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File: 060901

WHAREROA NORTH

APPLICATION TO CHANGE TAUPO DISTRICT PLAN

INFRASTRUCTURE REPORT

7th December 2017

"unlocking the answers"

WHAREROA NORTH

INFRASTRUCTURE REPORT

1 PREAMBLE

The current growth management strategy for Taupo District (TD2050), the Southern Settlements Structure Plan, and the Taupo District Plan all make provision for the expansion of Whareroa settlement across Whareroa Stream and up on to the higher land north of the stream. The Owners have envisaged this expansion since 1965 when the land on both sides of the Whareroa Stream was set aside for a holiday settlement. Following on from the first stages of the subdivision in the 1980's, the Owners have worked collaboratively with Taupo District Council (TDC) and designed and built the existing infrastructure to allow this northern expansion to happen. Examples of this co-operative relationship (one being the vesting of land by the Owners to give TDC the ability to meet wastewater resource consent conditions) are detailed later in this report.

This report describes the existing infrastructure and servicing arrangements at Whareroa village (including roading, water supply, wastewater, stormwater management, and utilities) and considers the servicing and infrastructure requirements needed to provide for the additional development anticipated. It also considers some of the physical aspects of the land in terms of suitability, and discusses issues of infrastructure efficiency.

A concept plan (Drawing number IBA1070-SC002 Rev F) of the proposed development north of the stream is attached as Appendix A. For the purpose of infrastructure design, a figure of 160 additional dwelling equivalents on the north side has been assumed as a maximum. It is acknowledged that the subsequent resource consent process will determine the final form and number of additional sections at Whareroa.

2 CONCEPT FOR EXPANSION TO THE NORTH

A preliminary concept involving the crossing of the Whareroa Stream with a new single span, two lane bridge and a spine road sidling up the escarpment to the north and east and then veering west through the centre of the proposed development is shown in Appendix A. The development area could generally be described as a gently sloping plateau with a lower "bowl" area in the southern quarter. The bulk of the development area is currently in pasture. A contour plan of the development area is included as Appendix L.

A loop road on the north side of the spine road is proposed along with two cul-de-sacs to the south providing for property access to individual sections.

Services would extend from their existing terminations at the end of Whareroa Road up the new spine road and branch out to service the new lots.

3 ROADING & ACCESS

a) Overview

Whareroa Village is accessed from SH32, Kuratau Hydro Road and Whareroa Road. Kuratau Hydro Road leaves SH32 approximately 2km north of its intersection with SH41 and Whareroa Road branches off this adjacent to the hydro lake. These two roads combine to provide “No Exit” access some 9km in length from SH32. The existing Whareroa Village plus the proposed development to the north will result in up to 362 lots being served by this access road.

Access options for the development area have been considered in depth. A Discussion Paper was prepared by KeySolutions dated May 2016 and is (attached as Appendix B). It concludes that *"Five options to gain access to new residential development north of the Whareroa Stream have been considered and nine questions asked regarding each. The evaluation shows that crossing the stream at site "D" (see Figure 1) as has been proposed since the mid 1980's remains the best option."* Site D in that study is the site adopted for this proposal.

One of the nine considerations referred to in this paper is the question of community connection. Keeping the village integrated, with easy to use and efficient vehicle and pedestrian connections is seen as an important aspect for the village expansion and the current proposal reflects this objective.

It is logical for all the new roading to ultimately transfer to public ownership and be operated and maintained along with the rest of the District roading network by the Taupo District Council. Discussions with TDC have been ongoing in this respect and with this in mind, it will be built to Council standards current at the time of construction.

b) Internal roading and pedestrian linkages

The concept for the internal layout of the proposed development is shown below.

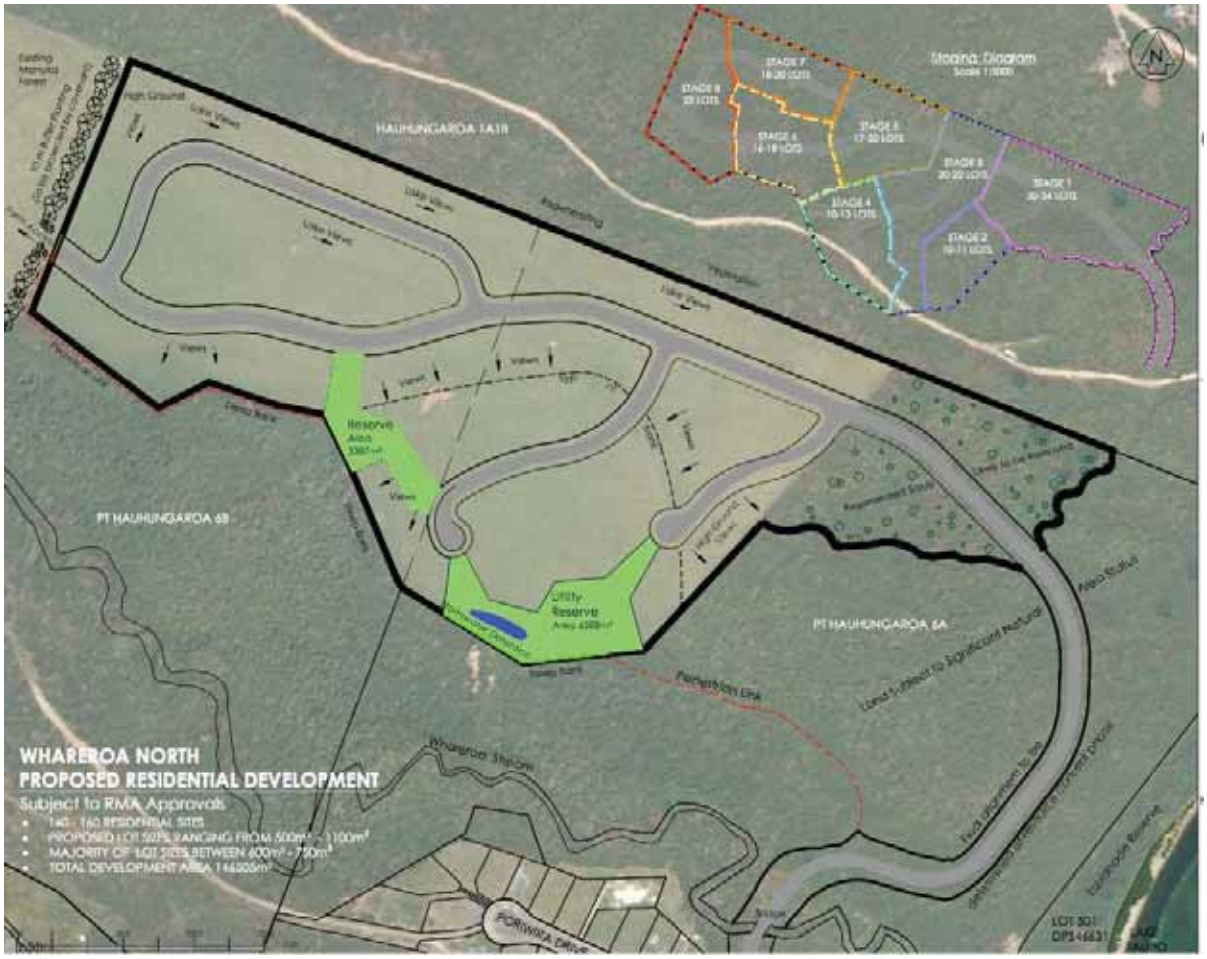
As mentioned in Section 2, a loop road is proposed on the north side of the spine road and two cul-de-sacs to the south of the spine road will provide frontage for all the new lots.

This roading layout permits the creation of mostly front lots (lots with a full street frontage) with less than 10% needing to be accessed from rights of way.

The two cul-de-sacs will combine to form access to the "bowl" area referred to in Section 2 and will also provide access to a Utility Reserve (Local Purpose Reserve). This Utility Reserve will be an important part of the stormwater management system for the new development and is described in detail in Section 6. It will also accommodate a wastewater pumping station.

The new bridge and spine road will also provide more efficient farm access to the land to the immediate west of the development area which has recently been planted in manuka for honey production. Vehicle access to this area is currently a

long and tortuous farm track from the gate at SH32.



The roading layout and geometry is designed to best realise the potential of the site with respect to property access, vistas, landscape and amenity. Pedestrian linkages (including provision on the bridge) are also envisaged as shown on the concept plan to provide appealing walking opportunities including a section through the pristine bush immediately north of the stream crossing.

The roading will be designed to comply with the Taupo District Council's Code of Practice for the Development of Land.

c) Bridging the Whareroa Stream and access to the Development Area

As mentioned in Section 3a), considerable research has been carried out regarding the options for accessing the development area. Practical access to the Whareroa North area has long been considered as most appropriate from the existing village across the Whareroa Stream, and this is still seen as the most efficient. The May 2016 investigation concludes that crossing the stream at the site shown as has been proposed since the mid 1980's remains the best option. (see Appendix B)

In fact consent from the Regional Council for a bridge crossing at this point was granted in 1990, but for various reasons, the project did not proceed at that

time.

Apex Consultants prepared a report “Bridge over Whareroa Stream” in April 2007. Whilst this work is now dated, much of it remains relevant today, particularly the physical characteristics of the proposed structure. This report is attached as Appendix C. References to the Waikato Regional Plan are now out of date but the reader is referred to the remainder of the report for details of the proposed structure, and an indication of predicted flood levels.

Obviously, pivotal to this access proceeding is the gaining of consent from the owner of the Whareroa Stream bed, the Waikato Regional Council, and the Taupo District Council as the future owner of the infrastructure. Discussion with these parties is ongoing.

The access road from the north side of the bridge to the development area negotiates a south facing escarpment so involves sidling construction as referred to in Section 2 and as exists on the south side of the bridge at present (see adjacent photo).

The proposed route options up the escarpment were investigated by Cheal in September 2016 as part of a supplementary paper to the May 2016 KeySolutions investigation (Appendix B).

This work is attached as Appendix D.

A preliminary design was prepared for the green and the blue options shown in the part plan on the right and these were costed for comparison purposes. The more direct blue alignment whilst being shorter, results in the access road being within a deep cutting (as can be seen from the long sections in Appendix D). This not only increases the necessary "footprint" of the road but also the shading problems. The comparison costings also showed this more direct (blue) western option to be more expensive.

The conclusion from this investigation is that the sidling (green) eastern option shown in this part plan has the least impact on the environment and is the most economic access route. This alignment is the one utilised in the preliminary concept, Appendix A, with, as that plan notes, *"final alignment to be determined at resource consent phase"*

There will be a number of options for stabilising treatment and revegetation of this sidling to ensure that there is the least impact possible on the natural landscape and amenity values of the area whilst maintaining the stability of the escarpment.

d) Kuratau Hydro Road and Whareroa Road

Kuratau Hydro Road and Whareroa Road traverse generally flat or easy contour country, and as a result both the horizontal and vertical alignments are of a good standard. Seal width averages approximately 6 metres and a good “at grade” grassed area exists on both sides of the carriageway over most of its length to allow for the small numbers of pedestrian and non vehicular traffic evident. This grassed area is less than a metre wide in some of the cuttings but given the low numbers of non vehicular traffic at present (and envisaged when Whareroa North is fully developed), this is not seen as an inappropriate level of service or safety issue.

The estimated traffic count on Kuratau Hydro Road at the intersection of SH32 is 107vehicles/day (see report by Gray Matter Ltd dated 13th November 2017 and attached as Appendix E). This will potentially double to 200 vehicles/day once Whareroa North is fully developed. Gray Matter has suggested that current peak hour traffic is 19 vehicles/hour and again this will likely double to 38 vehicles/hour when Whareroa North is fully developed.

This access was completed when the first stage of Whareroa Village was developed and was designed and constructed to geometrical standards appropriate at the time. Despite this, no safety concerns are apparent today and the addition of traffic generated from Whareroa North will not impact on the safety given that the expected traffic numbers are so low.

Whareroa is a finite settlement and expansion beyond this proposal is not contemplated by the Taupo District (TD2050) Growth Management Strategy, the Southern Settlements Structure Plan, the District Plan, or the owners of the land.

As with most infrastructural assets, increased usage (up to a "break" point) generally results in greater efficiency and greater cost effectiveness. In this case the extra traffic from Whareroa North will mean that the existing roading asset is better utilised.

Council may deem it appropriate in the fullness of time to complete some berm widening and earthworks to improve sight lines on isolated sections of both roads. It is not considered necessary in the foreseeable future.

e) Intersection Kuratau Hydro Road with SH32

Apex Consultants produced a report “State Highway 32 Kuratau Hydro Road intersection” dated February 2007 regarding this intersection and the potential effects of the proposed development on it and as stated in the previous section, Gray Matter Ltd has recently reviewed this. Both documents are attached as Appendix E.

The conclusion is that the existing intersection layout is generally in accordance with current standards both for the existing traffic volumes and allowing for the extra traffic generated from the proposed development at Whareroa North. Visibility to the north from Kuratau Hydro Road is less than the recommended 285m so it is suggested that vegetation within the road reserve be cleared to maximise the available visibility. Gray Matter advises *"...The deficient visibility to the north does not appear to pose a significant safety risk as traffic volumes at*

the intersection are relatively low. There does not appear to be an existing crash problem at the intersection...."

NZTA will be consulted regarding the findings from these reports and any recommendations from them will be incorporated into the design at the appropriate time.

4 WATER SUPPLY

a) Overview

The existing 202 lots are serviced by a system comprising a lakeshore intake from 2 shallow bores in a “gallery” arrangement. Pumps feed a “rising/falling” reticulation system and 2 timber reservoirs above the existing settlement.

Existing pumps and bores are understood to have an ability to deliver in excess of 500 m^3/day but it is intended to complete a comprehensive analysis of the existing infrastructure including condition and capacity, at the appropriate time.

The proposal is to extend the reticulation network north and to increase the capacity or supplement both the existing bores and the existing pumps as necessary to allow for the servicing of the additional area. The elevation of the floor of the existing reservoirs is 465m and the elevation at the highest point of the proposed development area is 421m so it is anticipated that the existing reservoirs will provide adequate pressure and fire fighting capacity over the whole development area.

The Owners want to clearly signal that water conservation and the minimising of demand is a high priority when developing this land and so the water supply philosophy will incorporate mechanisms to minimise demand. This is in line with TDC's 2008 Water Supply Strategy.

b) Current Resource Consent

Consent number 121300 from Waikato Regional Council authorises the take of up to 682 cubic metres of water per day from the “underground source”. It expires on 31st January 2033. A copy is attached as Appendix F. TDC when applying for this consent in 2010, applied for a "roll over" of the existing consented volume so as to include capacity for Whareroa North as signalled by TD2050. This was despite existing use being considerably less than the consented "take".

c) Headworks and network modifications to service Whareroa North

With modifications, the current headworks will be capable of servicing the larger area. Appropriate “demand management” will be instigated, not only for water conservation and consent compliance purposes, but also because it will be more costly to deliver water once it is treated to the new standards (see 3d below). The use of rainwater tanks is another mechanism being considered to manage the demand on the water supply. This is discussed further in Section 6a) below.

Reticulation will be extended from the existing termination at the end of Whareroa Road across the new bridge and up the access road to the development area. The network will be extended to provide a connection for all the new lots.

A Deed of Arrangement between Taupo District Council and the Developer is seen as the way forward for agreeing both the method and funding of developing capacity in the system to cater for Whareroa North.

d) Future Treatment Upgrade

A drinking water treatment programme for all of Taupo District's supplies is currently being implemented to comply with recent central government legislation. TDC's Long Term Plan 2015-25 signals that treatment of the Whareroa supply will be completed in 2025. This is a topical subject at time of report preparation given the recent problems experienced in Havelock North.

The question of funding of the water supply service, including full treatment, across all of TDC's schemes is also raised in this Long Term Plan. Costs per consumer on the larger schemes are generally less due to the economies of scale. Whareroa is a small scheme with only 202 consumers.

Should district wide funding of water supplies not eventuate (or a similar alternative) then increasing the number of consumers at Whareroa with the development of Whareroa North will produce economies of scale and more efficient use of the existing and new infrastructure.

5 WASTEWATER

a) Overview

Most of the wastewater from the current settlement is pumped to a treatment area adjacent to Whareroa Road at the western side of the settlement as seen top left in the above aerial photo. A few of the higher properties drain by gravity to the treatment facility but most are lower in elevation and it is necessary to pump the effluent. Whareroa North is well elevated but separated from the

existing development by the Whareroa Stream, so all of the new lots will require wastewater to be pumped to the treatment facility. This solution has been envisaged since Whareroa first developed.

Treatment consists of two oxidation ponds which reduce the suspended solids and BOD_5 of the effluent, and an irrigation regime on adjacent land to the west of the oxidation ponds (see above aerial photo) which reduces the nitrogen concentration in the effluent.

b) Resource Consent issues

The current resource consent for the operation (WRC 113031) was granted for a 15 year period in 2013 so expires in 2028 but has some conditions attached which make the operation of the system more difficult than necessary in practical terms, and which compromise the efficiency of the treatment processes.

TDC lodged a new resource consent application with Waikato Regional Council earlier this year to address these issues and the Owners are supporting this process (details in Section 5d below).

Both the current consent (WRC 113031) and the new application make provision for treatment of wastewater from the proposed development at Whareroa North.

c) System capacity

I. Pumping and Reticulation

The main pump station located on the south side of the stream, close to the proposed bridge site, pumps directly to the treatment facility via a pressure (rising) main. It will be cost effective both in terms of capital cost and ongoing maintenance costs to pump wastewater from Whareroa North directly to the oxidation ponds via this rising main.

If this proves impractical or undesirable, Whareroa North could discharge to the main pumping station and the wastewater "re-pumped" from there. This is a philosophy decision which will be made by Council's Asset Managers at the appropriate time.

An inverted syphon arrangement is not seen as cost effective given the likely variable flows and the practical and maintenance problems associated with these systems.

A new pumping station will be required to serve Whareroa North and this will likely be located on the Utility Reserve in the "bowl" area.

II. Treatment

Treatment capacity is usually determined by two main factors, the resource consent conditions which determine the required effluent quality, and the treatment infrastructure.

A new resource consent is being sought as detailed in 5b) above (which

makes provision for the connection of development at Whareroa North) and in 2010 Hauhungaroa No.6 vested more land in TDC ownership for sewage treatment purposes including additional land required for irrigation. TDC also has the ability to increase the number of mechanical aerators in the oxidation ponds to better cater for peak loads and improve the treatment efficiency of that component of the system.

d) "Partnership" approach between TDC and Land Owners

The Proprietors of Hauhungaroa No.6 are the land owners in this area and have been the sole developer at Whareroa since the first sections were created over 30 years ago. This has enabled a somewhat unique "partnership" approach to evolve over time.

The Owners have a constructive working relationship with Taupo District Council and, as mentioned in 5b), are currently working with TDC to facilitate improvements to the conditions of the wastewater resource consent which will allow TDC to operate the treatment facility in a more efficient manner. The Owners letter of support for this process is attached as Appendix G.

Another example of the "partnership" approach is illustrated in an extract from a letter from Councils Infrastructure Manager dated 19th March 2013 (full letter attached as Appendix H):-

> We are both agreed that there can be no benefit to the community at large for incurring the costs of such a hearing for this consent renewal and that it is in both council's and your clients interests to continue the harmonious working relationship that has existed over the past few years with respect to facilitating the proposed development of Whareroa North. I would at this point acknowledge your clients part in that relationship with the completion in 2010 of an agreement regarding the vesting of land for use for sewage treatment purposes including additional land required for irrigation, as an example of that co-operative working relationship.

The excellent working relationship has been a "win-win" for both parties.

6 STORMWATER

a) Overview

National best practice for stormwater management has gone through some rapid change over the last few years and the Taupo District and Waikato Region have been heavily involved in that process. Waikato Regional Council (WRC) is currently preparing new stormwater management guidelines which will ultimately be backed up by the Regional Plan.

At time of writing, WRC are in discussions as to how the new guidelines could best cater for Taupo's specific environment and unique geology. The Taupo area offers the opportunity for quite different stormwater management solutions to what could be considered best practice in other parts of the region and the common objective is to craft the new guidelines in such a way that they enable "Taupo specific" solutions to be consented.

With this in mind it is intended to incorporate current best industry practice into the Whareroa North development design at the appropriate time. Practical

experience is rapidly being gained around Taupo District and nationally which is guiding this “best practice”, and it is intended to utilise the most up to date information for the detailed design of the stormwater management system for this development.

It is expected that one of the criteria will be to provide the ability to contain a 10 year 1 hour storm event on site.

To enable this to happen, a Utility Reserve (Local Purpose Reserve) has been set aside in the concept plan (see Appendix A) to provide an area where this infrastructure could be constructed.

The use of on-site rainwater tanks for "recycling" water for irrigation or washing purposes is also proposed as a mechanism for managing stormwater. The Owners are considering covenanting the up to 160 new titles to the effect that storage of roof/hardstand stormwater be required to offset some demand on the water supply. This will also have the beneficial effect of easing the loading on the on-site soakage systems so is considered a win/win proposal.

b) Existing systems

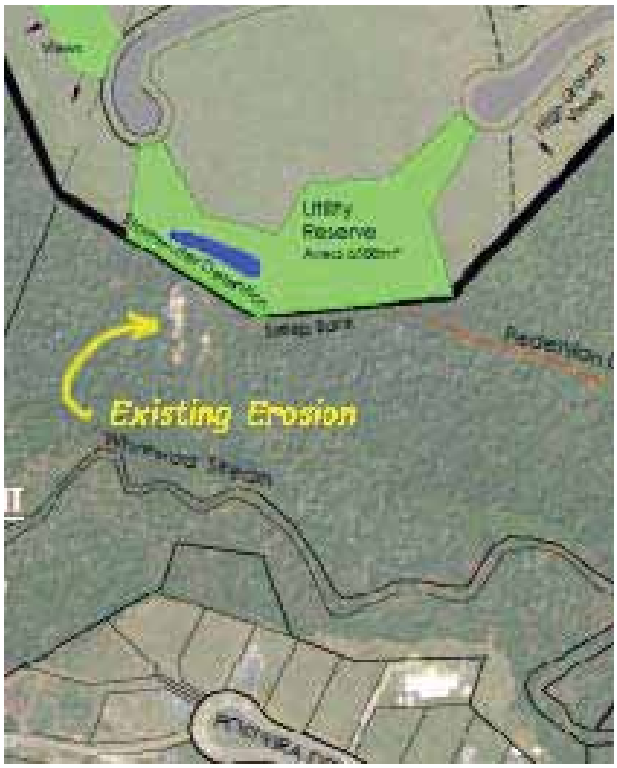
On site disposal for roof and hard stand stormwater as is usual throughout the Taupo District is required in the existing settlement.

Stormwater from the existing roading network is piped to a detention/sedimentation/soakage pond (see adjacent photo) on the south side of the Whareroa Stream, east of the proposed bridge.

Depending on the new stormwater guidelines referred to in 6a) above, similar systems may be utilised for Whareroa North. The steep section of new access road north of the proposed bridge will concentrate stormwater, and it is expected that attempting to use soakage systems on this steep contour to address this will create soil stability problems. The concentrated discharge will need to be managed down near the stream, but no assumptions are made here on how that will be achieved given the on-going discussions between TDC and WRC regarding the stormwater management guidelines and best industry practice.

c) Existing erosion

The "bowl" area described in Section 2 discharges stormwater directly over the bank above the stream in even a moderate rainfall event. This uncontrolled flow has resulted in severe scouring which can be seen in the adjacent aerial photograph.



The development of Whareroa North will allow controls and infrastructure to be put in place to prevent this continuing.

The proposed Utility Reserve immediately above the live scour will provide the opportunity to control the flow of stormwater and the use of a flume or other form of armouring and energy dissipation will prevent the runoff from extreme rainfall events causing further erosion.

7 UTILITY SERVICES

Both electricity and telecommunication reticulation extensions into Whareroa North were confirmed as viable by the respective service providers in 2006 and that status is not expected to have changed. An allowance for Whareroa North was taken into account when the existing development on the south side of the stream was constructed.

An update of those confirmations is currently being sought.

8 EARTHWORKS / GEOTECHNICAL / SITE SUITABILITY

Due to the gentle rolling contour of the body of the development area, earthworks can be kept to a minimum within the proposed residential area. However, the sidling access north of the Whareroa Stream will generate significant disturbance.

Mr Mark Mitchell, Geotechnical Engineer, carried out a geotechnical appraisal of the area in October 2006. This is attached as Appendix J.

Whilst part of his brief was to determine the viability of filling the “bowl” area (a proposal that is no longer considered appropriate and is not part of this concept) his investigation, which included the excavation of 7 test pits, results in conclusions regarding the suitability of the land for subdivision.

It also makes a preliminary assessment of the geotechnical issues associated with the proposed steeper section of road immediately north of the Whareroa Stream.

The conclusion is *"The results of this study indicate that based upon available information, the proposed subdivision area is stable and suitable for filling. The ash soils that mantle the site in their natural state and attitude have not caused significant slumping of the ground surface. The area under investigation is a natural bench feature created by welded ignimbrite bedrock mantled by younger air-fall tephra material".*

With respect to the possibility of contamination from previous farming operations, the land owners have advised that, to the best of their knowledge, no such hazards exist.

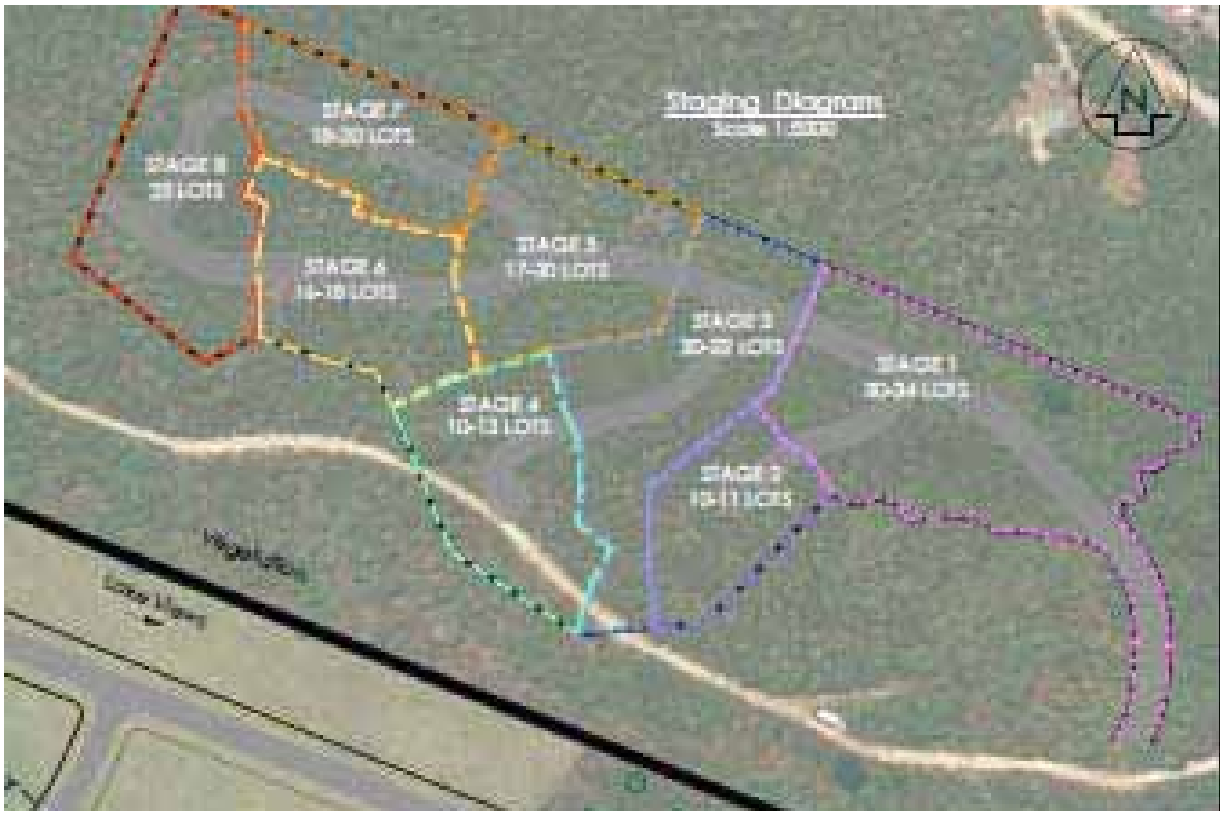
A preliminary assessment of potential faultline hazards in the area has not signalled any concerns, see Appendix K, Faultline Map.

It is acknowledged that soils in the area of the bridge have the potential to liquify so further investigation to assess this risk will be done at the design stage and the bridge foundations designed accordingly.

With respect to the potential flood hazard at the bridge site (and the recently notified Taupo District Plan Change), as mentioned in 3c) above, the assessed 100 year flood level will be taken into account in the bridge design.

9 STAGING

A staging scenario is shown on the concept plan, Appendix A.



This shows potentially 8 stages working up and out from the access/spine road.

Stage 1 is shown as 30-34 lots, the largest of the stages so as to be economically viable given the unusually high "up front" costs for the Developer associated with the new bridge and the access road up the escarpment.

A number of variables will potentially have a significant impact on this staging program including market demand, market prices, construction costs, infrastructure transfer to TDC etc. Obviously, transfer of infrastructural assets to TDC will need to be done at a time that suits all parties so will be the subject of ongoing consultation.

10 INFRASTRUCTURE EFFICIENCY

The development proposal seeks to increase the size of Whareroa Village from 202 lots to a maximum of 362, a potential increase of up to 80%.

In terms of infrastructure, much of what is required to provide an adequate level of service for the additional 160 residential lots is already in place due to previous good planning which has long provided for the northward expansion of the village.

Roading is in place from SH32 through to the proposed development which will cater for the extra traffic. Increased usage will result in greater cost effectiveness and efficiency.

The headworks for supplying water to the additional 160 lots is largely in place and the extra consumers will provide greater economies of scale especially if water supplies remain funded from a scheme specific rate.

Land for the treatment of wastewater, in particular nitrogen reduction, has been provided to TDC by the land owners and the basic infrastructure is in place to cater for the extra 160 lots. Again, cost effectiveness of the service is increased due to greater utilisation of existing infrastructure.

At 202 properties, Whareroa is regarded as a small settlement. The 80% increase proposed has the potential to improve the cost effectiveness of providing infrastructure to this small settlement and increases the economies of scale. It also improves subjective qualities such as pedestrian opportunities, farm access and community connectivity.

11 CONCLUSIONS

a) Work to date has produced a viable concept for expanding Whareroa by up to 80% as has been envisaged since well before the first lots were created over thirty years ago.

b) This area, Whareroa North, is signalled as a preferred location for future residential growth area in TDC's document TD 2050, the 2013 Southern Settlements Structure Plan and the Taupo District Plan. The Owners and TDC have been working in partnership for a long time to enable this to happen.

c) Roading infrastructure is in place to the boundary of Whareroa North which has the capacity to cater for the extra traffic which the development will

generate.

d) Water Supply headworks are largely in place to cater for Whareroa North. The WRC consent for the water supply will accommodate growth at Whareroa North.

e) Due to a collaborative effort between TDC and the Owners, wastewater infrastructure and the necessary WRC consents are in place to service Whareroa North.

f) Stormwater management, utilities provision and geotechnical issues all have potential solutions.

g) Staging is proposed so as to accommodate the needs of both the Developer and TDC

h) Economies of scale, cost effectiveness and general infrastructural efficiency all have the potential to increase as a result of the expansion of Whareroa.

12 APPENDICES

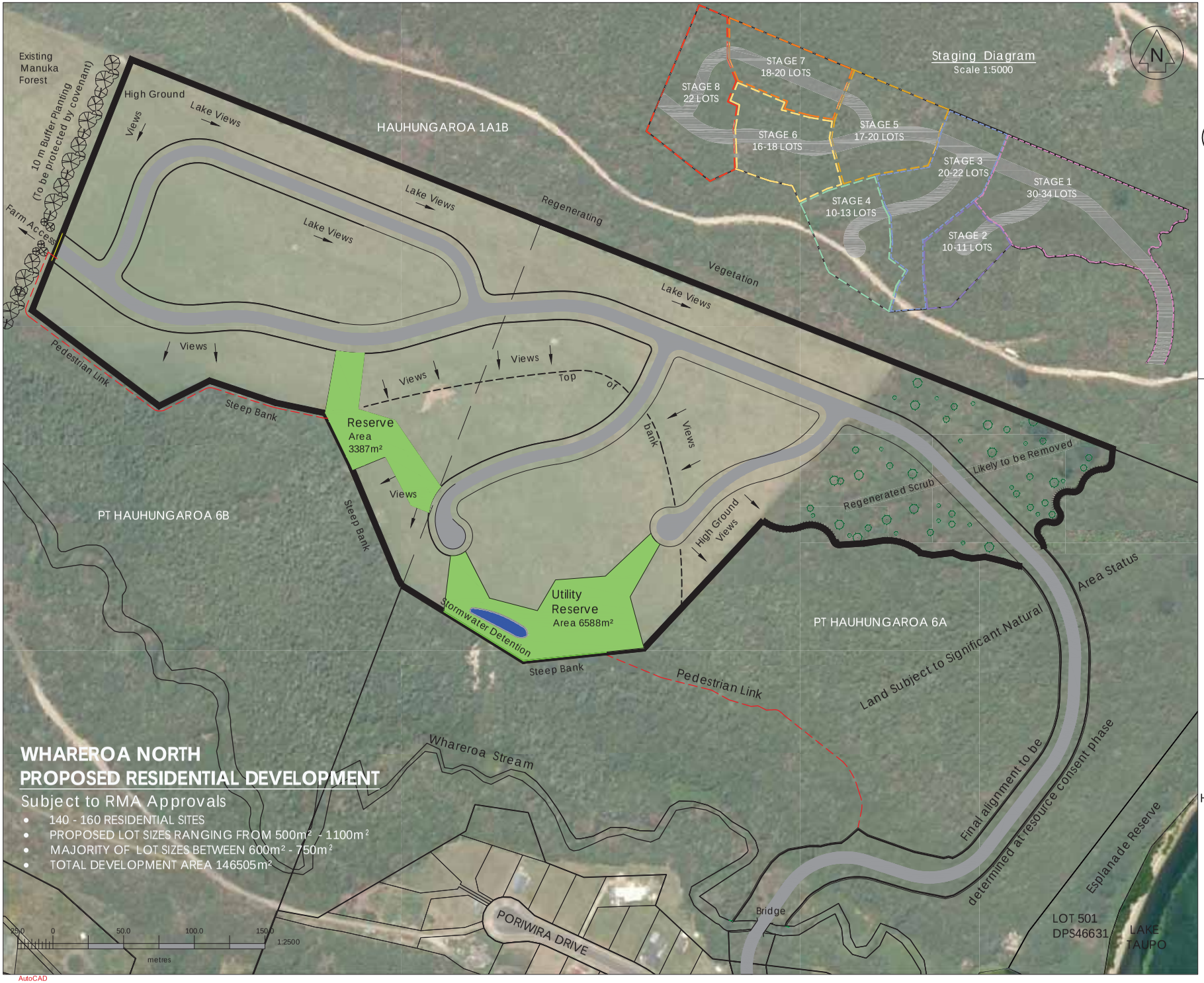
1. Appendix A: Plan, Conceptual Development of Hauhungaroa No 6 Trust Land
2. Appendix B: Whareroa Stream Bridge Discussion Paper; May 2016
3. Appendix C: Apex Bridge Report: April 2007
4. Appendix D: Supplementary information to Appendix 2; Sept 2016
5. Appendix E: SH32/Kuratau Hydro Road intersection report: Nov 2017 and 2007.
6. Appendix F: TDC's Water Supply Resource Consent
7. Appendix G: Letter to TDC supporting consent application; Oct 2016
8. Appendix H: Letter from TDC confirming position: March 2013
9. Appendix J: Geotechnical report; October 2006
10. Appendix K: TDC; Fault lines plan
11. Appendix L: Contour Plan of Development Area

Report Prepared by:

Mike Keys
KEYSOLUTIONS LTD

APPENDIX A

Plan, Conceptual Development of Hauhungaroa No 6 Trust Land



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LEGEND

PROPOSED RESIDENTIAL DEVELOPMENT

RESERVE

PROPOSED ROADING

PROPOSED PEDESTRIAN LINKAGE

NOTES:

- PROPOSED RESIDENTIAL DEVELOPMENT
- PLAN IS SUBJECT TO 'RMA' APPROVALS
- 140 - 160 RESIDENTIAL SITES
- PROPOSED LOT SIZES RANGING FROM 500m² - 1100m²
- MAJORITY OF LOT SIZE BETWEEN 600m² - 750m²
- TOTAL DEVELOPMENT AREA 146505m²

CONSULTANT TEAM

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LEWIS CONSULTANCY

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KEY SOLUTIONS

Rev	Date	Amendment	By	Chk	App
F	09/11/17	Lot boundaries removed staging	PH	DGF	DGF
E	08/11/17	Staging plan& road note added	PH	DGF	DGF

Project Title

THE PROPRIETORS OF HAUHUNGAROA No.6 TRUST WHAREROA NORTH

Drawing Title

CONCEPTUAL DEVELOPMENT OF HAUHUNGAROA No.6 TRUST LAND

Surveyed	IBA		
Designed	D FORSYTH	15/12/16	DGF
Drawn	P HARRIS	15/12/16	PH
Checked	D FORSYTH	15/12/16	DGF
Approved	D FORSYTH	15/12/16	DGF

Status DRAFT

Scale A3 1:2500 | A3

Drawing Number IBA1070-SC002 | Rev F

AutoCAD

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APPENDIX B

Whareroa Stream Bridge Discussion Paper; May 2016

Whareroa North – Access options

A Discussion Paper for the Owners - May 2016

A. Preliminary

At the request of the Owners this report considers the options for gaining access to development on the northern side of the Whareroa Stream.

B. The Development Proposal

The Owners have been developing the lakeside village of Whareroa for over 50 years and the area south of the Whareroa Stream is now fully developed. It has always been envisaged that an area north of the stream would be developed also and the proposal currently being discussed with Taupo District Council is shown in Appendix 1; Whareroa North Residential Concept Plan (Draft)

C. The June 2007 Report

Consultants Blance and Associates prepared a report in June 2007 entitled "Report on the Background to the proposed Whareroa Stream Crossing Location". It considered 4 sites, A, B, C and D shown in Figure 1 below

Figure 1

The report concluded:-

"In the 1980's various sites were considered for a stream crossing between the north and south sides of Whareroa Village. Over a period of time the options.....were discussed and the stream crossing at location "D" is considered the best option."

The full report is attached as Appendix 2.

D. Issues to be considered for the various options

a. Physical Impact

The physical impact of creating a road which crosses the stream and traverses the steep ground up to the proposed development area (which is some 40 metres above the stream) will be significant in terms of both earthworks and disturbance to vegetation. The best option will minimise this impact and the cost (including reinstatement costs).

b. Gradient/Slope

The Taupo District Council (TDC) sets minimum standards for new roading within the District. These standards are detailed in the Code of Practice for the Development of Land (CoP). One of those standards is the setting of a maximum gradient for various traffic situations. An extract from the CoP is shown below.

Figure 3.1R — Taupo District Council Roading Guidelines — Appendix 1

Road Description			Criteria for Road Design: Number of sites	Traffic volume	Speed	Elements of Road Width (m) (refer to std cross sections): Parking[1]	Min traffic	Min verge	Edging		Min road	Geometry: Min gradient	Max gradient	Normal crossfall	Max Super
Residential Environment Roads	Urban residential	Private road	≤2	<15	5	n/a	2.75	0.5/0.25	Nib		3.5	0.5%	15%	3%	6%
			≤3	<25			4.0	0.5/1.5			4.5				
			≤6	<50				1.0/2.0			6.0				
			≤9	<70					Nib/M kerb		8.0				
		Public road	≤12	<100	20	2.0[2]	5.0	4.5	Vertical kerb	M kerb option[3]	16.0		12%		
			≤20	<150											
			≤30	<250	30	1 @ 2.0	6.0	5.0			18.0				
			n/a	<300											
				<1000	40		6.5	5.25	Vertical kerb		19.0				
				<1500									10%		
	Collector			<5000	50	2 @ 2.0	7.0	5.5			22.0				
	Low Density				60	n/a	7.0	6.5	1.2 grass / M kerb[4]		20		12%		8%
Rural Roads	Local	Private Road	≤3	<30	10	n/a	3.0	1.0/2.0	0.5 grass		7.0	0.5%	15%	3%	8%
			≤6	<50	20		4.0				8.0				
			≤12	<120	60		6.0	2.0	1.2 grass		10.0		12%		
		Public Road	≤100	<1500	100		6.7	3.5			20.0		10%		
	Collector		n/a	<3000			7.4	4.0							
District Arterial Roads	Urban	Public Road	n/a	<20000	70	2 @ 2.5	8.0	6.0	Vertical kerb		25.0	0.5%	5%	3%	6%
				>20000	70	2 @ 3.0	8.0[5]	6.75			30.0				
	Rural			<5000	100	n/a	7.4	4.0	1.0 seal		24.0		7%		8%
				>5000			8.0								
Special Roads	Industrial	Public Road	n/a	<1000	30	2 @ 3.0	7.0	5.0	Vertical kerb		23.0	0.5%	5%	3%	6%
				>1000	50			4.5							
	Service lane			n/a	10	n/a	8.0	Nil	Nib		8.0		4%		
	Commercial				30	Angle		4.0	Vertical kerb		30.0				
	Regional Arterial				100	n/a			1.5 seal		25.0		5%		8%

It can be seen from this figure that in a residential low traffic density situation, the maximum permitted gradient is 12% or 1 in 8.33. This requirement has a big impact in the Whareroa situation because of the approximately 40 metres of elevation gain/loss that needs to be negotiated. Simple arithmetic suggests that to traverse 40 metres elevation difference, 40 x 8.33 = 333 metres minimum length of roading is required, any shorter length would result in the gradient being steeper. So the best option is likely to achieve this 333 metres (approx) in a way which minimises the physical impact as described above. It would be

difficult to argue for a higher gradient. For one thing, the location will be on a south facing escarpment where freezing in winter will be likely.

c. Initial cost

The initial cost will be affected by numerous factors. Some of the most significant are the amount of earthworks required to create a corridor for the road, the length of the new road, the height/length of the new bridge, the cost of extending water, wastewater and stormwater services, and the important aspect of stabilising new earthworks (both cut and fill surfaces), and reinstating vegetation.

d. New roading on south side of stream

The cost of new roading to get to the chosen stream crossing point from the south side (before the cost of the bridge and the climb up to the Development Area is factored in) must be taken into account when choosing the best option. It's obvious that this cost is least for a crossing at site "D", more at "A" and "B", and significantly more for western options (C and F). New roading (kerbed both sides and sealed with asphaltic concrete at 7m wide) is estimated to cost $30,000 - $40,000 per 100 metres. This estimate does not include the cost of the earthworks to create the platform for the kerbing and seal or the cost of any land acquisition that may be necessary, so minimising this length is a favourable objective.

e. New roading on north side of stream

As explained in b) above, over 300 metres length of road will be required to achieve an acceptable grade. This can be done by following the contour (sidling) around as is proposed at site "D", or approaching the elevation square on and going into a deep tapering cut. This second approach is described under the heading "Location A" in the Blance and Associates report, Appendix B. The sidling approach is shown in Cheal Consultants Plan 1070 - Whareroa[1], attached as Appendix 3. Neither approach is easy but the elevation difference requires one or the other.

f. Existing Roading Infrastructure

This issue is directly related to d) New Roading on south side of stream. Roading to TDC standards already leads directly to a crossing point at location "D" because this is the long envisaged crossing point. This existing sealed carriageway is only 50 metres short of the Whareroa Stream.

[1] Part of preliminary design work done for site "D" by Cheal Consultants in 2009

g. Connectivity

There is also a strong argument that there are social and economic gains from having efficient linkages between North and South Whareroa, both vehicular and pedestrian/cyclist connections. It could be argued that good connections don't exist between neighbouring Omori and Pukawa even thought they are geographically quite close, and this creates a separation which reduces the "Village" atmosphere. It's difficult to put a value on this connectivity, but it should be taken into consideration when choosing the best option for the stream crossing

h. Existing Services

Water Supply and Wastewater reticulation on the south side has been designed to extend to the north via site "D" during the development of Whareroa South, and sized in anticipation of extension to serve Whareroa North. Another way of describing this situation is that if a crossing point is chosen at any other location than "D", then larger diameter pipes will need to be extended from site "D" to the chosen crossing point.

i. Existing land ownership and tenure

The extension of roading at site "D" to serve Whareroa North has been envisaged for over 30 years and land on the south side of the stream at site "D" is already vested as "Road Reserve". Should a crossing point be chosen at "A", "B" or "E" (or in fact, anywhere other than "D"), other land will need to be traversed,

including private land and Esplanade Reserve for A, B and E. This would likely be very problematic in the case of Esplanade Reserve and it may be difficult for other land. Site D is "ready to go" in this respect apart from confirming Tuwharetoa Maori Trust Board approval (as land owner at the stream).

j. Consenting requirements

On top of TDC Consents for the Development, there is a requirement for specific consents for the bridge and access road on both sides of the stream. These include a resource consent for the bridge waterway and earthworks approval. A lot of preliminary discussion (and good progress toward approval) has occurred regarding the various consents required at Site D.

k. Long term costs

The option chosen will have a long-term (lifetime) operation and maintenance cost which will ultimately fall on those paying rates to the TDC. Longer roads, bigger (higher) bridges, deeper earthworks cuts all increase the lifetime cost of infrastructure. TDC will be looking for the most cost effective option

E. Options and Analysis

Five options are considered here and analysed against the "Issues to be considered" described in section C. Of the 11 issues described, only 9 are used in the analysis since b) Grade, is common to all options, and f) Existing roading Infrastructure considers the same issue as d) New roading on the south side.
Crossing sites A & B are considered very similar so are analysed as one option.
Crossings at C, D, E and a location between F1 and F2 are also analysed in the following table.

	Sites A&B	Site C	Site D	Site E	Site F1-F2
Physical Impact	1	1	2	1	1
Initial Capital Cost	2	1	2	1	1
New roading south side	2	1	3	2	2
New roading north side	1	1	2	2	1
Connectivity linkages	3	1	3	3	2
Existing Services	2	1	3	2	1
Existing Land Tenure	1	2	3	1	2
Consenting Requirements	1	2	2	1	1
Long Term Costs	2	1	3	2	2
Total Score	**15**	**11**	**23**	**15**	**13**

For the purposes of this analysis, a score of 3 is less difficult/costly, while a score of 1 is regarded as high difficulty/cost. The option with the highest total score is therefore the most favourable option.

The analysis doesn't "weight" the issues. In other words, it doesn't consider one issue more important than another although this is obviously the case. It hasn't been done because for every issue considered, Site D is scored either equal to or better than the other options. Weighting of the issues will therefore not change the relativity between the options.

F. Discussion

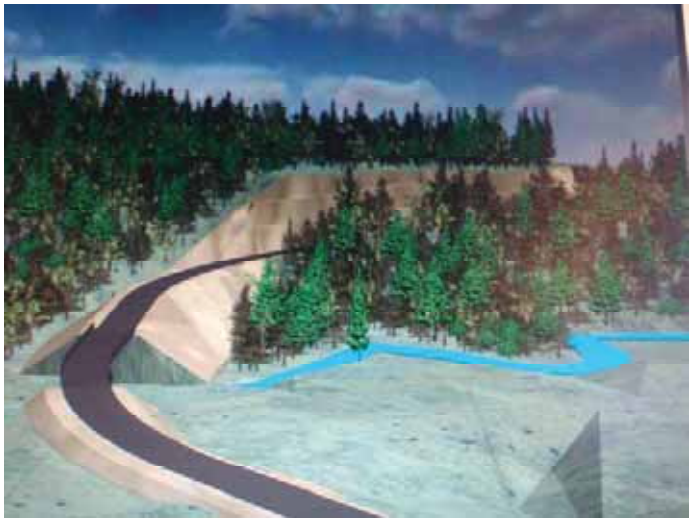
The above analysis is not a precise tool for comparing the options because it is subjective in a number of areas rather than using clear scientific principles. It's a "blunt instrument", but it has provided a clear answer that the previously accepted crossing site at Site "D" is the most favourable.

G. Conclusion

Five options to gain access to new residential development north of the Whareroa Stream have been considered and nine questions asked regarding each. The evaluation shows that crossing the stream at site "D" (see Figure 1) as has been proposed since the mid 1980's remains the best option.

H. Other considerations

a) There is understandable concern regarding the physical impact of the new bridge and road for option "D". The analysis recognises that this work is not easy (scoring 2 not 3), but the other options have more impact, all only scoring 1. A computer model of access at site "D" was prepared by Cheal Consultants in 2009[2] (see snap shot at right) and negotiations were held with TDC regarding the width of the new road up the escarpment with a view to minimising the impact. There is still some work to be done on this aspect.



b) The current thinking (and the concept being discussed with TDC - see Appendix 1; Whareroa North Residential Concept Plan) is for a shift of the new residential area westward to minimise the impact on the "Significant Natural Area" and the "Outstanding Landscape Area". This begs the question "After crossing the

[2] Again, part of preliminary design work done for site "D" by Cheal Consultants in 2009

stream at site D, is it practical to turn left and sidle up the escarpment in a westward direction rather than eastward". It warrants a closer look at this possibility, but an initial examination suggests that the gradient would be unacceptably steep.

I. Recommendations

1. That Site D be confirmed as the location of the crossing of the Whareroa Stream for the access road to Whareroa North

2. That Cheal Consultants be asked to confirm that gaining access to Whareroa North in a westward direction up the escarpment is not a better route than climbing in an eastward direction as currently proposed.

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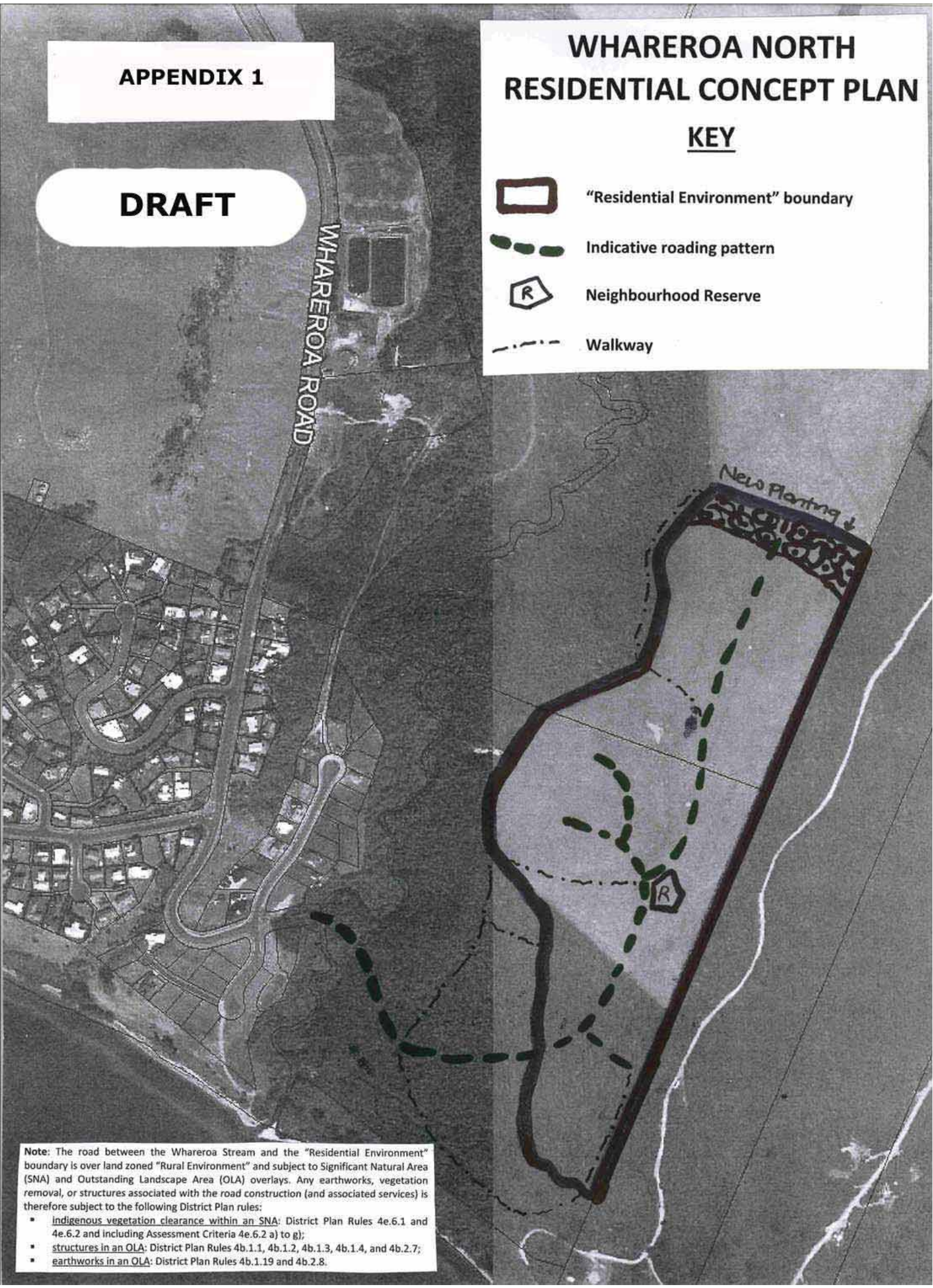
APPENDIX 1

DRAFT

WHAREROA NORTH RESIDENTIAL CONCEPT PLAN

KEY

- "Residential Environment" boundary
- Indicative roading pattern
- Neighbourhood Reserve
- Walkway



Note: The road between the Whareroa Stream and the "Residential Environment" boundary is over land zoned "Rural Environment" and subject to Significant Natural Area (SNA) and Outstanding Landscape Area (OLA) overlays. Any earthworks, vegetation removal, or structures associated with the road construction (and associated services) is therefore subject to the following District Plan rules:

- indigenous vegetation clearance within an SNA: District Plan Rules 4e.6.1 and 4e.6.2 and including Assessment Criteria 4e.6.2 a) to g);
- structures in an OLA: District Plan Rules 4b.1.1, 4b.1.2, 4b.1.3, 4b.1.4, and 4b.2.7;
- earthworks in an OLA: District Plan Rules 4b.1.19 and 4b.2.8.

APPENDIX 2

REPORT ON THE BACKGROUND TO THE PROPOSED WHAREROA STREAM CROSSING LOCATION

1 History

Since the 1980's when the Trustees of Hauhungaroa No 6 were considering the development of Whareroa Village, the long term vision for the settlement was always that it would be made up of two parts - the south side (which is now completed) and the north side (for which detailed planning is now underway). To join the two parts requires a crossing of the Whareroa Stream.

In general most of the consideration about the various alternative locations for the stream crossing took place in the early 1980's when the land on both the north side and the south side of the Whareroa Stream was zoned "Lakeshore Residential" under the then Taumarunui County District Plan.

2 Currently Proposed Bridge Crossing Location

The attached plan shows the existing layout of the Whareroa settlement which is located on the southern side of the Whareroa Stream. The land immediately to the south of the stream is set aside as reserve, with sections set back from the stream and lakefront area as shown.

As can be seen on that plan the roading pattern for the Whareroa settlement includes a roading pattern designed to link across a bridge at the location shown as "D" on the attached map. In 1987 the survey plan DPS 46631 vested the reserves and also created a Road Reserve for this crossing access. A bridge at this location was approved by Waikato Regional Council in 1990 but for several reasons the north side did not proceed at that time and the consent for that bridge has since lapsed. Construction of the latter stages of the Whareroa subdivision located on the flats immediately south of the stream reserves included provision of roading as well as services to this anticipated crossing point.

The process of seeking new approval for the bridge crossing now needs to commence with a "landowner approval" from the Tuwharetoa Maori Trust Board. The Tuwharetoa Maori Trust Board holds the title of the bed of Taupo-nui-a-Tia (including the Whareroa Stream bed upstream for a distance of 4.8km) in trust on behalf of the members of the Tuwharetoa hapu who adjoin the stream. This report is intended to provide some background to the choice of the bridge crossing location for which that landowner approval is now sought.

3 Other Stream Crossings Considered

Apart from the crossing point which was decided upon (shown as "D" on the attached plan, and outlined above), three other crossing places were also originally considered and discarded as follows:

- **Location "A"** (on the attached plan) was put forward in a concept plan in 1984. This consisted of a crossing of the Whareroa Stream some 460m upstream of the stream mouth, with the road traversing up the bush covered slope cresting on the north side some 75m back from the bank above Lake Taupo. Shortly after the 1984 concept plan was generated it was realized that by shifting the stream crossing some 220m closer to the stream mouth (ie at location "D") and increasing the grade of the road up the north side, a substantial reduction of earthworks and vegetation disturbance needed to form the road up to the north side could be achieved. It was considered that the revised location (ie "D") would also result in a more direct access link between the north and south sides of the village and this would promote more of a village aspect.
- **Location "B"** (on the attached plan) being a small distance upstream from location "A" was to traverse northwards from the valley floor through the slip into the grassed depression above. Engineering investigation showed that this option was not suitable because the steepness of the topography and the short length of road required would result in a road that (even at maximum allowable grade) would require a major cutting and large earthworks that would in turn require the removal of a substantial area of bush.
- **Location "C"** (on the attached plan) was to obtain access to the north side through Whareroa Station which would still require a stream crossing at some point. Access to the to the north side through Whareroa Station was discarded early on as this would separate the two parts of the Whareroa Village thereby creating a physical division in the community and an access barrier in terms of convenience and travel time for future northside residents wishing to use facilities located on the south side (eg boat ramp, Kowhai Flats, the river mouth, refuse transfer station, etc). Access through Whareroa Station would also have required a much greater length of access road and increased safety and security issues for the operation of the station's farming activities.

4 Conclusion

In the 1980's various sites were considered for a stream crossing between the north and south sides of Whareroa Village. Over a period of time the options outlined above were discussed and the stream crossing at location "D" is considered the best option.

Ian Blance
BLANCE AND ASSOCIATES

June 2007


'C'
'B'
'A'
'D'

Appendix 3

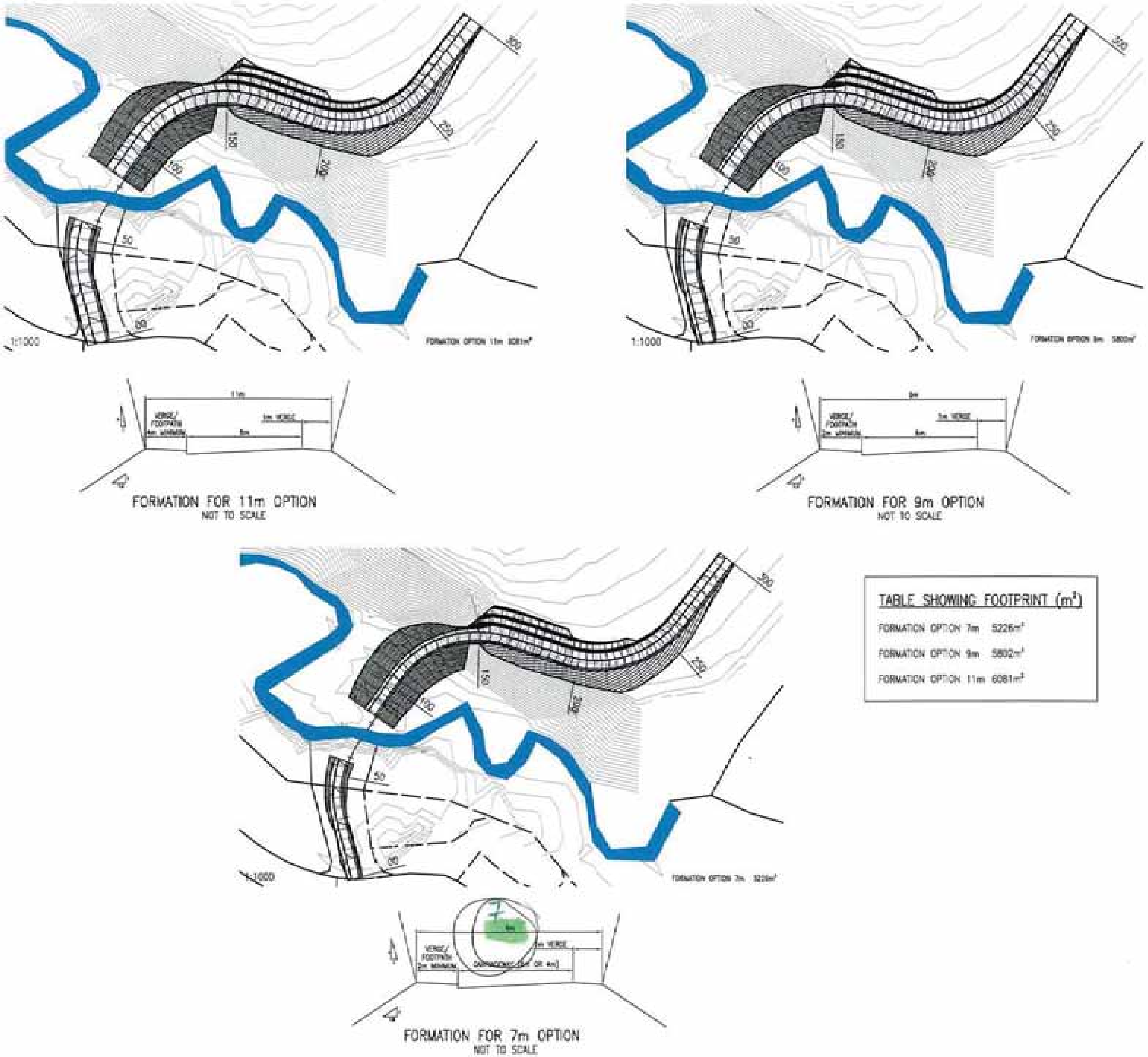


TABLE SHOWING FOOTPRINT (m²)

FORMATION OPTION 7m	5226m²
FORMATION OPTION 9m	5802m²
FORMATION OPTION 11m	6081m²

	Name	Date	Signed
Surveyed			
Designed	CO	MAY 2015	
Drawn	CO	MAY 2015	
Checked	RI		
Approved	RI		

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Project Title: WHENUA KETE LTD ACCESS ROAS WHAREROA NORTH

Drawing Title: PROPOSED ACCESS OPTION 7m, 9m & 11m FORMATION WIDTHS

Drawing Status: FOR INFORMATION

CAD Filename: 1070-SKETCH-02 | Scale: 1:1000 | A1

Drawing Number: 1070-WHAREROA | Rev: A

APPENDIX C

Apex Bridge Report: April 2007

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BRIDGE OVER WHAREROA STREAM

WHAREROA NORTH DEVELOPMENT
LAKE TAUPO

Document Author:	Colin Bell MIPENZ, CPEng	
Document Peer Reviewed by:	Steve Tooley MIPENZ, CPEng	13/July/2007 Date

BLA1008

April 2007

SECTION 1 – BRIDGE OVER WHAREROA STREAM

1.1 General

Extension of Whareroa Road for access to the north side of Whareroa Stream will require a stream crossing to provide for two traffic lanes, plus pedestrian traffic to and from the proposed Whareroa North subdivision. The bridge will also carry services including water, sewer, power and telephone as required for the new subdivision. This section describes the proposed bridge and refers to relevant clauses in the Waikato Regional Plan.

1.2 Location

The bridge is proposed to be located as shown on Blance and Associates plan 490/10 at a position 350m upstream from the mouth of the stream. The map reference on the topographic maps is sheet T18, ref 514569.

The bridge will provide access to a narrow, low lying area (flood plain) north of the stream. Access to the proposed land subdivision will require construction of a road embankment across the low area and a steeply rising length of road traversing a steep natural slope to reach an elevation of 385m above which the residential sections will be located. South of the stream the existing formed road stops approximately 60m short of the bridge site.

1.3 Catchment

At the proposed bridge site, the upstream catchment is a 60 sq km area extending 14km west from Lake Taupo and approximately 5km in width. The bulk of the catchment is in pasture, but the westernmost area of approximately 15 sq km is native forest.

In elevation, the catchment extends from lake level (358m) to a high point at 940m above sea level. The entire catchment is pumice country and can therefore be expected to have relatively high soil permeability and low storm runoff.

The upper 29 sq km, west of State Highway 32, drains under the highway through four concrete pipe culverts. In similar fashion an area of 6 sq km north of Karangahape Road drains through two culverts. Analysis shows that the State Highway culverts have adequate capacity for expected 1 in 100 year floods but that significant headwater depths will occur and therefore to some degree the flood peaks will be reduced by short term storage upstream of the culverts. The Karangahape Road culverts are of inadequate size and can be expected to significantly reduce peak flows from the 6 sq km area north of the road.

1.4 Design Flood Estimate

A 1 in 100 year flood estimate is required for conventional bridge or culvert design. At this site, two flood estimates have been calculated; (a) a 63 m^3/sec flood based on the Rational Method using a 114mm rainfall in a 12 hour period and (b) a 78 m^3/sec flood based on "Flood Frequency in New Zealand" by McKercher and Pearson.

Given the relatively high permeability of the catchment soils, it is judged that an adequately conservative estimate for the 1 in 100 year flood is 72 m^3/sec. The corresponding 1 in 50 year flood is 66 m^3/sec.

Analysis of the channel cross section and available stream gradient (0.25%) indicates that expected flood depths at the bridge site will be 2.75m for the 72 m^3/sec flood. For a stream bed level of 357.8m, allowing for flood depth, a clearance above flood level and a 0.6m structure depth, the desired minimum road level on the bridge is 361.8, but levels at

least 0.3m higher are to be preferred. This results in a minimum required bridge deck level of 362.1m.

Although a 72 m^3/sec flood is the current estimate for a 1 in 100 year event the Ministry for the Environment recommend that allowance needs to be made for 15% to 20% higher rainfalls due to climate change over the next 50 to 100 years. A long term possible flood of 86 m^3/sec has been considered and will result in peak water levels approximately 0.3m above the level of a 72 m^3/sec flood.

Clearly, even a flood as high as 86 m^3/sec will pass under the proposed bridge with the expectation that the bridge will remain undamaged.

1.5 Proposed Bridge

A brief description of the proposed bridge is as follows:

Foundations	-	driven steel piles
Deck	-	precast concrete DHC units
Clear span	-	15m between abutments
Carriageway width	-	8.0m
Footpath width	-	2.0m
Overall deck width	-	10.4m
Deck depth (nominal)	-	0.6m
Minimum deck level	-	362.1m (see below)
Design traffic load	-	HN -HO -72

It is proposed that the bridge will be a single span structure supported on insitu concrete abutments constructed clear of the river banks. On the north side a 50m length of embankment will be constructed to provide a road formation up to 4m above existing ground levels.

It is intended that the lower end of the bridge deck will be at level of 362.40 to suit the final road design, this being 0.3m higher than the minimum requirement listed above.

Full bridge details, including carriageway and footpath widths, will be subject to Taupo District Council engineering approval.

1.6 Stream Channel and Scour Protection

The natural channel is over 6m wide and at the bridge site the channel bed is approximately 1.5m below the adjacent flood plain. Construction of the bridge and associated road embankment across the flood plain will result in a concentration of flow under the bridge and a corresponding small rise in flood levels upstream of the bridge. The upstream river level rise (afflux) due to the bridge is calculated to be approximately 0.3m in the event of a 72 m^3/sec flood.

The stream bed is fine grained sandy material which is clearly subject to scouring when the river is in high flood. For the 1 in 100 year design flood the average stream velocity in the main channel is expected to be marginally less than 3 m/sec, sufficient to cause bed scour and localized erosion of stream banks. This is an entirely natural process which is expected to be marginally worsened by construction of the bridge and the associated road embankment. There will be an unavoidable small increase in stream velocity due to the concentration of flow under the bridge.

Provision for the effects of possible scour in the vicinity of the bridge will be in two forms. Firstly, the bridge foundations will extend down below bed level so as to provide full support to the bridge even in the event that the channel is temporarily deepened by scour during floods. Secondly, the upper banks, above the natural stream channel, will be protected by rock (on the right bank) and a concrete abutment wall (on the left bank) in

order to prevent scour directly under the bridge abutments. This scour protection work will be extended down to a depth approximately 1.2m below bed level as shown on the drawings.

It is proposed that the natural stream channel will remain entirely undisturbed during the construction of the bridge. On the north (left) side of the stream the proposed abutment construction will be 2m clear of the natural stream channel and on the south side a similar width will exist to the bottom of the rock rip rap plus a further 2.5m to the concrete abutment beam.

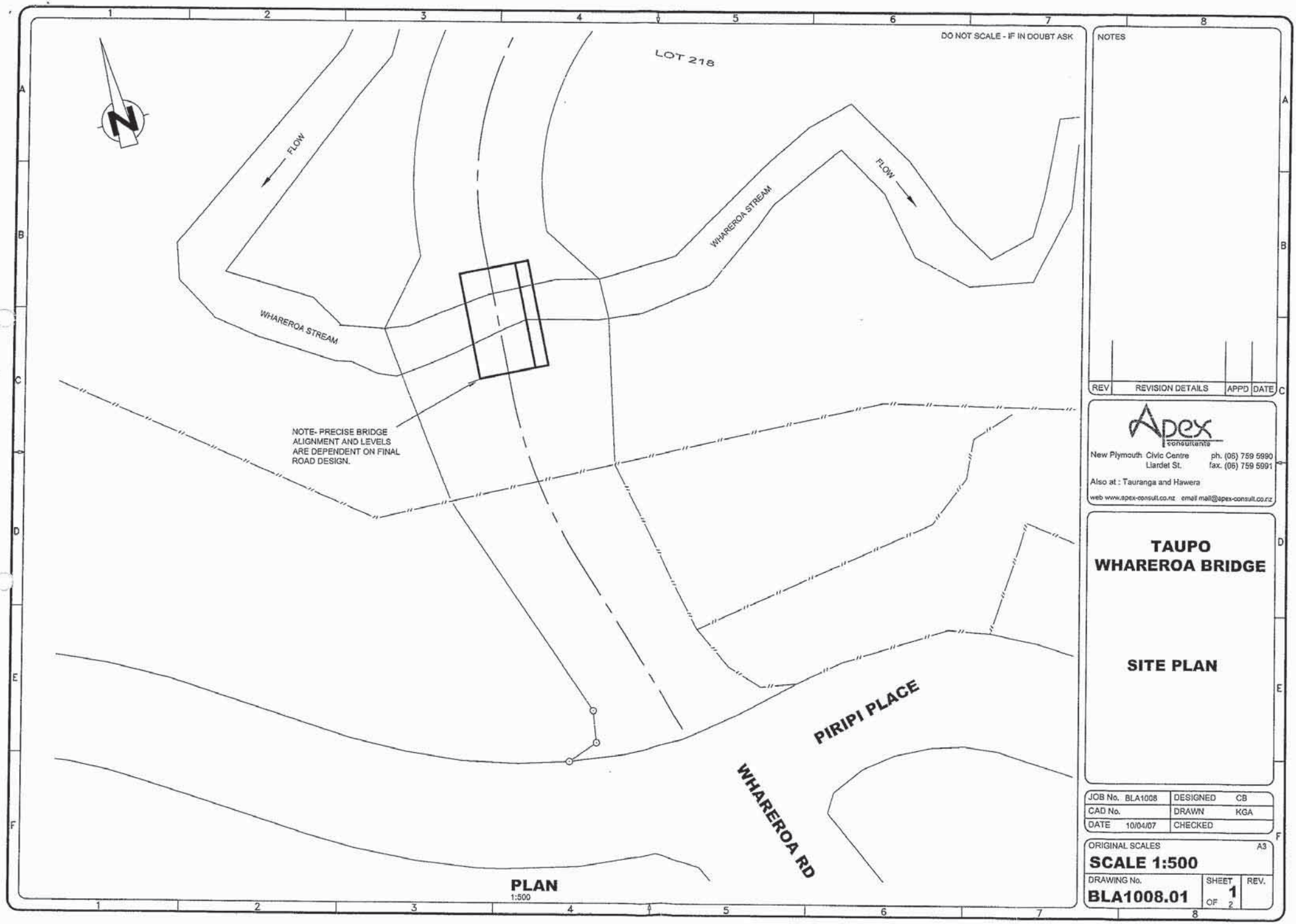
1.7 Waikato Regional Plan

Regional Council approval is sought under rule 4.2.8.2, Controlled Activity Rule – Bridges.

As described above, the proposal complies with conditions (a), (b), (c) and (e) of rule 4.2.8.2. Condition (d) requires reduction of the flood plain waterway area to be no greater than 10%.

As discussed in section 1.6 above, the flood plain will be unavoidably crossed by the road embankment and the consequential loss of flood waterway will cause a small degree of increased stream velocity and scour under the bridge. This effect will be negligible in regular, annual floods and relatively small in floods of long return intervals. Non-compliance with condition (d) is therefore submitted for Regional Council approval.

Other conditions (eg. (f), (g), (h), (j)) will be complied with as normal items in construction contract specifications and as issues of control of the contractor's activities during construction.



NOTES

REV	REVISION DETAILS	APPD	DATE

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Also at : Tauranga and Hawera
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TAUPO WHAREROA BRIDGE

SITE PLAN

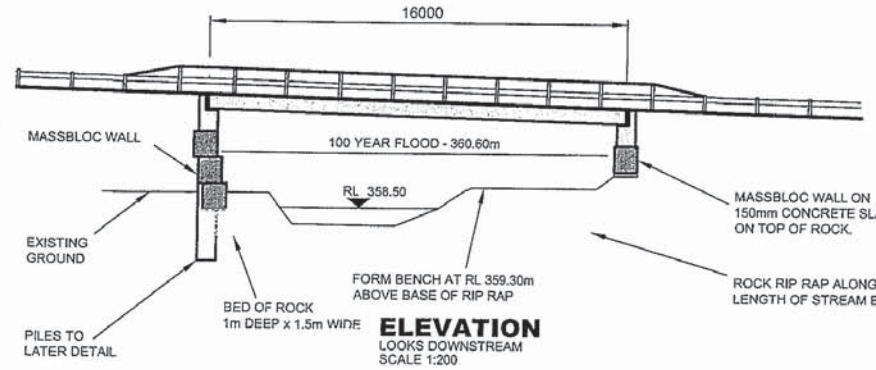
JOB No. BLA1008		DESIGNED	CB
CAD No.		DRAWN	KGA
DATE	10/04/07	CHECKED	

ORIGINAL SCALES A3

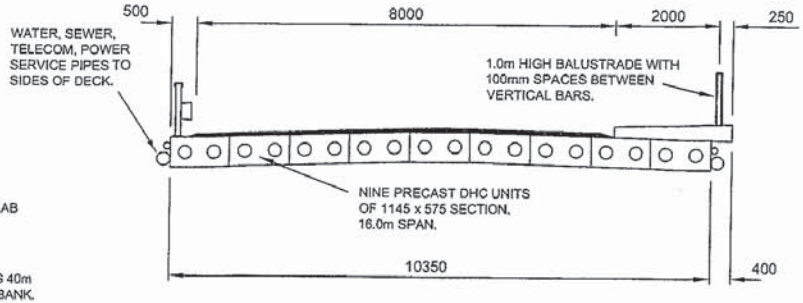
SCALE 1:500

DRAWING No.	SHEET	REV.
BLA1008.01	1 OF 2	

DO NOT SCALE - IF IN DOUBT ASK



ELEVATION
LOOKS DOWNSTREAM
SCALE 1:200



CROSS SECTION
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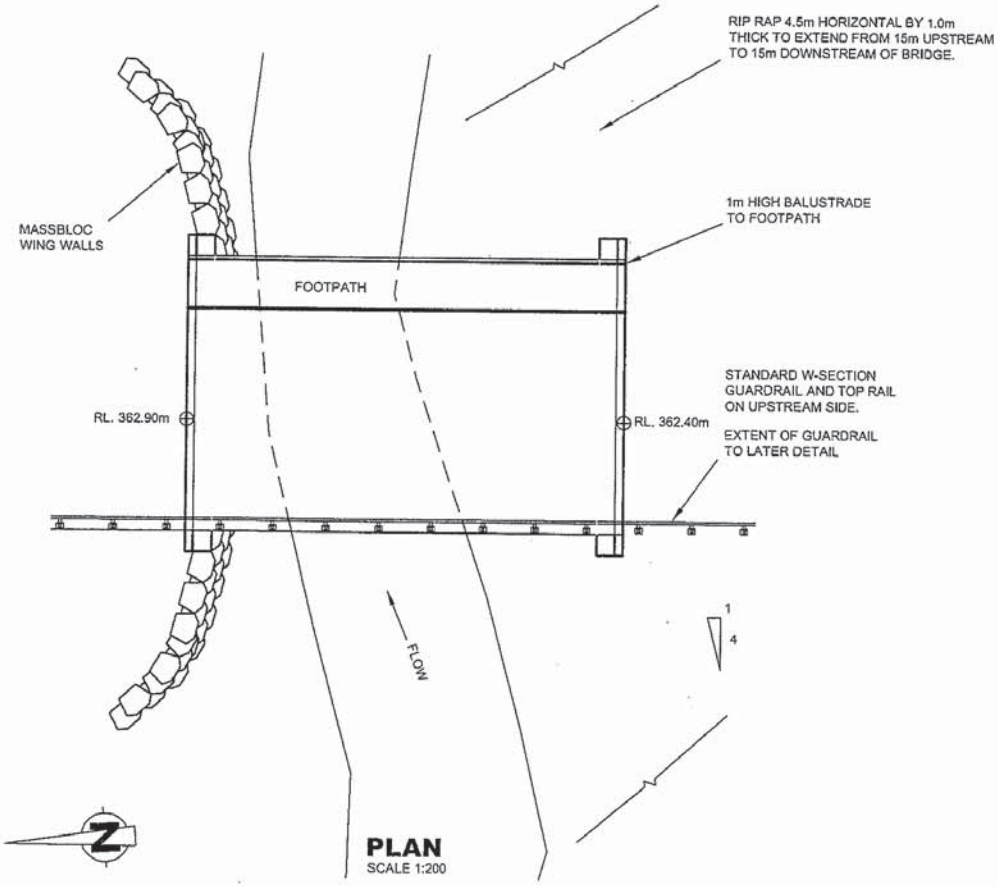
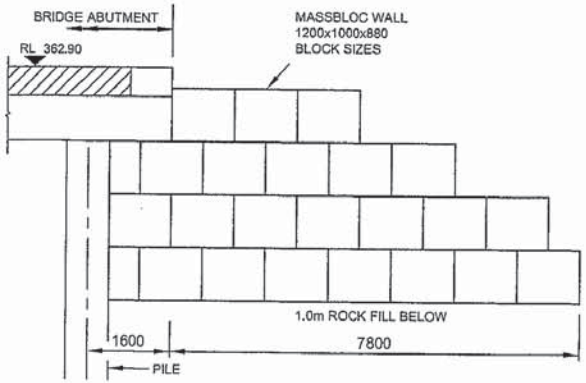


PLAN
SCALE 1:200



WINGWALL ELEVATION
SCALE 1:100

NOTES

1. LEVELS IN TERMS OF ASSUMED DATUM
2. CHECK ALL DIMENSIONS ON SITE BEFORE COMMENCEMENT OF WORK. FIGURED DIMENSIONS TAKE PRIORITY OVER SCALED.

REV	REVISION DETAILS	APPD	DATE

Apex consultants
New Plymouth Civic Centre, Liardet St. ph. (06) 759 5990 fax. (06) 759 5991
Also at : Tauranga and Hawera
web www.apex-consult.co.nz email mail@apex-consult.co.nz

TAUPO WHAREROA BRIDGE

PLAN, ELEVATION AND SECTION

JOB No.	BLA1008	DESIGNED	CB
CAD No.		DRAWN	KGA
DATE	10/04/07	CHECKED	

ORIGINAL SCALES A3

SCALE 1:100 1:200

DRAWING No.	SHEET	REV.
BLA1008.01	OF 2	

APPENDIX D

Supplementary information to Appendix 2; Sept 2016

Whareroa North – Access options - Supplementary paper
Further comparison of Options C and D - September 2016

A. Preliminary

Following discussions with Merilyn Connelly and discussions and a site visit with Kepa Patena on 21st July 2016, this supplementary paper focuses on a detailed comparison between Options C and D. It should be read in conjunction with the Access options Paper dated May 2016.

B. Background

The Owners want to be convinced and need to be convinced that the position chosen for the stream crossing to access new development at Whareroa North is the best one both from a financial point of view and an environmental point of view. Given that the current development proposal is to shift the bulk of the northern subdivision further westwards than originally proposed (further from D and closer to point C - see Figure 1; May 2016 paper), does this now swing the balance to favour a crossing at point C rather than D? This supplementary paper will address that question.
The analysis in Section E of the discussion paper dated May 2016 compared five options from 9 different perspectives. With respect to these 2 options it determined that Option D was more favourable than Option C in 8 of those. This supplementary paper focuses on Options C and D only and better quantifies the differences between those 2 options. It provides cost estimates for the two, and summarises the other issues.

C. Option D

This is the stream crossing point which has been preferred since the mid 1980's and is shown in Figure 1 below.

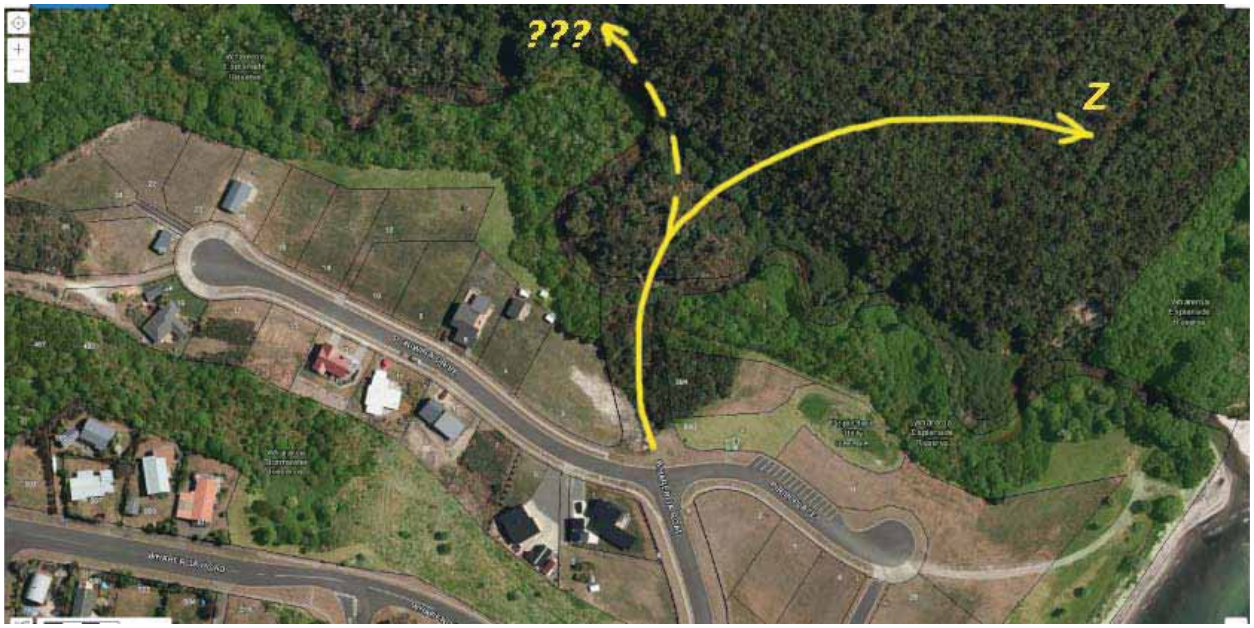


Figure 1

It is basically an extension of Whareroa Road from where it currently terminates at Poriwira Drive, crossing the stream and swinging eastwards towards Point Z (see Figure 1 above). In December 2009, Cheal Consultants reported that this alignment had been further researched and refined. Cheal estimated in 2009 that the cost of this access road would be $800,000 +/- 20%. Cheal have recently updated this estimate to reflect September 2016 construction costs and include the extra length given the westward shift of the proposed development area. It is currently estimated to cost $1.24 million (excluding GST and contingencies). The detailed Schedule of Prices is attached as Appendix 1.

D. Option C

Option C was identified in Blance and Associates June 2007 report (see Appendix 2, May 2016 paper) as a point upstream of the wastewater oxidation ponds. It was not specific as to where that point was exactly, just further upstream.

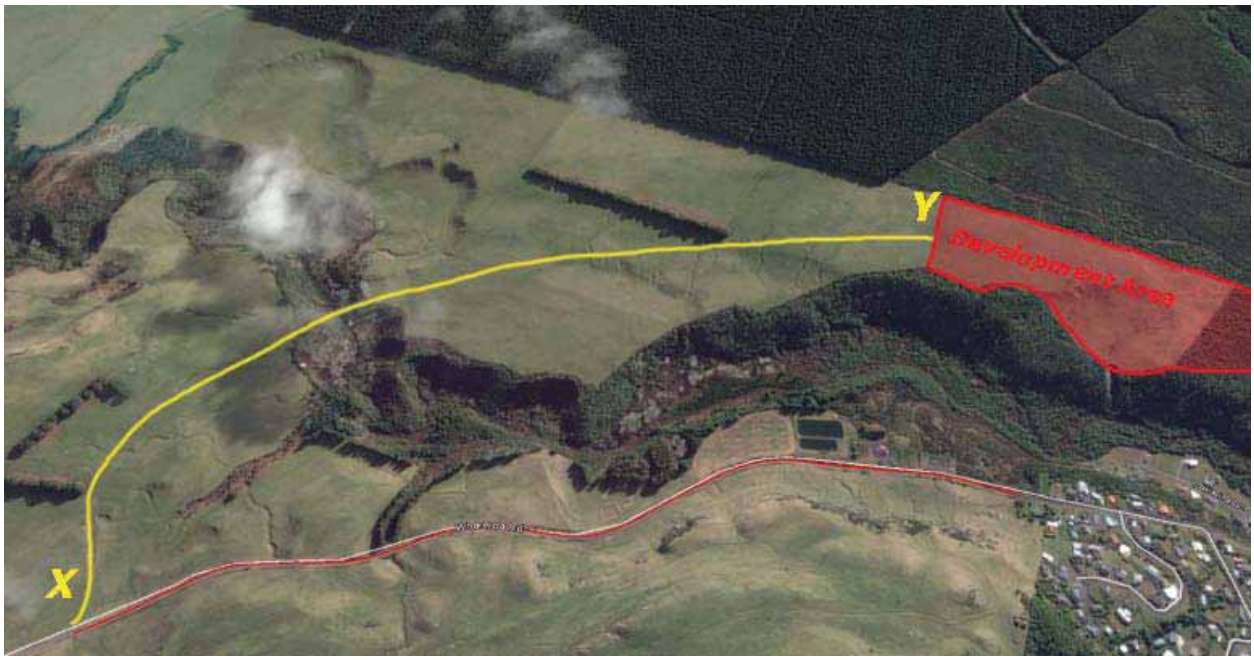


Figure 2

The Owners will be aware that Whareroa Stream is in a deep gully over this section making bridging difficult and expensive.

Discussions on site with Kepa in July revealed that there was a bridge across the stream below where the house was previously located at X in Figure 2, and certainly the contour of the adjoining land is more forgiving in this area. He advised that the house was accessed from Point X which is approximately 1.5km up Whareroa Road from where the house is currently located (the first house on the right in the Village). As a result of this discussion, alignment X - Y (Figure 2) is the one costed by Cheal as Option C. This alignment is estimated to cost $2.23 million (excluding GST and contingencies). The detailed Schedule of Prices is attached as Appendix 2.

Apart from the cost of the road itself, an important consideration in this comparison of options is the other public infrastructure which will be required to be extended to service the development, particularly stormwater, wastewater

reticulation, water supply and electricity reticulation. These all terminate (and have capacity for extension) at site D, the intersection of Whareroa Road and Poriwira Drive.

With Option D, these will all have an acceptable corridor for extension up the new road to the development, whereas with Option C (or anything in between), an additional service/pedestrian bridge will be required at site D and a suitable infrastructure corridor constructed from that point up to the development. My preliminary estimate for this work is $400,000 including the service/pedestrian bridge, but excluding the cost of the infrastructure itself.

E. Options in between C and D

Are there any other worthwhile options in between C and D?

A more direct approach at site D has also been costed by Cheal. With the shifting of the development area westward, it was appropriate (as suggested in the May 2016 paper) to consider whether a westward sidling up the escarpment was better. The sidling approach is too steep to be acceptable for roading (the dashed line shown ??? in Figure 1 above) so Cheal have costed Option D2 which takes the access across the stream then straight into a deep cutting rather than sidling around the slope.

This is shorter than Option D, but results in cut faces twice as high as Option D. It will have more impact on the landscape (more earthworks) and is more expensive at $1.28 million. The detailed Schedule of Prices is attached as Appendix 3.

There are of course other options for C as well, further downstream than the alignment X - Y shown in Figure 2 but still upstream of the oxidation ponds. These may cost less than the $2.23 million estimated for Option C, they haven't been further investigated, but given the fact that they will still require the additional service/pedestrian bridge at site D and a suitable infrastructure corridor up to the development (approx $400,000 as above), overall cost is likely to be significantly greater than the $1.24 million estimated for Option D.

F. Detailed comparison of Options C and D

i. Cost

	Option C	**Option D**
Roading Costs	$2.23m	$1.24m
Service/Pedestrian Corridor	$0.4m	0
Total Cost	**$2.63m**	**$1.24m**

Option C is more than double the cost of Option D

ii. Environmental considerations

It has always been accepted that the steep sidling nature of Option D will present some significant technical challenges during its design and construction. These challenges are not insurmountable. Cheal Consultants observed at the time the cost estimate was prepared in 2009 that the project was in line with numerous other successful projects throughout the district. This writer agrees with that observation. Time and modern landscaping methodology will go a long way to mitigating the temporary disruption.

On the other hand, Option C involves a much greater length of roading so will therefore have a greater "footprint" area. But again, time and modern landscaping methodology will assist in mitigating the temporary disruption.

Neither option is the perfect solution and it is difficult to quantify and compare the environmental impact of each, but suffice to say that the effects of both can be mitigated.

iii. Other considerations

As discussed in detail in the Access options Paper dated May 2016, Section E, Option D is considered superior to Option C in many respects.

Two of those worth repeating here are "Connectivity linkages" and "Existing Services". A roading connection at D will provide good community connectivity between the existing Village and Whareroa North. Option C will limit direct connection to pedestrian traffic only. And as explained earlier, other infrastructure (stormwater, wastewater reticulation, water supply and electricity reticulation) is designed to extend from Point D. It would add cost to the development to create a service bridge and corridor if the roading linkage is not at this location.

G. Conclusion

A detailed analysis of costs, environmental and other considerations for options C and D has confirmed that crossing the stream at site "D" as has been proposed since the mid 1980's remains the best option.

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68 WHAREWAKA RD, TAUPO

Appendix 1

The Proprietors of Hauhungaroa No.6 Trust

Whareroa North - Access Options
Whareroa North, Whareroa

Contract IBA1070

Schedule of Prices - Option "D"

Notes:

1. Descriptions of Items are all inclusive. Work not separately scheduled shall be included in appropriate scheduled items.
2. Items shown with Provisional Quantities will be remeasured and payment certified for the actual quantity of work performed.

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
1.0	**PRELIMINARY AND GENERAL**				
1.1	Establish to site	1	LS	$50,000.00	$50,000.00
1.2	Insurances	1	LS	$2,000.00	$2,000.00
1.3	Contractor to ensure all staff have appropriate general and site specific health and safety inductions and access clearances	1	LS	$5,000.00	$5,000.00
1.4	Contractor to establish and maintain Traffic Management for the duration of the Contract Works	1	LS	$2,000.00	$2,000.00
1.5	Contractor to maintain Health & Safety Register and Hazards Board	1		$500.00	$500.00
1.6	Survey setout	1	LS	$10,000.00	$10,000.00
1.7	Erosion & Sediment Control	1	LS	$15,000.00	$15,000.00
1.8	Asbuilts	1	LS	$5,000.00	$5,000.00
	ITEM 1: SUBTOTAL				**$84,500.00**

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
2.0	**EARTHWORKS**				
2.1	Clearing scrub etc up to 200mm Ø trees	1	LS	$20,000.00	$20,000.00
2.2	Clearing trees over 200mm Ø trees if required	1	LS	$20,000.00	$20,000.00
2.3	Strip and stockpile topsoil - 200mm depth, including screening	15,000	m^3	$5.00	$75,000.00
2.4	Cut to fill - compaction 95% MDD 0.6 Compaction Ratio Assumed	20,570	m^3	$5.00	$102,850.00
2.5	Respread topsoil to berms, reserves and lots	10,000	m^2	$2.50	$25,000.00
2.6	Grass seeding	10,000	m^2	$0.75	$7,500.00
	ITEM 2: SUBTOTAL				**$250,350.00**

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
3.0	**ROADING**				
3.1	Saw cut existing road	1	LS	$500.00	$500.00
3.2	Subgrade road - undercut to a depth of 450mm, replace and recompact	3,900	m²	$2.50	$9,750.00
3.3	Trim and roll subgrade - Road	3,900	m²		$0.00
3.4	Kerb and Channel (KC)	1,000	m	$35.00	$35,000.00
3.5	Basecourse road - 150mm NZTA M4	650	m³	$75.00	$48,750.00
3.6	2 Coat chip seal grade 3/5	3,900	m²	$25.00	$97,500.00
3.7	Footpath (concrete) - all works including subgrade preparation and formwork	1,300	m²	$25.00	$32,500.00
	ITEM 3: SUBTOTAL				**$224,000.00**

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
4.0	**CIVIL WORKS**				
4.1	Common services trench	650	m	$15.00	$9,750.00
4.2	Stormwater	1	LS	$25,000.00	$25,000.00
4.3	Bridge, including abuttments	1	LS	$650,000.00	$650,000.00
	ITEM 4: SUBTOTAL				**$684,750.00**

ITEMS 1 to 4 - TOTAL:	**$1,243,600.00**

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
5.0	**CONTINGENCY**				
5.1	Contingency (not to be expended without approval of Engineer)	$1,243,600.00	1	$0.15	$186,540.00
	ITEM 5: SUBTOTAL				**$186,540.00**

TOTAL :	**$1,243,600.00**

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Client Logo

Client Ref -

Rev	Date	Amendment	By	Chk	App
A	5/09/16	FOR INFORMATION	PH	CD	

Project Title

THE PROPRIETORS OF HAUHUNGAROA No.6 TRUST
WHAREROA NORTH

Drawing Title

ACCESS ROAD OPTION 'D'
PROFILE VIEW 9m FORMATION
12.5% MAXIMUM GRADE

Surveyed			
Designed	P HARRIS	5/09/16	PH
Drawn	P HARRIS	5/09/16	PH
Checked	C DAWSON	5/09/16	CD
Approved			

Status **INFORMATION**

Scale A1 1:1250 | A1
A3 1:2500

Drawing Number IBA1070-SK07 | Rev A

AutoCAD

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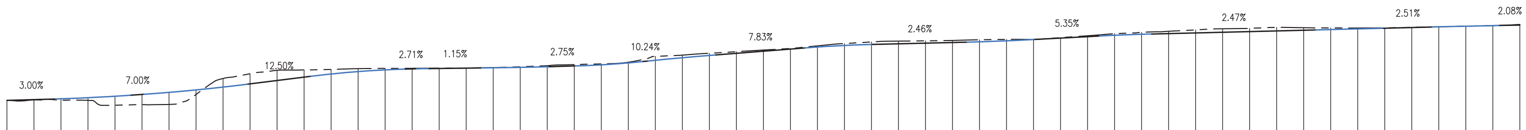

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EXISTING GL	362.19	362.57	362.30	362.23	358.61	359.16	359.25	366.53	378.44	381.93
DESIGN GL	362.19	362.79	363.39	364.19	365.28	366.63	368.15	369.96	372.05	374.43
CUT AND FILL	0.00	0.22	1.09	1.96	6.67	7.47	8.90	3.43	-6.39	-7.50

CHAINAGE	200.00	220.00	240.00	260.00	280.00	300.00	320.00	340.00	360.00	380.00
EXISTING GL	384.56	384.81	385.15	385.71	385.92	385.97	386.06	386.18	386.53	387.12
DESIGN GL	376.93	379.43	381.77	383.57	384.81	385.51	385.86	386.09	386.33	386.68
CUT AND FILL	-7.63	-5.38	-3.38	-2.14	-1.10	-0.46	-0.20	-0.09	-0.20	-0.44

CHAINAGE	400.00	420.00	440.00	460.00	480.00	500.00	520.00	540.00	560.00	580.00
EXISTING GL	387.91	388.73	389.24	390.46	394.85	395.72	397.05	398.28	399.49	400.66
DESIGN GL	387.16	387.71	388.53	389.95	391.91	393.81	395.52	397.09	398.65	400.22
CUT AND FILL	-0.75	-1.02	-0.71	-0.51	-2.94	-1.91	-1.53	-1.19	-0.84	-0.44

CHAINAGE	600.00	620.00	640.00	660.00	680.00	700.00	720.00	740.00	760.00	780.00
EXISTING GL	402.56	404.30	405.48	406.07	406.32	406.56	407.12	407.38	407.37	408.67
DESIGN GL	401.74	402.89	403.62	404.11	404.60	405.09	405.61	406.32	407.27	408.34
CUT AND FILL	-0.82	-1.41	-1.86	-1.96	-1.71	-1.47	-1.51	-1.06	-0.10	-0.34

CHAINAGE	800.00	820.00	840.00	860.00	880.00	900.00	920.00	940.00	960.00	980.00
EXISTING GL	410.08	411.66	412.62	413.37	414.41	415.23	415.55	416.27	416.02	415.84
DESIGN GL	409.41	410.43	411.18	411.70	412.19	412.68	413.18	413.67	414.17	414.66
CUT AND FILL	-0.67	-1.23	-1.44	-1.68	-2.22	-2.55	-2.37	-2.60	-1.85	-1.18

CHAINAGE	1000.00	1020.00	1040.00	1060.00	1080.00	1100.00	1120.00
EXISTING GL	415.84	415.89	416.30	416.73	417.16	417.59	418.44
DESIGN GL	415.16	415.66	416.16	416.66	417.14	417.58	417.99
CUT AND FILL	-0.68	-0.23	-0.14	-0.07	-0.03	-0.01	-0.45

10.0 0 20.0 40.0 60.0 80.0 100.0 1:1000
metres

SKETCH
NOT FOR CONSTRUCTION

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Client Logo

Client Ref -

Rev	Date	Amendment	By	Chk	App
A	5/09/16	FOR INFORMATION	PH	CD	

Project Title
THE PROPRIETORS OF HAUHUNGAROA No.6 TRUST WHAREROA NORTH

Drawing Title
ACCESS ROAD OPTION 'D' LONGSECTION

Surveyed			
Designed	P HARRIS	5/09/16	PH
Drawn	P HARRIS	5/09/16	PH
Checked	C DAWSON	5/09/16	CD
Approved			

Status **INFORMATION**

Scale A1 1:2000
A3 1:4000
A1

Drawing Number IBA1070-SK08
Rev A

AutoCAD
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Appendix 2

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The Proprietors of Hauhungaroa No.6 Trust

Whareroa North - Access Options
Whareroa North, Whareroa

Contract IBA1070

Schedule of Prices - Option "C"

Notes:

1. Descriptions of Items are all inclusive. Work not separately scheduled shall be included in appropriate scheduled items.
2. Items shown with Provisional Quantities will be remeasured and payment certified for the actual quantity of work performed.

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
1.0	**PRELIMINARY AND GENERAL**				
1.1	Establish to site	1	LS	$50,000.00	$50,000.00
1.2	Insurances	1	LS	$2,000.00	$2,000.00
1.3	Contractor to ensure all staff have appropriate general and site specific health and safety inductions and access clearances	1	LS	$5,000.00	$5,000.00
1.4	Contractor to establish and maintain Traffic Management for the duration of the Contract Works	1	LS	$2,000.00	$2,000.00
1.5	Contractor to maintain Health & Safety Register and Hazards Board	1	LS	$10,000.00	$10,000.00
1.6	Survey setout	1	LS	$20,000.00	$20,000.00
1.7	Erosion & Sediment Control	1	LS	$15,000.00	$15,000.00
1.8	Asbuilts	1	LS	$5,000.00	$5,000.00
	ITEM 1: SUBTOTAL				**$109,000.00**

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
2.0	**EARTHWORKS**				
2.1	Clearing	1	LS	$10,000.00	$10,000.00
2.2	Strip and stockpile topsoil - 200mm depth	42,000	m^3	$5.00	$210,000.00
2.3	Cut to fill - compaction 95% MDD 0.6 Compaction Ratio Assumed	81,000	m^3	$5.00	$405,000.00
2.4	Respread topsoil to berms, reserves and lots	31,000	m^2	$2.50	$77,500.00
2.5	Grass seeding	31,000	m^2	$0.75	$23,250.00
	ITEM 2: SUBTOTAL				**$725,750.00**

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
3.0	**ROADING**				
3.1	Saw cut existing road	1	LS	$500.00	$500.00
3.2	Subgrade road - undercut to a depth of 450mm, replace and recompact	12,000	m²	$6.00	$72,000.00
3.3	Trim and roll subgrade - Road	12,000	m²	$3.50	$42,000.00
3.4	Kerb and Channel (KC)	4,050	m	$35.00	$141,750.00
3.5	Basecourse road - 150mm NZTA M4	1,822	m³	$75.00	$136,650.00
3.6	2 Coat chip seal grade 3/5	12,000	m²	$25.00	$300,000.00
	ITEM 3: SUBTOTAL				**$692,900.00**

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
4.0	**CIVIL WORKS**				
4.1	Common service trench	2,000	m	$15.00	$30,000.00
4.2	Stormwater	1	LS	$25,000.00	$25,000.00
4.3	Bridge, including abuttments	1	LS	$650,000.00	$650,000.00
	ITEM 4: SUBTOTAL				**$705,000.00**

ITEMS 1 to 4 - TOTAL:	**$2,232,650.00**

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
5.0	**CONTINGENCY**				
5.1	Contingency (not to be expended without approval of Engineer)	2,232,650	1	$0.15	$334,897.50
	ITEM 5: SUBTOTAL				**$334,897.50**

TOTAL :	**$2,232,650.00**

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Client Ref -

Rev	Date	Amendment	By	Chk	App
A	5/09/16	FOR INFORMATION	PH	CD	

Project Title

THE PROPRIETORS OF HAUHUNGAROA No.6 TRUST WHAREROA NORTH

Drawing Title

ACCESS ROAD OPTION 'C' PROFILE VIEW 9m FORMATION 12.5% MAXIMUM GRADE. SHT 1/2

Surveyed			
Designed	P HARRIS	5/09/16	PH
Drawn	P HARRIS	5/09/16	PH
Checked	C DAWSON	5/09/16	CD
Approved			

Status **INFORMATION**

Scale A1 1:1500 | A1

A3 1:3000

Drawing Number IBA1070-SK09 | Rev A

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Client Logo

Client Ref -

Rev	Date	Amendment	By	Chk	App
A	5/09/16	FOR INFORMATION	PH	CD	

Project Title

THE PROPRIETORS OF HAUHUNGAROA No.6 TRUST
WHAREROA NORTH

Drawing Title

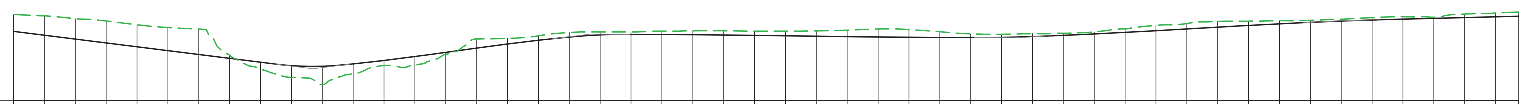
ACCESS ROAD OPTION 'C'
PROFILE VIEW 9m FORMATION
12.5% MAXIMUM GRADE. SHT 2/2

Surveyed			
Designed	P HARRIS	5/09/16	PH
Drawn	P HARRIS	5/09/16	PH
Checked	C DAWSON	5/09/16	CD
Approved			

Status **INFORMATION**

Scale A1 1:1500 | A1
A3 1:3000

Drawing Number IBA1070-SK10 | Rev A



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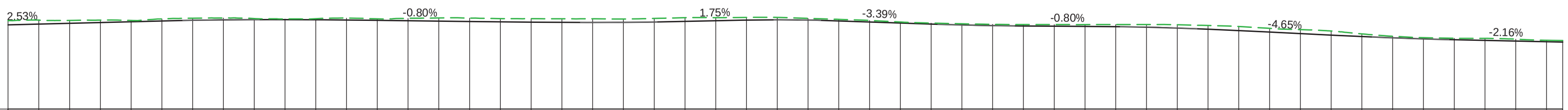
620.00	414.94	402.38	−12.57
640.00	413.08	399.88	−13.20
660.00	411.64	397.38	−14.27
680.00	409.12	394.88	−14.25
700.00	407.37	392.38	−15.00
720.00	406.41	389.88	−16.53
740.00	389.46	387.38	−2.08
760.00	380.88	384.88	3.99
780.00	375.00	382.68	7.68
800.00	370.50	382.29	11.79
820.00	377.43	383.89	6.46
840.00	382.73	386.39	3.66
860.00	382.97	388.89	5.92
880.00	390.07	391.39	1.32
900.00	400.00	393.89	−6.11
920.00	400.33	396.39	−3.94
940.00	401.96	398.89	−3.07
960.00	404.13	401.22	−2.91
980.00	404.50	402.60	−1.90
1000.00	404.50	402.90	−1.60
1020.00	405.01	402.73	−2.28
1040.00	405.26	402.55	−2.71
1060.00	405.30	402.38	−2.92
1080.00	405.00	402.20	−2.80
1100.00	405.00	402.03	−2.97
1120.00	405.20	401.85	−3.35
1140.00	405.66	401.67	−3.99
1160.00	406.43	401.50	−4.93
1180.00	406.00	401.32	−4.68
1200.00	404.67	401.15	−3.52
1220.00	403.26	400.97	−2.29
1240.00	402.99	400.99	−2.00
1260.00	403.38	401.49	−1.90
1280.00	403.64	402.43	−1.21
1300.00	404.54	403.47	−1.07
1320.00	406.48	404.50	−1.97
1340.00	408.78	405.54	−3.24
1360.00	409.99	406.57	−3.42
1380.00	411.30	407.61	−3.69
1400.00	411.50	408.65	−2.85
1420.00	411.82	409.68	−2.14
1440.00	412.01	410.71	−1.30
1460.00	412.75	411.59	−1.17
1480.00	413.83	412.25	−1.58
1500.00	414.37	412.76	−1.60
1520.00	414.05	413.27	−0.78
1540.00	416.11	413.78	−2.33
1560.00	416.76	414.28	−2.48
1575.00	417.38	414.66	−2.72



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1580.00	417.53	414.79	−2.74
1600.00	417.86	415.29	−2.56
1620.00	417.66	415.80	−1.86
1640.00	417.87	416.31	−1.57
1660.00	417.68	416.81	−0.87
1680.00	418.67	417.32	−1.35
1700.00	419.12	417.81	−1.31
1720.00	419.27	418.10	−1.18
1740.00	418.88	418.12	−0.77
1760.00	418.60	417.96	−0.65
1780.00	418.80	417.80	−1.01
1800.00	419.22	417.64	−1.58
1820.00	418.70	417.48	−1.22
1840.00	419.06	417.32	−1.74
1860.00	419.28	417.16	−2.12
1880.00	419.20	417.00	−2.20
1900.00	418.84	416.84	−2.00
1920.00	418.82	416.68	−2.14
1940.00	418.75	416.52	−2.23
1960.00	418.73	416.38	−2.36
1980.00	418.59	416.40	−2.19
2000.00	418.98	416.63	−2.36
2020.00	419.45	416.98	−2.48
2040.00	419.51	417.33	−2.19
2060.00	419.64	417.68	−1.97
2080.00	419.64	418.02	−1.61
2100.00	419.00	417.96	−1.04
2120.00	418.37	417.34	−1.03
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2380.00	413.73	410.94	−2.79
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2420.00	411.68	409.08	−2.59
2440.00	410.78	408.15	−2.62
2460.00	408.89	407.23	−1.67
2480.00	407.38	406.34	−1.04
2500.00	406.45	405.64	−0.81
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2540.00	406.00	404.71	−1.29
2560.00	405.48	404.28	−1.20
2580.00	404.78	403.85	−0.93
2590.56	404.62	403.62	−1.00

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Client Logo

Client Ref -

Rev	Date	Amendment	By	Chk	App
A	5/09/16	FOR INFORMATION	PH	CD	

Project Title
THE PROPRIETORS OF
HAUHUNGAROA No.6 TRUST
WHAREROA NORTH

Drawing Title
ACCESS ROAD OPTION 'C'
LONGSECTION

Surveyed			
Designed	P HARRIS	5/09/16	PH
Drawn	P HARRIS	5/09/16	PH
Checked	C DAWSON	5/09/16	CD
Approved			

Status **INFORMATION**

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A3 1:3500

Drawing Number IBA1070-SK11 | Rev A

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Appendix 3

The Proprietors of Hauhungaroa No.6 Trust

Whareroa North - Access Options
Whareroa North, Whareroa

Contract IBA1070

Schedule of Prices - Option "D 2"

Notes:

1. Descriptions of Items are all inclusive. Work not separately scheduled shall be included in appropriate scheduled items.
2. Items shown with Provisional Quantities will be remeasured and payment certified for the actual quantity of work performed.

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
1.0	**PRELIMINARY AND GENERAL**				
1.1	Establish to site	1	LS	$50,000.00	$50,000.00
1.2	Insurances	1	LS	$2,000.00	$2,000.00
1.3	Contractor to ensure all staff have appropriate general and site specific health and safety inductions and access clearances	1	LS	$5,000.00	$5,000.00
1.4	Contractor to establish and maintain Traffic Management for the duration of the Contract Works	1	LS	$2,000.00	$2,000.00
1.5	Contractor to maintain Health & Safety Register and Hazards Board	1	LS	$500.00	$500.00
1.6	Survey setout	1	LS	$10,000.00	$10,000.00
1.7	Erosion & Sediment Control	1	LS	$15,000.00	$15,000.00
1.8	Asbuilts	1	LS	$5,000.00	$5,000.00
	ITEM 1: SUBTOTAL				**$84,500.00**

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
2.0	**EARTHWORKS**				
2.1	Clearing scrub etc up to 200mm Ø trees	1	LS	$20,000.00	$20,000.00
2.2	Clearing trees over 200mm Ø trees if required	1	LS	$20,000.00	$20,000.00
2.3	Strip and stockpile topsoil - 200mm depth, including screening	12,500	m^3	$5.00	$62,500.00
2.4	Cut to fill - compaction 95% MDD 0.6 Compaction Ratio Assumed	38,900	m^3	$5.00	$194,500.00
2.5	Respread topsoil to berms, reserves and lots	8,500	m^2	$2.50	$21,250.00
2.6	Grass seeding	8,500	m^2	$0.75	$6,375.00
	ITEM 2: SUBTOTAL				**$324,625.00**

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
3.0	**ROADING**				
3.1	Saw cut existing road	1	LS	$500.00	$500.00
3.2	Subgrade road - undercut to a depth of 450mm, replace and recompact	3,240	m²	$2.50	$8,100.00
3.3	Trim and roll subgrade - Road	3,240	m²		$0.00
3.4	Kerb and Channel (KC)	800	m	$35.00	$28,000.00
3.5	Basecourse road - 150mm NZTA M4	550	m³	$75.00	$41,250.00
3.6	2 Coat chip seal grade 3/5	3,240	m²	$25.00	$81,000.00
3.7	Footpath (concrete) - all works including subgrade preparation and formwork	1,100	m²	$25.00	$27,500.00
	ITEM 3: SUBTOTAL				**$186,350.00**

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
4.0	**CIVIL WORKS**				
4.1	Common services trench	550	m	$15.00	$8,250.00
4.2	Stormwater	1	LS	$25,000.00	$25,000.00
4.3	Bridge, including abuttments	1	LS	$650,000.00	$650,000.00
	ITEM 4: SUBTOTAL				**$683,250.00**

ITEMS 1 to 4 - TOTAL:	**$1,278,725.00**

ITEM	DESCRIPTION	QTY	UNIT	RATE	VALUE excl GST
5.0	**CONTINGENCY**		1		
5.1	Contingency (not to be expended without approval of Engineer)	1,278,725	1	$0.15	$191,808.75
	ITEM 5: SUBTOTAL				**$191,808.75**

TOTAL :	**$1,278,725.00**

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Rev	Date	Amendment	By	Chk	App
A	5/09/16	FOR INFORMATION	PH	CD	

Project Title

THE PROPRIETORS OF HAUHUNGAROA No.6 TRUST
WHAREROA NORTH

Drawing Title

ACCESS ROAD OPTION 'D/2'
PROFILE VIEW 9m FORMATION
12.5% MAXIMUM GRADE

Surveyed			
Designed	P HARRIS	5/09/16	PH
Drawn	P HARRIS	5/09/16	PH
Checked	C DAWSON	5/09/16	CD
Approved			

Status **INFORMATION**

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A3 1:2500

Drawing Number IBA1070-SK12 | Rev A

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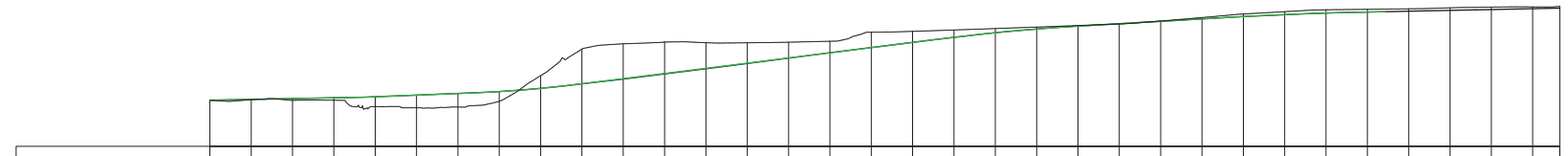

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DESIGN GL	362.29	362.69	363.09	363.49	363.99	364.79	365.59	366.50	368.04	370.25	372.74	375.24	377.73	380.23	382.72	385.22	387.71	390.20	392.69	394.91	396.72	398.13	399.28	400.42	401.57	402.71	403.68	404.42	404.92					
CUT AND FILL	0.00	0.12	0.84	1.18	4.77	6.17	6.58	4.76	-6.09	-16.76	-16.82	-15.19	-12.36	-9.83	-7.62	-5.58	-7.45	-5.38	-3.55	-2.03	-0.92	-0.27	0.12	-0.15	-0.66	-1.26	-1.40	-1.58	-1.31					
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	280.00	300.00	320.00	340.00	360.00	380.00	400.00	420.00	440.00	460.00	480.00	500.00	520.00	540.00	560.00	580.00	600.00	620.00	640.00	653.10

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metres

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Rev	Date	Amendment	By	Chk	App
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Project Title

THE PROPRIETORS OF HAUHUNGAROA No.6 TRUST WHAREROA NORTH

Drawing Title

ACCESS ROAD OPTION 'D/2' LONGSECTION

Surveyed			
Designed	P HARRIS	5/09/16	PH
Drawn	P HARRIS	5/09/16	PH
Checked	C DAWSON	5/09/16	CD
Approved			

Status **INFORMATION**

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A3 1:2500

Drawing Number IBA1070-SK13 | Rev A

APPENDIX E

SH32/Kuratau Hydro Road intersection report: Nov 2017

13 November 2017

Dave Forsyth
Cheal Consultants Ltd
4 Horomatangi Street
Taupo 3330

Gray Matter Ltd
2 Alfred Street,
PO Box 14178
Hamilton, 3252
Tel: 07 853 8997

112_02

Dear Dave

SH32/KURATAU HYDRO ROAD INTERSECTION ASSESSMENT

1. Background

Cheal Consultants Ltd has asked Gray Matter to provide an initial assessment of transport effects at the SH32/Kuratau Hydro Road intersection arising from a proposed plan change. The development at Whareroa Village proposes an additional 160 residential lots as part of a zone change.

Apex Consultants previously assessed development effects at the intersection in February 2007. This letter provides an update to that assessment of the intersection.

2. Existing Intersection

The intersection is located 2.2km north of the SH41 intersection with SH32. The Kuratau Hydro Road approach is stop controlled, and the intersection is located at the north end of a short section of straight road. SH32 is identified as a primary collector in the ONRC carrying 733veh/day and Kuratau Hydro Road is an access road carrying 107veh/day.

There are two vehicle crossings located on the western side of SH32 (one opposite Kuratau Hydro Road and one approximately 70m north of the intersection) and one vehicle crossing on the eastern side at the intersection.

The existing intersection appears to be well formed based on images from Google street view (February 2014) with wide shoulders either side of and opposite Kuratau Hydro Road and an existing flag light at the intersection

Figure 1: Existing Intersection Layout

Alasdair Gray 027 249 7648 alasdair.gray@graymatter.co.nz **Karen Hills** 021 923 905 karen.hills@graymatter.co.nz

Our visibility assessment is based on Google maps and street view and we have not visited the site. There may have been recent changes on site which could affect visibility.

Visibility to the north (looking right from the intersection) may be obscured by a horizontal curve to the north. Austroads Guide to Road Design Part 4A: Signalised and Unsignalised Intersections, Table 3.2 recommends that SISD of 285m is provided to the intersection (based on a 110km/h design speed = posted speed plus 10km/h). Visibility north of the intersection appears to be restricted by the horizontal curve, and appears to be around 180m. An intersection warning sign (PW-11) is located approximately 160m north of the intersection. Visibility looking right from the intersection could be improved with vegetation removal on the inside of the curve. It would be desirable to confirm the location of the property boundary and fence prior to removing vegetation within the road corridor to maximise the sight distance.

Visibility south of the intersection appears to be sufficient, with 285m available to the curve south of the intersection.

Figure 2: Visibility north of Kuratau Hydro Road limited by horizontal curve

Figure 3: Visibility south of Kuratau Hydro Road

3. Safety

We have completed a search using NZ Transport Agency's CAS system for the 10-year period 2007 to 2016. There have been no recorded crashes at the intersection in this period. The deficient visibility to the north does not appear to pose a significant safety risk as traffic volumes at the intersection are relatively low. There does not appear to be an existing crash problem at the intersection.

Using NZTA EEM crash prediction models (Appendix 6.5), the modelled crash rate for a typical high speed priority T-intersection based on existing traffic volumes is less than 0.02 injury crashes per year. This is equivalent to one injury crash every 50 years.

The speed management framework identifies SH32 and Kuratau Hydro Road in the area of the intersection as low collective risk and does not identify either of these roads as high priorities for intervention.

4. Proposed Development

The village currently provides 202 residential sections which are predominantly used as holiday houses. The applicant has indicated that 8 to 9% of the existing residential homes are permanently occupied. This equates to 16 to 18 existing dwellings being permanently occupied. The proposed zone change would offer a further 160 residential sections at Whareroa, it is anticipated that there will be a similar amount of permanent residents as these sections would be holiday homes.

Based on published rates[1] for rural residential land use, we would expect the proposal to generate an additional 1,616veh/day, with a 238veh/hr peak trips. This appears very high for a holiday home development.

	Dwellings	Daily Trip Generation Rate	Daily Trips	Peak Hour Trip Generation Rate	Peak Hour Trips
Existing	202	10.1veh/day/unit	2,040veh/day	1.4veh/hr /unit	283veh/hr
Proposed	160	10.1veh/day/unit	1,616veh/day	1.4veh/hr /unit	224veh/hr
Total	**362**		**3,656veh/day**		**507veh/hr**

Table 1: Trip generation based on published rates

Apex Consultants' report stated that traffic counts from the village in 2005 were 108veh/day. This appears consistent with current traffic count data[2] assuming there has been no additional development in the village since 2005. The report also stated that the peak hour traffic volumes approaching the intersection along Kuratau Hydro Road were 19veh/hour. The report indicated that the additional residential lots would double the peak hour traffic volume to and from the village to 38veh/hour. The peak hour traffic volume on SH32 is expected to be approximately 70veh/hour (assuming 10% of ADT).

Once fully developed Whareroa Village is expected to generate 38veh/hour during peak hours at the intersection. Assuming the trip distribution entering and exiting Kuratau Hydro Road is 50/50 for left and right turns we expect 19veh/hour to turn right towards Whareroa village. Plotting this against Figure A10 in Austroads Guide to Road Design Part 4 shows that a right-turn bay is not warranted until traffic volumes on both SH32 and Kuratau Hydro Road double.

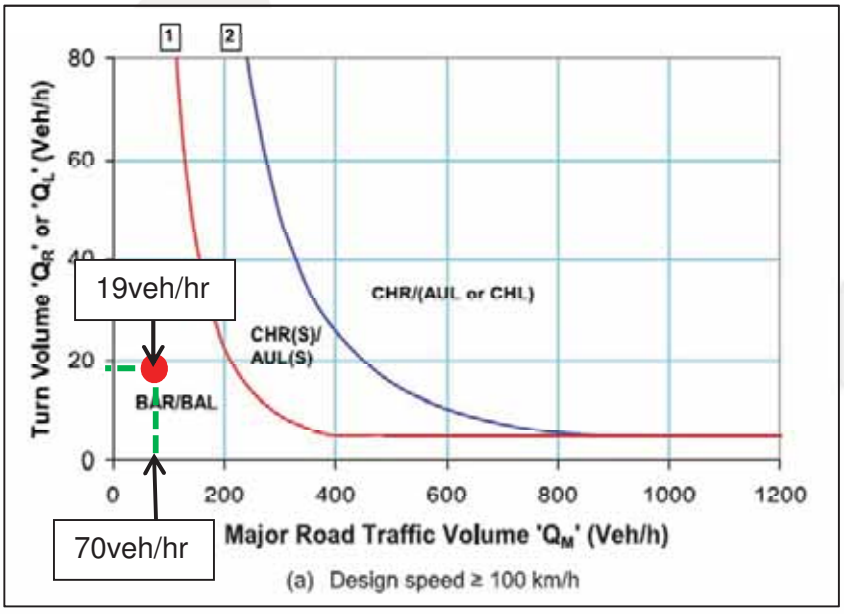


Figure 4: Austroads Figure A10: Turn Warrants

[1] NZTA Research Report 453, Appendix C, Table 7.4.
[2] Existing volume = 107veh/day (2016 estimate, mobileroad.org)

As the proposed development is likely to be similar to the existing village in that there a very few permanent residents, the lower traffic volumes in Apex Consultants' report appear to be a reasonable expectation of traffic generated from the proposed development.

5. Conclusion and Recommendations

Traffic volumes in Apex Consultants' 2007 report appear reasonable based on the assumption that traffic generated by the development will be similar in nature to the existing village where there are few permanently occupied dwellings, most being used as holiday homes.

The speed management framework does not identify either of these roads as high priorities for intervention. There does not appear to be a crash problem at the intersection.

The existing intersection has widened shoulders on both sides and opposite Kuratau Hydro Road. Visibility to the north appears to be restricted by a horizontal curve around 160m north of the intersection. Available visibility to the north (looking right from Kuratau Hydro Road) vehicles appears to be approximately 180m, below the recommended visibility of 285m. We recommend that vegetation within the road corridor is removed to maximise the available sight distance.

Widening to form a right-turn bay would be warranted if the existing volume on both SH32 and Kuratau Hydro Road doubled, and is not considered necessary for the proposed increase in traffic (an additional 19veh/hour).

Please do not hesitate to contact us if you have any queries.

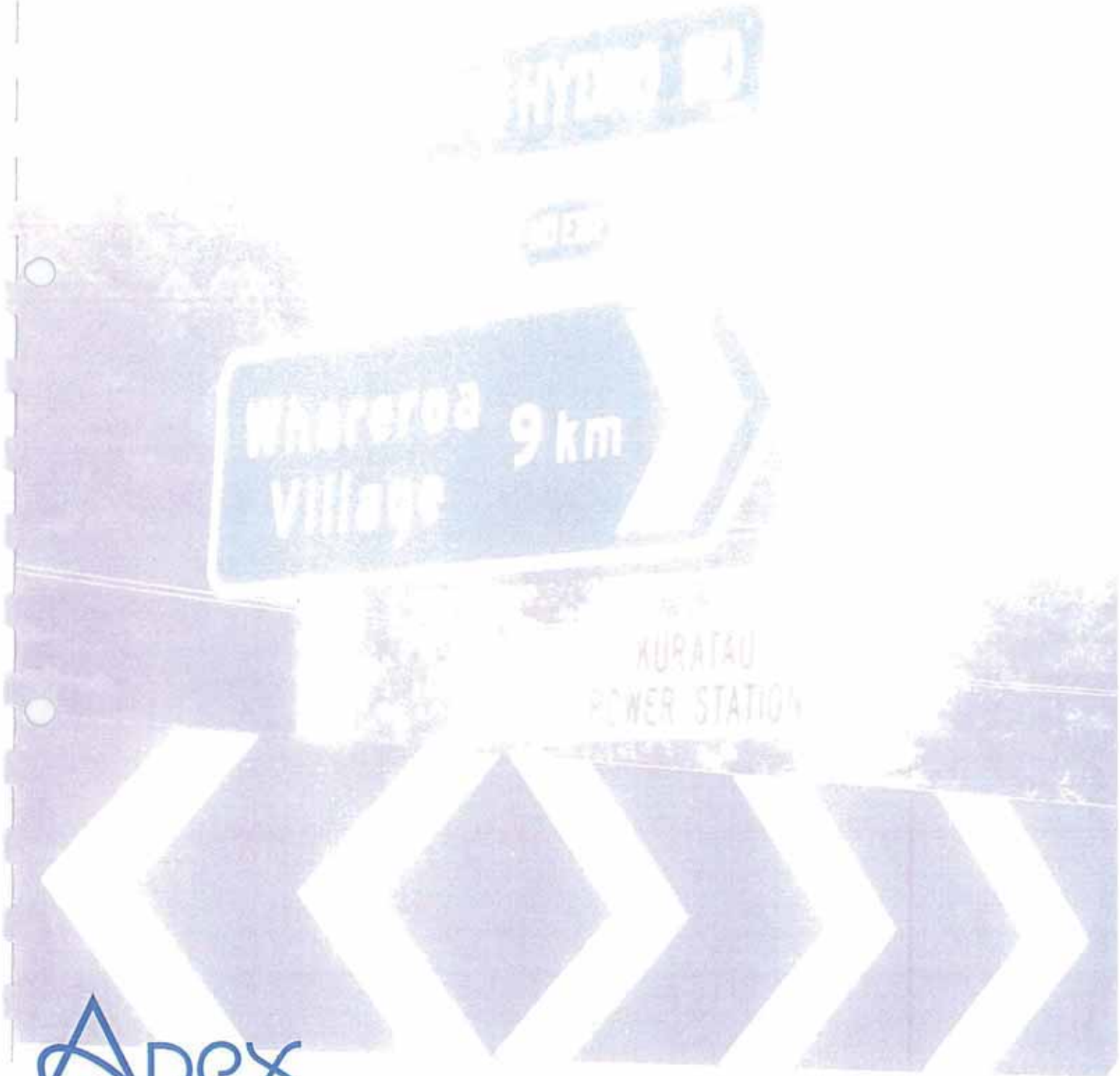
Yours sincerely

Darryl Woodhouse
Engineering Technician

pp
Isa Ravenscroft
Civil/Transportation Engineer

STATE HIGHWAY 32

KURATAU HYDRO ROAD INTERSECTION



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February 2007
BLA 1008

Document Author:	Norm Jacobs	
Document Peer Reviewed by:	Alex Ross	28/2/2007 Date

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1.2 WHAREROA VILLAGE 2

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6.0 RECOMMENDATION 7

APPENDICES

Appendix 1 Photos
- Photo 1 - SH32 South Approach to Kuratau Hydro Road
- Photo 2 – Intersection Signage
- Photo 3 – From Kuratau Hydro Road, looking south along SH32
- Photo 4 – Looking north along centreline of SH32 from intersection
- Photo 5 – SH32 North approach to Kuratau Hydro Road

Appendix 2 Three pages from Austroads "Guide to Traffic Engineering Practice, Part 5: Intersections at Grade"
- Figure 5.23a Warrants for Rural Right Turn Bays
- Figure 5.23b Treatments for Rural Turn Lanes
- Figure 5.22 Design Volumes
- Figures 5.21 Typical Right Turn Lanes – Rural Areas

Appendix 3 Traffic Counts
- State Highway Traffic Volumes 2001-2005 (5 sheets)
- Kuratau Hydro Road (7 sheets)

EXECUTIVE SUMMARY

This report has been requested by Ian Blance, Surveyor Taumarunui on behalf of the developers of the Whareroa sub-division.

The observations and photos of the site are as a result of a site visit on Tuesday 23 January 2007. Traffic Count data has been obtained form the Local Authority and from the Transit New Zealand (TNZ) website. Design information has been obtained by reference to the TNZ publication "Draft State Highway Geometric Design Manual" and the Austroads publication "Intersections at Grade".

The report assesses the impact of right turning vehicle movements off the state highway on both existing traffic volumes and those predicted in the next 25 years and recommends that the existing layout is appropriate for the foreseeable future.

1.0 INTRODUCTION

1.1 INTERSECTION

Kuratau Hydro Road intersects with SH32 approximately 2km north of the SH32/SH41 intersection at Kuratau Junction. This No Exit Road leads to the Whareroa Village (and the Kuratau Power Station). The state highway at this intersection is sealed with a 3.4m wide traffic lane in each direction. The highway is marked with a centreline, solid edgelines and a continuity line across the side road.

The topography of the state highway is flat with an approximately 350m straight on the southern approach and a 170m long straight on the northern approach. The state highway carriageway opposite the intersection has been widened and sealed by 2m outside the edgeline for 66m south of the intersection and 88m to the north.

On the same side of the state highway as Kuratau Hydro Road, the approach from the north (to make a left turn) has also been widened and sealed by 2m outside the edgeline over a distance of 175m. There is an approximately 35m long taper (2m wide at the intersection) for accelerating vehicles having left turned out of the side road, continuing south along the state highway.

Approximately 75m north of the intersection on the west side of the state highway, a driveway providing access to a farmhouse and yards/sheds has recently been sealed. For the left turn into this driveway, an additional 3m of seal widening (over and above the 2m) has been provided over a distance of 12m. The width of the driveway 15m back from the state highway is 6m wide, but at the tie in point of this sealed driveway alongside the state highway, the seal width is 20m.

There is another 3m wide metalled access drive to a house 8m south of the intersection, also on the west side of the state highway.

There is a flag light on the state highway opposite the side road, along with a Kuratau Hydro Road street name sign (blue), a Kuratau Power Station sign (yellow), an ID-1 format "Whareroa Village" Intersection Direction Sign (green) and a double ended chevron sign. The Whareroa Village sign has 120mm high initial capital letters with lower case alphabet.

On both state highway approaches, approximately 170m from the intersection is a PW-11 "Side Road Controlled" permanent warning sign. The side road is Stop controlled.

1.2 WHAREROA VILLAGE

The village is 9km down the no exit Kuratau Hydro Road. The current layout provides 202 predominantly holiday settlement residential sections.

The proposed extension to this settlement is to the north of the existing settlement over the Whareroa Stream, and will provide an additional 167 lots to give a total of 369 lots in the village. Again it is envisaged this extension will provide predominantly holiday home sites, with very few permanent residents.

2.0 INTERSECTION DESIGN CRITERIA

The "Draft State Highway Geometric Design Manual", Section 8: Intersections and Interchanges, refers the designer to the Austroads Guidelines as the preferred references.

Austroads "Guide to Traffic Engineering Practice, Part 5: Intersections at Grade", Section 5.9 Auxillary Lane Warrants and Details defines warrants and the procedure for determining the need for turn treatments. This process is:

- Determine design hour volumes. Typically morning or evening peak hour volumes are used, increased to an appropriate design year using typical growth rates. Where peak hour volumes are not available it may be assumed the design hour volume equals 10 – 15 percent of Average Annual Daily Traffic (AADT) volumes.

- Using Figure 5.23a of the Guide "Warrants for Rural Right Turns" establish whether treatment is required, and if so, which type. Figure 5.22 "Design Volumes" shows which vehicle flows are considered for these warrants. The Treatment types are shown in Figure 5.23b "Treatments for Rural Turn Lanes." (These Figures are attached to this report as the Appendices).

- The geometric layouts for the treatment types are then given in Figure 5.21 being:

  Type A – Vehicle can make a right turn from within the standard lane marking but with sufficient width on a sealed shoulder to allow the straight through vehicle to pass the right turning vehicle on its left hand side. This option also caters for when the right turn vehicle moves over to the left hand side, clear of the through traffic lane until the movement can be safely undertaken.

  Type B – Carriageway is widened to create two lanes with the centre lane being pavement marked with combined straight ahead/right turn arrows.

  Type C – Carriageway is widened to create two lanes so a dedicated right turn bay complete with advance diagonal hatching to provide deceleration space can be provided.

- A further factor which may influence selection of the appropriate treatment is the horizontal and vertical alignment, as poor approach visibility may lead to a desire to shelter the right turning vehicles.

3.0 TRAFFIC VOLUME DATA

3.1 STATE HIGHWAY

Data obtained from the TNZ website "SH Traffic Volumes 2001 – 2005" gives for SH32 at the West Taupo telemetry site (at 74km on this route this would locate this site approximately 10 – 15km north of Kuratau Junction) gives a 2005 AADT of 690 vpd (vehicles per day).

The same site AADT totals from 2001 – 2004 were 670, 750, 690 and 700 respectively.

Allowing for a 3% growth over the next 25 years the traffic volume along this road would be in the order of 1,450 vpd.

On the assumption that the traffic flow is evenly divided in each direction these figures equate to 345 vpd rising to 725 vpd in each direction.

The warrant guidelines chart suggests peak hour volumes when not measured should equate to 10 – 15% of the AADT. This suggests a current peak hourly rate of 35 – 52 in each direction on this road, rising in 25 years to 73 – 109 vehicles/hour in each direction.

3.2 KURATAU HYDRO ROAD

Traffic count data, provided by the Local Authority was undertaken approximately 100m east of the state highway over a six day period from Tuesday October 25 – Sunday October 30, 2005.

The 24 hour counts varied, ranging from 65 (Wednesday) to 108 (Tuesday) vehicles per day with an average of 89.

The peak hourly count varied, ranging from 9 (Wednesday, 8 – 9am and 2 – 3pm) to 19 (Sunday, 1 – 2pm).

On the assumption the extended development on the north side of Whareroa village will increase the total lot numbers from 202 by 167 to 369, the peak hourly count could increase by double to 38. Again allowing for an even distribution of traffic direction on this road, this equates to approximately 19 vehicles/hour at the peak entering the local road from the state highway. A 3% growth rate over 25 years of the existing daily count (108) would increase this daily count figure to 226 vpd, of which 10% is 24 vehicles and 15% is 34 vehicles. With an even distribution of flow, this would equate to 12 - 17 vehicles/hour in each direction. As a comparison, increasing the existing peak hour count of 19 with a 3% growth factor over 25 years, results in a figure of 40 vehicles/hour, or 20 per hour in each direction. It seems more reasonable to use 20 vehicles in each direction rather than the 12 - 17.

4.0 SUMMARY OF TRAFFIC COUNT DATA

		STATE HIGHWAY 32			KURATAU HYDRO ROAD		
		TOTAL	Assumed 50/50 Split		TOTAL	Assumed 50/50 Split	
			North Bound	South Bound		East Bound	West Bound
1.	**EXISTING**						
	24 hour Traffic Counts	690	345	345	108	54	54
	Assumed Peak hour count						
	If 10% of daily count	69	35	35			
	If 15% of daily count	104	52	52			
	Measured Peak hour count				19	10	10
2.	**FUTURE (25 years from now)**						
	24 hour Traffic Counts 3% growth rate	1450	725	725	226	113	113
	Assumed Peak hour count						
	If 10% of daily count	145	73	73	24	12	12
	If 15% of daily count	218	109	109	34	17	17
	Local Road Peak hour. Using double existing peak figures				38	19	19
	Using 3% growth rate of existing peak				40	20	20
3.	**ADOPTED FUTURE (25 years from now counts)**						
	24 hour	1450	725	725	226	113	113
	Peak hour (10% of SH count, 3% growth of existing peak Local Road)	145	73	73	40	20	20

5.0 INTERSECTION MOVEMENT EVALUATION

When calculating warrants for right turn bays, the issue is, the number of vehicles making the right turn being able to pick a gap from the opposing direction traffic flow, and the effect the vehicle slowing to make the right turn has on straight through vehicles traveling in the same direction.

Using the existing assumed peak hour figure of 35 vehicles in one direction on the state highway and the corresponding 10 vehicles east bound on the local road, Figure 5.23a requires a Type A right turn treatment. Even this assessment is on the high side as some of the vehicles on the local road departing from the intersection will have made a left turn so should be excluded from this assessment.

Using the adopted peak hour figures for 25 years from now with the peak hourly flow in each direction on the state highway of 73 vehicles and the corresponding 20 vehicles east bound on the local road, Figure 5.23a still shows a Type A right turn treatment is satisfactory. Again the side road assessment is on the high side as some of these vehicles will have left turned and should be excluded from the calculation. For a Type B right turn bay to apply, if the local road peak hour was 20 in each direction, the state highway volume in each direction would need to be 125, and if the state highway peak volume in each direction was 73, the local road number would need to be 40 in each direction.

6.0 RECOMMENDATION

Based on an assumed peak current 35 vehicles/hour flow in each direction on the state highway and a measured peak flow of 10 vehicles/hour on the local road, a Type A Right Turn intersection treatment is appropriate.

25 years from now, the assumed peak hourly flow in each direction on the state highway is 73 vehicles/hour (at a 3% growth rate) and by doubling the existing peak hourly flow in each direction on the local road, the peak is 20 vehicles/hour. A Type A Right Turn intersection treatment is still appropriate for that vehicle flow. A Type A Right Turn intersection treatment is additional width provided by the means of a sealed shoulder, and at this location, this is provided by a 2.0m sealed shoulder outside the 3.4m traffic lane. It is therefore considered that the existing intersection layout is appropriate for the foreseeable future.

Although not a requirement of this report, the Whareroa Village Information Destination sign at the intersection has 120mm high initial capital letters with lower case alphabet. The "Manual of Traffic Signs and Markings" (MOTSAM) Part 1: Traffic Signs, Section 7.1.4(g) "Letter Size" requires a minimum upper case height for two lane rural roads of 160mm, with a corresponding 120mm lower case height. The centre of this sign is approximately 8m-10m from the centre of the traveling lane and its conspicuity would be enhanced if the lettering size was increased to 160mm upper case initial letters

Appendix I

Photos

PHOTO 1 – SH32 SOUTH APPROACH TO KURATAU HYDRO ROAD
NOTE: INTERSECTION SIGNS

PHOTO 2 – INTERSECTION SIGNAGE

View looking left (towards Taumarunui) from Kuratau Hydro Rd

PHOTO 3 – FROM KURATAU HYDRO ROAD, LOOKING SOUTH ALONG SH32
NOTE: PW-11 : SIDE ROAD CONTROLLED" SIGN AT 170M

View of Northern approach from C/L at Kuratau-Hydro Rd Intersection

PHOTO 4 – LOOKING NORTH ALONG CENTRELINE OF SH32 FROM INTERSECTION
NOTE: PW-11 "SIDE ROAD CONTROLLED" SIGN BESIDE VEHICLE

PHOTO 5 – SH32 NORTH APPROACH TO KURATAU HYDRO ROAD
NOTE: PW-11 SIGN IS 170M FROM INTERSECTION

Appendix II

Three pages from Austroads "Guide to Traffic Engineering Practice, Part 5: Intersections at Grade"

the separate U-turn movement in such locations needs to be weighed against:

- the cost of constructing a separate U-turn lane
- or the consequences of the U-turn to be made at the end of the turn lane with the right turn movement.

5.8.3 Rural Right Turn Lanes

Figure 5.21 illustrates the design features of three levels of treatment to allow for right turning traffic at rural intersections. The volume warrants to aid in the selection of the appropriate treatment for a particular site are set out in Section 5.9. A further factor which may influence selection of the appropriate treatment is the horizontal and vertical alignment of the through road. Where the intersection is located on or near a crest or a horizontal curve it may be desirable to shelter right turning vehicles thus requiring a Type C treatment where the volume warrants may specify a lesser treatment.

Provision of storage length on a Type C treatment is generally not required in rural areas unless the turning and opposing through volumes are known to be high.

On divided rural roads right-turn lanes should be provided at median openings to minimise the disruption to high speed through traffic. Typically right-turn lanes should be of a similar design to Type C treatment shown in Figure 5.21.

5.9 Auxiliary Lane Warrants and Details

5.9.1 Introduction

An auxiliary lane is that portion of the roadway adjoining the travelled way for parking, speed change, turning,

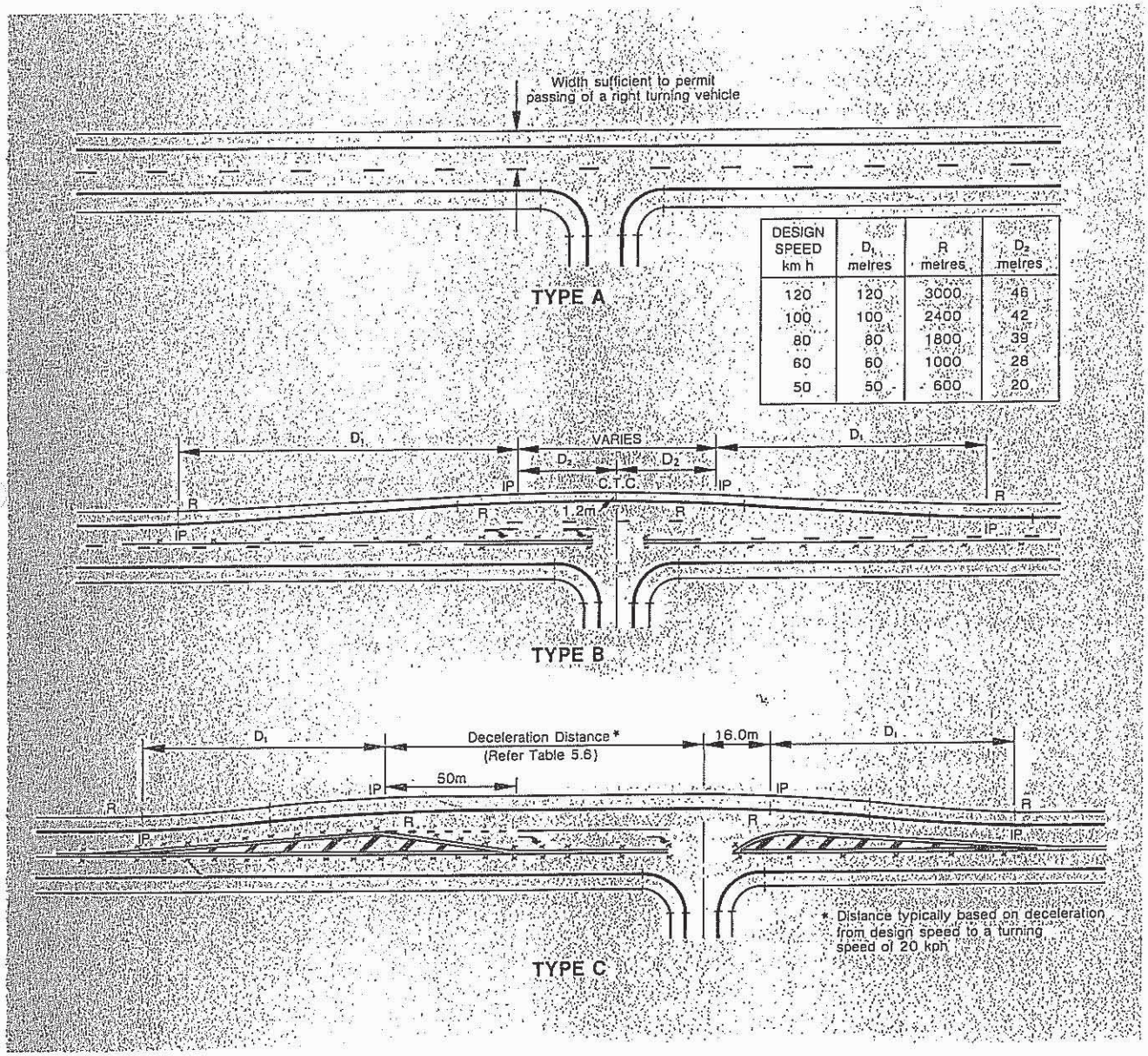


FIGURE 5.21 Typical Right-Turn Lanes - Rural Areas

storage for turning, weaving, truck climbing, or other purposes supplementary to through traffic movement.

This text discusses only those auxiliary lanes related to intersection design, ie deceleration, acceleration and additional through lanes.

5.9.2 Auxiliary Turn Lanes

(a) Auxiliary Turn Lane Warrants

In urban areas the provision of auxiliary turn lanes should be considered at all signalised intersections and at other intersections where turning volumes are high or where turning traffic would cause significant interruption to through traffic. Provision of turn lanes on the grounds of safety should also be considered, particularly where sight distance is limited.

In rural areas left and right turn lanes should be provided at all intersections on divided roads for safety reasons. Where turning volumes are low, the turn lane may often take the form of a sealed shoulder. While turn lanes are also desirable at all intersections on undivided rural roads, economic factors may preclude this and the warrants set out in this section can be used as a guide to the appropriate treatment.

The warrants shown in Figure 5.23(a) are based on assessment of the probabilities of turning vehicles obstructing through vehicles and or right turning vehicles not finding acceptable gaps in the opposing traffic stream, together with a subjective assessment of the operations of existing turn lane treatments. The warrants are recommended as a treatments at rural intersections. However, it is recognised that economic and site considerations may also influence the treatment to be selected.

Procedure for determining the need for left turn and right turn treatments at rural intersections is:

1. Determine design hour volumes - Typically these are based on morning or evening peak hour volumes (or weekend peak hour volumes on recreational routes) increased to an appropriate design year using typical growth rates. Where peak hour volumes are not available, it may be assumed that the design hour volume equals 10 to 15 percent of AADT.
2. Determine the design volumes shown in Figure 5.22
3. Left Turn Treatment - On Figure 5.23a determine the location of the point with the co-ordinates Q_L and Q_{T+L}. If the point lies within the B or C region, then a Type B left turn lane treatment as shown diagrammatically on Figure 5.23b is appropriate. Otherwise the minimum (Type A) treatment is provided. The geometric layout for Type A left turn treatments in rural areas is given in Figure 5.16 and for Type B treatments in Figure 5.17(b).
4. Right Turn Treatment - On Figure 5.23a determine the location of the point with the co-ordinates Q_R and Q_{T+R}. Depending on which region A, B or C the point lies within, the corresponding treatment shown diagrammatically in Figure 5.23b and would be selected. The geometric layouts for right turn lanes on rural undivided roads is given in Figure 5.21.
5. The basic rural area right turn lane length shown in Figure 5.21, Type C could be extended by increments of 6 m for each vehicle expected to queue (See Section 3.5.3). However, provision for vehicle storage is rarely required in rural areas.

(b) Lengths of Auxiliary Turn Lanes

Auxiliary turn lanes are provided to allow vehicles to decelerate in advance of an intersection or to accelerate beyond it. The lengths required for these manoeuvres are discussed below.

(1) Deceleration Lanes

Turn lanes are provided to separate left or right turning traffic from the through traffic stream to minimise disruption to traffic flow. The length of these lanes in rural areas is generally based on deceleration considerations. However, in urban areas where traffic speeds are significantly lower and right of way more restrictive, the length may be dictated more by vehicle storage requirements, particularly at traffic signal controlled intersections. At locations where a full length deceleration lane cannot be provided, a minimal treatment (eg 30 m taper plus 30 m parallel lane) can still provide significant benefits.

The total length required for deceleration lanes is given in Table 5.6. This length is provided by means of a taper and a parallel lane. The length of taper adopted is typically 50 m rural, 30 m urban, or less as discussed in (c) below.

The length of deceleration lane on grade is determined by multiplying the length from Table 5.6 by the ratio in Table 5.7.

(2) Acceleration Lanes

To provide a high volume free-flowing left-turn treatment or a right turn merge at a seagull type treatment, then an acceleration lane is appropriate to allow turning vehicles to accelerate to the speed of the through traffic and select a gap to merge safely.

The length of the acceleration lane is determined from Table 5.8 based on the speed of the turn and the design speed of the through road. The length of

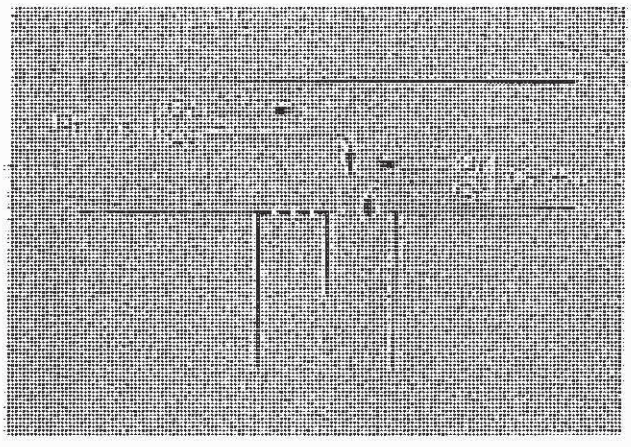
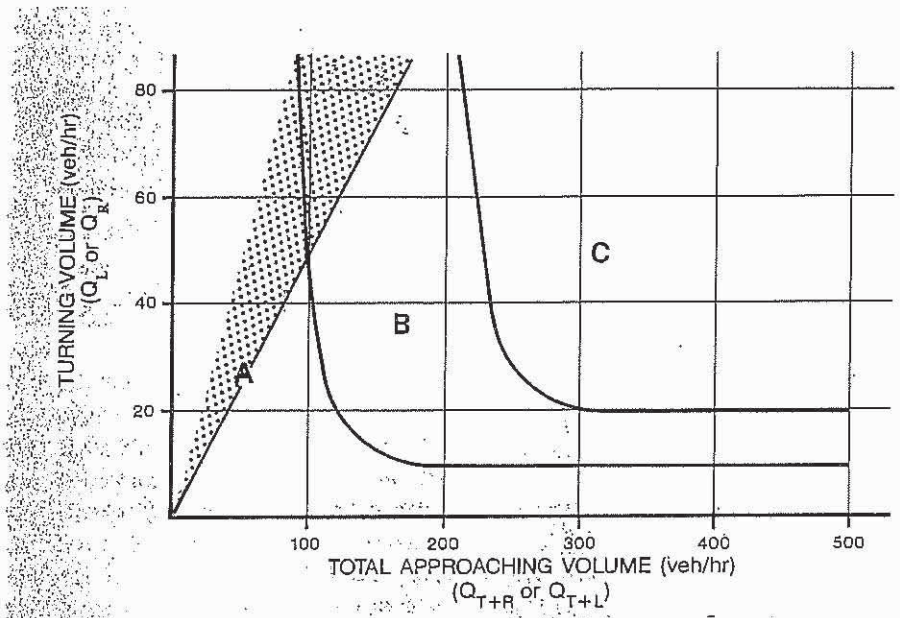


FIGURE 5.22 Design Volumes



Notes: (i) Warrants are interim only and are currently under review.

(ii) Where peak hour volumes are not available, assume the design peak hour volume equals 10% to 15% of the AADT.

In this region more than 50% of the approaching traffic turns. Hence consideration needs to be given to possible realignment of the intersection to suit the major traffic movement.

FIGURE 5.23a Warrants for Rural Turn Lanes

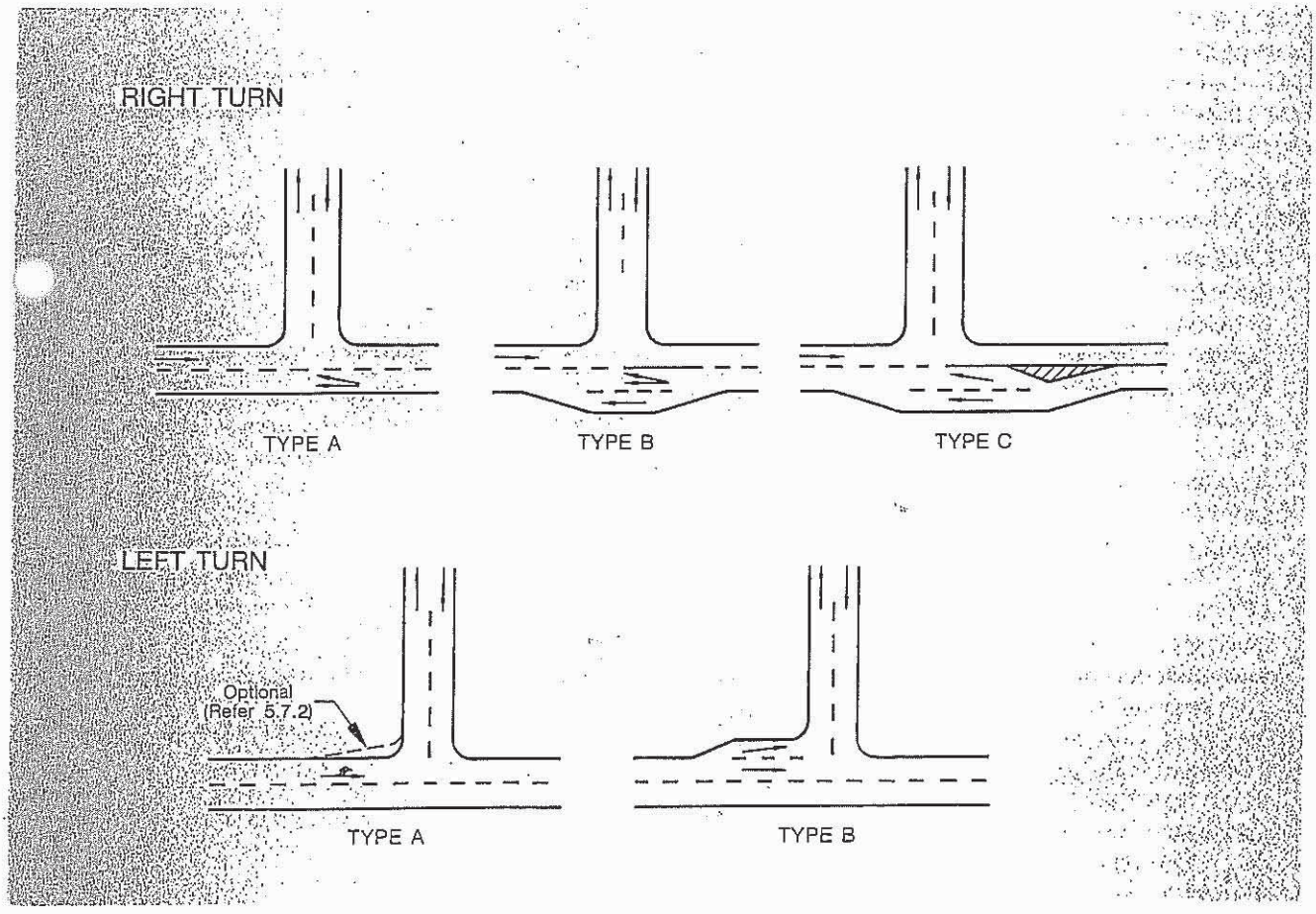


FIGURE 5.23b Treatments for Rural Turn Lanes

APPENDIX III

Traffic Counts

TRANSIT NEW ZEALAND
ARARAU AOTEAROA

State Highway Traffic Volumes 2001 to 2005

Prepared by
Traffic Design Group Ltd.
for Transit New Zealand

Preface

Traffic monitoring provides a fundamental tool for the management of the State Highway network. The measure of the traffic demand, imposed on the network, enables Transit New Zealand (Transit) to effectively and efficiently allocate resources.

The information contained in this publication is derived from Transit's traffic data collection system. This consists of a hierarchy of equipment that ranges from sophisticated weigh-in-motion and vehicle classification collection via telemetry to simple portable tube traffic counters.

The data collection, and processing, for the permanent weigh-in-motion and telemetry sites is managed by Transit's National Office in Wellington. The ATMS sites on the Auckland motorways are operated on behalf of Transit by an external contractor. The remaining sites, which represent the large majority of the sites throughout New Zealand, are not monitored continuously, and are counted several times a year as part of the Transit's regional traffic counting programmes managed by the Transit regional offices.

Transit welcomes any feedback on this publication. Note that this document is also available on the Transit website.

Disclaimer

The traffic data contained in this document is intended to be used as an approximate indication of traffic flows on state highways throughout New Zealand. The traffic volumes are typically calculated from individual counts over one week intervals. Most sites are counted one, two or three times a year, with other sites counted on a continuous basis.

The limitations of the traffic counters and their installation, conversion of axle pairs to vehicle counts (in the case of tube counts), seasonal variations, congestion effects, and various analysis procedures contribute to a level of approximation in the data. These factors should be taken into account when using the AADT data.

For detailed design and project evaluation purposes, the actual traffic counts upon which this document is based can be obtained from the appropriate Transit Region office.

Transit and its employees or agents involved in preparation and publication of this document cannot accept liability for its contents or for any consequences arising from its use. People using the contents of this document should apply, and rely upon, their own skill and judgement. The contents should not be used in isolation from other sources of advice and information.

Chris Parkman
Asset Information Manager
Network Operations
Transit New Zealand
March 2006

Notes

1. STATE HIGHWAY - State Highway 1 is suffixed N and S for the North and South Islands respectively.

2. DISTANCE - The approximate distance of the 'count site' in kilometres from the start of the highway.

3. LOCATION - The approximate descriptive location on the state highway. For more precise location details refer to the appropriate Transit region office.

4. AADT - Annual Average Daily Traffic volume, being an estimation of the daily traffic (two way total unless specified otherwise), averaged over the (calendar) year.

5. TYPE - The majority of the traffic counts provided in this publication have been undertaken at the particular count site over one or two typical weeks in the year and factored accordingly to provide a relatively robust estimate of the annual traffic volume at that location. There are other codes noted in the publication and these can be described as follows:

   ATMS - Advanced Traffic Management System, monitored continuously
   TEL - Telemetry sites (usually dual loop), monitored continuously
   WIM - Weigh-in-motion sites, monitored continuously.
   CON - Regional control site, not monitored continuously throughout the year but more frequently than other non-continuous count sites
   Etd - Estimated count provided by Transit Regional TMS Administrator in the absence of detailed count data for a particular site

6. Most of the continuous sites are able to distinguish between short and long vehicles. Accordingly the percentage of Heavy Motor Vehicles (HMV), vehicles greater than 3.5 tonnes gross, can be estimated at these sites.

   The continuous telemetry sites administered by Transit categorises vehicles into four standard vehicle length bins as follows:

0.5 to 5.5m	5.5 to 11m	11 to 17m	17 to 35m

   For convenience, the number of heavy commercial vehicles is typically calculated from the length bin counts as the total of all vehicles exceeding 11m in length plus half of the vehicles in the 5.5 to 11m vehicle length bin.

   The number in the % HMV column denotes the approximate percentage of Heavy Motor Vehicles measured at the particular count site

7. Where a State Highway spans more than one Transit region, the approximate location of the administrative boundary is shown.

8. Other traffic details such as the vehicle composition and the directional AADT are available for some sites from the Transit NZ regional offices.

9. The former SH 1F has now formed the first section of SH 1N. All reference stations on SH 1N have been adjusted accordingly.

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Transit New Zealand Traffic Volumes - 2001 to 2005 inclusive (revised April 2006)

STATE HIGHWAY	DISTANCE	LOCATION	AADT 2001	AADT 2002	AADT 2003	AADT 2004	AADT 2005	TYPE	%HMV 2005
25	123	340m past Speed Restriction Sign (Wharekaho North end)	960	1090	1140	1190	1130		
25	128	Past Racecourse Rd				1020	1060		
25	137	190m before 309 Rd	1810	2080	2100	2270	2380		
25	157	790m past Cooks Beach Rd	1360	1770	1830	2030	1920		
25	177	Swampy Stream Bridge	2040	2440	2390	2590	2510		
25	185	65m before State Highway 25A	2450	2800	3110	3140	3100		
25	188	200m past State Highway 25A	1350	1460	1550	1730	1970		
25	209	South of Harry Watt Dr	340	460	510	530	550		
25	240	Waihi, North of Gladstone Rd	1760	1920	1950	2140	2150		
25A	11	NEEVESVILLE - Telemetry Site 76 - 400m before Coromandel Forest Park Sign	3060	3010	3390	3380	3410	TEL	7
26	0	50m east of Mullane St	12720	11290	11640	11240	11860		
26	2	875m west of Lissette Rd	5390	5020	5260	5250	5350		
26	9	700m east of Platt Rd	4200	4160	4590	4520	4550		
26	22	855m west of Piako Rd (Moturnacho)	3960	4030	4560	4440	4600		
26	23	150m east of Piako Rd	6190	7870	8060	8710	8620		
26	34	100m west of SH 27 junction	5820	5430	5680	8030	5780		
26	38	250m east of No 7 Rd, Walloa	4520	4360	4470	4740	4800		
26	55	515m past Patuwhao Stream Bridge	2000	1850	2000	2060	2130		
26	67	Paeroa, LSZ Sign past Ryall Rd	4140	3890	4100	4150	4380		
26	75	Paeroa, 380m past Komata Stream Br	2790	2610	2770	2810	2870		
26	96	200m south of SH 25 Junction	6480	6770	6680	6890	6720		
27	11	KAIHERE - Telemetry Site 33	4610	4700	4800	4820	4730	TEL	18
27	45	300m north of SH 26 (Tatuanui)	4830	4830	4920	4960	4850		
27	46	300m south of SH 26 (Tatuanui)	4940	4910	5030	5170	5040		
27	65	At Airport Entrance	6990	7190	7670	7870	7360		
27	67	200m south of Wardville Rd	8290	8210	8580	8830	8780		
27	82	600m north of SH 29 Junction	3970	3800	3850	4080	4010		
27	83	320m past SH 29 Junction	3630	3830	3780	3880	3880		
28	0	163m past SH 1 (Putaruru)	2130	2120	2280	2210	2240		
28	9	245m past SH 5 (Whites Rd)	2810	2890	2990	3140	3140		
28	24	105m before SH 29	1470	1290	1470	1550	1470		
29	1	370m past Maru St (Bell Plumbing)	24350	23550	24230	25850	23550		
29	4	55m Past Exeter St	23130	22370	25160	25940	25710		
29	13	50m west of Hairini Roundabout (SBD)	12880	12510	14410	15250	14570		
29	13	50m west of Hairini Roundabout (NBD)	7140	9010	7640	7890	7400		
29	17	Tauranga, 215m past Oropi Rd	10430	10090	10070	10740	10970		
29	20	Tauranga, 535m before Passing Lane LHS (East of Cambridge Rd)	13010	12600	12110	12530	13080		
29	34	KAIMAI - Telemetry Site 12 - 100m past Boulder Bridge (Kaukumoutiti Stream)	7300	7800	8680	8930	8810	TEL	11
29	49	500m south of Matamata Rd	6530	7010	7300	7550	7400		
29	51	400m east of Waimou Bridge	3770	4210	4290	4320	4280		
29	57	450m east of McNab Rd	4010	4290	4460	4440	4430		
29	63	350m west of Rail Crossing (Hinuera Rugby Club)	4060	4290	4500	4220	4540		
29	69	200m south of Totman Rd	5080	5440	5520	5660	5780		
30	35	918m past Manaiti St (Bennydale)	600	690	690	710	710		
30	75	100m north of McLean Rd	780	810	980	880	950		
30	84	90m before State Highway 32 (Whakamaru)	1940	1930	2200	2080	2090		
30	85	235m past Pokuru Rd (Whakamaru)				1700	1910		
30	110	133m past SH 1 junction	2010	2140	2250	2090	2010		
30	141	Rotorua, South of City Dump	3020	3150	3140	3070	3000		
30	144	Froude St	10450	10670	11340	10850	10710		
30	148	TE NGAE - Telemetry Site 64 - East End of Puarenga Bridge (Total)	33620	34210	35190	35430	37140	TEL	5
30	149	TE NGAE - Telemetry Site 64 - East End of Puarenga Bridge (EBD)	16590	16940	17450	17580	18600	TEL	5
30	149	TE NGAE - Telemetry Site 64 - East End of Puarenga Bridge (WBD)	17030	17270	17740	17870	18540	TEL	5
30	157	385m before SH 33	9890	10520	11090	10800	10630		
30	160	East of SH 33 junction		4330	4120	4480	4400		
30	188	LAKE ROTOMA - Telemetry Site 22 - West of Kawarau Loop Rd	2790	2880	2950	3000	3120	TEL	9
30	205	107m before SH 34 (Military Rd)	2130	2150	2270	2380	2450		
30	218	265m before SH 2 (Awaken)	5720	5600	5580	5820	5880		
30	220	805m north of SH 2 (Te Rahu Bridge)	7530	7450	7490	7710	7720		
30	229	315m West of Keepa Rd (Whakatane)	14560	14060	14900	15260	15310		
30A	0	200m north of Pukuatua St	13200	13400	12660	13990	13870		
30A	2	420m south of Fenton St (SBD)	10810	10790	11710	11320	11220		
30A	2	400m south of Fenton St (NBD)	11230	11100	12020	11670	11580		
31	13	Otorohanga, 130m before Symes Rd	2070	2400	2150	2340	2440		
31	14	Otorohanga, 100m past Symes Rd	280	290	300	300	290		
31	22	500m west of Ngutunui Rd	660	740	650	670	650		
32	28	230m before Whakamaru Dam	1360	1240	1280	1190	1290		
32	41	55m before Poihipi Rd	1160	1160	1250	1420	1310		
32	74	WEST TAUPO - Telemetry Site 43	670	750	690	700	690	TEL	8
33	3	Te Ngae, 230m north of Okawa Bay Rd	6020	6000	6120	6350	6070		
33	30	PAENGAROA - Telemetry Site 14 - South of Maungarangi Rd	4300	4350	4360	4650	4220	TEL	11
34	0	220m south of SH 2 Intersection	1290	1230	1230	1300	1370		
34	11	195m south of SH 30 East	5810	5710	5870	6000	5860		
34	25	230m before SH 30 West	1280	1280	1150	1230	1320		
35	8	475m past Wairakia Rd (Tirohanga)	1890	1890	1960	2010	2070		
35	53	Forest Rd	540	590	610	570	550		

Transit New Zealand Traffic Volumes - 2001 to 2005 inclusive (revised April 2006)

STATE HIGHWAY	DISTANCE	LOCATION	AADT 2001	AADT 2002	AADT 2003	AADT 2004	AADT 2005	TYPE	%HMV 2005
35	69	1588 past Church Rd (Te Kaha)	790	850	860	720	780		
35	124	**Hamilton / Napier regional boundary**							
35	181	450m south of Poroporo Bridge	480	390	460	490	420		
35	237	100m south of Marotiri Culvert	740	860	850	890	890		
35	272	60m south of Dosil BM GF 82	830	1070	1110	1080	1070		
35	274	Uawa River Bridge	2130	2000	2020	2050	2100		
35	293	Tolaga Bay Mangakuri Bridge	1100	1210	1180	1290	1260		
35	314	200m north of Motel	1930	1710	1720	1670	1690		
35	319	200m south of Top of Makoroi Hill	1850	2410	2530	2410	2490		
35	321	Hamanatua Bridge	3380	4430	4650	4500	4500		
35	324	Gisborne City boundary							
35	327	South of Harris Stret	15230	16160	16320	17340	16980		
35	328	60m south of Watties overhead bridge	3710	3520	3580	3930	3890		
35	332	170m north of runway lighting towers (LHS)	2930	3190	3300	3450	3540		
36	1	1075m from SH29 (Barkes Corner)					8500		
36	12	750m South of Williams Road, Pyes Pa					2720		
36	28	275m North of Te Matai Rd					2150		
36	41	Tauranga Direct Road, 425 North of Hamurana Rd					3140		
36	48	215m North of Waiteti Road, Ngongotaha					6970		
37	0	115m past State Highway 3 (Waitomo)	1250	1420	1380	1420	1450		
38	0	165m east of SH 5 (Waiotapu)	2180	2550	2480	2450	2420		
38	35	50m south of Forestry Rd overbridge	1100	1280	1180	1240	1270		
		Hamilton / Napier regional boundary							
38	170	Mangakino Stream Bridge	340	290	320	290	300		
38	185	Chapmans Culvert	610	580	560	500	530		
38	192	Paeroa Stock Rd	1610	1650	1680	1540	1550		
39	3	100m past twin culvert bridge ERP 0/3.46	2380	2540	2700	2940	3040		
39	24	200m past Goile Rd Intersection (North)	2310	2380	2880	2790	2990		
39	34	100m before Meadway Rd Intersection	4000	4020	4810	5050	5320		
39	52	400m past Mangati Rd Intersection	2520	2490	2530	2900	2870		
39	58	200m before SH 31 Intersection	1910	1970	1990	2230	2310		
41	1	Taumaranui, near Bumands Rd	1370	980	910	920	930		
41	10	Taumaranui East, near Williamsons Rd	860	640	820	640	640		
41	23	**Wanganui / Hamilton regional boundary**							
41	29	50m east of Moerangi Rd	500	510	540	530	530		
41	49	Tokaanu, bottom of Waihi Hill	1640	1480	1600	1400	1570		
41	57	500m past SH 47 Junction	3320	3090	3000	2870	2970		
43	6	Stratford East	1680	1290	1250	1460	1480		
43	14	Toko, East of Gordon Rd	880	590	610	780	840		
43	36	Te Wora	170	150	200	180	170		
43	65	Whangamomona	160	120	160	180	200		
43	111	Ohura, South of River Rd	120	70	140	130	130		
43	117	West of Tokorima	250	130	210	210	220		
43	138	West of Te Maire Bluff	430	230	290	350	360		
43	148	West of Manaia Rd	670	360	370	500	500		
44	1	Molesworth St				13170	13040		
44	5	Breakwater Rd				6660	7190		
45	1	SH 45, Vivian St	11830	15210	14830	16050	16610		
45	1	SH 45, Powderham St	11830	13750	14400	13500	14280		
45	3	New Plymouth, Sea View Rd	12090	13120	13180	13880	13800		
45	5	New Plymouth, Spotswood	12300	12640	12710	13000	13180		
45	8	New Plymouth West, near Hurford Rd	5410	6220	6240	5150	5880		
45	19	Weld Rd	2900	3110	3030	3010	3160		
45	28	Okato Stony River Bridge	2310	2160	2020	2110	2250		
45	58	Opunake West, near Opua Rd	2100	1550	1550	1500	1560		
45	62	Opunake	2730	3150	3100	2940	3130		
45	71	Pihama, near Ouri Stream Bridge	1440	1060	1060	1110	1090		
45	101	HAWERA - Telemetry Site 71 - Ohawe Beach Rd	3710	3760	3810	3830	3830	TEL	10
46	0	90m past State Highway 1 (Rangipo)	390	470	490	470	430		
47	0	National Park East of SH 4	1830	2190	1980	2150	2200		
47	9	North of SH 48 (Chateau Turnoff)	1600	1910	2250	2300	2400		
47	26	Te Rata School (Otukou Jn)	740	1390	910	1630	1530		
47	29	**Wanganui / Hamilton regional boundary**							
47	46	242m before State Highway 41	1730	1360	1250	1300	1310		
48	4	Whakapapa-Nui Stream	2340	2250	2040	2050	2150		
49	8	West of Ohakune	1970	1900	1470	1280	1450		
49	11	Ohakune East (East of ex SH 49A)	3940	2910	2040	1870	2260		
49	38	Waiouru West of SH 1	2180	1770	1500	1550	1770		
50	0	Port of Napier Gate 3	4740	5010	5000	5070	4920		
50	4	Taradale Rd, 200m north of Maadi Rd (Total)	12900	14060	12630	11490	11500		
50	4	Taradale Rd, 200m north of Maadi Rd (SBD)	6450	7100	6350	5700	5740		
50	4	Taradale Rd, 200m north of Maadi Rd (NBD)	6450	6950	6280	5790	5760		
50	5	Napier Hastings Ex'way - South of Taradale Rd							
50	6	Napier Hastings Ex'way - Taradale Rd to Kennedy Rd	7000	6640	7690	9230	9490		
50	7	Napier Hastings Ex'way - Kennedy Rd to Meannee Rd	10540	9890	11920	13810	13770		

ount Traffic Executive	
Default	
CustomList-136 -- English (ENU)	
Datasets:	
Site:	**[152] WHAREROA ROAD. (S.H.32/ 100M. TO FIRST ST.)**
Direction:	6 - West bound A>B, East bound B>A., **Lane:** 0
Survey Duration:	18:00 Tuesday, October 18, 2005 => 14:26 Tuesday, November 01, 2005
File:	I:\Traffic Counting Programs\HISTORICAL\2005 traffic counts\15201Nov2005.EC0 (Plus)
Identifier:	N563D9VA MC56-L4 [MC55] (c)Microcom 19Sep03
Algorithm:	Factory default
Data type:	Axle sensors - Paired (Class, Speed, Count)
Profile:	
Filter time:	**0:00 Tuesday, October 25, 2005 => 0:00 Tuesday, November 01, 2005**
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Factory default profile
Scheme:	Vehicle classification (Scheme F2)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
Column Legend:	
0 [Time]	24-hour time (0000 - 2359)
1 [Total]	Number in time step
2 [Cls]	Class totals
3 [Mean]	Average speed
4 [Vpp]	Percentile speed

* Tue	sday, October 25,2005							
Time	Total	Car		LCV	Bus	MCV		
0	1	0	1	0	0	0	0	
100	0	0	0	0	0	0	0	
200	0	0	0	0	0	0	0	
300	0	0	0	0	0	0	0	
400	0	0	0	0	0	0	0	
500	0	0	0	0	0	0	0	
600	0	0	0	0	0	0	0	
700	11	0	9	2	0	0	0	
800	8	0	7	1	0	0	0	
900	2	0	1	1	0	0	0	
1000	11	0	11	0	0	0	0	
1100	11	0	10	1	0	0	0	
1200	10	0	9	1	0	0	0	
1300	11	0	10	1	0	0	0	
1400	14	0	14	0	0	0	0	
1500	8	0	8	0	0	0	0	
1600	6	0	6	0	0	0	0	
1700	10	0	10	0	0	0	0	
1800	5	0	4	1	0	0	0	
1900	0	0	0	0	0	0	0	
2000	0	0	0	0	0	0	0	
2100	0	0	0	0	0	0	0	
2200	0	0	0	0	0	0	0	
2300	0	0	0	0	0	0	0	
19-Jul	107	0	99	8	0	0	0	
22-Jun	107	0	99	8	0	0	0	
Jun-00	107	0	99	8	0	0	0	
00-00	108	0	100	8	0	0	0	

* Wed	nesday,October 26,2005						
Time	Total	Car		LCV	Bus	MCV	
0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0
200	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0
400	0	0	0	0	0	0	0
500	1	0	1	0	0	0	0
600	0	0	0	0	0	0	0
700	7	0	6	1	0	0	0
800	0	0	0	0	0	0	0
900	9	0	8	1	0	0	0
1000	2	0	2	0	0	0	0
1100	4	0	4	0	0	0	0
1200	4	0	4	0	0	0	0
1300	4	0	2	1	0	1	0
1400	8	0	8	0	0	0	0
1500	9	0	7	1	0	1	0
1600	6	0	5	1	0	0	0
1700	2	0	2	0	0	0	0
1800	4	0	4	0	0	0	0
1900	0	0	0	0	0	0	0
2000	2	0	2	0	0	0	0
2100	2	0	1	1	0	0	0
2200	1	0	1	0	0	0	0
2300	0	0	0	0	0	0	0
19-Jul	59	0	52	5	0	2	0
22-Jun	63	0	55	6	0	2	0
Jun-00	64	0	56	6	0	2	0
00-00	65	0	57	6	0	2	0

* Thursday, October 27, 2005							
Time	Total	Car		LCV	Bus	MCV	
0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0
200	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0
400	0	0	0	0	0	0	0
500	0	0	0	0	0	0	0
600	1	0	1	0	0	0	0
700	5	0	4	1	0	0	0
800	3	0	3	0	0	0	0
900	6	0	6	0	0	0	0
1000	13	0	10	2	0	0	1
1100	3	0	2	0	0	0	1
1200	4	0	4	0	0	0	0
1300	7	0	7	0	0	0	0
1400	4	0	4	0	0	0	0
1500	8	0	8	0	0	0	0
1600	7	0	6	1	0	0	0
1700	6	0	6	0	0	0	0
1800	9	1	7	1	0	0	0
1900	1	0	1	0	0	0	0
2000	3	0	3	0	0	0	0
2100	0	0	0	0	0	0	0
2200	1	0	1	0	0	0	0
2300	0	0	0	0	0	0	0
19-Jul	75	1	67	5	0	0	2
22-Jun	80	1	72	5	0	0	2
Jun-00	81	1	73	5	0	0	2
00-00	81	1	73	5	0	0	2

* Fri	day,October 28,2005						
Time	Total	Car		LCV	Bus	MCV	
0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0
200	0	0	0	0	0	0	0
300	1	0	1	0	0	0	0
400	1	0	0	1	0	0	0
500	2	0	2	0	0	0	0
600	2	0	2	0	0	0	0
700	11	0	9	1	0	0	1
800	4	0	4	0	0	0	0
900	3	0	3	0	0	0	0
1000	4	0	3	0	0	0	1
1100	6	0	5	0	0	0	1
1200	6	0	5	1	0	0	0
1300	8	0	8	0	0	0	0
1400	5	0	4	1	0	0	0
1500	5	0	5	0	0	0	0
1600	6	0	4	0	0	2	0
1700	3	0	3	0	0	0	0
1800	7	0	6	1	0	0	0
1900	11	2	9	0	0	0	0
2000	1	0	1	0	0	0	0
2100	1	0	1	0	0	0	0
2200	2	0	2	0	0	0	0
2300	1	0	1	0	0	0	0
19-Jul	68	0	59	4	0	2	3
22-Jun	83	2	72	4	0	2	3
Jun-00	86	2	75	4	0	2	3
00-00	90	2	78	5	0	2	3

* Saturday,October 29,2005							
Time	Total	Car		LCV	Bus	MCV	
0	0	0	0	0	0	0	0
100	1	0	1	0	0	0	0
200	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0
400	2	0	2	0	0	0	0
500	0	0	0	0	0	0	0
600	3	0	3	0	0	0	0
700	2	0	2	0	0	0	0
800	1	0	1	0	0	0	0
900	5	0	5	0	0	0	0
1000	7	0	6	1	0	0	0
1100	17	0	15	2	0	0	0
1200	3	0	3	0	0	0	0
1300	9	0	8	1	0	0	0
1400	4	0	4	0	0	0	0
1500	5	0	5	0	0	0	0
1600	7	0	7	0	0	0	0
1700	9	0	9	0	0	0	0
1800	3	0	2	1	0	0	0
1900	4	0	4	0	0	0	0
2000	3	0	2	1	0	0	0
2100	1	0	1	0	0	0	0
2200	0	0	0	0	0	0	0
2300	0	0	0	0	0	0	0
19-Jul	72	0	67	5	0	0	0
22-Jun	83	0	77	6	0	0	0
Jun-00	83	0	77	6	0	0	0
00-00	86	0	80	6	0	0	0

* Sun	day, October 30,2005						
Time	Total	Car		LCV	Bus	MCV	
0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0
200	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0
400	1	0	1	0	0	0	0
500	0	0	0	0	0	0	0
600	1	0	1	0	0	0	0
700	4	0	3	1	0	0	0
800	1	0	1	0	0	0	0
900	7	0	7	0	0	0	0
1000	12	0	12	0	0	0	0
1100	7	0	6	1	0	0	0
1200	10	0	7	3	0	0	0
1300	17	2	15	0	0	0	0
1400	19	2	17	0	0	0	0
1500	5	0	5	0	0	0	0
1600	10	0	10	0	0	0	0
1700	4	0	4	0	0	0	0
1800	3	0	3	0	0	0	0
1900	2	0	2	0	0	0	0
2000	2	0	2	0	0	0	0
2100	0	0	0	0	0	0	0
2200	1	0	1	0	0	0	0
2300	0	0	0	0	0	0	0
19-Jul	99	4	90	5	0	0	0
22-Jun	104	4	95	5	0	0	0
Jun-00	105	4	96	5	0	0	0
00-00	106	4	97	5	0	0	0

APPENDIX F

TDC's Water Supply Resource Consent

Waikato
REGIONAL COUNCIL
Te Kaunihera ā Rohe o Waikato

401 Grey Street
Hamilton East
Hamilton 3216

Private Bag 3038
Waikato Mail Centre
Hamilton 3240

ph +64 7 859 0999
fax +64 7 859 0998
www.waikatoregion.govt.nz

Resource Consent Certificate

Resource Consent: 121300

File Number: 60 54 64A

Pursuant to the Resource Management Act 1991, the Waikato Regional Council hereby grants consent to:

Taupo District Council
Private Bag 2005
Taupo Mail Centre
Taupo 3352

(hereinafter referred to as the Consent Holder)

Consent Type: Water permit

Consent Subtype: Ground water take

Activity authorised: Take up to 682 cubic metres of groundwater per day for community water supply purposes

Location: Ngati Parekawa Drive - Whareroa

Spatial Reference: NZTM 1841018 E 5694573 N

Consent Duration: This consent will commence on the date of decision notification, unless otherwise stated in the consent's conditions, and expire on 31 January 2033.

Subject to the conditions overleaf:

1) The activity authorised by this resource consent shall be undertaken:
   - in general accordance with the application for this resource consent lodged 17 May 2010 (as recorded on the Waikato Regional Council's electronic document management system document no. 1685230), and any documentation supporting that application; and
   - in accordance with the Water Demand Management Plan (as recorded in the Waikato Regional Council's electronic document management system document no. 1895982, received December 2010) or any subsequent version of that plan (as provided for by condition 9); and
   - as specified in the resource consent conditions below.

   Where there is any disagreement between the application and the consent conditions set out below, then the consent conditions shall prevail.

2) The maximum combined volume to be taken from the production bores (identified as Waikato Regional Council 'Located' ID.s. 72_399 and 72_237) shall not exceed 682 cubic metres in any 24 hour period.

3) The maximum combined volume of groundwater to be taken from the production bores shall not exceed 248,930 cubic metres for the period 1 July through to 30 June the following year.

4) Access to the bores to perform pumping tests, and for the measurement of static water levels and water quality sampling, shall be provided to the staff and agents of the Waikato Regional Council at all times.

5) A sealed tamper-proof water measuring system suited to the quality of water it is measuring and capable of electronic recording and reporting shall be installed in accordance with the manufacturer's specifications to record the quantity of water taken on a cumulative basis. The water measuring system shall have a reliable calibration to water flow which shall be maintained to an accuracy of plus or minus five percent. Evidence of the water measuring system's calibration to water flow and level of accuracy shall be provided to the Waikato Regional Council by 31 July 2013.

   Note: In accordance with the Resource Management (Measuring and Reporting of Water Takes) Regulations 2010, the water measuring system shall be installed at the location from which water is taken. Where installation at the point of take is not practicable, approval may be sought from the Waikato Regional Council to install the system at an alternative location. This approval shall be provided to the consent holder in writing.

6) Calibration of the water measuring system to water flow shall be undertaken by the consent holder:
   (1) At the written request of the Waikato Regional Council; and/or
   (2) At a frequency of no more than five yearly from the date of the first calibration required by condition (5).

   The consent holder shall engage an independent and suitably qualified person to conduct the calibration and evidence documenting the calibration to water flow and level of accuracy shall be forwarded to the Waikato Regional Council within one month of the calibration being completed.

7) The consent holder shall as a minimum keep a continuous record of water taken which includes the following data:
   (1) The date on which the record is taken; and
   (2) Comprise measurements (in units of cubic metres) of the cumulative volume of water taken for each day, and
   (3) If no water is taken, the records must specify the volume of water taken as 'zero' cubic metres for each day that no water is taken;

   This data 7(1), 7(2) and 7(3) shall be available to Waikato Regional Council at all reasonable times and on request. Water use records shall be provided to Waikato Regional Council at the following frequency:
   a) by 31 January in each year the consent is current for the period 1 July to 31 December.

b) by 31 July in each year the consent is current for the period 1 January to 30 June.

8) The consent holder shall carry out its water supply operations in general accordance with the Water Management Plan titled "Water Demand Management Plan" dated March 2010 or any subsequent updated version of this document as approved by Waikato Regional Council for the duration of this consent, and in particular shall implement as far as reasonably practicable the actions and strategies set out in Section 6.5 of that Plan, excluding those actions that are subject to other statutory processes.

9) During the years of 2014, 2020 and 2026 the consent holder shall review the water demand management plan and report on the effectiveness of the plan in achieving water conservation and water demand management for the next reporting period. The report shall include:
   (1) Any changes to the reticulation system; and
   (2) An update on forecasted water demand for the next review period including:
      i) A breakdown on forecast requirements for domestic and industrial/rural/commercial users; and
      ii) Identification of all users taking water in excess of 15 m^3/day;
   (3) The maximum daily take required during the next reporting period and the rationale for this (including any uncertainties associated with growth data used in the calculation of future demand).

   Following this review of the water demand and conservation management plan, the consent holder shall submit to the Waikato Regional Council an updated version of that plan by 30 October of that review year.

10) At any time during the:
   (1) years of 2018, 2023 and 2028, the Waikato Regional Council may, following service of notice on the consent holder, commence a review of this consent under section 128(1) of the Resource Management Act 1991, for the following purposes:
      i) to review the effectiveness of the conditions of this resource consent in avoiding or mitigating any adverse effects on the environment from the exercise of this resource consent and if necessary to avoid, remedy or mitigate such effects by way of further or amended conditions; and/or
      ii) to review the adequacy of and the necessity for monitoring undertaken by the consent holder; and/or
      iii) to review consent conditions to give effect to the matters identified in condition 9.
      iv) to review the consistency of the conditions of this consent with future changes to the 'Vision and Strategy" set out in Schedule 2 of the Waikato-Tainui Raupatu (Waikato River) Settlement Claims Act 2010; and set out in Schedule 1 of the Ngati Tuwharetoa, Raukawa, and Te Arawa River Iwi Waikato River Act 2010, and if necessary, to address any inconsistency of the conditions of this consent with the changes to the Vision and Strategy by way of further or amended conditions.
   (2) period 1 July 2016 to 30 June 2017 the Waikato Regional Council may, following service of notice on the consent holder, commence a review of the conditions of this resource consent pursuant to section 128(1) of the Resource Management Act 1991 to take into account of any change to the Waikato Regional Plan being proposed as a result of any catchment investigation undertaken by the Waikato Regional Council.

   Note: Costs associated with any review of the conditions of this resource consent will be recovered from the consent holder in accordance with the provisions of section 36 of the Resource Management Act 1991.

11) The consent holder shall pay to the Waikato Regional Council any administrative charge fixed in accordance with section 36 of the Resource Management Act 1991, or any charge prescribed in accordance with regulations made under section 360 of the Resource Management Act.

Advice notes

1. In accordance with section 125 RMA, this consent shall lapse five (5) years after the date on which it was granted unless it has been given effect to before the end of that period.
2. Where a resource consent has been issued in relation to any type of construction (e.g. dam, bridge, jetty) this consent does not constitute authority to build and it may be necessary to apply for a Building Consent from the relevant territorial authority.
3. This resource consent does not give any right of access over private or public property. Arrangements for access must be made between the consent holder and the property owner.
4. This resource consent is transferable to another owner or occupier of the land concerned, upon application, on the same conditions and for the same use as originally granted (s.134-137 RMA).
5. The consent holder may apply to change the conditions of the resource consent under s.127 RMA.
6. The reasonable costs incurred by Waikato Regional Council arising from supervision and monitoring of this/these consents will be charged to the consent holder. This may include but not be limited to routine inspection of the site by Waikato Regional Council officers or agents, liaison with the consent holder, responding to complaints or enquiries relating to the site, and review and assessment of compliance with the conditions of consents.
7. Note that pursuant to s333 of the RMA 1991, enforcement officers may at all reasonable times go onto the property that is the subject of this consent, for the purpose of carrying out inspections, surveys, investigations, tests, measurements or taking samples.
8. If you intend to replace this consent upon its expiry, please note that an application for a new consent made at least 6 months prior to this consent's expiry gives you the right to continue exercising this consent after it expires in the event that your application is not processed prior to this consent's expiry.
9. The water taken pursuant to this resource consent shall be used in accordance with the Waikato Regional Plan's 3.4.5.4 Permitted Activity Rule – Use of Water. This rule and its advisory note are reproduced below.

Permitted Activity Rule – Use of Water

(Implements Section 3.4.3 Policy 1)

Except as restricted by Rules 3.4.5.6, 3.4.5.7 and 3.4.5.8 the use (as restricted by s14 of the RMA) of water is a permitted activity subject to the following conditions:

a) The use of water shall comply with the water management class standards in section 3.2.4 of this Plan.

Exception

This rule does not apply to:

- The use of geothermal energy and water. Such uses are managed by the policies and rules in Module 7 – Geothermal
- The use of water for a dam or diversion. Such uses are managed by the policies and rules in Chapter 3.6.

Advisory Note:

Any subsequent discharge of water or contaminants arising from the use of water authorised by this rule may require separate resource consent under the rules in Chapters 3.5 and 5.2 of this Plan.

10. The Water Management Plan required by condition 9 shall be prepared in accordance with the Waikato Regional Plan's Method 8.1.2.2 - Water Management Plans. This method is reproduced below.

8.1.2.2 Water Management Plans

The Water Management Plan shall establish a long term strategy for the water requirements of domestic or municipal suppliers and their communities. It shall demonstrate that the volume of water required, including any increase over that previously authorised, has been justified and that the water take will be used efficiently and effectively. To this end the water management plan shall, to an extent which is appropriate for the scale of the activity, provide the following information:

1. A description of the water supply system including system operation, distribution extent, levels of service, water use measurement, maintenance and asset management procedures.
2. A comprehensive assessment of existing demand and future demand for water with regard to an assessment of reasonable population growth within the planning horizon to meet the following:

a. reasonable domestic needs;
b. public health needs in accordance with requirements under any Act of Parliament or regulation;
c. reasonable community needs (e.g. for public amenities);
d. reasonable commercial, rural supply and industrial needs;
e. an assessment as to how each of the assessments required by clauses a) to d) above is predicted to vary over time;
f. a justification for each of the assessments required by clauses a) to e) above including reference to any relevant planning instruments promulgated under the Resource Management act 1991 that provide for future growth or relevant documents promulgated under the Local Government Act 2002 such as Long Term Plans, growth strategies or spatial plans.

3. Any existing or proposed water pricing procedures and any linkages with wastewater pricing or management.
4. How water reticulation networks are planned and managed to minimise their water losses as far as practicable.
5. A description of patterns of water use practices and/or behaviour in all sectors of use (and distribution) with the objective of maximising water use efficiency and reducing water use, as far as practicable.
6. Water saving targets for the full range of demand conditions including demand saving targets for council owned facilities, domestic demand targets and demand saving targets for commercial and industrial customers.
7. Key performance indicators for each of the water saving targets.
8. Any external auditing and benchmarking procedures that have been adopted.
9. A drought management plan that includes:
    a. steps to be taken to reduce consumption during water shortage conditions, including those uses that will be restricted at the same time as priority SW-B users (in accordance with Policy 18 and Standard 3.3.4.27) and steps to be taken to implement those restrictions.
    b. Targets for the water savings expected to be achieved via the restriction of activities identified in a) above, which shall align as closely as possible to the restrictions for SW-B users provided for in Standard 3.3.4.27.
    c. public and commercial user education programmes.
    d. steps taken to reduce consumption when demand is approaching the maximum take volume specified under the relevant resource consent.
    e. Enforcement procedures
10. Actions, performance measures and a timeline for implementing actions. The actions and performance measures identified will depend on the circumstances of each applicant.
11. Any consultation undertaken with key stakeholders and outcomes of such consultation.
12. Details of an appropriate water conservation and demand management plan review process.
13. Identification of any anticipated increases in water demand over the term of the consent and ability to stage water take volumes to more closely reflect demand requirements over time.
14. Ability to reduce the amount of water used by existing industrial and agricultural users, as a result of improvements in the efficiency of the use of water, in order to meet any increase in water demand over the term of the consent.
15. Identification of any single industrial, commercial or agricultural use of water that uses more than 15 cubic metres of water per day (not being water used for human drinking purposes or human sanitation purposes).
16. Identification of future domestic or municipal supply take needs over and above authorised domestic or municipal supply takes required to meet growth and development that is provided for in planning instruments promulgated under the Resource Management Act 1991 or relevant documents promulgated under the Local Government Act 2002, such as Long Term Plans, growth strategies or spatial plans (or similar).
    a. The projected future needs shall be identified in terms of:
    b. Location of take; and
    c. Volume of take (including any seasonal variations); and
    d. The date at which the water is likely to be required.

APPENDIX G

Letter to TDC supporting consent application; Oct 2016

KeySolutions (2005) Ltd
Ph: 07 378 4415 • Mob: 027 494 0125 • info@keysolutions.co.nz • 66 Wharewaka Road • TAUPO

Friday, 7th October 2016

Taupo District Council
Private Bag 2005
Taupo Mail Centre
TAUPO 3352

Attention: Mr Ramesh Sharma

Dear Ramesh

WHAREROA WASTEWATER RESOURCE CONSENT APPLICATION

Confirming our recent discussion, I act on behalf of the Proprietors of Hauhungaroa No.6. These Owners as you know have been the sole developer at Whareroa since the first sections were created in the 1960's.

The Owners have an harmonious working relationship with Taupo District Council and are currently working with TDC to facilitate the proposed development at Whareroa North as provided for in various Council Plans and Documents. The completion in 2010 of an agreement regarding the vesting of more Hauhungaroa No.6 land for use for sewage treatment purposes including additional land required for irrigation, is an example of that co-operative working relationship.

Obviously the Owners are eager to see this land (and the whole wastewater system) used and operated in the most cost effective manner to optimise nitrogen (and other pollutant) reduction.

We are all aware that TDC operates several land treatment and disposal systems, the biggest serving Taupo itself, and TDC staff will be continually gaining knowledge and experience in how to best operate these systems. Resource Consent conditions should make provision for "best industry practice" to be incorporated into the design and operation of all the land based systems to optimise both environmental and financial outcomes.

The Proprietors of Hauhungaroa No.6 support any proposed changes to Whareroa Wastewater consent conditions which would allow Taupo District Council the flexibility to optimise both environmental and economical performance and continue to cater for not only the existing settlement, but also for the proposed development of up to 170 lots at Whareroa North.

Yours sincerely,

Mike Keys

APPENDIX H

Letter from TDC confirming position: March 2013

19 March 2013

GREAT LAKE TAUPŌ
Taupō District Council

72 Lake Terrace, Taupo 3330
Private Bag 2005, Taupo Mail Centre,
Taupo 3352, New Zealand
ph: 07 376 0899
fax: 07 378 0118

The Proprietors of Hauhungaroa No.6
c/o Mike Keys
66 Wharewaka Road
TAUPO

Dear Mike

Subject: Whareroa Wastewater Consent Renewal

As you are aware Waikato Regional Council has advised a hearing date for the above consent which includes provision allowance for further development of your clients land, for early May to enable your clients submission in support of the consent renewal to be heard.

We are both agreed that there can be no benefit to the community at large for incurring the costs of such a hearing for this consent renewal and that it is in both council's and your clients interests to continue the harmonious working relationship that has existed over the past few years with respect to facilitating the proposed development of Whareroa North. I would at this point acknowledge your clients part in that relationship with the completion in 2010 of an agreement regarding the vesting of land for use for sewage treatment purposes including additional land required for irrigation, as an example of that co-operative working relationship.

As I understand from our meeting you have the mandate to act for your client with respect to this matter and that you are seeking to gain comfort that the costs associated with any future connection by way of headworks contribution, by your client to the Whareroa wastewater scheme will be fair and reasonable. At this stage your client has no definite timetable proposed for the implementation of any sub division at Whareroa north nor has a specific yield been identified for this land. Although it is recognised that thru the planning process to date this yield is likely to be less than the 170 lots catered for in the resource consent application.

Council has determined that capital expenditure of some $587k is required to meet the draft consent conditions for the renewal of this consent. Included in this cost is provision for a telemetry upgrade of approximately $30k which can be attributed to existing use and therefore could be considered historical. The balance of the capital costs relates to requirements to meet the variation 5 nitrogen reduction requirements, which as you know, is not historical "catch up", but reflection of the fact that the standard of effluent treatment required in 2013 is higher than that required by the previous consent. Currently Whareroa contributes approximately 2% of the total nitrogen load in kg to the Lake Taupo catchment and this has been reducing over the past three years. Your client should therefore have some comfort that the costs identified above do not address historical issues. I would add that, at time of contribution determination, the capex referred to above will be better qualified and better quantified. Your client can be assured that the final agreed figure will be determined in the same collaborative way that this development proposal has progressed to date.

Reference: A1082893

As further evidence of the reasonableness of the likely head works contribution the current waste water connection charge for both Acacia Bay and Taupo Town as set out in the Appendix 1 of the current Development Contribution Policy is $5,558. This compares very favourably with a per lot cost on the basis of the identified capital cost of $550k spread over a yield of 100 lots at $5,500 per lot, or $4,250 for a yield of 130 lots or $3,500 for a yield of 160 lots

It must be acknowledged that the final agreed cost of connection will be a function of timing of the development and the final yield, but the basis of the calculation will be as described above.

As you are aware time is of the essence as WRC have already notified us that the clock has commenced for the consent hearing and costs are being incurred. I look forward to your early confirmation of the above or correction should that be the case.

Kind regards

Denis Lewis
Infrastructure Manager

APPENDIX J

Geotechnical report; October 2006

Mark T Mitchell Ltd

Consulting Geotechnical Engineers

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

Ref: T – 9036/1
19 October, 2006

Blance & Associates
Registered Surveyors
19 Manuaute Street
Taumaranui

Attention: Ian Blance

Dear Sirs,

Re: Site Assessment and Supplementary Geotechnical Engineering Appraisal
Proposed Whareroa North Residential Subdivision
Hauhungaroa No. 6, Whareroa Road North, West Lake Taupo

In accordance with your request, we have carried out a supplementary Geotechnical Assessment of the above referenced property. The purpose of our investigation and assessment was to determine the geomorphology and processes that formed the western side of the proposed subdivision area. We understand that the low-lying area has been allocated for future filling to bring it up to a level near that of the upper terraces.

This report is a supplement to our earlier report dated 4 August, 2006 that included site testing and recommendations for on-site disposal of stormwater for the proposed Whareroa North Residential Subdivision.

1. Introduction

The proposed residential subdivision is located within Whareroa Station farm, alongside the south-western shores of Lake Taupo, adjacent to Kuratau village. The property is bounded to the southwest and southeast by moderately steep to steep slopes that fall some 30 to 40 metres to Whareroa Stream and Lake Taupo respectively. (*ref.* Fig. 1).

The development site is presently accessed through Whareroa Station via farm tracks however, all lots will be accessed from a new road to be constructed from Kuratau. The road will course near parallel to Lake Taupo and then ascend the moderately steep to steep slope gaining access to the upper terraces being the proposed subdivision.

Fig. 1: View south towards the low-lying area with Lake Taupo in the distance. Test Pit No. 1 is in the foreground.

In the main, the site consists of a gently sloping terrace area. However, near the western edge of the subdivision, the land surface falls some 15 metres to a smaller, low-lying area. A steep slip-scarp is exposed along the south-western fenceline that drops to Whareroa Stream below. (*ref.* Fig. 2).

Fig. 2: Slip scarp along the south-western side of the subdivision displaying the distinct stratification of the volcanic soils.

An overall scheme plan showing the area investigated is re-presented on the attached Site Plan, Drawing No. 9036-01. The Plan includes the western part of the roading and section layout of the proposed subdivision, as prepared by Blance and Associates, Registered Surveyors. The development proposal involves the subdivision of the land to create some 150 separate titles.

The purpose of the Soils Investigation was to determine the subsurface conditions within an area of concern and to evaluate what special conditions, if any, would be required for the proposed filling within this area. The test pits were excavated to varying depths governed by the soils encountered.

2. Local Geology and Site Geomorphology

The underlying rock formation in the area consists of 'welded' rhyolitic Ignimbrite rock being the Whakamaru Ignimbrite. This was deposited during a volcanic episode from the Taupo Volcanic Zone during the Pleistocene period (New Zealand Castlecliffian Stage) approximately 300,000 years ago.

These rocks have been overlain by undifferentiated volcanic air-fall tephras (Ash) during various subsequent Taupo Volcanic Zone eruptions, creating the gently rolling country typical of the site under investigation.

The property sits above Lake Taupo and Whareroa Stream, the latter of which has cut down through the ashes and Ignimbrite bedrock to an equilibrium level at Lake Taupo. Apart from the cliff failure along the western fenceline, the site does not exhibit signs of significant historical landslips. Minor localised slumps were observed along the steepest section of the slope below the upper terrace. (*ref.* Fig. 3).

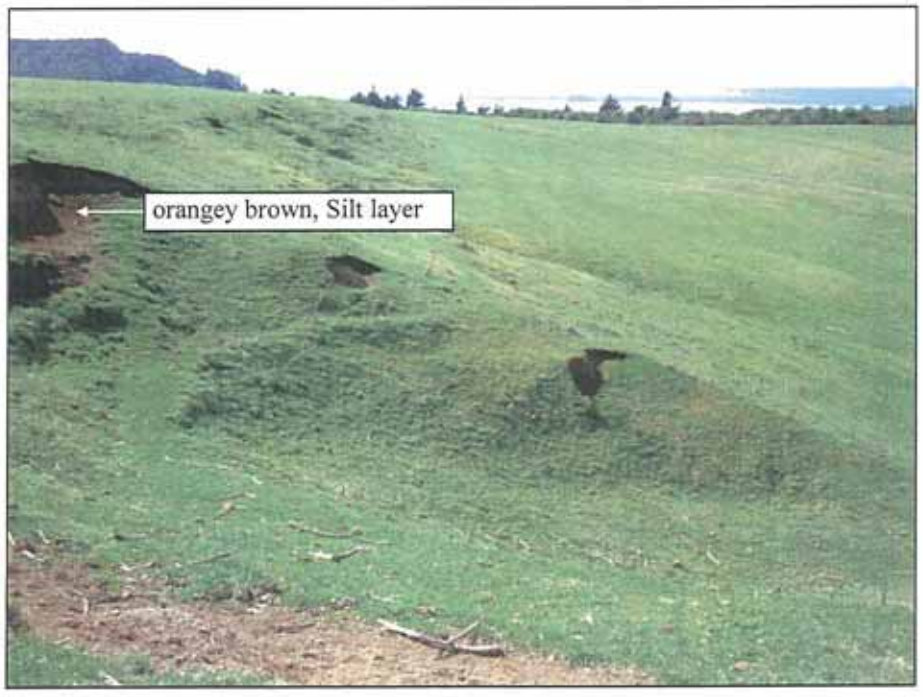


Fig. 3: Minor slumps along the east-west oriented slope that separates the upper terrace from the low area. Lake Taupo can be seen in the distance to the east.

The results of our investigation and assessment of the ground conditions are as follows:

3. Field Investigations and Soil Conditions

The subsurface conditions at the site were investigated by excavating seven Test Pits at the locations shown on the Site Plan, Drawing No. 9036-01. These Test Pits are designated Nos. 1 to 7 with the Test Pit Logs presented on Figs. A-1 to A-8 and are described below.

The purpose of the test pits was to provide guidance as to the general subsurface soil profile and variability of the soils within the proposed subdivision area. Actual ground conditions may vary across the proposed site however, and may differ slightly from those as described below due to the diverse nature of the volcanic soils in the area.

Soil conditions encountered below the site are also presented diagrammatically on the attached Ground Profiles, Drawing No. 9036-02. The profiles were surveyed through the site during the field investigations, by Blance and Associates staff, Registered Surveyors.

Test Pit Nos. 1 to 3, 6 and 7

These Test Pits were excavated along the east-west aligned, moderately steep slope (ref' Fig 3). The test pits revealed a deep Topsoil layer, some 200 to 500mm thick. Beneath the Topsoil, a layer of orangey brown, clayey, sandy SILT mantled the relict slope and was traced to varying depths in the test pits. (*ref'* Fig 4)

Fig. 4: Test Pit No. 1 revealed an orangey brown, clayey, sandy Silt layer below the Topsoil.

Just below the top and down the steeper part of the slope, the Silt layer was found directly beneath the Topsoil layer. However, on the upper terrace, near the toe of the slope and on the low-lying terrace area, various Sand layers overlie the Silt layer.

This displays a typical feature of the sandy Ash soils. These air-fall ashes and soils cannot maintain their position on moderately steep to steep slopes and will migrate downward to settle on less steep areas either during deposition, or soon afterwards.

Ground Profile AA displays the proposed stratification below the surface using information revealed by the test pits. The Silt layer can be seen to mantle the area and outcrops at the slip face some 1.5 metres below the surface as seen in Fig. 2.

Test Pit No. 5

This Test Pit was excavated to the east of the area of concern and encountered silty and gravelly pumiceous SANDS, but not the orangey brown, Silt layer. Ground Profile BB assumes that the Silt layer may indeed be present in this area however, probably at some depth below the Sand layers.

The test pits were terminated at varying depths from 3.1 to 4.8 metres below existing ground level.

Groundwater was not encountered in the Test Pits at the time of investigation.

4. Geotechnical Assessment

The purpose of carrying out the excavations along and down the depressed basin area of the site was to assess whether the bowl-shape feature was the remnants of a shallow landslide. If this were the case, the addition of filling over this feature could result in a further landslip feature.

As described in Section 3 above, the near-surface Silt-ash soils within the basin area do reveal that some downslope movement of these air-fall deposits has occurred, but it has likely been at a time soon after they were deposited. This movement has occurred over the top of the sand and gravel soils that were deposited some time before as alluvial or delta deposits when the lake level was considerably higher than it is today.

5. Site Preparation Recommendations

The test pits has revealed that the ash-soils that occur in the region of the steeper ground have been disturbed during their deposition and are therefore likely to be compressible.

On this account, it is recommended that at the time commencement of filling of this area, after the Topsoil has been removed, this steeper area is to be cut down to reveal the underlying sand and gravel soils. The excavated soils would be used as filling over the lower, near-level parts of the site, with some air-drying prior to their compaction.

This process would also enable benching of the underlying soils to be carried out over the steeper parts of the site.

Also, due to the extreme variability in material type present within the upper 2 to 3 metres in this area, and associated variations in compression, filling is to be carried out in the summer months under the supervision of a Chartered Engineer.

The steep and high slip-scarp at the south-western fenceline that runs down to the stream below will required remedial action to be taken as soon as possible as it appears that this erosion failure-feature is increasing in size.

5. Road Construction

Directly below the subject site and above the steep slopes that drop to the shores of Lake Taupo, a naturally occurring, 4-metre high relict bench exists along where the proposed access road is to be constructed. We understand that the road construction may follow alongside and below this high feature.

The high bench feature appears stable, however does not consist of welded Ignimbrites, but rather sandy ashes and Gravels. Therefore, the development of the road access to the development site will need to be carried out with caution as cut slopes in these materials will be prone to on-going slope instability unless they are cut back to less than the angle of repose of loose sand and gravel, which is about 33 degrees to the horizontal, or less than 1 in 1.5 slope gradient.

6. Conclusion

The results of this study indicate that based upon available information, the proposed subdivision area investigated is stable and suitable for filling. The Ash soils that mantle the site in their natural state and attitude have not caused significant slumping of the ground surface. The area under investigation is a natural bench feature created by welded Ignimbrite bedrock mantled by younger air-fall tephra material.

Yours faithfully

Mark T Mitchell Ltd

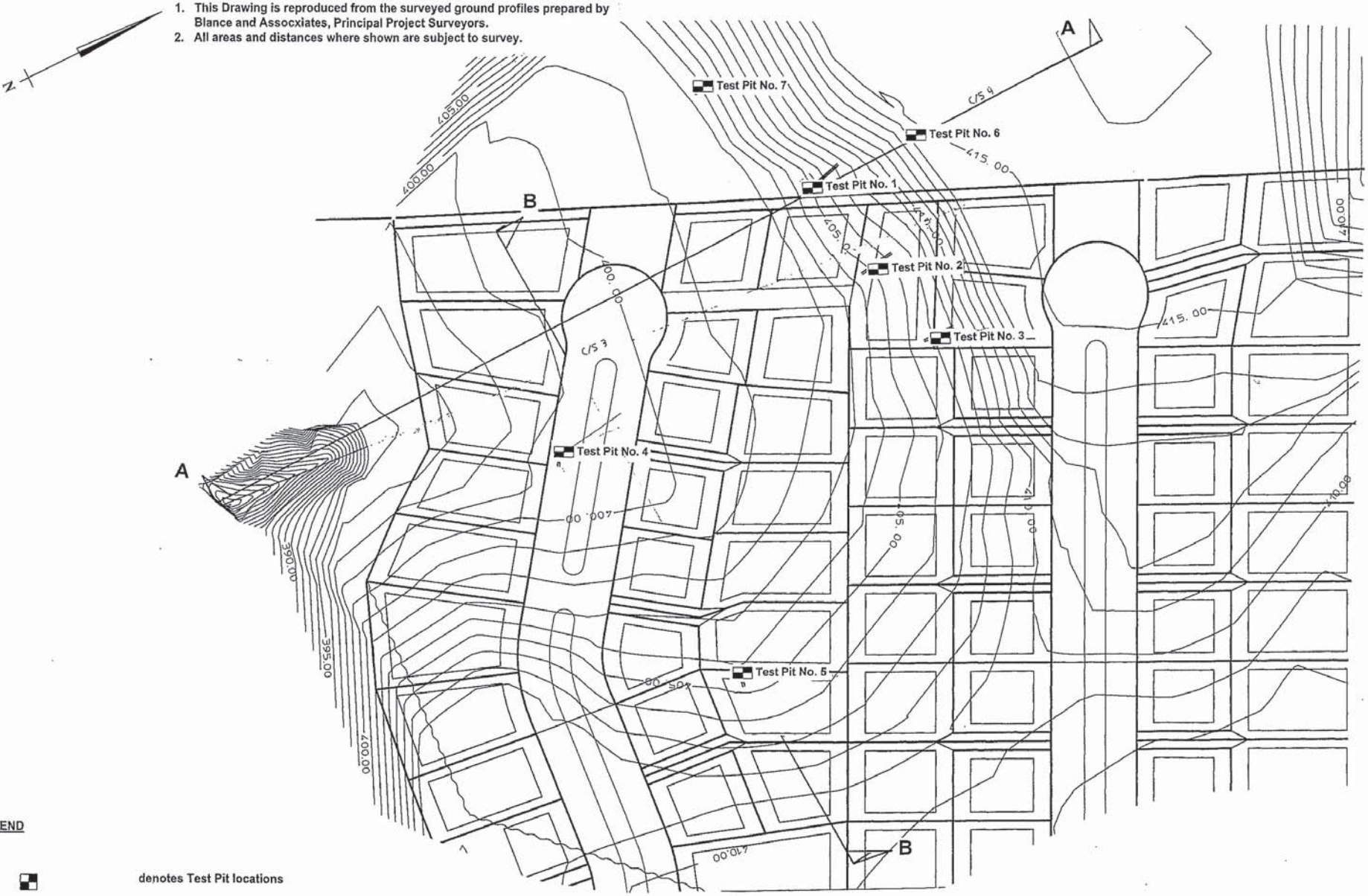
Mark T Mitchell
Director

References

Grindley, G.W., 1960: Geological Map of New Zealand, Sheet 8 – Taupo, 1:250,000. *New Zealand Geolocial Survey, Department of Scientific and Industrial research, Wellington, New Zealand.*

NOTES

1. This Drawing is reproduced from the surveyed ground profiles prepared by Blance and Assocxiates, Principal Project Surveyors.
2. All areas and distances where shown are subject to survey.



LEGEND

denotes Test Pit locations

" Ground Profile locations

SCALE 1: 1500

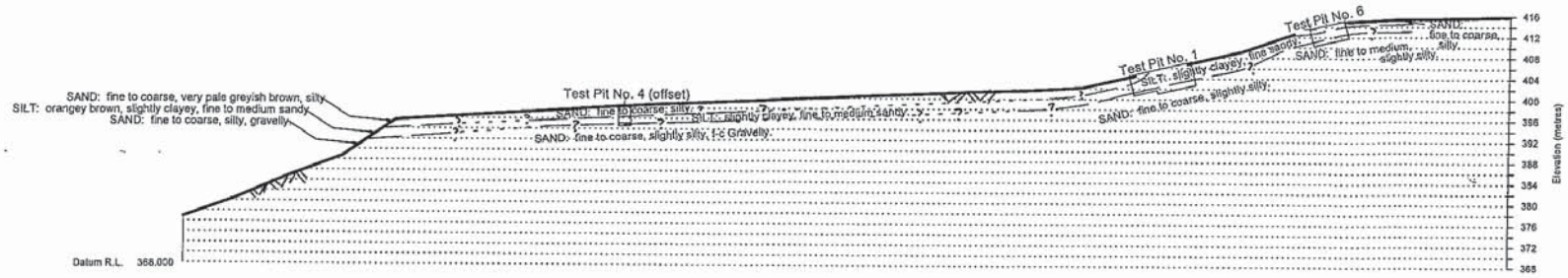
0 30 60 90 120 150 Metres

Mark T Mitchell Ltd Consulting Geotechnical Engineers 1150 Victoria Street, P.O. Box 9123, Hamilton	BLANCE & ASSOCIATES Investigation for Proposed Residential Subdivision Hauhungaroa No. 6, Whareroa North, Whareroa	**SITE PLAN**	DRAWING No. 9036-01 DATE October 2006 ISSUE One

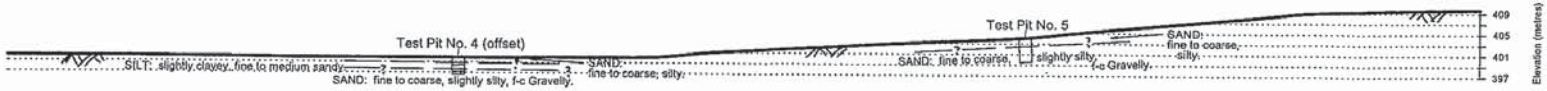
ptopalex\c\00Working Folder\9036_Whareroa Rd Kuratau BLANCE-draft profiles.VCD 9/30/2006

NOTES

1. This Drawing is reproduced from the surveyed ground profiles prepared by Blance and Associates, Principal Project Surveyors.
2. All areas and distances where shown are subject to survey.



GROUND PROFILE A - A



GROUND PROFILE B - B

SCALE 1: 1500

0 30 60 90 120 150 Metres

Mark T Mitchell Ltd Consulting Geotechnical Engineers 1150 Victoria Street, P.O. Box 9123, Hamilton	BLANCE & ASSOCIATES Investigation for Proposed Residential Subdivision Hauhungaroa No. 6, Whareroa North, Whareroa	**GROUND PROFILES**	DRAWING No. 9036-02 DATE October 2006 ISSUE One

TEST PIT LOG No. 1

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm) 1 2 3 4 5 6 7 8 9 10	PIEZOMETER / WATER LEVEL
	TOPSOIL.	0				
	SILT: orangey brown, moist, slightly clayey, fine sandy.	1				
		2				
		3				
	SAND: fine to coarse grained, light grey, moist, slightly silty.	4				
	Tets Pit Completed 07/09/06	5				
		6				

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES
JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa
JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator
RIG: 12T CAT
DRILLER: Dave Porritt

LOGGED: ACJ PLOTTED: ACJ
DATE: 07/09/06
CHECKED: KH

GEOCON SOIL TESTING LTD
Geotechnical Engineers
1150 Victoria Street, P.O. Box 9123, Hamilton

BORE HOLE LOG

TEST PIT No. 1
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-1

TEST PIT LOG No. 1A

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm) 1 2 3 4 5 6 7 8 9 10	PIEZOMETER / WATER LEVEL
	TOPSOIL.					
	SAND: fine to coarse grained, pale grey, moist, silty.	1				
	SILT: orangey brown, moist, slightly clayey, fine to medium sandy.	2				
	SAND: fine to coarse grained, light grey, moist, slightly silty containing fine Gravels.	3				
	Tets Pit Completed 07/09/06	4				
		5				
		6				

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES
JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa
JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator
RIG: 12T CAT
DRILLER: Dave Porritt

LOGGED: ACJ PLOTTED: ACJ
DATE: 07/09/06
CHECKED: KH

GEOCON SOIL TESTING LTD
Geotechnical Engineers
1150 Victoria Street, P.O. Box 9123, Hamilton

BORE HOLE LOG

TEST PIT No. 1A
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-2

TEST PIT LOG No. 2

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm) 1 2 3 4 5 6 7 8 9 10	PIEZOMETER / WATER LEVEL
	TOPSOIL.					
	SAND: fine to coarse grained, pale grey, moist, silty.	1				
	SILT: orangey brown, moist, slightly clayey, fine to medium sandy.	2 3				
	SAND: fine to coarse grained, moist, light grey, slightly silty containing fine Gravels.	4				
	Tets Pit Completed 07/09/06	5 6				

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES
JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa
JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator
RIG: 12T CAT
DRILLER: Dave Porritt

LOGGED: ACJ PLOTTED: ACJ
DATE: 07/09/06
CHECKED: KH

GEOCON SOIL TESTING LTD
Geotechnical Engineers
1150 Victoria Street, P.O. Box 9123, Hamilton

BORE HOLE LOG

TEST PIT No. 2
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-3

TEST PIT LOG No. 3

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm) 1 2 3 4 5 6 7 8 9 10	PIEZOMETER/ WATER LEVEL
	TOPSOIL.					
	SAND: fine to coarse grained, pale grey, moist, silty.	1				
	SAND: fine to coarse grained, very pale greyish brown, moist, slightly silty containing fine to coarse Gravels.	2				
	SAND: fine to coarse grained, pale grey, moist, silty.					
	SILT: orangey brown, moist, slightly clayey, fine to medium sandy.	3 4				
	SAND: fine to coarse grained, light grey, moist, silty.	5				
	Tets Pit Completed 07/09/06	6				

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES
JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa
JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator
RIG: 12T CAT
DRILLER: Dave Porritt

LOGGED: ACJ PLOTTED: ACJ
DATE: 07/09/06
CHECKED: KH

GEOCON SOIL TESTING LTD
Geotechnical Engineers
1150 Victoria Street, P.O. Box 9123, Hamilton

BORE HOLE LOG

TEST PIT No. 3
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-4

TEST PIT LOG No. 4

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)
	TOPSOIL.	
	SAND: fine to coarse grained, very pale greyish brown, moist, silty.	1
	SILT: orangey brown, moist, slightly clayey, fine to medium sandy.	2
	SAND: fine to coarse grained, light grey, moist, slightly silty containing fine to coarse Gravels.	3
	Tets Pit Completed 07/09/06	4
		5
		6

GEOLOGICAL FORMATION

VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)

SCALA PENETROMETER (blows/100mm)

1 2 3 4 5 6 7 8 9 10

PIEZOMETER / WATER LEVEL

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES
JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa
JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator
RIG: 12T CAT
DRILLER: Dave Porritt

LOGGED: ACJ PLOTTED: ACJ
DATE: 07/09/06
CHECKED: KH

GEOCON SOIL TESTING LTD
Geotechnical Engineers
1160 Victoria Street, P.O. Box 9123, Hamilton

BORE HOLE LOG

TEST PIT No. 4
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-5

TEST PIT LOG No. 5

GRAPHIC LOG | SOIL DESCRIPTION | DEPTH (metres) | GEOLOGICAL FORMATION | VANE SHEAR STRENGTH - kPa (In-situ/Remoulded) | SCALA PENETROMETER (blows/100mm) 1 2 3 4 5 6 7 8 9 10 | PIEZOMETER / WATER LEVEL

TOPSOIL.

SAND: fine to coarse grained, greyish brown, moist, silty.

SAND: fine to coarse grained, pale grey, moist, slightly silty containing fine to coarse pumiceous Gravels.

Tets Pit Completed 07/09/06

1 2 3 4 5 6

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES
JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa
JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator
RIG: 12T CAT
DRILLER: Dave Porritt

LOGGED: ACJ PLOTTED: ACJ
DATE: 07/09/06
CHECKED: KH

GEOCON SOIL TESTING LTD
Geotechnical Engineers
1150 Victoria Street, P.O. Box 9123, Hamilton

BORE HOLE LOG

TEST PIT No. 5
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-6

TEST PIT LOG No. 6

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm) 1 2 3 4 5 6 7 8 9 10	PIEZOMETER / WATER LEVEL
	TOPSOIL.					
	SAND: fine to coarse grained, pale grey, moist, silty.					
	SILT: orangey brown, moist, slightly clayey, fine to medium sandy.	1 2				
	SAND: fine to medium grained, pale brownish grey, moist, slightly silty.	3				
	Tets Pit Completed 07/09/06	4 5 6				

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES
JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa
JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator
RIG: 12T CAT
DRILLER: Dave Porritt

LOGGED: ACJ PLOTTED: ACJ
DATE: 07/09/06
CHECKED: KH

GEOCON SOIL TESTING LTD
Geotechnical Engineers
1150 Victoria Street, P.O. Box 9123, Hamilton

BORE HOLE LOG

TEST PIT No. 6
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-7

TEST PIT LOG No. 7

GRAPHIC LOG	SOIL DESCRIPTION	DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm) 1 2 3 4 5 6 7 8 9 10	PIEZOMETER / WATER LEVEL
	TOPSOIL.					
	SAND: fine to coarse grained, light brownish grey, moist, silty containing fine pumice Gravels.	1 2				
	SILT: orangey brown, moist, slightly clayey, fine to medium sandy.	3 4				
	SAND: fine to coarse grained, light brownish grey, moist, slightly silty.					
	Tets Pit Completed 07/09/06	5 6				

NOTES - The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

JOB NAME: BLANCE & ASSOCIATES
JOB LOCATION: Whareroa North Residential Dubdivision, Whareroa
JOB NUMBER: W-9036

DRILL METHOD: Hydraulic Excavator
RIG: 12T CAT
DRILLER: Dave Porritt

LOGGED: ACJ PLOTTED: ACJ
DATE: 07/09/06
CHECKED: KH

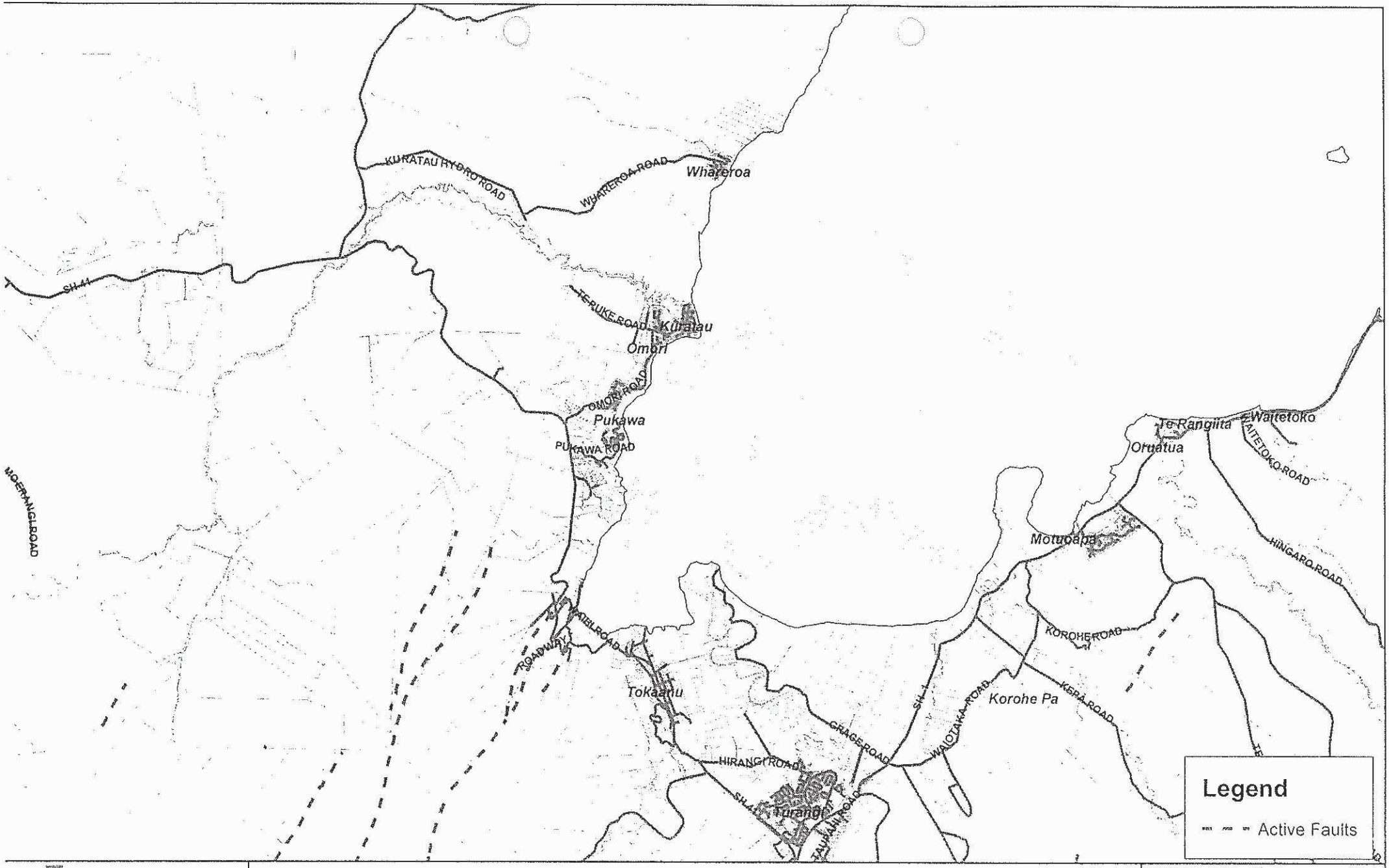
GEOCON SOIL TESTING LTD
Geotechnical Engineers
1150 Victoria Street, P.O. Box 9123, Hamilton

BORE HOLE LOG

TEST PIT No. 7
LOCATION: Refer Site Plan RL (m):
SHEET: 1 OF 1 Fig. No. A-8

APPENDIX K

TDC; Fault lines plan



Taupo District Council

Falut Lines Southern Lake Taupo

N

0 1,375 2,750 5,500 8,250 11,000 Meters

Scale (A3) - 1 112 000

Map Author Anna Eilers
Map Date. 9 May 2007
Map Location V:\GIS_Maps\Public Maps\Sth_Dist_faults

APPENDIX L

Contour Plan of Development Area

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NOTES:

- PLAN IS SUBJECT TO 'RMA' APPROVALS
- WARNING:

THIS PLAN HAS BEEN PREPARED FOR THE PURPOSE OF A MARKETING PLAN ONLY. IT IS NOT A PRECISE SURVEY PLAN. AS AREAS AND DIMENSIONS ARE LIKELY TO VARY UPON FURTHER DESIGN AND SURVEY IT SHOULD NOT BE ATTACHED TO ANY SALE & PURCHASE AGREEMENTS WITHOUT AN APPROPRIATE CONDITION TO COVER SUCH VARIATIONS.

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KEY SOLUTIONS
Mary Mannings Ltd

Rev	Date	Amendment	By	Chk	App
C	17/09/17	STAGE BOUNDARY AMENDED	PH	DGF	DGF
B	28/07/17	HATCH ADDED, TEXT AMENDED	PH	DGF	DGF
A	21/07/17	FOR REVIEW	PH	DGF	DGF

Project Title

THE PROPRIETORS OF HAUHUNGAROA No.6 TRUST WHARER0A NORTH

Drawing Title

CONCEPTUAL DEVELOPMENT OF HAUHUNGAROA No.6 TRUST LAND STAGE 1

Surveyed	IBA		
Designed	D FORSYTH	21/07/17	DGF
Drawn	P HARRIS	21/07/17	PH
Checked	D FORSYTH	21/07/17	DGF
Approved	D FORSYTH	21/07/17	DGF

Status DRAFT

Scale A3 1:1000 | A3

Drawing Number IBA1070-SC005 | Rev

DRAFT NOT FOR CONSTRUCTION

AutoCAD

F:\0.Cheal Consultants_Ian Blance & Assocs\1070 Whareroa\Whareroa CAD\Planning\1070-SC003-04.dwg 8/Dec/2017 12:42 p.m.