Appendix G

Geotechnical Appraisal

Report

MacKays to Peka Peka Expressway

Preliminary Geotechnical Appraisal Report

The New Zealand Transport Agency

By MacKays to Peka Peka Expressway Alliance

29 September 2010

NZ TRANSPORT AGENCY
WAKA KOTAHI

1 MacKays to Peka Peka Expressway

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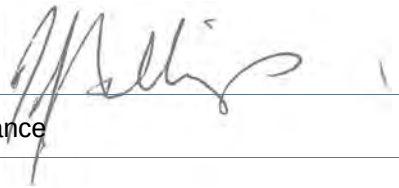
Approved by	Ian Billings		
on behalf of	MacKays to Peka Peka Alliance		

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1 Introduction

The SH1 MacKays to Peka Peka (M2PP) Expressway project is a critical part of the SH1 Wellington Northern Corridor. This corridor is one of seven Roads of National Significance (RoNS) prioritised by the Government to contribute to New Zealand's economic growth. The M2PP Expressway Alliance has been formed to deliver this project.

The M2PP Expressway project starts at MacKays Crossing and joins back into SH1 to the north of the existing Peka Peka Rd intersection. The MacKays Crossing project, located to the south of this project, has recently been completed. The delivery of the Peka Peka to Otaki project located immediately north of this project, is expected to overlap with the delivery of this project.

The Project Alliance is currently undertaking the investigation and scoping phase for the M2PP Expressway Project. As part of this phase, a long-list of alignment options and sub-options has been developed. These options and sub-options are currently being evaluated to allow the selection of a short-list of options to be taken forward into the scheme assessment phase.

This Preliminary Geotechnical Appraisal Report presents a review of the geotechnical information available, and the geotechnical/hydrogeological issues that may impact on the proposed scheme. Additional geotechnical testing is required to further evaluate the geotechnical conditions for preliminary design of this project. The recommended scope of geotechnical testing for the investigation and preliminary design phase (Stage 1A) is presented.

The geotechnical aspects across the study area are presented in terms of four project sectors. For the options and sub-options, the geotechnical considerations are highlighted where these vary significantly between options. This report is intended to be read in conjunction with the overall project evaluation presented in the MacKays to Peka Peka Expressway Scoping Report.

2 Proposed Scheme

The M2PP Expressway project consists of approximately 18km of four lane median divided expressway. The proposed expressway starts to the north of MacKays Crossing on SH1, runs through the areas of Paraparaumu and Waikanae, and joins SH1 just north of the existing Peka Peka Road intersection.

The project has been divided into four sectors, from the south to the north, as described and shown below. The geotechnical conditions are described in terms of these sectors within this report.

- Sector 1 MacKays Crossing to just north of Raumati Road
- Sector 2 North of Raumati Road to north of Mazengarb Road

- Sector 3 North of Mazengarb Road to north of Te Moana Road
- Sector 4 North of Te Moana Road to Peka Peka.

The project scope comprises a number of interchanges along the length to provide connections with local roads. The scope also includes bridge structures for local road crossings to maintain connectivity and for river/stream crossings, with a 200m long crossing over the Waikanae River. Earthworks comprise new embankments across low lying areas, cut slopes through sand dunes and new approach embankments for structures.

A number of base options and sub-options have been developed for the project as part of the investigation and scoping stage. These options are described in detail within the Scoping Report.

The base options provide different levels of connectivity, with a varying number of interchanges/partial interchanges and an additional Waikanae River Crossing.

- Option 1 - north and south connections but no intermediate interchanges.
- Option 2 - north and south connections plus one intermediate interchange (Otaihanga Road or Kapiti Road).
- Option 3 - north and south connections plus two intermediate interchanges (Combination of Iharaka Street Extension, Kapiti Road, Otaihanga Road or Te Moana Road).

The sub-options provide localised variation in alignment and interchange configurations. The significant variations in alignment being considered are outlined below:

- In Sector 1, there are two alignment sub-options for the southern connection. Sub-options S1A to S1Ciii deviate from the existing SH1 to the south of Poplar Avenue and run accross the corner of Queen Elizabeth Park, connecting into the designation north of Poplar Avenue. Sub-options S1Di and S1Dii continue along the existing SH1 alignment to Poplar Avenue and deviate to the north of Leinster Avenue, connecting into the designation immediately south of Raumati Road.
- In Sector 2, sub-options focus on interchange locations, split interchanges and a slight alignment shift to the east of the designation.
- In Sector 3, a number of cultural, environmental and property constraints have been identified. Six alignment sub-options (S3Ai to S3F) have been developed within this sector to reduce the impact of the Expressway.
- In Sector 4, the alignment is constrained by ecological areas to the north of Te Moana Road. There are two alignment sub-options to the north of Smithfield Road, one along the designation and one to the east of the designation.

3 Available Geotechnical Investigation Data

A review of the available geotechnical data has been completed for the expressway corridor. Several geotechnical investigations have previously been undertaken across the project site, for both the development of a north-south link along the designation (proposed Sandhills Motorway and Western Link Road) and the new MacKays Crossing Project. In addition, there is geotechnical data available for the Waikanae area from the Kapiti Coast District Council borefield project. The previous geotechnical investigation data are tabulated in Appendix A.

The existing geotechnical information generally covers the designation corridor from Poplar Avenue to Te Moana Road. The majority of this data is shallow (test pits, or bores up to 10 m), with deep data only available at selected locations (Wharemaku Stream, Waikanae River, and Raumati Road). There is limited data available adjacent to SH1 to the south of Poplar Avenue, and in locations where the proposed alignment option is outside the current designation. No is data available from Te Moana Road to Peka Peka Road.

The sources of existing geotechnical information that have been used to develop the geotechnical model for this project are outlined below.

Western Link Road Geotechnical Reports (Opus):

- Stage 1, Raumati Rd to Te Moana Rd Design and Project Documentation Stage, Geotechnical Report May 2008
- Stage 1, Raumati Rd to Te Moana Rd Design and Project Documentation Stage, Site Investigation Report (addition to July 2007) April 2008
- Stage 1, Raumati Rd to Te Moana Rd Site Investigation Report July 2007

- Stage 1, Raumati Rd to Te Moana Rd Design and Project Documentation Stage, Groundwater Monitoring Plan November 2008
- Stage 1 Boreholes and Trial Pits, complete copy of bore logs and variable head tests May 2007
- Stage 3 Geotechnical Investigations Site Investigations Report March 2009

Other Geotechnical Reports:

- Opus, 1997: State Highway 1 Poplar Avenue to MacKays Crossing Scheme Assessment: Geotechnical Report. Prepared for Transit New Zealand
- Opus, 1999: SH1 Poplar Avenue to MacKays Crossing: Safety Improvements, Geotechnical Assessment of Trial Embankment
- URS, 2005: Waikanae Borefield Technical Report, Prepared for KCDC
- Works 1992: Paraparaumu Bypass/Arterial Land Disposal Study: Geotechnical Report.

4 Topography

The expressway route traverses the Kapiti coastal lowlands to the west of the Tararua Ranges foothills. The route is undulating to rolling, with sand dunes forming areas of higher relief (up to around 20 m elevation) and intervening low-lying interdune areas, located within a relatively flat coastal plain a few metres above sea level. There are also low alluvial terraces associated with Waikanae River and streams in the area. The geology along the route is reflected in the landforms and topography observed.

5 Geology

The Expressway traverses across dune sands and swamp deposits, the dunes rising to around 20 m elevation, with intervening low lying areas and depressions typically containing peat. Recent river and fan alluvial deposits form low level terraces adjacent to the Waikanae River, including the present floodplain. The site is generally underlain by alluvial sand and gravel deposits, with greywacke bedrock expected to be encountered at depths between 70 and 120m.

Geological History

An understanding of the geological history of the Kapiti area provides a framework for interpreting the ground conditions which are likely to be encountered along the expressway route.

The near surface geology of the area developed during repeated glacial and interglacial cycles that have occurred over the past 2 million years. During the glacial cycles, sea levels were approximately 120 m lower than present as more water was locked up in ice-sheets and glaciers.

Conversely, when the climate warms during inter-glacial periods, sea levels rise because of melting of the ice-sheets and glaciers.

During the cold glacial periods, the Tararua Ranges held valley glaciers and the whole Wellington region was affected by intense periglacial activity. Physical weathering, combined with sea level fall, increased the amount of erosion from the ranges. This eroded material was redeposited as thick alluvial and glacio-fluvial outwash plains. Subsequent erosion of these deposits by the rising sea level occurred during the interglacial periods.

The oldest Quaternary deposits originate from the Last Interglacial (approximately 120,000 years ago). The rising sea level cut a cliff in the coastal hills, and deposited marine/beach gravel and sands, estuarine sands, and dune sands at the coast. These Pleistocene aged deposits can be expected at depth beneath the MacKays to Peka Peka route, forming a thick wedge over greywacke basement (depth to rock variable).

Towards the end of the Last Glaciation (15,000 years ago), sediment laden rivers laid down thick alluvial deposits of gravel, sand and silt as out-wash plains. These deposits form aggradation terraces known as the Parata Gravels which are exposed in the banks of the Waikanae River.

The rising Post-Glacial sea level eroded a flat sea bed along the Kapiti Coast, and the coast prograded as sediment was added from inland erosion. Beach and estuarine deposits accumulated, along with river alluvium. Several successively younger phases of sand dune formation took place. Collectively known as the Himatangi Group, the dune sands are interfingered with interdune swamp deposits named Paraparaumu Peat; the peat deposits may be overlain by sand dunes which in places have advanced over the swamps.

It is the dune sands and swamp deposits which dominate the geology along the expressway route, the dunes rising to around 20 m elevation, with intervening low lying areas typically containing peat. Some of the dune sands have a volcanic ash and pumice component from North Island volcanic activity around the time of their formation.

5.1 Material Descriptions

The geological units within the Kapiti Coast relevant to the Expressway route are described below. The unit names are taken from Heron and Van Dissen (1992).

Recent River and Fan Alluvium

Low level terraces adjacent to the Waikanae river, including the present floodplain. Generally moderately sorted, subrounded gravel to cobble sized greywacke with sandy/silty matrix, with local lenses of sand/sandy silt.

Recent Dune Sand (Himatangi Group)

Loose, medium sand, fresh/slightly weathered, with occasional thin clay/silt beds. Thin iron pans may be found near the water table in older (inland) dunes.

Interdune Deposits (Paraparaumu Peat)

Swamp deposits including soft peat and loose peaty sand through to spongy vegetable matter with high water content (some between 65 and 700% water by weight). This material is often described as woody peat with clay/silt and sand lenses. These deposits can extend beneath more recent dunes.

Beach/Marine/Estuarine Deposits

These deposits underlie the recent dune sands and interdune deposits, and tend to be gravelly sands nearer the mouths of rivers, elsewhere loose, fine to coarse sand.

Terrace Alluvium (Parata Gravels and others)

Poorly sorted greywacke gravel to boulder sized clasts in a matrix of coarse sand, with localised thin lenses of sand/sandy silt. Typically slightly weathered, older deposits may be moderately weathered. Loess may be found separating successive gravel deposits.

6 Seismicity

The Expressway is located within an area of high seismic activity. This section presents a summary of the known faults located in close proximity to the site. The design considerations associated with the seismicity, including the liquefaction hazard and design earthquake events are also presented.

There are SW-NE orientated active faults located north, south, and east of the Expressway route. Though no active faults are mapped passing directly through the site, there is a possibility that splinters of these major active faults may be present. Table 6.0 outlines the active faults in the area, their distances from the project site, and their characteristics (largely based on the published information contained in Begg and Johnston (2000), supplemented by more recent research).

Table 1 – Active Faults

Fault name	Distance from Expressway route	Estimated Characteristic Magnitude (Mw)	Recurrence Interval (1000 years)	Recurrence Interval Class	Elapsed time since last EQ (1000 years)	Est. single event displacement	Confidence of Recurrence Interval Class
Pukerua Fault*	7.5 km SW of southern end	7.6	2.5 – 5.0	Class II	> Ohariu F. (>1.06 – 1.14)	3.5 – 4.0 m (horz)	Low
Hadfield Fault**	1-2 km east of Peka Peka Rd end of route	?	?	?	?	?	?
Ohariu Fault	3 km E of route	7.6	1.3 – 3.8	Class II	1.06 – 1.14	3 – 5 m (horz)	Low
Gibbs Fault	4 – 5 km E of route	?	> 3.0 to <5.0	Class III	<10	1.5 m (vert)	Low
Northern Ohariu Fault	2 km NE of northern end of route	7.3 – 7.7	3 – 3.5	Class II	< 4	3 – 3.5 m	Low
Otaki Forks	15 k m E of route	7.3 – 7.6	> 3.0 to <5.0	Class III	?	2.5 -3.5 m (horz)	Low
Wellington Fault***	25 km E of route	7 – 7.6	0.9	Class I	0.3	3.5 – 5 m (horz)	High

* Pukerua Fault is considered part of the same geologic structure as the Shepherds Gully Fault, and rupture characteristics for the two are grouped in Begg and Mazengarb (1996). While this grouping is not given in the later map of Begg and Johnston (2000), it is assumed the rupture characteristics of the Shepherds Gully Fault also hold for the Pukerua Fault (in the absence of specific information for the Pukerua Fault.

** Currently the presence of the Hadfield Fault is disputed. It is likely to be a splinter fault as the Ohariu Fault steps to become the Northern Ohariu Fault. Earthquakes on the Ohariu and Northern Ohariu fault likely to govern seismic class.

*** The recurrence interval and elapsed time since last earthquake for the Wellington Fault quoted above are based on the media release on the GNS website, dated 18th September 2009.

6.1 Fault Hazard

A splinter fault of the Ohariu Fault known as the Hadfield Fault has been identified at the northern extent of the project, and this needs to be considered in relation to the proposed Peka Peka Road Connection. The fault is considered active, however this has been disputed. The fault complexity (i.e. possibly a fault zone as opposed to single fault trace), and level of uncertainty regarding its location, is indicated by the shaded triangle on the KCDC Fault Hazard Maps (Appendix B).

The fault is relatively well defined to the north-east of the scheme, though is less constrained, with greater uncertainty across the expressway area of interest.

This fault hazard needs to be considered in the selection of the Peka Peka Road interchange location, in particular the position of any interchange structures. Further work is required to better understand and define the fault complexity and hazard. This will reduce the uncertainty and zone of risk.

6.2 Seismic Design Hazard

The seismic design events for this project have been derived based on the Transit Bridge Manual and NZS1170.5. NZS1170.5 indicates that the Paraparaumu and Waikanae areas have a hazard factor (Z) of 0.4. Based on the ground profile information currently available and expected depths of soil, the site has been classified as subsoil class D.

The seismic design events have been derived from the importance levels outlined in the provisional amendment of the Transit Bridge Manual. For approach embankments and abutment walls associated with a bridge structure, the ultimate seismic design event is equivalent to that for the adjacent bridge structure. For embankments, cuts and retaining walls supporting the expressway and independent of bridge structures, the ultimate design event adopted is equivalent to a 1 in 1000 year return period event. The earthquake design parameters for the expressway route are then as follows:

Table 2 – Earthquake Design Parameters

Application	Importance level	Annual probability of exceedance (APE)	Ru	PGA (g)
Embankments and retaining walls associated with an Expressway Over Bridge	3 or 4 (ULS)	1/2500	1.8	0.81

Application	Importance level	Annual probability of exceedance (APE)	Ru	PGA (g)
Embankments and retaining walls associated with a Local Rd Over Bridge. Independent embankments and retaining walls.	2 (ULS)	1/1000	1.3	0.58

We recommend a site specific hazard assessment is undertaken to refine the seismic hazard, once the interchange and route alignment option has been selected.

6.3 Liquefaction Hazard

There is the potential for liquefaction to occur along the Expressway route, based on the high seismicity and ground conditions present.

Loose to medium dense sand deposits are present within the sand dunes and underlying marine and alluvial deposits. These deposits are susceptible to liquefaction where saturated, based on material characteristics and grain size. Above the ground water level, they will be susceptible to shaking induced settlement.

A preliminary liquefaction assessment has been carried out, considering the available borehole strength data and water levels from adjacent piezometers. This assessment indicates these saturated, loose to medium sand deposits are expected to liquefy under the 1000 year return period event. These deposits are expected to be encountered across the entire site.

Liquefaction of these deposits is expected to result in:

- Ground settlements.
- Seismic induced slope instability and horizontal movements of existing sand dunes and new embankments constructed over these deposits.
- Potentially lateral spreading or flow failure of existing sand dunes, new embankments, and new approach embankments for the Waikanae River Crossing.

The liquefaction hazard may be mitigated at specific locations by ground improvement techniques. Liquefaction potential and the likely effects are specifically addressed within Section 11.

7 Groundwater

Based on previous hydrogeological reports in the study area, it is understood that groundwater is drawn for public supply from a series of wells screened in the Waimea gravel aquifer at some 80 m

depth. The public water supply wells are primarily located along Ngarara Road, Park Avenue and Moana Road in Waikanae.

There are also shallow confined and semi-confined aquifers within the post glacial deposits, with groundwater levels near surface, located up to a few metres below ground in the interdunal areas, and at significant depths below ground in the dunes - though elevated a couple of metres relative to the interdunal areas (i.e. groundwater mounds beneath the dunes). A large number of wells for domestic supply are spread over the Kapiti Coast area and are mainly screened in these shallow aquifers.

It is understood that the groundwater flow in the region is east to west (i.e. toward the coast) on a 0.3 to 0.4% gradient, with the Waikanae River recharging groundwater in the east, and conversely groundwater feeding the river in the west of the region. The Mazengarb Drain and Wharemaku Stream are also said to be fed by groundwater.

Monitoring undertaken in Council observation wells suggests the shallow aquifers rapidly respond to rainfall recharge, and water levels may typically rise by 0.5 to 3.0 metres in winter. Plans indicating the range in groundwater levels across the scheme are attached in Appendix C.

8 Ground Conditions along Proposed Alignment

The topography and geology along the proposed base alignment is described in Table 8.0 below. Refer also to the long sections in Appendix D, which illustrate the geology and existing topography with the proposed design vertical alignment overlain for reference.

Table 3 – Topography and Soil Profile along the Proposed Route

Sector	Location	Description	Topography	Soil Profile	Long Section Sheet
1		This sector begins north of MacKays Crossing and joins the designation south of Raumati Road. There are two alternative routes at the southern end: one passes through Queen Elizabeth Park (located south of Poplar Avenue), and one deviates from SH1 north of Poplar Road.	The topography is fairly low-lying through Queen Elizabeth Park (at elevations of around 6-7 m), the route initially situated east of the sand dunes in Raumati South, then from south of Poplar Avenue northwards it rises onto the eastern margin of the dunes (which are typically up to 20 m elevation).	Interdune Deposits (Paraparaumu Peat) can be found near surface between MacKays Crossing and Poplar Avenue, to thicknesses of around 4 to 6 metres. The peat is generally underlain by alluvial sand and gravel deposits. Toward the end of this sector there are dune sand deposits.	1, 2, 3 (ch 0-4680)
2		This sector begins near Raumati Road, and runs through to a point approximately midway between Mazengarb and Otaihanga Roads, within the designation. The Otaihanga landfill is adjacent to the designation, off Otaihanga Road.	The topography is undulating, the route crossing over dunes which are typically up to 20 m elevation, with lesser amounts of lower-lying interdune areas in between. It appears that much of this sector of the road corridor preserves a remnant of what was a larger dune field which has undergone extensive earthworks for residential development in Paraparaumu. The Kapiti Rd interchange is constrained by the narrow designation in the urban area of Paraparaumu.	The ground conditions can be expected to comprise dune sand in the elevated areas, with as much as 4 metres of peat in the interdune areas. Underlying marine/beach sand and alluvium typically becomes very dense at depths of around 10 m below ground. The ground is understood to be contaminated by landfill leachate near Otaihanga Road.	3, 4, 5 (ch 4600-8355)
3		This sector runs through the semi-rural area between Paraparaumu and Waikanae within the designation, ending north of Waikanae near Te Moana Road.	The topography is undulating, the route passing over dunes (which are typically up to 20 m elevation) and lower-lying interdune areas. Toward the centre of this sector the Waikanae River cuts through the route east-west, with associated low-lying alluvial terraces on either side.	The geology can be expected to comprise dune sand in elevated areas, with up to a few metres of peat in the interdune areas. Underlying alluvium typically becomes very dense at depths of around 10 m below ground. Within the Waikanae River area, very dense alluvial gravels underlie alluvial sand at around 15 m depth.	5, 6, 7, 8 (ch 8355-12250)
4		This section runs from Te Moana Road through to Peka Peka Road over an area of farmland north of Waikanae.	The topography is undulating, dominated by dunes until Smithfield Road, east of which the route flattens out.	There are no previous geotechnical investigations in this area. Based on geomorphology and published maps, the geology is anticipated to comprise dune sand in the elevated areas, with some peat in low lying areas, underlain by marine/beach/estuarine deposits.	8, 9, 10, 11 (ch 12250-18339)

9 Geotechnical Considerations

The key geotechnical considerations that have been identified for this project are:

- The presence of peat deposits across the site, and associated embankment settlements and stability.
- The high seismic hazard and known active faults (refer Section 6).
- The presence of relatively loose saturated sand deposits with the potential to liquefy during the design seismic events. Liquefaction induced slope instability and settlements.
- Founding conditions for bridge structures comprising alluvial deposits to depth, predominately interbedded dense sands and gravels.
- Potential effects on the shallow unconfined aquifer system, which is used for irrigation and feeds ecologically valuable wetlands. Potential groundwater effects may result from changes in permeability of the near surface material.

These aspects are described in detail in Sections 10 to 14. The geotechnical aspects are of particular relevance to the following proposed scheme features:

- Proposed earthworks including cuts up to 20m high and embankments up to 8.5m high.
- Proposed bridge structures, including foundations and ground improvements.

The geotechnical considerations identified above are generally widespread across the area of interest, and therefore are applicable to all options and sub-options under consideration to varying degrees. Any interchange locations or alignment variations where these issues are expected to be of higher significance are highlighted below.

10 Peat Deposits

Peat deposits have been encountered along the route in the low lying inter-dunal depressions. The peat is very soft, with a high water content. It varies in nature from fibrous to amorphous. These deposits are typically 0.5m to 4.0m thick, and up to 6m thick in some locations.

The presence of peat deposits across the site is a key geotechnical aspect for this project. Key considerations associated with construction of a road embankment over weak peat deposits include:

- Settlement of these underlying deposits. Post construction settlements and potential differential settlements will impact on the performance of the Expressway, resulting in poor rideability, altered surface drainage patterns and increased maintenance.

- Stability of embankments constructed on weak foundations, in particular the temporary (construction stage) and seismic stability case.
- Potential settlement of services beneath the embankment and adjacent structures and property.

10.1 Peat Extent and Thickness

The peat deposits vary in thickness and depth along the alignment. This variation is described along the Expressway route below. The differences in peat distribution for the scheme options and sub-options are presented in Table 9.1.

At the southern end of the Expressway, a large area of relatively thick peat is present from the edge of the foothills and across Queen Elizabeth Park. Peat depths of 4m to 6m are expected in this area. Peat is also present north of Poplar Avenue between the foothills and the sand dunes within the designation.

From Raumati Rd to Te Moana Rd, peat is present in isolated depressions between the sand dunes. Near Wharemaku Stream, the peat deposits are interbedded with alluvial deposits to a depth of 6m. Significant peat deposits are also expected in the low lying area near Ihakara Street Extension.

There is limited information available on the peat depth and extent to the north of Te Moana Road. Based on a site walk over and discussions with local contractors, there is expected to be a large area of peat to the north of Smithfield Road. This is expected to be in the order of 2 to 3m thick.

Table 4 – Peat Deposits along Expressway

Location Description	Relevant Options	Peat Extent and Depth
Southern end, from foothills west across Queen Elizabeth Park	All options run adjacent to SH1 Sub-options S1A - S1Cii run across Queen Elizabeth Park	The limited data and experience from recent projects in close proximity, suggest the peat is typically 4.0 to 6.0m thick.
Queen Elizabeth Park towards Poplar Avenue	Sub-options S1A - S1Cii	Typically 3.0m
West of the existing designation, between Poplar Avenue and Raumati Road	Sub-options S1Di – S1Dii	Typically 2.0 to 3.0m
Along designation between Poplar Avenue and Te Moana	All options	Peat and Sand Dunes. Peat generally in isolated areas along the

Location Description	Relevant Options	Peat Extent and Depth
Road		alignment. Typically 1.0 to 3.0m, up to 4.0m.
Wharemaku Stream Bridge	All options	Peat interbedded with alluvial deposits to a depth of 6.0m.
East of designation, Wharemaku Stream to Kapiti Road	All options, particularly relevant to options 3B and 3C and sub-options S2Ai, S2Aii and S2Bi	Significant depression with up to 4.0m of peat.
Te Moana Road to Smithfield Road	All options	Limited data available. Peat and Sand Dunes. Peat generally in isolated areas along the alignment. Typically 1.0 to 2.0m.
North of Smithfield Road to Peka Peka Road	All options	The limited data and experience from recent projects in close proximity, suggest the peat is typically 3m

10.2 Peat Treatment and Ground Improvements

Ground improvements will be required where peat deposits are encountered below the Expressway footprint, to mitigate the risk of post-construction differential settlements, and increased maintenance requirements.

The level of ground improvements undertaken will directly affect the scheme cost and the residual risk of poor Expressway performance. The balance between upfront capital costs and on-going risk profile needs to be discussed and agreed with NZTA as this project progresses.

The treatment adopted will vary across the route depending on the depth and extent of the peat expected to be encountered, sensitivity of adjacent infrastructure, and cultural sensitivity of the area.

The treatment options available can be generally classified under two design approaches, as described below:

Excavate and Replace

This treatment option involves removing the peat deposits from below the expressway footprint. It is considered a high cost - low risk approach, as the potential risk of settlement is eliminated. This

approach is generally considered feasible where peat depths are less than 3m. Excavation and replacement is not considered a feasible treatment for greater peat depths based on economics, constructability and potential effects from dewatering. Environmental considerations associated with this treatment include disposal of peat and effects on groundwater.

Pre-load and Surcharge

This treatment option involves constructing the road embankment over the peat deposits and allowing the majority of settlement to occur prior to pavement construction, however some on-going creep settlements are expected as the peat continues to decompose. Other considerations associated with this treatment include potential to cause settlement to services below the footprint (and adjacent property), disposal of peat, and effects on groundwater.

Measures will need to be incorporated into the design to limit post-construction settlements to an acceptable level for serviceability and on-going maintenance. The magnitude of post construction settlements can be reduced by: surcharging above the final construction level, increasing the pre-load period, partial removal of the peat or strengthening of the peat with ground improvements. Differential settlements can be reduced by construction of a stiff raft over the peat.

10.3 Re-use and Disposal of Peat

The peat deposits are expected to be suitable for re-use as landscape fill, where on-going settlements are acceptable. These deposits would need to be dried to lower their naturally high water content prior to placement as fill, and may need to be mixed with sand.

11 Seismic Design

The proposed scheme is located in an area of high seismicity. The seismicity, including faulting and liquefaction hazards, is detailed in Section 6.

The seismic performance of the expressway, during and post seismic design events is a key design aspect. The acceptable level of damage, emergency access and post-earthquake repair requirements under design events needs to be considered by NZTA, and balanced against the economics and risk profile.

11.1 Liquefaction

Liquefaction is predicted to be widespread across the site under a significant earthquake event. Liquefaction induced instability and lateral spreading of slopes is expected. Movements are likely to be in the order of hundreds of millimetres up to several metres.

For earthworks (cuts and embankments) it is unlikely to be economically feasible to prevent seismic induced instability and lateral displacements where foundation soils liquefy. Ground improvements

to prevent wide spread liquefaction across the route are not currently proposed. This approach is in line with current practise, and has been adopted for other RONs projects (such as Christchurch Southern Motorway and Tauranga Eastern Link). Under a significant seismic event, the expected performance of slopes and envisaged repairs need to be assessed, and discussed with NZTA.

For bridge approach embankments, liquefaction is likely to result in lateral spreading of abutments and significant additional loads on the structure. This can lead to severe damage or collapse of the structures. It is expected that bridge structures along this NZTA strategic route will need to provide emergency access following a significant earthquake event and be repairable. Ground improvements at the bridge approaches are required to achieve this level of performance, and are currently proposed for this scheme.

12 Earthworks

The project earthworks involve:

- Cuts through sand dunes, up to approximately 20m high.
- Fill embankments across low lying areas, up to approximately 8m high.

The Expressway alignment (s) and earthworks requirements are associated with the undulating topography of the region and provision for grade separated crossings of local roads.

General earthworks considerations are detailed below, and are applicable for all options.

12.1 Cut Slopes

Design considerations for cut slopes within the sand dunes include:

- The cut slope profile required is likely to be approximately 3H:1V. A benched profile and drainage measures may be required for stability of large cut slopes.
- There are a number of existing cuts in the area. These cuts need to be inspected and the performance taken into consideration when assessing the stability of the proposed cuts.
- The dune sands are prone to erosion, by both wind and water. Water will be required during construction to control dust. Erosion control measures, such as re-vegetation of slopes, will need to be implemented during and immediately after construction.

12.2 Embankments

Design considerations for embankments include:

- The presence of peat deposits, and associated stability and settlement issues. These are detailed in Section 10.

- The material cut from the sand dunes is suitable for use as cut to fill, and is likely to be used for embankment construction. Additional water may need to be added to achieve the required compaction, and confinement by a coarser granular fill may be required in places.
- The embankment profile is expected to be approximately 3H:1V. This may be steepened depending on fill material type selected or use of reinforcement.
- The erosion control measures discussed above are also applicable for embankments constructed using dune sands.

13 Bridge Structures

There are a number bridge structures required for interchanges, and local road and river/stream/watercourse crossing along the expressway. The Waikanae River crossing is a major river crossing, and the structure is expected to be approximately 200m in length to bridge across the flood plain. The structures required for each option are detail in the Scoping Report.

General structural considerations are detailed below, and are applicable for all options.

13.1 Foundations

The site is underlain by dense to very dense sand/sandy gravel at depth. These are uncemented and vary with depth. At the Waikanae River crossing, the founding conditions are predominantly dense to very dense gravels at depth, with some cobbles and boulders. There is limited deep geotechnical data at structure locations, and further investigations are required to confirm foundation conditions.

For each bridge structure, piled foundations and approach embankments are expected to be required. The pile design needs to consider:

- Scour depths.
- Negative Skin Friction (NSF) resulting from both consolidation and liquefaction settlements.
- Seismic induced embankment displacements.

13.2 Ground Improvements

Ground improvements will be required below the approach embankments for seismic performance, based on high seismicity and liquefaction potential, refer Section 11.

14 Groundwater

The site is underlain by a series of shallow unconfined aquifers, with high connectivity. The groundwater level is close to the existing ground level in the low lying areas and wetlands. The

shallow aquifers feed the wetland areas, which are considered to have high ecological value. Shallow residential bores target this aquifer for irrigation purposes. Constraints associated with groundwater include:

- Changes in permeability and groundwater flow resulting from the Expressway construction need to be considered and affects assessed. Potential permeability changes include consolidation of peat or removal of peat and replacement with another more permeable material.
- The choice of construction techniques adopted for excavation (earthworks and piling) need to consider potential dewatering and impacts on water quality.
- Changes in ground water level resulting from the Expressway construction need to be considered and assessed, including potential settlements below the embankment and on surrounding properties.

15 Geotechnical Testing

Geotechnical investigations are recommended to further evaluate the geotechnical and hydrogeological conditions for the primary design, scheme assessment, and assessment of effects phases of this project. A schedule of the proposed investigations, along with the purpose for testing is provided in Appendix E.

It is proposed these investigations are carried out in two stages.

Initial Investigation Phase

The initial stage, programmed prior to preliminary design, will target areas along the route where there is limited geotechnical information available. The investigations during this phase have been scoped to provide general geotechnical information along the route corridor, and to assist in characterising the material types encountered in the area. These focus primarily on the southern and northern extents of the project.

The testing comprises:

- A series of cone penetration tests (CPTs) to provide efficient widespread coverage of the targeted areas.
- Boreholes to provide correlation of the between the CPT data and the ground conditions to the CPT data.
- A number of test pits to sample the peat deposits.
- Laboratory testing to characterise the materials encountered.

Second Investigation Phase

The second phase, programmed following more route certainty, is to determine the foundation conditions at specific interchange and bridge structure locations. This proposed investigation is to comprise of a series of deep boreholes to provide input into pile design. In addition, it will be used to fill in any gaps within the existing geotechnical data along the route where required.

The second phase will also include installation of piezometers, along the route and off- alignment, to provide information for groundwater modelling. These will be monitored to create a groundwater baseline for the project.

Additional Investigations

The following additional investigations are recommended:

- A trial embankment constructed on peat to provide information on settlement (magnitude and timing).
- Site specific seismic study, to further classify the Hadfield Fault complexity and refine the seismic hazard for the scheme.

16 References

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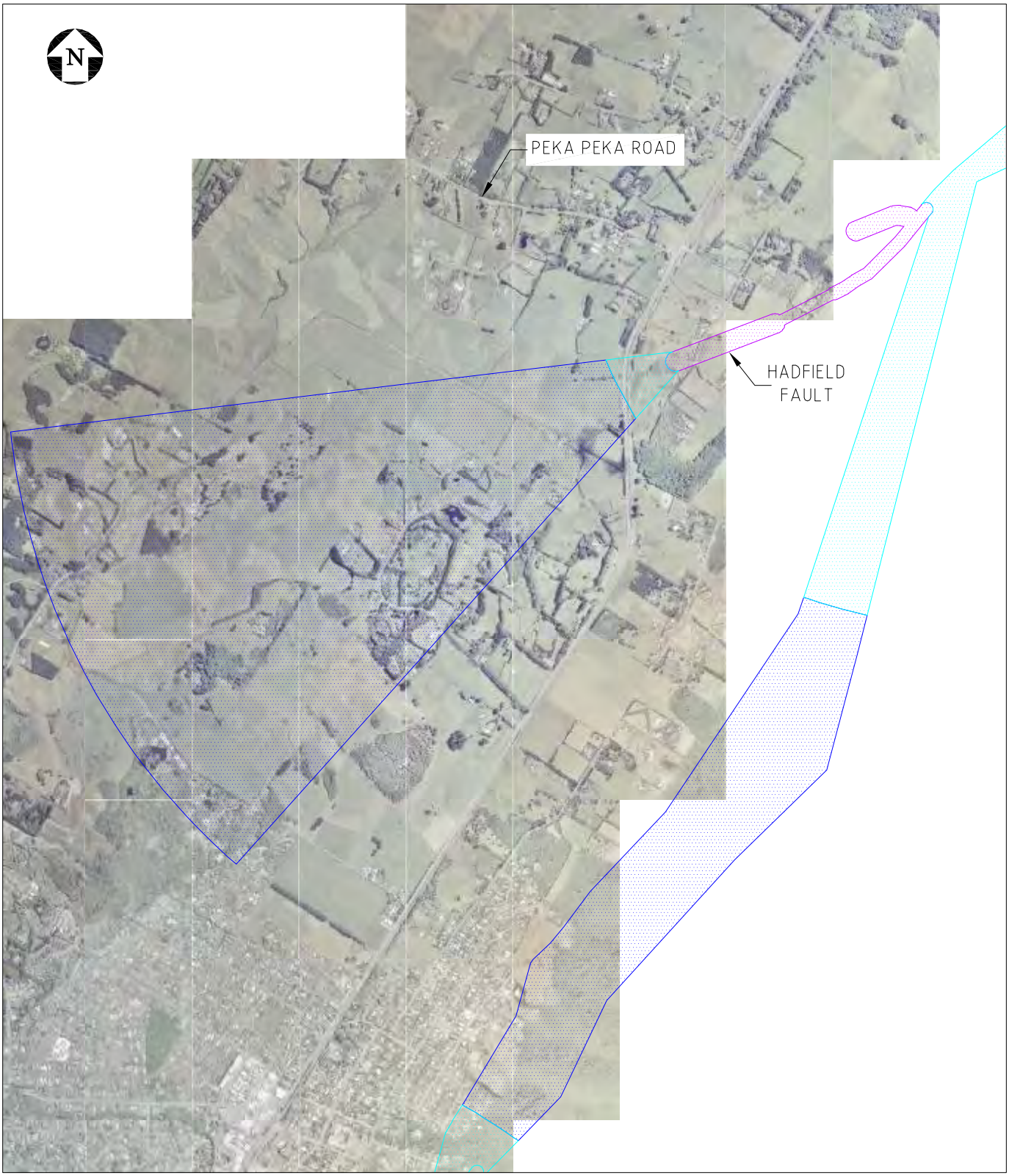
APPENDIX A Previous Investigation Data – Summary Table

Previous Geotechnical Investigation Data

Report Title (author)	Year	Investigations Undertaken
Stage 1, Raumati Rd to Te Moana Rd Design and Project Documentation Stage, Geotechnical Report (Opus International Consultants)	May 2008	▪ 2 CPTs ▪ 2 SPs
Stage 1, Raumati Rd to Te Moana Rd Design and Project Documentation Stage, Site Investigation Report (addition to July 2007) (Opus International Consultants)	April 2008	▪ 5 BHs ▪ 20 CPTs ▪ 11 TPs (including 11 Scala tests, 6 in situ density tests, and 9 California bearing ratio tests) ▪ 3 piezometers ▪ 11 HAs ▪ 151 SPs ▪ 10 PTPs ▪ 3.8 km Benkleman beam testing ▪ 1 Pilcon shear vane test ▪ Laboratory classification, compressibility and strength testing
Stage 1, Raumati Rd to Te Moana Rd Site Investigation Report (Opus International Consultants)	July 2007	▪ 20 BHs (including 19 piezo installations, 18 permeability tests) ▪ 20 TPs (including 7 scalas, 9 in situ CBR tests, 5 nuclear densometer tests, 6 push tube samples, 16 bulk samples) ▪ 41 CPTs ▪ 65 SPs ▪ 15 HAs ▪ 32 Pilcon shear vane tests ▪ 3 push tubes ▪ Lab testing (water content, Atterberg limits, particle size, one dimensional consolidation, triaxial, compression, organic content, CBR)
Stage 1, Raumati Rd to Te Moana Rd Design and Project Documentation Stage, Groundwater Monitoring Plan (Opus International Consultants)	November 2008	Groundwater monitoring results for 22 piezometers from existing bores (those listed in July 2007 and April 2008 reports)
Stage 1 Boreholes and Trial Pits, complete copy of bore logs and variable head tests (Webster Drilling and Exploration Ltd)	May 2007	Drillers records of 2007 investigation borehole, trial pit and variable head test data

Report Title (author)	Year	Investigations Undertaken
Stage 3 Geotechnical Investigations Site Investigations Report (Opus International Consultants)	March 2009	14 HAs
Paraparaumu Bypass. Land Disposal Study. Geotechnical Report (Works Consultancy Services)	1992	37 auger holes (truck mounted) 9 HAs Laboratory testing (standard compaction, particle size distribution)
Kapiti Coast SH1 Study. Paekakariki to Otaki Section. Geotechnical Desk Study Report (Works Consultancy Services)	1993	Desk study of geotechnical issues
Kapiti Urban Roading Project. Geotechnical Investigations for Estimation of Peat Thickness. Factual Report (Opus International Consultants)	1998	32 CPTs
SH1 Paraparaumu Bypass/ Arterial Land Disposal Study Geotechnical Report (Works Consultancy Services)	1992	37 Augers (truck mounted) 9 Hand Augers
Final Report - Waikanae Borefield Technical Report (Update of report issued 27 July 2004)	2005	19 pilot boreholes, 8 of which were completed as production wells; includes drillers logs, geological sections, and relevant water testing data.
HA = hand auger, BH = borehole, TP = test/trial pit, PTP = pavement trial pit, CPT = static cone penetrometer test, SP = Scala penetrometer test		

APPENDIX B KCDC Fault Hazard Map



WELL DEFINED

UNCERTAIN - CONSTRAINED

UNCERTAIN - POORLY CONSTRAINED

KAPITI DISTRICT COUNCIL FAULT ZONES

HADFIELD FAULT

SCALE A4: 1:2500

PROJECT No. 3320901
CAD FILE No. 3320901-GK41

APPENDIX C Groundwater Maps

Drawing Plotted: 16 Sep 2010 15:07

SECTOR 1

SECTOR 2

BH01
RL =
DEPTH =
MAX =
MIN =

BH02
RL =
DEPTH =
MAX =
MIN =

BH03
RL =
DEPTH =
MAX =
MIN =

BH04
RL =
DEPTH =
MAX =
MIN =

BH05
RL =
DPETH =
MAX =
MIN =

2007/BH-A P
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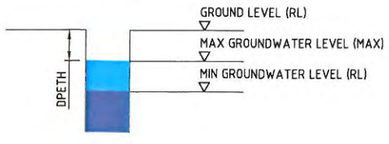
MIN = 4.31



BORE HOLE DETAIL

NTS

No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	SY			26.08.10

Original Scale (A1) 1:10,000
Reduced Scale (A3) 1:20,000

Design			Approved For Issue*
Drawn	SY	26.08.10	
Dsg Verifier			
Dwg Check			Date

* Refer to Revision 1 for Original Signature

NZ TRANSPORT AGENCY WAKA KOTAHI

1 Mackays to Peka Peka

Project: SH1 REALIGNMENT
MACKAYS TO PEKA PEKA
RP 1012/0.00 TO 1023/5.00

Title: GROUNDWATER PLAN SHEET 1

Discipline: CIVIL

Drawing No.: 3320901-CK208

Rev.: A

CAD FILE PATH: P:\332\3320901\CAD\3320901-CK208.DWG

DO NOT SCALE

IF IN DOUBT ASK.

Drawing Plotted: 16 Sep 2010 15:35

LEGEND
- Opus 2007
- Opus 2008
- GWRC
- Beca Proposed

R26/6833
RL(?) =
DEPTH = 1.175
MAX = 1.175m BELOW RL
MIN = 1.617m BELOW RL

SECTOR 2

SECTOR 3

2007/BH-D P
RL = 3.28
DEPTH = 0.81
MAX = 2.47
MIN = 1.61

2007/BH-C P
RL = 4.84
DEPTH = 1.14
MAX = 3.7
MIN = 2.64

2007/BH-W
RL = 3.28
DEPTH = 0.6
MAX = 2.68
MIN = 2.68

2007/BH-U
RL = 6.12
DEPTH = 0.95
MAX = 5.17
MIN = 3.62

2007/BH-E P
RL = 11.11
DEPTH = 5.74
MAX = 5.37
MIN = 3.81

2007/BH-T P
RL = 8.03
DEPTH = 2.2
MAX = 5.83
MIN = 5.02

2007/BH-B P
RL = 5.06
DEPTH = 0
MAX = 5.06
MIN = 4.43

R26/6831
RL(?) = 7
DEPTH = 5.516
MAX = 1.484
MIN = 0.22

2007/BH-K P
RL = 6.2
DEPTH = 0.41
MAX = 5.79
MIN = 5.03

2007/BH-J P
RL = 6.29
DEPTH = 0.08
MAX = 6.21
MIN = 5.72

2007/BH-V P
RL = 7.3
DEPTH = -0.05
MAX = 7.35
MIN = 6.27

2007/BH-I P
RL = 9.7
DEPTH = 1.9
MAX = 7.8
MIN = 3.85

SECTOR 2

SECTOR 1

No.	Revision	By	Chk	Appd	Date
+	UNDER REVISION				

Original Scale (A1) 2
Reduced Scale (A3)

			Approved For Issue*
Design			
Drawn			
Dsg Verifier			
Dwg Check			Date

* Refer to Revision 1 for Original Signature

NZ TRANSPORT AGENCY WAKA KOTAHI

1 Mackays to Peka Peka

Project: SH1 REALIGNMENT
MACKAYS TO PEKA PEKA
RP 1012/0.00 TO 1023/5.00

Title: GROUNDWATER PLAN SHEET 2

Discipline: CIVIL

Drawing No.: 3320901-CK209

Rev.: A

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IF IN DOUBT ASK.

Drawing Plotted: 16 Sep 2010 15:38

LEGEND
- Opus 2007
- Opus 2008
- GWRC
- Beca Proposed

SECTOR 3

SECTOR 4

R26/6673
RL = 4.18
DEPTH = 1.132
MAX = 3.048
MIN = 1.517

R26/6287
RL = 3.33
DEPTH = 1.692
MAX = 1.638
MIN = 0.570

2007/BH-S P
RL = 4.62
DEPTH = 0.69
MAX = 3.93
RANGE = 2.03

2007/BH-Q P
RL = 25.73
DEPTH = 23.1
MAX = 2.63
MIN = 2.2

2008/BH205 P
RL = 3.3
DEPTH = 0.04
MAX = 3.26
RANGE = 2.91

R26/6916
RL = 3.83
DEPTH = 1.889
MAX = 1.941
MIN = 1.087

2007/BH-O P
RL = 2.91
DEPTH = -0.06
MAX = 2.97
MIN = 2.31

2007/BH-N(A) P
RL = 3.36
DEPTH = 0.45
MAX = 2.91
MIN = -4.34

2007/BH-L P
RL = 3.68
DEPTH = 0.08
MAX = 3.60
MIN = 2.71

2008/BH204 P
RL = 13
DEPTH = 8.85
MAX = 4.15
MIN = 4.11

BH06
RL =
DEPTH =
MAX =
MIN =

2007/BH-R P
RL = 4.14
DEPTH = 0.16
MAX = 3.98
MIN = 1.62

BH07
RL =
DEPTH =
MAX =
MIN =

R26/6886
RL = 4.76
DEPTH = 8.118
MAX = 1.645
MIN = -0.032

2008/BH202 P
RL = 13.5
DEPTH = 9.71
MAX = 3.79
MIN = 3.25

2007/BH-M P
RL = 3.64
DEPTH = 0.93
MAX = 2.71
MIN = 1.52

2007/BH-N P
RL = 10.03
DEPTH = 1.7
MAX = 8.33
MIN = 2.75

BH08
RL =
DEPTH =
MAX =
MIN =

BH09
RL =
DEPTH =
MAX =
MIN =

R26/7025
RL(?) =
DEPTH = -0.717
MAX = 4.83m BELOW RL
MIN = 5.907 BELOW RL

No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	SY			26.08.10

Original Scale (A1) 1:10,000
Reduced Scale (A3) 1:20,000

Design			Approved For Issue*
Drawn	SY	26.08.10	
Dsg Verifier			
Dwg Check			Date

* Refer to Revision 1 for Original Signature

NZ TRANSPORT AGENCY WAKA KOTAHI

1 Mackays to Peka Peka

Project: SH1 REALIGNMENT
MACKAYS TO PEKA PEKA
RP 1012/0.00 TO 1023/5.00

Title: GROUNDWATER PLAN SHEET 3

Discipline: CIVIL

Drawing No.: 3320901-CK210

Rev.: A

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LEGEND
- Opus 2007
- Opus 2008
- GWRC
- Beca Proposed

BH10
RL =
DEPTH =
MAX =
MIN =

R26/6992
RL(?) = 4.5
DEPTH = 2.764
MAX = 1.736
MIN = 0.401

BH11
RL =
DEPTH =
MAX =
MIN =

BH12
RL =
DEPTH =
MAX =
MIN =

R26/6991
RL(?) =
DEPTH = 7.742
MAX = 7.742m BELOW RL
MIN = 8.31m BELOW RL

BH13
RL =
DEPTH
MAX =
MIN =

BH14
RL =
DEPTH =
MAX =
MIN =

BH15
RL =
DEPTH =
MAX =
MIN =

BH16
RL =
DEPTH =
MAX =
MIN =

No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	SY			26.08.10

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Design			Approved For Issue*
Drawn	SY	26.08.10	
Dsg Verifier			
Dwg Check			Date

* Refer to Revision 1 for Original Signature

NZ TRANSPORT AGENCY WAKA KOTAHI

1 Mackays to Peka Peka

Project: SH1 REALIGNMENT MACKAYS TO PEKA PEKA RP 1012/0.00 TO 1023/5.00

Title: GROUNDWATER PLAN SECTOR 4

Discipline: CIVIL

Drawing No.: 3320901-CK211

Rev.: A

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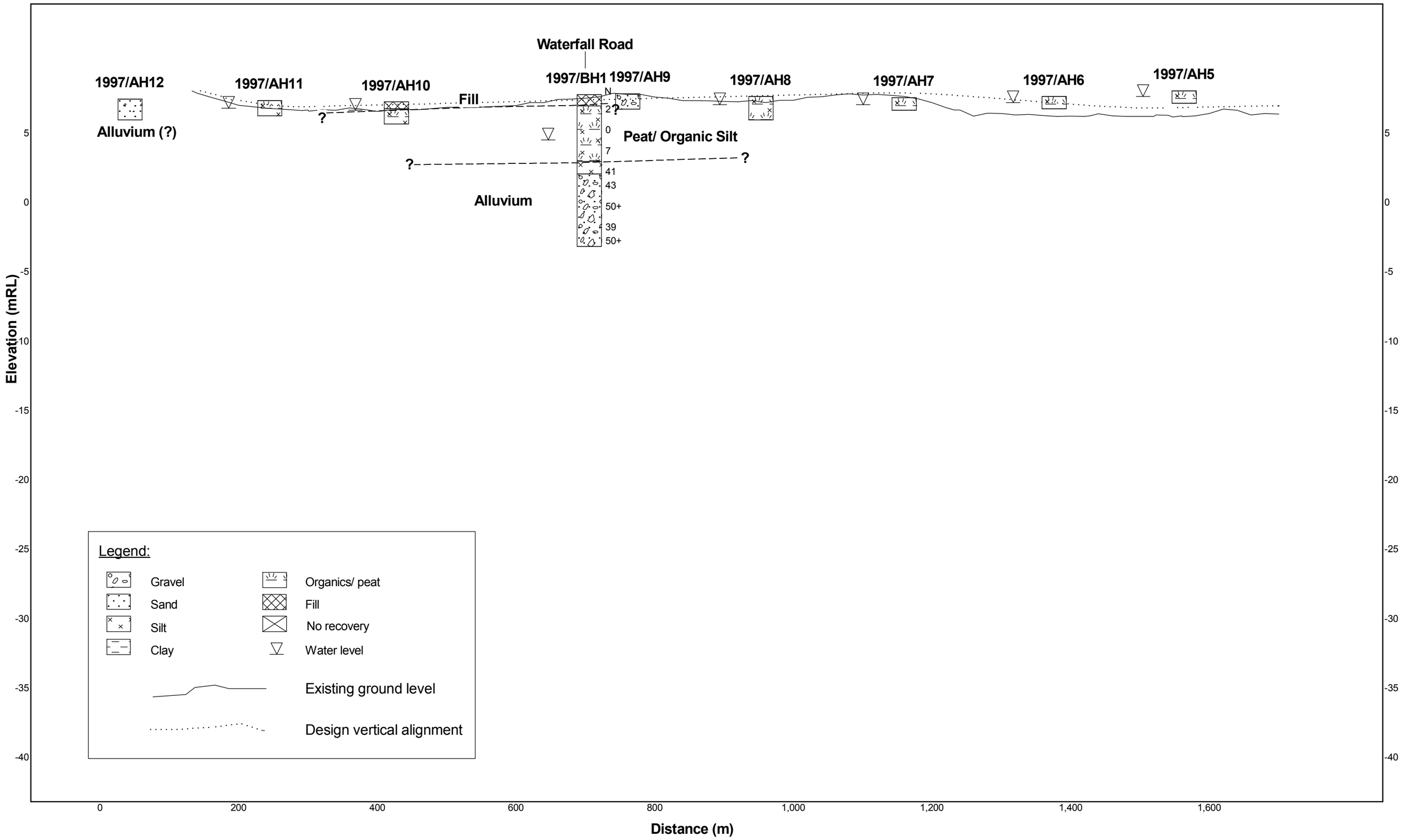
APPENDIX D Geological Long Sections



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Horizontal Scale 1:5000

N = Standard Penetration Test Blows (/300mm)

Mackays to Peka Peka Long Section
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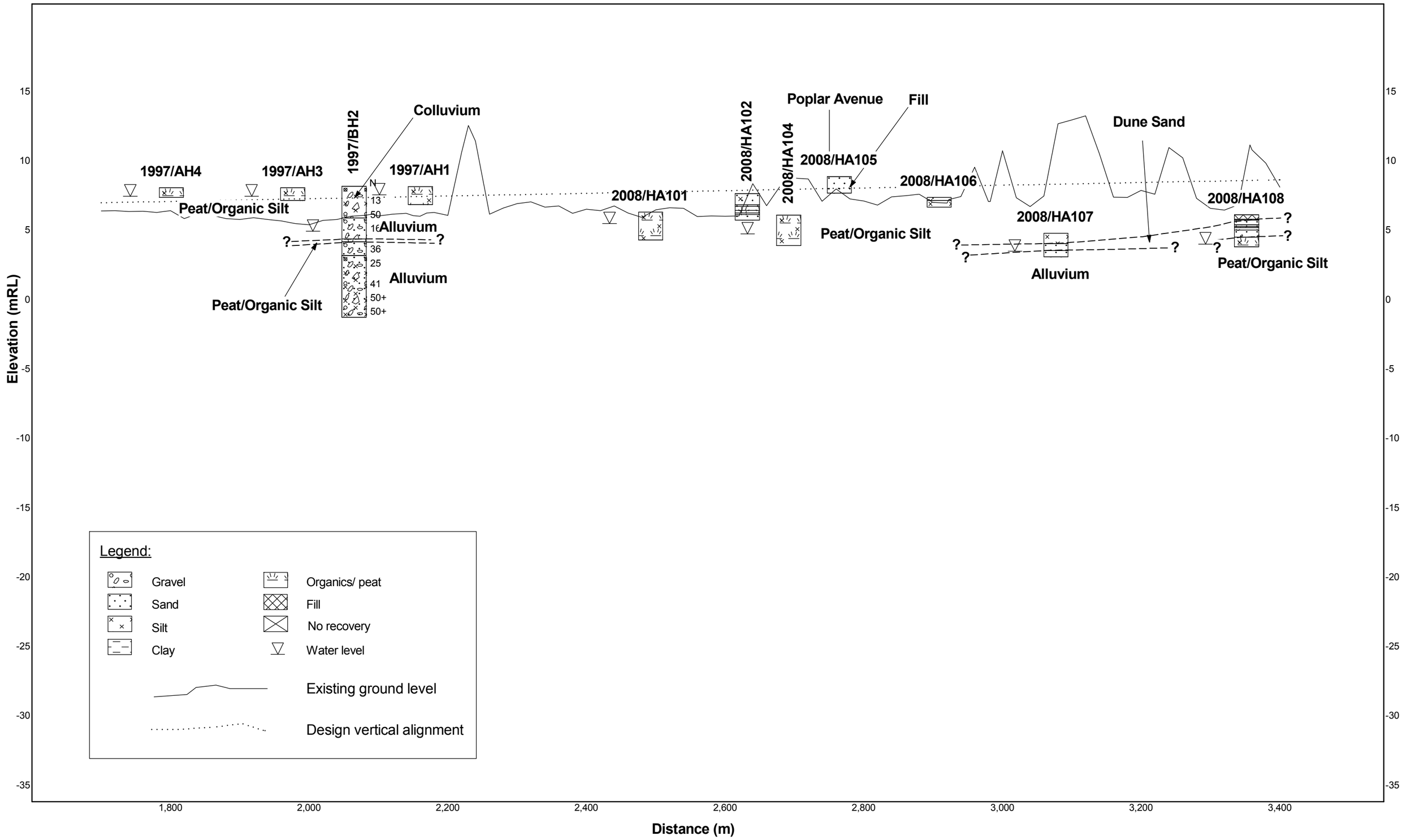

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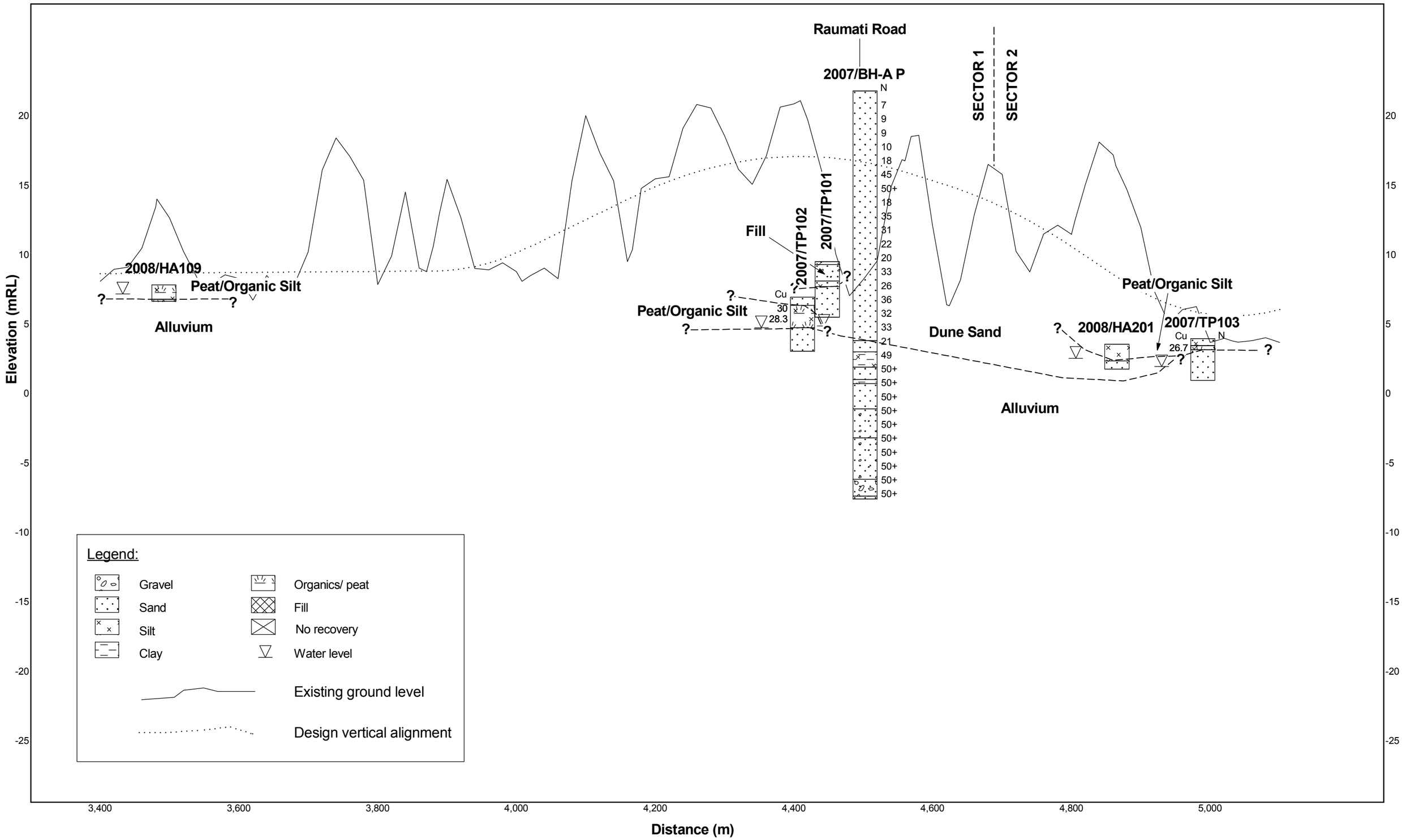

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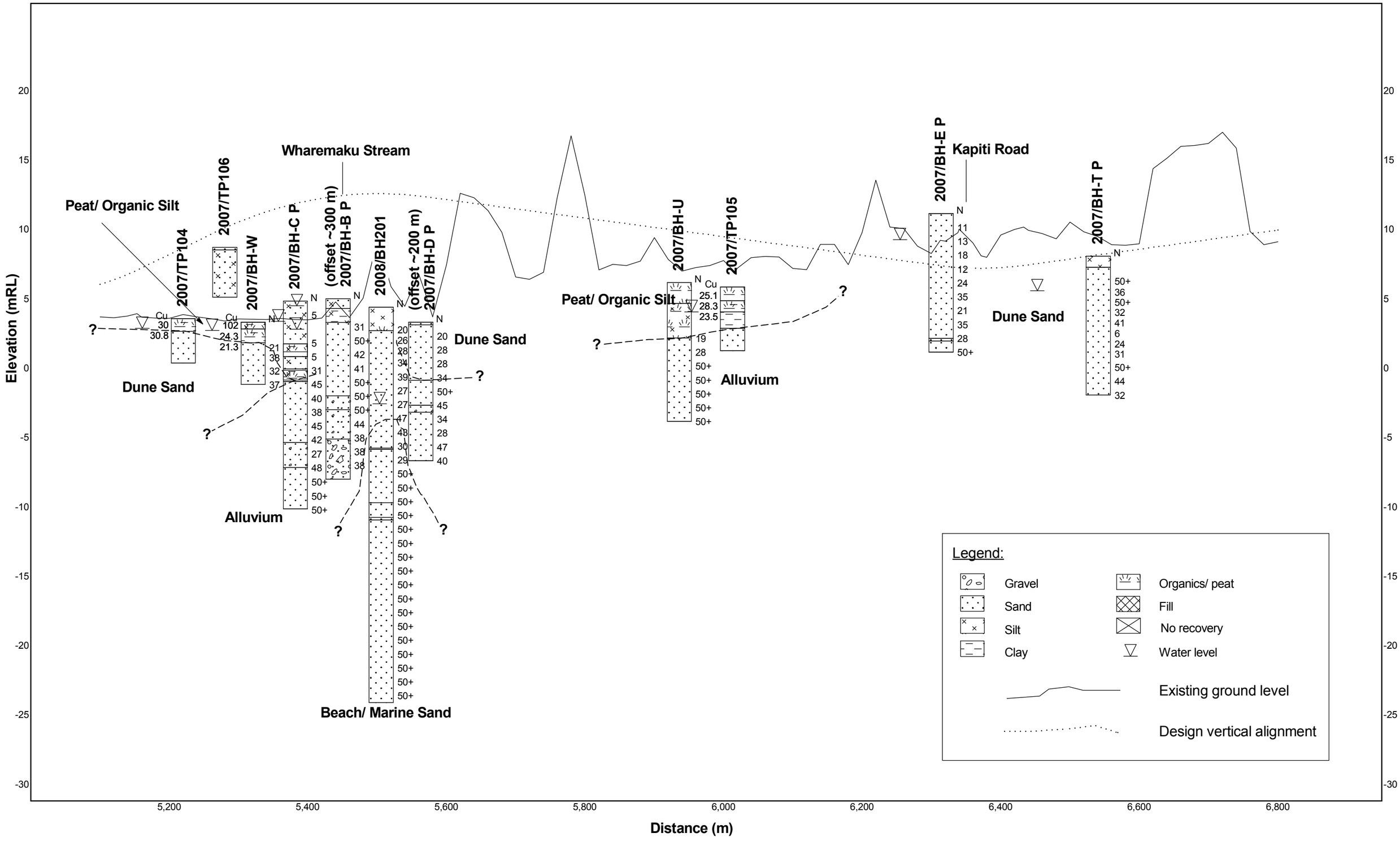

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Cu = Undrained Shear Strength (kPa) by Shear Vane
N = Standard Penetration Test Blows (/300mm)

Mackays to Peka Peka Long Section
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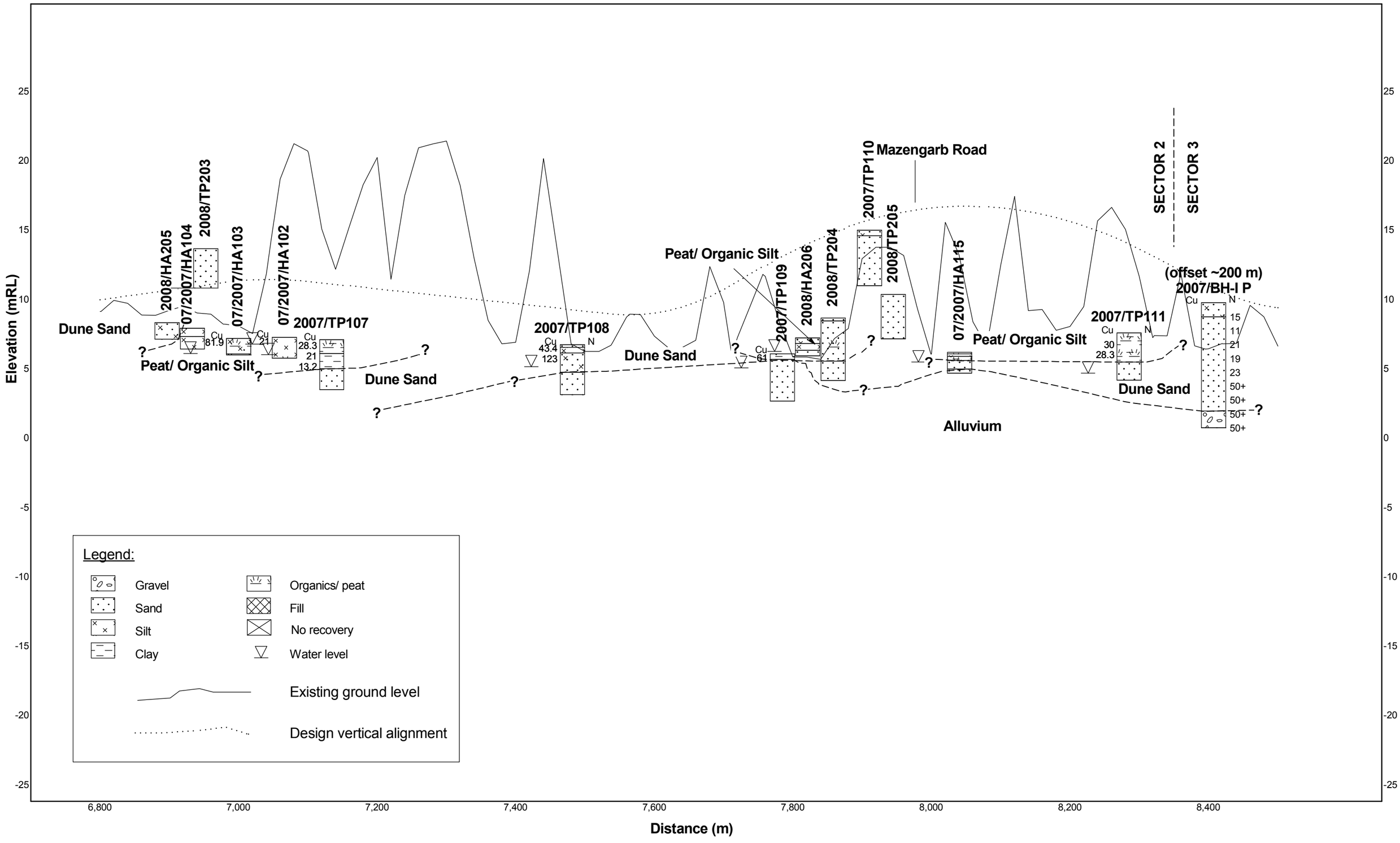
3320901/300 Printed 24/08/2010



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Vertical Scale 1:250
Horizontal Scale 1:5000

Cu = Undrained Shear Strength (kPa) by Shear Vane
N = Standard Penetration Test Blows (/300mm)

Mackays to Peka Peka Long Section
Sheet 5 (Ch 6800 - 8500 m)

3320901/300 Printed 24/08/2010

Elevation (mRL)

25
20
15
10
5
0
-5
-10
-15
-20
-25

Otaihanga Road

Peat/ Organic Silt

2007/BH-J P
N
17
42
19
50+
50+
41
50+
48

(offset ~ 150 m)
2007/BH-K P
N
7
11
50+
50+
50+
44
44
48
50+
50+

07/2007/HA111

2007/TP112
Cu
48.6
48.6
50.9
52.0

2007/BH-V P
N
6.0
18
22
30
50+
50+
50+
38
50+
50+

07/2007/HA101
N

2008/HA208

2007/TP113

2008/TP206

2008/TP207

Dune Sand

Alluvium

2007/TP114
Cu
N
59.0

2007/TP115
Cu
N

2007/TP116
Cu
N

2008/TP208
Cu
N

Dune Sand

Peat/ Organic Silt

2008/TP209
Cu
82.6
N

07/2007/HA110
N

Dune Sand

Legend:

Gravel	Organics/ peat
Sand	Fill
Silt	No recovery
Clay	Water level
Existing ground level	
Design vertical alignment	

8,600
8,800
9,000
9,200
9,400
9,600
9,800
10,000
10,200

Distance (m)

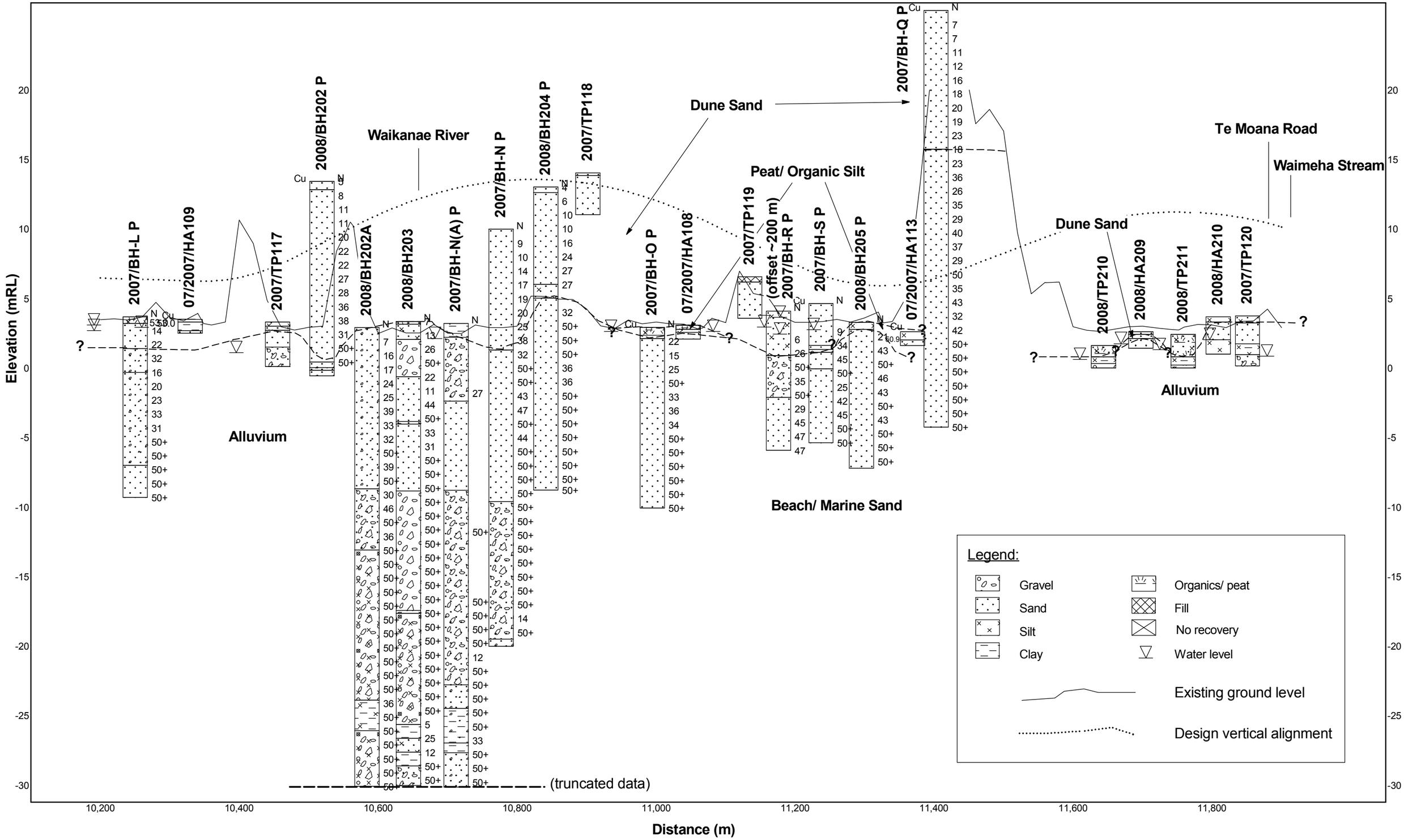
NZ TRANSPORT AGENCY WAKA KOTAHI
MacKays to Peka Peka

Vertical Scale 1:250
Horizontal Scale 1:5000

Cu = Undrained Shear Strength (kPa) by Shear Vane
N = Standard Penetration Test Blows (/300mm)

Mackays to Peka Peka Long Section
Sheet 6 (Ch 8500 - 10200 m)

3320901/300 Printed 24/08/2010



NZ TRANSPORT AGENCY WAKA KOTAHI — MacKays to Peka Peka

Vertical Scale 1:250
Horizontal Scale 1:5000

Cu = Undrained Shear Strength (kPa) by Shear Vane
N = Standard Penetration Test Blows (/300mm)

Mackays to Peka Peka Long Section
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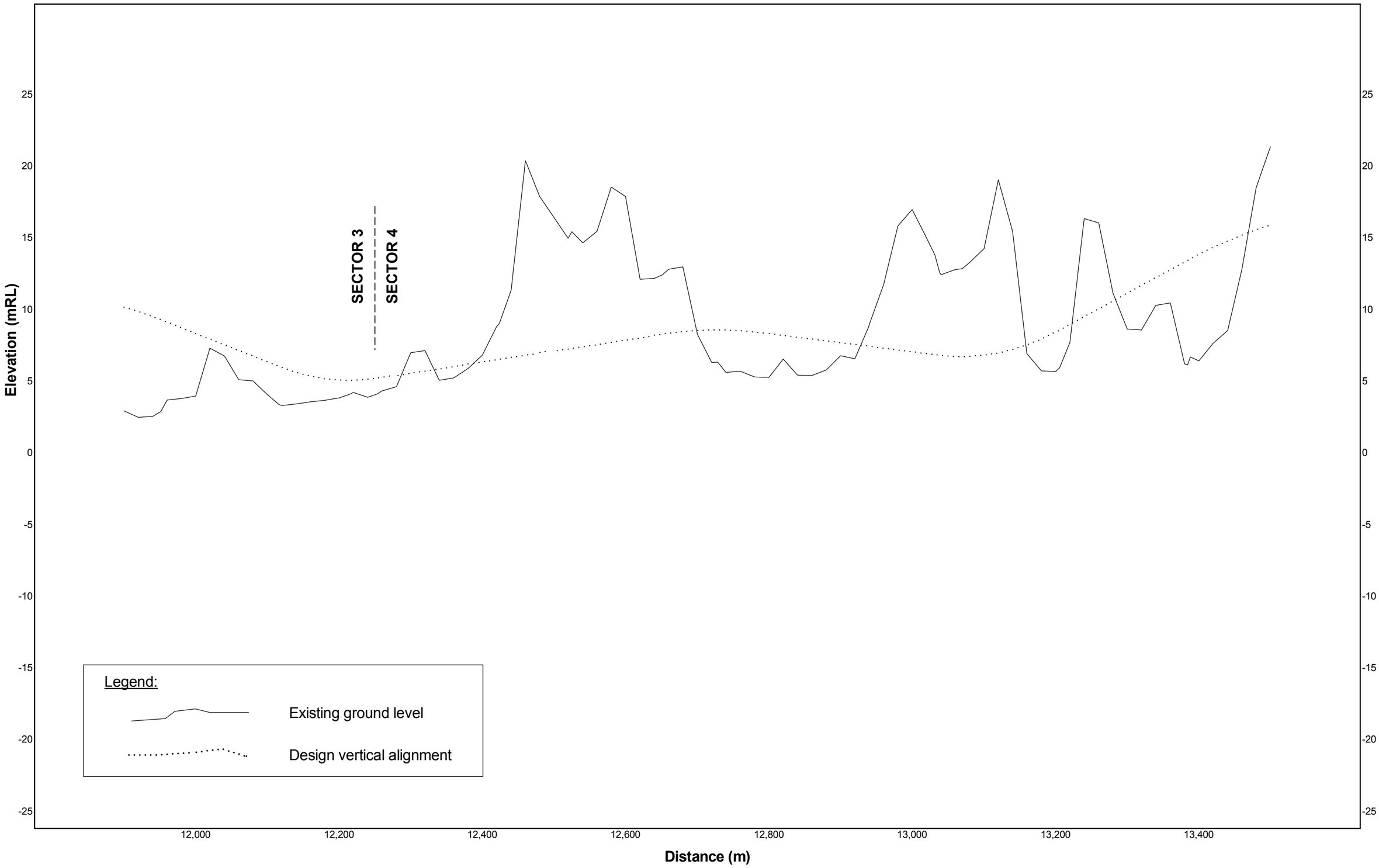
3320901/300 Printed 25/08/2010

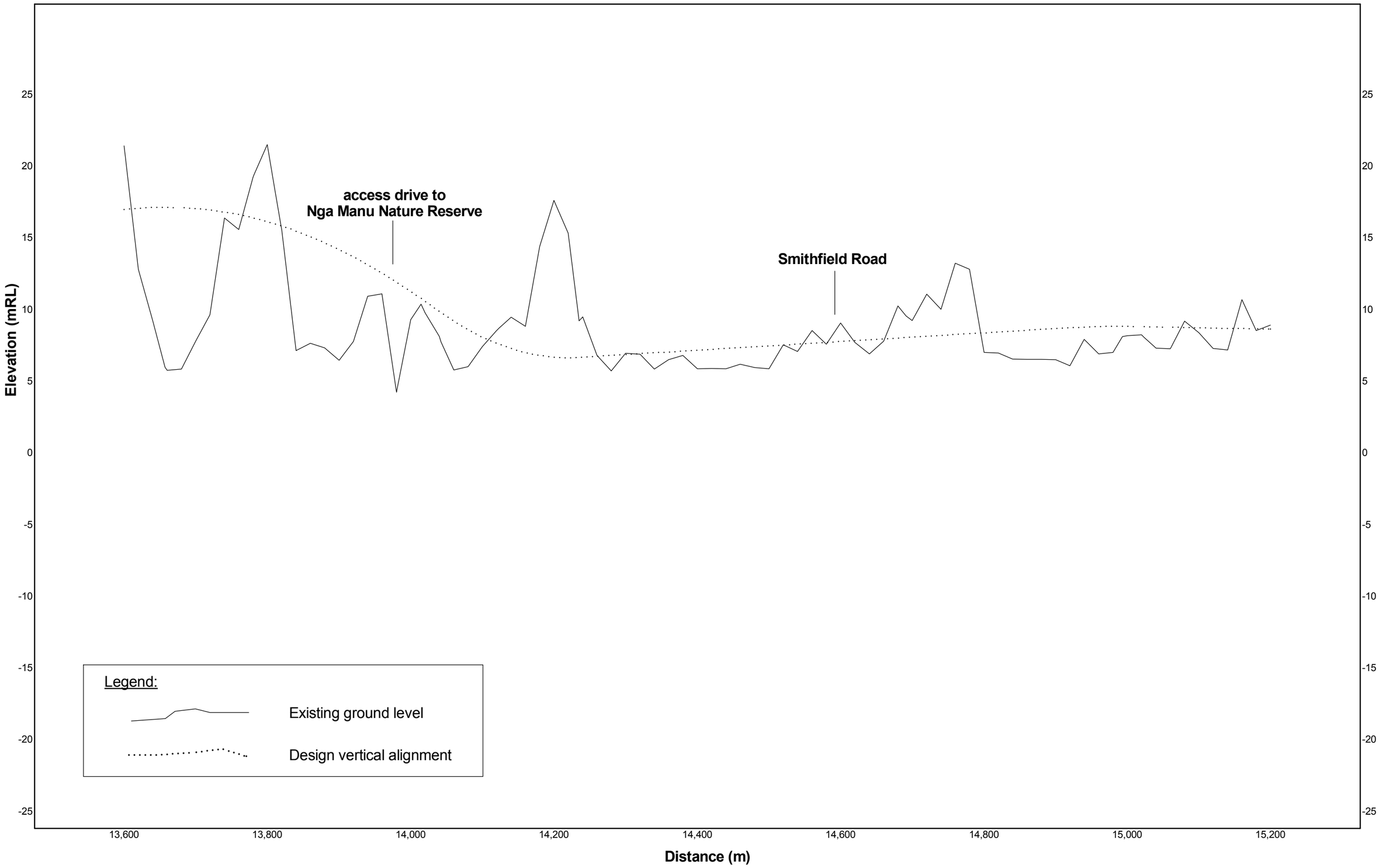


MacKays to Peka Peka

Vertical Scale 1:250
Horizontal Scale 1:5000

MacKays to Peka Peka Long Section
Sheet 8 (Ch 11900 - 13600 m)

3320901/300 Printed 31/08/2010

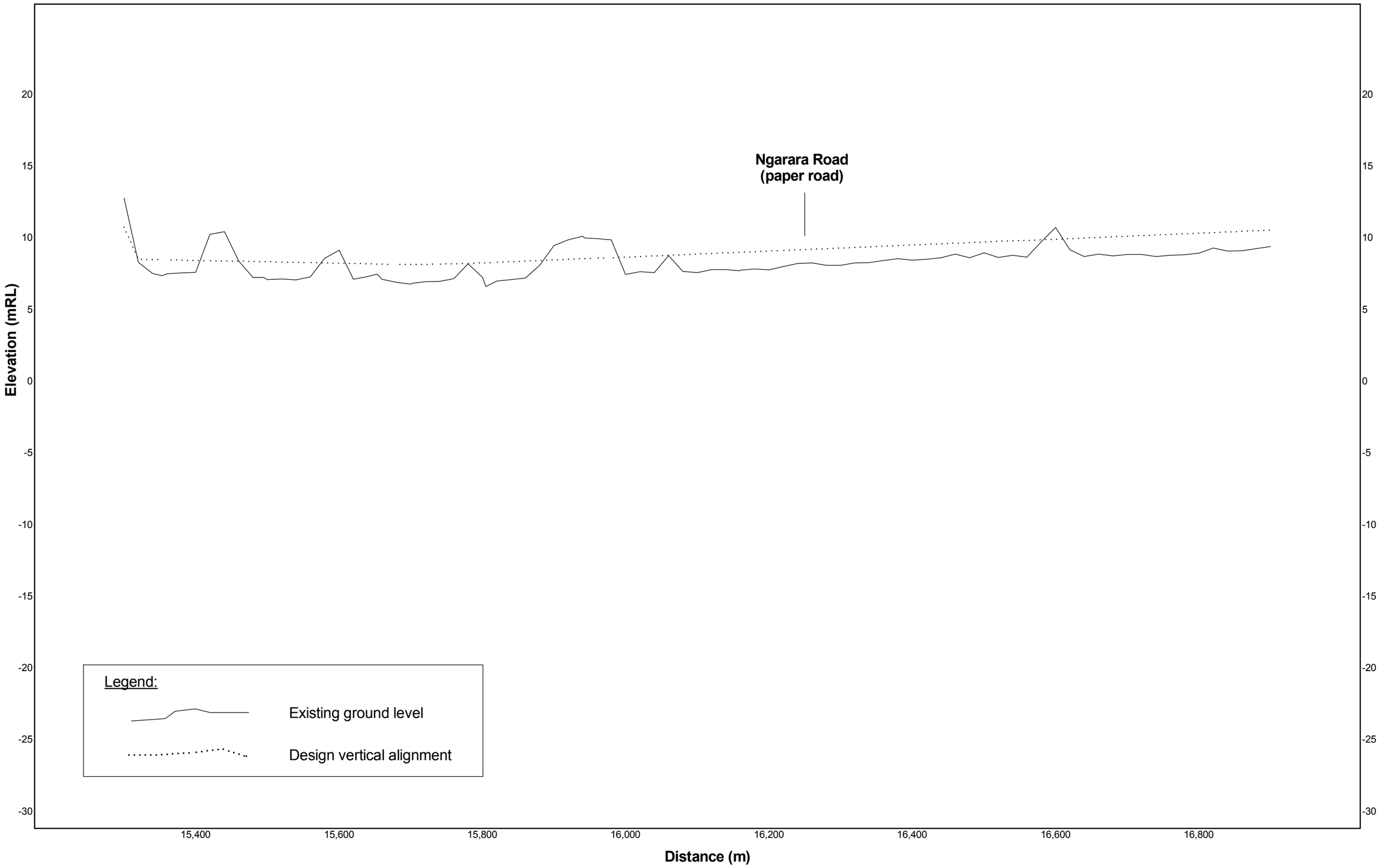


MacKays to Peka Peka

Vertical Scale 1:250
Horizontal Scale 1:5000

MacKays to Peka Peka Long Section
Sheet 9 (Ch 13600 - 15300 m)

3320901/300 Printed 31/08/2010



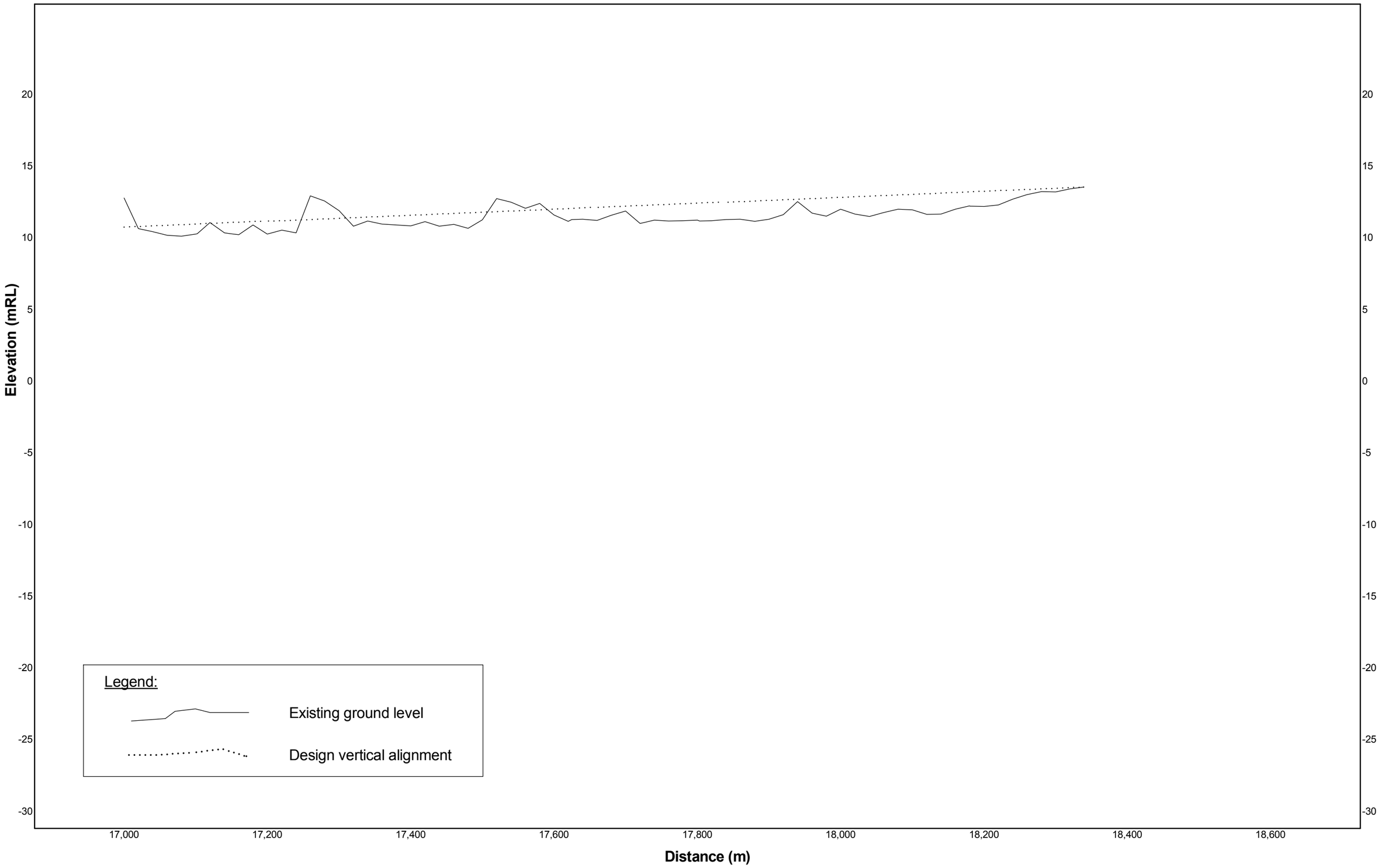
NZ TRANSPORT AGENCY WAKA KOTAHI

MacKays to Peka Peka

Vertical Scale 1:250
Horizontal Scale 1:5000

MacKays to Peka Peka Long Section
Sheet 10 (Ch 15300 - 17000 m)

3320901/300 Printed 31/08/2010



MacKays to Peka Peka

Vertical Scale 1:250
Horizontal Scale 1:5000

MacKays to Peka Peka Long Section
Sheet 11 (Ch 17000 - 18339 m)

3320901/300 Printed 31/08/2010

APPENDIX E Proposed Investigation & Testing Schedules

Table 1.0 – Investigation Stage

Sector	Location	Reason	Item	Quantity	Purpose	Depths
1	Waterfall Road to Poplar Avenue	No existing geotechnical investigation data south of Poplar Avenue, also filling in gaps in the data between Poplar Avenue and Raumati Road	Borehole	4	At accessible locations, for general information	10 m
			Piezometer	4	Monitoring groundwater levels	
			CPT test	22	In grid layout to cover range of potential alignments and investigate lateral variability in ground conditions	10 m
			Test Pit	5	Investigate and sample interdune deposits (peat)	Up to 4 m
4	Te Moana Road to Peka Peka Road	No existing geotechnical investigation data north of Te Moana Road	Borehole	11	At regular intervals, for general information	10 m
			Piezometer	11	Monitoring groundwater levels	
			CPT test	41	In grid layout to cover range of potential alignments and investigate lateral variability in ground conditions	10 m
			Test Pit	2	Investigate and sample interdune deposits (peat)	Up to 4 m

Table 2.0 – Preliminary Shortlist Design

Sector	Location	Reason	Item	Quantity	Purpose	Depths
1	Poplar Avenue interchange & Raumati Road crossing	Half interchange & local road crossing	Borehole	3	2 deep bores at interchange, 1 at local road crossing	20 m
				2	At interchange	10 m
			Piezometer	3	2 at interchange, 1 at local road crossing	
			CPT	3	2 at interchange, 1 at local road crossing	10 m
			Test Pit	4	Investigate and sample interdune deposits (peat)	Up to 4 m
2	Kapiti Road interchange & Mazengarb Road, Ihakara Street and Wharemaku Stream crossing	Interchange & local road crossings	Borehole	3	1 at each local road crossing	20 m
				3	At interchange	30 m
			Piezometer	5	2 at interchange, 1 at each local road crossing	
			CPT	5	2 at interchange, 1 at each local road crossing	10 m
			Scala	20	Peat thickness South of Kapiti Road	Up to 4 m
			Test Pit	4	Investigate and sample interdune deposits (peat)	Up to 4 m
3	Te Moana Road interchange, Otaihanga Road and Waikanae River	Interchange, local road crossing, and river crossing	Borehole	5	2 bores at interchange and river crossing, 1 at local road crossing	20 m
				2	2 deep bores at river crossing	30 m

Sector	Location	Reason	Item	Quantity	Purpose	Depths
	crossings		Piezometer	5	2 at interchange and river crossing, 1 at local road crossing	
			CPT	5	2 at interchange and river crossing, 1 at local road crossing	10 m
			Test Pit	4	Investigate and sample interdune deposits (peat)	Up to 4 m
4	Peka Peka Road interchange and Ngarara Road crossing	Half interchange and local road crossing	Borehole	1	At Ngarara Road crossing	20 m
				2	Deep bores at interchange	30 m
			Piezometer	2	1 at interchange, 1 at local road crossing	
			CPT	2	1 at interchange, 1 at local road crossing	10 m
			Test Pit	4	Investigate and sample interdune deposits (peat)	Up to 4 m

Appendix H

Principal Structures

Principal Structures

The principal structures that have been identified for the various options and sub-options are described below. The structures are firstly described in the table below for alignment option 3 and then variations for other options and sub-options are identified in a separate table.

a. Structures for Base Option 3 Alignment

Name	Location	Road carried	Obstacle crossed	Bridge type	Description
Southern Interchange Overpass	St 1870	Off ramp	Expressway	Overpass	98m long, 14m wide with 4 spans and 45 degree skew
Poplar Avenue Overpass	St 2740	Poplar Avenue	Expressway	Overpass	71m long, 14m wide with 3 spans and 10 degree skew
Raumati Road Underpass	St 4500	Expressway	Raumati Road	Underpass	73m long, 30m wide with 3 spans and 35 degree skew
Ihakara Street Extension Underpass	St 5420	Expressway	Ihakara Street Extension and Wharemauku Stream	Underpass	80m long, 30m wide with 4 spans and 15 degree skew
Kapiti Road Overpass	St 6380	Kapiti Road	Expressway	Overpass	68m long, 30m wide with 3 spans and 10 degree skew
Mazengarb Road Overpass	St 7970	Expressway	Mazengarb Road	Overpass	60m long, 30m wide with 3 spans and no skew
Otaihanga Road Overpass	St 9250	Otaihanga Road	Expressway	Overpass	69m long, 14m wide with 3 spans and 5 degree skew
Waikanae River Bridge	St 10700	Expressway	Waikanae River and El Rancho access road	River Bridge	282m long, 30m wide with 8 spans and no skew

Te Moana Road & Waimeha Stream Underpass	St 11900	Expressway	Te Moana Road and Waimeha Stream	Underpass	141m long, 30m wide with 5 spans and 10 degree skew
Te Moana Interchange Ramp Underpass	St 11930	On and off ramps	Waimeha Stream	Underpass	Two 32m long, 12m wide single span with 20 degree skew
Ngarara Road Underpass	St 13620	Expressway	Ngarara Road	Underpass	Two 62m long, 17m and 14m wide with 3 spans and 45 degree skew
Peka Peka Interchange Overpass	St 16750	Local access road	Expressway	Overpass	110m long, 14m wide with 4 spans and 50 degree skew

b. Structures for other Options and Sub-options

The structures described above for the options and sub-options are the same as for option 3 except as described in the table below.

Sub-option	Changes to Base Option 3 structures
SCii, &S1Bii	Southern Interchange Overpass is not required
S1Dii	Southern Interchange Overpass & Poplar Avenue Underpass are not required. Overpass is required at 200 Main Road similar to Southern Interchange Overpass
S2Bi Check with Geoff	Ihakara Street Extension Underbridge is replaced by Ihakara Street Extension Overbridge which is a 68m long, 14m wide 3 span overbridge to carry Ihakara street Extension over the Expressway, and a single 22m long, 30m wide stream bridge to carry the Expressway over Wharemauku Stream.

Appendix I

MCA Scoring Sheets

M2PP PROJECT - OPTION ASSESSMENT OUTCOMES

(For Workshop on 15 September)

Outcome 1 – MOVEMENT

The project provides for people to move efficiently, conveniently and safely throughout the Kapiti District as pedestrians, cyclists or in vehicles.

Contributing Elements:

- Travel Safety
  Level of safety provided by option design, safety design of SH1 and local connectors.
- Vehicles – Level of Service (State Highway)
  Level of service, movement efficiency and user benefits of local network from traffic model outputs.
- Vehicles – Level of Service (Local Network)
  Level of service, movement efficiency and user benefits of local network from traffic model outputs.
- Integration with Public Transport
  Level of integration with public transport (train/ bus/ rail/ Paraparaumu Airport). Ability of public transport to safely and efficiently integrate with option design.
- Integration with Local Destinations
  Ability for vehicle commuters to conveniently move through-out the District and travel to and from key destinations (Coastlands, Paraparaumu Beach, Kapiti Road Commercial Area, Raumati Village, Waikanae Commercial Centre, Waikanae Beach).
- Integration with Cycleways
  Level of integration with cycleways. Ability of cycleways to safely and efficiently integrate with option design.
- Integration with Pedestrian Access
  Level of integration with pedestrian access ways. Ability of pedestrian access ways to safely and efficiently integrate with option design.

Outcome 2 – BUILT ENVIRONMENT

The project provides for the integration of infrastructure in the urban environment. The design does not significantly detract from the urban form and the adverse effects on the urban form and features are no more than minor.

Contributing Elements:

- Visual Impact
  Visual relationship to the local environment. The extent of visual impact of structures, earthworks, landscaping in relation to context including urban villages, residential, Waikanae River corridor and other public amenity locations.
- Built Form
  Relationship to urban form and town centres, including responding to the individual urban identities of Raumati Village, Paraparaumu, Paraparaumu Beach and Waikanae.
- Impact on Public Areas/Parks/Recreational Areas

Significance (positive or negative) of impact on public open space areas.

Outcome 3 –Cultural / Heritage

The project traverses areas with significant heritage and cultural values. The design does not significantly impact on areas of significance.

Contributing Elements:

- Historic Heritage
  Significance (positive or negative) of impact on identified heritage (District Plan or NZAA) including buildings, structures, features and archaeological sites.
- Cultural Sites
  Significance (positive or negative) of impact on identified cultural sites (District Plan or identified by iwi).

Outcome 4 –NATURAL ENVIRONMENT

The project integrates well with the environment and any adverse environmental effects on natural resources and systems such as land, air and water are no more than minor.

Contributing Elements:

- Land and Vegetation
  Extent of environmental impact on land and vegetation.
- Natural Landscapes & Features
  Extent of environmental impact on natural landscapes and features identified as requiring protection by the local and regional plans.
- Ecological Processes
  Extent of environmental impact on natural processes and systems.
- Surface Water
  Extent of environmental impact on surface water resources, including flooding issues around town centre, Waikanae River etc.
- Groundwater
  Extent of environmental impact on groundwater and underground aquifers.

Outcome 5 – Social

The project provides for peoples well-being and health and promotes the safe and efficient movement to and from community health and emergency services

Contributing Elements:

- Air Emissions
  Extent of changes to air quality based on fuel consumption and greenhouse gas from traffic model.
- Noise
  The level of noise effects in relation to proximity to noise sensitive activities such as residential areas.
- Social / Community
  The effect on community including well being and displacement

Outcome 6 – ECONOMIC

The project promotes national, regional and local economic growth.

Contributing Elements:

- National & Regional Economic Growth
  Consistency with national & regional economic growth policies (eg the Wellington Regional Growth Strategy).
- Local Economic Growth
  Consistency with local economic growth policy, particularly the impact on local town centres (eg KCDC LTCCP, District Plan and Community Outcomes).

Outcome 7 – IMPLEMENTATION TIMEFRAME

The project is able to be consented and implemented within the project timeline.

+2 years = -3 1-2 years = -2 0-1 year = -1 0 year = 0

Contributing Elements:

- Resource Consent/Planning Approval Process
  Preliminary planning assessment of likely issues, activity status, planning process.
- Land Acquisition

Preliminary assessment of property acquisition requirements, number and nature of properties required.

Outcome 8 – Cost

Option cost relative to Option 2

Sub option cost relative to lowest cost sub option for the segment

+2	-5.0% to -7.5%
+1	-2.5% to -5.0%
0	-2.5% to +2.5%
-1	+2.5% to +5.0%
-2	+5.0% to +7.5%
-3	+7.5% to +10%

Outcome 9 – Benefit Cost Ratio

BCR calculated in accordance with NZTA Evaluation Manual

BCR scoring as below, (note BCR of less than 1 score a negative value) .

0	0.9 to 1.1
-1	0.7 to 0.9
-2	0.5 to 0.7
-3	0.3 to 0.5

15/9/2010		Non Cost Asessment Outcomes									Cost / BCR Assessment Outcomes					
		1	2	3	4	5	6	7								
	Base options	**Movement X2**	**Built Environment**	**Cultural / Historic**	**Natural Environment**	**Social**	**Economic X 2**	**Implementation Timeframe**	**Total**		**Percentage Cost Difference**	**Cost Estimate Outcome**	**BCR**	**BCR Outcome**		**BASE OPTION DESCRIPTION**
	1	2	-2	-2	-1	-1	2	-3	-5		-1	0	0.64	-2		South-facing ramps south of Poplar Ave, north-facing ramps at Peka Peka.
	1A	4	-3	-2	-2	-2	2	-2	-5		7	-2	0.87	-1		South-facing ramps south of Poplar Ave, local crossing at Weggery Dr, north-facing ramps at Peka Peka.
	2	4	-2	-2	-2	-1	0	-3	-6		0	0	0.77	-1		South-facing ramps south of Poplar Ave, full interchange at Otaihanga Road, north-facing ramps at Peka Peka.
	2A	6	-3	-2	-2	-2	0	-2	-5		8	-3	0.96	0		South-facing ramps south of Poplar Ave, full interchange at Otaihanga Road, local crossing at Weggery Dr, north-facing ramps at Peka Peka.
	2B	4	-1	-2	-1	-1	2	-2	-1		0	0	0.89	-1		South-facing ramps south of Poplar Ave, north-facing ramps at Peka Peka. Interchages at Kapiti Road.
	3	6	0	-2	-2	-2	6	0	6		2	0	0.98	0		South-facing ramps south of Poplar Ave, north-facing ramps at Peka Peka. Interchanges at Kapiti Road and Te Moana Road.
	3A	6	-2	-2	-3	-3	6	-1	1		10	-3	1.01	0		South-facing ramps south of Poplar Ave, north-facing ramps at Peka Peka. Local crossing at Weggery Drive. Full Interchages at Kapiti Road and Te Moana Road.
	3B	6	-2	-2	-3	-2	6	0	3		2	0	0.86	-1		South-facing ramps south of Poplar Ave, north-facing ramps at Peka Peka. Full interchnages at Ihakara Street extension and Te Moana Road.
	3C	6	-2	-2	-3	-2	6	0	3		4	-1	0.95	0		South-facing ramps south of Poplar Ave, north-facing ramps at Peka Peka. Full interchange at Te Moana Road. Split interchange, with south facing ramps at Ihakara Street extension and north facing ramps at Kapiti Road with one way auxillary lanes for loc
	3D	6	-2	-2	-3	-3	6	-1	1		6	-2	0.97	0		South-facing ramps south of Poplar Ave, north-facing ramps at Peka Peka. Full interchange at Te Moana Road. Split interchange with south facing ramps Raumati Road and north facing ramps Kapiti Road. One way auxillary lanes for local traffic.
	3E	6	-2	-2	-2	-3	6	-1	2		3	-1	1.02	0		Full interchange at Poplar Ave.North-facing ramps at Peka Peka. Full interchage at Kapiti Road. Full interchange Te Moana Road.
	3F	6	-2	-2	-2	-2	4	-1	1		3	-1	0.99	0		South-facing ramps south of Poplar Ave. Full interchage at Kapiti Road. Full interchange Te Moana Road. Full interchange at Peka Peka

LIVE SUB-OPTIONS		Non Cost Asessment Outcomes														
Sub-options by Sector		**Movement**	**Built Environment**	**Cultural / Historic**	**Natural Environment**	**Social**	**Economic**	**Implementation Timeframe**	**Total**		**Cost Estimates**	**Cost Estimate Outcome**	**BCR**	**BCR Outcome**		**Sector 1**
Base Options	**Sub-option**															
1--3	S1Cii	1	-2	-1	-2	-3	0	-3	-10		0	0				South facing ramps at Poplar Ave. Alignment located east of the Steiner School.
	S1Ciii	2	-2	-1	-2	-2	0	-3	-8		0	0				South facing ramps , including local road over bridge in QE park. Alignment located east of Steiner school
1--3	S1Dii	-1	1	0	-1	-3	0	-1	-5		13	-1				Ties in at 200 Main Road. Interchange on local road between Main Road and Poplar Ave.
Sector 2																
1 -- 3	S2Ai	1	-1	0	-1	-2	1	-1	-3							Follow existing designation through this section. With or without Interchange at extended Ihakara Street
1 -- 3	S2Bi	1	0	0	-1	-1	1	0	0							Alignment east of existing designation . With or without Interchange at extended Ihakara Street.
Sector 3																
1--3	S3Ai	2	-2	-3	-2	-2	1	-3	-9			0				Follows existing designation apart from where alignment crosses river further west of current designation (via El Rancho camp and wetlands). Reconnects with existing designation at wahi tapu area.
3	S3B	2	-2	-3	-3	-1	1	-3	-9		0	0				Generally follows existing designation. To achieve 110kph design speed is located just east of designation at tightest point.
	S3C	2	-2	-3	-3	-1	1	-3	-9		0	0				Alignment slightly east of designation between Waikanae River & Te Monana but west of Urupa and Maketu
3	S3D	2	-2	-2	-2	-2	1	-2	-7		0	0				Crosses river via existing designation - east of urupa, west of Maketu (straighter north/south alignment).
1--3	S3E	1	-3	-1	-2	-3	1	-3	-10		7	-1				Crosses river east of current designation, straighter north/south alignment. East of urupa/maketu.
Sector 4																
1--3	S4E	0	-1	-1	-2	-1	0	-1	-6							Alignment has a minor encroachment on the QEII convenants and stays within Maypole property.
1--3	S4F	0	-1	-1	-1	-1	0	0	-4							Alignment avoids QEII covenants and other wetland areas. Crosses additional property north of Maypole.
1--3	S4Ai	0	-1	-1	-1	-1	0	0	-4							Alignment within designation north of Smithfield Road.

DELETED BASE-OPTIONS

DELETED SUB-OPTIONS

Sub-options																
Base Options	Sub-option															Sector 1
1--3	S1A															Southern tie-in at MacKays Crossing
1--3	S1Bi															South facing/north facing ramps south of Poplar Ave with additional local road tie-in. Alignment located west of the Steiner School (located within existing designation)
1--3	S1Bii															South facing ramps at Poplar Ave. Alignment located west of the Steiner School (located within existing designation)
	S1Biii															South facing ramps , including local road over bridge in QE park. Alignment located west of Steiner school
1--3	S1Ci															South facing/north facing ramps south of Poplar with additional local road tie-in. Alignment located east of the Steiner School.
1--3	S1Di															Ties in at 200 Main Road. South facing ramps. (this option includes variations 1E and 1F). Local service road runs parallel to SH1.
Sector 2																
3D	S2Aii															Follows existing designation. South facing ramps at Raumati Road and north facing ramps at Kapiti Road. One way auxillary lanes for local traffic - as per Option 7.
T3, T6, T9, T10	S2Aiv															Follows existing designation. Interchange at Kapiti Road.
T1, T2, T8	S2Biii															No interchanges
	S2Biii															Interchange at Mazengarb.
Sector 3																
1--3	S3F															Straight line alignment from Otaihanga (near Peka Peka). Possible interchange at Otaihanga Road & interchange at Te Moana Road.
Sector 4																
1--3	S4A															Follow existing designation. North facing ramps at Peka Peka.
1--3	S4B															Straight line alignment from Otaihanga. North facing ramps at Peka Peka.
1--3	S4C															Alignment close to urban growth boundary. North facing ramps at SH1 (south of Peka Peka).
1--3	S4D															Deviates from the designation south of urban growth edge and ties into existing highway 2km south of Peka Peka

Assessment comments for workshop 15 sept

	Base options	BASE OPTION DESCRIPTION	Comments (please state key points which influenced your assessment)
	1	South-facing ramps south of Poplar Ave, north-facing ramps at Peka Peka.	(S) - Score due to minor air quality, noise and property effects. However effects more severe than 'do nothing'. (IT) - Would face very strong and large community opposition, including KCDC; lose current level of support. (BE) - No interchanges- ignores local urban form as centres but has minimal visual inpact due to minimal footprint on road only. (NE) - Minor effects on ecology, flood areas and rivers. Landscape effects minimised due to no interchanges. (M) - Improvement in mobility for through traffic. Limited improvement in mobility for local traffic due to through traffic transfering to expressway relieving some congestion on the local network. No improvement in connectivity between Paraparaumu and Waikanae. (E) - Consistency with regional/national policy by constructing expressway (GPS) relieving congestion and improving travel times.
	1A	South-facing ramps south of Poplar Ave, local crossing at Weggery Dr, north-facing ramps at Peka Peka.	(S) - Score due to noise, displacement effects associated with the additional river crossing. (IT) - Would face very strong and large community opposition, including KCDC; lose current level of support (BE) - In addition option 1 and the lack of interchanges have additional river crossing- significant negative impact on local suburban amenity either side of local crossing and greater impact on visual and recreational quality of Waikanae River corridor. (ONL) (NE) - Additional crossing of Waikanae River not desirable (adds to ecological impacts and effects on Outstanding Landscape (river corridor). (M) - Improvement in mobility for through traffic. Limited improvement in mobility for local traffic due to through traffic transfering to expressway relieving some congestion on the local network. There is an improvement in connectivity between Paraparaumu and Waikanae from provision of new local crossing. (E) - Consistency with regional/national policy by constructing expressway (GPS) relieving congestion and improving travel times. Inconsistent with local and regional policy by providing interchange at Otaihanga, which will likely increase pressure for growth in an area KCDC intend to keep rural.
	2	South-facing ramps south of Poplar Ave, full interchange at Otaihanga Road, north-facing ramps at Peka Peka.	(S) - Score due to minor air quality, noise and property effects. However effects more severe than 'do nothing'. (IT) - Would face very strong and large community opposition, including KCDC; lose current level of support. (BE) - 1 interchange-significant change to the character of the semi rural environment. In conflict with urban form proposals from KCDC and generates pressure on urban development here - Interchange relates to neither community. (M) - Improvement in mobility for through traffic. There is an improvement in mobility for local traffic by provision of interchange. No improvement in connectivity between Paraparaumu and Waikanae. (E) - Consistency with regional/national policy by constructing expressway (GPS) relieving congestion and improving travel times. Inconsistent with local and regional policy by providing interchange at Otaihanga, which will likely increase pressure for growth in an area KCDC intend to keep rural.
	2A	South-facing ramps south of Poplar Ave, full interchange at Otaihanga Road, local crossing at Weggery Dr, north-facing ramps at Peka Peka.	(S) - Score due to noise, displacement effects associated with the additional river crossing. (IT) - Would face very strong and large community opposition, possibly including KCDC; lose current level of support. (BE) - In addition to option 2 and 1 interchange at Otaihanga adds another river crossing - significant negative impact on local suburban amenity either side of local crossing and greater impact on visual and recreational quality of Waikanae River corridor (ONL). In conflict with urban form proposals from KCDC and generates pressure on urban development here - Interchange relates to neither comminity. (M) - Improvement in mobility for through traffic. There is an improvement in mobility for local traffic due to provision of interchange. There is an improvement in connectivity between Paraparaumu and Waikanae. (E) - Consistency with regional/national policy by constructing expressway (GPS) relieving congestion and improving travel times. Inconsistent with local and regional policy by providing interchange at Otaihanga, which will likely increase pressure for growth in an area KCDC intend to keep rural. Unsure how Weggery Crossing will impact economic growth.
	2B	South-facing ramps south of Poplar Ave, north-facing ramps at Peka Peka. Interchages at Kapiti Road.	(S) - Score due to minor air quality, noise and property effects. However effects more severe than 'do nothing'. (IT) - Would face very strong and large community opposition, possibly including KCDC; lose current level of support. (BE) - Less change in landscape character with interchange located in highly modified landscape, good relationship to Paraparaumu town centre and propsed redevelopment.Ties in with PTC redevelopment proposals and supports airport development (NE) - Minor effects on flood areas and rivers and ecological values. Landscape effects minor ie change in already modified landscape (M) - Improvement in mobility for through traffic. There is an improvement in mobility for local traffic by provision of interchange. No improvement in connectivity between Paraparaumu and Waikanae. (E) - Consistency with regional/national policy by constructing expressway (GPS) relieving congestion and improving travel times. Consistency with local and regional policy by providing convenient access to expressway from Paraparaumu growth area.
	3	South-facing ramps south of Poplar Ave, north-facing ramps at Peka Peka. Interchanges at Kapiti Road and Te Moana Road.	(S) - Score due to noise, air quality and displacement effects associated with the two interchanges. (IT) - Most likely to obtain approvals within timeframe (BE) - Interchange at Te Moana in less urban setting with a larger footprint will have greater visual impact. However, balanced by the benefits in urban planning terms by the connections in the 2 communities and support this gives to urban form of PTC and north Waikanae growth area (NE) - Interchange at Te Moana Road (flood overflow path) adds some flood risk issues. Additional ecological effects in relation to interchange at Waimeha Stream. Bigger footprint of landscape change due to 2 interchanges. (M) - Improvement in mobility for through traffic. There is an improvement in mobility for local traffic due to provision of two interchanges. There is an improvement in connectivity between Paraparaumu and Waikanae by allowing trips between Paraparaumu and Waikanae to access the expressway. (E) - Consistency with regional/national policy by constructing expressway (GPS) relieving congestion and improving travel times. Consistency with local and regional policy by providing convenient access to expressway from Paraparaumu and Waikanae growth areas.
	3A	South-facing ramps south of Poplar Ave, north-facing ramps at Peka Peka. Local crossing at Weggery Drive. Full Interchages at Kapiti Road and Te Moana Road.	(S) - Score due to noise, air quality and displacement effects associated with the two interchanges and the additional river crossing. (IT) - Most likely to obtain approvals within timeframe (BE) - Second river crossing _significant negative impact on local suburban amenity either side of local crossing and greater impact on visual and recreational quality of Waikanae River corridor.Adds potential for urban development also at Otahihanga. Split inetrcanges at Ihakara and Krd makes bigger footprint and issues with centre legibility (NE) - Interchange at Te Moana Road adds some flood risk issues, and additional crossing of Waikanae River not desirable. Max effect on landscape two river crossings (ONL area) and 2 interchanges, major intervention. (M) - Improvement in mobility for through traffic. There is an improvement in mobility for local traffic due to provision of two interchanges. There is an improvement in connectivity between Paraparaumu and Waikanae by allowing trips between Paraparaumu and Waikanae to access the expressway, and through the provision of a new local crossing. (E) - Consistency with regional/national policy by constructing expressway (GPS) relieving congestion and improving travel times. Consistency with local and regional policy by providing convenient access to expressway from Paraparaumu and Waikanae growth areas.
	3B	South-facing ramps south of Poplar Ave, north-facing ramps at Peka Peka. Full interchnages at Ihakara Street extension and Te Moana Road.	(S) - Score due to noise, air quality and displacement effects associated with the two interchanges. (IT) - Most likely to obtain approvals within timeframe (BE) - 2 interchanges with a larger combined footprint will have greater visual impact, and overall effects on local character. The issues of legiblity remain and the imapct of Ihakara Street interchange more significant than at Krd (NE) - Interchange at Te Moana Road adds some flood risk issues, and additional crossing of Waikanae River not desirable. Max effect on landscape two river crossings (ONL area) and 2 interchanges, major intervention. (M) - Improvement in mobility for through traffic. There is an improvement in mobility for local traffic due to provision of two interchanges. There is an improvement in connectivity between Paraparaumu and Waikanae by allowing trips between Paraparaumu and Waikanae to access the expressway. (E) - Consistency with regional/national policy by constructing expressway (GPS) relieving congestion and improving travel times. Consistency with local and regional policy by providing convenient access to expressway from Paraparaumu and Waikanae growth areas.
	3C	South-facing ramps south of Poplar Ave, north-facing ramps at Peka Peka. Full interchange at Te Moana Road. Split interchange, with south facing ramps at Ihakara Street extension and north facing ramps at Kapiti Road with one way auxillary lanes for loc	(S) - Score due to noise, air quality and displacement effects associated with the two interchanges. (IT) - Most likely to obtain approvals within timeframe (BE) - Larger footprint of Paraparaumu interchange footprint will have greater visual effects and affect a larger part of the residential community. (NE) - Interchanges at both Ihakara Street (with slip roads in flood storage area) and Te Moana Road (flood overflow path) add some flood risk issues in two areas. Some good ecological restoration potential associated with flood works. Increased landscape effects due to elongated footprint of Paraparaumu interchange. (M) - Improvement in mobility for through traffic. There is an improvement in mobility for local traffic due to provision of two interchanges. There is an improvement in connectivity between Paraparaumu and Waikanae by allowing trips between Paraparaumu and Waikanae to access the expressway. (E) - Consistency with regional/national policy by constructing expressway (GPS) relieving congestion and improving travel times. Consistency with local and regional policy by providing convenient access to expressway from Paraparaumu and Waikanae growth areas.
	3D	South-facing ramps south of Poplar Ave, north-facing ramps at Peka Peka. Full interchange at Te Moana Road. Split interchange with south facing ramps Raumati Road and north facing ramps Kapiti Road. One way auxillary lanes for local traffic.	(S) - Score due to noise, air quality and displacement effects associated with the extended Ihakara interchange. (IT) - Likely to obtain approvals within timeframe but increased risks due to opposition likely re Raumati Road (BE) - Larger footprint of Praraparaumu interchange footprint will have greater visual effects and affect a larger part of the residential comunity. (NE) - Interchange at Te Moana Road (flood overflow path) with split interchange and slip roads in Wharemauku flood storage area add some flood risk issues in two areas. (M) - Improvement in mobility for through traffic. There is an improvement in mobility for local traffic due to provision of two interchanges. There is an improvement in connectivity between Paraparaumu and Waikanae by allowing trips between Paraparaumu and Waikanae to access the expressway. (E) - Consistency with regional/national policy by constructing expressway (GPS) relieving congestion and improving travel times. Consistency with local and regional policy by providing convenient access to expressway from Paraparaumu and Waikanae growth areas.
	3E	Full interchange at Poplar Ave.North-facing ramps at Peka Peka. Full interchage at Kapiti Road. Full interchange Te Moana Road.	(S) - Significant effects associated with the Poplar Ave connection located adjacent to the schools resulting in increased noise and air quality issues. (IT) - Likely to obtain approvals within timeframe but increased risks due to opposition likely re imapcts on Poplar Avenue (NE) - Interchange at Te Moana Road (flood overflow path) adds some flood risk issues and increases ecological impacts on Waihmeha Stream. Large footprint in QE Park increase landscape effects 3 interchanges. (M) - Improvement in mobility for through traffic. There is an improvement in mobility for local traffic due to provision of two interchanges. There is an improvement in connectivity between Paraparaumu and Waikanae by allowing trips between Paraparaumu and Waikanae to access the expressway. (E) - Consistency with regional/national policy by constructing expressway (GPS) relieving congestion and improving travel times. Consistency with local and regional policy by providing convenient access to expressway from Paraparaumu and Waikanae growth areas.
	3F	South-facing ramps south of Poplar Ave. Full interchage at Kapiti Road. Full interchange Te Moana Road. Full interchange at Peka Peka	(S) - Score due to noise, air quality and displacement effects associated with the two interchanges. (IT) - Likely to obtain approvals within timeframe but increased risks due to opposition likely re imapcts on Poplar Avenue. (BE) - 3 interchanges collectively a larger footprint (than 1 or 2) and greater visual effects and impacts on local character. Full interchange at Pekapeka will promote a node of development inconsitent with rural environment. (NE) - Interchange at Te Moana Road (flood overflow path) adds some flood risk issues and increases ecological impacts on Waihmeha Stream. Large footprint with 3 interchanges. (M) - Improvement in mobility for through traffic. There is an improvement in mobility for local traffic due to provision of two interchanges. There is an improvement in connectivity between Paraparaumu and Waikanae by allowing trips between Paraparaumu and Waikanae to access the expressway. (E) - Consistency with regional/national policy by constructing expressway (GPS) relieving congestion and improving travel times. Consistency with local and regional policy by providing convenient access to expressway from Paraparaumu and Waikanae growth areas. Inconsistent with local policy by providing full interchange at Peka Peka which is likely to encourage growth in an area KCDC intends to keep rural.

LIVE SUB-OPTIONS

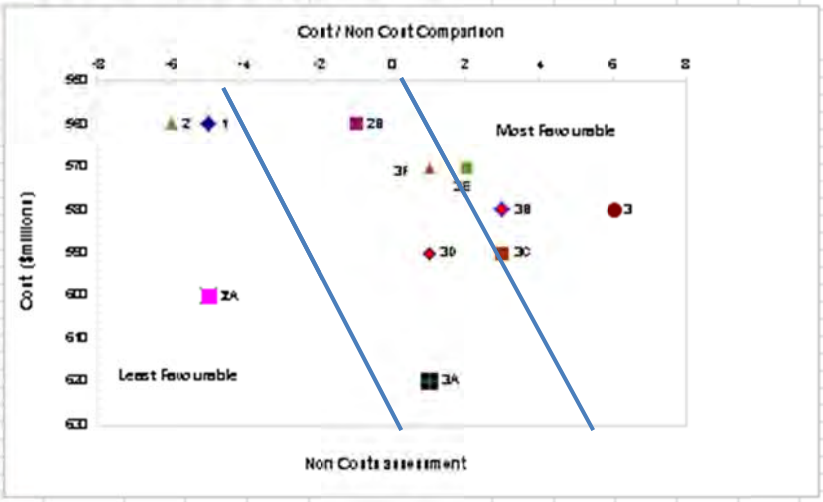
Sub-options by Sector		Sector 1	
Base Options	**Sub-option**		
1--3	S1Cii	South facing ramps at Poplar Ave. Alignment located east of the Steiner School.	(S) - Score due to significant air quality and noise effects of having expressway and ramps at Poplar Ave. (score changed from -2 to -3 due to alignment passing between both schools). (IT) - Strong opposition from school and affected residents (BE) - 3 interchanges collectively a larger footprint (than 1 or 2) and greater visual effects and impacts on local character. Full interchange at Pekapeka will promote a node of development inconsitent with rural environment. (NE) - Minor effects on flood areas. Significant effects on KCDC listed ecosite (Raumati Sth peatlands - moderate value).
	S1Ciii	South facing ramps , including local road over bridge in QE park. Alignment located east of Steiner school	(S) - Score due to air quality and noise effects of expressway passing between the two schools. (IT) - Strong opposition from school local residents and possibly GWRC because of scale of impact. (BE) - Significant impact on recreation and visual qualities of QE Park. Negative impact on definition of rural/urban edge. Cuts through land between Raumati east and west and impact on school connectivity
1--3	S1Dii	Ties in at 200 Main Road. Interchange on local road between Main Road and Poplar Ave.	(S) - Score due to significant deplacement effects on property owners at this location. (IT) - Strong opposition from affected residents re choice of not following existing designation (BE) - Avoids encroachment into QE Park and retains defined rural urban edge. Opportunity to improve local east-west connections across designation. Opportunity to reconnect Ruamtai east to west, links for school movements, new urban development areas (NE) - Minor effects on flood areas. Minor edge effects on moderate value wetlands west of 200 Main Rd (not listed eco-sites). Options for local road alignment may impact on local landforms.
		Sector 2	
1 -- 3	S2Ai	Follow existing designation through this section. With or without Interchange at extended Ihakara Street	(S) - Score due to minor air quality, noise and property effects. However effects more severe than 'do nothing'. (IT) - Likely to achieve timeframe but KCDC and local residents may oppose Ihakara Street I/C (BE) - Will be issues with the proximity of the expressway to residential edges and integrating with the urban form of these areas re noise walls and elevation of structures. (NE) - Minor effects on flood areas. Minor edge effects on moderate value wetlands west of 200 Main Rd (not listed eco-sites). Options for local road alignment may impact on local landforms.
1 -- 3	S2Bi	Alignment east of existing designation . With or without Interchange at extended Ihakara Street.	(S) - As above for comment (score changed from 0 to -1, cannot make this zero as social effects will result from building the road). (IT) - Most likely to achieve timeframe (BE) - Slightly better opportunity to take the expressway away from residential edge but still visual imapcts (NE) - Assessment assumes no Ihakara interchange. Less favourable if there is an Ihakara interchange. Minor ecological impacts, largely around Wharemauku Stream, but good potential to add values through stormwater and habitat in this area. Aligment beneficial as partly avoids dunes which could remain as buffer.
		Sector 3	
1--3	S3Ai	Follows existing designation apart from where alignment crosses river further west of current designation (via El Rancho camp and wetlands). Reconnects with existing designation at wahi tapu area.	(S) - Score due to significant effects on El Rancho Christain Holiday Camp (providing recreational land to the community). Alignment option will affect approx 6-8 residential dwellings resulting in displacement effects. (IT) - Unclear as to how strong opposition - signficant effects to be addressed (BE) - Significant impact on suburban character for residential area to west. Interchange at Te Moana will have significant visual effects and change to the semi rural/suburban charcater of the area. (NE) - Less favourable crossing location of Waikanae River - may affect flood overflow path. Significant edge effects on El Rancho and Osbournes wetlands (identified ecological and QEII eco-sites). Loss of 2-3 wetland areas in vicinity of Otaihanga Landfill complex. Destructioj of high dunes to west of designation.
3	S3B	Generally follows existing designation. To achieve 110kph design speed is located just east of designation at tightest point.	(S) - Score due to minor air quality, noise and property effects. However effects more severe than 'do nothing'. (IT) - Unclear as to how strong opposition - signficant effects to be addressed (BE) - Significant impact on recreational values of El Rancho. Interchange at Te Moana will have significant visual effects and change to the semi rural/suburban charcater of the area. (NE) - Significant effects on El Rancho and Osbournes Swamp wetlands (identifed ecological and QEII eco-sites). Reasonable crossing point of Waikanae River. Loss of 2-3 wetland areas in vicinity of Otaihanga Landfill complex. Largely avoids high dunes.
	S3C	Alignment slightly east of designation between Waikanae River & Te Monana but west of Urupa and Maketu	(S) (IT) - Score due to minor air quality, noise and property effects. However effects more severe than 'do nothing'. (BE) - Interchange at Te Moana will have significant visual effects and change to the semi rural/suburban charcater of the area. (NE) - Significant effects on El Rancho and Osbournes Swamp wetlands (identifed ecological and QEII eco-sites). Reasonable crossing point of Waikanae River. Skirts around east of high dunes
3	S3D	Crosses river via existing designation - east of urupa, west of Maketu (straighter north/south alignment).	(S) - Score due to property displacement effects. (IT) - Score due to property displacement effects. Unclear as to how strong opposition - signficant effects to be addressed: however, the "compromise" nature of option may weigh better against the alternatives (BE) - Interchange at Te Moana will have significant visual effects and change to the semi rural/suburban charcater of the area. (NE) - Minor edge effects on El Rancho wetland (identified KCDC eco-site). Reasonable crossing point of Waikanae River. Loss of 2-3 wetland areas in vicinity of Otaihanga Landfill complex. Avoids most dunes alignment located on interdunal flats reducing need for landform modification.
1--3	S3E	Crosses river east of current designation, straighter north/south alignment. East of urupa/maketu.	(S) - Score due to significant property displacement and noise effects. (IT) - Unclear as to how strong opposition - signficant effects to be addressed: however, the "compromise" nature of option may weigh better against the alternatives. (BE) - Significant effect on established residential area. Interchange at Te Moana will have significant visual effects and change to the semi rural/suburban charcater of the area. (NE) - Less favourable crossing location of Waikanae River - may affect Muaupoko Stream. Minimum ecological effects other than stream crossings. Loss of 2-3 wetland areas in vicinity of Otaihanga Landfill complex. Avoids most dunes alignment located on interdunal flats reducing need for landform modification.
		Sector 4	
1--3	S4E	Alignment has a minor encroachment on the QEII convenants and stays within Maypole property.	(S) - Score due to minor air quality, noise and property effects. However effects more severe than 'do nothing'. (IT) - May not acheive timeframe because of effects on QEII Covenanted wetland (BE) - Visual effects similar for S4E and S4F (NE) - Minor effects on flood areas, impacts Ngarara Stream tributary. Ecological edge effects on regenerating wetland (QEII and KCDC listed). Similar degree og landfcape effects for both options
1--3	S4F	Alignment avoids QEII covenants and other wetland areas. Crosses additional property north of Maypole.	(S) - Score due to minor air quality, noise and property effects. However effects more severe than 'do nothing'. (IT) - Most likely to achieve timeframe (BE) - Visual effects similar for S4E and S4F (NE) - Minor effects on flood areas. Minor ecolgoical effects in relation to hydrology and regenerating vegetation. Similar degree og landfcape effects for both options

DELETED SUB-OPTIONS

Sub-options by Sector		Sector 1	
Base Options	**Sub-option**		
1--3	S1A	Southern tie-in at MacKays Crossing	Unlikely to be consentable as it divides QE Park in two. Recreational impacts too high to continue
1--3	S1Bi	South facing/north facing ramps south of Poplar Ave with additional local road tie-in. Alignment located west of the Steiner School (located within existing designation)	Interchange in the park was not preferred due to negative env implications. Unecceassary work in the park. Benefits of the interchange are not justiifiable against env and recreation impacts.
1--3	S1Bii	South facing ramps at Poplar Ave. Alignment located west of the Steiner School (located within existing designation)	**Sub option to removed from current live list.**Net poor score. Scores badly on most outcomes.
	S1Biii	South facing ramps , including local road over bridge in QE park. Alignment located west of Steiner school	**Sub option to removed from current live list.**Net poor score. Scores badly on most outcomes.
1--3	S1Ci	South facing/north facing ramps south of Poplar with additional local road tie-in. Alignment located east of the Steiner School.	Interchange in the park was not preferred due to negative env implications. Unecceassary work in the park. Benefits of the interchange are not justiifiable against env and recreation impacts.
1--3	S1Di	Ties in at 200 Main Road. South facing ramps. (this option includes variations 1E and 1F). Local service road runs parallel to SH1.	Potential impact on properties too severe to accommodate service road, therefore deleted as a live option.
Sector 2			
3D	S2Aii	Follows existing designation. South facing ramps at Raumati Road and north facing ramps at Kapiti Road. One way auxillary lanes for local traffic - as per Option 7.	Potential impact on properties too severe to accommodate interchange, therefore deleted as a live option. Traffic modelling shows severe impacts on local roads.
	S2Biii	Interchange at Mazengarb.	Potential impact on properties too severe to accommodate interchange, therefore deleted as a live option. Traffic modelling shows severe impacts on local roads.
Sector 3			
1--3	S3F	Straight line alignment from Otaihanga (near Peka Peka). Possible interchange at Otaihanga Road & interchange at Te Moana Road.	Potential property impacts are too severe to justify the alignement benefits in order to continue this option.
Sector 4			
1--3	S4A	Follow existing designation. North facing ramps at Peka Peka.	**Sub option to removed from current live lis**tFatally flawed due to location through QEII covenants and ecological areas
1--3	S4B	Straight line alignment from Otaihanga. North facing ramps at Peka Peka	Potential property impacts are too severe to justify the alignement benefits in order to continue this option
1--3	S4C	Alignment close to urban growth boundary. North facing ramps at SH1 (south of Peka Peka).	The 2 variations of this options were discussed at the meeting on the 14 July and it was agreed that the options cut through the urban growth area and were not achieving the intended purpose. It is not possible to obtain a suitable alignment without sign
1--3	S4D	Deviates from the designation south of urban growth edge and ties into existing highway 2km south of Peka Peka	

Score comparison from Multi Criteria Analysis

Base option	Adjusted Non Cost Assessment	Cost Assessment
1	-5	560
1A	-5	600
2	-6	560
2A	-5	600
2B	-1	560
3	6	580
3A	1	620
3B	3	580
3C	3	590
3D	1	590
3E	2	570
3F	1	570



Base option	Cost Assessment Outcomes	Assessment Outcomes
1	-5	0.6
1A	-5	0.9
2	-6	0.8
2A	-5	1
2B	-1	1
3	6	1
3A	1	1
3B	3	0.9
3C	3	1
3D	1	1
3E	2	1
3F	0	1