

**GEOTECHNICAL SUBDIVISION COMPLETION REPORT
(INSPECTING ENGINEERS REPORT)
FRONTIER DEVELOPMENTS SUBDIVISION – Stage 1
Lots 2 to 41
PIRONGIA ROAD, HAMILTON**

for

Frontier Developments Ltd
c/- Design Management Consultants Ltd
PO Box 5254
Hamilton 3242

by

Mark T Mitchell Ltd
Consulting Geotechnical Engineers
1150 Victoria Street – PO Box 9123
Hamilton 3240

4 December, 2019

Mark T Mitchell Ltd

Consulting Geotechnical Engineers

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Ref: W – 16234.7
4 December, 2019

Frontier Developments Ltd
c/- Design Management Consultants Ltd
PO Box 5254
Hamilton 3242

Attn: Steven Green – Design Management Consultants Ltd

Dear Sir,

**Re: Geotechnical Completion Report - Soils and Earth Fill Report,
Frontier Developments Residential Subdivision
Stage 1 - Lots 2 to 41
Pirongia Road, Hamilton**

Please find enclosed four copies of our Soils Investigation and Geotechnical Completion Report for the above-referenced project.

The results of our studies indicate that the site is suitable for use as a residential subdivision. A test hole has been drilled within each of the lots so as to provide a guide to the soil conditions present. The results of these tests indicate that standard foundations are to be used for Lot Nos. 3 to 41 as detailed in the attached report.

At the time of building site preparation work, where site soils are found to be different from those shown on the attached Bore Hole Logs, which could arise following wet weather conditions, we should inspect the site excavations to advise on the extent of remedial work required.

Yours faithfully

Mark T Mitchell Ltd



Mark T Mitchell
Director

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Lots 2 to 41
PIRONGIA ROAD, HAMILTON**

1. Introduction

This report combines the Soils Investigation Report and the Subdivision Completion Report (or the Inspecting Engineer's Report) for Frontier Developments Residential Subdivision Stage 1, which is located off Pirongia Road, Te Awamutu. This stage of the development comprises Lots 2 to 41, the locations of which are shown on the attached Site Plan, Drawing No. 16234-01. The development is being undertaken by Frontier Developments Ltd, with the land surveying and engineering design carried out by Design Management Consultants.

The topography of the majority of Stage 1 of the subdivision consists of an elevated, low hill area. But to the north-east, Lot 2 is within a low lying area.

The purpose of the Soils Investigation was to determine the subsurface conditions within the specified lots and to evaluate what special conditions, if any, would be required for the foundation support of residential dwellings to be constructed on the site. This Geotechnical Completion Report also details the extent of filling and other activities that have taken place during the site development and outlines limitations of earth filling that has been placed during the subdivision development.

2. Field Investigations and Site Testing

2.1 Soil testing

The soil conditions within the Stage 1 subdivision areas were investigated following completion of the site earthworks, which consisted of cut and fill land re-contouring. These earthworks were carried out between last autumn and the current construction seasons and included excavations of up to 4 metres in depth within elevated regions and filling of up to about 2 metres in lower areas. The Filling was placed and compacted within localised areas to produce near-level building sections.

The earthworks for Road 1 has also received compacted filling, up to about 8 metres in depth in parts in order to attain an appropriate road gradient.



The Filling that has been placed within this Stage 1 Development has been inspected and tested under the direction of Geocon Geotechnical Ltd and Mark T Mitchell Ltd geotechnical staff. On-site testing included nuclear density (NDM) testing, *in-situ* shear vane and Scala Penetrometer probe testing. Laboratory testing including soil compaction, water content and shear vane testing. The testing criteria adopted were in general accordance with NZS 4431:1989 "Code of Practice for Earthfill for Residential Development".

The soil conditions within the Stage 1 project site were investigated by drilling forty hand auger test borings, together with Scala Penetrometer probe and *in-situ* shear vane tests at the centre point of each lot, as shown on the attached Site Plan. The designated bore hole number corresponds to the relevant Lot number, with Bore Hole Logs and associated test results presented on Figs. A-1 to A-20.

The purpose of the bore holes and associated testing was to provide guidance as to the general consistency, relative density and shear strength of soils located within the building site areas. This testing was also to determine general requirements for foundation construction for residential dwellings.

It should be noted that the Topsoil depths encountered within each of the bore holes are likely to vary across the general lot areas.

2.2 Soil Descriptions

2.2.1 Elevated Areas (Lots 3 to 41)

The near-surface soil conditions consist of 200 to 500mm of re-spread Topsoil over natural soils or shallow, Engineer-certified Fill to variable depths. The Fill composition is a mixture of light to dark brown, compacted, Clays, Silts and Sands. The natural soils and naturally occurring soils below the Filling consist of stiff to very stiff, Silts and Clays which continue to at least the base of the 2 metre deep bore holes.

The original soils have developed by the progressive weathering of volcanic ash (tephra) erupted about 60,000 to 350,000 years B.P. and described generally as the Hamilton Ash Formation. The ash layers are a few metres thick and are representative of a sequence of volcanic ash deposits weathered to Clay and Silt soils. Some of these ash soils were excavated during earthworks and provided the bulk material for the filling operations.

Peat soils have been encountered at in excess of 20 metres depth during well drilling below the volcanic ash soils. These Peat soils were found at a level that corresponds with Peat soils on the low lying area near the Sediment Retention Pond. This implies that compressed Peat may underlie some of the elevated area of the site but at a depth that will not affect the residential dwelling sites.

The Walton Subgroup soils are present below the upper layers, consisting of two geological units referred to as the Karapiro and Puketoka formations. However these soils are not likely to be exposed during house foundation excavations.



2.2.2 Low Lying Area (Lot 2)

Lot 2 is located within a low lying area of Stage 1. The near-surface soil conditions encountered within Bore Hole No. 2 consist of 300mm of re-spread Topsoil overlying Engineer-certified Fill to about 0.9 metres depth. The Fill composition is a mixture of compacted light to dark brown, Clays, Silts and Sands.

The naturally occurring soils below the Filling consist of stiff to very stiff Silts overlying loose to medium dense silty, fine to medium Sand which continues to at least the base of the 2.2 metre deep bore hole.

The natural Silts and Sands are categorized as Recent Alluvium which comprises soft Silts and Sands, deposited within the last 10,000 years by local streams and rivers. These soils typically exhibit low strengths which are typical of young sediments and represent relatively low energy depositional environments.

3. Engineer-Certified Fill – Lot Nos. 3, 7, 13 to 17, 21 to 23, 27 to 31, 40 and 41

3.1 Fill Areas and Depths

Earth filling has been place within all, or part of the following lots so as to form near-level building site areas:

Approximate Fill Depth	Lot Numbers
Less than 0.5 metres	7, 17, 21, 22, 27, 28 and 31
Between 0.5 and 1.0 metres	3, 13, 16, 29, 30, 40
Between 1.0 and 2.0 metres	14, 15, 23, 41

Note that the filling will typically cover only a portion of the lots concerned.

Also noted, that within Lot 23 some of the filling was required to backfill an area where rubbish from a former farm rubbish hole had been removed.

3.2 Fill Description

The *Engineer-certified Fill* was placed and compacted between March and November 2019 by C & R Developments Ltd, with periodic field and laboratory testing carried out by Geocor Geotechnical Ltd and Mark T Mitchell Ltd, to ensure that the filling was constructed to the requirements of New Zealand Standard NZS 4404:2010, Land Development and Subdivision Infrastructure. Compaction of these soils was carried out using a combination of 12 and 24 tonne sheep-foot/wedge-foot and flat-drum rollers and loaded HM300 and HM400 articulated dump trucks.



The Contract Specification required the level of compaction effort applied to achieve a density which is acceptable for building construction to the NZ Standard for Light Timber Framed Buildings, NZS 3604:2011. Engineer-verification consisting of site inspections and testing was carried out during regular inspections during the backfilling process.

The *Engineer-certified Filling* is generally capable of supporting residential foundation designed in accordance with NZS 3604:2011. However, because building sites may contain areas of well-compacted filling that are alongside naturally occurring soils of a lower density, it is recommended for lots within this category further compaction of soils takes place. This would take place after the building site area has been excavated to design level, with the entire building site area then to be compacted with a roller of minimum 2 tonne weight.

3.3 Fill Placement Procedures

Prior to placement of *Engineer-certified Filling* within the lots, the topsoil and some of the underlying soils were removed and stockpiled for later re-spreading. Benching was completed across areas where natural slopes of greater than 1 vertical to 5 horizontal were located prior to any filling being placed.

4. Engineer-Certified Fill - Lot No. 2

Lot 2 is located within a low-lying area to the west of the other lots within Stage 1. At that location, Filling was placed within all of this lot in the same manner as that described in Section 3 above.

The *Engineer-certified Filling* within Lot 2 is generally capable of supporting residential foundations designed in accordance with NZS 3604:2011. However where low-strength soils within the proposed building sites are exposed, those soils should be either compacted in place, or removed and replaced with compacted pit sand.

5. Natural Ground - Cut Areas – Lot Nos. 3 to 27 and 31 to 41

5.1 Lot Locations

These lots are located within locations where site excavations have taken place, with the excavated soils being utilized as Certified Fill areas located elsewhere within the subdivision.

5.2 Ground Conditions

The near-surface soils within these lots typically consist of 300 to 500mm of respread Topsoil, overlying stiff to very stiff, clayey Silt and silty Clay soils. These soils are generally able to provide satisfactory support for residential foundations that are designed in accordance with NZS 3604:2011. However where low-strength soils are exposed within the proposed building site areas, those soils should be either compacted in place, or removed and replaced with compacted pit sand or rockfill.



An alternative option for this situation would be provide additional steel reinforcement within the exterior foundations, to an engineer-design.

Where the presence of low-strength soils is on account of water-exposure to the near-surface soils, the affected soils should be removed and replaced with pit sand or rockfill.

6. General Foundation Recommendations – Lot Nos. 3 to 41

Lot Nos. 3 to 41 have all been excavated into the original clay soils and lightly rolled prior to the placement of the Topsoil layer. However at some locations, over-excavations were required to remove filling that had been placed during previous farm operations.

The soil test results carried out and represented by the attached Bore Hole logs indicate that all foundations may be designed and constructed in accordance with NZS 3604:2011, the NZ Standard for Timber Framed Buildings or NZS 4229:2013 Code of Practice for Concrete Masonry Buildings not requiring Specific Design.

However if site excavations for footings and floor slab reveal soft areas to be present within the exposed soils, or if rain softens them prior to pouring of concrete, these soils are to be removed and replaced with pit sand as part of the general foundation support for concrete slab construction.

Due to the nature of the Clay and Silt soils, all foundations, including the perimeter beams of concrete floor slabs, should be founded to a minimum depth of 400mm below the adjacent final ground level. This is in order so that shrinkage of the foundation soils during summer does not affect the concrete house foundations.

7. Foundation Recommendations – Lot No. 2

The soil test results carried out within Lot No. 2 indicate that the natural, saturated Sand soils are prone to liquefaction during a large seismic event, as discussed in Section 11 of this report, although due to the presence of the overlying relatively high strength *Engineer-certified Filling* and stiff Silt soils, sand boils at ground surface are unlikely to develop should liquefaction of some of the underlying soils take place.

However the currently proposed amendments to NZS 3604; 2011, when published, may require engineer-foundations to be used for this lot.

8. Site Preparation – Concrete slab-on-grade Construction

This form of construction should be carried out by firstly excavating and removing all Topsoil and soft soils from below and surrounding the proposed foundation area. The exposed surface should then be proof rolled with the roller that is to be used for compaction of the hardfill layer that immediately underlies the concrete slab. Any soft areas encountered are to be compacted further or the soft soil removed and replaced with hardfill.



The replacement hardfill (compacted pit sand or similar) below the concrete slab and footings should be placed in layers not exceeding 200mm in thickness, with each layer thoroughly compacted with the roller, adding water to assist compaction as required.

9. Timber Floor Construction

The near surface, stiff to very stiff, Silt and Clay soils and the Engineer-Certified Fill soils that occur within the development are generally capable of supporting foundations for timber floor structures which are designed to the requirements of NZS 3604:2011 the NZ Standard for Timber Framed dwellings. This is provided that foundations are deepened to found below the Topsoil to a depth at which the Scala values exceed 5 blows per 100mm, or to such other minimum depth specified in NZS 3604:2011. Alternatively *in-situ* shear vane values must exceed minimum shear strength of 80kPa in cohesive soils.

Where the Scala blows do not achieve the required 5 blows per 100mm or shear vane values do not achieve 80kPa, the diameter of the footings will need to be increased by about 100mm greater than the minimum values set out in Table 6.1 of NZS 3604:2011.

10. Groundwater

Groundwater only encountered only in Bore Hole No. 2 at the time of our November 2019 test drilling program.

11. Variations of Soil Type, Density and Shear Strength

Prospective purchasers and owners of lots within this development are advised that variations in soil type, density and shear strength will occur across the overall site and within individual sections. This fact applies to both unfilled and filled ground and in some circumstances, supplementary foundation preparation and construction work may be required where soft soil conditions are encountered.

12. Assessment of Natural Hazards

For this particular site, the natural hazards consist of:

- liquefaction
- ground subsidence
- surface flooding
- slope instability



12.1 Liquefaction

Tonkin and Taylor Ltd have recently released a Liquefaction Desktop Study (2019) identifying the likely spatial distribution of liquefaction vulnerability within the Hamilton City Council (HCC) boundary. For land areas that are located within *low hills* (which is applicable to the subject site), the Tonkin and Taylor (2019) report indicates that the potential for liquefaction for Lot Nos. 3 to 41 of this category is *unlikely*.

Lot No. 2 is low lying and therefore characterised as a river terrace gully comprising alluvial sediments in which liquefaction damage is possible. The high strength *Engineer-Certified Filling* and stiff to very stiff Silt soils that cap the alluvial sands is expected to contain the effects of site liquefaction, with the likelihood of liquefaction occurring and damaging the surface with sand boils is assessed as low. However currently proposed amendments to NZS 3604; 2011 may require engineer-foundations to be used for this lot.

12.2 Ground Subsidence – Building Sites

Sections 4 to 7 of the above report state that in general, the results of the recent testing indicates that the soils underlying the subdivision are suitable for foundation support, subject to our recommendations being followed.

12.3 Surface Flooding

The land topography within Stage 1 development currently consists of a gently sloping ground surface and therefore surface water flooding of the respective lots in their as-developed state is not expected to occur.

12.4 Slope Stability

The completed land topography is such that all as-constructed ground slopes, within both cuts and fills possess a Factor of Safety of at least 1.5 and 'safe' building platforms have been provided, as required by Section 106 of the Resource Management Act (1991).

12.5 Certification

A Statement of Professional Opinion as to suitability of Land for Subdivision is presented at the end of this report, which includes a statement that providing the recommendations presented in this report are adhered to, the environmental risks associated with the proposed subdivision development are acceptable.



13. Limitations

The Geotechnical opinions and recommendations that are contained in this report are based on site conditions as they presently exist and further assume that the exploratory holes and soundings are representative of subsurface conditions throughout the site, i.e. inferences about the nature and continuity of ground conditions away from the bore holes have been made in the preparation of this report. It is assumed that subsurface conditions elsewhere are not significantly different from those disclosed by the investigation.

We should be notified of any subsurface conditions that appear to be different from those as disclosed by this investigation so that the conditions may be reviewed and our recommendations reconsidered where necessary.

This report and certification does not preclude routine foundation inspections by the Builder or the Waipa District Council Building Inspectors. Where such inspections reveal the presence of localised soft areas, further soils investigations may need to be carried out in order to assess the extent of the problem soils and to determine what treatment, if any, of the foundation soils is required.

14. Conclusions and Recommendations

The results of this study indicate that, based upon all available information, there is a stable building site available on each of the proposed lots. A test hole has been drilled centrally within each of the lots so as to provide a guide to the soil conditions present. Some lots will require engineer-design of foundations on account of the soil conditions present.

A Statement of Suitability of Earth Fill for Residential Development (NZS 4431 Appendix A) and a Statement of Suitability of Land for Building Development (Schedule 2A: NZS 4404:2010) are included with this report.

Mark T Mitchell Ltd

Mark T Mitchell
Director

Attached:

Site Plan Drawing No. 16234-01
Geocon Geotechnical Ltd Bore Holes; Figs. A-1 to A20
Schedule 2A: Ref: NZS 4404:2010
Appendix A: Ref: NZS4431:1989



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The topography of the majority of Stage 1 of the subdivision consists of an elevated, low hill area. But to the north-east, Lot 2 is within a low lying area.

The purpose of the Soils Investigation was to determine the subsurface conditions within the specified lots and to evaluate what special conditions, if any, would be required for the foundation support of residential dwellings to be constructed on the site. This Geotechnical Completion Report also details the extent of filling and other activities that have taken place during the site development and outlines limitations of earth filling that has been placed during the subdivision development.

2. Field Investigations and Site Testing

2.1 Soil testing

The soil conditions within the Stage 1 subdivision areas were investigated following completion of the site earthworks, which consisted of cut and fill land re-contouring. These earthworks were carried out between last autumn and the current construction seasons and included excavations of up to 4 metres in depth within elevated regions and filling of up to about 2 metres in lower areas. The Filling was placed and compacted within localised areas to produce near-level building sections.

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The purpose of the bore holes and associated testing was to provide guidance as to the general consistency, relative density and shear strength of soils located within the building site areas. This testing was also to determine general requirements for foundation construction for residential dwellings.

It should be noted that the Topsoil depths encountered within each of the bore holes are likely to vary across the general lot areas.

2.2 Soil Descriptions

2.2.1 Elevated Areas (Lots 3 to 41)

The near-surface soil conditions consist of 200 to 500mm of re-spread Topsoil over natural soils or shallow, Engineer-certified Fill to variable depths. The Fill composition is a mixture of light to dark brown, compacted, Clays, Silts and Sands. The natural soils and naturally occurring soils below the Filling consist of stiff to very stiff, Silts and Clays which continue to at least the base of the 2 metre deep bore holes.

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The naturally occurring soils below the Filling consist of stiff to very stiff Silts overlying loose to medium dense silty, fine to medium Sand which continues to at least the base of the 2.2 metre deep bore hole.

The natural Silts and Sands are categorized as Recent Alluvium which comprises soft Silts and Sands, deposited within the last 10,000 years by local streams and rivers. These soils typically exhibit low strengths which are typical of young sediments and represent relatively low energy depositional environments.

3. Engineer-Certified Fill – Lot Nos. 3, 7, 13 to 17, 21 to 23, 27 to 31, 40 and 41

3.1 Fill Areas and Depths

Earth filling has been place within all, or part of the following lots so as to form near-level building site areas:

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Also noted, that within Lot 23 some of the filling was required to backfill an area where rubbish from a former farm rubbish hole had been removed.

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The *Engineer-certified Filling* is generally capable of supporting residential foundation designed in accordance with NZS 3604:2011. However, because building sites may contain areas of well-compacted filling that are alongside naturally occurring soils of a lower density, it is recommended for lots within this category further compaction of soils takes place. This would take place after the building site area has been excavated to design level, with the entire building site area then to be compacted with a roller of minimum 2 tonne weight.

3.3 Fill Placement Procedures

Prior to placement of *Engineer-certified Filling* within the lots, the topsoil and some of the underlying soils were removed and stockpiled for later re-spreading. Benching was completed across areas where natural slopes of greater than 1 vertical to 5 horizontal were located prior to any filling being placed.

4. Engineer-Certified Fill - Lot No. 2

Lot 2 is located within a low-lying area to the west of the other lots within Stage 1. At that location, Filling was placed within all of this lot in the same manner as that described in Section 3 above.

The *Engineer-certified Filling* within Lot 2 is generally capable of supporting residential foundations designed in accordance with NZS 3604:2011. However where low-strength soils within the proposed building sites are exposed, those soils should be either compacted in place, or removed and replaced with compacted pit sand.

5. Natural Ground - Cut Areas – Lot Nos. 3 to 27 and 31 to 41

5.1 Lot Locations

These lots are located within locations where site excavations have taken place, with the excavated soils being utilized as Certified Fill areas located elsewhere within the subdivision.

5.2 Ground Conditions

The near-surface soils within these lots typically consist of 300 to 500mm of respread Topsoil, overlying stiff to very stiff, clayey Silt and silty Clay soils. These soils are generally able to provide satisfactory support for residential foundations that are designed in accordance with NZS 3604:2011. However where low-strength soils are exposed within the proposed building site areas, those soils should be either compacted in place, or removed and replaced with compacted pit sand or rockfill.



An alternative option for this situation would be provide additional steel reinforcement within the exterior foundations, to an engineer-design.

Where the presence of low-strength soils is on account of water-exposure to the near-surface soils, the affected soils should be removed and replaced with pit sand or rockfill.

6. General Foundation Recommendations – Lot Nos. 3 to 41

Lot Nos. 3 to 41 have all been excavated into the original clay soils and lightly rolled prior to the placement of the Topsoil layer. However at some locations, over-excavations were required to remove filling that had been placed during previous farm operations.

The soil test results carried out and represented by the attached Bore Hole logs indicate that all foundations may be designed and constructed in accordance with NZS 3604:2011, the NZ Standard for Timber Framed Buildings or NZS 4229:2013 Code of Practice for Concrete Masonry Buildings not requiring Specific Design.

However if site excavations for footings and floor slab reveal soft areas to be present within the exposed soils, or if rain softens them prior to pouring of concrete, these soils are to be removed and replaced with pit sand as part of the general foundation support for concrete slab construction.

Due to the nature of the Clay and Silt soils, all foundations, including the perimeter beams of concrete floor slabs, should be founded to a minimum depth of 400mm below the adjacent final ground level. This is in order so that shrinkage of the foundation soils during summer does not affect the concrete house foundations.

7. Foundation Recommendations – Lot No. 2

The soil test results carried out within Lot No. 2 indicate that the natural, saturated Sand soils are prone to liquefaction during a large seismic event, as discussed in Section 11 of this report, although due to the presence of the overlying relatively high strength *Engineer-certified Filling* and stiff Silt soils, sand boils at ground surface are unlikely to develop should liquefaction of some of the underlying soils take place.

However the currently proposed amendments to NZS 3604; 2011, when published, may require engineer-foundations to be used for this lot.

8. Site Preparation – Concrete slab-on-grade Construction

This form of construction should be carried out by firstly excavating and removing all Topsoil and soft soils from below and surrounding the proposed foundation area. The exposed surface should then be proof rolled with the roller that is to be used for compaction of the hardfill layer that immediately underlies the concrete slab. Any soft areas encountered are to be compacted further or the soft soil removed and replaced with hardfill.



The replacement hardfill (compacted pit sand or similar) below the concrete slab and footings should be placed in layers not exceeding 200mm in thickness, with each layer thoroughly compacted with the roller, adding water to assist compaction as required.

9. Timber Floor Construction

The near surface, stiff to very stiff, Silt and Clay soils and the Engineer-Certified Fill soils that occur within the development are generally capable of supporting foundations for timber floor structures which are designed to the requirements of NZS 3604:2011 the NZ Standard for Timber Framed dwellings. This is provided that foundations are deepened to found below the Topsoil to a depth at which the Scala values exceed 5 blows per 100mm, or to such other minimum depth specified in NZS 3604:2011. Alternatively *in-situ* shear vane values must exceed minimum shear strength of 80kPa in cohesive soils.

Where the Scala blows do not achieve the required 5 blows per 100mm or shear vane values do not achieve 80kPa, the diameter of the footings will need to be increased by about 100mm greater than the minimum values set out in Table 6.1 of NZS 3604:2011.

10. Groundwater

Groundwater only encountered only in Bore Hole No. 2 at the time of our November 2019 test drilling program.

11. Variations of Soil Type, Density and Shear Strength

Prospective purchasers and owners of lots within this development are advised that variations in soil type, density and shear strength will occur across the overall site and within individual sections. This fact applies to both unfilled and filled ground and in some circumstances, supplementary foundation preparation and construction work may be required where soft soil conditions are encountered.

12. Assessment of Natural Hazards

For this particular site, the natural hazards consist of:

- liquefaction
- ground subsidence
- surface flooding
- slope instability



12.1 Liquefaction

Tonkin and Taylor Ltd have recently released a Liquefaction Desktop Study (2019) identifying the likely spatial distribution of liquefaction vulnerability within the Hamilton City Council (HCC) boundary. For land areas that are located within *low hills* (which is applicable to the subject site), the Tonkin and Taylor (2019) report indicates that the potential for liquefaction for Lot Nos. 3 to 41 of this category is *unlikely*.

Lot No. 2 is low lying and therefore characterised as a river terrace gully comprising alluvial sediments in which liquefaction damage is possible. The high strength *Engineer-Certified Filling* and stiff to very stiff Silt soils that cap the alluvial sands is expected to contain the effects of site liquefaction, with the likelihood of liquefaction occurring and damaging the surface with sand boils is assessed as low. However currently proposed amendments to NZS 3604; 2011 may require engineer-foundations to be used for this lot.

12.2 Ground Subsidence – Building Sites

Sections 4 to 7 of the above report state that in general, the results of the recent testing indicates that the soils underlying the subdivision are suitable for foundation support, subject to our recommendations being followed.

12.3 Surface Flooding

The land topography within Stage 1 development currently consists of a gently sloping ground surface and therefore surface water flooding of the respective lots in their as-developed state is not expected to occur.

12.4 Slope Stability

The completed land topography is such that all as-constructed ground slopes, within both cuts and fills possess a Factor of Safety of at least 1.5 and 'safe' building platforms have been provided, as required by Section 106 of the Resource Management Act (1991).

12.5 Certification

A Statement of Professional Opinion as to suitability of Land for Subdivision is presented at the end of this report, which includes a statement that providing the recommendations presented in this report are adhered to, the environmental risks associated with the proposed subdivision development are acceptable.



13. Limitations

The Geotechnical opinions and recommendations that are contained in this report are based on site conditions as they presently exist and further assume that the exploratory holes and soundings are representative of subsurface conditions throughout the site, i.e. inferences about the nature and continuity of ground conditions away from the bore holes have been made in the preparation of this report. It is assumed that subsurface conditions elsewhere are not significantly different from those disclosed by the investigation.

We should be notified of any subsurface conditions that appear to be different from those as disclosed by this investigation so that the conditions may be reviewed and our recommendations reconsidered where necessary.

This report and certification does not preclude routine foundation inspections by the Builder or the Waipa District Council Building Inspectors. Where such inspections reveal the presence of localised soft areas, further soils investigations may need to be carried out in order to assess the extent of the problem soils and to determine what treatment, if any, of the foundation soils is required.

14. Conclusions and Recommendations

The results of this study indicate that, based upon all available information, there is a stable building site available on each of the proposed lots. A test hole has been drilled centrally within each of the lots so as to provide a guide to the soil conditions present. Some lots will require engineer-design of foundations on account of the soil conditions present.

A Statement of Suitability of Earth Fill for Residential Development (NZS 4431 Appendix A) and a Statement of Suitability of Land for Building Development (Schedule 2A: NZS 4404:2010) are included with this report.

Mark T Mitchell Ltd



Mark T Mitchell
Director

Attached:

Site Plan Drawing No. 16234-01
Geocon Geotechnical Ltd Bore Holes; Figs. A-1 to A20
Schedule 2A: Ref: NZS 4404:2010
Appendix A: Ref: NZS4431:1989



Mark T Mitchell Ltd

Consulting Geotechnical Engineers

1150 Victoria Street
P O Box 9123
Hamilton 3240
New Zealand
Telephone 07 838 3119
Facsimile 07 839 3125
email: mtm@geocon.co.nz

APPENDIX A (Ref: NZS 4431:1989)

To: The Director of Works
Waipa District Council
Private Bag 2402
Te Awamutu 3840

Ref: W – 16234

STATEMENT OF SUITABILITY OF EARTH FILL FOR RESIDENTIAL BUILDING DEVELOPMENT

Subdivision : Frontier Developments – Stage 1
Owner/Developer : Frontier Developments Ltd
Location : Lots 2 to 41
Pirongia Road, Te Awamutu

I, Mark Thomson Mitchell, Consulting Geotechnical Engineer of 1150 Victoria Street, Hamilton and a Director of Mark T Mitchell Ltd, hereby confirm that:

1. The Engineer-Certified Earth Fill has been placed to a standard equal to or better than the requirements of NZS 4431:1989, the NZ Standard Code of Practice for Earth Fill for Residential Development.
2. While work was in progress I carried out the function of Inspecting Geotechnical Engineer.
3. During the work, my staff and I, made periodic visits of inspection to the site, as detailed in my report dated 4 December, 2019, a copy of which is attached.
4. Fill is present in the following lots:

Engineer-Certified Fill: 3, 7, 13 to 17, 21 to 23, 27 to 31, 40 and 41
5. In the opinion of the Inspecting Engineer, the limitations as set out in our 4 December, 2019 report should be observed when constructing dwellings over, or in the vicinity of Filled ground.
6. This Certification, that the Controlled Earth Fills have been placed equal to or to a better standard than the requirements of NZS 4431, does not remove the necessity for the normal inspection and design of foundations as would be made in natural ground.

Mark T Mitchell Ltd

Signed 
Mark T Mitchell, BE(Civil), MS, MIPENZ
(Member ACENZ, IPENZ, ASCE)

Date: 4 December, 2019

Mark T Mitchell Ltd

Consulting Geotechnical Engineers

1150 Victoria Street
P O Box 9123
Hamilton 3240
New Zealand
Telephone 07 838 3119
Facsimile 07 839 3125
email: mtm@geocon.co.nz

SCHEDULE 2A (Ref: NZS 4404:2010)

To: The Director of Works/Development Engineer
Waipa District Council
Private Bag 2402
Te Awamutu 3840

Ref: W – 16234

STATEMENT OF PROFESSIONAL OPINION AS TO SUITABILITY OF LAND FOR RESIDENTIAL BUILDING DEVELOPMENT

Subdivision : Frontier Developments – Stage 1
Owner/Developer : Frontier Developments Ltd
Location : Lots 2 to 41
Pirongia Road, Te Awamutu

I, Mark Thomson Mitchell, a Director of Mark T Mitchell Ltd, Consulting Geotechnical Engineers of 1150 Victoria Street, Hamilton, hereby confirm that:

1. I am a geo-professional as defined in Section 1.2.2 of NZS 4404:2010 and was retained by the Developer, as the geo-professional on the above development.
2. The extent of our inspections during construction and the results of all tests carried out are as described in our Soils and Earthfill report dated 4 December, 2019.
3. In my professional opinion, not to be construed as a guarantee, I consider that:
 - a. The Engineer-Certified Earth Fill has been placed in compliance with the requirements of the Waipa District Council.
 - b. The completed works take into account land slope and foundation stability considerations, subject to the foundation recommendations contained in our report dated 4 December, 2019
 - c. Subject to 3(a) and 3(b) of this Schedule, the original ground not affected by Filling is suitable for the erection thereon of buildings designed according to NZS 3604:2011, although the presence of groundwater within both naturally occurring and fill soils may result in a decrease in soil strength, thereby resulting in additional building site preparation work.
 - d. The original ground not affected by Filling and the Filled ground are not subject to erosion, subsidence, or slippage in accordance with the provisions of Section 106 of the Resource Management Act 1991 provided the recommendations contained in our report dated 4 December, 2019 are followed.

4. This professional opinion is furnished to Waipa District Council and the Developer for their purposes alone on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any building.
5. This certificate shall be read in conjunction with our geotechnical report referred to in clause 2 and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.

Signed by 
Mark T Mitchell, BE (Civil), MS, CPEng
(Member ACENZ, IPENZ, ASCE)

Date: 4 December, 2019


On behalf of **Mark T Mitchell Ltd**, Consulting Geotechnical Engineers



PIRONGIA ROAD



LEGEND

 denotes Bore Hole locations
 " Lot Number

SCALE 1:1000



Mark T Mitchell Ltd
 Geotechnical Engineers
 1150 Victoria Street, P.O. Box 9123, Hamilton

FRONTIER DEVELOPMENTS LTD
 Proposed Residential Subdivision
 Stage 1, Lots 2 to 41, Pirongia Road

SITE PLAN

DRAWING No. 16234-01
DATE November, 2019
ISSUE DATE 4.12.2019

GRAPHIC LOG	BORE HOLE LOG No. 4 (Lot 4)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL			
					1	2	3	4	5	6	7	8	9	10				
	TOPSOIL. Respread.		Topsoil															
	 silty CLAY with trace fine sand. Stiff to very stiff, moist, slightly plastic, yellowish brown.	132/38		Volcanic Ash														
140+																		
140+																		
88/16																		
120/27																		
110/42																		
	Bottom of Bore Hole completed 01/11/19	2																
		3																

BORE HOLE LOG No. 5 (lot 5)

SOIL DESCRIPTION

NOTES The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
 - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa).
 - Scala test was carried out in 1.0 metre depth increments.

GRAPHIC LOG	BORE HOLE LOG No. 5 (lot 5)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL			
					1	2	3	4	5	6	7	8	9	10				
	TOPSOIL. Respread.		Topsoil															
	 silty CLAY with trace fine sand. Stiff to very stiff, moist, highly plastic, yellowish brown. Becoming moist to wet @ 1.2 metres.	140+		Volcanic Ash														
140+																		
140+																		
140+																		
110/24																		
118/26																		
	Bottom of Bore Hole completed 01/11/19	2																
		3																

JOB NAME: FRONTIER DEVELOPMENTS LTD DRILL METHOD: Hand Auger LOGGED: MMC/AR PLOTTED: TD

JOB LOCATION: Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu VANE No. 446 / 1432 DATE LOGGED: 01/11/19

JOB NUMBER: W-16234 DRILLER: MMC/AR CHECKED: *PW*

GRAPHIC LOG	BORE HOLE LOG No. 6 (Lot 6)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL				
					1	2	3	4	5	6	7	8	9	10					
	TOPSOIL. Respread.		Topsoil																
	 silty CLAY with trace fine sand. Stiff to very stiff, moist, highly plastic, yellowish brown. Becoming moist to wet @ 1.6 metres. " firm @ 2.0 metres.	132/32	140+	140+	140+	140+	140+	124/48	110/50	97/35	75/30								
	Bottom of Bore Hole completed 01/11/19	2																	
		3																	

BORE HOLE LOG No. 7 (lot 7)

SOIL DESCRIPTION

NOTES The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
 - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa).
 - Scala test was carried out in 1.0 metre depth increments.

GRAPHIC LOG	BORE HOLE LOG No. 7 (lot 7)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL				
					1	2	3	4	5	6	7	8	9	10					
	TOPSOIL. Respread.		Topsoil																
	 silty CLAY with trace fine sand. Very stiff, moist, highly plastic, yellowish brown.	140+	140+	140+	140+	140+	140+	138/32	140+	140+	140+								
	Bottom of Bore Hole completed 01/11/19	2																	
		3																	

JOB NAME: FRONTIER DEVELOPMENTS LTD DRILL METHOD: Hand Auger LOGGED: MMC/AR PLOTTED: TD

JOB LOCATION: Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu VANE No. 446 / 1432 DATE LOGGED: 01/11/19

JOB NUMBER: W-16234 DRILLER: MMC/AR CHECKED: RW

GRAPHIC LOG	BORE HOLE LOG No. 8 (Lot 8)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL					
					1	2	3	4	5	6	7	8	9	10						
	TOPSOIL. Respread.		Topsoil																	
	silty CLAY with trace fine sand. Very stiff, moist, highly plastic, yellowish brown. Becoming yellowish brown @ 1.6 metres.	1	Volcanic Ash	140+																
				140+																
				140+																
				140+																
				140+																
				140+																
	Bottom of Bore Hole completed 01/11/19	2		140+																
			3																	

NOTES The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
 - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa).
 - Scala test was carried out in 1.0 metre depth increments.

GRAPHIC LOG	BORE HOLE LOG No. 9 (lot 9)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL					
					1	2	3	4	5	6	7	8	9	10						
	TOPSOIL. Respread.		Topsoil																	
	silty CLAY with trace fine sand. Very stiff, moist, highly plastic, yellowish brown.	1	Volcanic Ash	140+																
				140+																
				140+																
				140+																
				140+																
				140+																
	Bottom of Bore Hole completed 01/11/19	2		130/36																
					120/28															
		3		122/26																

JOB NAME: <u>FRONTIER DEVELOPMENTS LTD</u>	DRILL METHOD: <u>Hand Auger</u>	LOGGED: <u>MMC/AR</u> PLOTTED: <u>TD</u>
JOB LOCATION: <u>Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu</u>	VANE No. <u>446 / 1432</u>	DATE LOGGED: <u>01/11/19</u>
JOB NUMBER: <u>W-16234</u>	DRILLER: <u>MMC/AR</u>	CHECKED: <u>Rh</u>

GRAPHIC LOG	BORE HOLE LOG No. 10 (Lot 10)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL					
					1	2	3	4	5	6	7	8	9	10						
TOPSOIL. Respread.			Topsoil																	
silty CLAY with trace fine sand. Very stiff, moist, highly plastic, yellowish brown. Becoming moist to wet @ 1.5 metres.		1	Volcanic Ash		140+	140+	140+	140+	140+	130/44	102/25	140+	140+							
Bottom of Bore Hole completed 01/11/19		2			140+															
		3																		

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
 - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa).
 - Scala test was carried out in 1.0 metre depth increments.

GRAPHIC LOG	BORE HOLE LOG No. 11 (lot 11)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL					
					1	2	3	4	5	6	7	8	9	10						
TOPSOIL. Respread.			Topsoil																	
silty CLAY with trace fine sand. Very stiff, moist, highly plastic, yellowish brown. Becoming moist to wet @ 1.4 metres.		1	Volcanic Ash		140+	140+	140+	140+	140+	110/30	108/45	140+	140+							
Bottom of Bore Hole completed 01/11/19		2			140+															
		3																		

JOB NAME: <u>FRONTIER DEVELOPMENTS LTD</u>	DRILL METHOD: <u>Hand Auger</u>	LOGGED: <u>MMC/AR</u> PLOTTED: <u>TD</u>
JOB LOCATION: <u>Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu</u>	VANE No. <u>446 / 1432</u>	DATE LOGGED: <u>01/11/19</u>
JOB NUMBER: <u>W-16234</u>	DRILLER: <u>MMC/AR</u>	CHECKED: <u>RW</u>

GRAPHIC LOG	BORE HOLE LOG No. 12 (Lot 12)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL						
					1	2	3	4	5	6	7	8	9	10							
	TOPSOIL. Respread.		Topsoil																		
	silty CLAY with trace fine sand. Very stiff, moist, highly plastic, yellowish brown.	1	Volcanic Ash	140+																	
				140+																	
				140+																	
				114/22																	
				140+																	
				140+																	
	Bottom of Bore Hole completed 04/11/19	2		140+																	
			3		110/39																

BORE HOLE LOG No. 13 (lot 13)

SOIL DESCRIPTION

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
 - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa).
 - Scala test was carried out in 1.0 metre depth increments.

GRAPHIC LOG	BORE HOLE LOG No. 13 (lot 13)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL						
					1	2	3	4	5	6	7	8	9	10							
	TOPSOIL. Respread.		Topsoil																		
	clayey SILT with trace fine sand. Very stiff, moist, moderately plastic, yellowish brown.		Volcanic Ash	140+																	
	silty CLAY with trace fine sand. Very stiff, moist, highly plastic, brown. Becoming yellowish brown @ 1.7 metres.	1		114/42																	
				140+																	
				140+																	
				140+																	
				140+																	
	Bottom of Bore Hole completed 04/11/19	2		140+																	
			3		140+																

JOB NAME: FRONTIER DEVELOPMENTS LTD	DRILL METHOD: Hand Auger	LOGGED: MMC/AR PLOTTED: TD
JOB LOCATION: Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu	VANE No. 446 / 1432	DATE LOGGED: 04/11/19
JOB NUMBER: W-16234	DRILLER: MMC/AR	CHECKED:

GRAPHIC LOG	BORE HOLE LOG No. 14 (Lot 14)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL				
					1	2	3	4	5	6	7	8	9	10					
	TOPSOIL. Respread.		Topsoil																
	clayey SILT with trace fine sand. Very stiff, moist, moderately plastic, yellowish brown.	1	Volcanic Ash	140+															
				140+															
				114/25															
				112/23															
				112/30															
				110/28															
		2		140+															
				140+															
				140+															
	Bottom of Bore Hole completed 04/11/19	3																	

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
 - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa).
 - Scala test was carried out in 1.0 metre depth increments.

GRAPHIC LOG	BORE HOLE LOG No. 15 (lot 15)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL				
					1	2	3	4	5	6	7	8	9	10					
	TOPSOIL. Respread.		Topsoil																
	clayey SILT with trace fine sand. Stiff to very stiff, moist, moderately plastic, yellowish brown.	1	Volcanic Ash	128/30															
				140+															
				134/22															
				112/18															
				90/20															
	silty CLAY with trace fine sand. Very stiff, moist, highly plastic, yellowish brown.	2		128/50															
				140+															
					140+														
				140+															
	Bottom of Bore Hole completed 04/11/19	3																	

JOB NAME: FRONTIER DEVELOPMENTS LTD
 JOB LOCATION: Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu
 JOB NUMBER: W-16234

DRILL METHOD: Hand Auger
 VANE No. 446 / 1432
 DRILLER: MMC/AR




LOGGED: MMC/AR PLOTTED: TD
 DATE LOGGED: 04/11/19
 CHECKED: PW

GRAPHIC LOG	BORE HOLE LOG No. 16 (Lot 16)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL					
					1	2	3	4	5	6	7	8	9	10						
	TOPSOIL. Respread.		Topsoil	87/19																
	clayey SILT with trace fine sand. Stiff to very stiff, moist, moderately plastic, yellowish brown. Containing manganese nodules @ 1.4 metres.	1	Volcanic Ash	88/14																
				92/14																
				79/16																
				122/42																
				140+																
		140+																		
		140+																		
		140+																		
	Bottom of Bore Hole completed 04/11/19	2																		
		3																		

BORE HOLE LOG No. 17 (lot 17)		NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual. - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa). - Scala test was carried out in 1.0 metre depth increments.																		
GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL					
					1	2	3	4	5	6	7	8	9	10						
	TOPSOIL. Respread.		Topsoil	140+																
	silty CLAY with trace fine sand. Very stiff, moist, moderately plastic, yellowish brown.	1	Volcanic Ash	140+																
				131/25																
				132/23																
				138/42																
				140+																
		140+																		
		140+																		
		140+																		
	Bottom of Bore Hole completed 04/11/19	2																		
		3																		

JOB NAME: FRONTIER DEVELOPMENTS LTD	DRILL METHOD: Hand Auger	LOGGED: MMC/AR PLOTTED: TD
JOB LOCATION: Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu	VANE No. 446 / 1432	DATE LOGGED: 04/11/19
JOB NUMBER: W-16234	DRILLER: MMC/AR	CHECKED: <i>pm</i>


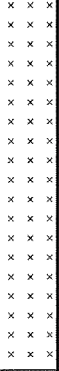

Geocon Geotechnical Ltd Geotechnical Engineers 1150 Victoria Street, P.O. Box 9123, Hamilton	<h2>BORE HOLE LOG</h2>	BORE HOLE LOG Nos. 16 & 17	
		LOCATION: refer Site Plan	RL (m): SHEET: 1 OF 1


GRAPHIC LOG	BORE HOLE LOG No. 20 (Lot 20)		DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL					
	SOIL DESCRIPTION					1	2	3	4	5	6	7	8	9	10						
	TOPSOIL. Respread.			Topsoil																	
	clayey SILT with trace fine sand. Very stiff, moist, moderately plastic, yellowish brown.		1	Volcanic Ash	140+																
	Bottom of Bore Hole completed 04/11/19 		2		140+																
			3		140+																

BORE HOLE LOG No. 21 (lot 21)

SOIL DESCRIPTION

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
 - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa).
 - Scala test was carried out in 1.0 metre depth increments.

GRAPHIC LOG	BORE HOLE LOG No. 21 (lot 21)		DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL					
	SOIL DESCRIPTION					1	2	3	4	5	6	7	8	9	10						
	TOPSOIL. Respread.			Topsoil																	
	clayey SILT with trace fine sand. Stiff to very stiff, moist, moderately plastic, yellowish brown.		1	Volcanic Ash	140+																
	Bottom of Bore Hole completed 04/11/19 		2		140+																
			3		140+																

JOB NAME: FRONTIER DEVELOPMENTS LTD	DRILL METHOD: Hand Auger	LOGGED: MMC/AR PLOTTED: TD
JOB LOCATION: Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu	VANE No. 446 / 1432	DATE LOGGED: 04/11/19
JOB NUMBER: W-16234	DRILLER: MMC/AR	CHECKED: 

GRAPHIC LOG	BORE HOLE LOG No. 22 (Lot 22)		DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL				
	SOIL DESCRIPTION					1	2	3	4	5	6	7	8	9	10					
	TOPSOIL. Respread.			Topsoil																
	silty CLAY with trace fine sand. Very stiff, moist, moderately plastic, yellowish brown.		1	Volcanic Ash	140+															
					130/24															
					140+															
					122/20															
					140+															
					140+															
			2		140+															
			3		140+															
	Bottom of Bore Hole completed 04/11/19																			

BORE HOLE LOG No. 23 (lot 23)

SOIL DESCRIPTION

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
 - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa).
 - Scala test was carried out in 1.0 metre depth increments.

GRAPHIC LOG	BORE HOLE LOG No. 23 (lot 23)		DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL				
	SOIL DESCRIPTION					1	2	3	4	5	6	7	8	9	10					
	TOPSOIL. Respread.			Topsoil																
	FILLING: Mixture of Silt, Clay and Sand. Engineer certified, high strength, moist, highly plastic, yellowish brown.		1	Filling	140+															
					123/40															
					137/38															
					140+															
					82/36															
					130/42															
			2		140+															
	silty CLAY with trace fine sand. Very stiff, moist, moderately plastic, yellowish brown.		3	Volcanic Ash	122/45															
					140+															
					140+															
					140+															
					140+															
					108/26															
			3		118/35															
	Bottom of Bore Hole completed 04/11/19																			

JOB NAME: FRONTIER DEVELOPMENTS LTD DRILL METHOD: Hand Auger LOGGED: MMC/AR PLOTTED: TD

JOB LOCATION: Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu VANE No. 446 / 1432 DATE LOGGED: 04/11/19

JOB NUMBER: W-16234 DRILLER: MMC/AR CHECKED:

GRAPHIC LOG	BORE HOLE LOG No. 24 (Lot 24)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL		
					1	2	3	4	5	6	7	8	9	10			
	TOPSOIL. Respread.		Topsoil														
	silty CLAY with trace fine sand. Very stiff, moist, highly plastic, yellowish brown. Becoming moist to wet @ 1.8 metres.	1	Volcanic Ash	140+													No Groundwater
		2		140+													
	Bottom of Bore Hole completed 01/11/19																
		3															

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
 - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa).
 - Scala test was carried out in 1.0 metre depth increments.

GRAPHIC LOG	BORE HOLE LOG No. 25 (lot 25)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL		
					1	2	3	4	5	6	7	8	9	10			
	TOPSOIL. Respread.		Topsoil														
	silty CLAY with trace fine sand. Very stiff, moist, highly plastic, yellowish brown. Becoming moist to wet @ 1.4 metres. yellowish brown @ 1.8 metres.	1	Volcanic Ash	140+													No Groundwater
		2		140+													
	Bottom of Bore Hole completed 01/11/19																
		3															

JOB NAME: FRONTIER DEVELOPMENTS LTD
 JOB LOCATION: Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu
 JOB NUMBER: W-16234

DRILL METHOD: Hand Auger
 VANE No. 446 / 1432
 DRILLER: MMC/AR

LOGGED: MMC/AR PLOTTED: TD
 DATE LOGGED: 01/11/19
 CHECKED:

GRAPHIC LOG	BORE HOLE LOG No. 28 (Lot 28)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL					
					1	2	3	4	5	6	7	8	9	10						
	TOPSOIL. Respread.		Topsoil																	
	FILLING: Mixture of Clay and Silt. Engineer certified, high strength, moist, moderately plastic, brown, mottled yellowish brown.		Fill	140+																
	clayey SILT. Very stiff, moist, slightly plastic, brown. Becoming brown @ 0.8 metres. " stiff @ 1.4 metres.	1	Volcanic Ash	140+																
				107/22																
				102/20																
				70/32																
	silty CLAY with trace fine sand. Very stiff, moist, brown.			140+																
				140+																
		2		140+																
	Bottom of Bore Hole completed 20/11/19																			
		3																		

BORE HOLE LOG No. 29 (lot 29)

SOIL DESCRIPTION

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
 - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa).
 - Scala test was carried out in 1.0 metre depth increments.

GRAPHIC LOG	BORE HOLE LOG No. 29 (lot 29)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL					
					1	2	3	4	5	6	7	8	9	10						
	TOPSOIL. Respread.		Topsoil																	
	FILLING: Mixture of Clay and Silt. Engineer Certified, high strength, moist, moderately plastic, brown, mottled yellowish brown.		Fill	135/53																
	clayey SILT with trace fine sand. Stiff to very stiff, moist, slightly plastic, light brown. Becoming yellowish brown @ 0.9 metres.	1	Volcanic Ash	140+																
				140+																
				112/20																
				84/20																
			130/30																	
			92/16																	
			90/24																	
		2		140+																
	Bottom of Bore Hole completed 20/11/19																			
		3																		

JOB NAME: FRONTIER DEVELOPMENTS LTD DRILL METHOD: Hand Auger LOGGED: MMC/AR PLOTTED: TD

JOB LOCATION: Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu VANE No. 446 / 1432 DATE LOGGED: 20/11/19

JOB NUMBER: W-16234 DRILLER: MMC/AR CHECKED: RW

GRAPHIC LOG	BORE HOLE LOG No. 32 (Lot 32)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL				
					1	2	3	4	5	6	7	8	9	10					
	TOPSOIL. Respread.		Topsoil																
	silty CLAY with trace fine sand. Stiff to very stiff, moist, highly plastic, yellowish brown. Becoming brown @ 0.9 metres. moist to wet @ 1.9 metres.	1	Volcanic Ash	140+															
				105/18															
				78/16															
				140+															
				140+															
				140+															
	Bottom of Bore Hole completed 01/11/19	2		140+															
			3		140+														

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
 - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa).
 - Scala test was carried out in 1.0 metre depth increments.

GRAPHIC LOG	BORE HOLE LOG No. 33 (lot 33)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL				
					1	2	3	4	5	6	7	8	9	10					
	TOPSOIL. Respread.		Topsoil																
	clayey SILT with trace fine sand. Very stiff, moist, slightly plastic, brown. Becoming light brown @ 1.6 metres.	1	Volcanic Ash	140+															
				140+															
				140+															
				140+															
				140+															
				140+															
	silty CLAY with trace fine to coarse sand. Stiff to very stiff, moist, yellowish brown.	2		82/22															
	Bottom of Bore Hole completed 20/11/19	3																	

JOB NAME: FRONTIER DEVELOPMENTS LTD
 JOB LOCATION: Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu
 JOB NUMBER: W-16234

DRILL METHOD: Hand Auger
 DRILLER: MMC/AR

LOGGED: MMC/AR PLOTTED: TD
 DATE LOGGED: 01 & 20/11/19
 CHECKED: *RW*

GRAPHIC LOG	BORE HOLE LOG No. 34 (Lot 34)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL			
					1	2	3	4	5	6	7	8	9	10				
	TOPSOIL. Respread.		Topsoil															
	silty CLAY with trace fine sand. Very stiff, moist, moderately plastic, yellowish brown		Volcanic Ash	126/32														
				106/21														
				96/13														
	silty CLAY with trace fine to coarse sand. Stiff to very stiff, moist, yellowish brown, mottled orangey brown.	1		73/10														
				110/22														
				140+														
				140+														
	silty CLAY with trace fine to coarse sand. Stiff, moist to wet, contains manganese nodules, light greyish brown.	2	Watton Subgroup	69/20														
				72/16														
	Bottom of Bore Hole completed 20/11/19																	
		3																

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
 - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa).
 - Scala test was carried out in 1.0 metre depth increments.

GRAPHIC LOG	BORE HOLE LOG No. 35 (lot 35)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL				
					1	2	3	4	5	6	7	8	9	10					
	TOPSOIL. Respread.		Topsoil																
	silty CLAY with trace fine sand. Stiff to very stiff, moist, highly plastic, yellowish brown. Becoming wet @ 1.4 metres.		Volcanic Ash	76/20															
		92/20																	
		140+																	
		140+																	
		140+																	
		140+																	
		1		110/34															
				98/38															
				70/18															
	Bottom of Bore Hole completed 01/11/19																		
		3																	

JOB NAME: FRONTIER DEVELOPMENTS LTD
 JOB LOCATION: Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu
 JOB NUMBER: W-16234

DRILL METHOD: Hand Auger
 VANE No. 446 / 1432
 DRILLER: MMC/AR

LOGGED: MMC/AR PLOTTED: TD
 DATE LOGGED: 01 & 20/11/19
 CHECKED: *AW*

Geocon Geotechnical Ltd
 Geotechnical Engineers
 1150 Victoria Street, P.O. Box 9123, Hamilton

BORE HOLE LOG

BORE HOLE LOG Nos. 34 & 35

LOCATION: refer Site Plan RL (m):
 SHEET: 1 OF 1 Fig. No. A-17

GRAPHIC LOG	BORE HOLE LOG No. 36 (Lot 36)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL				
					1	2	3	4	5	6	7	8	9	10					
	TOPSOIL. Respread.		Topsoil																
		silty CLAY with trace fine sand. Very stiff, moist, highly plastic, yellowish brown. Becoming brown @ 0.6 metres.	1	Volcanic Ash	140+														
2			140+																
	Bottom of Bore Hole completed 01/11/19																		
		3																	

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
 - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa).
 - Scala test was carried out in 1.0 metre depth increments.

GRAPHIC LOG	BORE HOLE LOG No. 37 (lot 37)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL			
					1	2	3	4	5	6	7	8	9	10				
	TOPSOIL. Respread.		Topsoil															
		silty CLAY with trace fine sand. Stiff to very stiff, moist, highly plastic, yellowish brown. Becoming brown @ 0.7 metres.	1	Volcanic Ash	124/32													
2			58/20															
	Bottom of Bore Hole completed 01/11/19																	
		3																

JOB NAME: FRONTIER DEVELOPMENTS LTD
 JOB LOCATION: Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu
 JOB NUMBER: W-16234

DRILL METHOD: Hand Auger
 VANE No. 446 / 1432
 DRILLER: MMC/AR

LOGGED: MMC/AR PLOTTED: TD
 DATE LOGGED: 01/11/19
 CHECKED: RW

GRAPHIC LOG	BORE HOLE LOG No. 38 (Lot 38)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (in-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL
					1	2	3	4	5	6	7	8	9	10	
	TOPSOIL. Respread.	1	Topsoil	140+											No Groundwater
			silty CLAY with trace fine sand. Very stiff, moist, highly plastic, yellowish brown.	Volcanic Ash											
		Bottom of Bore Hole completed 01/11/19	2		140+										
				140+											
		3		130/36											
				130/34											
				136/38											

BORE HOLE LOG No. 39 (lot 39)

SOIL DESCRIPTION

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.
 - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 446 of 1.42 and Geotechnics Vane 1432 of 1.55 should be applied to attain Undrained Shear Strength (kPa).
 - Scala test was carried out in 1.0 metre depth increments.

GRAPHIC LOG	BORE HOLE LOG No. 39 (lot 39)	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (in-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL
					1	2	3	4	5	6	7	8	9	10	
	TOPSOIL. Respread.	1	Topsoil	140+											No Groundwater
			silty CLAY with trace fine sand. Very stiff, moist, highly plastic, yellowish brown. Containing manganese nodules @ 1.6 metres. Becoming stiff and wet @ 2.0 metres.	Volcanic Ash											
		Bottom of Bore Hole completed 01/11/19	2		132/27										
				138/28											
		3		140+											
				140+											
				82/28											

JOB NAME: FRONTIER DEVELOPMENTS LTD DRILL METHOD: Hand Auger LOGGED: MMC/AR PLOTTED: TD

JOB LOCATION: Stage 1, Lots 2 - 41, Pirongia Road, Te Awamutu VANE No. 446 / 1432 DATE LOGGED: 01/11/19

JOB NUMBER: W-16234 DRILLER: MMC/AR CHECKED: RW

