

Watercare Services Limited
Private Bag 92 521
Wellesley Street
Auckland 1141

Attention: Belinda Petersen

Dear Belinda

Central Interceptor Project Technical report on settlement for site AS2 - S41C RMA Direction

1 Introduction

This technical report has been prepared for Watercare Services Limited (WSL) at their request to assist them in preparing a response to a S41C RMA Direction from the Auckland Council Hearing Panel.

It provides information specific to the S41C RMA Direction under item 4 (a) (v), which requests:

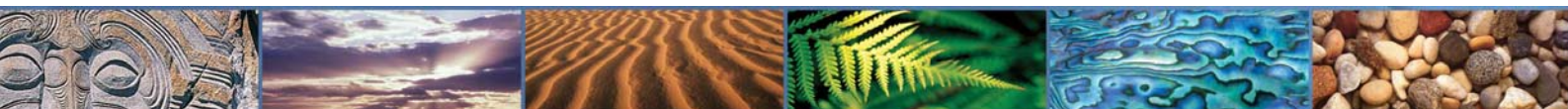
“A quantified risk assessment of the potential for ground settlement adversely affecting the SGLA buildings during construction of the tunnel and shaft for both alternatives.”

The S42C identifies that the alternatives are the Lyon Avenue site proposed by WSL and the Mt Albert Grammar School option (MAGS), presented by Mr Maddren at the Hearing.

2 Scope

Given the potential extent of work and timeframe required to undertake a quantitative risk assessment, a qualitative risk assessment has been undertaken. This assessment is based on inference from existing analysis and available information including Auckland Council’s property files for the St Lukes Gardens Apartments (SLGA). The geological conditions and shaft configurations studied in the existing analyses are sufficiently similar to those in this study, that the findings and conclusions presented here can be considered appropriate for this stage of the project.

This report provides estimates of potential settlement that might arise as a result of construction activities for the Proposed Lyon Avenue site and the Mt Albert Grammar School (MAGS) Alternative site. Based on these estimates AECOM have separately prepared an assessment of the potential for the settlement to adversely affect the SGLA buildings.



3 Assumptions

The assessments made here are based on the attached geological information and the layouts for each of the alternatives provided by AECOM, (AEE-MAIN-3.1 issue D, LYON-SK1101 issue C and LYON-SK1001 issue Included in Appendix C).

Watercare's Proposed Lyon Avenue site is shown on AEE-MAIN-3.1 issue D, with all the shafts located on the eastern side of Meola Creek.

The MAGS Alternative site is shown on LYON-SK1101 issue C and LYON-SK1001 issue C. These two drawings identify a layout with shafts constructed on both sides of Meola Creek, connected by either pipeline constructed by trenching, or a deeper pipeline constructed by pipe jacking.

3.1 Existing analyses utilised in this study

The geological information (Figure 1 and Figure 2 in Appendix A) identifies that the conditions at the Proposed Lyon Avenue site and the MAGS Alternative site are similar to those previously studied at the Mt Albert War Memorial Reserve site and at the Whitney Street site respectively.

Example construction methodologies were developed for both those sites during settlement studies as part of S92 settlement studies pre Hearing. Those studies will be utilised here to provide qualitative assessments of potential settlement.

In utilising those studies, we have adopted the same assumptions around the construction methodologies used as examples for those sites. Those methodologies were developed to specifically address the conditions at those sites.

4 Geology of sites for AS2

In the vicinity of the Proposed Lyon Avenue site and the MAGS Alternative site, Meola Creek demarcates a change in the geological ground profile. Basalt flows dominate surface geology to the east and north overlying Puketoka Formation, and East Coast Bays Formation (ECBF) rock at depth. To the south and west surface geology is air fall ash deposits or Puketoka Formation deposits, overlying ECBF rock.

For the purposes of this comparative study, these two geological environments are considered similar to the geology at the Mt Albert War Memorial Reserve site and the Whitney Street site respectively. The qualitative study of potential surface effects, completed for those two sites during S92 responses, have been utilised here to provide a basis for assessing the potential settlement effects at the two alternative locations for site AS2.

Table 1 and Table 2 provide a direct comparison of general geological conditions at the two alternative AS2 locations with the corresponding existing analyses.

Table 1 – Proposed Lyon Avenue Site – Typical main shaft (drop shaft and access shaft) geology comparison

Geological Unit	Proposed Lyon Avenue Site thickness	Comparative Mt Albert War Memorial Reserve site thickness
Basalt rock	5 to 7 m	11 m
Puketoka Formation	22 to 24 m	19 m
ECBF	18 m+	20 m+

Table 2 – MAGS Alternative – Typical main shaft (drop shaft and access shaft) geology comparison

Geological Unit	MAGS Alternative site thickness	Comparative Whitney Street site thickness
Ash	2 to 5 m	NIL
Puketoka Formation	NIL	8 m
ECBF	40 m+	60 m+

The Mt Albert War Memorial Reserve analyses provide a reasonable comparison to the Proposed Lyon Avenue site. The basalt rock is considered incompressible in terms of direct settlement arising from groundwater drawdown, so the difference in overlying thickness is of little importance in this comparison. The Puketoka Formation is mostly likely to contribute the majority of settlement that might arise from groundwater drawdown. The Proposed Lyon Avenue site has Puketoka Formation about 25% thicker than the Mt Albert War Memorial Reserve site. Drawdown effects, i.e. settlement estimates are likely to be proportional to the thickness of the compressible layer. Therefore the estimates of settlement that were made using numerical analysis techniques for the Mt Albert War Memorial Reserve site can be extrapolated to the MAGS Alternative site without significant loss in accuracy.

The Whitney Street site provides a relatively good geotechnical match to the MAGS Alternative site, despite a difference in surface geology. The ash is likely to be slightly less compressible than the Puketoka Formation, meaning that the assessments of settlement at the MAGS Alternative site based on the Whitney Street analyses are likely to be conservative (over estimates of settlement that might arise).

5 Settlement estimates

Estimates have been adopted directly from the S92 work for the Whitney Street site and the Mt Albert War Memorial site.

5.1 Proposed Lyon Avenue site shafts

The Whitney Street site settlement estimates have been factored up by 25% to estimate settlement at the Proposed Lyon Avenue site to allow for the greater thickness of compressible material potentially present at this site.

These estimates are considered appropriate for assessing the effects of the access shaft and drop shafts.

Table 3 – Proposed Lyon Avenue site estimated settlement with distance from edge of single shaft

Distance from Shaft	0 m	5 m	10 m	20 m	30 m	40 m	50 m	100 m
Estimated settlement	60 mm	55 mm	55 mm	50 mm	45 mm	40 mm	35 mm	20 mm

Settlement differentials are estimated to be 1:2,000 or flatter in all cases.

5.2 MAGS Alternative site shafts

The Whitney Street site settlement estimates have been adopted directly as estimates of settlement for the MAGS Alternative site.

These estimates are considered appropriate for assessing the effects of the access shaft and drop shafts.

Table 4 – MAGS Alternative site estimated settlement with distance from edge of single shaft

Distance from Shaft	0 m	5 m	10 m	20 m	30 m	40 m	50 m	100 m
Estimated settlement	30 mm	30 mm	30 mm	30 mm	30 mm	30 mm	30 mm	20 mm

Settlement differentials are estimated to be flatter than 1:2,000 in all cases.

For the drop shaft on the eastern side of Meola Creek associated with this option, the settlement is expected to similar to that estimated for the access shaft and drop shafts in the Proposed Lyon Avenue site, repeated here in Table 5.

Table 5 – MAGS Alternative estimated settlement for drop shaft on eastern side of Meola Creek (refer LYON-SK1001 issue C)

Distance from Shaft	0 m	5 m	10 m	20 m	30 m	40 m	50 m	100 m
Estimated settlement	60 mm	55 mm	55 mm	50 mm	45 mm	40 mm	35 mm	20 mm

Settlement differentials are estimated to be 1:2,000 or flatter in all cases.

5.3 MAGS Alternative site – connection across Meola Creek

For the MAGS Alternative site, there are two options for connecting the flows from the diversion chamber to the drop shaft:

- A trench excavation, and,
- A pipe jacked connection some 10-15 m depth to invert below ground level.

In both cases, AECOM advises the connection will be via a pipe some 2.7 m in diameter.

5.3.1 Open trench installation (LYON-SK1101)

The trench will be excavated through basalt and Puketoka formation on the eastern side of Meola Creek, and Puketoka Formation and ECBF rock.

The trench will mostly likely be excavated progressively in small sections, within a support shield. This construction methodology is not likely to result in significant surface settlement away from the immediate excavation area.

5.3.2 Pipe jacking installation (LYON-SK1001)

A nominally 2.7 m diameter pipe is shown with installation from the drop shaft on the western side of Meola Creek to the reception shaft/drop shaft on the eastern side.

The pipe jack will start within ECBF rock, before transitioning into Puketoka Formation material some 2/3 of the way along the run.

This is a similar construction methodology to much of the proposed combined sewer overflow network, as reported in "Central Interceptor Project, CSO Settlement Study", Tonkin & Taylor Ltd, July 2012.

In that study, estimates of potential surface settlement that could arise from construction were presented. Those estimates indicate that when the pipe jack is entirely within the ECBF, little if any surface settlement would be expected. This is the situation for most of the pipeline on the western side of Meola Creek. On the eastern side, where the pipeline is constructed with approximately 10 m cover to the pipe crown in Puketoka Formation some 10-20 mm of settlement is estimated immediately above the pipeline, reducing away from the centreline such that settlement is expected to be close to zero 20 m from the pipe centreline. Maximum differentials associated with the settlement are estimated to be in the order of 1:1,000 some 6 m from the pipe centreline.

6 Conclusions

A qualitative assessment has been undertaken of the potential for settlement arising from the Proposed Lyon Avenue site and the MAGS Alternative site. This assessment is based on inference from existing analysis where the geological conditions and shaft are sufficiently similar to those in this study, such that the findings and conclusions presented here can be considered appropriate for this stage of the project.

This report provides estimates of potential settlement that might arise as a result of construction activities for the Proposed Lyon Avenue site and the MAGS Alternative site. Based on these estimates AECOM have separately prepared an assessment of the potential for the settlement to adversely affect the SGLA buildings.

For the Proposed Lyon Avenue site, settlement associated with shaft construction is estimated to be 60 mm immediately adjacent to the shaft, reducing to some 20 mm approximately 100 m from the shaft.

For the MAGS Alternative site settlement associated with shaft construction is estimated to be 30 mm immediately adjacent to the shaft, reducing to some 20 mm approximately 100 m from the shaft.

Construction of the drop shaft on the eastern side of Meola Creek associated with the MAGS Alternative site is estimated to result in 60 mm of settlement immediately adjacent to the shaft, reducing to some 20 mm approximately 100 mm from the shaft.

An additional feature of the MAGS Alternative site is the need to connect flows from the diversion chamber on the eastern side of Meola Creek to the shafts on the western side: two options are considered;

- A trenched option is not expected to result in significant surface settlement away from the immediate excavation area.
- The alternative pipe jacked option could result some 10-20 mm of settlement immediately above the pipeline, reducing away from the centreline such that settlement is expected to be

close to zero 20 m from the pipe centreline. Maximum differentials associated with the settlement are estimated to be in the order of 1:1,000 some 6 m from the pipe centreline.

7 Applicability

This report has been prepared for the benefit of Watercare Service Limited with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:

Authorised for Tonkin & Taylor Ltd by:

Graeme Twose

Senior Geotechnical Engineer

Robert Hillier

Geotechnical Group Manager

19-Sep-13
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Appendix A: Geological information



LEGEND

- Edge of basalt flow
- 25 Elevation, base of basalt
- 0 Elevation, top of Waitemata Group
- Geological Section Line

A3 SCALE 1:2500
 A1 SCALE 1:1250
 0 50 100 150 (m)

ORIGINAL IN COLOUR

INFORMATION ONLY
 September 2013

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DESIGNED	KJH	08/13
DES. CHECKED		
DRAWN	AGI	08/13
DWG. CHECKED		
REV'D P.MGR		
APP'D P.DIR		

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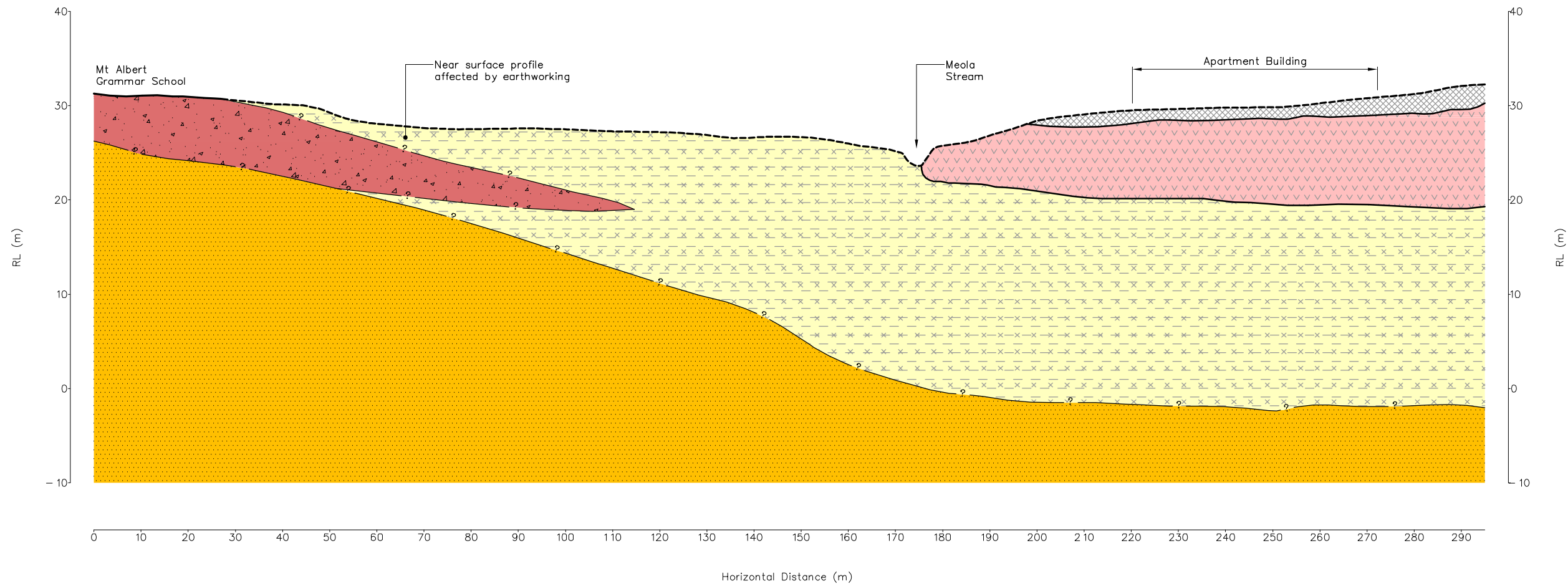
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CENTRAL INTERCEPTOR AND ASSOCIATED WORKS
GEOTECHNICAL CONDITIONS

CAD FILE 29200-F01	DATE 1-Jun-12
ORIGINAL SCALE A1 1:1250	CONTRACT No.
DRAWING No. FIGURE 1	ISSUE

WEST
A

EAST
A'



SECTION A
 SCALE 1:500(H)
 1:250(V)

LEGEND

- Fill
- Basalt
- Ash
- Puketoka Formation
- East Coast Bay Formation

A3 SCALE 1:500
 A1 SCALE 1:250

ORIGINAL IN COLOUR

INFORMATION ONLY
 September 2013

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DRAWN	AGI	08/13
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REV'D P.MGR		
APP'D P.DIR		

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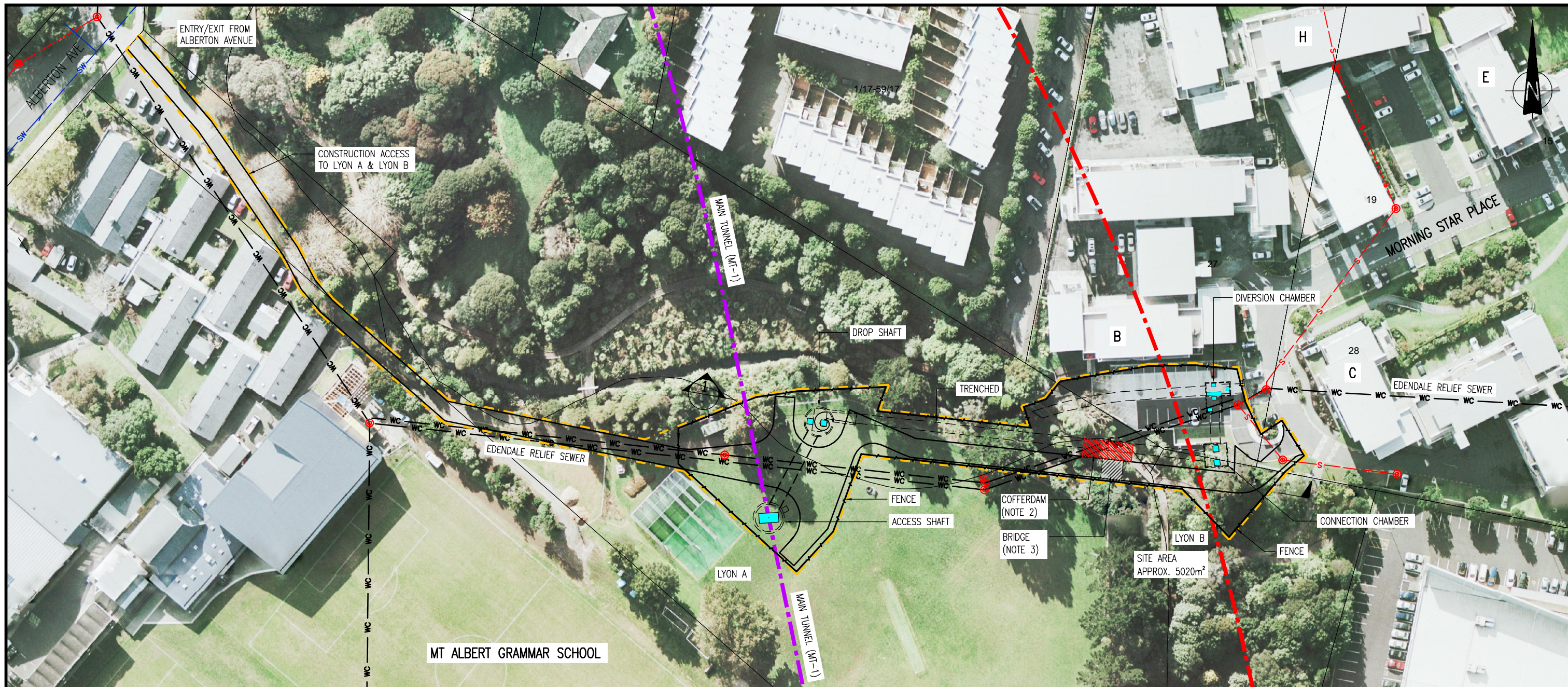
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GEOTECHNICAL CONDITIONS

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AS SHOWN	
DRAWING No.	ISSUE
FIGURE 2	

Appendix B: Layout drawings from AECOM

- **LYON-SK1101**
- **LYON-SK1001**
- **AEE-MAIN-3.1_D**

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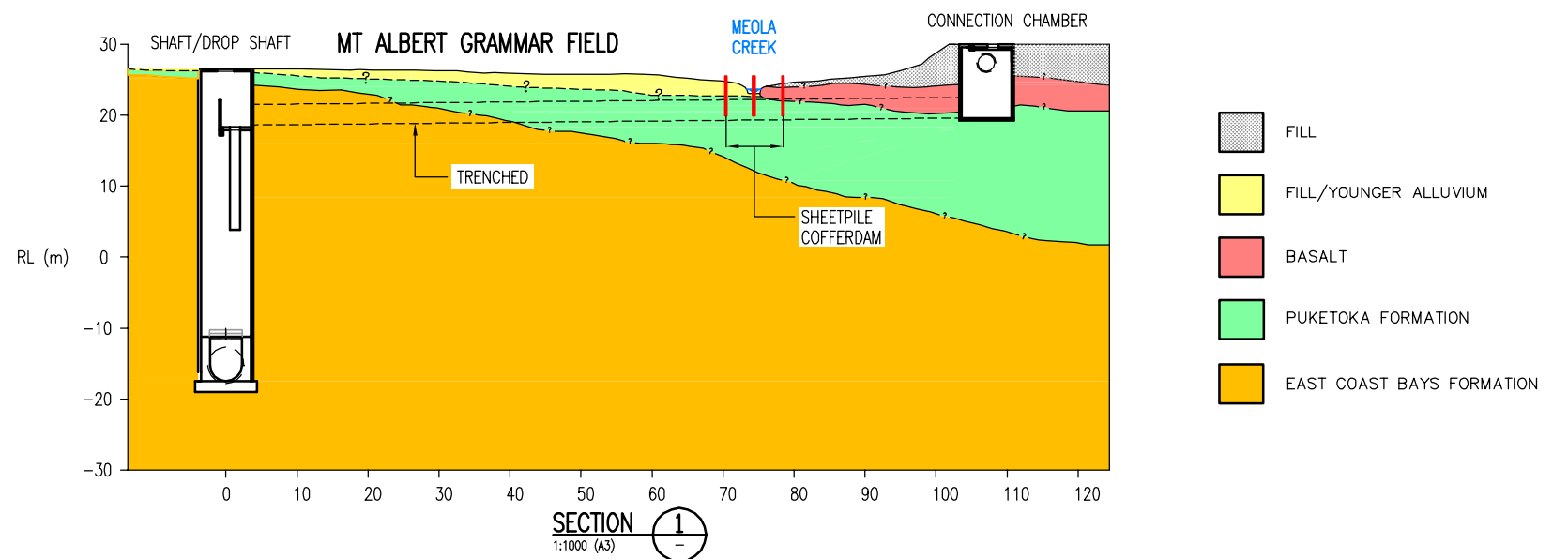


LEGEND

- - - - - PROPOSED TUNNEL ALIGNMENT
- - - - - MAGS ALTERNATIVE TUNNEL ALIGNMENT
- = = = = = CONNECTION PIPELINE
- - - - - S EXISTING RETICULATION SEWER
- WC - EXISTING TRUNK SEWER
- SW - EXISTING STORMWATER
- - - - - PROPOSED SITE BOUNDARY
- LID/STRUCTURE FLUSH WITH GROUND
- LID/STRUCTURE ABOVE GROUND

NOTES:

1. SEE DRAWING LYON-SK401_OA FOR PLAN OF TUNNEL ALIGNMENTS FOR LYON AVE SITE OPTIONS.
2. MEAOLA STREAM TO BE DIVERTED LEFT AND THEN RIGHT WITHIN SHEETPILE COFFERDAM TO ALLOW CONSTRUCTION OF TRENCH AND PIPE LAYING. FOOTPATH TO BE DIVERTED.
3. BRIDGE REQUIRED FOR ACCESS ACROSS STREAM (EITHER PERMANENT OR TEMPORARY, DEPENDING ON ACCESS ARRANGEMENTS).



ISSUE	DATE	AMENDMENT	BY	APPD.	DESIGNED	DES. CHECKED	DRAWN	DWG. CHECKED	REV'D P.MGR	APP'D P.DIR	BY	DATE
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B	17/09/13	FOR INFORMATION	AP	JQC	NL	JQC	AP	NL				
A	-	DRAFT	AP	PR	NL	JQC	AP	NL				

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SITE LAYOUT AND DESIGNS INDICATIVE ONLY AND SUBJECT TO CHANGE DURING DETAILED DESIGN DEVELOPMENT

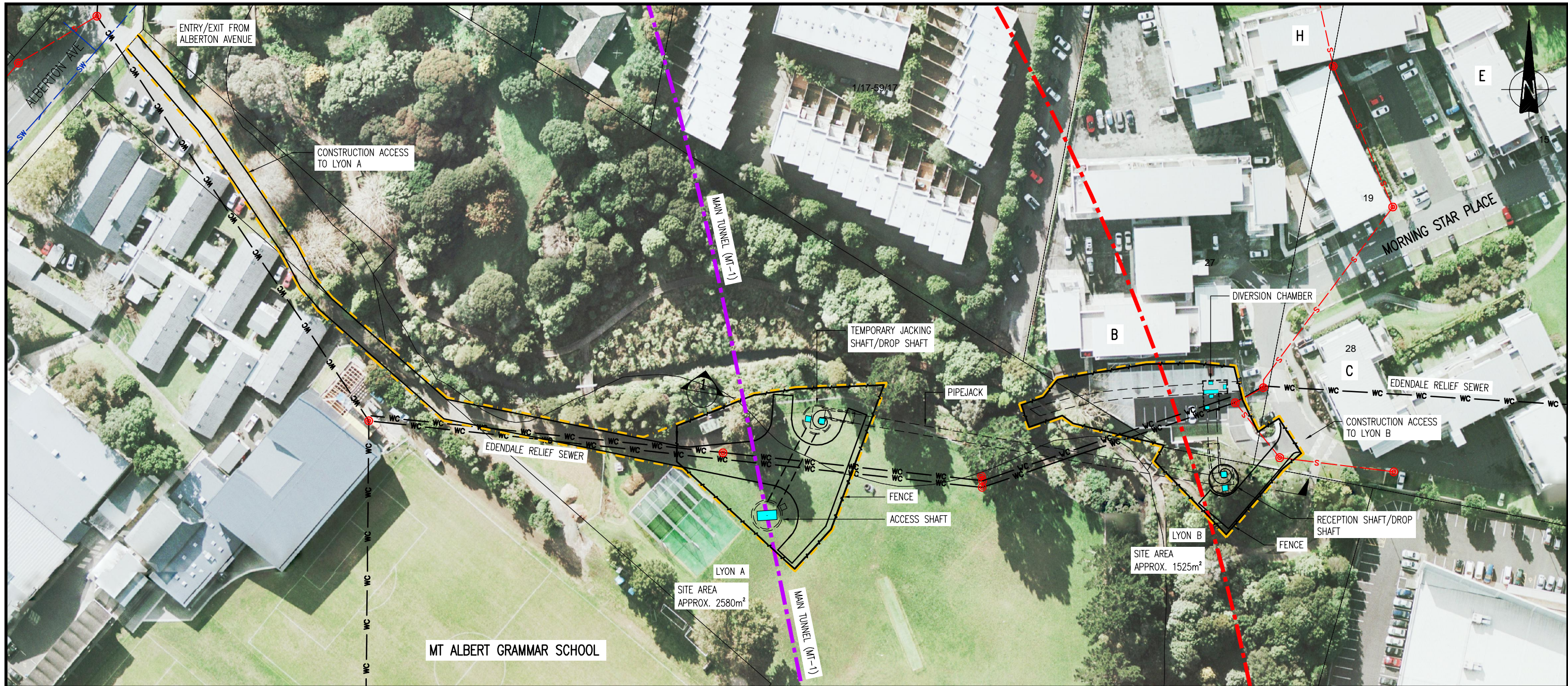
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CENTRAL INTERCEPTOR
GENERAL - MT ALBERT GRAMMAR SCHOOL ALTERNATIVE 2
LYON AVENUE (AS2) - CONSTRUCTION ACCESS FROM MAGS (TRENCHED OPTION)

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DRAWING No. LYON-SK1101	ISSUE C

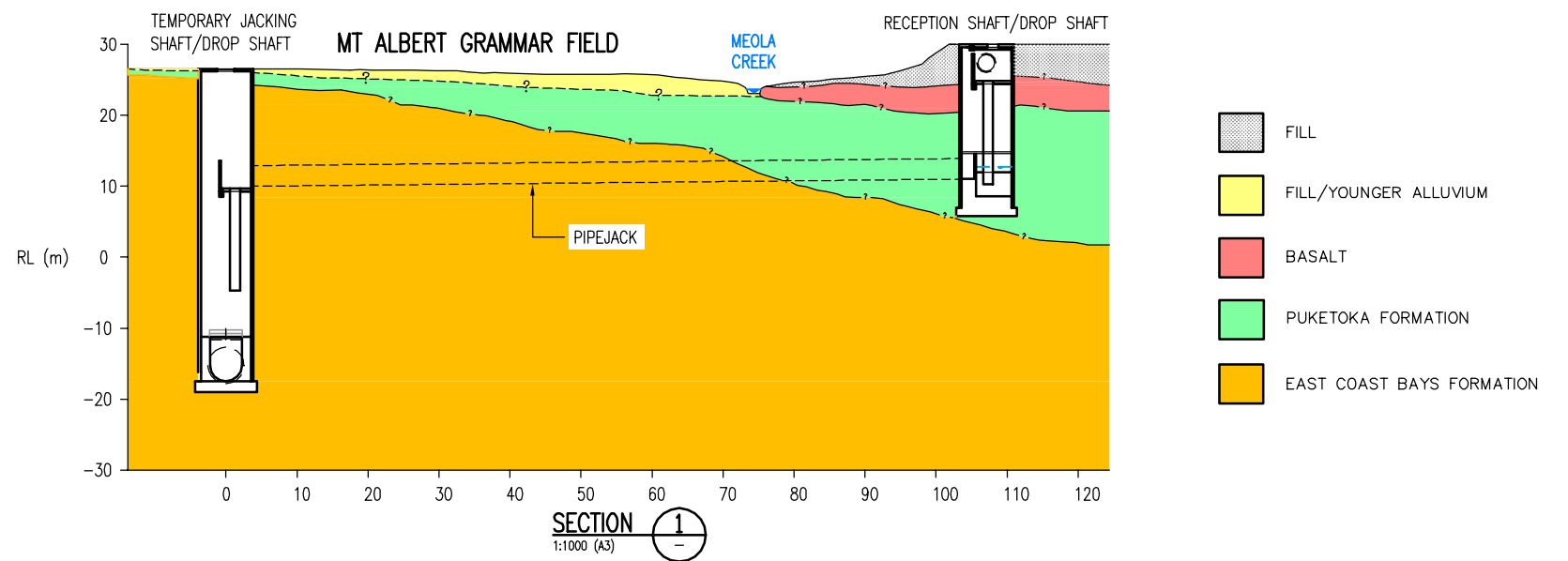


LEGEND

- - - PROPOSED TUNNEL ALIGNMENT
- - - MAGS ALTERNATIVE TUNNEL ALIGNMENT
- = = = CONNECTION PIPELINE
- S - EXISTING RETICULATION SEWER
- WC - EXISTING TRUNK SEWER
- SW - EXISTING STORMWATER
- - - PROPOSED SITE BOUNDARY
- LID/STRUCTURE FLUSH WITH GROUND
- LID/STRUCTURE ABOVE GROUND

NOTES:

- SEE DRAWING LYON-SK401_OA FOR PLAN OF TUNNEL ALIGNMENTS FOR LYON AVE SITE OPTIONS.



Plot Date: 19-Sep-13 9:26 a.m.
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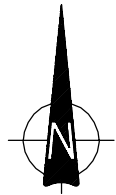
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CENTRAL INTERCEPTOR
 GENERAL - MT ALBERT GRAMMAR SCHOOL ALTERNATIVE 1
 LYON AVENUE (AS2) - SEPARATE CONSTRUCTION ACCESS (PIPEJACK OPTION)

CAD FILE LYON-SK1001	DATE 19-Sep-13
ORIGINAL SCALE A1	CONTRACT No. 0538
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DRAWING No. LYON-SK1001	ISSUE C



NOTES:

- 1. DESIGNATION AREA TO BE REDUCED UPON COMPLETION OF WORKS.

LEGEND

- MAIN TUNNEL
- LINK SEWER
- CSO COLLECTOR
- CONNECTION PIPELINE
- VENTILATION DUCTS
- EXISTING RETICULATION SEWER
- EXISTING TRUNK SEWER
- EXISTING STORMWATER
- PROPOSED DESIGNATION BOUNDARY
- LID/STRUCTURE FLUSH WITH GROUND
- LID/STRUCTURE ABOVE GROUND

Plot Date: 18-Jul-13 3:03 p.m.
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C	12/07/13	ADDRESS NUMBERS ADDED AND AERIAL IMAGE REVISED	AP	JQC	DWG. CHECKED	NL
B	28/05/13	CONSENT ISSUE - DESIGNATION BOUNDARY/ACCESS REVISED	AP	PR	REV'D P.MGR	JS
A	17/08/12	CONSENT ISSUE	AP	PR	APP'D P.DIR	CC

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AEE JULY 2013



**CENTRAL INTERCEPTOR
 GENERAL**
 LYON AVENUE (AS2) - PERMANENT WORKS PLAN

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