Engineering Geology Ltd
CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS

Unit 7C, Rosedale Office Park, 331 Rosedale Road
Albany, Auckland, New Zealand
PO Box 301054, Albany, North Shore 0752
Phone: 64 9 486 2546 Fax: 64 9 486 2556

Ref: 7546

WINEGROWERS OF ARA LIMITED
PROPOSED VINEYARD DEVELOPMENT
WATER STORAGE POND, WAIHOPAI VALLEY
RESOURCE CONSENT APPLICATION
TECHNICAL REPORT

Prepared for:

Winegrowers of Ara Ltd
P O Box 106306
AUCKLAND 1143

8 October 2014

CONTENTS

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1.0 INTRODUCTION

Winegrowers of Ara are planning to develop and expand its existing vineyard located in the Waihopai Valley, Marlborough. It is understood that as part of the future development some 900ha of the farming land will be converted into vineyards. The future vineyard development will incorporate new water storage facilities for irrigation and frost protection purposes. We understand a total storage volume of up to 1,000,000m^3 will be required to support the future vineyard.

The future vineyard will be developed in stages. The initial stage will include an approximately 250ha of vineyard development, which requires a pond with storage capacity of 260,000m3 to meet the vineyard water storage requirements. It will be a HDPE lined pond for the purposes of storing water to irrigate grapes and frost control.

Construction of the pond is proposed to take place in early 2015. This report describes the technical aspects of the proposed pond and is to support the applications for Resource Consents. At this stage the principal design concepts have been established and a feasibility design has been completed.

2.0 SITE LOCATION AND DESCRIPTION

The vineyard is located off SH63 in the Wairau Valley, Marlborough. The property is approximately 9km long and 2km wide and is bounded by the Waihopai River to the east and hills to the west. The northern portion of the property has already been developed and planted with vineyards. A water storage pond, Lake Pinot, was constructed in 2008 for irrigating the northern portion of the vineyard. A layout of the property is shown in the attached Figure 1 included in Appendix A.

Winegrowers of Ara are now planning to develop the southern portion of the property, south of Lake Pinot. This includes the development of some 900ha of near flat land which is currently being used for cropping. A number of central pivot irrigators are also currently in use over the proposed vineyard area. This area is generally flat, sloping very gently to the north at about 1 in 250. Elevated terraces at the toe of the hills run along the western edge of the site. The terraces are generally 200m wide and some 10 to 15m above the adjacent ground. They become narrower towards the north and taper ultimately into the hill just south of Lake Pinot.

Storage up to 1,000,000m^3 is ultimately required to provide sufficient water for irrigation and frost protect of the proposed vineyard development. Although at this stage it is proposed to construct a water storage pond with storage capacity of 260,000m^3 to meet the near future water requirements for the vineyard.

A feasibility study (Ref.1) was previously undertaken by Engineering Geology Ltd (EGL). The aim of the study was to assess the feasibility of constructing ponds at either the flat central site or at the elevated terraces located along the western edge of vineyard. The study covers four options with storage capacities of 250,000m^3 and 500,000m^3.

As agreed with the client (Winegrowers of Ara Ltd) that the option with the centrally located pond with storage capacities of 260,000m^3 will be constructed in the first stage in the future vineyard development to meet the project water storage demand.

Topographical information of the site has been provided by Ayson and Partners Ltd. A site investigation, consisting of excavation of 11 test pits and drilling 4 machined boreholes, has been undertaken to develop a general geotechnical model for the site. Moreover, a number of tests have been conducted on selected samples obtained during the fieldwork. This is discussed further in the following sections.

3.0 SEISMIC HAZARD

The site is located in an area of high seismic hazard with three known active faults (Awatere, Clarence and Wairau) within 30km of the site. The closest fault is the Wairau Fault which is 3.5km north (Ref.2 GNS Active Fault Database). This fault is a strike-slip fault and is considered capable of generating up to magnitude 7.6 earthquakes with an estimated average recurrence interval of movement of between 1,100 and 1,900 years. The last major earthquake on this fault is estimated to have occurred 1,400 and 2,600 years ago (Ref.3). The proposed HDPE lined pond is formed by a homogeneous earthfill embankment where construction materials will generally be sandy gravels and cobbles with minor fines (i.e. silt and clay) and is capable of withstanding very high levels of earthquake shaking.

4.0 GEOTECHNICAL INVESTIGATIONS

A geotechnical investigation was carried out in August 2014. The investigation compromised of 11 test pits (TP1 to TP11) and 4 machine drilled boreholes (MBH1 to MBH4). The locations of the test pits and machine drilled boreholes are shown on Figure 2.

Limited laboratory testing has been carried out on selected samples of the test pits. This includes moisture content tests and particle size distribution (PSD) analysis.

No cultural or historical values were identified on site during the site walk-over inspection.

4.1. Test Pits

The test pits were excavated to depth between 0.3m-4.8m. The test pits TP1 to 9 located at the proposed pond site were excavated to depths of between 4.0-4.8m to assess to subsurface condition at the pond site. The test pits TP10 and 11 were excavated to a depth of 0.3m to confirm the depth of topsoil. Description of the

materials encounter in the tests pits are presented on the attached log sheets in Appendix A.

Subsoil conditions in test pits TP1A to 11A are summarised in Table 1 below:

TABLE 1. Materials Encountered in Test Pits

Geological Origin		
Topsoil (m)	**Loess (m)**	**Glacial Outwash (m)**
0.0-0.2	0.2-0.5	0.5-4.8 or greater

4.2. Machine Boreholes

The machine boreholes were undertaken by PRO-DRILL using a track mounted drill rig and the boreholes designated MBH1 to MBH4. Sonic drilling technique has been used for all boreholes. The boreholes were taken down to depths of between 10m (MBH2 and MBH3) to 15m (MBH1 and MBH4). Standard Penetration Tests (SPT's) were performed at about 1m intervals or wherever practicable over the depth of the boreholes. The SPT 'N' values were generally exceeded 50. The exceptions are in boreholes BMH2, 3 and 4 where 'N' ranges between 31 and 45 at depths shallower than 4m.

The soils were logged by Engineering Geologist on site throughout drilling. The locations of the borehole are shown on Figure 2. Descriptions of the soils encountered in the boreholes together with the SPT results are presented on the attached borehole log sheets included in Appendix B.

A summary of the soil encountered in the machine boreholes MBH1 to MBH4 is presented in Table 2 below.

TABLE 2. Materials Encountered During Drilling

Borehole ID	Topsoil (m)	Loess (m)	Glacial Outwash (m)	Termination Depth (m)
MBH1	0.0-0.2	-	0.2-15.0	15.0
MBH2	-	0.0-0.5	0.5-10.0	10.0
MBH3	0.0-0.2	0.2-0.6	0.6-10.0	10.0
MBH4	-	0.0-0.6	0.6-15.0	15.0

4.3. Groundwater Conditions

Groundwater was not encountered in most of the machine boreholes during drilling. The exception is that groundwater level at 3.9m below the ground surface has been encountered in MBH2.

After completion of drilling, a standpipe piezometer was installed in each of the machine boreholes for monitoring groundwater levels. The piezometers were constructed with a 3.0m slotted screen. Backfill above the screen included at least

1.0m of bentonite to prevent the ingress of surface water. The piezometers were covered with a lockable metal standpipe for easy location and protection for ongoing monitoring. The most recent measured groundwater levels are presented below in Table 3 below:

TABLE 3. Summary of Groundwater Measurement Information

Borehole	Type	Surface R.L. (m) (approx. only)	Termination Depth (m)	Measured Groundwater Depth (m)	Screen Depth (m)	Date of Drilling	Date of Measurement
MBH1	Standpipe	134.2	15.0	5.22	10.0-13.0	12 Aug 2014	24 Sep 2014
MBH2	Standpipe	135.0	10.0	5.30	3.0-7.0	13-14 Aug 2014	24 Sep 2014
MBH3	Standpipe	135.8	10.0	5.40	3.0-7.0	14 Aug 2014	24 Sep 2014
MBH4	Standpipe	135.5	15.0	4.80	10.0-13.0	13 Aug 2014	24 Sep 2014

Note: Water levels will fluctuate with the seasons and meteorological conditions.

4.4. Laboratory Testing

Laboratory testing was carried out on selected samples obtained from the test pits. This includes moisture content tests and particle size distribution (PSD) analysis. The results are presented in Appendix C.

Moisture content tests were conducted on 9 samples obtained from 1.0 to 3.0 depths. The test results indicate the natural moisture content varies between 4.4 and 7.6%.

The particle size test results show that the materials are sandy gravel with some cobbles and boulders and a trace of fines (i.e. less than 5%). It should be noted that the samples were screened so the clasts greater than 100mm (cobbles) were removed from the bulk samples on site during the investigation, hence they are excluded from the particle size test results. It is estimated that such cobbles make up to 20% of the materials.

4.5. Site Soil Conditions

The results of the site investigation indicate that the pond site is generally underlain by topsoil and loess up to 0.6m, which overlies deep glacial outwash gravel (clayey, silty gravel).

4.6. Suitability for Pond Site

The site consists of topsoil and loess in shallow depth (up to 0.6m) overlies dense to very dense glacial outwash gravels with SPT 'N' values mostly greater than 50. The pond will be lined with geomembrane that would provide effective containment for the pond. Any weak materials that overlie the glacial outwash gravels will be removed from beneath the upstream and downstream shoulders of the embankment.

4.7. Construction Materials

It is considered that material excavated from the pond footprint is generally suitable for construction of the perimeter embankment. The material available for construction mainly consists of sandy gravels and cobbles with minor fines (i.e. silt or clay). The excavated material from the pond area in excess of embankment fill requirements will be placed in the waste disposal stockpile or be used for landscaping purposes. The embankment will be homogeneous earthfill structure.

Containment of water will be provided by a suitable geomembrane. Some fine grained soils may need to be sourced to provide a suitable subgrade beneath the liner to the satisfaction of the liner supplier/installer. This is necessary to prevent damage to the liner. Such materials would ideally be sourced from on-site borrow areas.

5.0 POND DESIGN

The dam will be designed in accordance with the New Zealand Society on Large Dams (NZSOLD) Dam Safety Guidelines (Ref.4) and relevant International Commission on Large Dams (ICOLD) Design Guidelines. The NZSOLD design requirements are dependent on the potential impact classification (PIC) of the dam. We have undertaken a preliminary dambreak analysis and we assess the PIC to be low based on an assessment of the consequences. The details of the dambreak analysis are discussed in more detail in Section 5.3.

5.1. Pond

The proposed layout of the pond is shown in Figure 3. The pond crest is at RL140.2. The pond is designed to store 260,000m^3 and has a footprint area of approximately 66,100m^2. It is approximately 270m in length and 250m in width and can pond water to a maximum depth of 7.6m. The pond is to be developed by a combination of cut and fill. The fill is to be used to construct the perimeter embankment. It will be mainly sourced from the material excavated within the pond footprint. The volume of fill required for construction is approximately 83,000m^3. The pond is proposed to be lined with a 1.5mm thick HDPE geomembrane.

Excavation to form the pond will be approximately 3.2m below the natural ground. The maximum height of the embankment formed in the northern side of the pond is approximately 6.0m high (downstream toe to crest). The crest width of the embankment is 5m. The embankment will be formed predominantly from glacial outwash soils obtained locally. A thin layer of soils free of gravels will be placed over the embankment fill and excavated surfaces where gravels are presented to act as a cushion beneath the HDPE geomembrane. Cut and fill slopes for the pond are 2.5:1 (H:V). Typical sections through the pond are shown in Figure 4. We consider that these slopes are acceptable for a line pond, taking into account the nature of the soils (sandy gravel) used for construction and the practicality of placement of the liner.

The excavation of the pond is designed to keep the pond floor above the expected zone of groundwater fluctuation in order to avoid any adverse impact on the HDPE liner. As a contingency, a network of subsoil drains will be constructed beneath the floor of the pond both along and across the pond to intercept and divert away any seepage occurring beneath the liner.

A piped spillway is included in the design of the pond. It consists of a 450mm diameter HDPE pipe. The level of the pipe controls the normal pond water level so that the pond has 1.2m freeboard. The pipe discharges through the wall of the embankment in the north eastern side of the pond (refer to Figure 3). Riprap will be placed at the downstream end of the pipe to dissipate energy and prevent erosion. Details of the spillway are shown on Figure 5.

An outlet pipe will be laid beneath the embankment to enable water to be withdrawn from the reservoir. The size and details of the outlet pipe will be confirmed at the detail design stage. The pipe will be installed through the northern wall of the pond as shown on Figure 3.

5.2. Breach Analysis and Potential Impact Classification

Modern dam design guidelines require assessment of the consequence of a failure. The results are used to determine the appropriate design criteria (more conservative design where consequences are greater) and to then develop appropriate dam safety management and emergency preparedness procedures.

The scenario of a breach of the proposed water storage pond assumes a hypothetical uncontrolled release of water due to a breach of the embankment forming the pond. It is hypothetical because an embankment designed, constructed and operated in accordance with modern practice would not be expected to fail. No assumptions are made about the mode of failure and it takes no account of the risk of failure, or the type of failure.

The consequences of a hypothetical breach of the Water Storage Pond and determination of the PIC have been assessed in accordance with the Building (Dam Safety) Regulations 2008 (Ref.5). This requires consideration of various effects (population at risk, environmental, economic and community recovery time). A breach of the pond would result in release of the water from the reservoir into the downstream creek.

We have assessed the consequences of a potential breach based on Washington State Department of Ecology "Dam Safety Guidelines" (Ref.6). Historic breaches of water storage dams show that earthfill embankments are much more erodible than rockfill embankments (Ref.7). The Water Storage Pond is designed to be constructed with earthfill material. Therefore we assumed a breach depth over the full height of the embankment will occur. Empirical relationships are provided for water storage dam breach analysis. Three empirical relationships have been used in this study: Froehlich (Ref.8), MacDonald and Langridge-Monopolis (Ref.7) and Bureau of Reclamation (an envelope relationship, Ref.9). The average estimated flow of these methods has been adopted. Peak discharge of $320m^3/s$ and $340m^3/s$ has been estimated for the sunny day condition and flood induced condition respectively.

In order to analyse the incremental effects of the hypothetical breach of the water storage pond from a flood induced breach it is necessary to establish the flow downstream of the pond in the design flood. We have estimated the peak flood flow downstream of the pond to be approximately $50m^3/s$. This assumes a catchment area of 1500 hectares. Consequently the total peak flow in a flood induced breach condition is $390m^3/s$. The flow in a sunny day failure would be slightly less (i.e. $320m^3/s$).

The flood plain immediately downstream of the pond is very wide. The average width is approximately 1500m. This is the distance measured from the unnamed creek channel on the West and the Waihopai River on the East. The original ground contour is falling gently towards the North East, i.e. falling towards the Waihopai River. The average bed-slope gradient downstream of the pond is approximately 0.008.

We estimate a breach formation time of approximately 20 minutes. This is based on the average of three empirical methods, Frohlich (Ref.10), MacDonald and Langridge-Monopolis (Ref.7) and Bureau of Reclamation (Ref.11). By taken both the breach volume of water and the breach formation time into consideration, the inundation of land downstream of the pond will only occur over a very short duration as the time to empty the pond due to a breach is estimated to be less than 60 minutes.

Theoretically the pond embankment can breach in all directions. However no matter which direction its breaches, the breach flow will flow and spread following the natural ground contour, i.e. towards the North. The estimates of flood inundation depths have been determined using both the guidance provided in the Washington State Guidelines (Ref.6) and the Manning's formula for open channel flow. The results are generally consistent. Estimates of flood inundation depths are summarised in Table 4. The results show that the flood inundation depth will be less than 0.5m when the water spreads over a width of 700m.

TABLE 4. Summary of Flood Inundation Depth Estimation

Flood Plain Width (m)	Empirical Equation		Manning's Formula	
	Velocity (m/s)	Estimated Inundation Depth (m)	Velocity (m/s)	Estimated Inundation Depth (m)
1500 (Average Flood Plain Width)	1.5	0.18	0.8-1.1	0.23-0.32
700 (Inundation Depth is 0.5m)	1.5	0.37	1.1-1.5	0.37-0.50

A time-weighted approach has been used to assess the Population at Risk (PAR). The PAR is defined as the number of people likely to be affected by inundation greater than 0.5m in depth. Criteria for assessing damage levels are defined in Table 1 of the Building (Dam Safety) Regulations 2008 (Ref.5). The only location that there will be PAR is immediately downstream of the embankment to the distance where the water is spread over a width of greater than 700m (i.e. flood inundation depth is less than 0.5m). We assume that the water will be spread out in a triangular shape and a flood width of 700m will be reached at a distance of 700m from the dam breach location. Based on this assumption, we estimate the area where PAR are present is approximately 24.5 hectare.

The area of the Vineyard downstream of the proposed dam covers an area of approximately 650 hectares. There will be both permanent employees (approximately 26) and casual employees (average of 78 over a year) working over this area. The employees could be anywhere within the 650 hectares. We have estimated the PAR using a time-weighted approach by assuming the ratio that the employee that will be presented in the zone of PAR is 24.5/650. There will be two buildings located next to the embankment but there are no other buildings located within 700m of the embankment. There will be a pump shed located next to the embankment (near the northern end) which will have 3 persons present when

discharging water for frost protection (approximately 50 hrs every year). Another building will be located next to the embankment (near the southern end) where employees will take tea and lunch breaks. We have also considered these in the assessment of PAR. Taking into account the number and average exposure time for people in the office and working on the land, we assess the PAR to be 2 based on the Building (Dam Safety) Regulations 2008 (Ref.5).

There are some other buildings including two houses that are located beyond 1.5km downstream flood plain of the proposed pond. A method for assessing the consequences of a breach of the pond, including the risk to life is using the damage parameter 'dv' which is a product of 'd' the depth of flow above floor level and 'v' the velocity of water. The level of damage to houses can also be assessed using this method. Estimates of damage and potential hazard to life based on '*dv*' are provided by Reiter (Ref.12) and Amos et al (Ref.13) and are presented in Tables 5 and 6 respectively. The '*dv*' parameter is approximately 0.55 and 0.27 when the flow width reaches 700m (inundation depth less than 0.5m) and 1500m (width of the flood plain) respectively. The buildings located beyond 1.5km are only likely to be subject to minor damage and danger to life is unlikely.

In the event of a hypothetical breach of the Northern or Eastern embankment, the flow is likely to flow in the northern direction and water will flow gradually towards the Waihopai River. Eventually most of the water will enter the Waihopai River and flow under the State Highway (SH) 63 Bridge located at approximately 4.5km downstream of the embankment. The Waihopai River flows into the Wairau River 2.5km (river meandering distance) downstream of the SH63 Bridge. We have estimated the capacity of the bridge opening to be approximately 2,900 to 3,900m^3/s using Manning's equation and the 1m ground contour information from Marlborough District Council (Ref.14). The bridge opening has an effective width and height of approximately 150m and 4m respectively. There are no flood data at the location of SH63 Bridge. However, the data from Marlborough District Council Floodwatch system (Ref.15) suggests that the 100 year flow in the Waihopai River at Craiglochart is approximately 1,000m^3/s. This point is approximately 14.5km (river meandering distance) upstream of the SH63 Bridge. We estimate that the catchment of the Waihopai River in-between Craiglochart and the SH63 Bridge is approximately 6,500ha and the additional flow due to a 100 Year Rainfall from this catchment is estimated to be approximately 200m^3/s. Thus the total flow at the SH63 including the peak flood-induced dam breach flow is approximately 1,600m^3/s. This is much less than the estimated capacity of the bridge opening 2,900-3,900m^3/s. A breach of the proposed pond will not result in overtopping of the bridge. We conclude that the peak incremental effect of a breach on the bridge will be small as the breach flow is only 30% of the 100 year flood and the combined flows can easily pass beneath the bridge. The incremental increase in flow depth due to a breach is only about 0.4m (15-20% of 100 Year flood flow depth of 2-2.4m) and the incremental increase in flow velocity is 0.45m/s (10-15% of 100 Year flood flow velocity 3.4-4.1m/s). Also the duration of a breach flow is short (less than 60 minutes). We assess the incremental effects of the flow on the SH63 Bridge Piers and abutments are likely to be only minor as the percentage increase in flow depth and velocity are both small. We assess the incremental effects of a breach flow on the environment beyond the SH63 Bridge to be minor as the additional flow from a dam breach and the total amount of volume of water released due to a hypothetical breach is small compared to the 100 year flood and the flow is fully contained within the banks of Waihopai River. It would not have significant effect on flows in the Wairau

River which is a further 2.5km downstream of the SH63 Bridge as the Wairau River is much bigger than the Waihopai River.

If we assume a hypothetical breach of the Western embankment, the flow is likely to flow in the unnamed creek channel located west of the pond and its flood plain. The flow will eventually reach SH63 at a distance of approximately 4.5km downstream of the embankment. The inundation depth will be similar to the breach of the Northern or Eastern embankment, i.e. approximately 0.3m. A small volume of water is likely to flow through the culvert beneath the SH63 embankment. Most water will be ponded temporarily behind the SH63 embankment and flow eastwards towards Waihopai River. The embankment associated with SH63 at this location is approximately 4m high which is significantly greater than the inundation depth of 0.3m. Therefore we assess it is highly unlikely the water will overflow SH63. Eventually most of the water will be flow into Waihopai River and flow under the SH63 Bridge.

TABLE 5. Critical Structural Damage and Loss of Life Parameters (Reitar, Ref.12)

Risk for loss of life classes of houses	Damage Parameter *dv* (m^2/s)		
	Small damages, small danger	**Medium damages, medium danger**	**Total damages, very high danger**
Lightly constructed detached one family house	<1.5	1.3-2.5	>2.5
Well Constructed wooden houses	<2.0 (v>2.0m/s)	2.0-5.0 (v>2.0m/s)	>5.0
Brick houses, concrete structures	<3.0 (v>3.0m/s)	3.0-7.0 (v>3.0m/s)	>7.0

TABLE 6. Potential Hazard (Amos et al. Ref.13)

dv	**Potential Hazard**
$dv < 0.5$	No danger to life
$0.5<dv<1.0$	Some danger to life exists
$dv>1.0$	Danger to life significant

In summary, based on the results of the pond breach analysis we assess the PAR to be 2. We consider it is unlikely that any lives would be lost because:

- there are no permanently occupied buildings where flow depths are greater than 0.5m
- it takes some time for the maximum flow to develop and so there is some warning of a dangerous situation developing
- people at risk will only normally be present during daylight hours and would notice rising water levels and move to higher ground

Damage to residential buildings would be minimal. There is one critical or major infrastructure downstream of the pond, SH63. We assess there would only be minor damage to its major components. Environmental damage would be short-term and is assessed as minimal and community recovery time would also be minimal. On this

basis the PIC of the water storage pond is assessed to be **Low** based on the Building (Dam Safety) Regulations 2008.

6.0 CONSTRUCTION

It is recommended that construction be undertaken by an experienced earthworks Contractor. Construction is planned to commence in early 2015 and is expected to take approximately 6 months.

The construction of the pond will be in accordance with the New Zealand Society on Large Dams (NZSOLD) Dam Safety Guidelines (Ref. 4).

Construction Drawings and a Technical Specification will be prepared. They will detail the requirements for construction including standards for foundation preparation, earthfill compaction, drainage materials and spillway as well as quality assurance and control requirements. The Designer will undertake inspections at times to confirm critical details and to ensure design requirements are being achieved. The Contractor will be required to undertake control testing to confirm fill standards have been achieved. Independent tests will also be undertaken if necessary.

The Contractor will be required to provide means of controlling any flood flows during construction of the pond. The Contractor will be required to provide a sediment control plan prior to construction commencing. This will set out the proposed works and construction methods that will be implemented to minimise and control sediment that could enter the watercourse downstream.

Water for conditioning the fill and dust suppression will be sourced from existing irrigation facility on-site. The main potential environmental impacts from the pond construction (erosion and sediment, noise, dust) would be minimal owing to the flat terrain downstream of the pond and the relatively isolated location of the proposed pond (i.e. located well away from neighbouring properties and public roads).

7.0 OPERATION, MAINTENANCE AND SURVEILLANCE

An Operation, Maintenance and Surveillance Manual will be prepared. This will set out operational and maintenance requirements necessary to ensure the ongoing safety of the pond. Monitoring and inspections are a fundamental part of the pond safety process. These range from routine regular inspections to more comprehensive reviews at longer periods. Specific requirements in accordance with NZSOLD Guidelines, will be prepared for the pond.

8.0 POTENTIAL RISKS AND MITIGATION MEASURES

1. Potential risks associated with the proposed pond will be minimised by designing, constructing and operating in accordance with NZSOLD Guidelines.

2. Potential geotechnical risks have been investigated by comprehensive geotechnical investigations. The investigation confirmed suitable foundation conditions and identified suitable material for construction.

3. The site is located 3.5km from the Wairau Fault which is capable of producing large ground motions at the site. The pond will be formed by earthfill embankments and the pond will be lined with HDPE. Material for construction of the pond will be glacial outwash gravel sourced on-site. Embankment constructed from such materials has good strength and good performance when subject to earthquake ground motions.

4. The pond is to be lined with a HDPE geomembrane. This material has a good performance history and is compliant and capable of withstanding deformations associated with earthquake ground motions.

5. Sediment control measures will be required during construction to prevent and mitigate associated potential environmental effects.

6. Dust will be controlled by spraying dry surfaces with water. Water will also be required to condition the earthfill and this will assist in reducing the potential for dust.

7. Water for construction (conditioning fill and dust control) will be sourced on-site.

8. The pond is located on a rural property well away from occupied houses so there will be no adverse noise impact.

Prepared by
ENGINEERING GEOLOGY LTD

Calvin Wu (Geotechnical Engineer)

Reviewed by

Rambod Amigh (CPEng)

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APPENDIX A

TEST PIT LOGS

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP1

SHEET 1 OF 1

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1658987.5 North 5398088.5 **RL GROUND:** 134.5m **DATE:** 12/08/2014

GRID: NZTM 2000 **DATUM:** MSL **TESTPIT DEPTH:** 4.0m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
	Organic SILT with some fine to coarse gravel and minor clay (TOPSOIL); dark brown. Moist, low plasticity	134.5 / 0.2	TS			F					
Loess	SILT with minor clay and trace fine to coarse gravel; orange brown. Very stiff, moist, low plasticity	134.3 / 0.4				VSt					
	gravelly (fine to coarse)	134.1 / 0.5				VSt-H					
Speargrass Formation (Glacial Outwash Gravels)	Silty, sandy (fine to coarse) GRAVEL with some cobbles and trace boulders; brownish grey. Very dense, moist, well graded; gravel cobbles and boulders consist of unweathered subrounded to rounded clasts of greywacke up to 250mm; 10-20% of clasts >100mm in size	134.0		1	M						Bulk disturbed sample (Bulk 1) 0.5 - 3.0m Small disturbed sample (Mst 1) 1.0 - 1.1m
	greywacke boulder up to 500mm in size	1.7 / 132.8		2		VD					Small disturbed sample (Mst 2) 2.0 - 2.1m
	cobbly with some boulders up to 400mm in size; 30% of clasts >100mm	2.4 / 132.1									
	wet	2.9 / 131.6		3	W				3.50m, 12/08/2014		Small disturbed sample (Mst 3) 2.9 - 3.0m
	some silty clay, saturated, seepage encountered at 3.5m	3.4 / 131.1			S						Bulk disturbed sample (Bulk 2) 3.5 - 4.0m
		4.0		4							Small disturbed sample (Mst 4) 3.9 - 4.0m

EOH: 4.00 m

NOTES:

LOGGED: DLM

CHECKED: RA **EXCAVATOR:** 20 tonne Excavator

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP2

SHEET 1 OF 1

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1659099.2 North 5398087.3 | RL GROUND: 134.2m | DATE: 12/08/2014

GRID: NZTM 2000 | DATUM: MSL | TESTPIT DEPTH: 4.8m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
	Organic SILT with some fine to coarse gravel and minor clay (TOPSOIL); dark brown. Moist, low plasticity	134.2	TS			F					
		0.2									
Loess	SILT with some clay and trace fine to coarse gravel; orange brown. Very stiff, moist, low plasticity	134.0				VSt					
		0.4									
	some cobbles up to 100mm	133.8				H					
		0.5									
Speargrass Formation (Glacial Outwash Gravels)	Sandy (fine to coarse) GRAVEL with some silt and cobbles; brownish grey. Very dense, moist, well graded; gravel and cobbles consist of unweathered subrounded to rounded clasts of greywacke up to 200mm; 10-20% of clasts >100mm in size	133.7		1							Bulk disturbed sample (Bulk 1) 0.5 - 3.0m
											Small disturbed sample (Mst 1) 1.0 - 1.1m
		1.2									
	minor boulders, clasts up to 300mm	133.0			M						
				2							Small disturbed sample (Mst 2) 2.0 - 2.1m
						VD			Groundwater Not Encountered		
		2.9									
	silty, minor sand, moist to wet, 30% of clasts >100mm	131.3		3	M-W						Small disturbed sample (Mst 3) 2.9 - 3.0m
		3.3									
	some clay and silt, wet	130.9			W						Bulk disturbed sample (Bulk 2) 3.5 - 4.8m
				4							Small disturbed sample (Mst 4) 4.0 - 4.1m
		4.1									
	some boulders, clasts up to 400mm, saturated	130.1			S						
		4.8									

EOH: 4.80 m

NOTES:

LOGGED: DLM

CHECKED: RA

EXCAVATOR: 20 tonne Excavator

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP3

SHEET 1 OF 1

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1659210.9 North 5398086.4 RL GROUND: 134.1m DATE: 12/08/2014

GRID: NZTM 2000 DATUM: MSL TESTPIT DEPTH: 4.7m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
	Organic SILT with some fine to coarse gravel and minor clay (TOPSOIL); dark brown. Moist, low plasticity	134.1	TS			F					
		0.2									
Loess	Gravelly (fine to coarse) SILT with minor clay and cobbles; orange brown. Hard, moist, low plasticity; greywacke clasts up to 150mm	133.9				H					
		0.4									
Speargrass Formation (Glacial Outwash Gravels)	Silty, sandy GRAVEL with minor cobbles; brownish grey. Very dense, moist, well graded; gravel and cobbles consist of subrounded to rounded greywacke clasts up to 150mm, 5% of clasts >100mm	133.7			M						Bulk disturbed sample (Bulk 1) 0.5 - 2.0m
		0.9									
	10% of clasts >100mm, cobble up to 200mm	133.2		1							Small disturbed sample (Mst 1) 1.0 - 1.1m
		1.3									
	moist to wet	132.8									
		1.4			M-W						
	cobbly, minor boulders up to 300mm, 20-30% of clasts >100mm	132.7									
				2		VD					Small disturbed sample (Mst 2) 1.9 - 2.0m
											Bulk disturbed sample (Bulk 2) 2.0 - 4.0m
		3.0		3							
	wet	131.1									Small disturbed sample (Mst 3) 3.0 - 3.1m
		3.3									
	some clay and silt, minor sand	130.8			W						
				4							Small disturbed sample (Mst 4) 3.9 - 4.0m
											Bulk disturbed sample (Bulk 3) 4.0 - 4.7m
		4.5									
	saturated, seepage encountered at 4.6m	129.6			S				4.60m, 12/08/2014		
		4.7									Small disturbed sample (Mst 5) 4.6 - 4.7m

EOH: 4.70 m

NOTES:

LOGGED: DLM

CHECKED: RA EXCAVATOR: 20 tonne Excavator

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TEST PIT LOG

TESTPIT No.: TP4

SHEET 1 OF 1

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1658982.5 North 5397976.6 **RL GROUND:** 134.9m **DATE:** 13/08/2014

GRID: NZTM 2000 **DATUM:** MSL **TESTPIT DEPTH:** 4.0m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
	Organic SILT with some fine to coarse gravel and minor clay (TOPSOIL); dark brown. Moist, low plasticity	134.9	TS			F					
		0.2	TS								
Loess	Gravelly (fine to coarse) SILT with minor clay and cobbles; orange brown. Hard, moist, low plasticity; greywacke clasts up to 200mm	134.7				H					
		0.5									
Speargrass Formation (Glacial Outwash Gravels)	Silty, sandy GRAVEL with some cobbles and trace boulders; brownish grey. Very dense, moist, well graded; gravel, cobbles and boulders consist of subrounded to rounded greywacke clasts up to 300mm, 10-20% of clasts >100mm	134.4		1	M						Bulk disturbed sample (Bulk 1) 0.5 - 3.0m Small disturbed sample (Mst 1) 1.0 - 1.1m
	cobbly, some boulders, 20-30% of clasts >100mm and up to 400mm	2.0 132.9		2		VD					Small disturbed sample (Mst 2) 2.0 - 2.1m
	rounded greywacke boulder up to 500mm	2.7 132.2									
	minor clay silt and sand, wet	2.9 132.0		3	W						Small disturbed sample (Mst 3) 2.9 - 3.0m
	saturated, seepage encountered at 3.1m	3.1 131.8							3.10m, 13/08/2014		Bulk disturbed sample (Bulk 2) 3.0 - 4.0m
					S						
		4.0		4							Small disturbed sample (Mst 4) 3.9 - 4.0m

EOH: 4.00 m

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NOTES:

LOGGED: DLM

CHECKED: RA EXCAVATOR: 20 tonne Excavator

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TEST PIT LOG

TESTPIT No.: TP5

SHEET 1 OF 1

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1659098.2 North 5397975.6 **RL GROUND:** 135.3m **DATE:** 13/08/2014

GRID: NZTM 2000 **DATUM:** MSL **TESTPIT DEPTH:** 4.7m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
	Organic SILT with some fine to coarse gravel and minor clay (TOPSOIL); dark brown. Moist, low plasticity	135.3 / 0.2	TS			F					
Loess	Gravelly (fine to coarse) SILT with minor clay and cobbles; orange brown. Hard, moist, low plasticity; greywacke clasts up to 200mm	135.1 / 0.5	TS			H					Bulk disturbed sample (Bulk 1) 0.2 - 0.5m
Speargrass Formation (Glacial Outwash Gravels)	Sandy GRAVEL with some silt, minor cobbles; brownish grey. Very dense, moist, well graded; gravel and cobbles consist of subrounded to rounded greywacke clasts up to 200mm, 10% of clasts >100mm	134.9		1							Bulk disturbed sample (Bulk 2) 0.5 - 3.0m
	1.0m - 1.3m: silty lense	1.3									Small disturbed sample (Mst 1) 1.0 - 1.1m
	minor boulders up to 300mm, 20% of clasts >100mm	134.0			M						
				2							Small disturbed sample (Mst 2) 2.0 - 2.1m
	moist to wet	2.6 / 132.7				VD					
		3.0		3							Small disturbed sample (Mst 3) 2.9 - 3.0m
	cobbly, minor sand and clay, 30% of clasts >100mm	132.3			M-W						Bulk disturbed sample (Bulk 3) 3.0 - 4.7m
	wet	3.5 / 131.8									
	some silt and clay	4.0 / 131.3		4	W				4.60m, 13/08/2014		Small disturbed sample (Mst 4) 4.0 - 4.1m
	greywacke boulder up to 350mm	4.2 / 131.1									
	saturated, seepage encountered at 4.6m	4.5 / 130.8			S						Small disturbed sample (Mst 5) 4.6 - 4.7m
		4.7									

EOH: 4.70 m

NOTES:

LOGGED: DLM

CHECKED: RA

EXCAVATOR: 20 tonne Excavator

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TEST PIT LOG

TESTPIT No.: TP6

SHEET 1 OF 1

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1659210.0 North 5397984.6 **RL GROUND:** 134.6m **DATE:** 13/08/2014

GRID: NZTM 2000 **DATUM:** MSL **TESTPIT DEPTH:** 4.7m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
	Organic SILT with some fine to coarse gravel and minor clay (TOPSOIL); dark brown. Moist, low plasticity	134.6	TS			L					
		0.2	TS								
Loess	SILT with some gravel (fine to coarse), minor clay; orange brown. Very stiff to Hard, moist, low plasticity	134.4				VSt-H					
		0.4									
Speargrass Formation (Glacial Outwash Gravels)	Sandy (fine to coarse) silty GRAVEL with minor cobbles and trace boulders; brownish grey. Very dense, moist, well graded; gravel, cobbles and boulders consist of subrounded to rounded greywacke clasts up to 250mm, 20% of clasts >100mm	134.2		1	M						Bulk disturbed sample (Bulk 1) 0.4 - 3.0m
											Small disturbed sample (Mst 1) 1.3 - 1.4m
	moist to wet	2.0 132.6		2							Small disturbed sample (Mst 2) 2.0 - 2.1m
	rounded greywacke boulder up to 350mm, clay film on clasts	2.5 132.1			M-W	VD					
	minor clay, silt and sand, rounded greywacke boulder up to 500mm, wet, 30% of clasts >100mm	3.0 131.6		3							Small disturbed sample (Mst 3) 2.9 - 3.0m Bulk disturbed sample (Bulk 2) 3.0 - 4.7m
	some clay and silt	3.5 131.1			W						
				4							Small disturbed sample (Mst 4) 4.0 - 4.1m
	saturated, seepage at 4.7m	4.6 130.0 4.7			S				4.70m, 13/08/2014		Small disturbed sample (Mst 5) 4.6 - 4.7m

EOH: 4.70 m

NOTES:

LOGGED: DLM

CHECKED: RA

EXCAVATOR: 20 tonne Excavator

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP7

SHEET 1 OF 1

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1658985.5 North 5397864.9 **RL GROUND:** 136.4m **DATE:** 13/08/2014

GRID: NZTM 2000 **DATUM:** MSL **TESTPIT DEPTH:** 4.3m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
	Organic SILT with some fine to coarse gravel and minor clay (TOPSOIL); dark brown. Moist, low plasticity	136.4 / 0.2	TS			L					
Loess	Gravelly (fine to coarse) SILT with minor clay and cobbles; orange brown. Very stiff to hard, moist, low plasticity; greywacke clasts up to 150mm	136.2 / 0.5				VSt-H					
Speargrass Formation (Glacial Outwash Gravels)	Sandy (fine to coarse) silty GRAVEL with minor cobbles; brownish grey. Very dense, moist, well graded; gravel and cobbles consist of subrounded to rounded greywacke clasts up to 200mm, 10% of clasts >100mm	135.9 / 1.2		1							Bulk disturbed sample (Bulk 1) 0.5 - 3.0m
	minor boulders up to 250mm, 20% of clasts >100mm,	135.2 / 2.4		2	M						Small disturbed sample (Mst 1) 1.2 - 1.3m Small disturbed sample (Mst 2) 2.0 - 2.1m
	rounded greywacke boulder up to 350mm, 30% of clasts >100mm	134.0 / 3.0		3		VD					
	minor sand, wet	133.4 / 3.8			W				4.00m, 13/08/2014		Small disturbed sample (Mst 3) 3.0 - 3.1m
	some clay and silt, saturated	132.6 / 4.0		4							
	seepage encountered at 4.0m	132.4 / 4.3			S						Small disturbed sample (Mst 4) 4.0 - 4.1m

EOH: 4.30 m

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NOTES:

LOGGED: DLM

CHECKED: RA **EXCAVATOR:** 20 tonne Excavator

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TEST PIT LOG

TESTPIT No.: TP8

SHEET 1 OF 1

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1659097.2 North 5397864.0 **RL GROUND:** 136.1m **DATE:** 13/08/2014

GRID: NZTM 2000 **DATUM:** MSL **TESTPIT DEPTH:** 4.7m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
	Organic SILT with some fine to coarse gravel and minor clay (TOPSOIL); dark brown. Moist, low plasticity	136.1 / 0.2	TS			L					
Loess	SILT, minor clay; orange brown. Very stiff to Hard, moist, low plasticity	135.9 / 0.5				VSt-H					
Speargrass Formation (Glacial Outwash Gravels)	Sandy (fine to coarse) silty GRAVEL with minor cobbles and trace boulders; brownish grey. Very dense, moist, well graded; gravel, cobbles and boulders consist of subrounded to rounded greywacke clasts up to 250mm, 10% of clasts >100mm	135.6		1					Groundwater Not Encountered		Bulk disturbed sample (Bulk 1) 0.5 - 3.0m Small disturbed sample (Mst 1) 1.0 - 1.1m
	20% of clasts >100mm and up to 300mm	1.5 / 134.6			M						
				2							Small disturbed sample (Mst 2) 2.0 - 2.1m
						VD					
	rounded greywacke boulder up to 500mm, 30% of clasts >100mm	2.7 / 133.4									
	some clay and silt, minor sand, wet	3.0 / 133.1		3							Small disturbed sample (Mst 3) 2.9 - 3.0m Bulk disturbed sample (Bulk 2) 3.0 - 4.7m
					W						
				4							Small disturbed sample (Mst 4) 4.0 - 4.1m
		4.7									

EOH: 4.70 m

NOTES:

LOGGED: DLM

CHECKED: RA **EXCAVATOR:** 20 tonne Excavator

ENGINEERING GEOLOGY LTD

TEST PIT LOG

TESTPIT No.: TP9

SHEET 1 OF 1

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1659208.9 North 5397859.1 | RL GROUND: 135.7m | DATE: 13/08/2014

GRID: NZTM 2000 | DATUM: MSL | TESTPIT DEPTH: 4.7m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	FIELD TESTS
	Organic SILT with some fine to coarse gravel and minor clay (TOPSOIL); dark brown. Moist, low plasticity	135.7 / 0.2			L	
Loess	SILT with some gravel (fine to coarse), minor clay; orange brown. Very stiff to Hard, moist, low plasticity	135.5 / 0.5			VSt-H	
Speargrass Formation (Glacial Outwash Gravels)	Sandy (fine to coarse) silty GRAVEL with minor cobbles and trace boulders; brownish grey. Very dense, moist, well graded; gravel, cobbles and boulders consist of subrounded to rounded greywacke clasts up to 250mm, 20% of clasts >100mm	135.2 / 2.0	1	M		Bulk disturbed sample (Bulk 1) 0.5 - 3.0m Small disturbed sample (Mst 1) 1.3 - 1.4m
	30% of clasts >100mm and up to 300mm	133.7 / 2.6	2			Small disturbed sample (Mst 2) 2.0 - 2.1m
	rounded greywacke boulder up to 700mm	133.1 / 3.0			VD	
	some clay and silt, minor sand, wet	132.7 / 4.6	3	W		Small disturbed sample (Mst 3) 3.0 - 3.1m Small disturbed sample (Mst 4) 4.0 - 4.1m
	saturated, seepage at 4.7m	131.1 / 4.7	4	S		Small disturbed sample (Mst 5) 4.6 - 4.7m

WATER LEVEL: 4.70m, 13/08/2014

CORRECTED VANE SHEAR STRENGTH (kPa): ●Field Vane (BS 1377) ○Remoulded Field Vane; 50 100 150

EOH: 4.70 m

NOTES:

LOGGED: DLM

CHECKED: RA

EXCAVATOR: 20 tonne Excavator

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TEST PIT LOG

TESTPIT No.: TP10

SHEET 1 OF 1

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1659017.0 North 5398061.7 **RL GROUND:** 134.4m **DATE:** 13/08/2014

GRID: NZTM 2000 **DATUM:** MSL **TESTPIT DEPTH:** 0.3m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
Topsoil	Organic SILT with minor gravel and trace clay; dark brown. Moist, low plasticity	134.4 / 0.2	TS		M				Groundwater Not Encountered		
Loess	SILT with minor clay and minor gravel; brown. Moist, low plasticity	134.2 / 0.3									

EOH: 0.30 m

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NOTES:

LOGGED: DLM

CHECKED: RA **EXCAVATOR:** 20 tonne Excavator

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TEST PIT LOG

TESTPIT No.: TP11

SHEET 1 OF 1

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1659215.9 North 5398023.1 **RL GROUND:** 134.3m **DATE:** 13/08/2014

GRID: NZTM 2000 **DATUM:** MSL **TESTPIT DEPTH:** 0.3m

GEOLOGICAL UNIT	SOIL MATERIAL DESCRIPTION	DEPTH / RL	GRAPHIC LOG	DEPTH (m)	MOISTURE CONDITION	CONSISTENCY / DENSITY	SAMPLES	WATER CONTENT (%)	WATER LEVEL	CORRECTED VANE SHEAR STRENGTH (kPa) ●Field Vane (BS 1377) ○Remoulded Field Vane 50 100 150	FIELD TESTS
Topsoil	Organic SILT with minor gravel and trace clay; dark brown. Moist, low plasticity	134.3 / 0.2	TS		M				Groundwater Not Encountered		
Loess	SILT with minor clay and minor gravel; brown. Moist, low plasticity	134.1 / 0.3									

EOH: 0.30 m

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NOTES:

LOGGED: DLM

CHECKED: RA EXCAVATOR: 20 tonne Excavator

APPENDIX B

MACHINE BOREHOLE LOGS

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SOIL LOG

DRILLHOLE No.: MBH1

SHEET 1 OF 2

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1659121.3 North 5398087.1 **RL GROUND:** 134.2

GRID: NZTM 2000 **DATUM:** MSL

HOLE STARTED: 12/08/2014

HOLE FINISHED: 12/08/2014

HOLE DEPTH: 15.0m

INCLINATION: Vertical

ORIENTATION:

Core Description					Defects		Drilling & Testing								
GEOLOGICAL UNIT	ROCK / SOIL MATERIAL DESCRIPTION	DEPTH (m)	DEPTH RL	GRAPHIC LOG	DEFECT LOG	DEFECT DESCRIPTION & Additional Observations	MOISTURE CONDITION	CONSISTENCY / DENSITY	TCR (%)	DATE / DEPTH	CORE LENGTH / TYPE	SAMPLES	WATER LEVEL	WATER LOSS (%)	FIELD TESTS
Speargrass Formation (Glacial Outwash Gravels)	Organic gravelly SILT with minor clay (TOPSOIL); dark brown. Moist, low		134.2 0.2												
	Sandy (fine to coarse) GRAVEL with minor silt; light brownish grey. Very dense; gravel consists of unweathered subangular to rounded clasts of greywacke up to 60mm		134.0						100%		1.00 PQ				
	silty, minor sand and cobbles, moist; occasional unweathered greywacke clast >80mm	1	1.2 133.0						100%		1.00 PQ				N = 50+ (C) 1.00m 14, 21 , 31, 19 245mm
		2							100%		1.00 PQ				N = 50+ (C) 2.00m 23, 27 130mm
		3							100%		1.00 PQ				N = 50+ (C) 3.00m 11, 11 , 12, 16, 15, 7 390mm
		4							100%		1.00 PQ				N = 50+ (C) 4.00m 8, 26 , 32, 18 275mm
	greywacke clast >100mm		4.6 129.6												
	sandy (fine to coarse), greywacke clasts up to 40mm	5	4.8 129.4					VD							
	greywacke clasts up to 70mm		5.2 129.0						100%		1.00 PQ				N = 50+ (C) 5.00m 5, 12 , 15, 17, 18 355mm
		6							100%		1.00 PQ				N = 50+ (C) 6.00m 20, 24 , 23, 27 295mm
	greywacke clast >80mm		6.6 127.6												
		7							100%		1.00 PQ				N = 50+ (C) 7.00m 14, 18 , 20, 22, 8 335mm
	Gravelly SILT; orange brown; greywacke clasts up to 30mm		7.8 126.4												
	Silty GRAVEL (fine to coarse) with minor sand and cobbles; light orange brownish grey. Very dense; gravel consists of unweathered subangular to rounded clasts of greywacke up to 70mm	8	8.0 126.2						100%		1.00 PQ				N = 50+ (C) 8.00m 19, 31 110mm
	greywacke clast >80mm		8.6 125.6												
		9							100%		1.00 PQ				N = 50+ (C) 9.00m 8, 24 , 45, 5 235mm
	greywacke clast >80mm		9.6 124												
		10													

Groundwater Not Encountered

NOTES:

LOGGED: DLM **DRILLER:** PRO-DRILL

CHECKED: RA **DRILL TYPE:** Sonic Drill Rig

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SOIL LOG

DRILLHOLE No.: MBH1

SHEET 2 OF 2

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1659121.3 North 5398087.1

GRID: NZTM 2000

RL GROUND: 134.2

DATUM: MSL

HOLE STARTED: 12/08/2014

HOLE FINISHED: 12/08/2014

HOLE DEPTH: 15.0m

INCLINATION: Vertical

ORIENTATION:

Core Description					Defects		Drilling & Testing								
GEOLOGICAL UNIT	ROCK / SOIL MATERIAL DESCRIPTION	DEPTH (m)	DEPTH RL	GRAPHIC LOG	DEFECT LOG	DEFECT DESCRIPTION & Additional Observations	MOISTURE CONDITION	CONSISTENCY / DENSITY	TCR (%)	DATE / DEPTH	CORE LENGTH / TYPE	SAMPLES	WATER LEVEL	WATER LOSS (%) 25 50 75	FIELD TESTS
Speargrass Formation (Glacial Outwash Gravels)	Silty GRAVEL (fine to coarse) with minor sand and cobbles; light orange brownish grey. Very dense; gravel consists of unweathered subangular to rounded clasts of greywacke up to >100mm		10.0 / 124.2					VD	100%		1.00 PQ		Groundwater Not Encountered		N = 50+ (C) 10.00m 11, 39 100mm penetration
	sandy (fine to coarse), greywacke clasts up to 70mm	11	11.2 / 123.0						100%		1.00 PQ				N = 50+ (C) 11.00m 22, 28 145mm penetration
	minor sand	12	12.0 / 122.2						100%		1.00 PQ				N = 50+ (C) 12.00m 18, 25 , 25, 25 300mm penetration
	greywacke clast >100mm	13	13.0 / 121.2						100%		1.00 PQ				N = 50+ (C) 13.00m 10 0mm penetration
	Gravelly (fine to coarse) SILT; greyish orange brown; greywacke clasts up to 50mm		13.6 / 120.6												
	Silty GRAVEL (fine to coarse); light orange brownish grey. Very dense; gravel consists of unweathered subangular to rounded clasts of greywacke up to >50mm	14	14.0 / 120.2						100%		1.00 PQ				N = 50+ (C) 14.00m 22, 28 105mm penetration
	2 greywacke clasts >60mm		14.5 / 119.7												
	Gravelly (fine to coarse) SILT; greyish orange brown, red laminations; greywacke clasts up to 50mm		119.6												
	greywacke clast >100mm	15	14.9 / 119.3												N = 50+ (C) 15.00m 18, 32 135mm penetration
	EOH: 15.00 m														

NOTES:

LOGGED: DLM

CHECKED: RA

DRILLER: PRO-DRILL

DRILL TYPE: Sonic Drill Rig

ENGINEERING GEOLOGY LTD

SOIL LOG

DRILLHOLE No.: MBH2

SHEET 1 OF 1

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1659209.8 North 5397962.4

GRID: NZTM 2000

RL GROUND: 135.0

DATUM: MSL

HOLE STARTED: 13/08/2014

HOLE FINISHED: 14/08/2014

HOLE DEPTH: 10.0m

INCLINATION: Vertical

ORIENTATION:

Core Description					Defects		Drilling & Testing								
GEOLOGICAL UNIT	ROCK / SOIL MATERIAL DESCRIPTION	DEPTH (m)	DEPTH RL	GRAPHIC LOG	DEFECT LOG	DEFECT DESCRIPTION & Additional Observations	MOISTURE CONDITION	CONSISTENCY / DENSITY	TCR (%)	DATE / DEPTH	CORE LENGTH / TYPE	SAMPLES	WATER LEVEL	WATER LOSS (%)	FIELD TESTS
Loess	Clayey SILT; orange brown. Moist, low to moderate plasticity minor gravel (fine to coarse)		135.0 0.3 134.7 0.5					VSt D	100%		1.00 PQ				
Speargrass Formation (Glacial Outwash Gravels)	Silty GRAVEL (fine to coarse) with minor clay and cobbles; light orange brownish grey. Very dense; gravel consists of unweathered subangular to rounded clasts of greywacke up to 80mm greywacke clast >100mm	1	134.5 1.0 134.0					VD	100%		1.00 PQ				N = 50+ (C) 1.00m 10
	dense	2	2.0 133.0 2.2			, Fines washed out		D	100%		1.00 PQ				N = 45 (C) 2.00m 10, 18 , 13, 11, 9, 12 450mm penetration
	silty, sandy (fine to coarse), greywacke clasts up to 50mm		132.8 132.7												
	greywacke clast >100mm	3	3.0 132.0			, 200mm boulder broken up by SPT test			100%		1.00 PQ				N = 50+ (C) 3.00m 9, 13 , 17, 16, 15, 2 380mm
	no sand, greywacke clasts up to 60mm		3.4 131.6												
	greywacke clast >80mm greywacke clasts up to 60mm	4	3.8 131.2 131.1						100%		1.00 PQ		3.90m, 14/08/2014		N = 42 (C) 4.00m 12, 12 , 10, 10, 10, 12 450mm penetration
	minor cobbles, greywacke clasts up to 70mm	5	5.0 130.0						100%		1.00 PQ				N = 50+ (C) 5.00m 10, 9 , 19, 19, 12 325mm
	5.4m - 5.5m: 100mm silt layer		5.8												
	greywacke clast >80mm	6	129.2 6.1						100%		1.00 PQ				N = 50+ (C) 6.00m 7, 15 , 30, 20 265mm
	greywacke clasts up to 60mm		128.9					VD							
		7							100%		1.00 PQ				N = 50+ (C) 7.00m 14, 15 , 18, 18, 14 365mm
		8	8.0 127.0			, 200mm boulder broken up by SPT test, fines washed out			100%		1.00 PQ				N = 50+ (C) 8.00m 18, 23 , 30, 20 250mm
	silty, greywacke clasts up to 50mm		8.5 126.5												
	greywacke clasts up to 80mm	9	9.0 126.0			, Fines washed out			100%		1.00 PQ				N = 50+ (C) 9.00m 20, 30 150mm
	Gravelly SILT, minor clay; greyish brown, orange brown. Gravel consists of rounded greywacke clasts up to 50mm		9.5 125.5												
		10	10.0												N = 50+ (C) 10.00m 13, 15 , 19, 27, 4 305mm penetration

EOH: 10.00 m

NOTES:

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CHECKED: RA

DRILLER: PRO-DRILL

DRILL TYPE: Sonic Drill Rig

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SOIL LOG

DRILLHOLE No.: MBH3

SHEET 1 OF 1

Job No.: 7546/CENTRAL

PROJECT: ARA
LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1659119.4 North 5397883.9
GRID: NZTM 2000
RL GROUND: 135.8
DATUM: MSL

HOLE STARTED: 14/08/2014
HOLE FINISHED: 14/08/2014
HOLE DEPTH: 10.0m
INCLINATION: Vertical
ORIENTATION:

Core Description					Defects		Drilling & Testing								
GEOLOGICAL UNIT	ROCK / SOIL MATERIAL DESCRIPTION	DEPTH (m)	DEPTH RL	GRAPHIC LOG	DEFECT LOG	DEFECT DESCRIPTION & Additional Observations	MOISTURE CONDITION	CONSISTENCY / DENSITY	TCR (%)	DATE / DEPTH	CORE LENGTH / TYPE	SAMPLES	WATER LEVEL	WATER LOSS (%) 25 50 75	FIELD TESTS
Loess	Organic gravelly SILT with minor clay (TOPSOIL); dark brown. Moist		135.8 0.2					F							
Loess	SILT with some gravel and minor clay; orange brown. Moist, low plasticity		135.6 0.6					VSt-H	100%		1.00 PQ				
Speargrass Formation (Glacial Outwash Gravels)	Silty GRAVEL (fine to coarse) with minor clay and cobbles; light orange brownish grey. Dense; gravel consists of unweathered subangular to rounded clasts of greywacke up to 50mm	1	135.2 1.0			, Fines washed out									
	greywacke clast >80mm, broken up		134.8 1.4						100%		1.00 PQ				N = 50+ (C) 1.00m 10
	sandy (fine to coarse), silty		134.4					D							
		2							100%		1.00 PQ				N = 31 (C) 2.00m 8, 7 , 7, 8, 7, 9 450mm penetration
		3	3.0												
	greywacke clast >80mm, broken up, very dense		132.8 3.4						100%		1.00 PQ				N = 50+ (C) 3.00m 13, 22 , 15, 18, 17 375mm
	minor sand		132.4 3.6												
	greywacke clast >80mm, broken up		132.2 3.8			, Fines washed out									
		4	132.0 4.4						100%		1.00 PQ				N = 50+ (C) 4.00m 16, 20 , 19, 16, 15 360mm
	Gravelly SILT; greyish orange brown;		131.4 4.6												
	Silty GRAVEL (fine to coarse) with minor clay; light orange brownish grey. Very dense		131.2 5.0												
	greywacke clast >100mm	5	130.8 5.2			, 200mm boulder broken up by SPT test									N = 50+ (C) 5.00m 24, 26 150mm
	gravel consists of subrounded to rounded greywacke clasts up to 50mm		130.6						100%		1.00 PQ				
		6	6.0												
	greywacke clasts >100mm, broken up		129.8 6.6			, Boulder broken up by SPT test. Fines washed out		VD	100%		1.00 PQ				N = 50+ (C) 6.00m 10
	silty, greywacke clasts up to 50mm		129.2												
		7	7.3						100%		1.00 PQ				N = 50+ (C) 7.00m 10, 18 , 17, 33 370mm
	Gravelly SILT; greyish orange brown;		128.5 7.5												
	Silty GRAVEL (fine to coarse) with minor clay and cobbles; light orange brownish grey. Very dense; gravel consists of unweathered subangular to rounded clasts of greywacke up to 50mm with some clasts >80mm	8	128.3						100%		1.00 PQ				N = 50+ (C) 8.00m 24, 26 130mm
	no cobbles, greywacke clasts up to 50mm		127.1 8.7												
	greywacke clasts >80mm, broken up	9	9.0 126.8			, Boulder broken up by SPT test. Fines washed out									N = 50+ (C) 9.00m 10
	silty, greywacke clasts up to 50mm		9.5 126.3						100%		1.00 PQ				
	EOH: 10.00 m	10	10.0												N = 50+ (C) 10.00m 13, 13 , 27, 19, 4 360mm penetration

Groundwater Not Encountered

NOTES:

LOGGED: DLM
CHECKED: RA
DRILLER: PRO-DRILL
DRILL TYPE: Sonic Drill Rig

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SOIL LOG

DRILLHOLE No.: MBH4

SHEET 1 OF 2

Job No.: 7546/CENTRAL

PROJECT: ARA
LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

HOLE STARTED: 13/08/2014
HOLE FINISHED: 13/08/2014
HOLE DEPTH: 15.0m
INCLINATION: Vertical
ORIENTATION:

COORDINATES: East 1659006.4 North 5397964.4
GRID: NZTM 2000
RL GROUND: 135.5
DATUM: MSL

Core Description					Defects		Drilling & Testing								
GEOLOGICAL UNIT	ROCK / SOIL MATERIAL DESCRIPTION	DEPTH (m)	DEPTH RL	GRAPHIC LOG	DEFECT LOG	DEFECT DESCRIPTION & Additional Observations	MOISTURE CONDITION	CONSISTENCY / DENSITY	TCR (%)	DATE / DEPTH	CORE LENGTH / TYPE	SAMPLES	WATER LEVEL	WATER LOSS (%) 25 50 75	FIELD TESTS
Loess	Clayey SILT; orange brown. Moist		135.5					VSt							
	gravelly (fine to coarse)		0.2 135.3					H	100%		1.00 PQ				
			0.6 134.9												
Speargrass Formation (Glacial Outwash Gravels)	Silty GRAVEL (fine to coarse) with minor clay and cobbles; light orange brownish grey. Dense; gravel consists of unweathered subangular to rounded clasts of greywacke up to 80mm	1						D							
	sandy (fine to coarse)		1.2 134.3						100%		1.00 PQ				N = 34 (C) 1.00m 6, 8 , 10, 6, 8, 10 450mm penetration
	very dense	2	2.0 133.5												
			2.4 133.1						100%		1.00 PQ				N = 50+ (C) 2.00m 13, 16 , 21, 29 300mm
	minor sand, greywacke clast >100mm		133.0												
	greywacke clast >100mm		2.7 132.8												
	greywacke clast >100mm	3													
			3.3 132.2						100%		1.00 PQ				N = 50+ (C) 3.00m 11, 14 , 14, 13, 14, 9 415mm
	greywacke clast >100mm	4													
									100%		1.00 PQ				N = 50+ (C) 4.00m 12, 11 , 12, 14, 14, 10 440mm
		5													
			5.2 130.3						100%		1.00 PQ				N = 50+ (C) 5.00m 18, 32 145mm
	greywacke clast >100mm														
	greywacke clasts up to 70mm					Fines washed out									
	greywacke clast >100mm	6	6.0 129.5					VD							
									100%		1.00 PQ				N = 50+ (C) 6.00m 10
	Gravelly (fine to coarse) SILT; greyish orange brown. Moist; gravel consists of greywacke clasts up to 50mm		6.3 129.2												
	greywacke clast >80mm		6.7 128.8												
	GRAVEL (fine to coarse); grey. Very dense, gravel consists of rounded greywacke clasts up to 80mm	7	7.0 128.5												
						Fines washed out			100%		1.00 PQ				N = 50+ (C) 7.00m 24, 26 150mm
		8	8.0 127.5												
	silty with some sand (fine to coarse)								100%		1.00 PQ				N = 50+ (C) 8.00m 10, 15 , 15, 19, 16 360mm
		9	9.0 126.5												
	no silt and sand					Fines washed out									
			9.4 126.1						100%		1.00 PQ				N = 50+ (C) 9.00m 25, 25 150mm
	greywacke clast >80mm														
	silty	10	10.0												

Groundwater Not Encountered

NOTES:

LOGGED: DLM
CHECKED: RA
DRILLER: PRO-DRILL
DRILL TYPE: Sonic Drill Rig

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SOIL LOG

DRILLHOLE No.: MBH4

SHEET 2 OF 2

Job No.: 7546/CENTRAL

PROJECT: ARA

LOCATION: 1033 - West Coast Road, Waihopai Valley, BLENHEIM

COORDINATES: East 1659006.4 North 5397964.4

GRID: NZTM 2000

RL GROUND: 135.5

DATUM: MSL

HOLE STARTED: 13/08/2014

HOLE FINISHED: 13/08/2014

HOLE DEPTH: 15.0m

INCLINATION: Vertical

ORIENTATION:

Core Description					Defects		Drilling & Testing								
GEOLOGICAL UNIT	ROCK / SOIL MATERIAL DESCRIPTION	DEPTH (m)	DEPTH RL	GRAPHIC LOG	DEFECT LOG	DEFECT DESCRIPTION & Additional Observations	MOISTURE CONDITION	CONSISTENCY / DENSITY	TCR (%)	DATE / DEPTH	CORE LENGTH / TYPE	SAMPLES	WATER LEVEL	WATER LOSS 25 50 75 (%)	FIELD TESTS
Speargrass Formation (Glacial Outwash Gravels)	Silty, GRAVEL (fine to coarse); light orange brownish grey. Very dense		125.5												
	Gravelly SILT, minor clay; greyish orange brown. Moist		10.3 125.2												
	Silty GRAVEL (fine to coarse) with minor clay; light orange brownish grey. Very dense; gravel consists of unweathered subangular to rounded clasts of greywacke up to 60mm	11	10.5 125.0						100%		1.00 PQ				N = 50+ (C) 10.00m 7, 27 , 14, 22, 14 370mm penetration
		12							100%		1.00 PQ		Groundwater Not Encountered		N = 50+ (C) 11.00m 8, 10 , 13, 15, 18, 4 380mm penetration
	minor cobbles, greywacke clast >80mm		12.2 123.3					VD	100%		1.00 PQ				N = 50+ (C) 12.00m 9, 10 , 13, 13, 10, 14 445mm penetration
	Gravelly SILT, minor clay; greyish orange brown. Moist greywacke clast >100mm	13	12.8 122.7 13.0 122.6 122.4						100%		1.00 PQ				N = 50+ (C) 13.00m 25, 25 130mm penetration
		14	14.0 121.5						100%		1.00 PQ				N = 50+ (C) 14.00m 29, 31 150mm penetration
	Silty GRAVEL (fine to coarse) with minor clay; light orange brownish grey. Very dense; gravel consists of unweathered subangular to rounded clasts of greywacke up to 70mm	15	15.0												
	EOH: 15.00 m														N = 50+ (C) 15.00m 10, 10 , 12, 17, 19, 2 380mm penetration

NOTES:

LOGGED: DLM **DRILLER:** PRO-DRILL

CHECKED: RA **DRILL TYPE:** Sonic Drill Rig

APPENDIX C

LBORATORY TESTING RESULTS

Lab Ref No : 14/702
Client Ref No : -

Civil Engineering Laboratory Services Ltd
PO Box 1424, Nelson Unit 3/30 Echodale Place Stoke
Ph 03 547 0110 Fax 03 547 0120 Mob 027 4457071

WATER CONTENT REPORT

Project :	**Ara Wines**	Date Received :	**28-Aug-14**
Location :	**Waihopai Valley**	Date sampled :	**Unknown**
Source :	**Various Test Pits**	Date tested :	**2-Sep-14**
Client :	**Ara Wines**	Sampled by :	**Engineering Geology Ltd**
Contractor :	**Engineering Geology Ltd**	Sample condition :	**Damp**
Sample description :	**Various Gravels**	Sampling method :	**Unknown**

Test Pit #	1	4	4	4	5
Depth (m)	2.0	1.0	2.0	3.0	1.0
Moisture Content (%)	6.3	4.4	5.3	5.6	5.5

Test Pit #	5	6	6	9
Depth (m)	2.0	1.3	3.0	1.3
Moisture Content (%)	7.7	6.7	7.3	5.0

Test Methods
Water Content NZS 4407 : 1991 : 3.1

Notes
Sampling is not covered by IANZ endorsement

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Date reported : 2-Sep-14

Reported by : *Robbie Burns*
Approved IANZ Signatory

Designation: Assistant Laboratory Manager

IANZ
ACCREDITED LABORATORY
1021

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

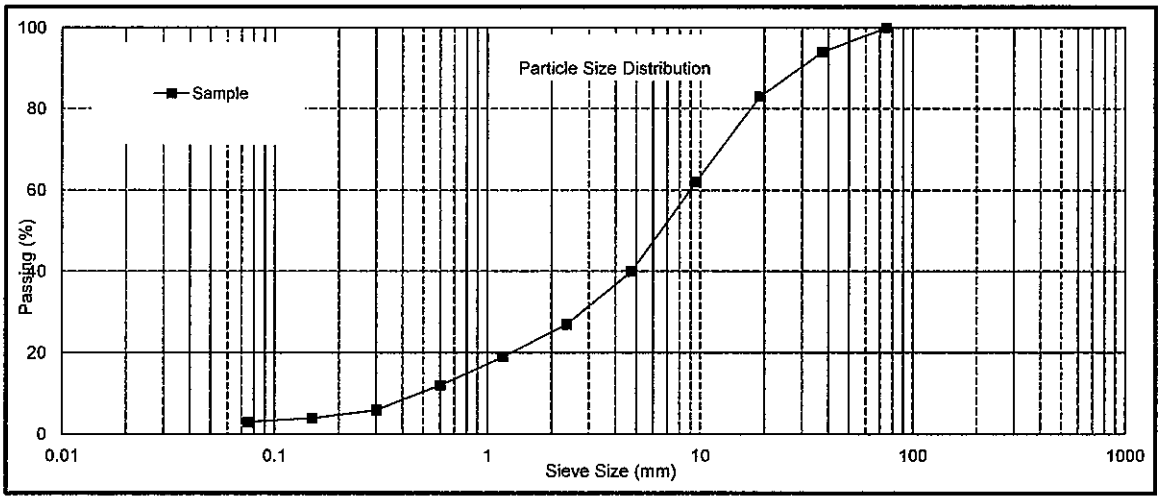
Lab Ref No : **14/703**
Client Ref No : -
Order No : -

Civil Engineering Laboratory Services Ltd
PO Box 1424, Nelson Unit 3/30 Echodale Place Stoke
Ph 03 547 0110 Fax 03 547 0120 Mob 027 4457071

PARTICLE SIZE DISTRIBUTION TEST REPORT

Project :	**Ara Wines**	Date sampled :	**Unknown**
Location :	**Waihopai Valley**	Sampling method :	**Unknown**
Client :	**Ara Wines**	Sampled by :	**Engineering Geology Ltd**
Contractor :	**Engineering Geology Ltd**	Sample description :	**Gravel**
Source :	**B2 TP5 0.45-3.0m**	Sample condition :	**Damp**

Particle Size Distribution		
Sieve Size	Percentage Passing	
(mm)	Sample	
150	-	
75	**100**	
37.5	**94**	
19	**83**	
9.5	**62**	
4.75	**40**	
2.36	**27**	
1.18	**19**	
0.6	**12**	
0.3	**6**	
0.15	**4**	
0.075	**3**	
	% passing the finest sieve is obtained by difference	



Test Methods	Notes
Particle Size Distribution	NZS 4407 : 1991 : Test 3.8.1

Date tested : 2/09/14
Date reported : 2/09/14

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Robbie Burns
Designation : *Assistant Laboratory Manager*
IANZ Approved Signatory

IANZ ACCREDITED LABORATORY 1021

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Lab Ref No : **14/704**
Client Ref No : -
Order No : -

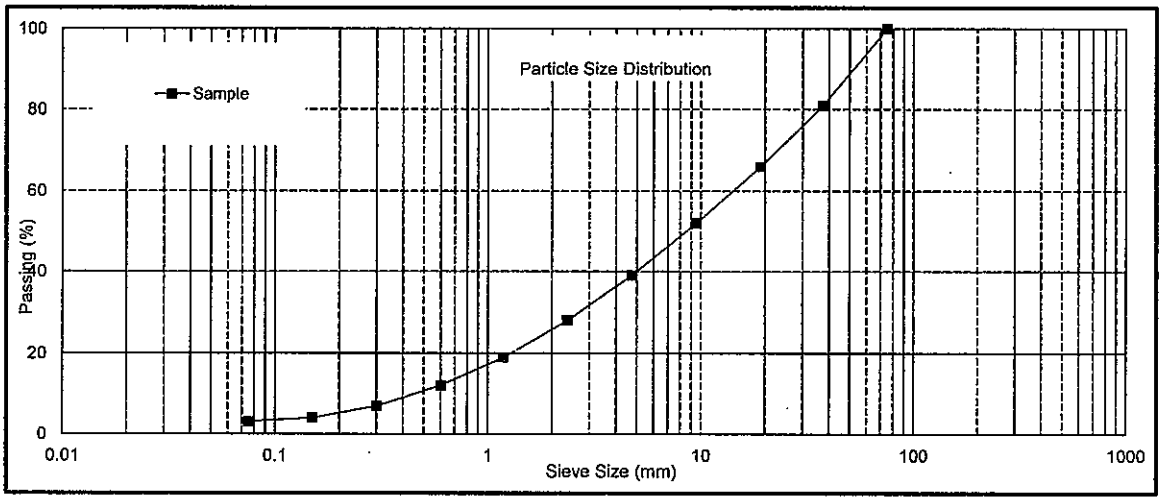
Civil Engineering Laboratory Services Ltd
PO Box 1424, Nelson Unit 3/30 Echodale Place Stoke
Ph 03 547 0110 Fax 03 547 0120 Mob 027 4457071

PARTICLE SIZE DISTRIBUTION TEST REPORT

Project :	**Ara Wines**	Date sampled :	**Unknown**
Location :	**Waihopai Valley**	Sampling method :	**Unknown**
Client :	**Ara Wines**	Sampled by :	**Engineering Geology Ltd**
Contractor :	**Engineering Geology Ltd**	Sample description :	**Gravel**
Source :	**B1 TP8 0.5-3.0m**	Sample condition :	**Damp**

Particle Size Distribution

Sieve Size	Percentage Passing	
(mm)	Sample	
150	-	
75	**100**	
37.5	**81**	
19	**66**	
9.5	**52**	
4.75	**39**	
2.36	**28**	
1.18	**19**	
0.6	**12**	
0.3	**7**	
0.15	**4**	
0.075	**3**	
	% passing the finest sieve is obtained by difference	



Test Methods
Particle Size Distribution — NZS 4407 : 1991 : Test 3.8.1

Notes

Date tested : 2/09/14
Date reported : 2/09/14

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Sampling is not covered by IANZ endorsement

Robbie Burns
Designation : *Assistant Laboratory Manager*
IANZ Approved Signatory

IANZ ACCREDITED LABORATORY 1021

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FIGURES 1 TO 5

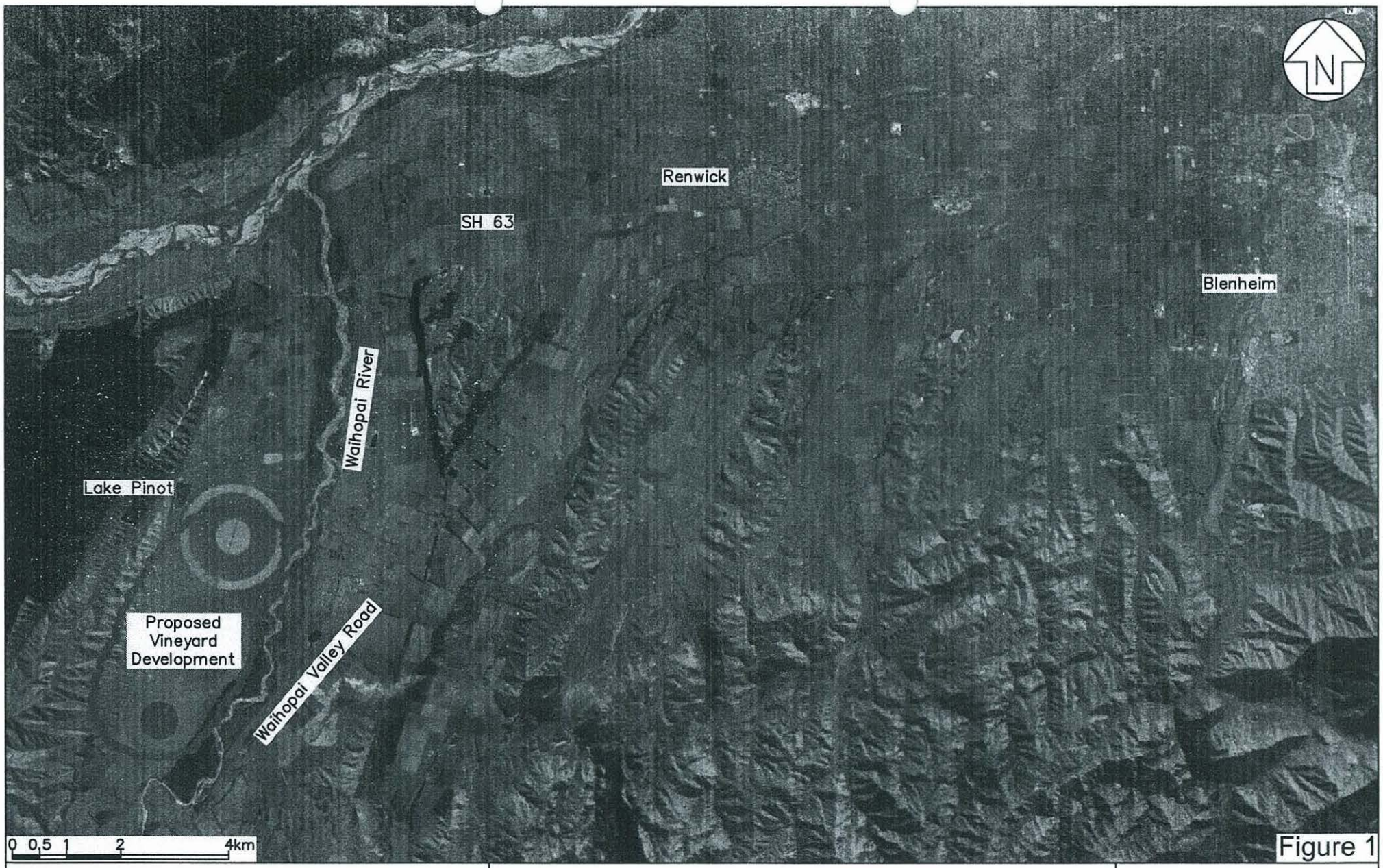


Figure 1

ENGINEERING GEOLOGY LTD
Unit 7C, 331 Rosedale Rd, PO Box 301054, Albany
Ph (09)486-2546, Fax (09)486-2556

ARA WINES PROPOSED VINEYARD DEVELOPMENT
Water Storage Ponds, Waihopai Valley
Locality Plan

Drawing No.	7546-Fig 1
Date:	8 Nov 2013
Drawn:	BL
Scale:	NTS
Filename:	7546-Fig 1.dwg

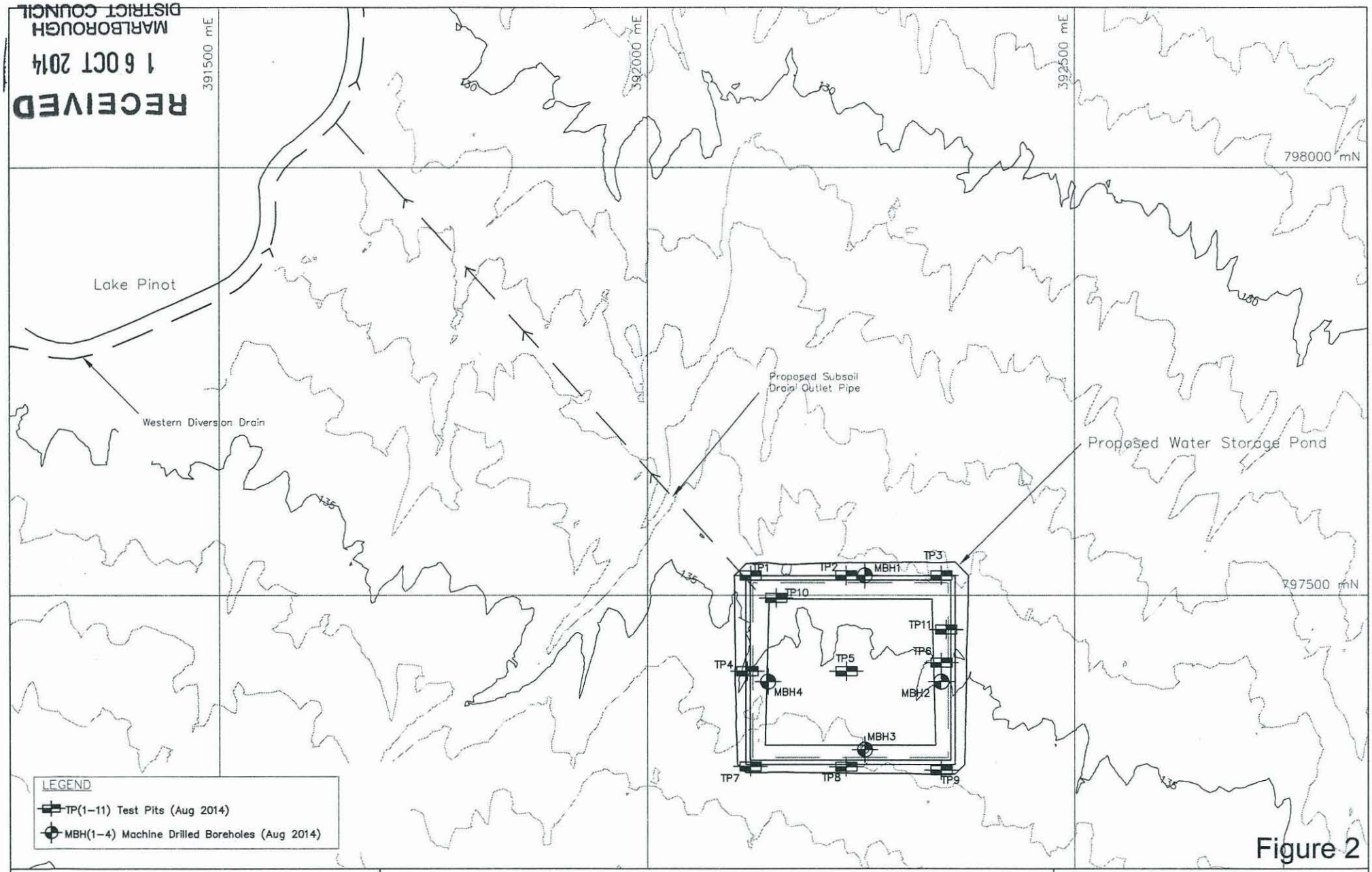


Figure 2

ENGINEERING GEOLOGY LTD
Unit 7C, 331 Rosedale Rd, PO Box 301054, Albany
Ph (09)486-2546, Fax (09)486-2556

ARA WINES PROPOSED VINEYARD DEVELOPMENT
Water Storage Ponds, Waihopai Valley
Site Investigation Plan

Drawing No.	7546–Fig 2
Date:	24 Sept 2014
Drawn:	GS
Scale:	1:4000 (A3)
Filename:	7546–Figure 2.dwg

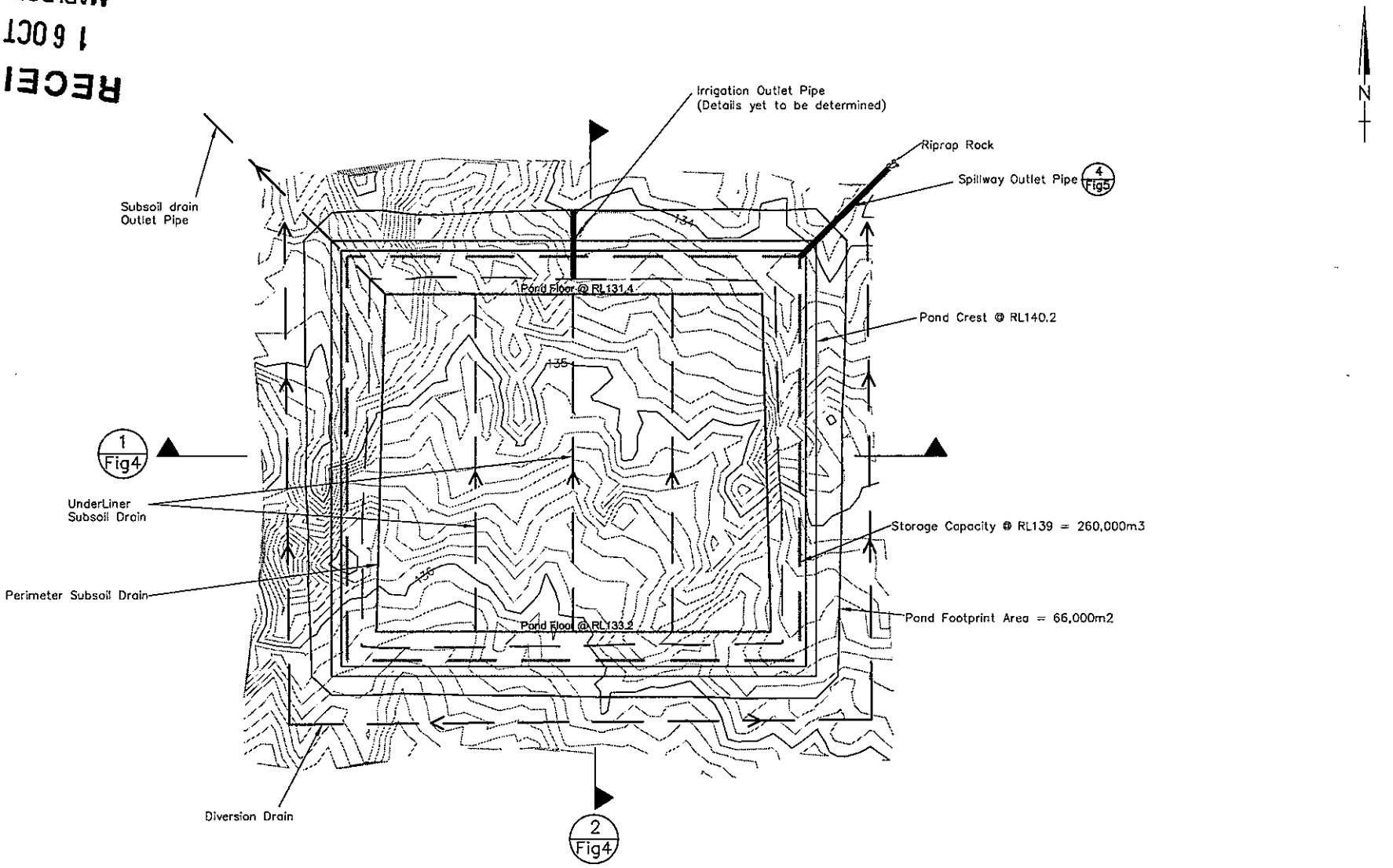
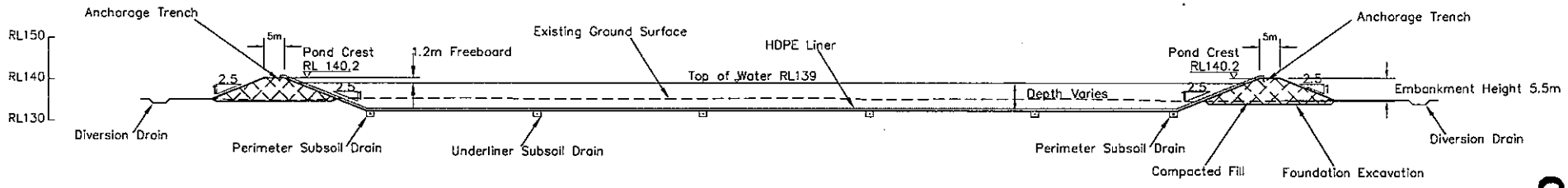
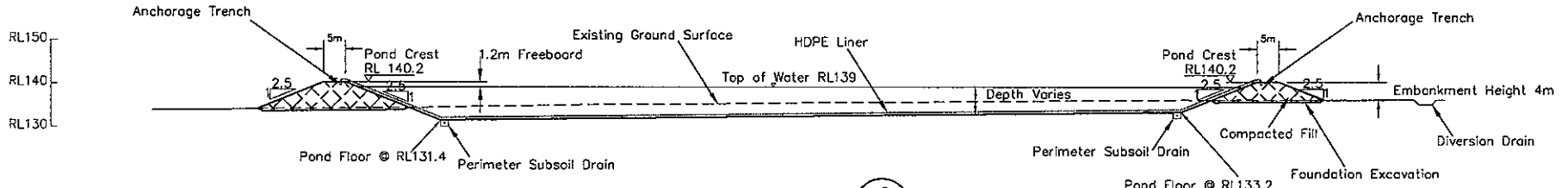


Figure 3

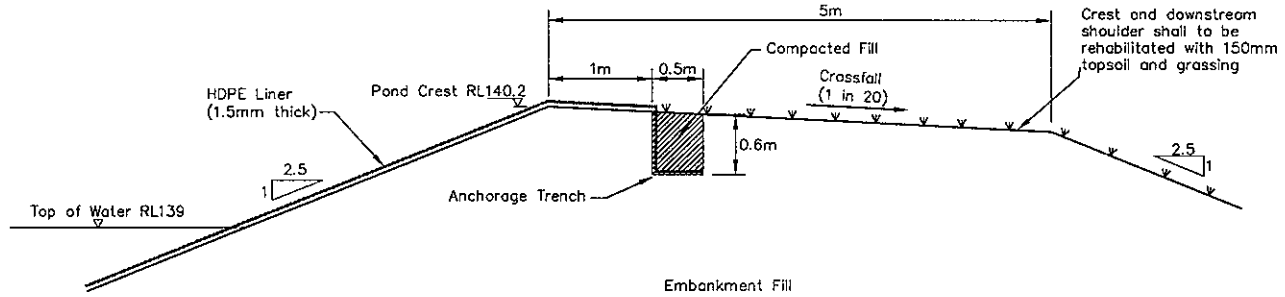
ENGINEERING GEOLOGY LTD Unit 7C, 331 Rosedale Rd, PO Box 301054, Albany Ph (09)486-2546, Fax (09)486-2556	ARA WINES PROPOSED VINEYARD DEVELOPMENT Water Storage Pond, Waihopai Valley *Pond Site Plan*	Drawing No. 7546-Fig 3 Date: 25 Sept 2014 Drawn: GS Scale: 1:2000 (A3) Filename: 7546-Figures 3 to 6.dwg



CROSS SECTION 1 (Fig3)
1:1000 (A3)



CROSS SECTION 2 (Fig3)
1:1000 (A3)



SECTION THROUGH EMBANKMENT CREST & ANCHORAGE TRENCH DETAILS (Fig4)
Scale 1:50 (A3)

0 0.5 1 2 3m

Note: 1. Where larger size gravels/cobbles are present in the surface that in the opinion of the HDPE supplier/installer could potentially cause damage to the liner they shall be removed by undercutting to a depth of 100mm and replaced with bedding material (AP7 or as directed by Engineer) free of gravels that is compacted to Zone B standards.

Figure 4

ENGINEERING GEOLOGY LTD
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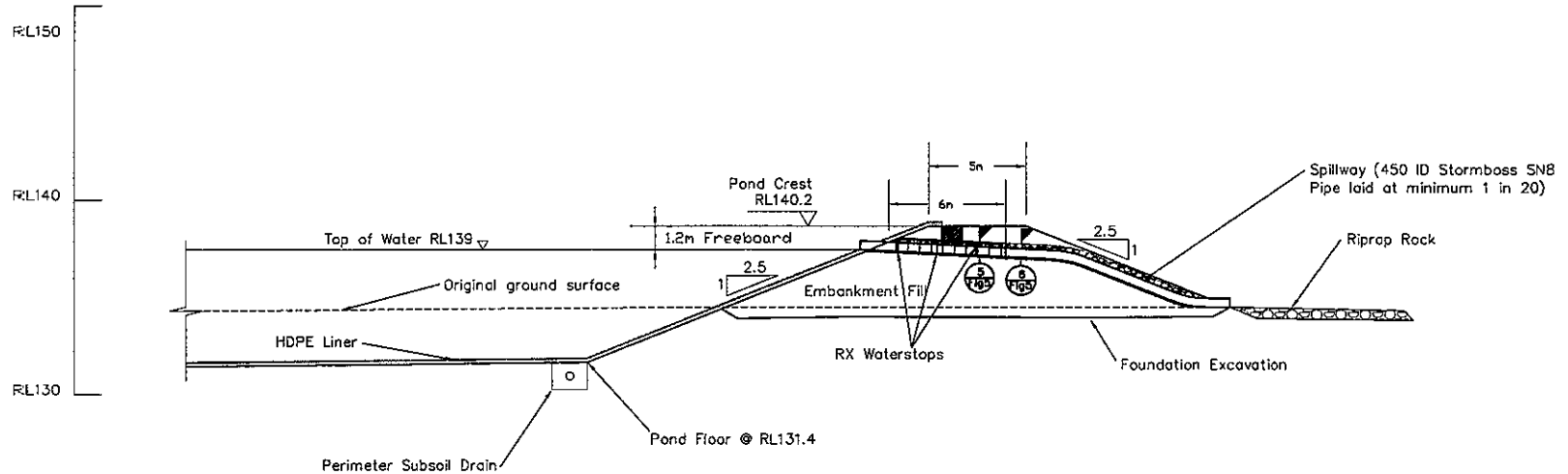
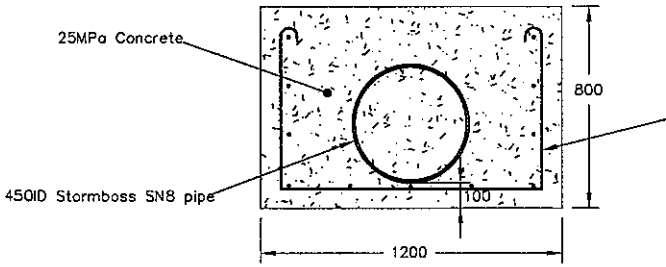
ARA WINES PROPOSED VINEYARD DEVELOPMENT
Water Storage Pond, Waihopai Valley
Pond Typical Sections

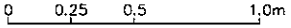
Drawing No.	7546-Fig 4
Date:	25 Sept 2014
Drawn:	GS
Scale:	As shown
Filename:	7546-Figures 3 to 6.dwg

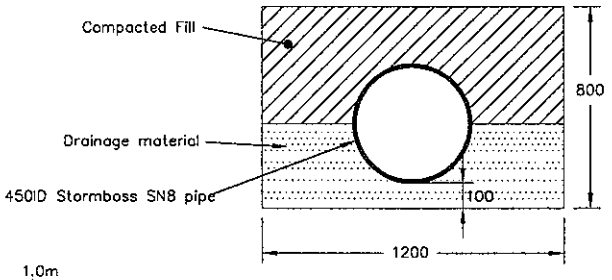


SPILLWAY CROSS SECTION 4 / Fig1
Scale 1:250 (A3)



SPILLWAY OUTLET
PIPE THOUGH EMBANKMENT 5 / Fig5
Scale 1:20 (A3)





SPILLWAY OUTLET PIPE
THROUGH DOWNSTREAM EMBANKMENT 6 / Fig5
Scale 1:20 (A3)

Figure 5

ENGINEERING GEOLOGY LTD
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ARA WINES PROPOSED VINEYARD DEVELOPMENT
Water Storage Pond, Waihopai Valley
Spillway Section and Details

Drawing No.	7546-Fig 5
Date:	25 Sept 2014
Drawn:	GS
Scale:	As Shown
Filename:	7546-Figures 3 to 6.dwg