

Before the Board of Inquiry
Waterview Connection Project

in the matter of: the Resource Management Act 1991

and

in the matter of: a Board of Inquiry appointed under s 149J of the Resource Management Act 1991 to decide notices of requirement and resource consent applications by the NZ Transport Agency for the Waterview Connection Project

Rebuttal evidence of **Ann Williams (Groundwater)** on behalf of the
NZ Transport Agency

Dated: 1 February 2011

Hearing start date: 7 February 2011

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REBUTTAL EVIDENCE OF ANN WILLIAMS ON BEHALF OF THE NZ TRANSPORT AGENCY

INTRODUCTION

- 1 My full name is Ann Louisa Williams. I refer the Board of Inquiry to the statement of my qualifications and experience set out in my evidence in chief (*EIC*) (dated 8 November 2010).
- 2 I repeat the confirmation given in that statement that I have read and agree to comply with the Code of Conduct for Expert Witnesses in the Environment Court.

PURPOSE OF EVIDENCE

- 3 The purpose of this rebuttal evidence is to respond to certain aspects of the evidence lodged by submitters. Specifically, my evidence will respond to the evidence of:
 - 3.1 Mr Andrew Tauber, Apartments Ltd (Submitter 75-1¹) (1510 Great North Road);
 - 3.2 Mr Andrew Stiles, Auckland Council (Submitter 111-3);
 - 3.3 Mr Neil Buchanan, KiwiRail (Submitter 164-1);
 - 3.4 Ms Shona Myers, Living Communities and Friends of Oakley Creek (Submitter 167 and 179-2); and
 - 3.5 Ms Wendy John, Friends of Oakley Creek (Submitter 179-1).
- 4 In addition, I will comment on relevant aspects of the Supplementary Section 42A Report prepared by Earthtech Consulting Ltd (*Earthtech*) dated 23 December 2010 (*Earthtech Section 42A Report*).
- 5 This evidence also includes comments on further amendments to the proposed Groundwater conditions discussed and I understand agreed during expert caucusing which I attended.²

¹ References are to the Submitter's Evidence as listed on the EPA website.

² As at the date my rebuttal evidence was finalised, the expert joint report following the Stormwater, Groundwater and Contamination caucusing session held on 26 January 2011 had not yet been signed.

ANDREW TAUBER – REQUEST FOR REPORT ADDRESSING LONG TERM EFFECTS ON WATER TABLE MOVEMENTS

- 6 Mr Tauber (point 7, final paragraph, page 11 of his evidence) seeks that the NZTA prepares comprehensive foundation reports for the building at 1510 Great North Road (Unitec One), which should include long term effects of water table movements on the building.
- 7 In my opinion, the Assessment of Groundwater Effects Report G.7 provides sufficient detail on groundwater level movements, including in the vicinity of Unitec One.³ I also note that the NZTA's proposed Groundwater conditions G.1 to G.6, G.8 and G.9 require piezometers to be installed and monitored to check changes in water level, before, during and following construction.
- 8 Accordingly, I consider that there will be sufficient understanding of water level changes in the vicinity of Unitec One to provide warning of potential groundwater drawdown induced settlement. I do not consider that the further comprehensive foundation reports sought by Mr Tauber are necessary.
- 9 My view is supported by Earthtech which observes that:⁴

“This fieldwork represents the most extensive groundwater investigations ever carried out for a project in the Auckland area.”

ANDREW STILES – INCORRECT WATER LEVEL DATA INCLUDED IN GEOTECHNICAL FACTUAL REPORT – 700 SERIES

- 10 Mr Stiles points out (at paragraph 4.6 of his evidence) that the 700 series groundwater level data supplied in the Geotechnical Factual Report G.29 is incorrect. On checking, I have found that an error was made in converting the excel spreadsheet to pdf format for presentation in the Report. The correct data is now attached as **Annexure A** to my rebuttal evidence.
- 11 I note that the water level data for the same group of piezometers was correctly presented in Appendix B of the Assessment of Groundwater Effects Report G.7.
- 12 Because the error only related to formatting of the data for presentation in the Geotechnical Factual Report, the error has not been carried though into any technical outputs prepared. Accordingly, I confirm that the correct data has been used in all assessments and analyses.

³ Cross-sections analysed at 3785 m (Appendix G); Second plan page of Drawing no. GIS-3180000-1-1.1 in Appendix A to the Groundwater Management Plan (Appendix H of the Assessment for Groundwater Effects Report G.7).

⁴ See Section 3.2.1 of the Earthtech Section 42A Report.

NEIL BUCHANAN – EFFECT OF GROUT CURTAIN

13 Mr Buchanan considers that the proposed grout curtain at the southern portal could result in differing water levels on either side of the curtain which might impact on the ability to create a stable rail corridor.⁵ His opinion is based on a report prepared by Aurecon commissioned by KiwiRail and attached as Annexure A to his evidence.

14 The Aurecon report states (at section 5.2) that the change in water level across the curtain might result:

“...in varying strata stiffness performance criteria and make it more difficult to maintain a high quality longitudinal profile, resulting in “drop-offs” or “swales”. In short, the top profile of the rail alignment may suffer more through seasonal change than if it were built in an area where there is a uniform water table.”

15 I do not agree with Aurecon’s comments, and therefore I do not agree with Mr Buchanan’s concern. The groundwater table in this area is relatively shallow, being controlled by the proximity to Oakley Creek. The grout curtain will be installed in the permeable fractured basalt which, irrespective of the groundwater level within it, will form a cemented rock subgrade. I am advised that the position of the grout curtain and the water table within the basalt can be readily dealt with in the geotechnical design of the railway embankment to avoid slumping.

16 Because the predominant groundwater flow is to the northwest (rather than towards the Creek), the grout curtain will have only a small effect on water levels.

SHONA MYERS – REDUCTION OF BASE FLOW

17 Ms Shona Myers states that the Freshwater Ecology Review report prepared by Dr Ryder (Appendix B to the EMS Section 42A Report dated 7 December 2010) suggests base flows in Oakley Creek could be reduced by up to 21% by the drawdown of groundwater during tunnel and portal construction.⁶

18 A reduction of base flow by about 20% was calculated for the theoretical option where the tunnels and portals are fully drained in the long term. However, the NZTA is not taking this option forward; the tunnels will not be fully drained in the long term.

⁵ See paragraph 3.5(b) of Mr Buchanan’s evidence.

⁶ See paragraph 5.12 of Ms Myer’s evidence.

- 19 As I state in my EIC (at paragraph 21), Beca's analyses indicate a reduction of Oakley Creek base flow by 6% over the length of the approaches to the southern portal, reducing to 2% over the length of the driven tunnel and northern cut and cover tunnel. The effect of this reduction in base flow is considered to be less than minor, as explained in paragraphs 52 and 71 of the EIC of Mr Eddie Sides.
- 20 Ms Myers further suggests that Groundwater condition G.10 (and the Groundwater Management Plan) should be extended to require monitoring of changes in water level in the Creek, flow velocity and turbidity. As I explained in my EIC (at paragraph 69), flow monitoring to date indicates that the Creek is flashy with significant flow variations and a low base flow component. Monitoring of river level and flow velocity is unlikely to provide the information sought by Ms Myers. These vary widely naturally and a record spanning tens of years would be needed to establish background levels and velocities sufficient to identify variations that might be attributed to tunnel construction.
- 21 In my view, the base flow monitoring proposed by the NZTA will give the warning sought by Ms Myers.
- 22 I attended expert freshwater ecology caucusing on 27 January 2011 and this issue was discussed.⁷ The ecological experts and Ms Myers agreed that the base flow monitoring would act as a suitable warning, provided:
- 22.1 There was reference in proposed Groundwater condition G.12 to review of the data collected by a freshwater ecologist; and
- 22.2 Condition G.12 is cross-referenced in Condition F.5.
- 23 That agreement is confirmed in the Expert Caucusing Joint Report – Freshwater Ecology (paragraph 7) as follows:
- (a) Amend Condition G.12 as follows:
- The continuous monitoring results shall be reviewed on a monthly basis to determine if there is any effect of the tunnelling on base flows in Oakley Creek. The results shall be **reviewed by a hydrologist and freshwater ecologist and** included in the 3 monthly groundwater reports, and provided to the Auckland Council.

⁷ Freshwater Ecology caucusing held on 27 January 2011 at offices of Boffa Miskell, Auckland.

- (b) Amend Condition F.5 to read as follows:

The NZTA shall review the freshwater monitoring results, provided from Conditions F.2 to F.4, and results in monitoring detailed in earthworks Conditions E.9, E.19 **and** **Groundwater Condition G.12**. In the event that potential adverse effects are identified, the NZTA shall develop and implement appropriate contingency plans and/or remedial measures in accordance with the measures set out in the ECOMP.

WENDY JOHN – COLUMNAR BASALT EXPOSED IN OAKLEY CREEK

- 24 Ms John identifies that columnar basalt outcrops in the banks of Oakley Creek in Sector 9. Ms John explains that the basalt columns were the result of blasting to divert the creek in the 1930s and that removal of the basalt should be avoided, or if affected by the proposed stream realignment, should be recreated in the new stream alignment (paragraphs 11.10 and 11.11 of her evidence).
- 25 Columnar basalt forms from the quick cooling of a lava flow. Contractional joints (fractures) form a random, but often hexagonal, cellular network. Columnar basalt is common in the Auckland Region, with perhaps the best known example being exposed in the old Mt Eden Quarry at Auckland Grammar School. In the Waterview area, columnar basalt is also exposed in the Oakley Inlet Heritage Area, road cuttings for SH16, in the Meola Stream within Chamberlain Park Golf Course and no doubt at other locations also.
- 26 While the columnar basalt could be considered attractive, it is not geologically unique. I understand that the best of the examples exposed in Oakley Creek will be preserved and note that it is possible that further columnar basalt may be exposed in the process of stream realignment.⁸

COMMENTS ON EARTHTECH SECTION 42A REPORT

- 27 Earthtech is in agreement with the scope of investigations carried out, the geological model developed and the hydrogeological units established and their properties.⁹ Earthtech agrees with the approach to groundwater modelling and that sufficient information has been provided to assess effects on groundwater.¹⁰ However, there remain some points of difference that I describe below. As

⁸ Dr Rod Clough discusses the heritage value of the basalt in his rebuttal evidence (paragraphs 21 and 22).

⁹ See section 3.2.1, paragraphs 1 and 2 and section 3.2.3 of the Earthtech Section 42A Report.

¹⁰ See section 3.2.2 and section 3.3.1, paragraph 1 of the Earthtech Section 42A Report.

noted below, however, during expert caucusing it was agreed that, provided the extent and magnitude of settlement does not exceed that identified in Figure E14, Total Estimated Settlement – Tunnel and Approaches (updated Figure attached to the rebuttal evidence of Gavin Alexander), then the difference in interpretation (as between Earthtech and myself) is of little consequence.

Geology modelled at CH2750 m

- 28 Earthtech suggests the depth to unweathered East Coast Bays Formation rock (*ECBF*) used in 2D groundwater modelling of section CH2750 m should be locally greater (under the centre of the ridge) than that presented in the NZTA groundwater modelling.¹¹ A greater thickness of weathered rock would have the effect of increasing the thickness of potentially compressible ground that could be subject to ground settlement.
- 29 As I have explained in my EIC (at paragraph 29), the 2D groundwater modelling has used sections cut from a 3D geological model developed from all the investigation data available at that time. I have checked the levels of strata in boreholes on the section CH2750 m against the levels used in the NZTA's 2D modelling and found they are correct.
- 30 I therefore disagree (with Earthtech) that the depth to unweathered rock is in part shown incorrectly on the 2D section modelled at CH2750 m.

2D Groundwater Modelling

- 31 Earthtech presents an incorrect interpretation of the groundwater system within the ECBF.¹² Earthtech considers that the decreasing water levels recorded in the series of deepening piezometers installed in BH508 in the Blockhouse Bay Ridge, indicate that the ridge is fully saturated to the level of the shallowest recorded water level and that the full head (from the near surface) would be experienced throughout the profile. I disagree with this interpretation.
- 32 I have already provided additional description to respond to Earthtech's earlier questions on the groundwater system that exists within the Waitemata Group rocks in my addendum report (Appendix 4 to Addendum to Technical Report G.7, Assessment of Groundwater Effects).¹³ I consider that the groundwater levels are not perched in the traditional sense (that is, in many cases they do not form separate water levels that are not in hydraulic connection with underlying water levels), but form a cascading series of linked perched water tables as found throughout the Waitemata Group rocks in the Auckland Region.

¹¹ See section 3.2.1, paragraph 3 of the Earthtech Section 42A Report.

¹² See section 3.3.2, pages 6 - 8 of the Earthtech Section 42A Report.

¹³ Annexure C to my EIC.

- 33 In **Annexure B** to my rebuttal evidence, I show the groundwater levels recorded in the 3 nested piezometers in the Avondale Heights (Blockhouse Bay Road) ridge (referred to by Earthtech as the Waterview Ridge). The piezometers show a cascading series of perched water tables, with a deeper water level being recorded in each successively deeper piezometer.
- 34 In **Annexure C** of my rebuttal evidence, I show the water levels expected if the situation was as assumed by Earthtech in Section 3.3.2 of its Report. That is, the groundwater level, irrespective of piezometer depth, would be about the same. If this were the case, then the water pressure throughout the profile would be the same and drawdown from this same groundwater level would need to be considered in settlement analyses. But this is not the case.
- 35 A new 2D groundwater model at CH2750m is presented in Appendix B to the Earthtech Section 42A Report. There is not sufficient information provided for me to check the model. However, I note that 6 – 8% rainfall recharge has been applied to the left hand side of the model (to the lower permeability ECBF) and 3 % has been applied to the right hand side (to the higher permeability basalt) in order to achieve calibration with the unusual mound shown. This is not appropriate because the higher permeability rocks will accept more rainfall recharge than the lower permeability rocks.
- 36 Earthtech suggests that its model is better calibrated than the NZTA model.¹⁴ I strongly disagree. As described in the Assessment of Groundwater Effects Report and the Addendum Technical Report G.7, the model presented by the NZTA does not attempt to calibrate to perched water levels because the head of water on each successive water table is only a fraction of the total head between the regional water table and the uppermost near surface water table. Despite this, Table B1 in Appendix B of the Earthtech Section 42A Report shows that in many cases (BH508b, BH518d, BH307s) the NZTA model is better calibrated than the Earthtech model, and the overall difference in calibration is insignificant.
- 37 I note that drilling of the proposed monitoring bores and installation of piezometers in them has been proceeding for the Project in parallel with this consenting process. I have examined the water level data collected from monitoring of these new piezometers and have found that where nested piezometers have been installed within ECBF, the recorded water levels indicate head differences of 3.5 m to 10 m (see **Annexure D** to my rebuttal evidence) between successive deeper and deeper piezometers, other than in lower lying areas where perched water tables do not exist. This data confirms the existence of the cascading series of perched water levels.

¹⁴ Appendix B, final sentence in section B2.2 and Table B1 of the Earthtech Section 42A Report.

- 38 I note also that the shallower piezometers have high water levels that show a greater variation (about 2.5 m at BH508) in response to rainfall than the deeper piezometers (the intermediate piezometer at BH508 has a variation of about 1.5 m, and the deep piezometer a variation of about 0.5 m) indicating that the upper water tables vary more in response to rainfall than the deeper water tables, which is expected.
- 39 In summary, I consider that Earthtech's interpretation of the groundwater system within the Waitemata Group rocks is incorrect. Therefore, its assessment of the amount of groundwater drawdown and associated settlement is also incorrect.
- 40 However, as agreed with Earthtech in expert caucusing,¹⁵ if the extent and magnitude of settlement does not exceed that identified in updated Figure E14 (attached to the rebuttal evidence of Mr Gavin Alexander), then the difference in interpretation of the groundwater system in the Waitemata Group is of little consequence.
- 41 I disagree with Earthtech's suggestion that the principal aim of groundwater investigations is to provide conservative drawdown predictions.¹⁶ The NZTA has provided a significant volume of data to estimate the expected drawdown. Conservative assumptions may be used where data is not available, but in this case we have sufficient data to allow reasonable modelling. This is acknowledged in Earthtech's report, where it states that the fieldwork represents the most extensive groundwater investigations ever carried out for a project in the Auckland area.¹⁷

Proposed Groundwater Conditions

- 42 Earthtech suggests that groundwater take volumes should be specified in the consent conditions for the purpose of "*long term management of the AVF and ECBF aquifers in terms of future groundwater availability*".¹⁸ While I agree that long term groundwater take volumes could be specified for this purpose, I note that the aquifers are not being utilised (as described in paragraph 67 of my EIC). I therefore see no value in the requirement for monitoring of groundwater take volumes during excavation and construction, as the abstraction volume will vary according to progress and will be of no use in the long term management of the aquifers.
- 43 Therefore, with respect to the new groundwater condition proposed by Earthtech (which is shown inserted above proposed Groundwater

¹⁵ Stormwater, Groundwater and Contamination caucusing held on 26 January 2011 at the District Court, Auckland.

¹⁶ Section 3.3.5 of the Earthtech Section 42A Report.

¹⁷ Section 3.2.1 of the Earthtech Section 42A Report.

¹⁸ Section 6.2.1, page 19 of the Earthtech Section 42A Report.

condition G.1 in Appendix C1 to the Earthtech Section 42A Report), I consider that part (a) is not needed. This was agreed with Earthtech in expert caucusing.

- 44 While I agree that part (b) of the condition proposed by Earthtech could provide information useful in the long term management of the aquifers, the detail given in the draft condition is unnecessarily complicated. I therefore suggest that, if imposed, such a condition should read:

The volume of water abstracted in the long term (following completion of the tunnels) shall not exceed 750 m³/day.

750 m³/day is the rounded total expected abstraction volume from the portals and the tunnels. This was agreed with Earthtech in caucusing¹⁹, who suggested an annual take identifying that this volume would be abstracted 365 days of the year, should also be included.

- 45 These matters are now included in a new proposed Groundwater condition G.13, which reads:

Authorised Quantity: Following completion of excavation and construction, the daily quantity diverted and taken shall not exceed 750 m³ and the annual quantity diverted and taken shall not exceed 273,750 m³.

- 46 I agree with Earthtech's proposed amendments to the NZTA's groundwater condition G.1, except for the suggested requirement for the Groundwater Monitoring Plan to be submitted to Auckland Council "three months" prior to the commencement of construction dewatering. This is a significant time period and, in my view, not necessary. I consider that "one month" would be more than adequate to enable Auckland Council to review the Plan, particularly as a draft Groundwater Monitoring Plan has already been submitted as part of this application. An amended Groundwater condition G.1 was agreed with Earthtech in expert caucusing,²⁰ to read as follows:²¹

The NZTA shall finalise, and implement through the CEMP, the Groundwater Management Plan (GWMP), submitted with this application ~~and provide it to the [Auckland Council]~~ prior to commencement of tunnelling **construction dewatering**. The GWMP shall include, but not be limited to:

¹⁹ Stormwater, Groundwater and Contamination caucusing held on 26 January 2011.

²⁰ Stormwater, Groundwater and Contamination caucusing held on 26 January 2011.

²¹ The bold underlined wording is new, as agreed with Earthtech.

- (a) **A schedule of monitoring bores identifying piezometer depth and geological unit;**
- (b) **The method of bore construction and piezometer installation (including testing carried out in piezometers);**
- (c) **The location of the groundwater monitoring bores and monitoring cross-sections shown on plans;**
- (d) The location of the continuous monitoring stations on Oakley Creek;
- (e) The methods and frequency for groundwater monitoring;
- (f) The groundwater trigger levels;
- (g) Procedures to follow in the event of trigger levels being exceeded;
- (h) Reporting requirements.

The NZTA shall submit the GWMP to the Auckland Council one month prior to the commencement of construction dewatering for written approval of the Manager.

- 47 I agree with the recommendation by Earthtech,²² in its proposed amendment to groundwater condition G.7, that monitoring of leachate indicators be carried out between the base of the Phyllis Street landfill and the tunnel alignment at 3 monthly intervals for the period when tunnel construction is within 100 m of the landfill, continuing until the tunnel within 100 m of the landfill is lined. However, I note that this is already proposed in a more stringent Contaminated Land condition, CL.9. This was pointed out in expert caucusing and Earthtech agreed that an amendment to G.7 is not therefore required.
- 48 Earthtech suggested that a condition should be inserted fixing the alignment considered by the NZTA in this application²³ and proposes a new condition that requires the design of the tunnels and approaches to be as described in the Geotechnical Interpretative Report (Appendix C1, new Groundwater condition G.10). I do not agree with this proposed condition, as the detailed design has only just begun and further refinements in design may result in considerable cost or time savings and/ or reduction in effects. I note also that the designation boundaries will be fixed.

²² Section 6.2.5, page 21 of the Earthtech Section 42A Report.

²³ Section 6.2.3, page 20 of the Earthtech Section 42A Report.

- 49 I consider, however, that it would be appropriate to fix the extent of effects expected (that is the settlement effects discussed by Mr Gavin Alexander. It was agreed with Earthtech in expert caucusing that provided Figure E14 (which shows the expected extent of settlement effects, as attached to the rebuttal evidence of Mr Alexander) forms part of the consent conditions, then the new condition G.10 is not needed.
- 50 Earthtech correctly notes that the units that have been considered as potentially compressible are Fill, Tauranga Group Alluvium, Weathered Parnell Grit and Weathered East Coast Bays Formation.²⁴ Earthtech notes however that the Weathered East Coast Bays Formation is not listed in the first two tables included in section 6.1.7 of the GWMP (Shallow Bores). I agree that Weathered East Coast Bays Formation should be referenced in these two tables.
- 51 Finally, I understand that Earthtech is agreed that no further changes are required to proposed Groundwater conditions G.2 to G.11 and G.14.

Conclusion

- 52 In summary, I understand that Earthtech is in agreement with most of the groundwater investigations and analysis undertaken for the Project. The remaining difference of expert opinion is in the understanding of the behaviour of groundwater beneath the centre of the Avondale Heights ridge. However, the experts agreed during caucusing that this difference in interpretation is of no consequence provided the ground settlement effects associated with groundwater drawdown do not exceed those shown in the updated Figure E14.²⁵



Ann Williams
February 2011

²⁴ Section 7.1.4, page 24 of the Earthtech Section 42A Report.

²⁵ I note that as a result of caucusing, updated Figure E14 is now specifically referred to in Ground Settlement conditions S.1 and S.7; ground settlement effects shall not exceed those shown in this Figure (see rebuttal evidence of Gavin Alexander, Annexure A).

**ANNEXURE A: GEOTECHNICAL FACTUAL REPORT - CORRECTED 700
SERIES STANDPIPE PIEZOMETER DATA**

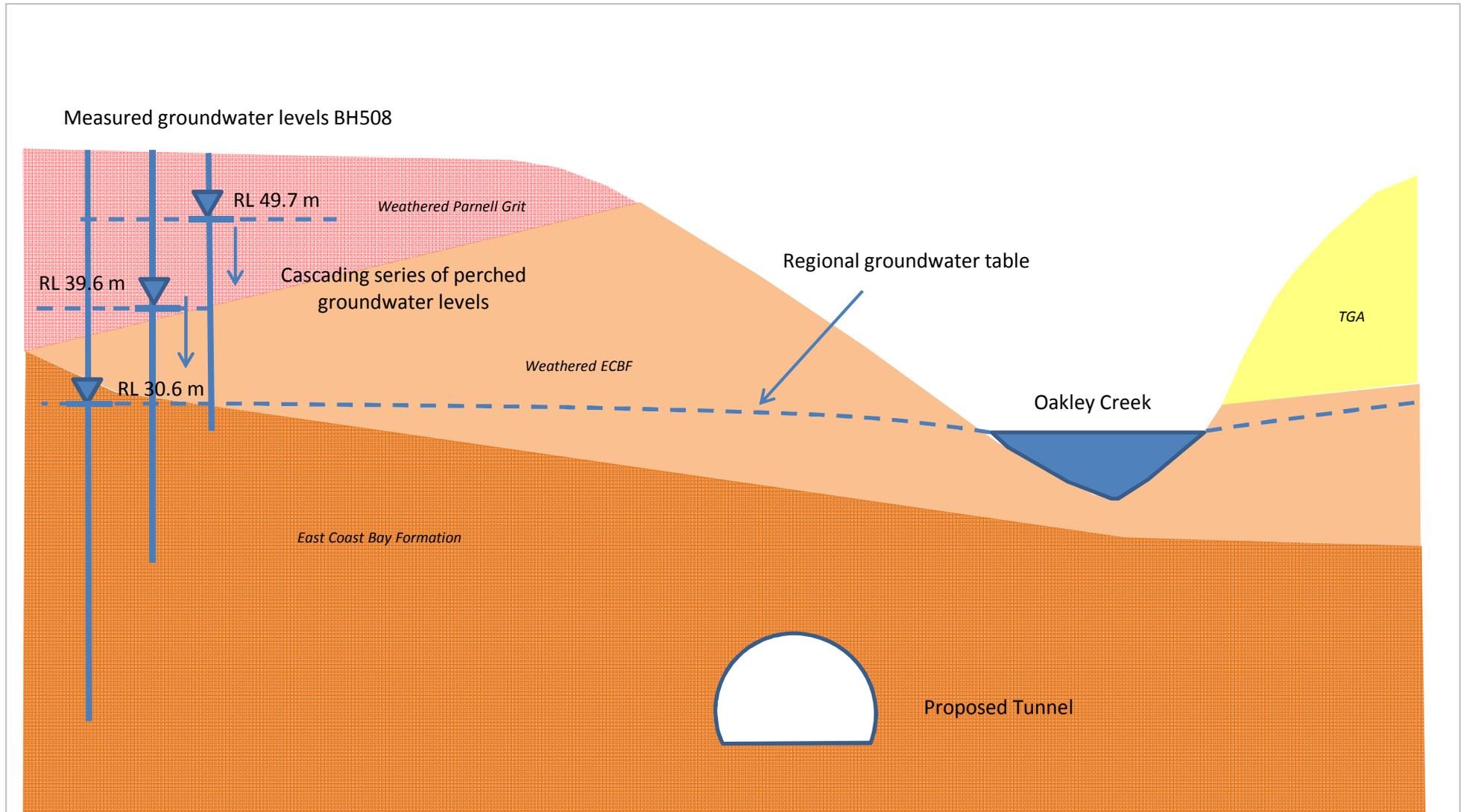
Waterview Connection Project

700 series		Ground Level	25-Feb-10		26-Feb-10		1-Mar-10		3-Mar-10		5-Mar-10	
Borehole ID	mbgl		mRL	mbgl	mRL	mbgl	mRL	mbgl	mRL	mbgl	mRL	
BH 701 a		41.37										
BH 701 b		41.34										
BH 702 a		39.78										
BH 703 a		46.10									20.70	25.40
BH 705 a		31.06									7.30	23.76
BH 706 ad		29.51									10.20	19.31
BH 706 as		29.51									5.95	23.56
BH 706 b		29.48									Dry	Dry
BH 707 ad		30.53									15.05	15.48
BH 707 as		30.53									13.35	17.18
BH 707 c		30.54									8.52	22.02
BH 708		25.26										
BH 709 ad		31.08	15.83	15.25	15.76	15.32	15.55	15.53	15.48	15.60	15.45	15.63
BH 709 as		31.08	13.60	17.48	13.52	17.56	13.35	17.73	13.25	17.83	13.20	17.88
BH 709 a1		31.13	7.74	23.39	6.77	24.36	6.80	24.33	6.82	24.31	6.85	24.28
BH 709 c		30.06	15.02	15.04	14.85	15.21	14.43	15.63	14.26	15.80	13.10	16.96
BH 709 c1 d		29.96	14.73	15.23	14.72	15.24	14.00	15.96	14.42	15.54	14.42	15.54
BH 709 c1 s		29.96	9.97	19.99	9.96	20.00	10.01	19.95	10.02	19.94	10.08	19.88
BH 709 d		30.83	3.93	26.90	3.91	26.92	3.90	26.93	2.85	27.98	3.85	26.98
BH 710 a		27.10										
BH 716		18.11										

Standpipe Piezometer Data

ANNEXURE B: CASCADING PERCHED GROUNDWATER LEVELS

Waterview Connection Project

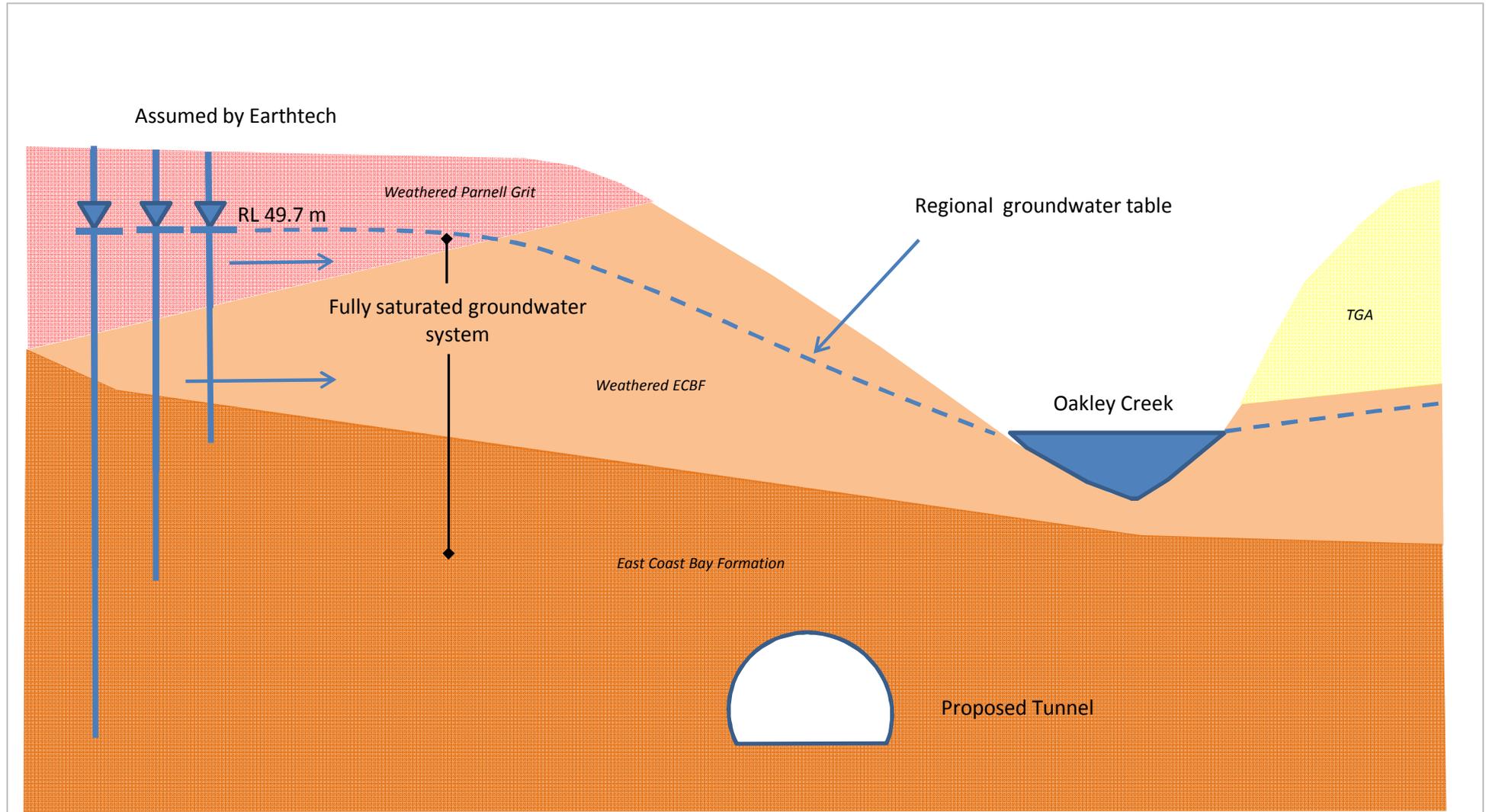


Schematic - Not to Scale

Cascading Perched Groundwater Levels

ANNEXURE C: HYDROSTATIC GROUNDWATER SYSTEM

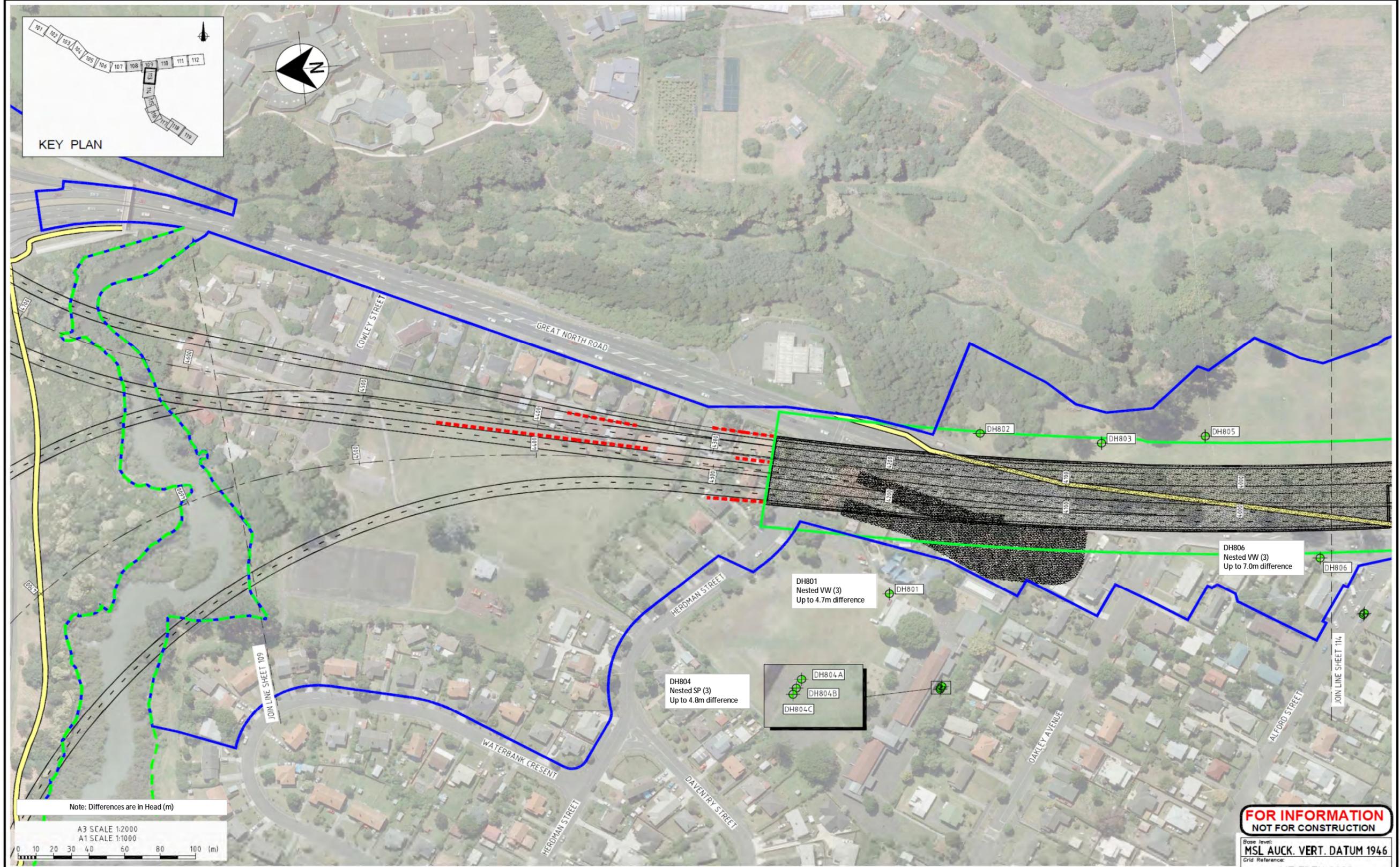
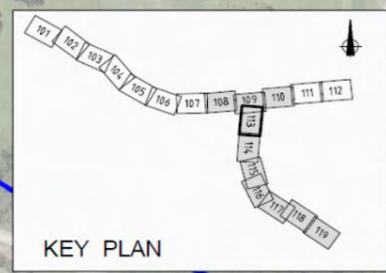
Waterview Connection Project



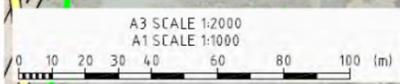
Schematic - Not to Scale

Hydrostatic Groundwater System (Assumed by Earthtech)

ANNEXURE D: HEAD DIFFERENCES IN NESTED PIEZOMETERS



Note: Differences are in Head (m)



**FOR INFORMATION
NOT FOR CONSTRUCTION**

Base Level:	MSL AUCK. VERT. DATUM 1946
Grid Reference:	MT EDEN 2000
Originator No.:	208955
Project No.:	20.1.11-5-D-J-200-333
Rev.:	A

No.	Revision	By	Chk	Appd	Date
TI	ISSUED FOR INFORMATION	PC	BOL	TI	29.10.10

Drawing Originator:
aurecon
 Aurecon New Zealand Limited
 138 Clifton Grove Road (PO Box 9782) Newmarket, Auckland, New Zealand
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Original Scale (A1)	1:1000	Design Engineer	PC
Reduced Scale (A3)	1:2000	Review Engineer	PK
		Drafting Checked	-
		Consultant Approval	-
			OL
			W/C

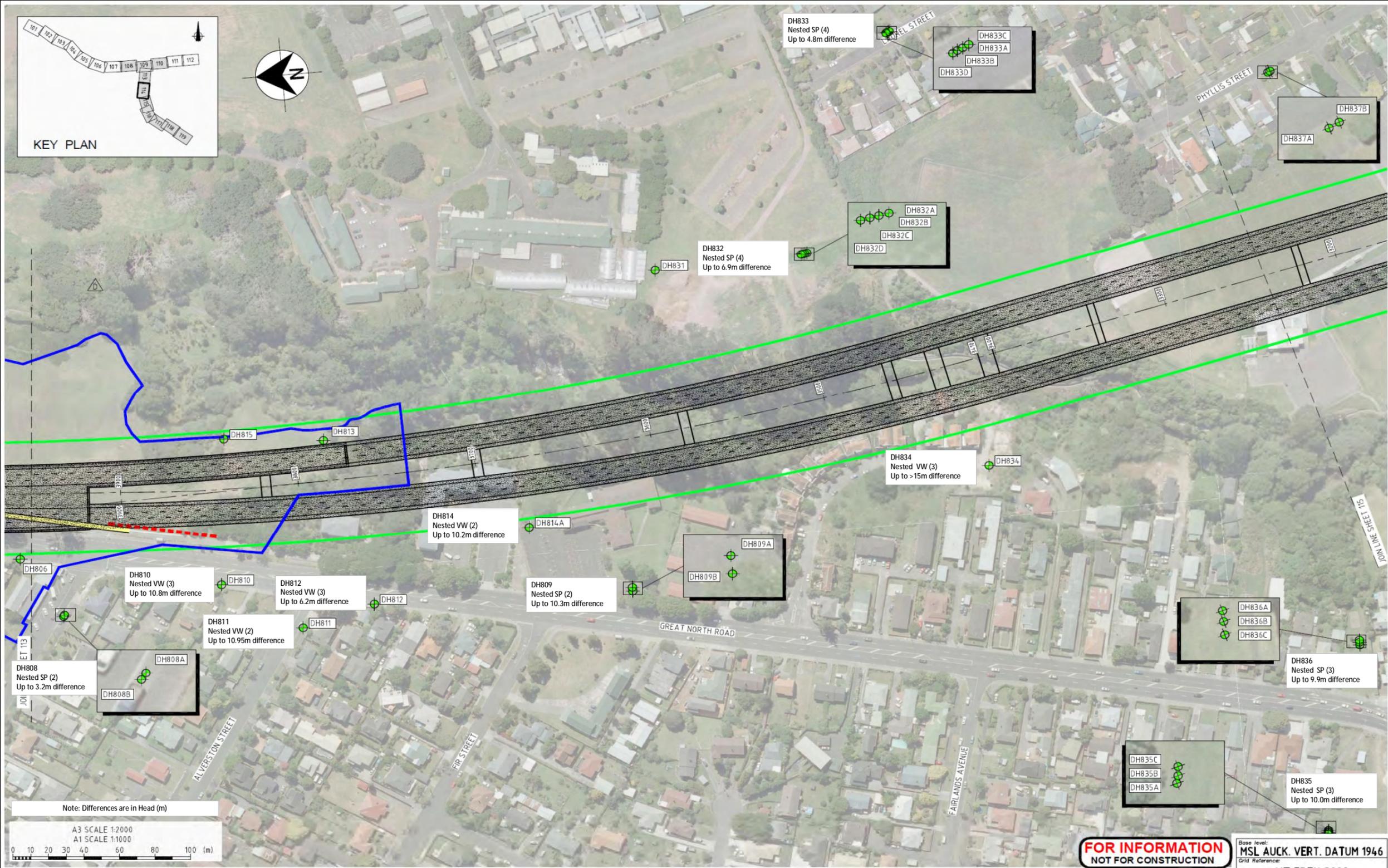
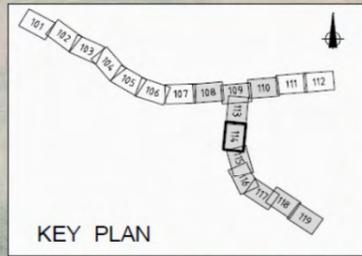


Project:
**SH20 WATERVIEW CONNECTION
 TUNNELS & GREAT NORTH ROAD
 INTERCHANGE**

Title:
**GEOTECHNICAL INVESTIGATION POSITIONS
 800 SERIES
 SHEET 113**

DO NOT SCALE

Document No. 2011-5-D-J-200-333-339.dwg



Note: Differences are in Head (m)

A3 SCALE 1:2000
A1 SCALE 1:1000

FOR INFORMATION
NOT FOR CONSTRUCTION

Base level: MSL AUCK. VERT. DATUM 1946
Grid Reference: MT EDEN 2000
Originator No. 208955
Project No. 20.1.11-5-D-J-200-334
Rev. A

No.	Revision	PC	BOL	TI	29.10.10
A	ISSUED FOR INFORMATION				

Drawing Originator:
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Original Scale (A1)	1:1000	Design Engineer	PC
Reduced Scale (A3)	1:2000	Review Engineer	BOL
		Drafting Checked	WC
		Consultant Approval	TI



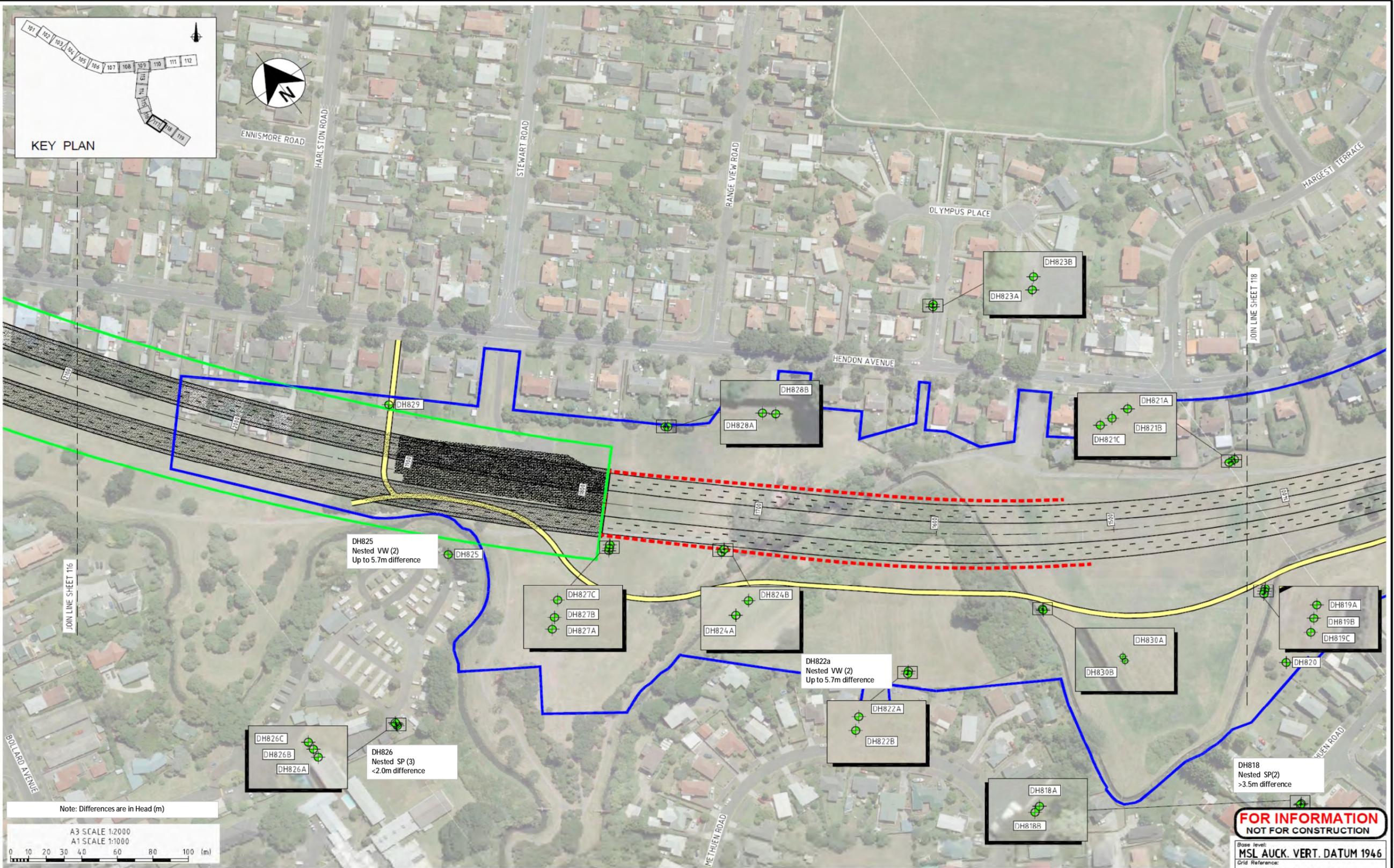
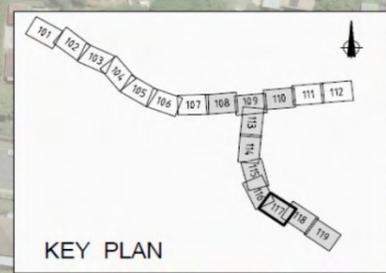
Project: SH20 WATERVIEW CONNECTION
TUNNELS & GREAT NORTH ROAD
INTERCHANGE

Title: GEOTECHNICAL INVESTIGATION POSITIONS
800 SERIES
SHEET 114

DO NOT SCALE

Document No. 201115-D-J-200-334-114

Annexure D Map 2-3



Note: Differences are in Head (m)

A3 SCALE 1:2000
A1 SCALE 1:1000

**FOR INFORMATION
NOT FOR CONSTRUCTION**

Base level:
MSL AUCK. VERT. DATUM 1946
Grid Reference:
MT EDEN 2000
Originator No. **208955**
Project No. **20.111-5-D-J-200-337**
Rev. **A**

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		Drafting Checked	WC
		Consultant Approval	TI



Project:
**SH20 WATERVIEW CONNECTION
TUNNELS & GREAT NORTH ROAD
INTERCHANGE**

Title:
**GEOTECHNICAL INVESTIGATION POSITIONS
800 SERIES
SHEET 117**

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Document No. 20111-5-D-J-200-337-339.dwg