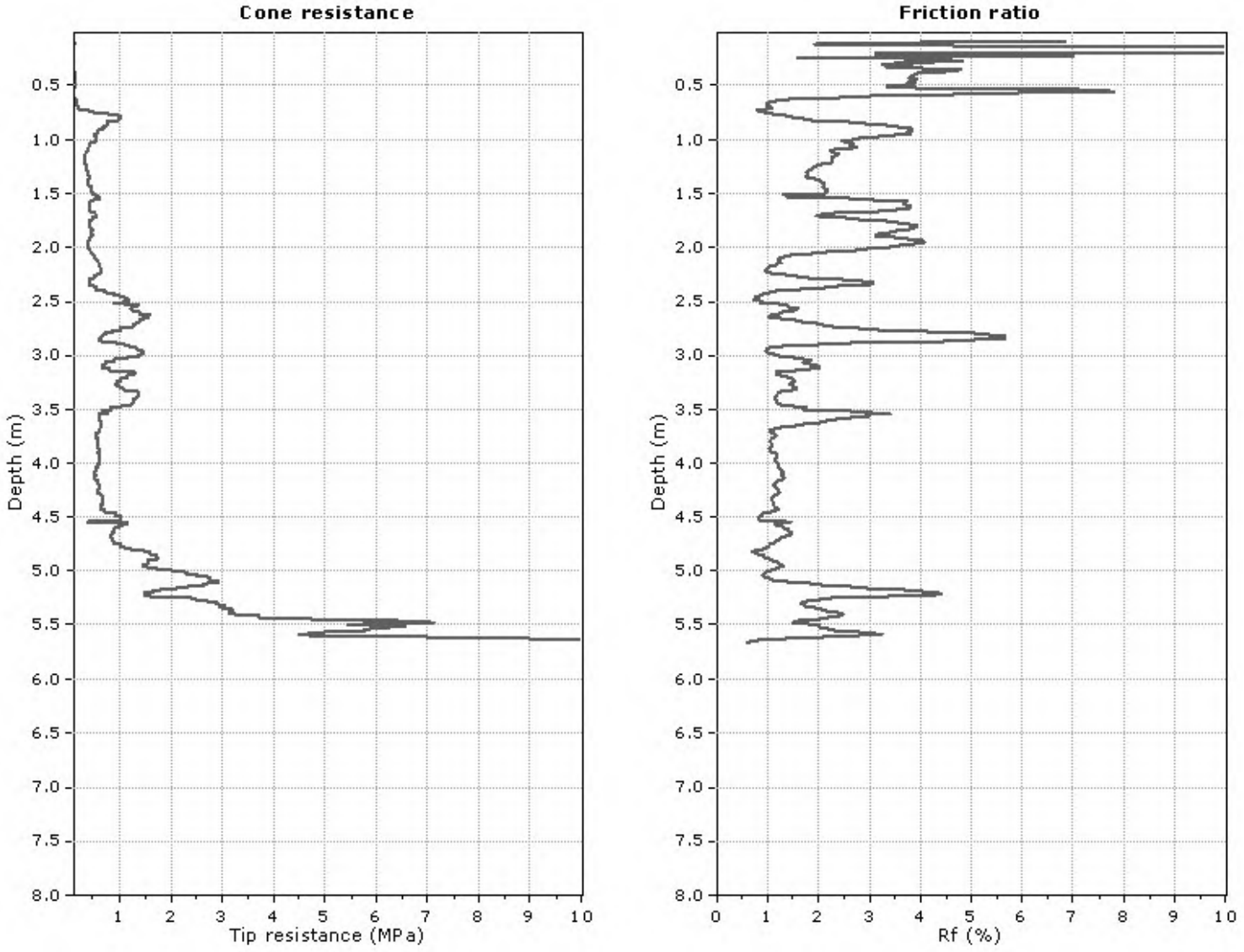
CPT: CPT114
Total depth: 5.66 m, Date: 22/11/2022
Surface Elevation: 86.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine**
Location: **1945 State Highway 10, Waipapa**



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Geotechnical Specialists
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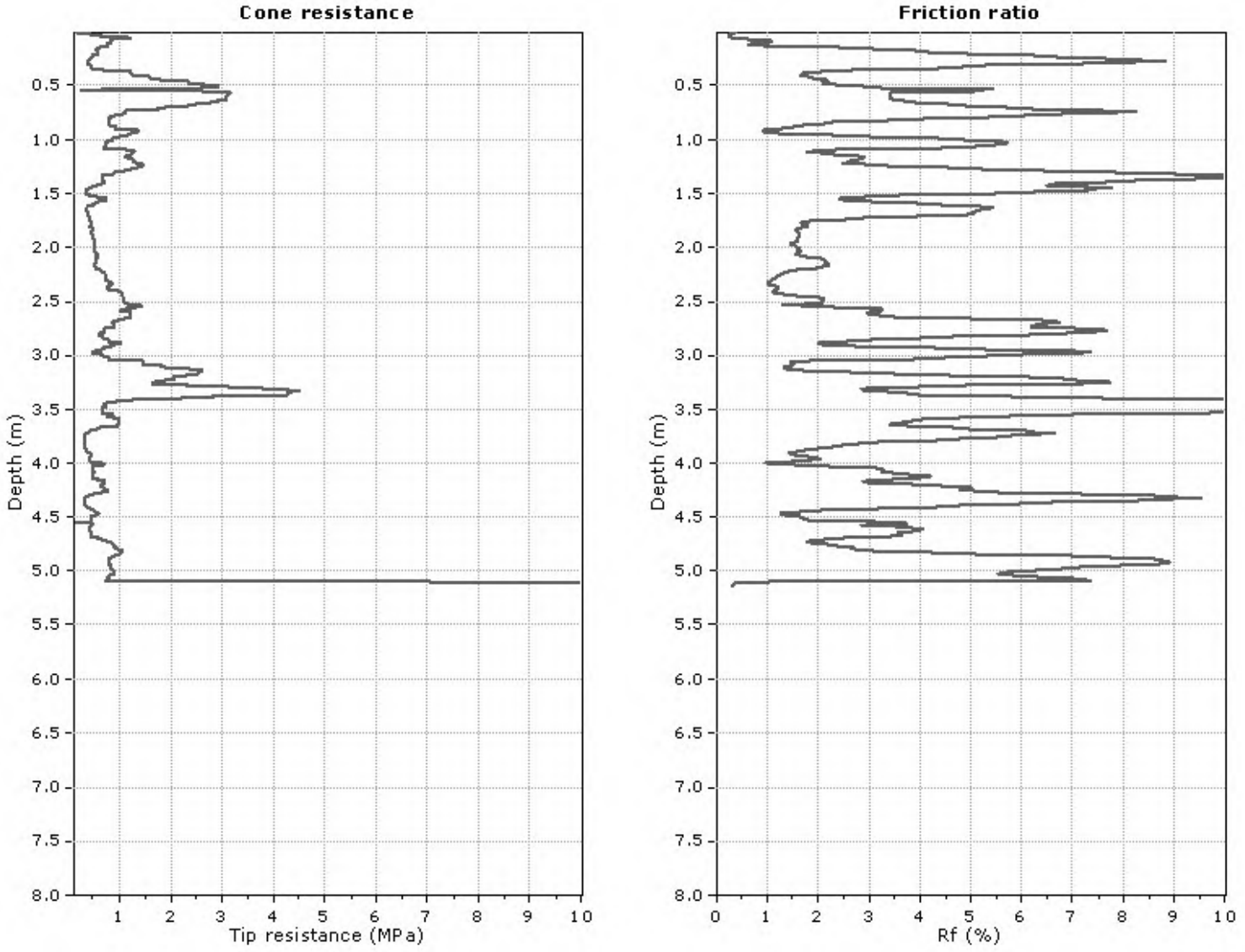
CPT: CPT115
Total depth: 5.12 m, Date: 22/11/2022
Surface Elevation: 87.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **Waipapa Pine**
Location: **1945 State Highway 10, Waipapa**



Babbage Geotechnical Laboratory
Level 4
68 Beach Road
Auckland 1010
Telephone
E-mail

P O Box 2027
New Zealand
64-9-367 4954
wec@babbage.co.nz

Please reply to: W.E. Campton

Haigh Workman Ltd.
PO Box 89
Kerikeri 0245

Job Number: 63632#L
BGL Registration Number: 2828
Checked by: WEC

Attention: **JOHN POWER**

8th April 2024

ATTERBERG LIMITS & LINEAR SHRINKAGE TESTING

Dear Sir,

Re: WAIPAPA PINE LTD.

Your Reference: 23 256
Report Number: 63632#L/AL Waipapa Pine Ltd.

The following report presents the results of Atterberg Limits & Linear Shrinkage testing at BGL of soil samples delivered to this laboratory on the 25th of March 2024. Test results are summarised below, with page 3 showing where the samples plot on the Unified Soil Classification System (Casagrande) Chart.

Test standards used were:

Water Content:	NZS4402:1986:Test 2.1
Liquid Limit:	NZS4402:1986:Test 2.2
Plastic Limit:	NZS4402:1986:Test 2.3
Plasticity Index:	NZS4402:1986:Test 2.4
Linear Shrinkage:	NZS4402:1986:Test 2.6

Borehole Number	Sample Number	Depth (m)	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Linear Shrinkage (%)*
BH05	Sample 1	0.40 – 0.80	72.0	115	62	53	20
BH10	Sample 2	1.00 – 1.40	71.7	72	43	29	12

**The amount of shrinkage of the sample as a percentage of the original sample length.*

The whole soils were used for the water content tests (the soils were in a natural state), and for the liquid limit, plastic limit & linear shrinkage tests. The soils were wet up and dried where required for the liquid limit, plastic limit & linear shrinkage tests.

As per the reporting requirements of NZS4402: 1986: Test 2.1: water content is reported to two significant figures for values below 10%, and to three significant figures for values of 10% or greater. Test 2.2: liquid limit, test 2.3: plastic limit, and test 2.6: linear shrinkage are reported to the nearest whole number.

Please note that the test results relate only to the samples as-received, and relate only to the samples under test.

Thank you for the opportunity to carry out this testing. If you have any queries regarding the content of this report please contact the person authorising this report below at your convenience.

Yours faithfully,

Justin Franklin
Key Technical Person
Assistant Laboratory Manager
Babbage Geotechnical Laboratory

ACCREDITED
IANZ
TESTING LABORATORY
№ 126

BGL Babbage Geotechnical Laboratory	Job Number:	63632#L	Sheet 1 of 1	Page 3 of 3
	Reg. Number:	2828	Version No:	7
	Report No:	63632#L/AL Waipapa Pine Ltd.	Version Date:	July 2022
	Project:	WAIPAPA PINE LTD.		

DETERMINATION OF THE LIQUID LIMIT, PLASTIC LIMIT & THE PLASTICITY INDEX

Test Methods: NZS4402: 1986: Test 2.2, Test 2.3 and Test 2.4

Tested By:	WC / JL / SG	March / April 2024
Compiled By:	JF	8/04/2024
Checked By:	JF	8/04/2024

SUMMARY OF TESTING

Borehole Number	Sample Number	Depth (m)	Liquid Limit	Plastic Limit	Plasticity Index	Soil Classification Based on USCS Chart Below
BH05	Sample 1	0.40 - 0.80	115	62	53	MH
BH10	Sample 2	1.00 - 1.40	72	43	29	MH

The chart below & soil classification terminology is taken from ASTM D2487-17^{e1} "Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)", April 2020, & is based on the classification scheme developed by A. Casagrande in the 1940's (Casagrande, A., 1948: Classification and identification of soil. Transactions of the American Society of Civil Engineers, v. 113, p. 901-930). The chart below & the soil classification given in the table above are included for your information only, and are not included in the IANZ endorsement for this report.

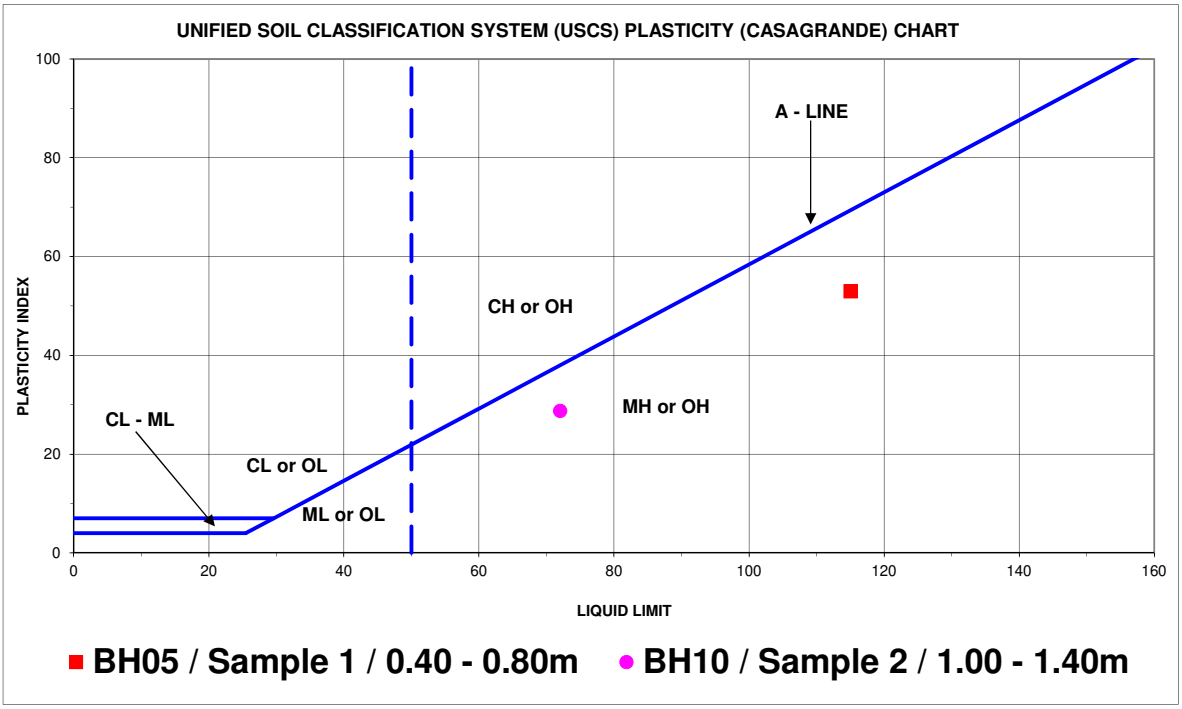


CHART LEGEND

CL = CLAY, low plasticity ('lean' clay)
OL = ORGANIC CLAY or ORGANIC SILT, low liquid limit
ML = SILT, low liquid limit
CL - ML = SILTY CLAY
CH = CLAY, high plasticity ('fat' clay)
OH = ORGANIC CLAY or ORGANIC SILT, high liquid limit
MH = SILT, high liquid limit ('elastic silt')

Appendix C – Settle 3D Analysis and Liquefaction Assessment Results

Table of Contents

Settle3 Analysis Information

Mv 0

Stage Settings

Stage #	Name
1	Stage 1
2	Stage 2
3	Stage 3

Results

Time taken to compute: 0.184926 seconds

Stage: Stage 1

Data Type	Minimum	Maximum
Total Settlement [mm]	0	0
Total Consolidation Settlement [mm]	0	0
Virgin Consolidation Settlement [mm]	0	0
Recompression Consolidation Settlement [mm]	0	0
Immediate Settlement [mm]	0	0
Loading Stress ZZ [kPa]	0	0
Loading Stress XX [kPa]	0	0
Loading Stress YY [kPa]	0	0
Effective Stress ZZ [kPa]	0	46.1347
Effective Stress XX [kPa]	0	25.3741
Effective Stress YY [kPa]	0	25.3741
Total Stress ZZ [kPa]	0	116.08
Total Stress XX [kPa]	0	95.3194
Total Stress YY [kPa]	0	95.3194
Modulus of Subgrade Reaction (Total) [kPa/m]	0	0
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	0	0
Total Strain	0	0
Pore Water Pressure [kPa]	0	69.9453
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [kPa]	0.00624968	46.1157
Over-consolidation Ratio	1	1
Void Ratio	0	0
Hydroconsolidation Settlement [mm]	0	0
Undrained Shear Strength	0	0

Stage: Stage 2

Data Type	Minimum	Maximum
Total Settlement [mm]	0	52.7317
Total Consolidation Settlement [mm]	0	52.7317
Virgin Consolidation Settlement [mm]	0	52.7317
Recompression Consolidation Settlement [mm]	0	0
Immediate Settlement [mm]	0	0
Loading Stress ZZ [kPa]	7.5	30.0006
Loading Stress XX [kPa]	5.00833	23.9532
Loading Stress YY [kPa]	-1.79069	20.0626
Effective Stress ZZ [kPa]	7.5	71.1617
Effective Stress XX [kPa]	7.20448	39.4705
Effective Stress YY [kPa]	1.98038	40.1018
Total Stress ZZ [kPa]	7.5	136.512
Total Stress XX [kPa]	7.20448	104.21
Total Stress YY [kPa]	1.98038	106.604
Modulus of Subgrade Reaction (Total) [kPa/m]	0	2169.5
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	0	2169.5
Total Strain	0.000750078	0.00899985
Pore Water Pressure [kPa]	0	69.9453
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [kPa]	7.56728	71.1454
Over-consolidation Ratio	1	1
Void Ratio	0	0
Hydroconsolidation Settlement [mm]	0	0
Undrained Shear Strength	0	0.924131

Stage: Stage 3

Data Type	Minimum	Maximum
Total Settlement [mm]	0	96.3659
Total Consolidation Settlement [mm]	0	96.3659
Virgin Consolidation Settlement [mm]	0	96.3659
Recompression Consolidation Settlement [mm]	0	0
Immediate Settlement [mm]	0	0
Loading Stress ZZ [kPa]	7.5	60
Loading Stress XX [kPa]	5.24281	47.0735
Loading Stress YY [kPa]	-2.40951	38.2535
Effective Stress ZZ [kPa]	7.5	97.5618
Effective Stress XX [kPa]	5.24281	53.3533
Effective Stress YY [kPa]	-0.953763	52.4599
Total Stress ZZ [kPa]	7.5	156.029
Total Stress XX [kPa]	5.24281	111.821
Total Stress YY [kPa]	-0.953763	112.891
Modulus of Subgrade Reaction (Total) [kPa/m]	0	2167.6
Modulus of Subgrade Reaction (Immediate) [kPa/m]	0	0
Modulus of Subgrade Reaction (Consolidation) [kPa/m]	0	2167.6
Total Strain	0.000750078	0.0179997
Pore Water Pressure [kPa]	0	69.9453
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [kPa]	7.56728	97.5468
Over-consolidation Ratio	1	1
Void Ratio	0	0
Hydroconsolidation Settlement [mm]	0	0
Undrained Shear Strength	0	1.57305

Loads

1. Polygonal Load: "Polygonal Load 1"

Label	Polygonal Load 1
Load Type	Flexible
Area of Load	6000 m2
Elevation	0 m
Installation Stage	Stage 2

Coordinates and Load

X [m]	Y [m]	Load Magnitude [kPa]
60	-20	30
60	30	30
60	80	15
0	80	15
0	30	30
0	-20	30

2. Rectangular Load: "Rectangular Load 2"

Length	40 m
Width	58 m
Rotation angle	0 degrees
Load Type	Flexible
Area of Load	2320 m2
Load	30 kPa
Elevation	0 m
Installation Stage	Stage 3

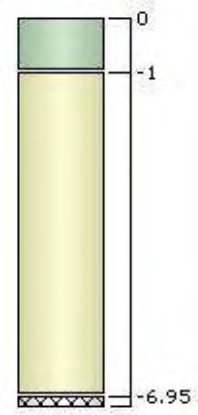
Coordinates

X [m]	Y [m]
10	1
50	1
50	59
10	59

Soil Layers

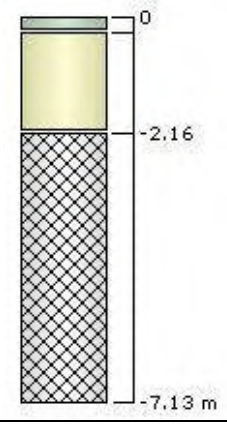
CPT107

XY Location:		CPT107: (0, 60)	
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**
1	crust	1	0
2	Alluvium	5.95	-1



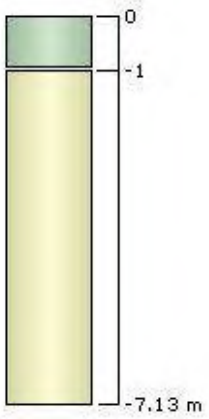
CPT101

XY Location:		CPT101: (60, 60)	
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**
1	crust	0.3	0
2	Alluvium	1.86	-0.3



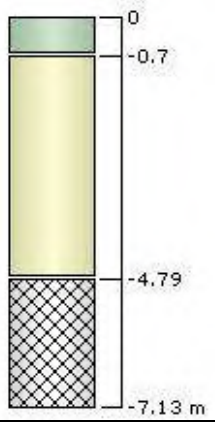
CPT2415

XY Location:		CPT2415: (0, 30)	
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**
1	crust	1	0
2	Alluvium	6.13	-1



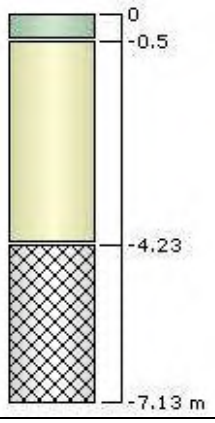
CPT2414

XY Location:		CPT2414: (60, 30)	
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**
1	crust	0.7	0
2	Alluvium	4.09	-0.7



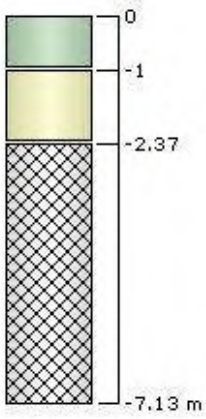
CPT2412

XY Location:		CPT2412: (0, 0)	
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**
1	crust	0.5	0
2	Alluvium	3.73	-0.5



CPT2413

XY Location:		CPT2413: (60, 0)	
Layer #	**Type**	**Thickness [m]**	**Elevation [m]**
1	crust	1	0
2	Alluvium	1.37	-1

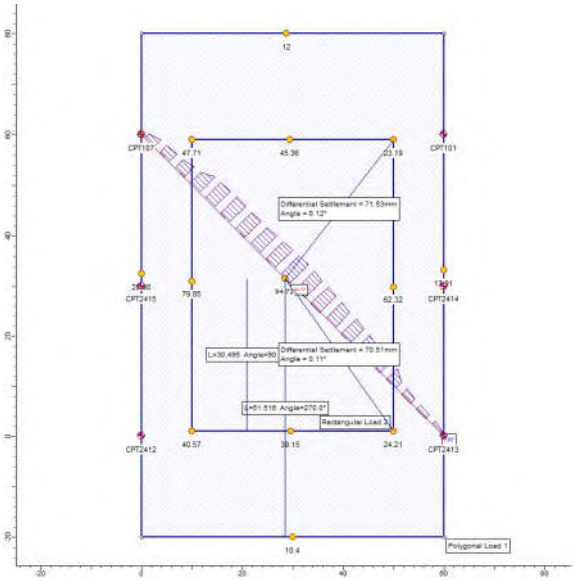


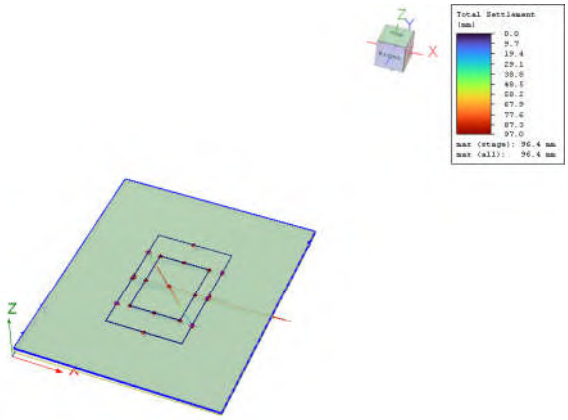
Soil Properties

Property	Alluvium	crust
Color		
Unit Weight [kN/m3]	16	18
Saturated Unit Weight [kN/m3]	16	18
K0	0.55	1
Primary Consolidation	Enabled	Enabled
Material Type	Linear	Linear
mv [m2/kN]	0.0003	0.0001
mvur [m2/kN]	0.0003	0.0001
Undrained Su A [kN/m2]	0	0
Undrained Su S	0.2	0.2
Undrained Su m	0.8	0.8
Piezo Line ID	1	1

Report Views

Plan/3D View 1 1





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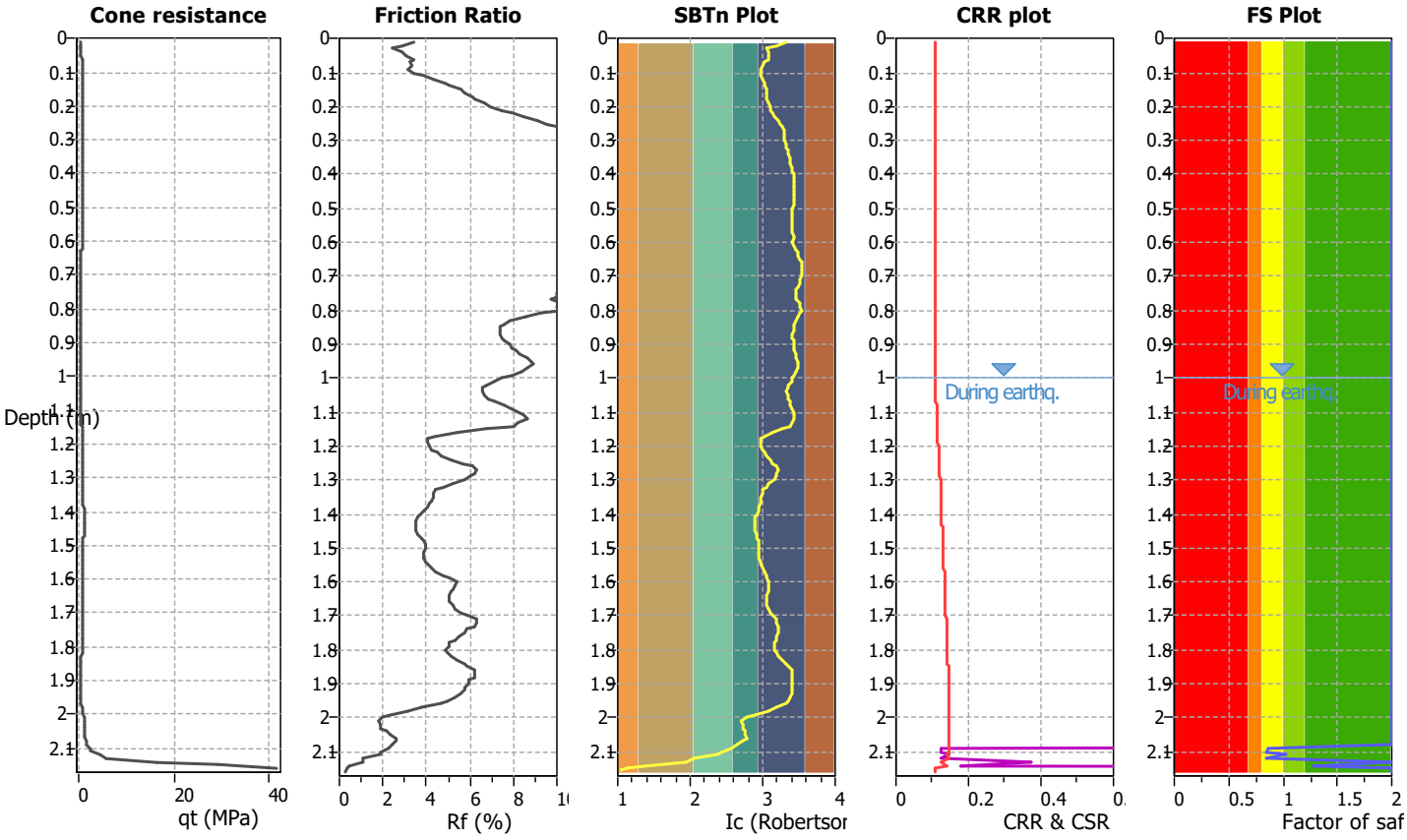
LIQUEFACTION ANALYSIS REPORT

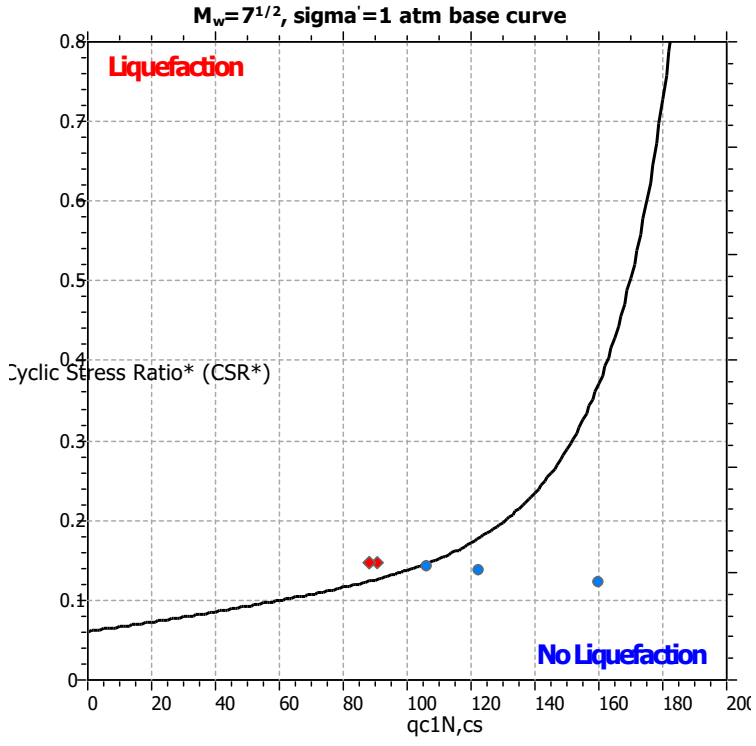
Project title : Waipapa Pine Limited **Location : Waipapa Pine Sawmill**

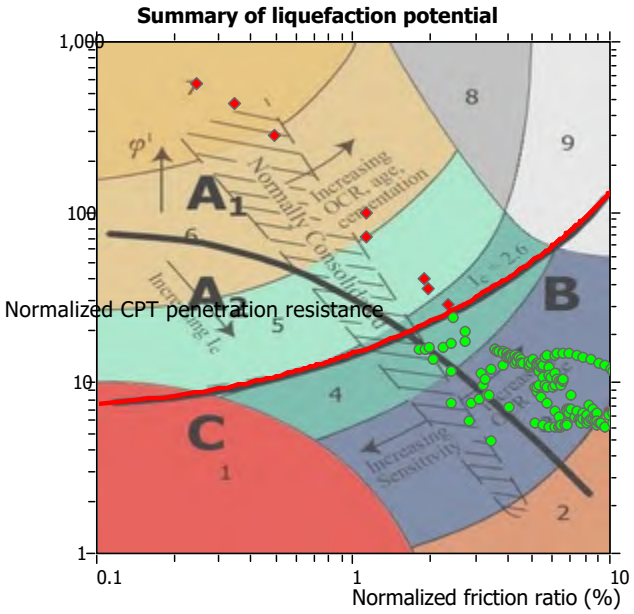
CPT file : CPT101

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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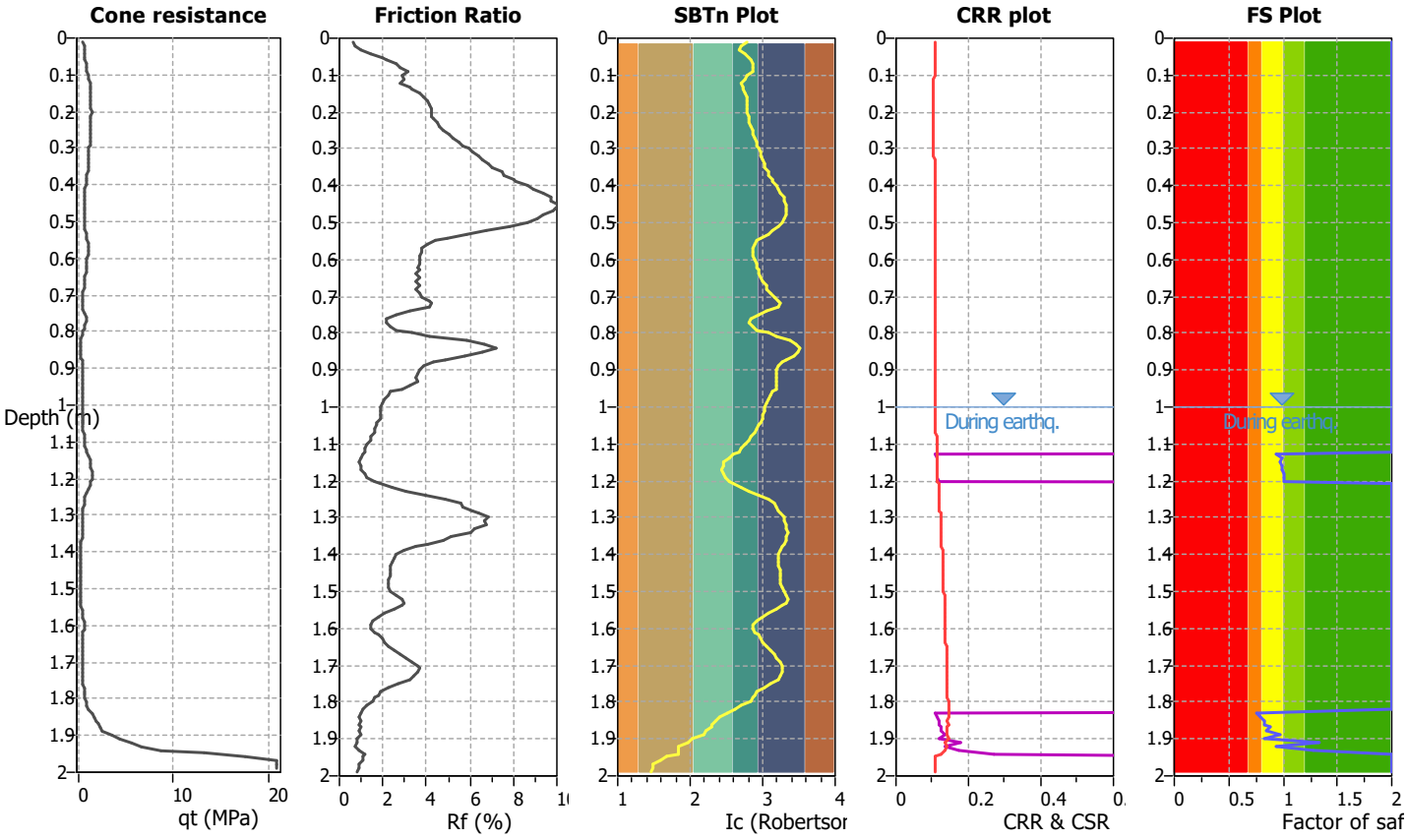
LIQUEFACTION ANALYSIS REPORT

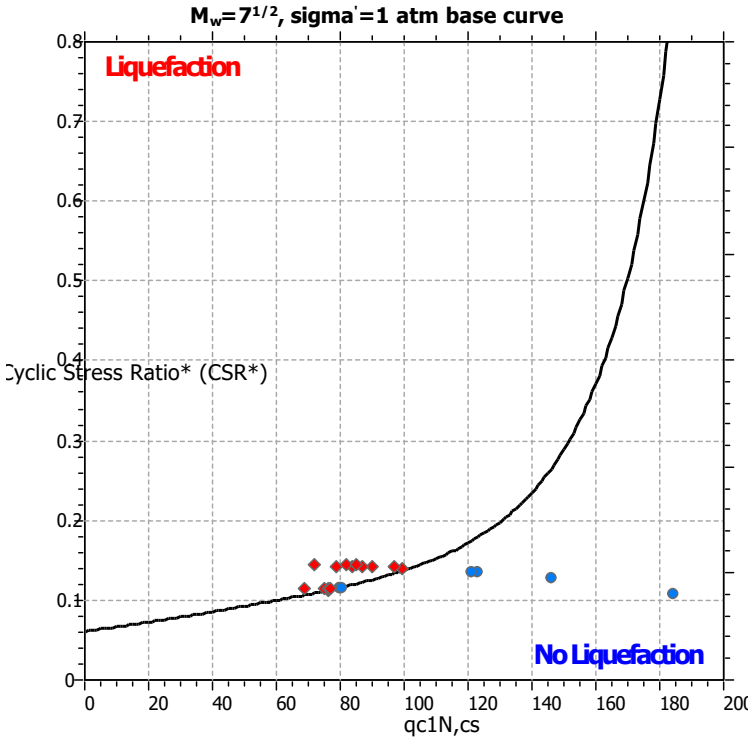
Project title : Waipapa Pine Limited **Location : Waipapa Pine Sawmill**

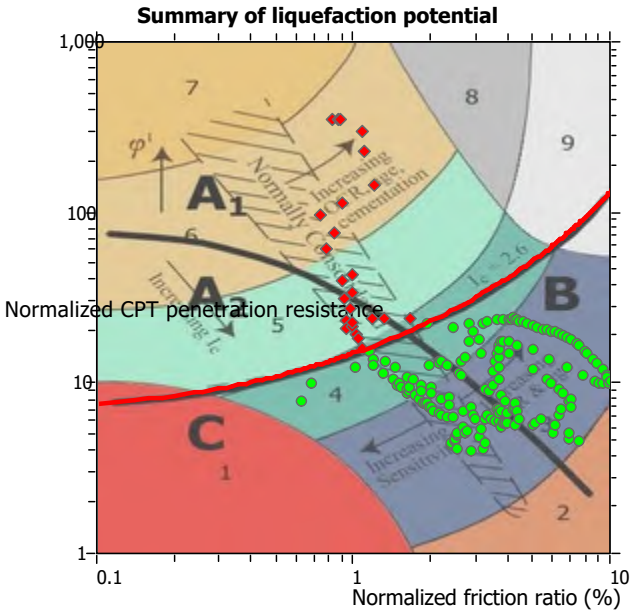
CPT file : CPT104

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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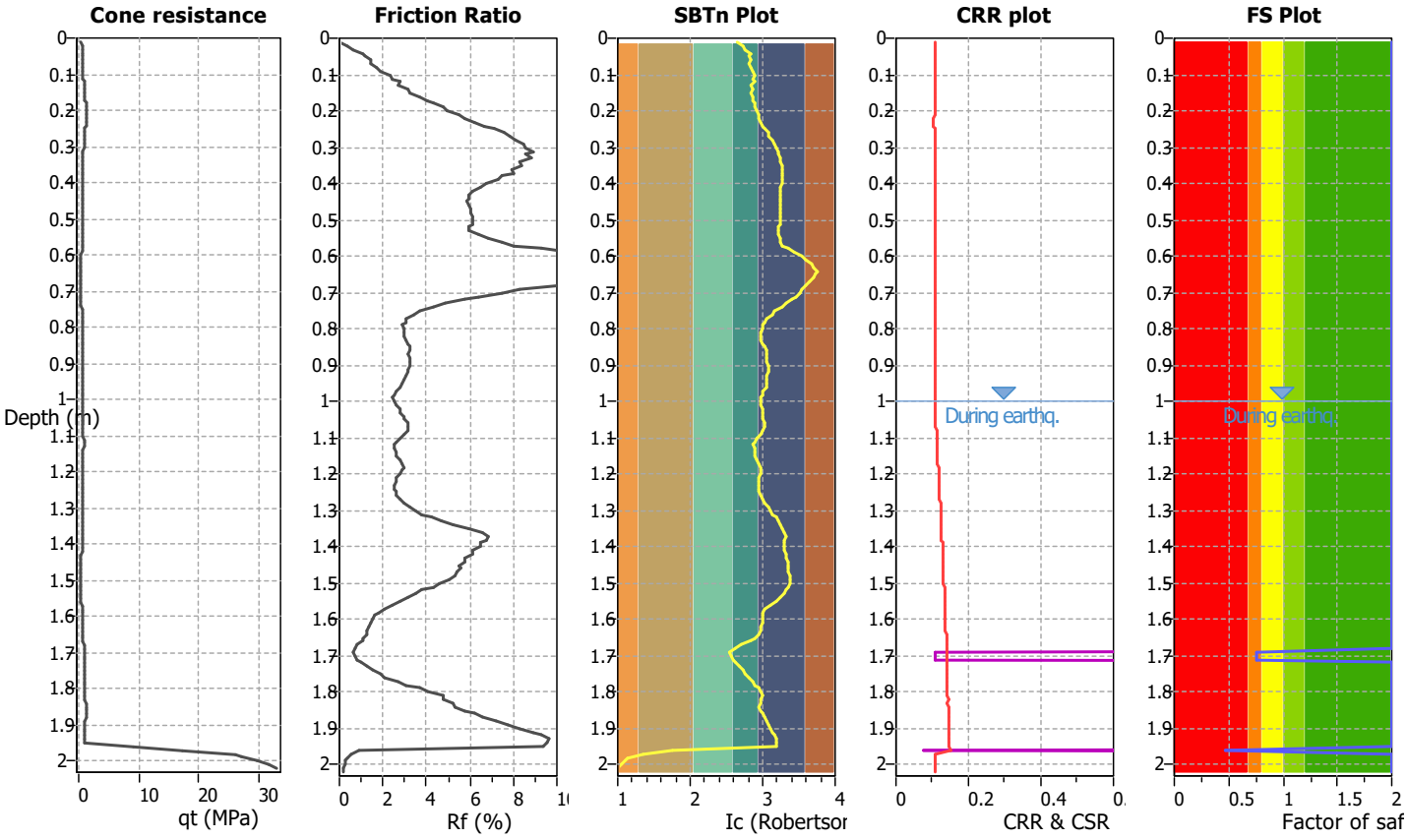
LIQUEFACTION ANALYSIS REPORT

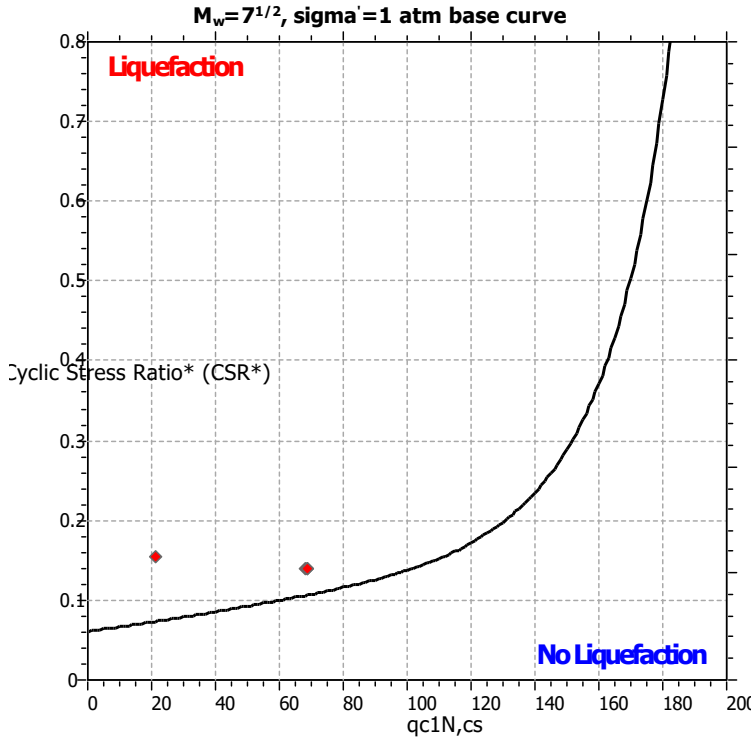
Project title : Waipapa Pine Limited **Location : Waipapa Pine Sawmill**

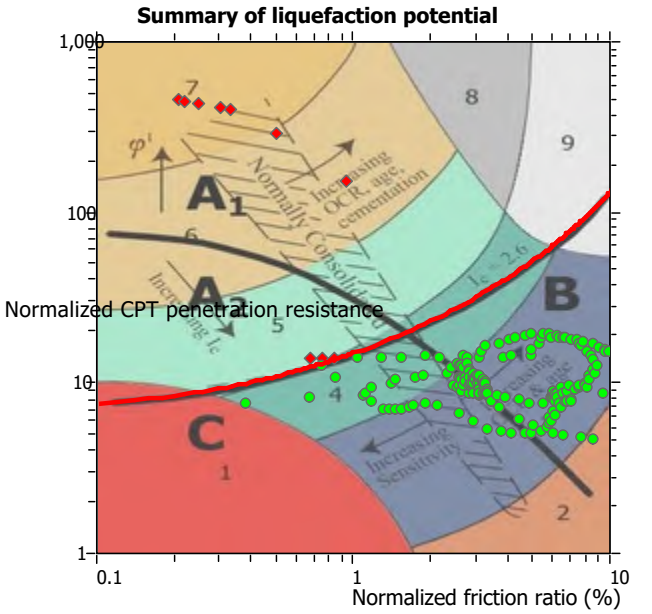
CPT file : CPT105

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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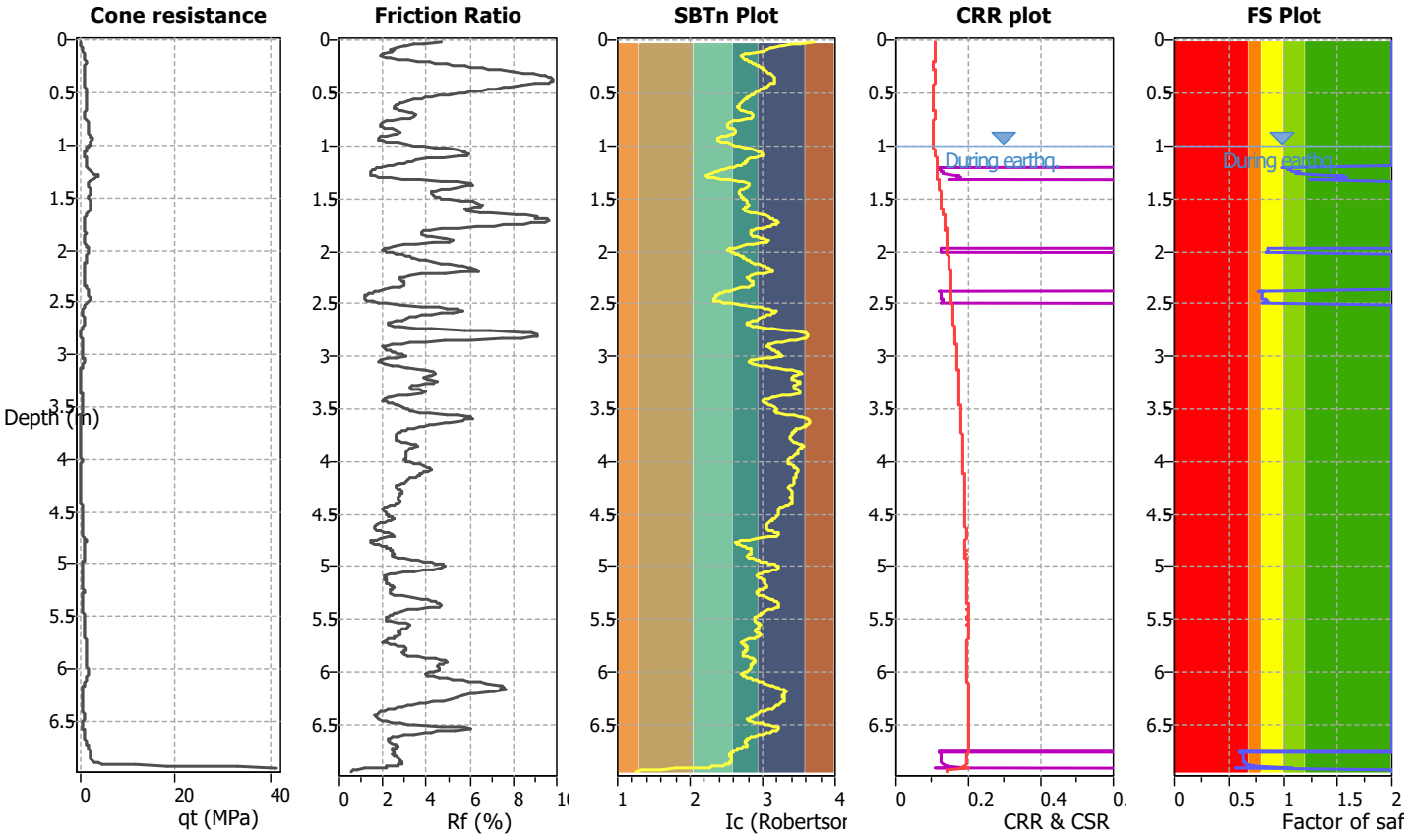
LIQUEFACTION ANALYSIS REPORT

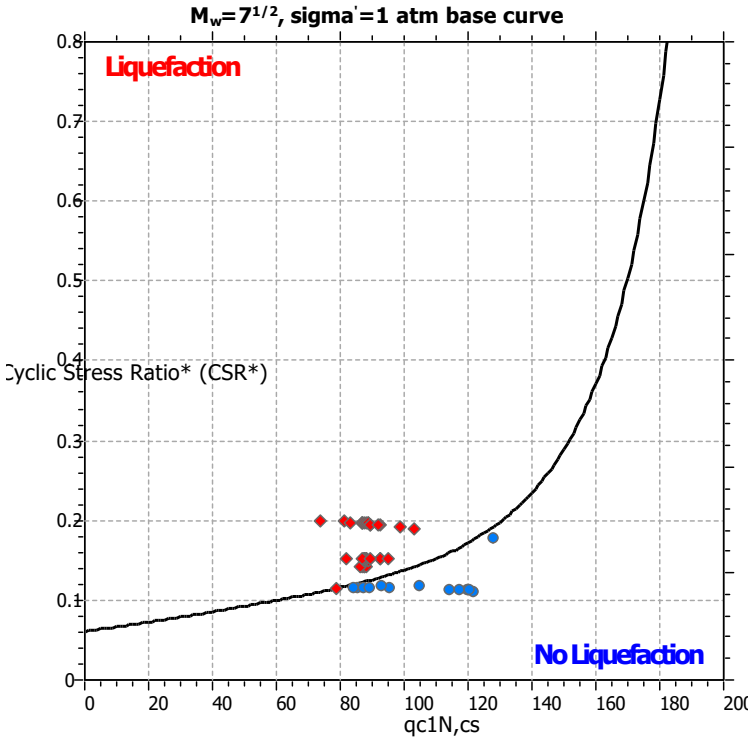
Project title : Waipapa Pine Limited **Location : Waipapa Pine Sawmill**

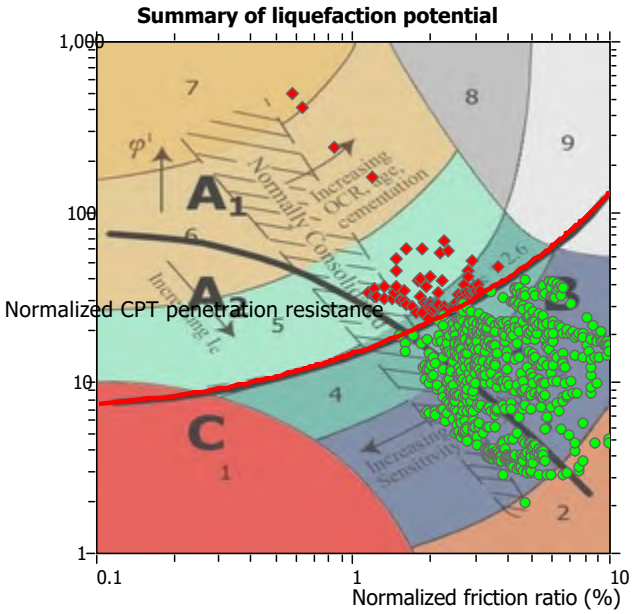
CPT file : CPT107

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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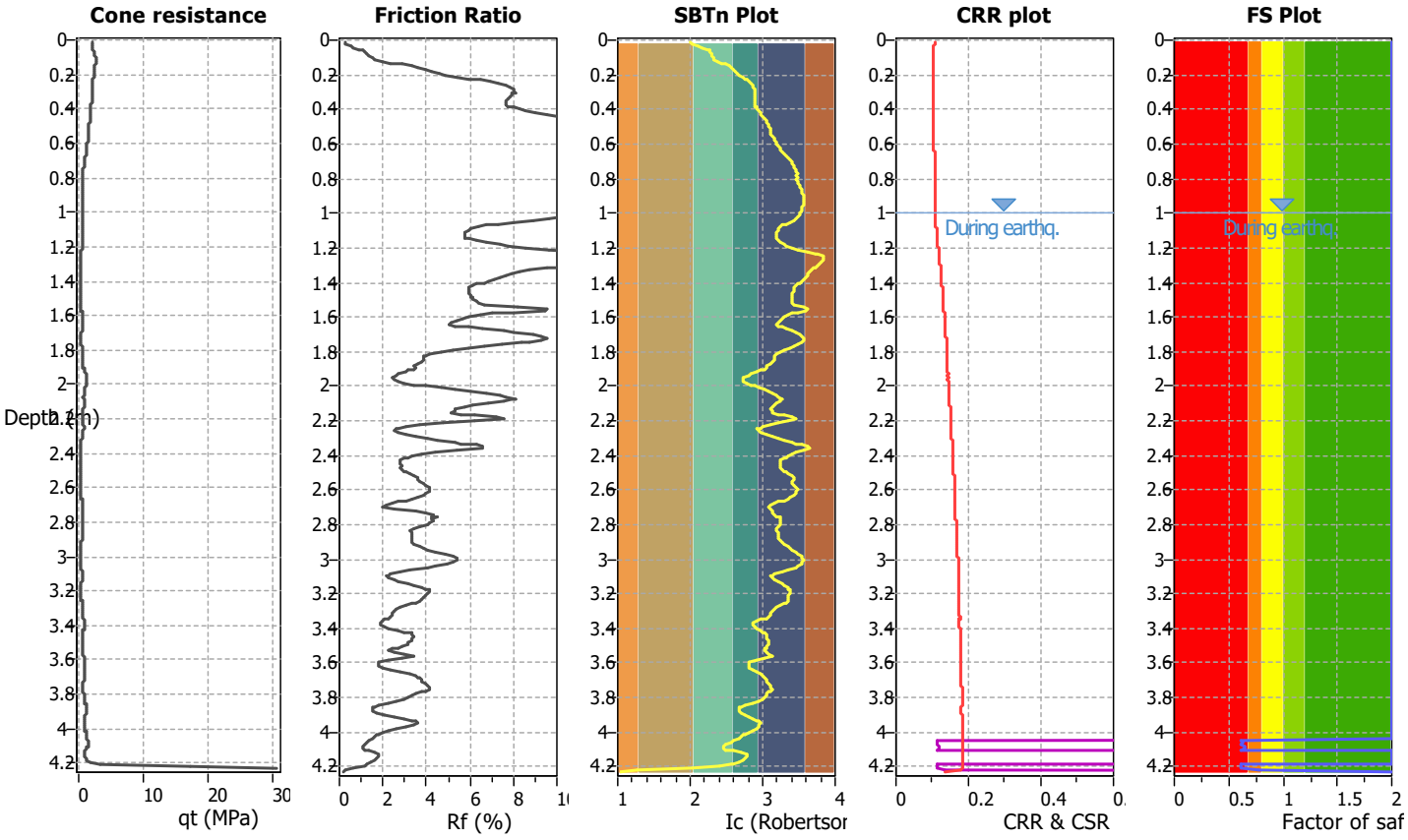
LIQUEFACTION ANALYSIS REPORT

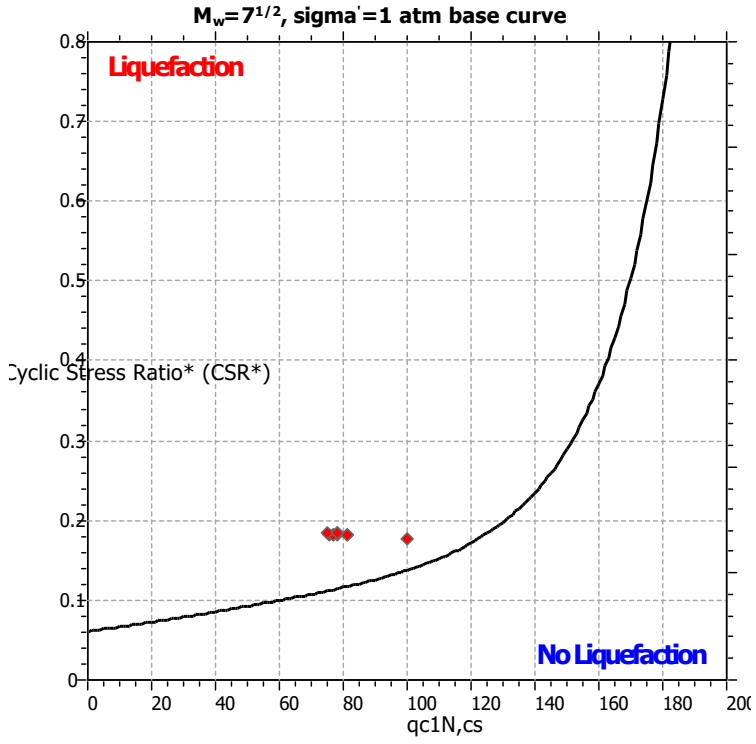
Project title : Waipapa Pine Limited **Location : Waipapa Pine Sawmill**

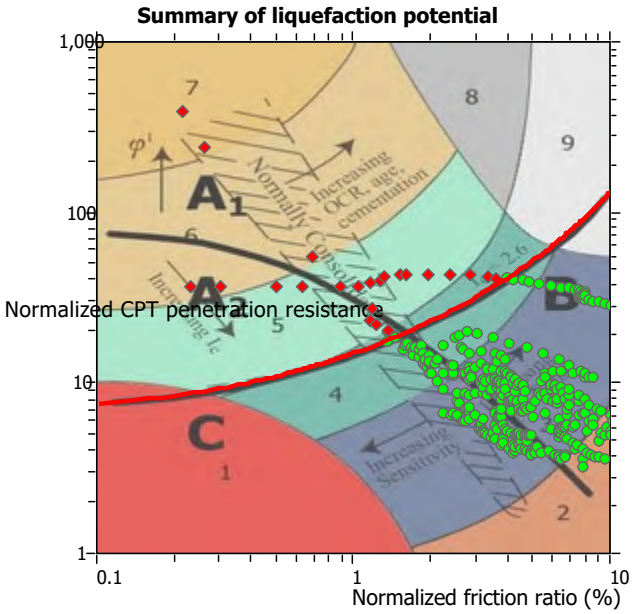
CPT file : CPT2412

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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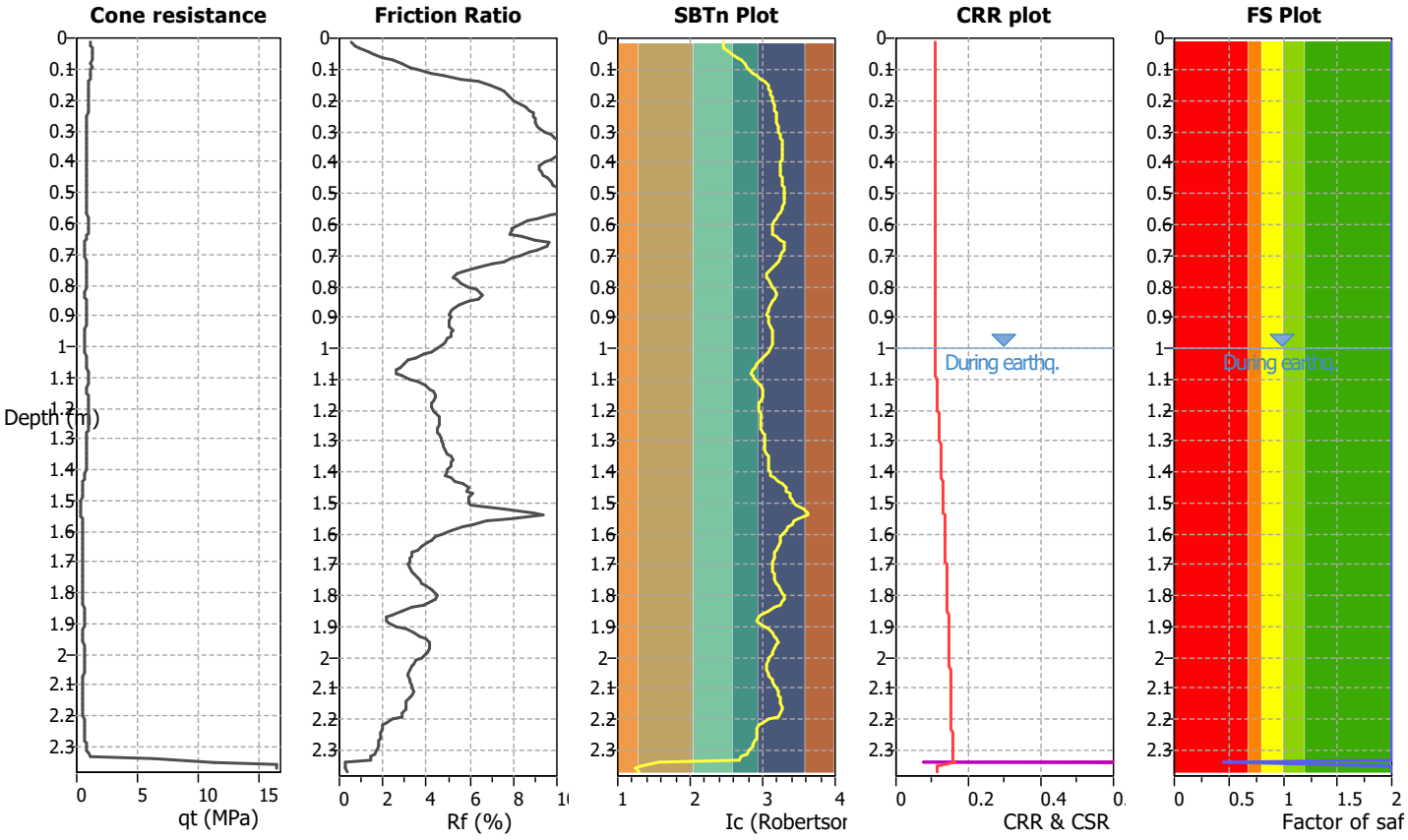
LIQUEFACTION ANALYSIS REPORT

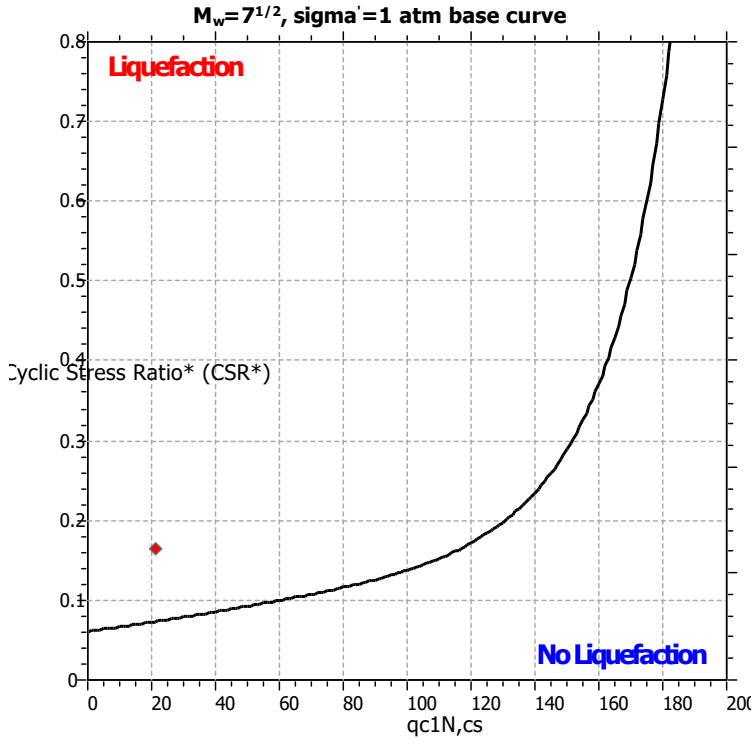
Project title : Waipapa Pine Limited **Location : Waipapa Pine Sawmill**

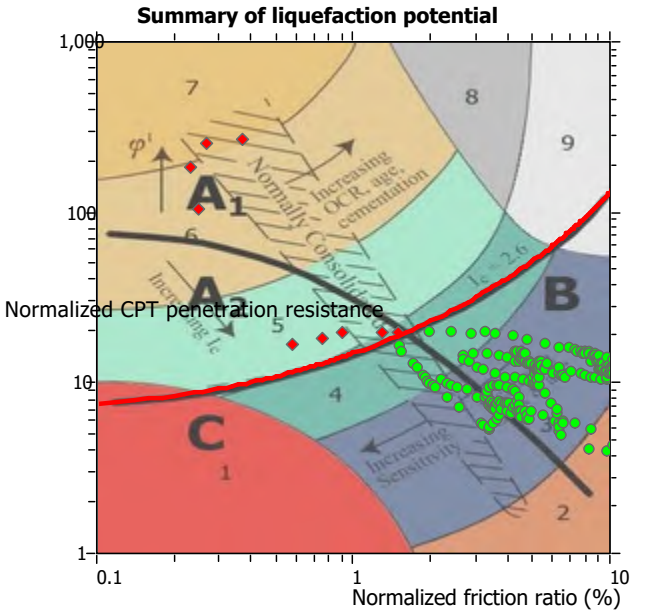
CPT file : CPT2413

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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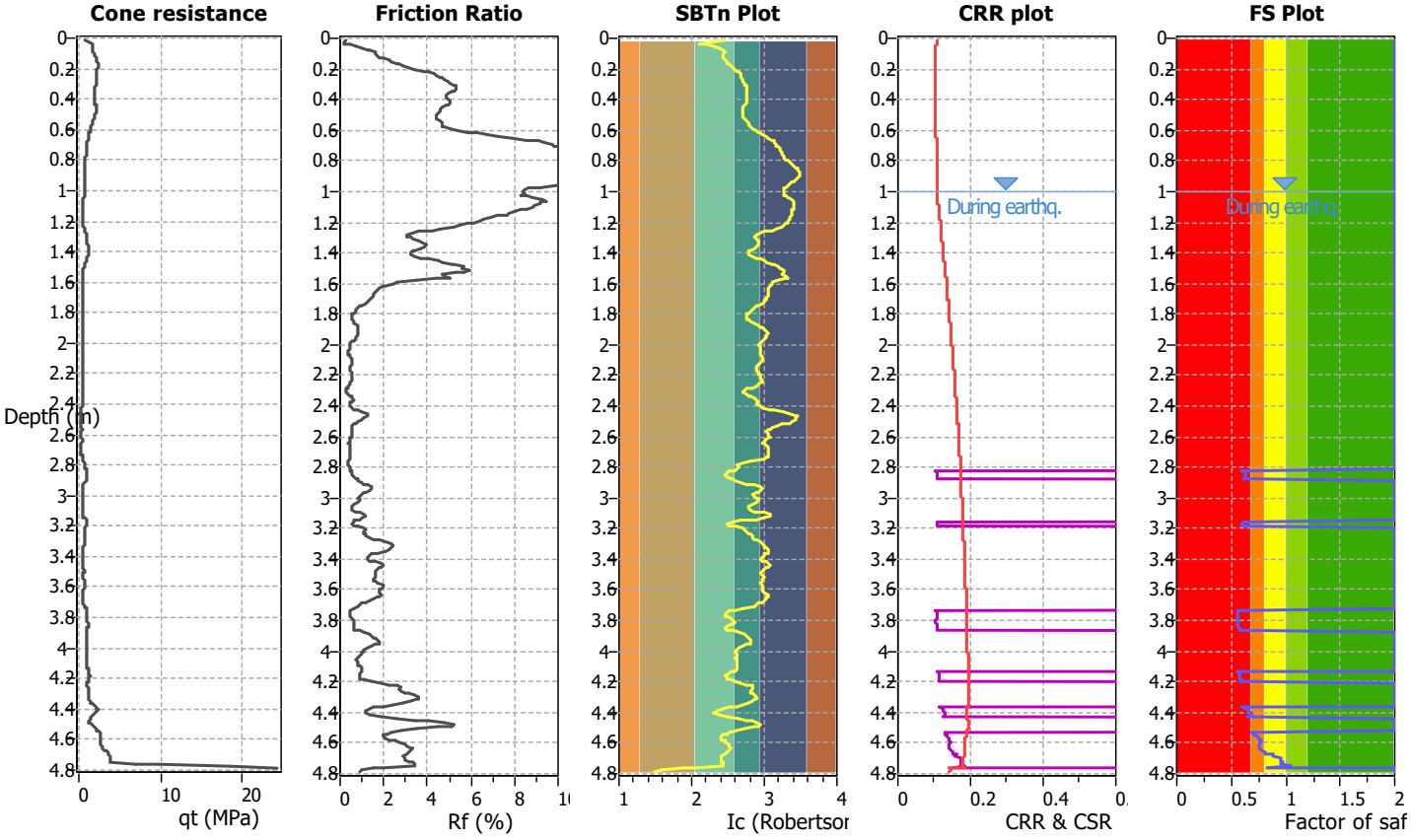
LIQUEFACTION ANALYSIS REPORT

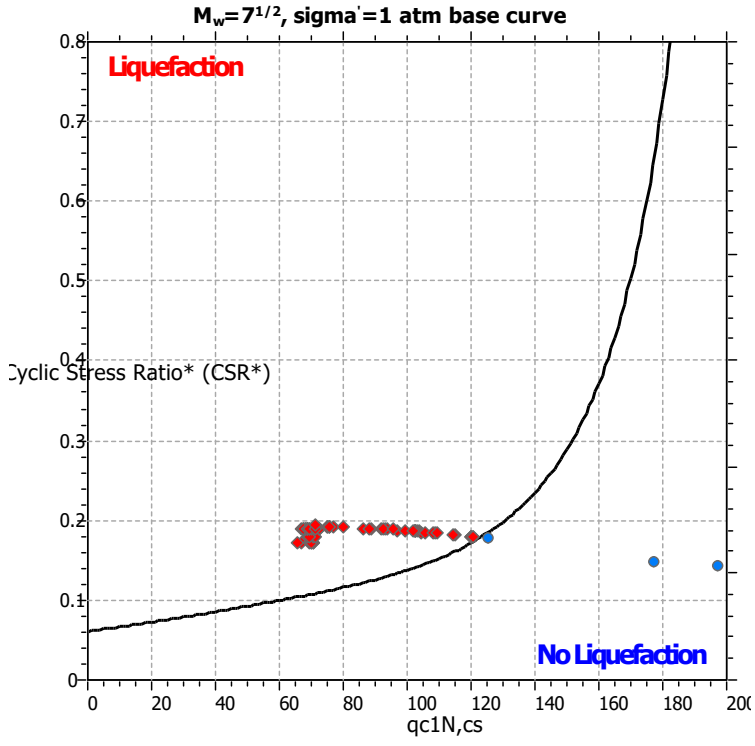
Project title : Waipapa Pine Limited **Location : Waipapa Pine Sawmill**

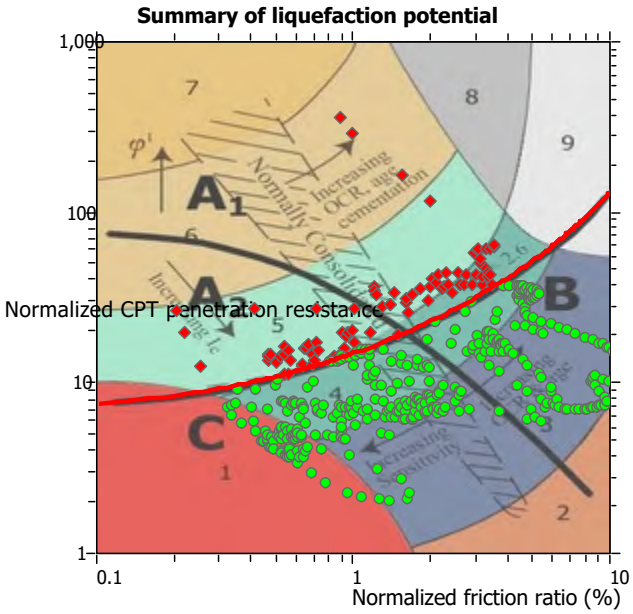
CPT file : CPT2414

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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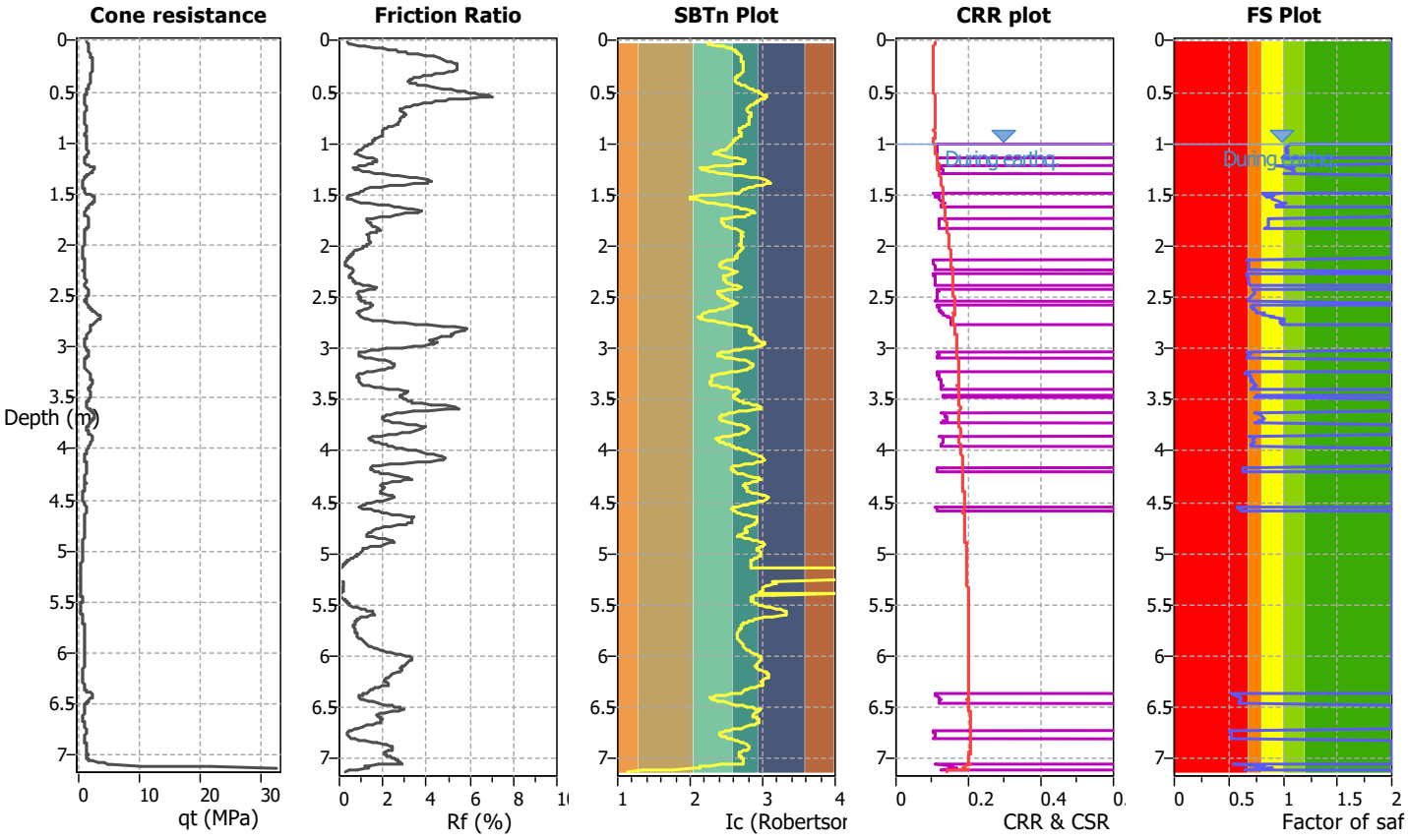
LIQUEFACTION ANALYSIS REPORT

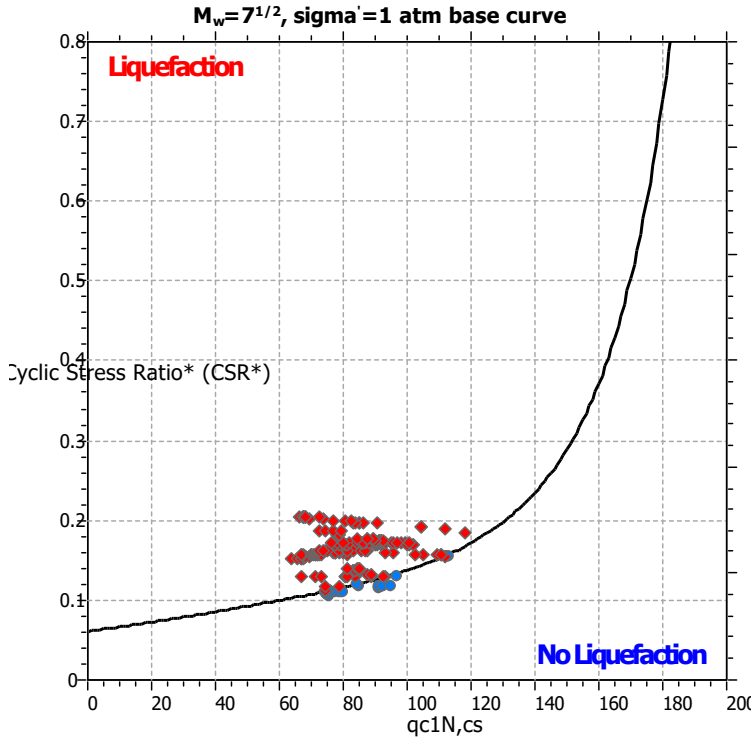
Project title : Waipapa Pine Limited **Location : Waipapa Pine Sawmill**

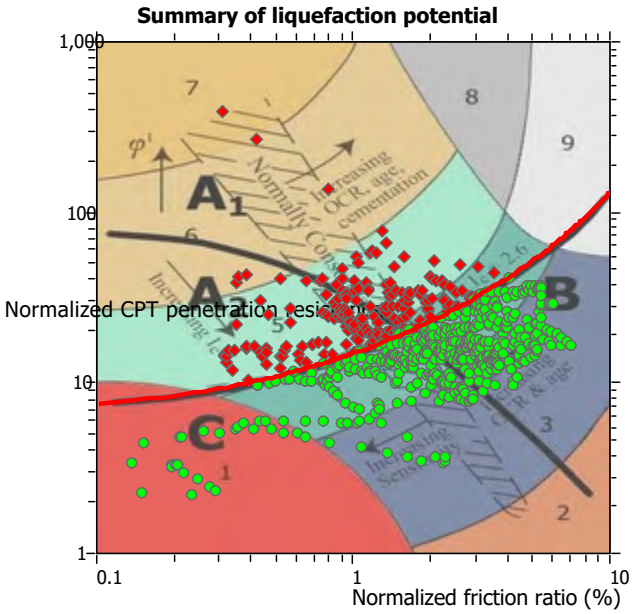
CPT file : CPT2415

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.00 m	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.00 m	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	10.00 m
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.19	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

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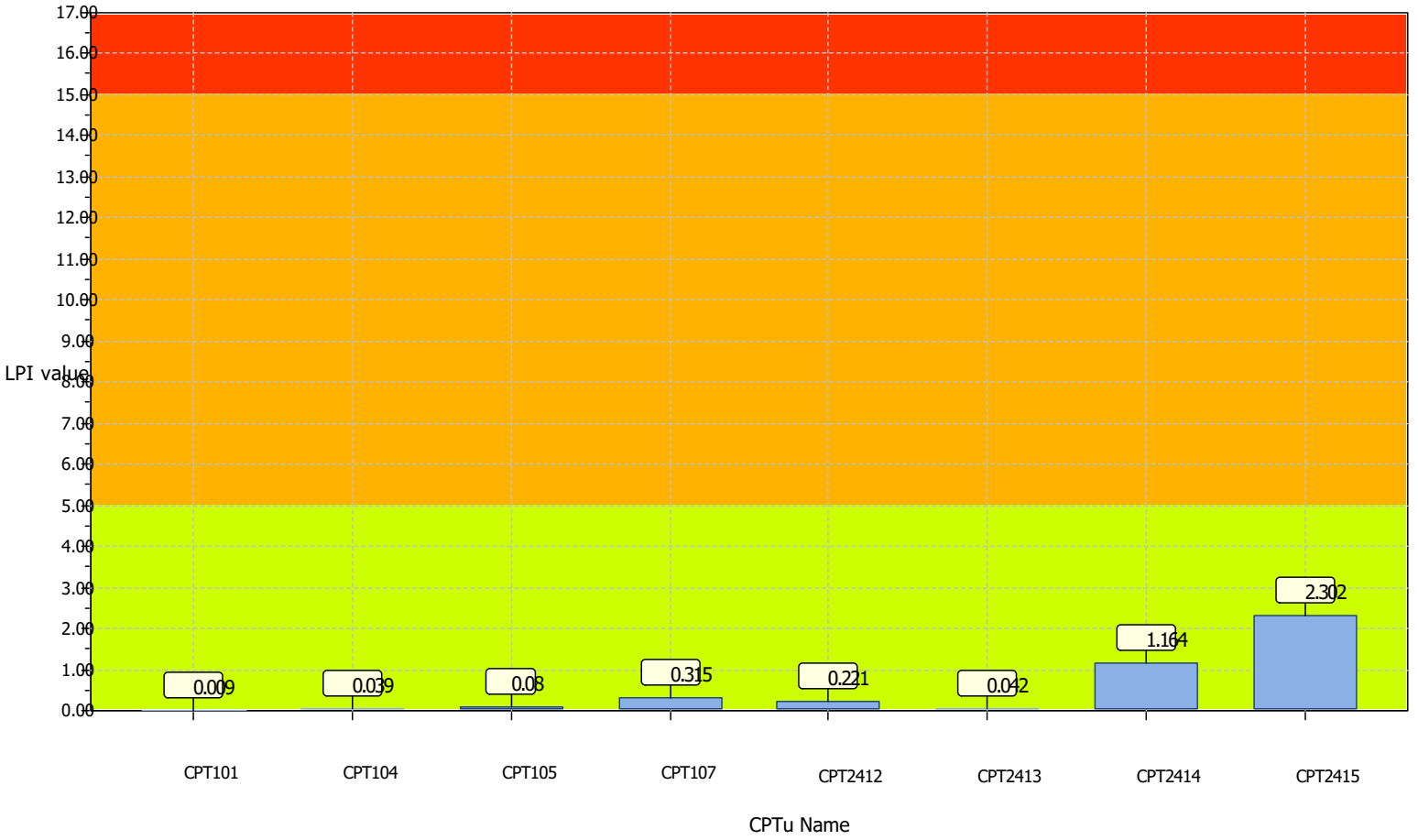
Project title : Waipapa Pine Limited

Location : Waipapa Pine Sawmill

Overall Liquefaction Potential Index report



LPI color scheme

- Very high risk
- High risk
- Low risk

Basic statistics

Total CPT number: 8
100.00% low risk
0.00% high risk
0.00% very high risk

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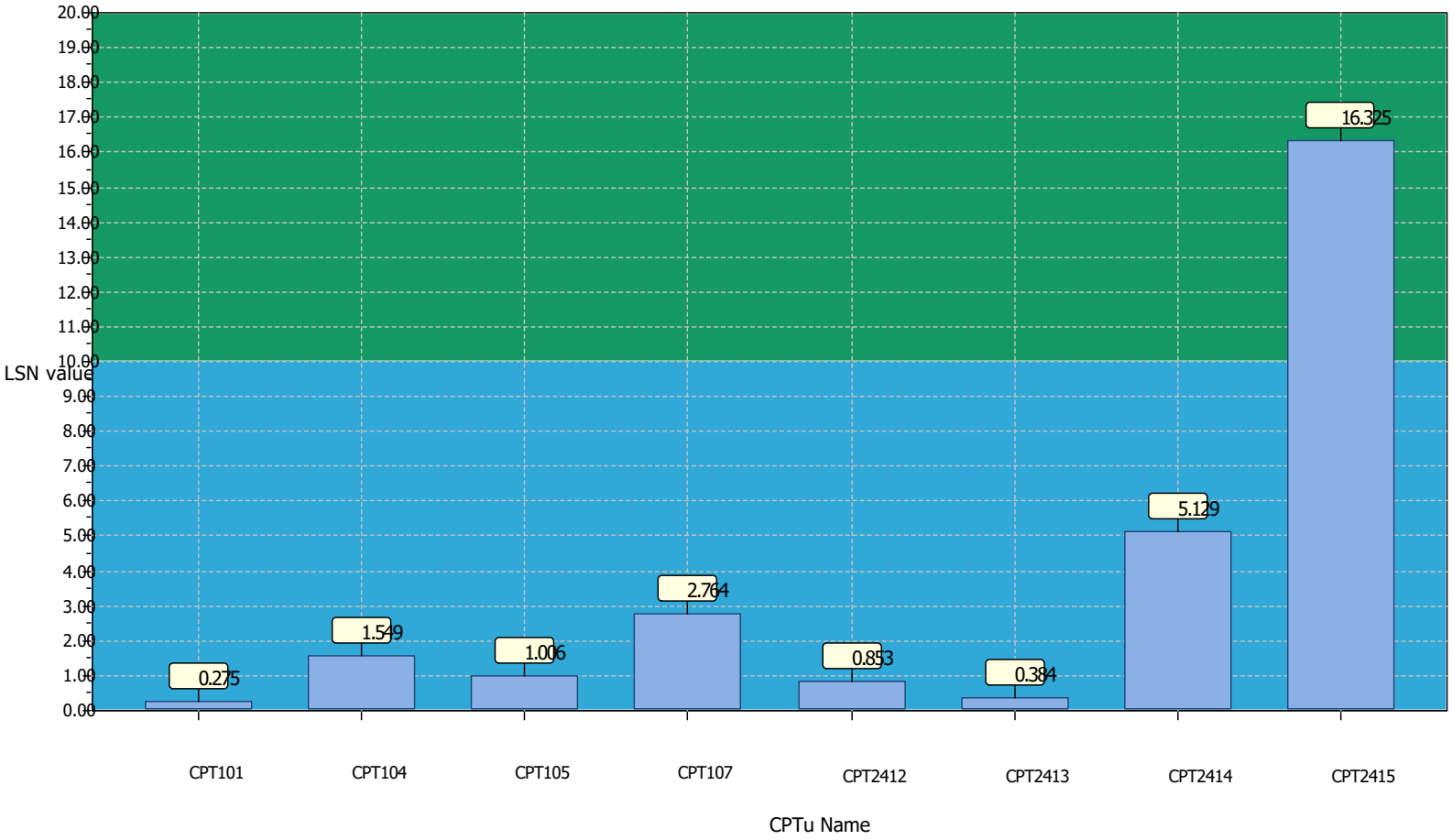
Project title : Waipapa Pine Limited

Location : Waipapa Pine Sawmill

Overall Liquefaction Severity Number report



LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction

Basic statistics

Total CPT number: 8

87.50% little liquefaction

12.50% minnor liquefaction

0.00% moderate liquefaction

0.00% moderate to major liquefaction

0.00% major liquefaction

0.00% severe liquefaction

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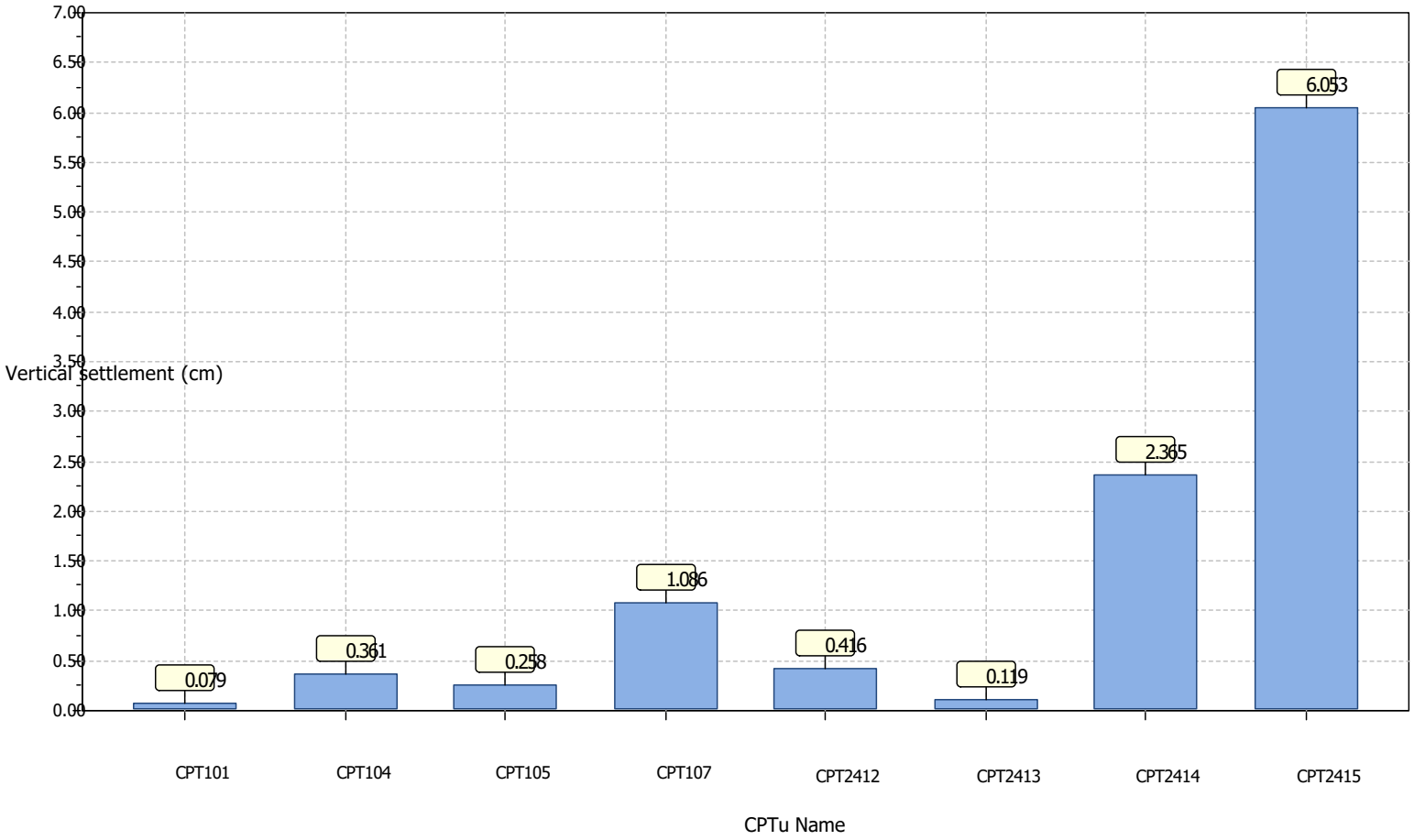
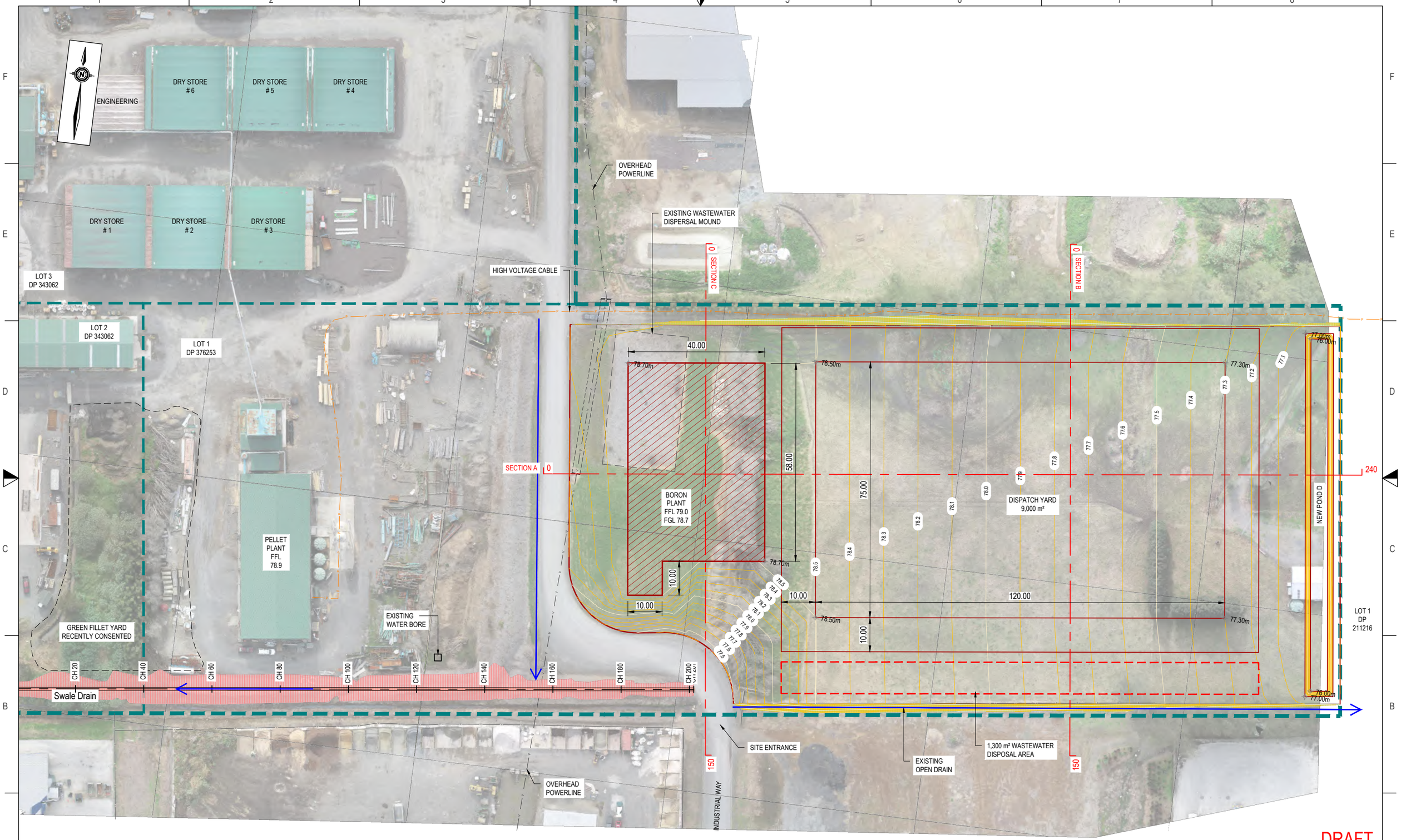
Project title : Waipapa Pine Limited

Location : Waipapa Pine Sawmill

Overall vertical settlements report



Appendix D – Concept Layout



DRAFT

Rev	Date	Description	By	Checked
A	24/04/2024	DRAFT	JT	AP

DWG SITE PLAN

A3 SCALE 1:1000 (0 – 20m – 50m)

Date 24/04/2024

Drawn JT | Checked AP | Approved

File O:\SUITEFILES - 23 256 - WAIPAPA MILL -1945B STATE HIGHWAY 10, WAIPAPA\ENGINEERING\DRAWINGS\01_CIVIL\23_256_CIVIL_DESIGN_C3D.DWG

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6 Fairway Drive
Kerikeri, BOI
T: 09 407 8327
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E: info@haighworkman.co.nz

Project FACILITIES DEVELOPMENT
WAIPAPA MILL - 1945B STATE HIGHWAY 10, WAIPAPA

Client WAIPAPA PINE LIMITED

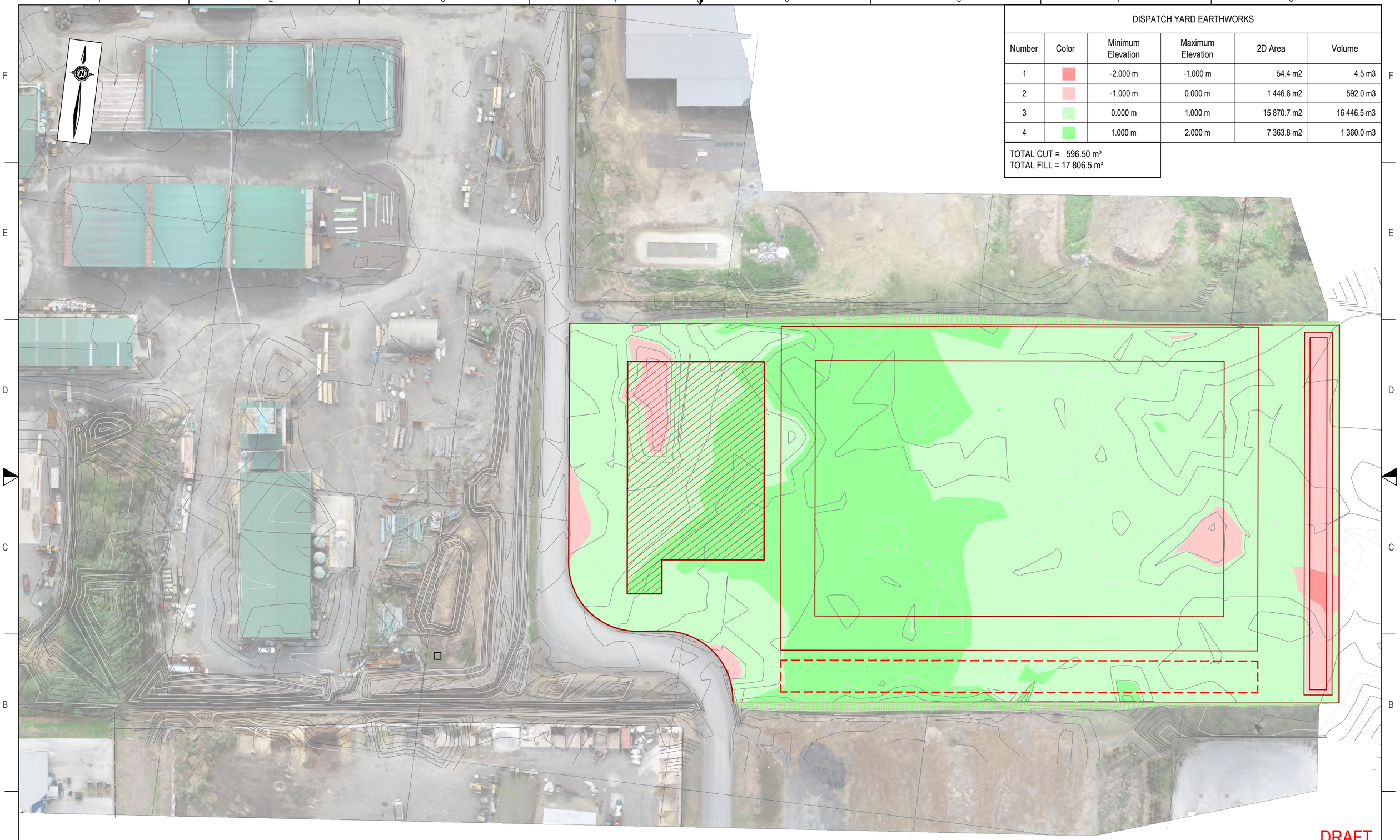
Project No. 23 256

RC no.

Stage

Dwg No. RDP01

Sheet No. 1 of 2



DISPATCH YARD EARTHWORKS					
Number	Color	Minimum Elevation	Maximum Elevation	2D Area	Volume
1		-2.000 m	-1.000 m	54.4 m2	4.5 m3
2		-1.000 m	0.000 m	1 446.6 m2	592.0 m3
3		0.000 m	1.000 m	15 870.7 m2	16 446.5 m3
4		1.000 m	2.000 m	7 363.8 m2	1 360.0 m3

TOTAL CUT = 596.50 m³
TOTAL FILL = 17 806.5 m³

DRAFT

Rev	Date	Description	By	Checked
A	24/04/2024	DRAFT	JT	AP

DWG EARTHWORKS PLAN

A3 SCALE 1:1000 0 20m 50m

Date 24/04/2024

Drawn JT | Checked AP | Approved

File O:\SUITEFILES - 23 256 - WAIPAPA MILL -1945B STATE HIGHWAY 10, WAIPAPA\ENGINEERING\DRAWINGS\01_CIVIL\23_256_CIVIL_DESIGN_C3D.DWG

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Project FACILITIES DEVELOPMENT
WAIPAPA MILL - 1945B STATE HIGHWAY 10, WAIPAPA

Client WAIPAPA PINE LIMITED

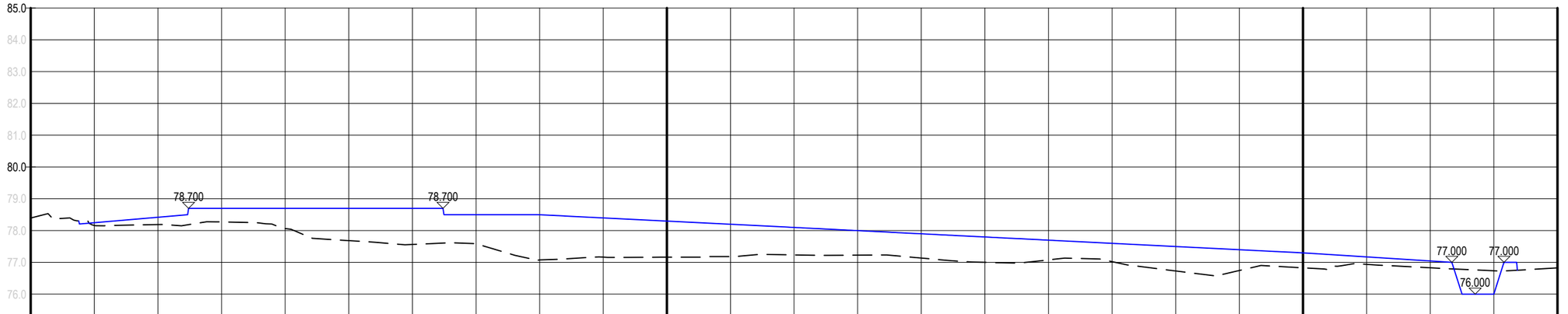
Project No. 23 256

RC no.

Stage

Dwg No. RDP02

Sheet No. 2 of 2



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Datum 70.0

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Existing Levels	78.394	78.161	78.189	78.271	78.062	77.683	77.562	77.587	77.076	77.164	77.16	77.180	77.234	77.226	77.135	77.000	77.077	77.020	76.729	76.743	76.83	76.936	76.830	76.735	76.752	76.825
Cut/Fill Depth		0.086	0.230	0.429	0.638	1.017	1.138	0.913	1.422	1.234	1.137	1.018	0.864	0.772	0.764	0.799	0.621	0.578	0.770	0.655	0.470	0.235	0.213	-0.734		
Chainage	0.000	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	90.000	100.000	110.000	120.000	130.000	140.000	150.000	160.000	170.000	180.000	190.000	200.000	210.000	220.000	230.000	233.694	240.000

SECTION A

Scale: Horizontal 1:500, Vertical 1:100

DRAFT

Rev	Date	Description	By	Checked
A	24/04/2024	DRAFT	JT	AP

DWG SECTION A

A3 SCALE 1:750 0 15m 37.5m Date 24/04/2024

Drawn JT | Checked AP | Approved

File O:\SUITEFILES - 23 256 - WAIPAPA MILL -1945B STATE HIGHWAY 10, WAIPAPA\ENGINEERING\DRAWINGS\01_CIVIL\23_256_CIVIL_DESIGN_C3D.DWG

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Project FACILITIES DEVELOPMENT
WAIPAPA MILL - 1945B STATE HIGHWAY 10, WAIPAPA

Client WAIPAPA PINE LIMITED

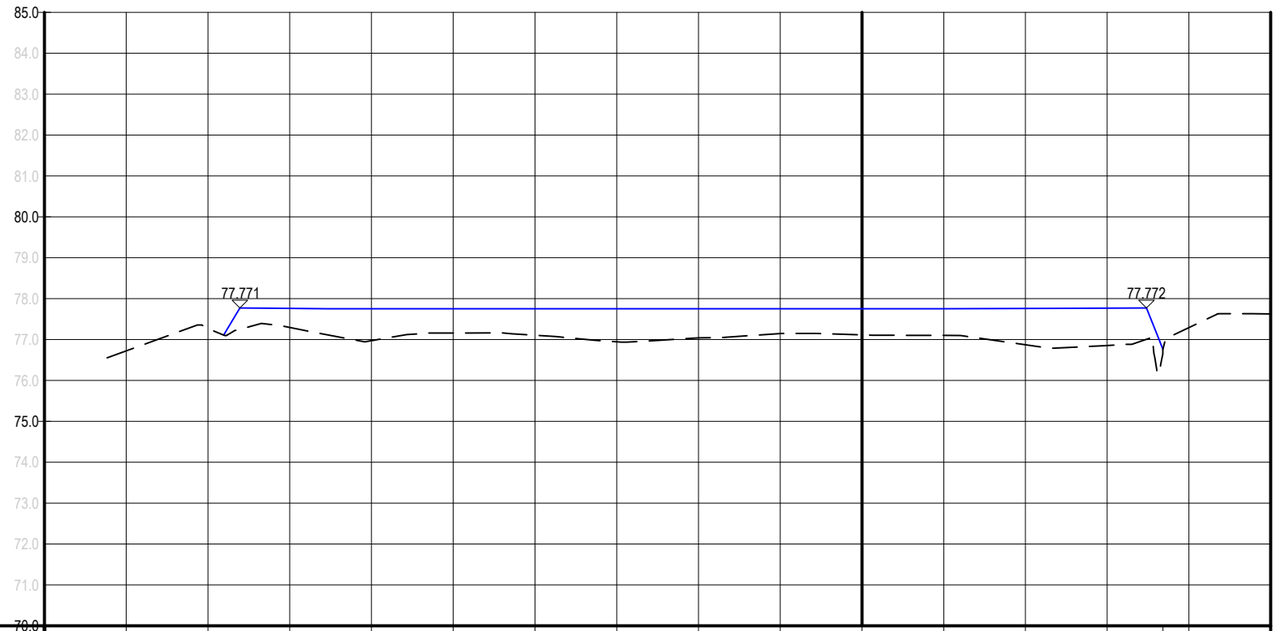
Project No. 23 256

RC no.

Stage

Dwg No. RDL01

Sheet No. 1 of 3



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Horizontal: 1:500

Datum 70.0

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Cut/Fill Depth			0.466	0.781	0.593	0.647	0.809	0.712	0.608	0.640	0.652	0.890	0.914			
Chainage 0.000	10.000	20.000	30.000	40.000	50.000	60.000	70.000	80.000	90.000	100.000	110.000	120.000	130.000	136.819	140.000	150.000

SECTION B

Scale: Horizontal 1:500, Vertical 1:100

DRAFT

Rev	Date	Description	By	Checked
A	24/04/2024	DRAFT	JT	AP

DWG SECTION B

A3 SCALE 1:750 0 15m 37.5m

Date 24/04/2024

Drawn JT | Checked AP | Approved

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Project FACILITIES DEVELOPMENT
WAIPAPA MILL - 1945B STATE HIGHWAY 10, WAIPAPA

Client WAIPAPA PINE LIMITED

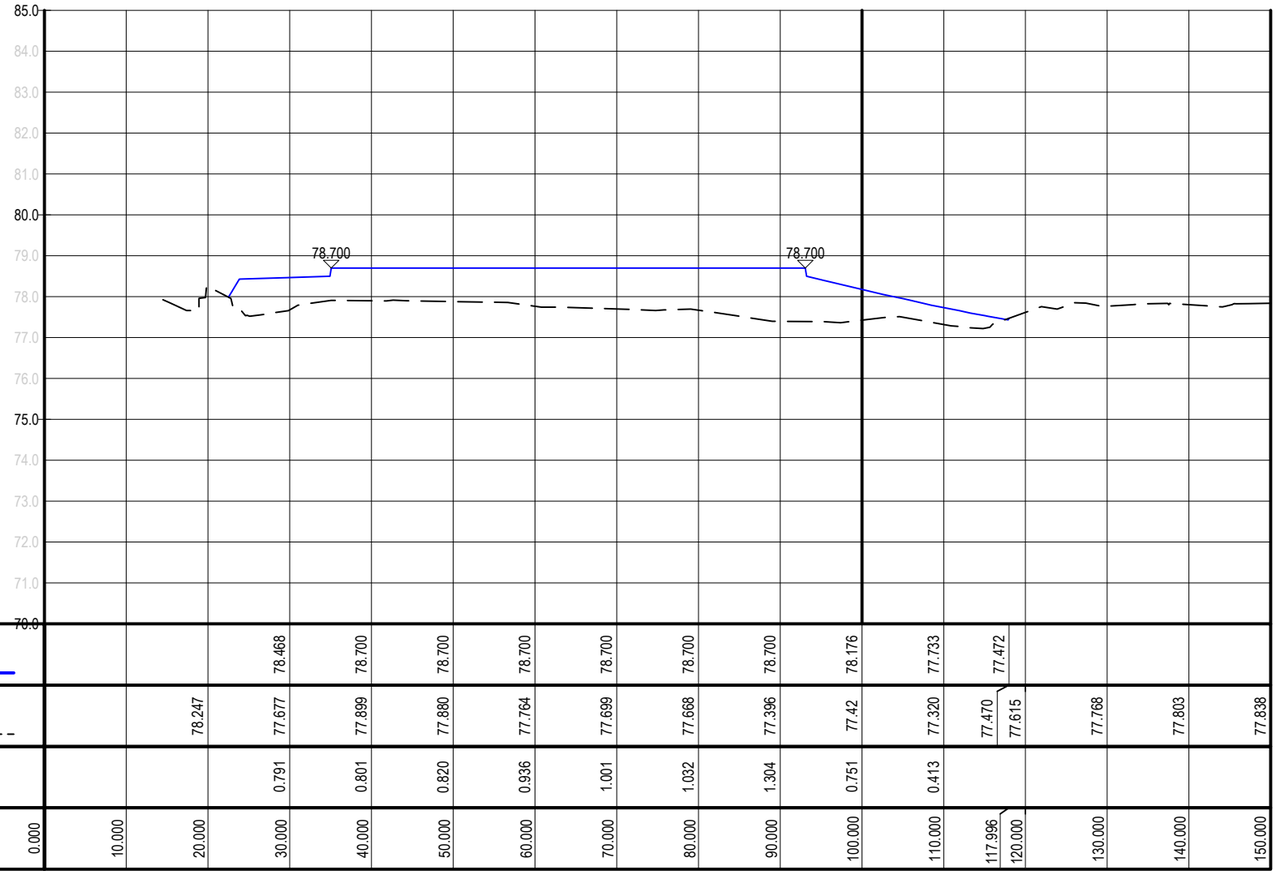
Project No. 23 256

RC no.

Stage

Dwg No. RDL02

Sheet No. 2 of 3



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Datum 70.0

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Design Levels				78.468	78.700	78.700	78.700	78.700	78.700	78.700	78.176	77.733	77.472				
Existing Levels		78.247	77.677	77.899	77.880	77.764	77.699	77.668	77.396	77.42	77.320	77.470	77.615		77.768	77.803	77.838
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SECTION C

Scale: Horizontal 1:500, Vertical 1:100

DRAFT

Rev	Date	Description	By	Checked
A	24/04/2024	DRAFT	JT	AP

DWG SECTION C

A3 SCALE 1:750 | 0 | 15m | 37.5m | Date 24/04/2024

Drawn JT | Checked AP | Approved

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Project FACILITIES DEVELOPMENT
WAIPAPA MILL - 1945B STATE HIGHWAY 10, WAIPAPA

Client WAIPAPA PINE LIMITED

Project No. 23 256 | RC no.

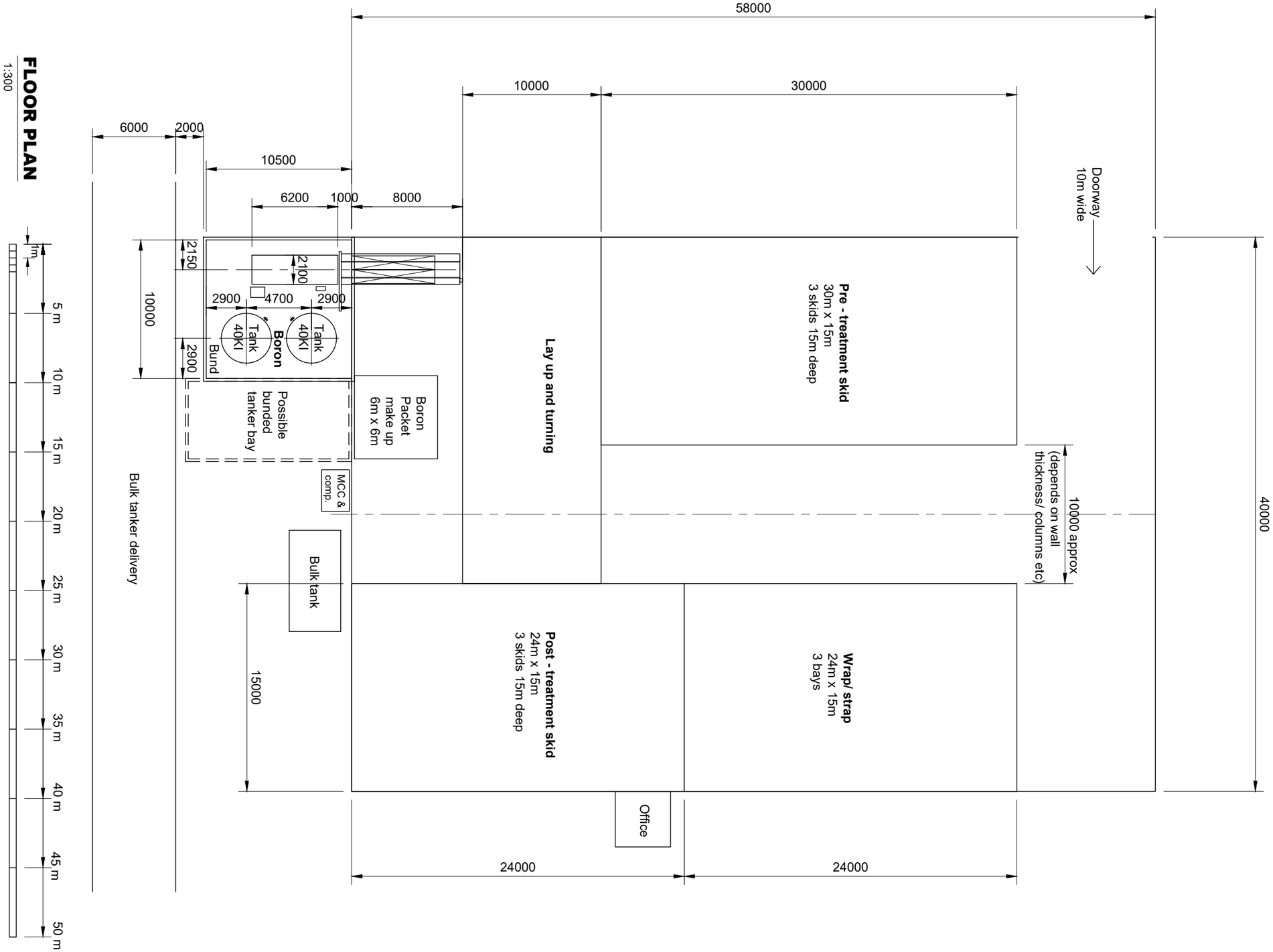
Stage

Dwg No. RDL03

Sheet No. 3 of 3

FLOOR PLAN

1:300



Rev:	Date:	By:	Details:
C	29/04/24	WS	Building length reduced, issued for site planning
B	09/04/24	WS	Updated & issued for site planning
A	02/12/23	WS	Issued for site planning

Prepared By:
Will Sumner Design Ltd
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WAIPAPA PINE
TIMBER PRODUCTS NEW ZEALAND

PROPOSED FLOOR PLAN

Design:	Date: 02/12/23	
Drawn: WILL	Scale: 1:300 @ A3	

Project: NEW BORON PLANT

Drg No: S01

Rev: C

WILLIAMSON
WATER & LAND ADVISORY

Preliminary and Detailed Site Investigation (Ground Contamination)

Proposed Dispatch Yard and Boron Plant

WAIPAPA PINE LIMITED

WWLA1088 | Rev. 4

2 July 2024

Preliminary and Detailed Site Investigation (Ground Contamination)

Project no:	WWLA1088
Revision:	4
Date:	2 July 2024
Client name:	Waipapa Pine Limited
Project manager:	Shane Moore
Author(s):	Steve Tyson
File name:	G:\Shared drives\Projects\Fletcher Building Ltd\WWLA1088_Waipapa Sawmill Boron Plant & Dispatch Yard\Deliverables\WWLA1088_Waipapa Sawmill Boron Plant DSI_020724_Rev4.docx

Williamson Water & Land Advisory

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Document history and status

Rev	Date	Description	By	Review	Approved
1	13 May 2024	Draft for client review	Steve Tyson	Shane Moore	Wendi Williamson
2	31 May 2024	Updated draft for client review	Steve Tyson	Shane Moore	Wendi Williamson
3	12 June 2024	For legal review	Steve Tyson	Shane Moore	Wendi Williamson
4	2 July 2024	For lodgement	Steve Tyson	Shane Moore	Wendi Williamson

Distribution of copies

Rev	Date issued	Issued to	Comments
1	13 May 2024	Fletcher Building Limited	Draft for client review
2	31 May 2024	Fletcher Building Limited, SLR Consulting	Updated draft for client review
3	12 June 2024	Fletcher Building Limited, SLR Consulting	For legal review
4	2 July 2024	Fletcher Building Limited	For lodgement

Executive Summary

Williamson Water & Land Advisory (WWLA) has prepared this combined preliminary and detailed site investigation (PSI / DSI) to assist Waipapa Pine Limited (Waipapa Pine) with its project to expand operations at its existing sawmill located at 1945B State Highway 10, Waipapa (the site). This includes the construction of a new dispatch yard, new boron treatment plant, a second boiler, on-site infrastructure upgrades, removal of existing bunds and associated earthworks. Minor works such as construction of the second boiler, associated local service connections, and formation of new car parking areas will occur within the existing sawmill plant area, which is identified as a HAIL by FNDC and NRC. However, these works are expected to be able to occur as permitted activities and are therefore not addressed further by this report. The PSI / DSI was undertaken to assess the potential for ground contamination to be present within the remaining development area and inform the ground contamination-related resource consent status. The key findings of this assessment are as follows:

History and potential for contamination [Section 3]	**The site history review has identified that NO activities listed on the Ministry for the Environment's Hazardous Activities and Industries List/ HAIL (those with potential to cause significant ground contamination) have been or are occurring in the area where bulk soil disturbance works are proposed:** • Review of the site history identified that the development area for the new dispatch area and boron treatment plant) was covered in pasture until 2017, when a laydown yard was created on the site of the proposed boron plant. The remainder of the development area remained in pasture and is still currently being grazed. • While the wider site has been used for sawmilling since 2004, associated activities with the potential to cause ground contamination, have not impacted on the primary development area. • Only the formation of existing stockpiles and bunds on parts of the primary development area were identified as being potential HAILs (category I). However, testing of site topsoil, bund materials and stockpiles shows that contaminants are not present at concentrations that pose a risk to human health. On this basis the HAIL activity I categorisation does not apply to the development area.
Conceptual site model (CSM) [Section 5]	**The CSM, developed to show where potential contamination risks lie, indicates there is no risk to site workers during earthworks associated with the redevelopment of the site, future users of the site, or the environment (during or post redevelopment).** • The presence of contaminants above expected background ranges means that some surplus topsoil will need to be disposed to appropriately consented managed fill facilities.
Consenting requirements [Section 6.1]	**The requirements of the National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health Regulation (NESCS) and contamination-related rules of Section C.6.8 of the Proposed Regional Plan for Northland (PRPN) DO NOT APPLY to the proposed development area.** • As no HAIL activities have been or are occurring on the site the NESCS does not apply to the site and consent is not required under this legislation. • As no HAIL activities have been or are occurring the contaminated land rules of Section C.6.8 of the PRPN do not apply to the proposed works and consent is not required under these regulations.
Construction implications [Section 6.2]	**Standard earthworks and health and safety procedures are expected to be suitable for earthworks, but some surplus surficial soil material is not suitable for disposal as cleanfill:** • All soils can be reused onsite. • Specific contamination-related health and safety controls are NOT required for disturbing any soils in the development area. • All soils can be removed and placed onsite under standard earthworks controls. • Some topsoil across the proposed development area contains cadmium above the criteria for protection of human health under rural residential land use, meaning that beneficial offsite reuse of some of these soils will need to be appropriately managed. Management options could comprise: - Allowing reuse of soils only on non-rural residential properties. - Separating soils to divert unsuitable material away from rural residential properties. - Mixing soils to dilute the contamination so it complies with rural residential acceptance criteria. • Soil around the implement shed (expected to be limited to a 1-2 m wide halo) and the eastern most stockpile (SP06) contains metals at concentrations slightly above expected background ranges. This soil is should either be retained onsite or, if surplus to site requirements, disposed of to appropriately consented facilities (managed or Class 3 fill sites are suitable). It may also be possible to mix these materials with topsoil from the

	wider development area to comply with background ranges. However, this option must be accepted by the receiving site before mixing occurs.

Contents

Figures:

Tables:

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1. Introduction

Williamson Water & Land Advisory (WWLA) was commissioned by Waipapa Pine Limited (Waipapa Pine) to prepare this combined preliminary and detailed site investigation (PSI / DSI) to assist with its project to expand operations and construct new facilities at its existing sawmill located at 1945B State Highway 10, Waipapa (the site). This includes the construction of a new dispatch yard, new boron treatment plant, a second boiler, on-site infrastructure upgrades, removal of existing bunds and associated earthworks.

For the purposes of this report:

- References to "the site" means Waipapa Pine's entire property.
- References to "the development area" means the area on the site where the majority of the new facilities will be developed and associated bulk earthworks will be undertaken.

An aerial photograph of the site (outlined in red) and the development area (outlined in yellow) is shown in **Figure 1** (overpage).

While most of the works are proposed to occur in the development area, minor works such as construction of the second boiler, associated local service connections, and formation of new car parking areas will occur within the existing plant area. For the following reasons these minor works are not specifically addressed by this report:

- Foundations for the second boiler are expected to be installed using piling methods with the area needing to be filled to achieve design levels.
- Local service connections and formation of car parks are expected to require only limited disturbance of soils underlying the site.
- Collectively the works required within the existing plant area are expected to comply with the permitted activity thresholds set out under:
  - Regulation 8[1] of the Resource Management (National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations (2011), herein referred to as the NESCS; and
  - Rule C.6.8.2 of the Northland Regional Council's (NRC) Proposed Regional Plan for Northland (PRPN)[2].
- On completion of the upgrade works the areas will be covered by new structures and/or pavements so that soil contamination (if any) will not present an unacceptable risk to either human health or the environment.

1.1 Background and objective

The Waipapa Sawmill processes logs to produce a range of industrial and structural grade sawn timber products. The mill's primary product is high grade framing timber for the new house construction market in the North Island. Further development of the site is planned, including a new boron plant and dispatch yard to be located to the east of the main access road. Bulk earthworks will also include removal of stockpiles and bunds currently located immediately to the west of the main access road (see **Figure 1**). Selected development plans are included for reference in **Appendix A**.

The development area has principally been used for pastoral farming / rural residential purposes with sawmilling activities limited to outdoor storage of equipment, stockpiling of soil and operation of a wastewater treatment field (septic system only). Nevertheless, development will require stripping of topsoil and other unsuitable soils. If this material is surplus to site requirements (likely) then offsite disposal facilities are likely to require testing before they will accept it.

[1] Based on the plant site area of some 75,000 m^2, Regulation 8 the NESCS allows for disturbance of some 3,750 m^3 of soil, with up to 750 m^3 of this material being able to be disposed offsite per year. The minor works are expected to fall within these thresholds.
[2] On completion of the works ongoing passive discharges from the minor works areas are not expected to give rise to concentrations of contaminants in either surface or groundwater that would exceed drinking water standards or ANZECC 2000 guidelines.

In addition, Far North District Council (FNDC) and NRC identify the site as a "Verified HAIL"[3], under category "A18. Wood treatment or preservation or bulk storage of treated timber". As a result, soil disturbance may trigger the need for resource consent under the NESCS and/or the PRPN. The objective of this investigation was to confirm the contamination status of the soil materials in the areas that are to be developed. This will determine if the NESCS and/or contaminated land requirements of the PRPN apply to the proposed development.

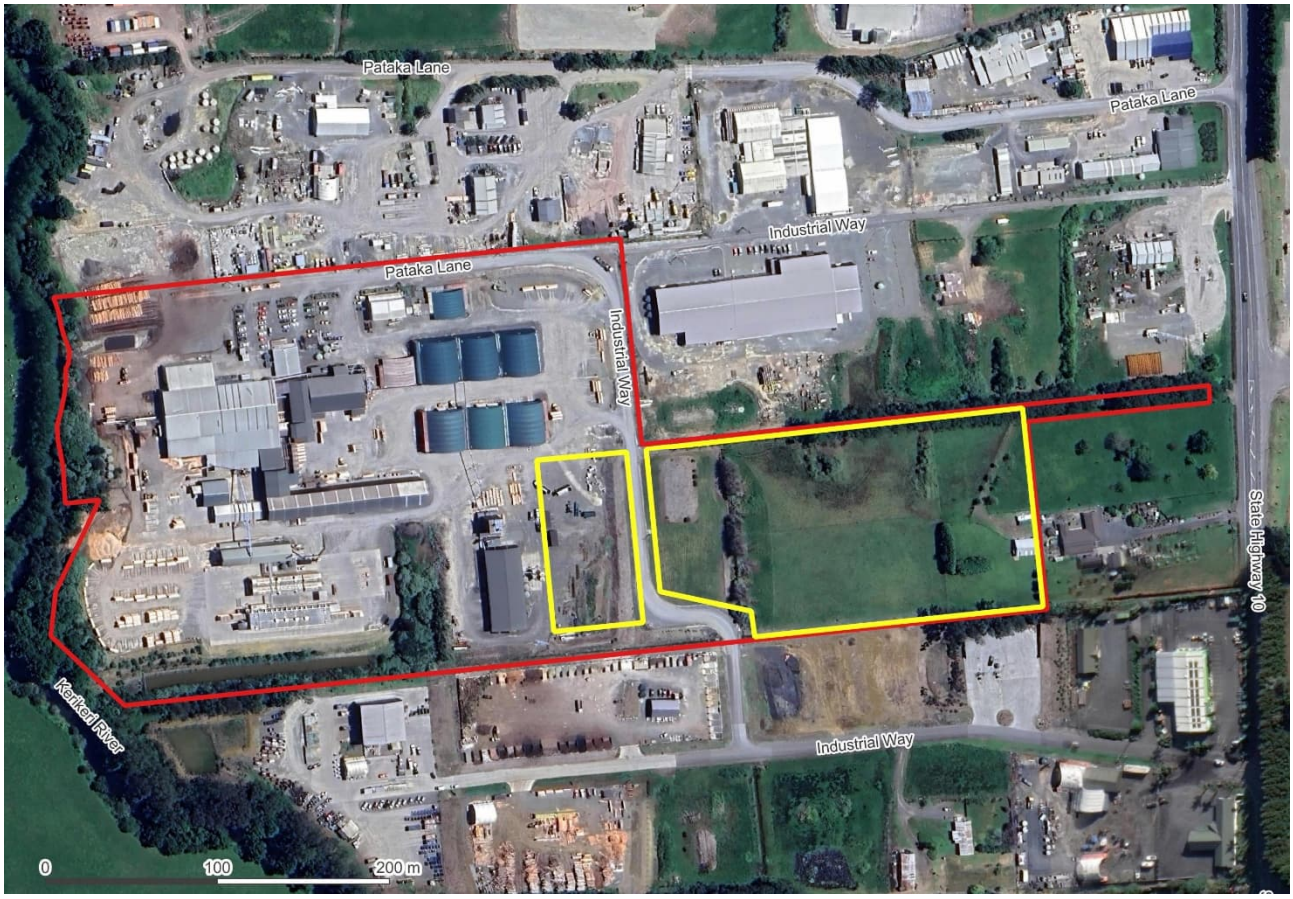


Figure 1. Site Location (Aerial source: LINZ)
Development area (bulk earthworks) outlined in yellow, wider sawmill site (the site) in red

1.2 Scope of work

The following scope of works was undertaken:

1. Review of existing ground contamination related reports and publicly available aerial photographs to establish the site history.
2. Collection and analysis of soil samples from within the development area to evaluate potential contamination levels.
3. Development of a conceptual site model (CSM) to assess contaminant risks and mitigation requirements.
4. Evaluation of the consenting and earthworks/construction implications for potential development in a commercial / industrial land use context.
5. Preparation of this report which summarises the above.

[3] Ministry for the Environment's Hazardous Activities and Industries List (HAIL)

1.3 Legislative requirements

WWLA has undertaken investigations and prepared this report in general accordance with requirements of published industry best practice guidance, including:

- Ministry for the Environment (MfE). Contaminated Land Management Guideline No. 1: Reporting on Contaminated Sites in New Zealand (Revised 2021), (CLMG1); and
- MfE's Contaminated Land Management Guidelines No. 5: Site Investigation and Analysis of Soils (Revised 2021), (CLMG5).

This report has been prepared, reviewed, and certified by a SQEP as described in the NESCS and NESCS Users' Guide[4]. CVs confirming the SQEP status of our contaminated land specialists are available on request.

[4] MfE, April 2012. *NESCS Users' Guide: National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health*.

2. Site Setting

The site setting is described in **Table 1**. The features of the site setting are considered in the context of their potential to affect the distribution, mobility and form of contaminants (if present). These variables inform the conceptual site model (CSM) evaluation (**Section 5**), if it is established that activities with potential to cause ground contamination have occurred.

Table 1. Site setting

Site surrounds	*The nature of surrounding land uses affects both how the site might be impacted by activities in its surrounds (e.g. be contaminated by adjacent land uses), and how contaminants present at the site (if any) might impact on surrounding land uses.* The site is bordered from State Highway 10 to the east and Kerikeri River to the west. It is bordered principally by a mixture of industrial uses, including immediately to the: • South by Northland Waste Kerikeri and Waipapa Landscape Supplies; and • North by Precast Products and Mahalo Transport. In the wider area uses include truck refuelling stops (Z and Allied Petroleum), kiwifruit packing, rural supplies (PCG Wrightson and Farm Source), various automotive and marine servicing businesses and an equipment hire business, amongst other commercial and industrial uses. The nearest residential dwelling, a rural residential property (lifestyle block), is located immediately east of the proposed dispatch yard. However, no other residences are located within a radius of at least 250 m of the site. The development area is bordered by: • Industrial sites to the north (including part of the existing sawmill, refer below) and south; • The rural residential property to the east; and • The sawmill to the west (pellet plant) and partially to the north (dry stores).
Topography and drainage	*The topography and drainage influences where contaminants may migrate to if present and surface water features are potential receiving environments for contaminants (if any) derived from the site.* The topography of the site and surrounds is subdued with a gentle fall west towards the Kerikeri River. Both NRC and FNDC map floodplains associated with the Kerikeri River, but these are not inferred to extend into the development area even under the climate change inundation scenarios modelled. The proposed dispatch yard comprises grassed paddocks that have a gentle fall to the south where a drainage channel, which also takes runoff from State Highway 10, flows towards the south-west. Two vegetated stockpiles of soil are located approximately centrally on the northern boundary of this part of the development area. The proposed development areas are divided by a gravel access road (Industrial Way). A roadside drainage ditch runs north to south on the western side of Industrial Way (the proposed boron plant side of the road). The ditch, which was dry at the time of the site investigation, connects to the drainage south-westerly flowing drainage channel described above. A bund wall of stockpiled soil (2 to 3 m above the surrounding grade) has been formed to the west of the roadside drainage ditch, it forms the eastern extent of the proposed boron plant area and curves to the west to also form the southern boundary. The remainder of the proposed boron plant area comprises a level gravel yard / laydown area.
Geology	*The geology is considered in the context of its potential to promote or retard the movement of contamination. For example, coarser grained soils (e.g. sands and gravels) can enable contaminants to move more quickly and potentially further than clay-rich soils that retain or prevent penetration of contaminants.* The published geological map[5] indicates that the site is underlain by Tauranga Group alluvium. The Tauranga Group comprises unconsolidated to poorly consolidated mud, sand, gravel and peat deposits of alluvial, colluvial and lacustrine origins. The Tauranga Group alluvium overlies volcanic deposits (basalt flows) of the Kerikeri Volcanic Group.
Hydrogeology	*Hydrogeological conditions affect the potential risk of a contaminant entering and being transported in groundwater*. During the site investigation, groundwater was encountered at around 1 m below ground level at some of the deeper hand auger locations. The shallow depth to groundwater is consistent with the alluvial / flood plain setting. A deeper aquifer is associated with the underlying basalt lava flows.
	Sensitive environmental receptors could include aquatic or terrestrial ecosystems. This is not an ecological assessment but is instead an initial review of the surrounding environment to assess where contaminants (if present) on the site

[5] Edbrooke, S.W., and Brooke., F.J., (compiler) 2005, Geology of the Whangārei area. Institute of Geological and Nuclear Sciences 1:250,000 geological map 2, Institute of Geological and Nuclear Sciences.

Sensitive receptors	*could migrate to and whether the receiving ecosystem could be vulnerable to contaminants*. The Kerikeri River and associated ecosystems are the nearest significant sensitive environmental receptors.
	Sensitive human receptors could for example be children at a school or kindergarten on or adjacent to a site. Workers on industrial land (including or adjacent to a site) would be considered less sensitive. Surrounding properties are predominantly commercial and industrial in nature so the users are not considered to be sensitive receptors. There is one rural residential property immediately to the east of the development area which could include sensitive receptors.

3. HAIL Assessment

This section provides a review of current and historical land uses to assess the potential for any identified HAIL activities to have resulted in ground contamination. The HAIL assessment also informs the consenting status under the NESCS.

3.1 Site Layout

The development area was visited by a SQEP from WWLA on 26 and 27 March 2024. Site observations and selected photographs are provided below, the layout and key features are shown on **Figure 2**:

- The topography of the development area is generally flat, with the area of the proposed dispatch yard being pastoral and currently grazed (**Photograph 1**).
- A three-bay garage / farm implement shed (**Photograph 2**) is located at the eastern boundary of the development area, it is associated with the nearby residential dwelling. It is clad (walls and roof) in unpainted corrugated iron, has basic unpainted timber joinery and no evidence of asbestos containing material cladding. At the time of the investigation it was being used to house a large caravan.
- Two soil stockpiles are present within the proposed dispatch yard area. These appear to consist of topsoil that has been stripped from the wider sawmill site.
- An effluent soakage field (**Photograph 3** and **Photograph 4**) is located in the northwestern corner of the proposed dispatch yard area. This field takes treated wastewater from onsite toilets and amenities. Waipapa Sawmill staff (Dan Spake, General Manager) confirmed that no process water discharges to this field. During the investigation the soakage area was observed to be dry, with no ponding of liquid nor odours detected. A small pile of concrete rubble has been placed to the east of the effluent soakage field (**Photograph 4**).
- The proposed boron treatment plant location is bounded on its eastern and southern sides by an earthen bund (**Photograph 5**). There is a stockpile (**Photograph 6**) of similar material in the southern portion of this area, both are presumed to consist of soil that has been removed during development of the wider sawmill site.
- The majority of the proposed boron treatment plant area comprises a gravel yard / laydown area (**Photograph 6** and **Photograph 7**) which is being used to store a variety of equipment and pipework (concrete, polyethylene and PVC pipes) and similar inert materials. No staining of the gravel surface, other evidence of contamination, was observed during the site investigations.

Photograph 1. View to west from grazed area of the proposed dispatch yard.

Photograph 2. View of the western side of the three bay implement shed / garage.

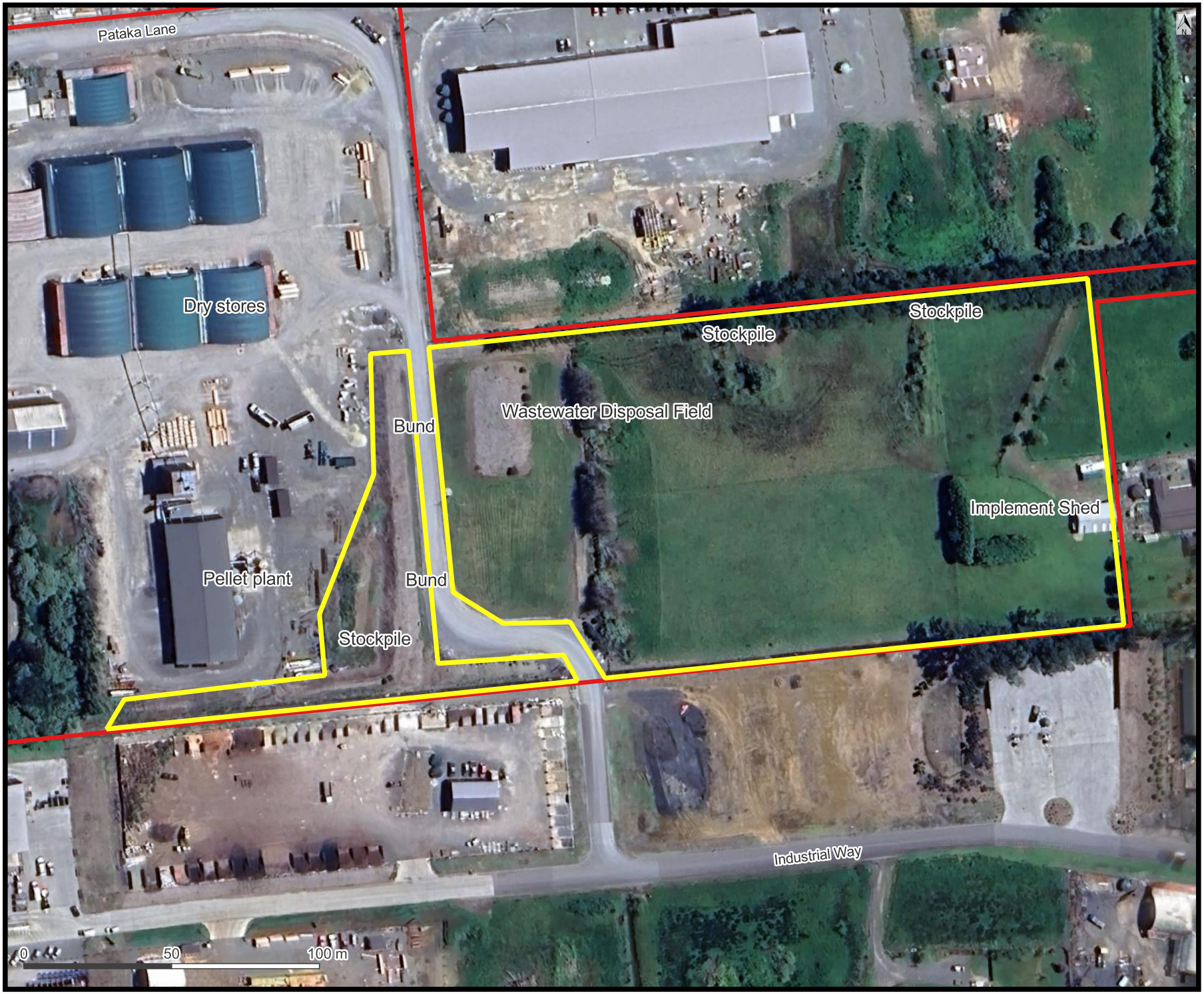
Photograph 3. View of the effluent soakage field, looking west. Soakage field in foreground with Industrial Way and bund beyond.

Photograph 4. View of the effluent soakage field, looking south, with small pile of concrete rubble to left of image.

Photograph 5. View of the roadside drainage ditch and bund along eastern side of the proposed boron plant area, looking south.

Photograph 6. View of the proposed boron plant area, looking south. Pellet plant and associated silos to right of image. Stockpile of soil with bund beyond to the left of image.

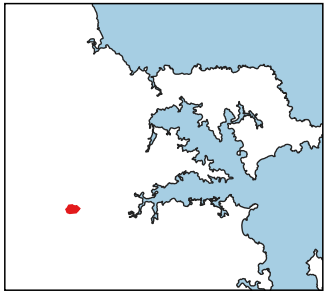
Photograph 7. View of the proposed boron plant area, looking north, taken from soil stockpile. Drying sheds in background, pellet plant to left of image



Map Title:
Site features layout

Project:
Waipapa Sawmill Boron Plant & Disptach Yard

Client:
Fletcher Building Ltd



Legend

- **Site boundary**
- **Extent of bulk soil disturbance works**

Data Provenance
Aerial imagery and land parcels from Land Information New Zealand

Drawn by: Becki Williamson
05/06/2024

Layout Name
Figure 2

WILLIAMSON WATER & LAND ADVISORY

Figure 2.

3.2 Site history

The site history was assessed by review of the property file and client-provided data (previous investigation reports).

In summary, the historical review outlined in the following sections confirms the site was developed in the early 2000s for use as a sawmill. Development of the site has continued to the present day, however the proposed development area has remained largely undeveloped, principally being used for grazing. Activities within the development area have been limited to:

- ***The construction of a three bay farm implement shed, probably in the 1990s, at its eastern end;***
- ***Placement of gravel hardfill and use as a laydown yard at its western end;***
- ***Limited stockpiling of soil along with the construction of earth bunds along the main site access road; and***
- ***Operation of an effluent soakage field that receives treated wastewater from the sawmill toilets and amenities.***

3.2.1 Previous Investigations

Pattle Delamore Partners Ltd (PDP) recently assessed ground contamination conditions as part of Fletchers' due diligence process prior to its recent acquisition of the sawmill[6]. The assessment included a review of the wider site history which identified the following key findings:

- The northeast corner of the wider site was being used for market gardening / horticultural purposes in the 1971 historical aerial photograph. This activity was not evident by 1981. Anecdotal evidence provided during site interviews suggests topsoil from this portion of the site may have been moved to form bunds and stockpiles that are present elsewhere on the wider site, including within the subject area.
- The northwest portion of the wider site has been operational the longest, with development occurring circa 2004. Anti-sapstain treatment was used in the older portions of the wider site, but this activity has not occurred at the Sawmill since 2011. The areas where anti-sapstain treatment most likely occurred are some 150-200 m from the western end of the development area.
- The pellet plant uses sunflower oil as a binding agent. There are no chemical additives.
- Forklifts are refilled as required via mini tanker operated by a specialist contractor.
- Asbestos is known to be present in the weatherboard cladding and soffits of the main site office (some 150 m from the northwestern end of the development area).
- Maintenance and engineering workshops were identified as being present on the northern side of the wider site (some 125 m from the north eastern end of the development area).

Collectively the above information suggests that the possible deposition of topsoil potentially derived from a former horticultural area and stockpiled or used to create boundary bunds in defined areas of the development area is the only activity with potential to have resulted in contamination of the development area. All other activities are sufficiently distant from the development area that they are highly unlikely to have resulted in soil contamination. To further evaluate potential sources of contamination we have conducted a review of historic aerial photographs focussing specifically on activities undertaken in the vicinity of the development area (proposed boron plant and dispatch yard). Selected historic aerial photographs (reproduced from PDP, 2022) are provided for reference in **Appendix B**.

In summary, review of the historic aerial photographs confirms that other than the construction of the three bay implement shed at the eastern boundary, the effluent soakage field and stockpiling of soils, there is no evidence of any other activities with the potential to cause significant ground contamination having been conducted on the development area. As this area was only disturbed or developed (circa 2017) after the use of anti-sapstain

[6] PDP, 2022. Due Diligence Investigation for 1945b State Highway 10, Waipapa. Report prepared for Fletcher Building Limited by Pattle Delamore Partners Ltd, dated 5 December 2022. Reference: A03977100L001 WAIPAPA.docx

chemicals ceased at sawmill (circa 2011) there is no mechanism for these chemicals to be present within the development area (proposed boron plant and dispatch yard areas).

3.2.2 Property file

The property file for Lot1 DP 372653, which encompasses the development area, was received from Far North District Council in March 2024. The only documents in the file relate to subdivision to create the existing lifestyle property (current residential dwelling to the east of the development area), and associated parcels and accessways. No evidence of activities with the potential to cause significant ground contamination were identified in the property file.

3.3 Potential for contamination

Potentially contaminating activities identified for the development area are described in **Table 2** along with an assessment of the likelihood and magnitude of any contamination resulting from the activity, and whether the activity constitutes a HAIL. Shading indicates the status of potential HAIL activities based on the site walkover and historical review. Those activities highlighted red are confirmed HAILs (none), those activities that have potential to have occurred but require soil testing to confirm are highlighted in orange and those that are not a HAIL in the context of the development area are indicated in green.

Table 2. Evaluation of potentially contaminating activities from previous and current land use

Land use and associated HAIL Activity	Potential Contaminants	Potential likelihood and magnitude of contamination	HAIL Assessment
Placement of fill (stockpiles and bunds). *HAIL Activity I: Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment.*	Based on surrounding land use - organochlorine pesticides (OCPs) and metals from horticulture	It is possible that residues of pesticides may be present in the stockpiles and/or bunds formed within the development area if these were derived from the horticultural areas that previously occupied part of the wider sawmill site. However, contaminants are unlikely to be present at concentrations that present an unacceptable risk to human health or the environment.	HAIL Activity I **may apply** to the development area if contaminants are present at concentrations posing a risk to human health or the environment.
Operation of effluent soakage field *Activity G5: Waste disposal to land.*	Pathogens, nutrients, metals	The HAIL guidance[7] includes an exclusion for: • *"Domestic septic tanks. While these systems may discharge wastewater to ground containing biological hazards, the amount of organic chemicals or inorganic contaminants, such as metals and metalloids, that could persist in soil will generally be low."* The effluent soakage field only receives sewage from toilets and greywater from staff showers and other amenities (e.g. lunchrooms). No process wastewater discharges to the soakage field. Operation of the effluent soakage field is therefore consistent with a domestic septic tank and we consider that HAIL activity G5 does not apply in this instance.	HAIL activity G5 **does not apply** to the development area.
Storage of equipment and materials. *HAIL Activity I (as above).*	Hydrocarbons (fuels, oils, grease) and metals	Outdoor storage of equipment and various inert materials is highly unlikely to cause contamination that would present an unacceptable risk to human health or	Not considered to be a HAIL activity in this instance.

[7] Ministry for the Environment. 2023. Hazardous Activities and Industries List guidance: Identifying HAIL land. Wellington: Ministry for the Environment.

Land use and associated HAIL Activity	Potential Contaminants	Potential likelihood and magnitude of contamination	HAIL Assessment
		the environment, especially since this activity has only occurred intermittently since circa 2017.	
Sawmilling *Activity A18: Wood treatment including the use of anti-sapstain chemicals during milling.*	Timber treatment preservatives such as chromated copper arsenate (CCA), boron and other pesticides.	The nearest sawmilling activities, being covered drying sheds and the pellet plant, either do not include contaminants or do not release them in a way that would affect soils underlying the development area.	HAIL activity A18 **does not apply** to the development area.

4. Investigation Methodology

4.1 Previous investigations

As described in **Section 3.2.1**, PDP recently assessed ground contamination conditions across the sawmill site, this included collecting and testing:

- Three samples (SP01, SP06 and SP07) from the stockpiles in the northern part of the development area;
- One sample from near the centre of the development area (HA01); and
- From one location from immediately to the west of the development area, adjacent to the existing sawmill operations (HA04), from which three samples from depths of up to 1.2 mbgl were tested.

The sampling locations are included on **Figure 3** and the results have been assessed in **Section 4.5**.

4.2 Sampling rationale

The following sampling rationale adopted for this investigation:

- Composite sampling was undertaken to provide coverage across the development area and assess potential diffuse source of contamination, such as from neighbouring horticultural activities.
- Discrete samples were collected to target specific features of interest and/or address gaps in the due diligence (PDP) sampling locations. Targets of interest include:
  - The effluent soakage field in the northwestern corner of the development area.
  - The implement shed at the eastern end of the development area.
  - Bunds and stockpiles formed at the western end of the development area (to the west of the main access road).

Sampling locations are shown on **Figure 3** (overpage). In total:

- Thirty-four composite sub-sample locations were selected on an approximate grid pattern across the development area to provide spatial coverage. The sub-sample locations were composited into eight samples, taken at 0.1m into the topsoil. Composite samples S7 and S8 were collected at 0.3m depth due to the overlying gravel hardfill.
- Eight discrete sample locations were collected across the development area to target specific features of interest and/or address gaps fill coverage gaps or target specific features / activities provides the sample locations.

All samples were tested for metals (plus boron), PAHs, total petroleum hydrocarbons (TPH) and OCPs to assess typical urban and rural contaminants and those most commonly associated with both sawmilling and horticultural uses. Samples collected from adjacent to the effluent soakage field (HA3 and HA4) and within the bund adjacent to the main access road (HA8) were also tested for a broader range of pesticides to confirm the anecdotal evidence that anti-sapstain chemicals were unlikely to be present.

This testing was undertaken principally for disposal purposes, since as described in **Section 3.3**, only the stockpiles / bunds were considered to have the potential to contain elevated level of contamination.

4.3 Sampling methodology

Soil sampling was conducted by WWLA personnel on 26 and 27 March 2024 as follows:

- For composite sub-sampling vegetation (or gravel hardfill in the boron plant area) was hand cleared from each sample location and then the soil hand excavated by clean spade to approximately 0.3 m.
- A clean hand trowel was then used to sample the soil.

- For discrete sampling locations a hand auger was used to obtain samples to depths of up to 1.2m below ground level (usually encountering groundwater which prevented further sampling).

The data quality objectives (DQOs) for this investigation were to:

- Undertake the investigation in general accordance with CLMG 5; and
- Collect and analyse soil samples and with sufficient accuracy and precision to provide evaluation against relevant human health and environmental acceptance criteria.

The following quality assurance and quality control measures were implemented to meet the investigation DQOs:

- Appropriately experienced staff were used to undertake the field investigation work.
- Soil sampling equipment was decontaminated (as required).
- Soil analyses were carried out by International Accreditation New Zealand (IANZ) accredited laboratories using industry standard methods.
- Appropriate chain of custody documentation was used.

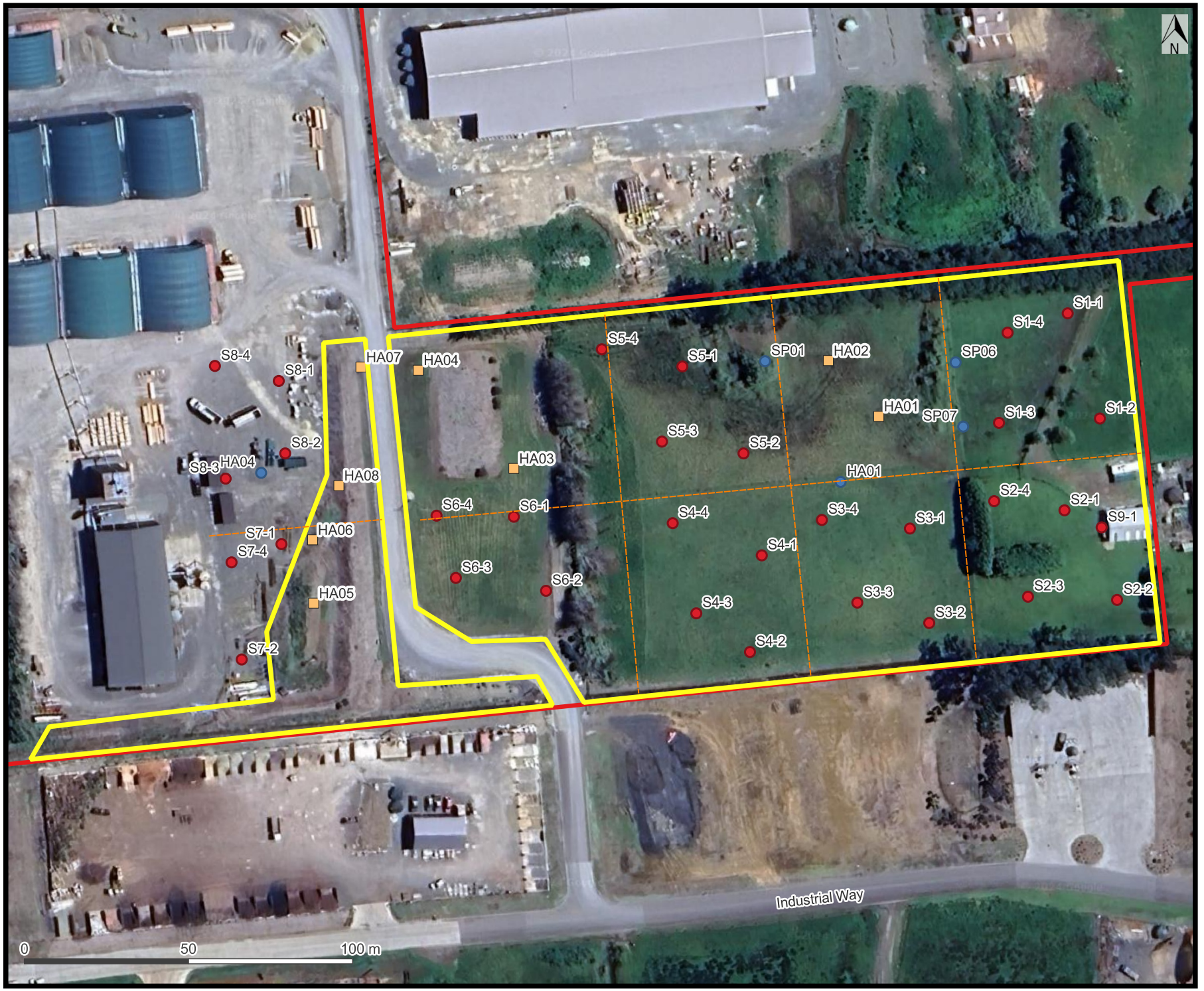
4.4 Field observations

The following observations of soil or inground conditions were also made during the investigations, with selected photographs included below:

- Soil encountered beneath areas that were in pasture typically comprised a black / brown silty topsoil (see **Photograph 8**). Similar soil was encountered below the 0.2 – 0.3 m of compacted gravel in the yard laydown areas (proposed boron plant).
- Deeper sampling encountered brown / grey silty soil with occasional traces of clay.
- Other than gravel hardfill present across the yard laydown area (proposed boron plant), fill was not encountered in any of the sample locations.
- The stockpile / bunds typically comprised an uncompacted light brown-grey silty topsoil (see **Photograph 9**).
- No visual or olfactory evidence of contamination was observed.
- Groundwater was encountered at approximately 1 -1.2 mbgl.

Photograph 8. Typical topsoil encountered beneath pasture (sample location S2-3).

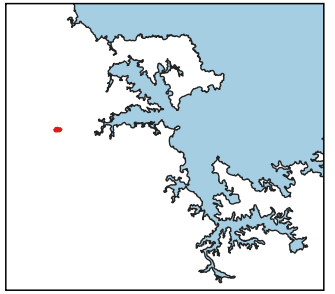
Photograph 9. HA05, stockpile in the proposed location for the boron plant.



Map Title:
Sample Location Plan

Project:
Waipapa Sawmill Boron Plant & Dispatch Yard

Client:
Fletcher Building Ltd



Legend

- Site boundary
- Extent of bulk soil disturbance works
- Composite Sampling Areas
- PDP Sample Locations
- WWLA Discrete Sample Locations
- WWLA Composite Sample Locations

Data Provenance
Aerial imagery and land parcels from Land Information New Zealand

Drawn by: Becki Williamson
05/06/2024

Layout Name
Figure 3

WILLIAMSON WATER & LAND ADVISORY

Figure 3.