APPENDIX 4: Three Waters Feasibility Report (Holmes Consulting)

Te Kowhai Airpark Development
3 Waters Feasibility Report

Limmer Road (SH6)
Te Kowhai
Hamilton

Holmes Consulting

Revision 2
27 June 2017
131928.00

Report

Te Kowhai Airpark Development -3 Waters Feasibility

Prepared For: TK Airfield Limited Partnership

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Holmes

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APPENDICES

TABLES

Holmes

1 INTRODUCTION

Te Kowhai Airpark development is a proposed airpark with commercial facilities located adjacent to Te Kowhai Airfield. Once complete the development will contain 133 residential dwellings, 11,124 m^2 of commercial floor area, and 75 public aircraft hangers.

1.1 Scope

The scope of work for this project included the following:

1. Assess stormwater, wastewater, and water supply requirements
2. Provide a feasibility report to support a plan change application

1.2 Limitations

Findings presented as a part of this project are for the sole use of TK Airfield Limited Partnership and Waikato District Council in their evaluation of the subject property. The findings are not intended for use by other parties, and may not contain sufficient information for the purposes of other parties or other uses. Our professional services are performed using a degree of care and skill normally exercised, under similar circumstances, by reputable consultants practicing in this field at this time. No other warranty, expressed or implied, is made as to the professional advice presented in this report.

2 SITE CONDITIONS

2.1 General

The site is located in Waikato District Council on flat ground adjoining Te Kowhai airfield. It is bordered on the south by State Highway 39a and to the north by the Te Kowhai airfield runway. The site is located approximately 3 km from the Waipa River to the west and 6.5 km from the Waikato River to the east.

2.2 Surface Water

As noted above, the Waipa River lies approximately 3 km from the boundary of the subject site. A number of small tributaries of the Waipa River drain the land surrounding the site. The largest of these is Ohote Stream which drains Lake Rotokauri to the south. The closest tributaries are located 400-600m from the proposed development.

2.3 Vegetation Cover

The site vegetation is largely grassed pasture, with isolated areas of hedge-rows and trees.

2.4 Permeability Testing

Permeability testing has been carried out by Bloxam, Burnett & Olliver Limited (BBO) and is included as Appendix B. Soakage rates in both boreholes tested was approximately 350 mm/h. It is noted that standard test procedures were not followed and therefore this testing is only seen as indicative of soakage rates. However 350 mm/hr is well above the 125 mm/hr threshold for category 1 soils within AS/NZS 1547:2012 and therefore this categorisation is likely. Further permeability testing should be undertaken prior to any detailed design.

2.5 Groundwater

As outlined in the BBO geotechnical report, groundwater was generally encountered at 1.3-2.5 m below ground. However, this was during summer months and higher groundwater levels are expected through winter months, including minor areas of low land flooding.

3 WASTEWATER

3.1 Wastewater Flows

The proposed subdivision development is split into four main areas or precincts. The layout of these areas is as per the proposed development plan attached as Appendix A.

Precinct A Runway and Operations Precinct
It is anticipated that the runway and operations precinct will have minimal wastewater demand.

It is noted that no allowance has been made for aeroplane wash down. Aircraft wash down has the potential to adversely impact an onsite wastewater treatment system due to oils/grease and large hydraulic loads. In this regard it is assumed that a separate system will be established for treatment and disposal from a dedicated wash down area. This will likely be in the form of a proprietary oil and grit interceptor followed by a bio retention swale and soakage to ground. Treatment in this manner is deemed feasible and further consideration will occur under detailed design.

Precinct B Commercial Precinct
This precinct can be split into public hangers and a collection of light commercial buildings.

The public hanger portion of this precinct will contain approximately 75 aircraft hangers. To cater for the hangers there will be a number of centralised bathrooms. It is conservatively assumed that on the busiest day of the year half the hangers would be in use. Assuming a maximum 4 persons per aircraft, and all persons using bathroom facilities prior to or after flight, this would equate to 150 bathroom uses. A single toilet use will on average produce 6-7 litres of wastewater from the toilet itself and 2-3 litres from hand washing. Conservatively it is estimated a bathroom use will produce 10 litres of wastewater. This is consistent with Table H4 of NZS1547:2012 'Community Halls – Meetings' which is the closest applicable source within the standard. On the busiest day of the year it is therefore anticipated that the 75 public hangers will produce a maximum 1,500 litres/day of wastewater.

The light commercial activity will cover approximately 3.5 hectares. In the absence of specific supportable design data, Figure 5.1 of The Hamilton City Design Manual requires commercial flows to be calculated at a density of 30 persons per hectare. The total land area within the commercial precinct is approximately 3.5 hectares and therefore 105 persons are anticipated based on the Design Manual requirements. Table 6.2 of ARC TP58 recommends 40 l/day for 'Day Staff' for standard facilities. Based on these numbers the commercial buildings portion of this precinct is anticipated to produce 4,200 litres/day of wastewater.

Precinct C Medium Density Residential
Table H3 of AS/NZS1547:2012 recommends 180 l/day/person for a household with standard fixtures and on-site roof water supply. NZS4404:2010 recommends an average 2.5-3.5 persons per dwelling and based on this an average 3 persons is anticipated per dwelling. Precinct D is proposed to contain 30 residential dwellings. Based on NZS1547 and NZS4404 this equates to a maximum 16,200 litres/day of wastewater.

Precinct D General Residential
Table H3 of AS/NZS1547:2012 recommends 180 l/day/person for a household with standard fixtures and on-site roof water supply. NZS4404:2010 recommends an average 2.5-3.5 persons per dwelling and therefore an average 3 persons is anticipated per dwelling. Precinct D is proposed to contain 88 residential dwellings. Based on NZS1547 and NZS4404 this equates to a maximum 47,520 litres/day of wastewater.

Based on the above volumes the peak day total wastewater production from the development as a whole is expected to be in the order of 70,000 litres.

It is acknowledged that the design factors discussed above are at the upper range of the possible usage scenarios and that production of wastewater to this maximum level is likely to occur only intermittently. However, it is necessary to design the wastewater system for the proposed development to handle the maximum potential loading. Should the airpark be used for a large event, or at some future point be transformed into a more typical residential development with higher density dwellings, then the wastewater system must be capable of treating and disposing of these larger flows.

3.2 Wastewater Strength

The wastewater on the site will come from a mix of both residential and commercial premises. Due to the lack of dilution from showers, baths, washing machines and other similar facilities, the wastewater strength from the commercial premises is normally expected to be much higher than that from the typical domestic strength residential effluent, a comparison is as shown in Table 3-2 below.

Table 1: Wastewater Strength Comparison

Constituent (mg/l)	Typical Domestic Strength [1]	Typical Commercial Premises
BOD_5	250-350	800
Total Suspended Solids	300-400	800
Total Nitrogen	varies	120-180

[1] ARC TP58

However, as the commercial flows only make up a small portion of the wastewater flows from the total development it is anticipated that they will be diluted substantially. Wastewater strength will therefore be close to that normally expected from standard residential development.

3.3 Nitrogen Reduction

Any discharge of treated wastewater or effluent onto or into land within the Waikato Regional Council's jurisdiction needs to comply with the maximum loadings outlined in the Waikato Regional Plan. At present this limit is noted as 150 kg N/ha/year. As the total land area for the greater site is very large (at approximately 45 ha), the overall nitrogen loading easily complies with this limit. However, as the intention is to dispose of the treated wastewater over as small a disposal field as possible, the possibility of a concentrated plume of nitrogen forming and entering the groundwater is possible and therefore some nitrogen reduction is recommended. It is also recommended that grass or other vegetation is grown over the disposal field, and that the grass clippings are removed from this area when the lawn is mowed to allow uptake of some of the nitrogen by the vegetation.

3.4 Treatment/Disposal Options

There are a number of options generally available for dealing with wastewater of the type expected from the Te Kowhai Airfield development, however, due to the specifics of the site, some of these options are not considered economically or technically viable.

3.4.1 Discharge to Council Sewer

Te Kowhai township 1 km to the north has a small localised wastewater scheme serving approximately 10 houses. This scheme is not considered to have capacity for connection of this development.

The Te Kowhai Airfield development is approximately 5 km from the nearest branch of the Hamilton City Council reticulated wastewater network located at Te Rapa Park to the east. The option to construct a conventional gravity sewer has been considered and discounted due to cost associated with constructing and operating intermediary pump stations, as well as difficulties with inter council wastewater connections between Waikato District and Hamilton City.

An alternative to the conventional gravity sewer to connect to the council system is a Septic Tank Effluent Pumping (STEP) system. With this system large volume septic tanks receive all of the wastewater from the development, where solids settlement and decomposition occurs. Screened pump vaults take effluent from the clear zone within the septic tank and pump the primary treated wastewater into a small bore effluent sewer. The small bore effluent sewer then conveys the treated effluent to the reticulated gravity network. For this site, a small bore sewer system associated with a STEP system is technically feasible, however, the associated costs are deemed to be significantly higher than for on-site treatment and disposal and general disruption in installing pipe infrastructure within the road reserve and difficulties with inter council wastewater connections makes this a less desirable option.

As neither a conventional gravity sewer nor STEP system are viable due to cost, general disruption, and difficulties with inter council wastewater connections, it has been concluded that onsite treatment and disposal is the most feasible wastewater solution for the Te Kowhai Airfield development.

3.4.2 On-site Wastewater Treatment

A number of feasible options exist within New Zealand for on-site wastewater treatment at the scale required for this project. These include:

- Recirculating Textile Packed Bed Reactors (PBR)
- Submerged Aerated Filtration (SAF)
- Sequencing Batch Reactor (SBR)
- Membrane Bioreactors (MBR)

It is likely that due to low OPEX costs and ability for staging of installation a PBR will be the preferred treatment method. PBRs have a proven history of being able to achieve secondary treatment standards of <20 mg/ltr BOD_5 and TSS, with total nitrogen to meet the permitted activity threshold of <150 kgN/ha/year, averaged across the development.

For on-site wastewater treatment systems on greenfield sites that have a limited number of wastewater sources in close proximity, a STEP system or pressure sewer is likely to be the best option to convey flows. Such sealed sewer systems should result in no significant inflows and infiltration, and accordingly the wet weather peaking factor can be excluded when sizing the on-site wastewater treatment system.

3.4.3 Wastewater Dispersal

The discharge of wastewater into water is a discretionary activity under the Waikato Regional Council's Water Plan, and a resource consent for this discharge where there is the ability to discharge onto or into land is unlikely to be granted. For this reason, the discharge of treated wastewater into any of the water courses in the area is not seen as feasible.

Dispersal into or onto land, including land treatment, can be carried out in a number of ways, including drip irrigation, infiltration trenches or beds, mounds or surface irrigation. The method of disposal is determined by the soils on the site and the sensitivity of the receiving environment. Two main disposal options are considered feasible for the Te Kowhai Airfield Development. These are drip irrigation and traditional trench disposal.

To achieve suitable contact time and biological treatment AS/NZS 1547:2012 requires a minimum set back of 0.6-1.5 m between the disposal field and groundwater. With winter groundwater levels close to the existing ground surface both disposal options will require modification of the existing ground to achieve the required minimum 0.6 m unsaturated soil below and thereby achieve appropriate levels of treatment prior to effluent entering the water table. This can be achieved by scarifying/ploughing the existing ground surface and then placing suitable fill prior to placement of dripline or pipe.

In order to achieve suitable contact times and nutrient retention, Table L1 of AS/NZS1547:2012 identifies that conventional trenches within category 1 & 2 soils require importation of a suitable filtration media to achieve a discharge control trench as per Figure L4 of the standard. In this regard the material utilised to raise the local ground level shall be Category 3 (or below) to ensure appropriate contact times.

The following design loading rates and land areas have been have been determined from AS/NZS1547:2012.

Table 2: Dripline Design Loading Rate (Category 1 soil)

Disposal Methodology	Design Loading Rate (DLR)	Area required
Drip irrigation	5 l/m^2/day	14,000 m^2

Table 3: Trench Design Loading Rates (Category 3 soils)

Disposal Methodology	Design Loading Rate (DLR)	Area required
Conventional Trenches	50 l/m^2/day	1,400 m^2

Based on the loss of developable land it is likely that conventional trench disposal will be used. The location for the dispersal area for the Te Kowhai Airfield Development has yet to be confirmed but possible locations include adjacent to the access road and north of the runway.

Overall based on the above assessment the onsite treatment and disposal of wastewater is deemed an appropriate and feasible solution for the Te Kowhai Airfield development. Environment Waikato effluent quality standards can more than likely be achieved through use of a Packed Bed Reactor or similar. To comply with AS/NZS1547:2012 effluent dispersal will require the placement of suitable fill material to ensure suitable ground water separation and this can relatively easily be achieved.

4 STORMWATER

The subject site does not have close access to a Council reticulated stormwater network. There are no formal waterways within close proximity to the development and so the option of disposal directly to these is not viewed as feasible. The most appropriate method of disposal is therefore direct soakage to ground via engineered soak pit/s in accordance with E1 of the Building Code.

The BBO geotechnical report in Appendix B confirms that underlying soils are relatively free draining and are likely Category 1 soils as determined under NZS 1547:2012. However, advice that the groundwater level is at, or near, the surface in places during winter indicates that ground soakage will not be possible at all times. Additional stormwater control measures are therefore likely to be required at this site, including the use of proposed rainwater tanks and ponding to attenuate stormwater flows. As recommended in the BBO geotechnical report additional soakage testing at each proposed disposal field, and winter watertable monitoring over the site, should be undertaken to allow the stormwater design to proceed.

For the residential areas, assuming a soakage rate of 350 mm/day and based on E1 of the Building Code a 200 m^2 dwelling in this location could dispose of stormwater within the site by a combination of rain tanks and soakage pits. Given the proposed lot areas and likely building coverage, it is anticipated that adequate area will be available to install the required soak pits. Floor levels will need to be carefully set to avoid any localised surface water ponding.

Stormwater from the road and runway hardstand should be able to be adequately treated and disposed to ground via shallow grassed swales or, alternatively, via sumps and a piped stormwater network leading to centralised soak pit/s. Stormwater from carparking and some aircraft activities such as refuelling, mechanical and washdown will more than likely require separation or other treatment before disposal to ground. Area 9, as shown on the drawing in Appendix A, is a planned area for stormwater treatment and disposal in close proximity to the commercial, carpark, hangar and aircraft operations area.

Overall, given the rural location and ground conditions, the soakage of stormwater runoff to ground is deemed an appropriate and feasible solution for the Te Kowhai Airfield development.

5 WATER SUPPLY

Te Kowhai township, which is located 1 km to the north of the proposed airpark development has no reticulated community water supply. The nearest council water is a 100mm Hamilton City main located at the intersection of Exelby Road and Te Kowhai Road, 2km to the east of the proposed airpark. Given the offset distance and diameter of this main it is unlikely that this infrastructure will have the pressures and flows required for the proposed development.

Given the rural location and high ground water table leading to potential contamination of any bore supply or surface supply, the most secure and practical form of supply is deemed to be a roof rain water collection system.

The average monthly rainfall for the local area is as per Table 5 below. This data has been obtained by averaging the last 8 years of rainfall data collected by NIWA for the local area at the Whatawhata site, located 6km south of the proposed airpark.

Table 4: Averaged NIWA Cliflo Rainfall Data (West Hamilton)

Month	Rainfall mm
Jan	97
Feb	74
Mar	120
Apr	187
May	186
Jun	221
Jul	195
Aug	130
Sep	160
Oct	131
Nov	117
Dec	130

5.1 Residential

Part 6.4.2 of the Hamilton City Development Manual requires a domestic demand of 260 litre/person/day. This volume is based on an urban reticulated supply and appears excessive given that rural dwellings on roof water generally use less water than those within an urban environment. In this case it is assumed that any irrigation demands will be met by other means. Water demand has therefore been assumed to match anticipated wastewater flows (180 litres/person/day). With an average occupancy of 3 persons per dwelling unit this equates to 540 litres per dwelling.

It is anticipated, as a minimum, that each residential lot will contain a 150 m^2 dwelling and associated 150 m^2 hanger. Based on 300 m^2 of roof area a minimum of 60 mm of rainfall would be needed each month to supply the required 540 litres a day.

Based on the average rainfall figures the required rainfall volumes for roof water collection would be achieved for all months of the year. In times of below average rainfall, on site buffering would be required in the form of suitably sized storage tanks and refilling with a water truck. The size of buffering tanks would be dependent on the household occupancy and roof area.

The option for a restricted low pressure supply from the 100mm Hamilton City main located at the intersection of Exelby Road and Te Kowhai Road as a supplement to roof water can be further investigated if required but could prove problematic due to inter Council issues.

5.2 Commercial

It is anticipated that water demand from the commercial precinct will closely match that of the wastewater flows anticipated under Figure 5.1 of The Hamilton City Design Manual and Table 6.2 of ARC TP58. It is therefore anticipated that the commercial area will have a daily water supply demand of 4,200 litres. Based on the 11,124 m^2 commercial roof area proposed a minimum of 12 mm would be needed each month to supply the required 4,200 litres a day. This is deemed easily achievable for all months of the year.

Any additional demands from the public hanger precinct and possible aircraft wash down can easily be achieved through the relatively large roof areas associated with hangers and commercial roof areas.

Overall, based on the average rainfall data available and anticipated installation of appropriate buffering storage, the use of roof water supply systems is deemed an appropriate and feasible solution for the Te Kowhai Airfield development.

5.3 Firefighting

A firefighting supply is required for all residential and commercial buildings within the airpark development. Under the Council rules these supplies must comply with SNZ/PAS 4509:2008 New Zealand Fire Service Fire Fighting Water Supplies Code of Practice.

It is noted that storage of firefighting supply within a ponded area would not be in the best interest of the development as it would encourage birdlife within the area, which can be a hazard to aircraft. As such, the use of tank storage is deemed to be the best practice solution to the firefighting requirements.

In relation to the residential areas, SNZ/PAS 4509:2008 states that all lots require 45 m3 of firefighting storage located within 90m of the property. This requirement would be met by having a static storage volume within the water supply rainwater tank for each dwelling.

For the commercial areas of the development the exact firefighting requirements will be dependent upon the final layout and size of the buildings. A series of storage tanks and firefighting couplings would be provided throughout this area of the development to meet the SNZ/PAS 4509:2008 requirements.

6 REFERENCES

1. *Auckland Regional Council Technical Publication No. 58 (TP58) On-site Wastewater Systems: Design and Management Manual Third Edition 2004*, A W Ormiston & R E Floyd

2. *AS/NZS1547:2012 On-site domestic-wastewater management*, Standards Australia/Standards New Zealand

3. *Hamilton City Council Development Manual 2006*

7 APPENDICIES

File Ref: A16289_005_Te_Kowhai_Masterplan_Opt_2.indd

LEGEND

- Airside Lot - 1000m² -1200m² (13 total)
- Airside Lot - 1200m²-2500m² (21 total)
- Airside Lot - 2500m²-2600m² (36 total)
- Large Lot 2600m²+ (17 total)
- Small Lot - Typically 600m²-1000m2 (46 total)
- Street Trees
- Planted Acoustic Bund
- Taxiway (live aircraft movements)
- Existing Gas Main
- Existing Contours (0.5m intervals)
- Precinct Boundary
- Site Boundary

PRECINCTS

Precinct A - Runway and Operations
Precinct B - Commercial Precinct
Precinct C - Medium Density Residential
Precinct D - General Residential

NOTES

1. Aircraft storage hangers for general public use
2. General commercial hangers
3. Potential aeronautical themed cafe and playground
4. Existing building to be retained / renovated
5. Re-fueling / service hub
6. Public carpark
7. New airside commercial building
8. Aircraft operations area
9. Potential landscape buffer / SW storage area
10. Pedestrian / cyclist / golf cart access only
11. Entry feature / potential gate to residential area
12. Entry / gateway landscape feature
13. Existing gas lines to run underneath road
14. Potential helipad location
15. Existing gas line infrastructure

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1:4,000 @ A3

INDICATIVE LAYOUT
FOR DISCUSSION PURPOSES ONLY

TE KOWHAI AIRFIELD MASTERPLAN

Concept Masterplan

| Date: 13 April 2017 | Revision: B |

Plan prepared for Foster Develop Ltd. by Boffa Miskell Limited

Project Manager: Jonathanb@boffamiskell.co.nz | *Drawn:* SFo | *Checked:* JBr

TE KOWHAI AIRFIELD

PROPOSED SUBDIVISION

GEOTECHNICAL REPORT

BLOXAM BURNETT & OLLIVER

ENGINEERS • PLANNERS • SURVEYORS

MARCH 2008

TE KOWHAI AIRFIELD

PROPOSED SUBDIVISION

GEOTECHNICAL REPORT

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TABLE OF CONTENTS

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1. INTRODUCTION

This geotechnical report has been prepared for Te Kowhai Airfield and Micro Aviation to assist in their application for subdivision consent. The proposed subdivision is located between Limmer Road and the Te Kowhai airfield, as shown on the site plan in Appendix A, and is proposed to be rural/residential in nature, with airfield access to all lots.

The purpose of the investigation is to determine the suitability of the in situ soils to found standard timber framed buildings and for the disposal of stormwater and wastewater from each new lot. Characteristic information that is indicative of the site in general has been obtained, and further investigations will be required to allow detailed design work to proceed.

This report presents the results of the geotechnical investigation carried out at the site and makes general development recommendations.

2. SITE DESCRIPTION

The site is located between Limmer Road and the Te Kowhai airfield, to the south of Te Kowhai. The site is currently in pasture. The topography is generally flat, except for an area on the north (airfield) boundary, which has been used as a sand quarry and fill site, and contains both excavated and raised areas. The extent of fill in this area is indicated on the site plan.

3. SITE GEOLOGY

The Institute of Geological and Nuclear Sciences geological map "Geology of the Waikato Area" (2005) shows Hinuera Formation alluvium of late Quaternary age in the site area. This material is described as "cross-bedded pumice sand, silt and gravel with interbedded peat".

Seismicity and volcanism are not considered to be significant issues at this site. There are no known or observed active faults or recent volcanic activity in the area. No reason has been identified to depart from normal properties for seismic load.

4. FIELDWORK

Fieldwork was undertaken at the site on the 22nd of February 2008. This consisted of six machine augered boreholes located as shown on the site plan. The boreholes were excavated to depths ranging from 2.5 to 4.95 m, and Standard Penetration Tests (SPT's) were undertaken at 1.5 m intervals. Detailed field descriptions of the soils encountered are shown on the exploratory borehole logs attached in Appendix B. Two falling head soakage tests were undertaken adjacent to boreholes 1 and 6. Soakage test 1 was 0.94 m deep, and soakage test 6 was 0.8 m deep. These tests were not presoaked and testing was only undertaken during drilling of the adjacent boreholes.

5. SUBSOIL MATERIALS AND CONDITIONS

5.1 Fill

Fill was encountered throughout boreholes 4 and 5, these boreholes ended at 2.5 and 3.45 m depth respectively. These boreholes were not extended further due to auger damage that occurred in the drilling of borehole 4, where something grinded the auger shaft down, and concerns that further damage may occur in the drilling of borehole 5. Fill typically consisted of silt and sand layers, with medium dense/very stiff strengths (SPT's of 18 to 26). Apart from whatever caused the auger damage, the fill was relatively clean, with occasional topsoil streaks, dark grey and dark brown layers, and sub angular gravels that were inconsistent with Hinuera Formation materials.

The indicative extent of fill at the site is shown on the site plan in Appendix A. This information has been provided by the client.

5.1 Topsoil

Topsoil was typically encountered at the surface of the boreholes, down to depths ranging from 0.05 to 0.2 m. Exceptions to this are boreholes 4, 5, and 6. Boreholes 4 and 5 encountered fill at the surface, however borehole 5 has topsoil fill in the top 0.2 m. borehole 6 encountered topsoil down to 0.4 m depth.

5.2 Silt and Sand Layers

Hinuera Formation alluvial sand with occasional silt layers underlie the site, these were encountered in all boreholes except boreholes 4 and 5. Textures ranged from silt through to coarse grained sand, and gradings ranged from well graded (such as fine grained sand), through to poorly graded (such as silty fine to coarse grained sand). The most common texture was fine grained sand, or silt with fine grained sand. This material was dilatant and liquefied when vibrated.

Soil strength in the top 0.5 m of the boreholes appeared to be affected by the current soil moisture deficit, with dry, stiff descriptions in some boreholes underlain by moist, firm soils. The higher strengths observed near the surface are likely to be significantly reduced in winter when the watertable is raised.

The SPT test results were typically loose near the surface. Boreholes 3 and 6 also contained loose material at depth, and borehole 2 contained very loose material at depth (at 4.5 m). Medium dense results were obtained at depth in boreholes 1 and 2, and near the surface in borehole 6.

A silty peat layer was encountered in borehole 6 from approximately 4.2 to 4.5 m depth. This layer was described as dark brown, amorphous, and firm.

5.6 Groundwater

Material in the boreholes was described as being wet below 1.3 to 2.5 m depth, this is expected to be the depth of the current summer groundwater level. The groundwater level is expected to be much higher in winter, and according to local advice, low-lying areas of the site flood during prolonged periods of rainfall in winter.

5.4 Soakage

The soakage test results are included in Appendix C. As standard test procedures were not followed this testing is only indicative of soakage rates, and these rates may be optimistic. The final soakage rates in both boreholes was approximately 350 mm/h. This soakage rate falls within Category A of NZS 4610:1982, and is considered to be rapid to very rapid draining.

6. DESIGN CONSIDERATIONS

6.1 Floor Foundations

The proposed light weight residential building foundations are expected to have static design bearing pressures of 100 kPa under standard residential foundations. If design pressures exceed this please refer the matter back to Bloxam, Burnett & Olliver Ltd.

The in situ loose sands typically encountered near the surface of the site are not expected to have adequate allowable bearing capacity to support standard light weight timber frame structures (NZS 3604). Excavation and replacement of these materials, or piled foundations, may be possible where medium dense sands underlie these materials. Where loose material extends with depth, specially designed raft foundations will be required. Further geotechnical investigations will be required at each building site to determine the most appropriate foundation type and design.

The medium dense fill material typically encountered at the site is generally expected to have adequate allowable bearing capacity to support standard light weight timber frame structures (NZS 3604). Some minor excavation and replacement of loose/soft materials near the surface may be required, and a thorough investigation will be required at each building site to ensure strength consistency. Shallow spread or strip footings are expected to be sufficient to found standard light weight structures over this material. Where the required bearing capacity is not met either specially designed raft or piled foundations are expected to be acceptable. Piled foundations will require the presence of an acceptable founding layer.

Any especially weak or organic layers (such as those encountered in boreholes 2 and 6) underlying proposed buildings should be assessed for potential settlement. The relatively low organic content of the peat in borehole 6 is such that significant settlement due to organic decomposition is considered unlikely. The depth of this organic layer, and the very loose layer encountered in borehole 2, is such that pressures from typical building loadings are unlikely to have a significant effect at this depth. If layers with high peat contents, or peat/weak soils, occur close to the surface then their potential settlement should be considered in detail. If potential settlements are greater than acceptable then specially designed foundations will be required above these soils. If similar materials are found in other areas, they will require similar assessments and foundation designs.

Geotechnical investigations will be required at each building site to determine the most appropriate foundation type and design. Structure foundations are to be inspected by an Engineer to ensure the required minimum allowable bearing capacity for each structure is met.

6.2 Dilatant Materials

The extensive deposits of dilatant silts and fine grained sands at the site are expected to be unsuitable for earthworks, and should be left in place where possible. Unnecessary vibration of this material should also be avoided. The liquefaction potential of these materials should be recognised when designing foundations, and the risk and consequences of liquefaction specifically accommodated in design proposals. Further detailed investigations are required to examine the effects of liquefaction.

6.3 Stormwater Disposal

It is intended that stormwater from this site will be disposed of to ground. The site investigations indicate that soil soakage is typically rapid to very rapid with possible slight limitation only. However the advice that the groundwater level is at or near the surface in places during winter indicates that ground soakage will not be possible at all times. Additional stormwater control measures likely to be required at this site include ponding and tanks to detain and attenuate stormwater flows.

Additional soakage testing at each proposed disposal field, and winter watertable monitoring over the site, should be undertaken to allow the stormwater design to proceed.

6.4 Wastewater Disposal

The high winter watertable level will also affect the wastewater disposal design. The final design may include features such as a large holding tank or above surface low impact systems. The soakage testing and piezometers recommended in section 6.3 above will be required to allow the wastewater disposal design to proceed.

7. FURTHER INVESTIGATIONS

Further geotechnical investigation is required at individual building platforms to allow foundation design to proceed. Settlement assessments are required for building platforms on any weak silt and peat deposits. Liquefaction assessments are required to examine the effects of liquefaction on the proposed structures.

Piezometers are required over the site to monitor the winter groundwater levels. Soakage tests are required at each site where stormwater and wastewater disposal to ground is proposed to allow the soakage and wastewater design to proceed.

8. CONCLUSIONS

The surfical in situ soils are considered to generally be unsuitable to found light weight structures. In some areas the excavation of weak materials and replaced with engineered fill will be possible, however some areas are expected to require specially designed raft or piled foundations. The potential for liquefaction should be considered in the design of foundations above dilatant materials. Building platforms over weak or organic layers will require settlement assessments.

The high winter watertable level is expected to affect stormwater and wastewater disposal, requiring specially designed disposal systems.

9. LIMITATION

The recommendations and options contained in this report are based on our visual reconnaissance of the site, information from geological maps, data from the field investigation, and the results of in situ testing of soil samples from the site. Inferences about the nature and continuity of the subsoils away from and beyond the boreholes are made, but cannot be guaranteed.

During construction a geotechnical engineer competent to judge whether the conditions are compatible with the assumptions made in this report should examine the site. In all circumstances, if variations in the subsoil occur which differ from those described or assumed to exist, then the matter should be referred back to Bloxam, Burnett and Olliver Ltd.

This report has been prepared for the particular project described in the report and no responsibility is accepted for the use of any part of this report in any other context or for any other purposes.