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Memorandum

To	Sydney Water	Page	14
CC	Todd Ewart, David Hull, Natalia Cook, Matthew Adler, Michael Nasiry, Nick Watts, Jane Ciabattoni, William Hammond		
Subject	Cranbrook School - Sydney Water Services Engineering Assessment		
From			
File/Ref No.	60549969-SWC-BOA-01	Date	02-Sep-2019

1.0 Introduction and Purpose of Technical Note

AECOM has been engaged by the Cranbrook School to undertake the civil design of the school's redevelopment involving delivery of a new sports and fitness centre underneath the Hordern Oval, a new integrated learning centre known as the Centenary Building (to replace the existing Memorial Hall and Mansfield buildings) and regrading of the existing driveway along Rose Bay Avenue.

AECOM's scope of works includes civil and landscape works above and adjacent to Sydney Water pipe assets which require supporting documentation to inform the Building Over Asset (BOA) application. The proposed design includes construction of a driveway for access to an underground carpark on Rose Bay Avenue as shown in Figure 1 below indicated in in green hatching.

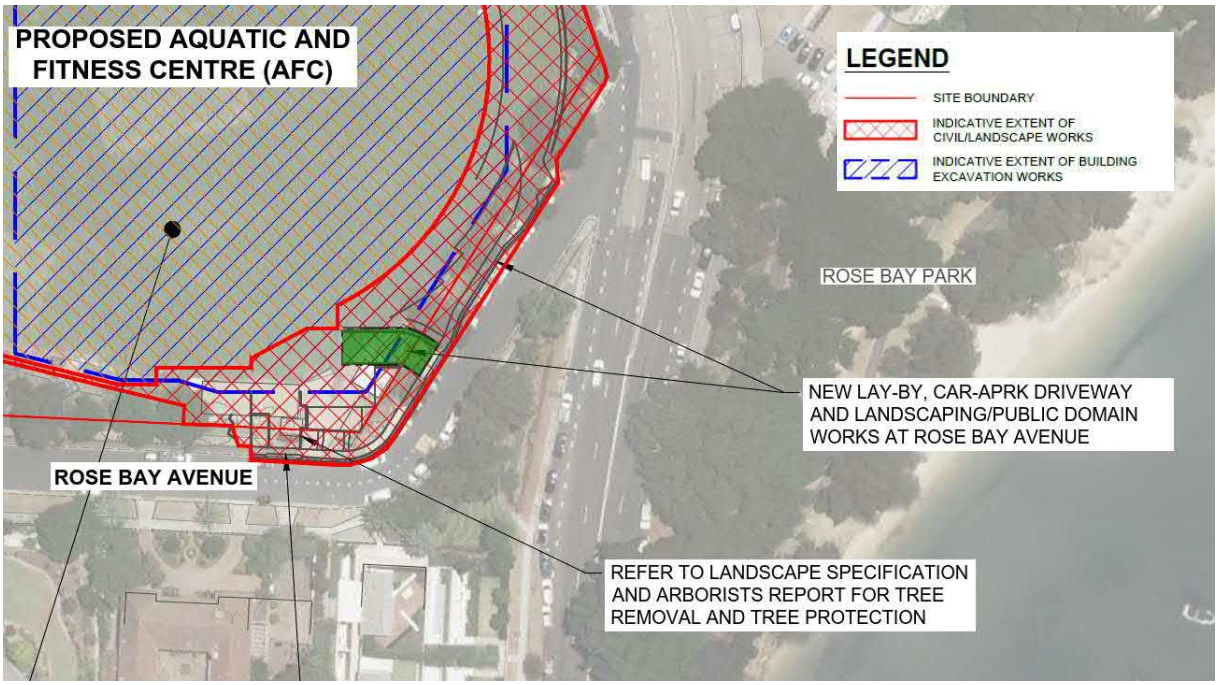


Figure 1 Cranbrook School Extent of Works

The purpose of this memo is to demonstrate to Sydney Water how Sydney Water assets including a sewer and water pipe running underneath the footpath on Rose Bay Avenue are to be protected from the impact of the construction and ongoing operation of the carpark driveway resulting in reduced cover and additional vehicular loads. This BOA submission details existing asset conditions and protection measures proposed to protect the existing sewer and potable water sewer pipes from the

impact of construction and subsequent long term vehicular loads associated with the Cranbrook School redevelopment.

This memo addresses the following sections:

- Details of the proposed works,
- Details of Sydney Water sewer assets impacted by the works,
- Description of site geology,
- Details of equipment used in construction,
- Proposed construction methodology an sequencing,
- Appraisal of the potential impact of the works,
- Details of sewer pipe protection measures, and
- Proposed monitoring during construction and contingency planning.

2.0 Details of Proposed Works

As part of the Cranbrook School redevelopment, civil and landscaping works outside the site boundary are required as part of the new Aquatic and Fitness Centre (AFC) building works as shown in Figure 1 above. This includes a new driveway entry/exit to the new underground AFC carpark and public domain works along the frontage of the new building, It is noted these works will involve reduction of existing levels to allow compliant grading and tie-ins for the new driveway and footpaths with the existing Rose Bay Avenue.

Sydney Water asset locations and information obtained from Dial Before You Dig (DBYD) records can be found in Appendix A.

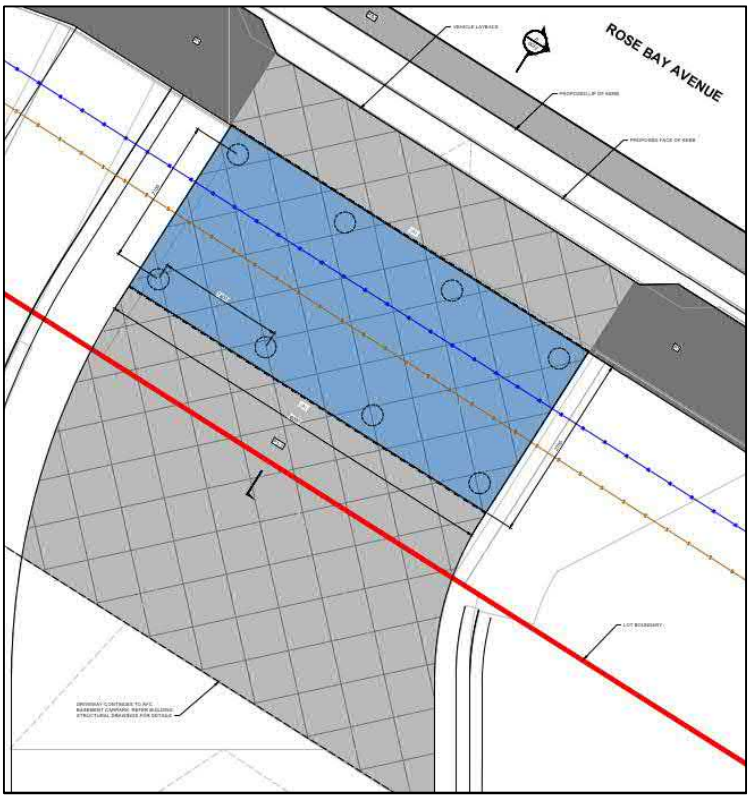


Figure 2 Proposed Carpark Driveway Entry at Rose Bay Avenue

3.0 Details of Sydney Water Assets

Underneath the proposed carpark driveway are a number of services including Sydney Water assets. A description of these impacted by the construction and the subject of this BOA submission are presented in Figure 2 and summarised in Table 1 below:

Table 1 Sydney Water sewer and water assets impacted by proposed works

Sydney Water Asset	Type	Description
DN225 Salt Glazed Ware (SGW), 1918, SO 2393	Sewer	Located underneath Rose Bay Avenue; Services adjacent properties along Rose Bay Avenue and connects into manhole located on New South Head Road. Refer to 'SO 2393' in Appendix C for details.
DN100 Modified Polyvinylchloride (mPVC), 2006, PRO 10005205-5	Water	Located underneath Rose Bay Avenue; Constructed to replace 100mm water main running parallel. Connects across New South Head Road. Refer to 'PRO 10005205-5' in Appendix C for details.

DBYD and Hydra plans have been included in Appendix B and Works-as-Executed drawings for the affected assets are located in Appendix C.

A services survey was undertaken by Vac Group Operations Pty Ltd on 15th September 2018 which identified levels of existing manholes and depths of cover. Location and level survey data has been included in Appendix D of this report.

4.0 Site Geology

The latest geotechnical investigations for the Cranbrook School were prepared by Douglas and Partners in February 2018. This report makes reference to and supersedes the geotechnical investigation undertaken in 2015 and 2017 involving the sampling of boreholes, augured boreholes, cone penetration tests (CPTs), laboratory analysis and engineering interpretation. The findings of this report indicate for the overall site, there is a presence of Hawkesbury Sandstone with some quaternary-aged marine sands with podsols.

Adjacent the proposed carpark driveway, the geotechnical investigation reported the presence of silty sand filling (dark brown and grey brown) at depths of 0.6m to 4.5m and silty sand (brown and brown-grey, fine to medium grained sand) at depths of 4.5m to 7m from the existing surface level.

Borehole location and data can be found in Appendix E. BH4, BH111, BH113 and BH117 borehole results have also been referenced to determine the approximate level of medium dense sand relative to the location of the driveway highlighted in Figure 3

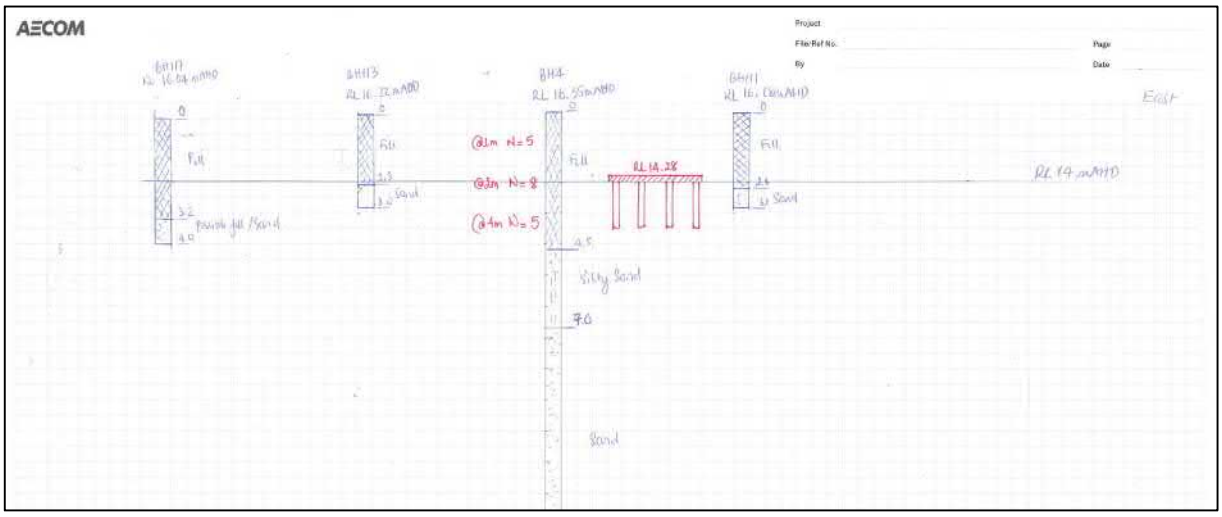


Figure 3 Expected ground profile

5.0 Proposed Construction Equipment

The following list of equipment may be operating over and around the sewer and water assets during construction and on-going operation of the AFC carpark driveway:

- Excavator;
- Piling rig for 300mm diameter bored pile; and
- Road legal dump truck.

The Contractor (TBC) will ensure axle loading near the pipe asset is no greater than that specified in the Sydney Water Technical Requirements 4-7. It is the Contractor's responsibility to ensure correct control measures will be in place to adequately protect and monitor the sewer assets in terms of construction equipment loading and methodology.

6.0 Proposed Construction Methodology

The following construction methodology is proposed for the works:

1) Provide Class A survey to locate the existing DN225 sewer and DN100 water pipes and identify the extent of the bridging slab and pile locations;
2) Perform a conditions assessment of the DN225 sewer using CCTV and DN100 water pipe by visual inspection.
3) From the survey data, peg out the zone of influence and exclude or restrict construction plant loading within zones of influence. This will be enforced using site controls and dedicated personnel.
4) Bored piles to be constructed as per detail provided in Appendix A recognising minimum clearance requirements as shown in the drawing. Pile depth required to be 150mm below sewer invert to be embedded into medium dense sand material to provide minimum bearing capacity as required.
5) Compact base material and place 50mm thick void former below proposed bridging slab
6) A reinforced concrete bridging slab to be constructed to be fully supported on RC piles according to detail provided in Appendix A and as per Sydney Water Infrastructure Delivery Technical Specifications for Civil Works outlined in Appendix G
7) Undertake CCTV survey of sewer pipe following completion of the works to assess pipe condition and provide details to Sydney Water.

7.0 Analysis of construction impacts of the works

This section describes the assessment of the impact of the construction works over Sydney Water water and sewer assets in compliance with Sydney Water Technical Requirements for building over or adjacent to pipe assets to determine if protection works are required.

The following construction details have been considered in construction of the bridging slab over the sewer and water pipe. Services survey as attached in Appendix F prepared by Vac Group Pty Ltd on 4th October 2018 has been used for this analysis.

- The existing DN225 SGW sewer has approximately 1.4-1.5m depth of cover from the existing surface level. The proposed driveway mayreduce the sewer depth of cover to approximately 0.7-0.8m which does not comply with the recommended cover as indicated in the Sydney Water Technical Guideline Diagram 4.
- Similarly, an existing DN100 mPVC water main has approximately 0.9-1.0m depth of cover from the existing surface level. The proposed driveway will reduce the depth of cover of the water main to approximately 0.5-0.6m which does not comply with the recommended cover as indicated in the Sydney Water technical Guideline Diagram 4.
- The bridging slab will provide additional protection from additional loading resultant from vehicular traffic entering and exiting the AFC underground carpark. The slab will span across the sewer pipe and water main zone of influence.
- The surface of the bridging slab will tie in to the proposed driveway finish level.
- Construction and operating loads are to be considered.
- An imposed load of 5kPA has been nominated for the driveway bridging slab (as per AS 1170.1 table 3.1 – load type C “Medium vehicle traffic areas”). Consistent with imposed loading requirements adopted for the structural design of the main driveway connecting to the underground carpark.
- A review of geotechnical assessment of ground condition of areas within the vicinity of the sewer and water mains is to be found in Appendix E.
- The sewer and water mains will remain operational during construction. The existing levels of maintenance holes south and north of the Carpark driveway will remain unchanged.

8.0 Details of Protection Slab

The protection slab will be constructed with the following properties:

- 300mm thick Reinforced concrete slab supported on 300mm diameter RC piles;
- Approximately 2.7 meters wide;
- Approximately 7.2 meters long;

A detail sketch based on the proposed design drawings are provided in Appendix A.

Figure 4 below provides a section view of the bridging slab. A structural calculation check as shown in Appendix D has been produced for the proposed reinforced bridging slab design to demonstrate design adequacy.

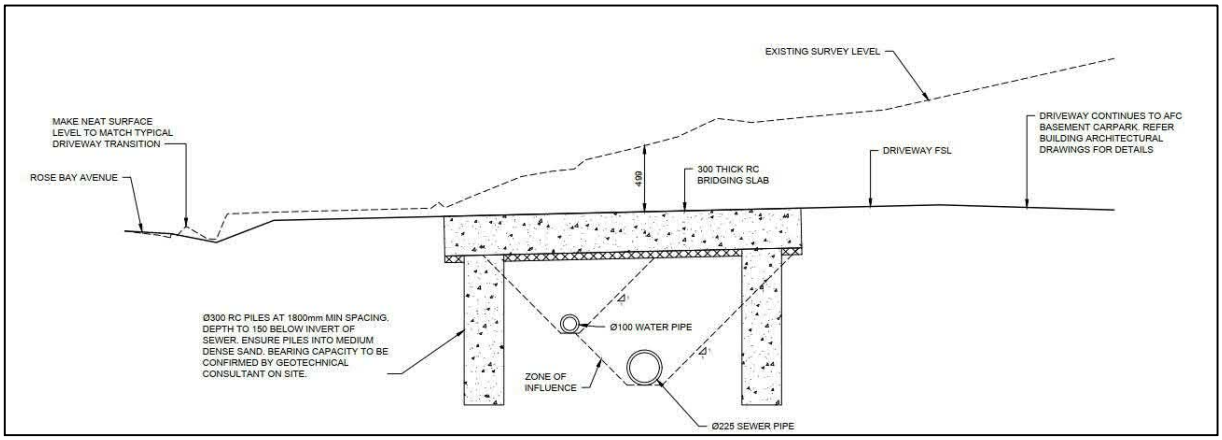


Figure 4 Bridging slab section

9.0 Details of Protection Measures

The existing sewer and water main will be protected by a bridging slab with the carpark driveway operating above it.

The Contractor shall ensure only light construction plant loading is applied to the pipe's zone of influence where it crosses underneath the AFC driveway. For areas where depth of cover is cut down to less than 450 mm during construction, no construction plant is to run over the pipe asset.

The following protection measures will be implemented for the protection of the DN225 sewer and DN100 water mains.

- During construction, peg out the zone of influence and exclude or restrict construction plant loading within the zone of influence. This will be enforced by using dedicated personnel and on site controls;
- During construction, where necessary, install steel plates over the sewer and water main to mitigate distribution loading of any construction vehicles required to traverse the mains.

10.0 Methodology to monitor integrity of the asset during construction

A post CCTV inspection will be performed to check the post construction condition of the mains.

Traffic site controls will be documented and enforced to ensure no vehicular loading is to be applied over the pipe's zone of influence during the construction of the AFC driveway.

11.0 Appendices and References

- Appendix A – Design Drawings
- Appendix B – DBYD/Hydra
- Appendix C – Work As Executed Drawings
- Appendix D – Bridging Slab Structural Calculations
- Appendix E – Douglas Partners Geotechnical Report and Borehole Data
- Appendix F – Utilities Survey
- Appendix G – Sydney Water Technical Guidelines Building over and adjacent to pipe assets

	Prepared	Checked	Certified
Name	Jeffrey Chan	William Hammond	Tung Le (CPEng)
Signature			

Appendix A – Design Drawings

LOCALITY PLAN

STRUCTURAL NOTES

CONCRETE NOTES

1. PLACING AND CURING OF CONCRETE SHALL COMPLY WITH RMS QA SPECIFICATION B80.
2. CONCRETE EXPOSURE CLASSIFICATION B1.
3. CONCRETE MIX SHALL COMPLY WITH RMS QA SPECIFICATION B80.
4. EDGES SHALL BE CHAMFERED 20 x20mm AND RE-ENTRANT ANGLES FILLETED 20x20mm UNLESS NOTED OTHERWISE (UNO). MINIMUM 28 DAY CONCRETE COMPRESSIVE STRENGTH AND NOMINAL COVER TO REINFORCEMENT UNO :
   a) CAST IN-SITU - CAST AGAINST GROUND : 40MPa/45mm
   b) CAST IN-SITU - ELSEWHERE : 40MPa/45mm
   c) PIER : 40MPa/75mm

REINFORCEMENT NOTES

1. ALL REINFORCEMENT SHALL COMPLY WITH AS 4671 AND BE GRADE D500N.
2. COGS, HOOKS, SPLICES AND PIN DIAMETERS SHALL BE IN ACCORDANCE WITH AS5100.5_2017.
3. REINFORCEMENT UNO MAY BE DISPLACED SLIGHTLY WHERE NECESSARY TO CLEAR STEEL DOWELS, ANCHOR BOLTS, FORMED HOLES AND RECESSES.
4. ALL LAPPED PORTIONS OF BARS TO BE IN CONTACT.
5. LAP LENGTHS FOR UNEQUAL BAR SIZES MUST BE BASED UPON THE SMALLER BAR DIAMETER UNO.
6. WHERE REBATES OR RECESSES ARE REQUIRED, MINIMUM CLEAR COVER TO THE REINFORCEMENT SHALL BE MAINTAINED.
7. MECHANICAL COUPLERS SHALL BE CAPABLE OF DEVELOPING A STRESS IN TENSION OR COMPRESSION OF NO LESS THAN 1.1FSY, AS APPROPRIATE TO THE WEAKER BAR AT THE SPLICE. THE COUPLER SHALL BE SUBMITTED TO THE PRINCIPAL FOR ACCEPTANCE.
8. REINFORCEMENT IS SHOWN DIAGRAMMATICAL. IT IS NOT NECESSARILY SHOWN IN TRUE PROJECTION.
9. SPLICES OF REINFORCEMENT SHALL ONLY BE MADE IN POSITIONS SHOWN.
10. WRITTEN APPROVAL OF THE ENGINEER SHALL BE OBTAINED FOR ANY OTHER SPLICES.
11. WHERE LAPS ARE NOT SHOWN THEY SHALL SATISFY THE REQUIREMENTS OF RMS SPECIFICATION R53 AND RMS SPECIFICATION B80.
12. DO NOT WELD REINFORCEMENT UNLESS SHOWN ON THE DRAWING.
13. UNLESS OTHERWISE SPECIFIED, THE MINIMUM DEVELOPMENT LENGTHS AND LENGTHS OF LAPS SHALL BE AS FOLLOWS:

BAR SIZE	N12	N16	N20	N24	N28	N32	N36	N40
a) HORIZONTAL BARS WITH >300mm OF CONCRETE CAST BELOW THE BAR	500	700	1000	1300	1650	2000	2400	2800
b) OTHER BARS	350	550	750	1000	1250	1550	1850	2150

WHERE MORE THAN 50% OF BARS ARE LAPPED IN ANY ONE CROSS SECTION, THE TABULATED LAP LENGTHS SHALL INCREASE BY 30% UNO.

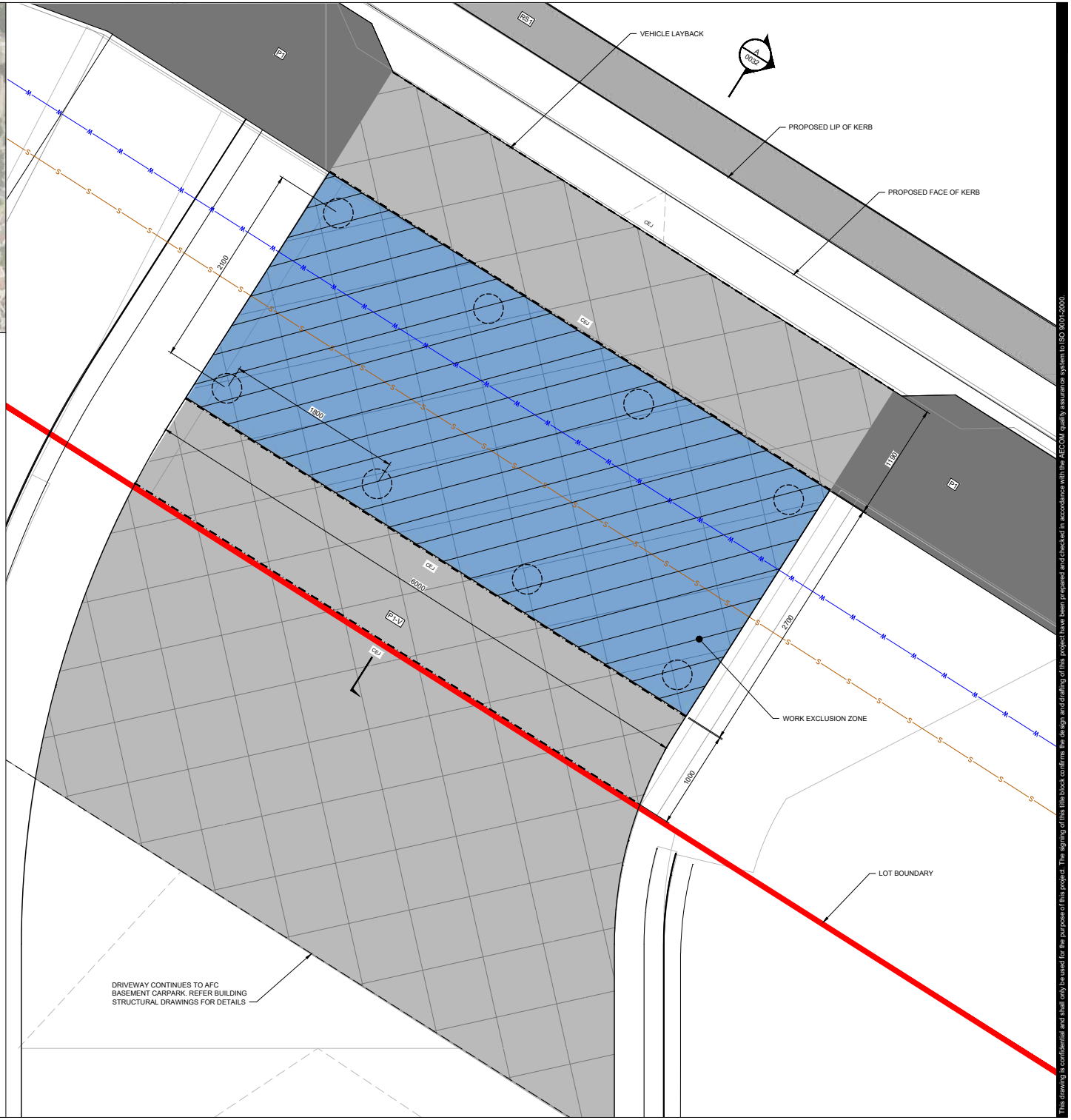
BAR MARKING LEGEND

THE METHOD USED TO DESCRIBE REINFORCEMENT ON THE DRAWINGS IS AS FOLLOWS:

10 N16-300 EF
- 10 — NUMBER OF BARS IN THE SET
- N16 — BAR GRADE/DIAMETER IN MILLIMETRES
- 300 — SPACING ALONG LIMIT LINE
- EF — INFORMATION FOR PLACING

BULK EARTHWORKS

1. REFER TO THE FOLLOWING DOCUMENTS:
   a) GEOTECHNICAL REPORT BY DOUGLAS PARTNERS DATED OCTOBER 2018.
   b) ADDITIONAL GEOTECHNICAL INVESTIGATION REPORT BY DOUGLAS PARTNERS DATED 03.10.2018.
2. THE CONTRACTOR MUST FAMILIARISE THEMSELVES WITH THE RECOMMENDATIONS OF BOTH THE GEOTECHNICALDEPORTS AND SITE REMEDIATION REQUIREMENTS.
3. ALL BULK EARTHWORKS TO CONFORM TO ENVIRONMENTAL CONSULTANT'S REQUIREMENTS
4. COMPACTION, TESTING, FILLING, STANDARD DRY DENSITIES AND MOISTURE CONTENTS TO BE IN ACCORDANCE WITH THE SPECIFICATION.
5. ALL EARTHWORKS AREAS SHALL BE ROLLED EACH EVENING TO RESTRICT THE INGRESS FROM POTENTIAL WATER INGRESS.
6. CONTRACTOR TO ENSURE EMBANKMENT STABILITY IS MAINTAINED DURING WORKS. GEOTECHNICAL ENGINEER TO CONFIRM EMBANKMENT STABILITY FOR ANY WORKS IMPACTING THE EMBANKMENT INCLUDING CLEARING OFDEGETATION AND TREE REMOVAL.



AECOM

PROJECT

Cranbrook School Redevelopment

CLIENT

Cranbrook School
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Prepared for:
CRANBROOK SCHOOL
A.B.N 000 007 723

CONSULTANT

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LEGEND

- LOT BOUNDARY
- RS1 — ASPHALT ROAD REINSTATEMENT
- P1 — CONCRETE FOOTPATH PAVING
- P1-V — CONCRETE DRIVEWAY PAVING
- 300 THICK RC BRIDGING SLAB
- Ø300 PILE
- DOWELED EXPANSION JOINT (REFER DETAIL)
- W — WATER
- S — SEWER

REGISTRATION

NOT FOR CONSTRUCTION

SCALE BAR (A1)

0 0.5 1 m
1:20

PROJECT MANAGEMENT INITIALS

-	-	-
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

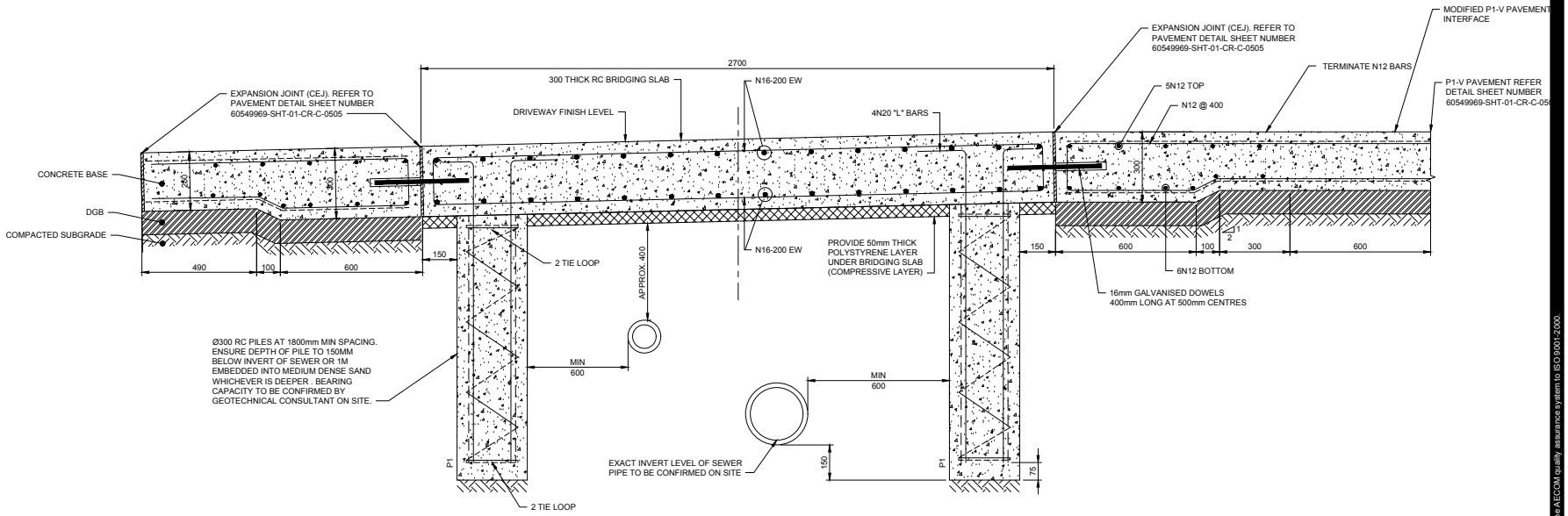
60549969

SHEET TITLE

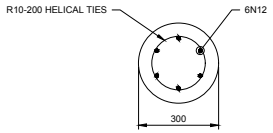
BRIDGING SLAB
PLAN

SHEET NUMBER

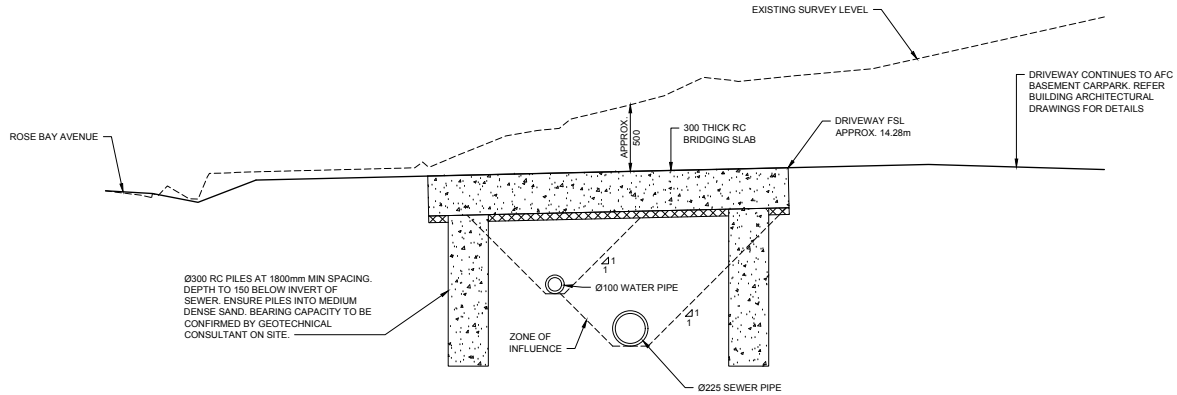
60549969-SKE-00-0000-CI-0030



SECTION A
Scale 1:10



Ø300mm PILE REINFORCEMENT
Scale 1:10



A | SECTION
0030 SCALE 1:20

0 0.25 0.5 m
1:10

0 0.5 1 m
1:20

AECOM

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REGISTRATION

NOT FOR CONSTRUCTION

SCALE BAR (A1)

PROJECT MANAGEMENT INITIALS

-	-	-
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION

KEY PLAN

PROJECT NUMBER

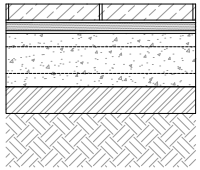
60549969

SHEET TITLE

BRIDGING SLAB
DETAILS AND SECTIONS

SHEET NUMBER

60549969-SKE-00-0000-CI-0031

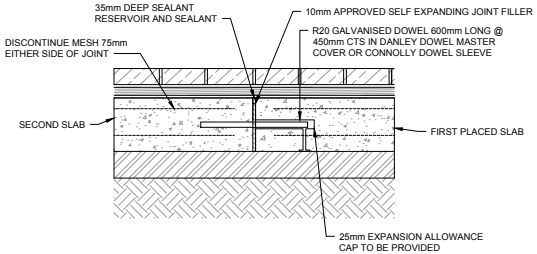


STONE COBBLE ROAD PAVEMENT (RS2 / P5)

SCALE 1:10

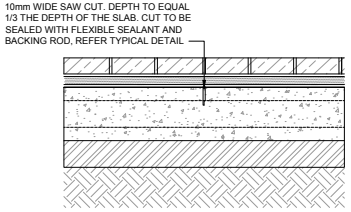
NOTE:

1. REFER TO KERB DETAILS FOR REQUIREMENTS FOR EDGE THICKENINGS WHERE PAVEMENT IS TIED INTO KERB.
2. JOINTS:
   - TRANSVERSE EXPANSION JOINTS TO BE PLACED AT MAX. 20,000mm CENTRES
   - TRANSVERSE CONTRACTION JOINTS TO BE PLACED AT MAX. 5,000mm CENTRES
   - LONGITUDINAL EXPANSION JOINTS TO BE PLACED AT MAX. 5,000mm CENTRES
   - JOINT LAYOUT TO AVOID ELONGATED OR IRREGULAR SHAPED SLABS, LAYOUT TO BE AGREED PRIOR TO POURING CONCRETE



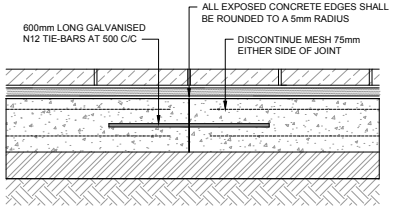
STONE UNIT ROAD PAVEMENT EXPANSION JOINT (REJ)

SCALE 1:10



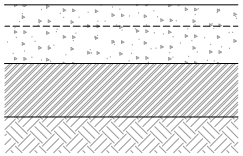
STONE UNIT ROAD PAVEMENT CONTRACTION JOINT (RCJ)

SCALE 1:10



STONE UNIT ROAD PAVEMENT CONSTRUCTION JOINT (RCCJ)

SCALE 1:10

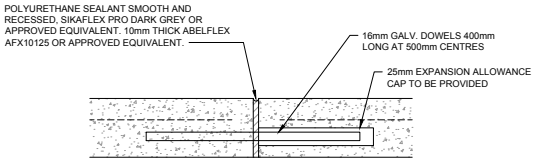


CONCRETE PAVING (P1)

SCALE 1:5

NOTE:

1. PAVEMENT TO BE INCREASED TO 250mm 32MPa, 2 LAYERS SL82 MIN. COVER 50mm WHERE LOCATED IN DRIVEWAY, REFER (P1-V) ON PLANS.
2. WHERE REINSTATEMENT OF EXISTING PAVEMENT ADDITIONAL SAW CUTS TO BE OMITTED, REFER (P1-EX) ON PLANS.
3. JOINTS:
   - TRANSVERSE EXPANSION JOINTS TO BE PLACED AT TYP. 4,500mm CENTRES (5,400mm MAX.)
   - TRANSVERSE CONTRACTION JOINTS TO BE PLACED AT TYP. 1,500mm CENTRES (1,800mm MAX.)
   - LONGITUDINAL EXPANSION JOINTS TO BE PLACED AT MAX. 5,000mm CENTRES
   - JOINT LAYOUT TO AVOID ELONGATED OR IRREGULAR SHAPED SLABS, LAYOUT TO BE AGREED PRIOR TO POURING CONCRETE



CONCRETE PAVING - EXPANSION JOINT (EJ)

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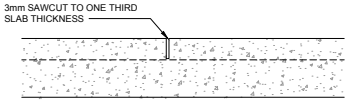
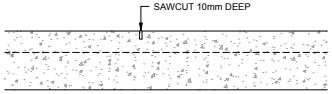


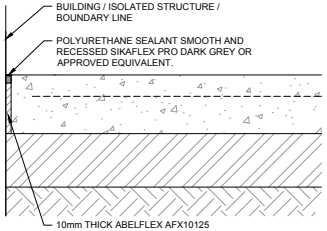
CONCRETE PAVING - CONTRACTION JOINT (CJ)

SCALE 1:5



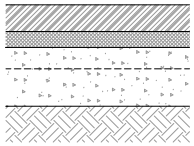
CONCRETE PAVING - SAW CUT (SC)

SCALE 1:5



CONCRETE PAVING JUNCTION WITH BUILDING (INT3)

SCALE 1:5

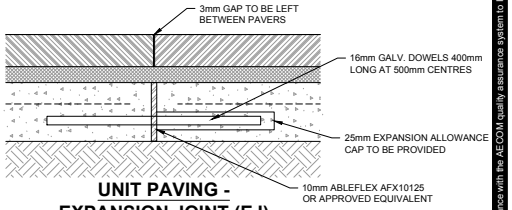


STONE UNIT PAVING (P2 & P3)

SCALE 1:5

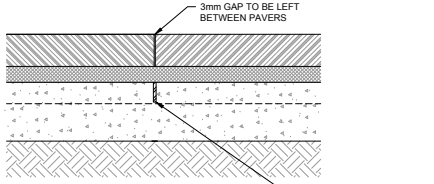
NOTE:

1. PAVEMENT TO BE SEALED IN ACCORDANCE WITH THE LANDSCAPE ARCHITECT REQUIREMENTS
2. JOINTS:
   - EXPANSION JOINTS (EJ) TO BE PLACED AT TYP. 12,000mm CENTRES
   - CONTRACTION JOINTS (CJ) TO BE PLACED AT TYP. 4,000mm CENTRES
   - LONGITUDINAL EXPANSION JOINTS TO BE PLACED AT MAX. 5,000mm CENTRES
   - JOINT LAYOUT TO AVOID ELONGATED OR IRREGULAR SHAPED SLABS, LAYOUT TO BE AGREED PRIOR TO POURING CONCRETE



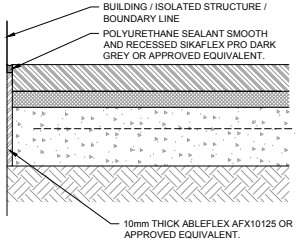
UNIT PAVING - EXPANSION JOINT (EJ)

SCALE 1:5



UNIT PAVING - CONTRACTION JOINT (CJ)

SCALE 1:5



UNIT PAVING - ISOLATION JOINT (IJ)

SCALE 1:5

AECOM

PROJECT

Cranbrook School Redevelopment

CLIENT

Cranbrook School
5 Victoria Road
Bellevue Hill NSW 2023
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Prepared for:
CRANBROOK SCHOOL
A.B.N 000 007 723

CONSULTANT

AECOM Australia Pty Ltd
A.B.N 20 093 846 925
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CONCRETE PAVING NOTES:

1. FOOTPATHS TO BE FINISHED WITH A MEDIUM BROOM FINISH PARALLEL WITH JOINTS AND PERPENDICULAR TO THE DIRECTION OF TRAVEL. BROOM FINISH TO EXTEND TO THE EDGE OF SLAB, NO TROWELLED EDGE TO BE PROVIDED.
2. ALL CONCRETE SLABS MUST HAVE A JOINT ALONG THE BUILDING LINE, KERB LINE AND ANY PENETRATIONS.

REGISTRATION

NOT FOR CONSTRUCTION

0 125 250 mm
1:5

0 250 500 mm
1:10

PROJECT MANAGEMENT INITIALS

JW	WH	NM
DESIGNER	CHECKED	APPROVED

ISSUE/REVISION

I/R	DATE	DESCRIPTION
3	10.04.2019	100% TENDER ISSUE
2	26.10.2018	80% DRAFT ISSUE
1	10.08.2018	60% ISSUE

KEY PLAN

PROJECT NUMBER

60549969

SHEET TITLE

KERB AND PAVEMENT DETAILS

SHEET 2

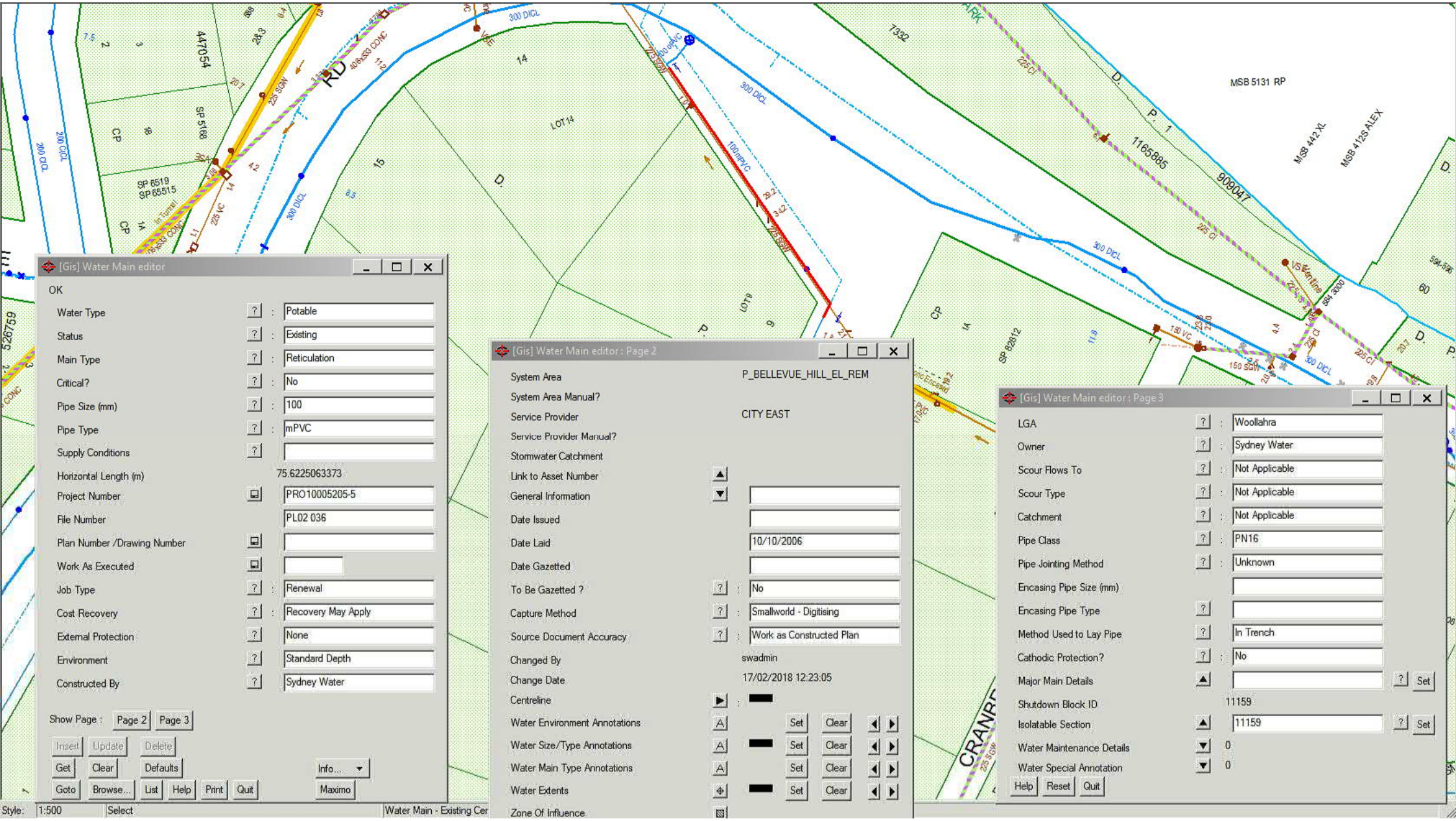
SHEET NUMBER

60549969-SHT-01-CR-C-0505

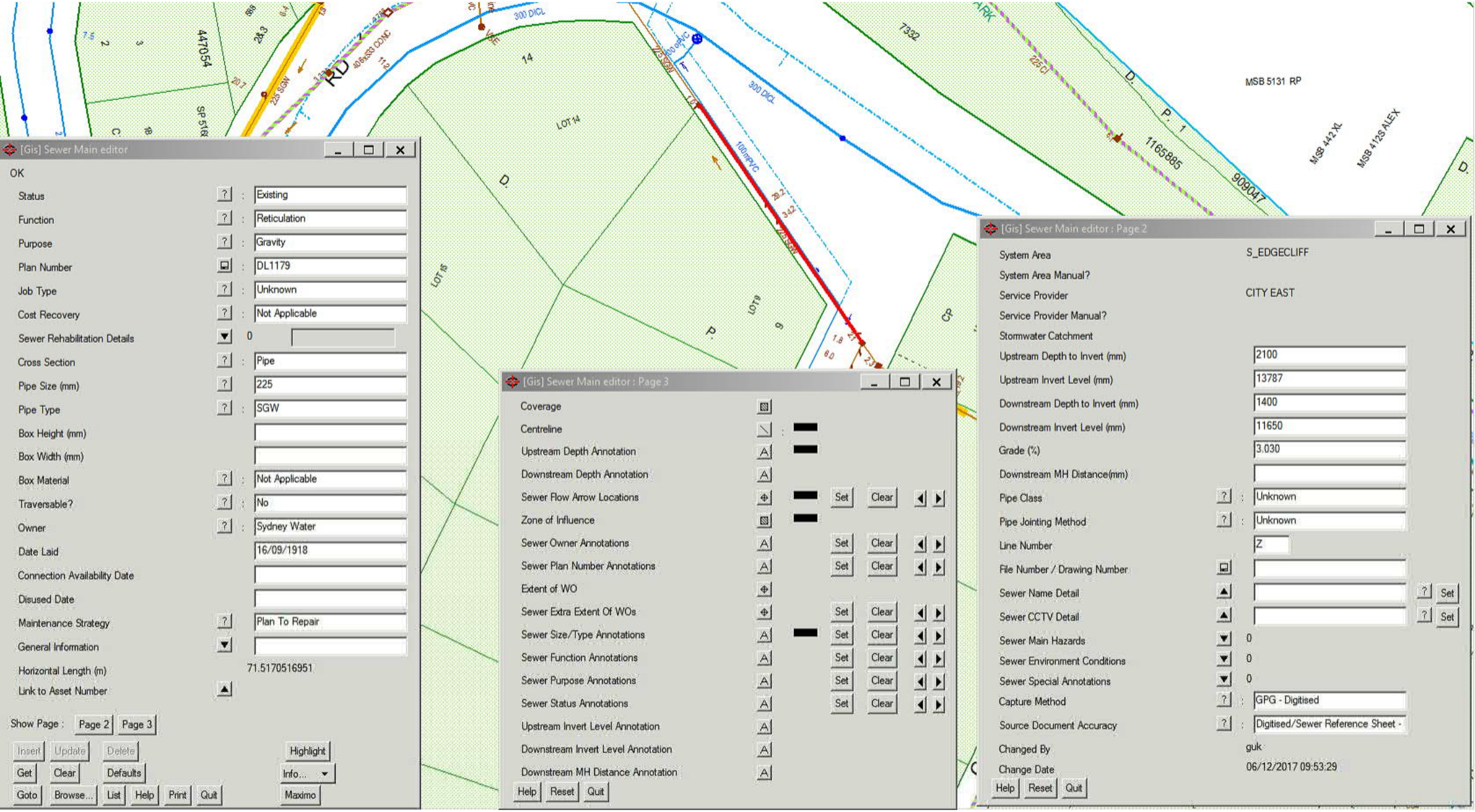
Appendix B – DBYD/Hydra

MGA Zone 56 (m) Central Co-ord: 338411 6250825	Suburb: BELLEVUE HILL Map:237 Grid:F10 Edition:Sydney UBD Edition 41 CMA Sheet: 1845-24-23	Scale: 1:750 Produced By: Rigo Manahan Date: 26/08/2019	Plot Theme: None Plot Request: None		Page

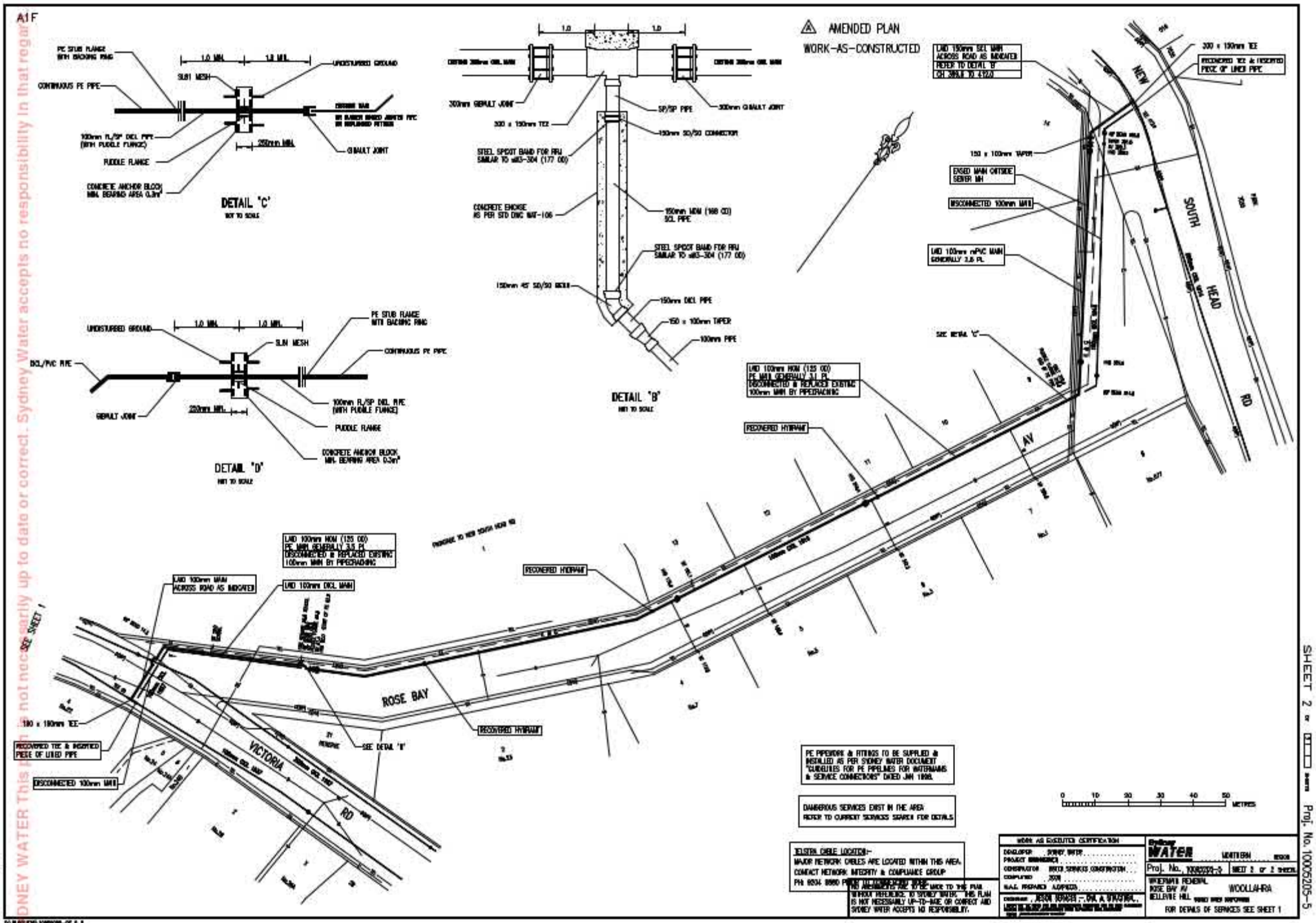
POTABLE WATER DN100 mPVC



SEWER DN225 SGW



Appendix C – Work As Executed Drawings



M . B . W . S & S

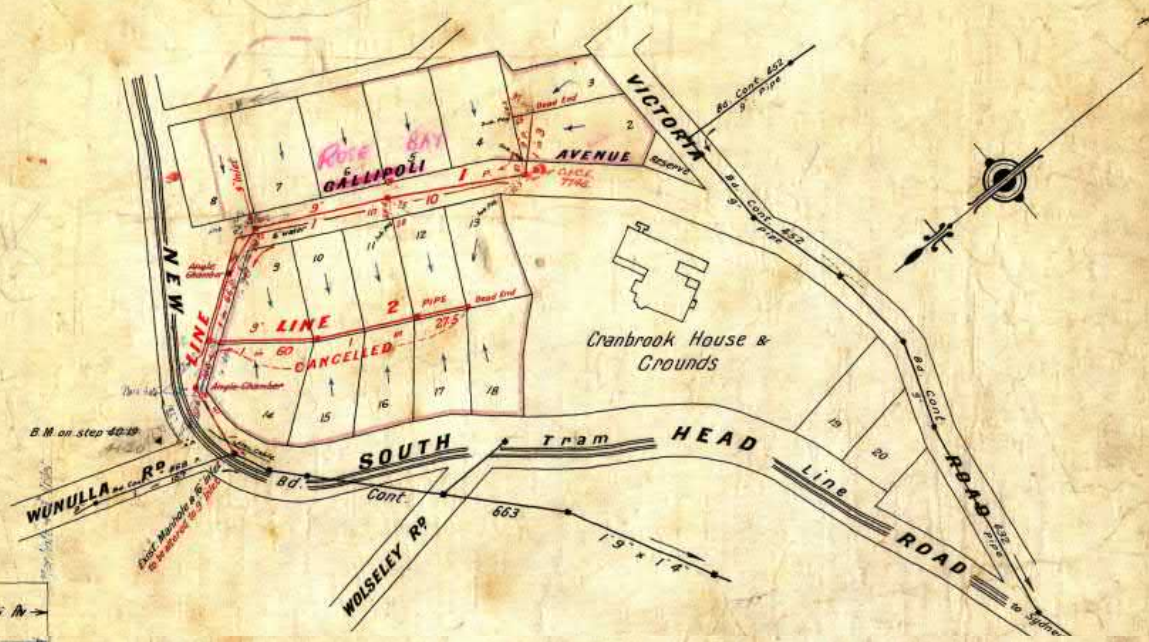
WOOLLAHRA SEWERAGE

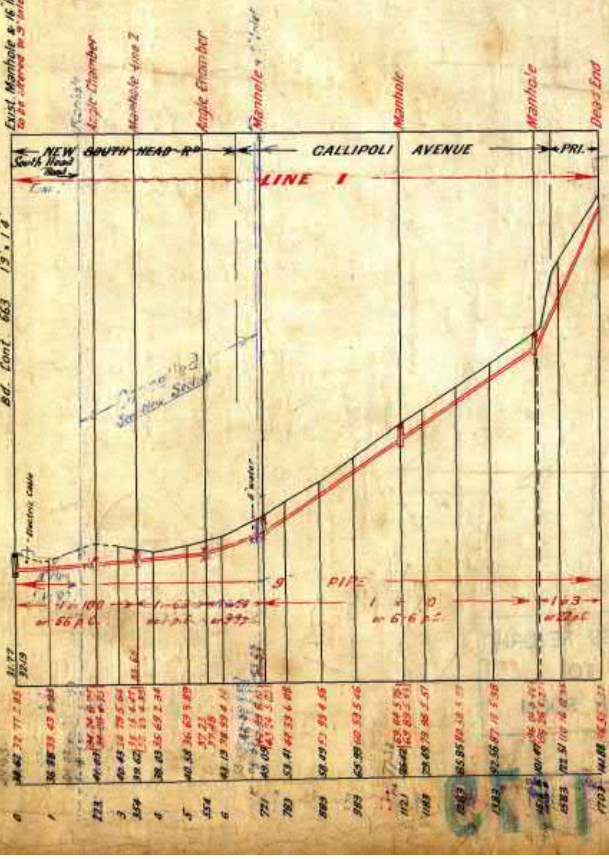
NORTHERN DIVISION

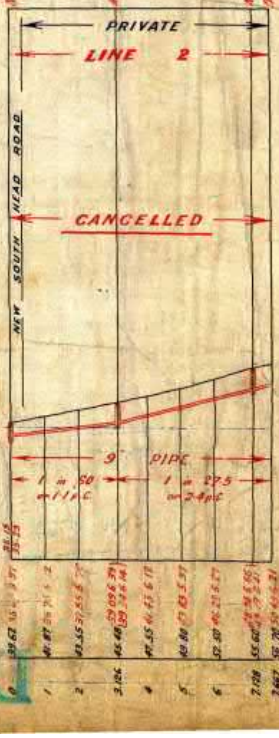
Scales. Hor. 2 Chains. Ver. 20 Feet to 1 Inch

DAY LABOR 1179

S.O. 2393.







Appendix D – Bridging Slab Structural Calculations

SIMPLY SUPPORTED SLAB ON PILES													APPROACH CANTILEVER							
	Arup	Live Load =	5	kPa		LL factor	1.5			Factored =	7.5									
AS1170.1	Section 2	Dead Load =	7.5	kPa		DL factor	1.2			Factored =	9									
		Span =	2.7	m									Drawing	Span =	1.3	m				
		M* = wL^2/8	15.04	kNm		V* = wL/2	22.3	kN		V*(punch)	31	kN		M* = wL^2/2	13.94	kNm		V* = wL	21.45	kN
	Table 3.2.1	fsy =	500	MPa	Cl 8.2.1.9	dv =	216	mm	Cl9.3.3	fcv =	1.92	MPa	Table 3.2.1	fsy =	500	MPa	Cl 8.2.1.9	dv =	183.6	mm
	Drawing	spacing =	200	mm	Cl 8.2.1.5	bv =	1000	mm	Cl9.3.1.4	d0 =	234	mm	Drawing	spacing =	400	mm	Cl 8.2.1.5	bv =	1000	mm
	Drawing	Ast =	1005	mm2	Cl 8.2.4.1	Vuc =	122	kN	Cl9.3.1.4	u =	1536	mm	Drawing	Ast =	283	mm2	Cl 8.2.4.1	Vuc =	104	kN
	AS4100, Cl7	T =	502.7	kN	Table 2.2.2	Phi =	0.7		Cl9.3.3	Vuo =	691	kN	AS4100, Cl7	T =	141.3717	kN	Table 2.2.2	Phi =	0.7	
	Clause 3.1	f'c =	32	MPa		Phi Vuc =	85.5	kN	Fig 9.3(B)	a =	1770	mm	Clause 3.1	f'c =	32	MPa		Phi Vuc =	72.7	kN
	Cl 8.1.3	gamma =	0.89				OK		Cl 9.3.4	Vu =	527	kN	Cl 8.1.3	gamma =	0.89				OK	
	Cl 8.1.3	alpha =	0.802							Phi =	0.7		Cl 8.1.3	alpha =	0.802					
	Drawing	b =	1000	mm						Phi Vu =	369	kN	Drawing	b =	1000	mm				
	Drawing	D =	300	mm							OK		Drawing	Ave D =	260	mm				
	Drawing	cover =	50	mm									Drawing	cover =	50	mm				
AS3600	Drawing	ds =	16	mm									Drawing	ds =	12	mm				
	Cl 1.7	d =	242	mm									Cl 1.7	d =	204	mm				
	Cl 8.1.3	C =	5528	ku									Cl 8.1.3	C =	4660	ku				
	C = T	ku =	0.090937										C = T	ku =	0.03034					
	Cl 8.1.3	z =	232.207	mm									Cl 8.1.3	z =	201.2457	mm				
	Mu = C z	Mu =	116.72	kNm									Mu = C z	Mu =	28.45044	kNm				
	Table 2.2.2	Phi =	0.65										Table 2.2.2	Phi =	0.65					
		Phi Mu =	75.9	kNm										Phi Mu =	18.5	kNm				
			OK												OK					
	Cl 9.1	Min Ast =	750	mm2									Cl 9.1	Min Ast =	250	mm2				
		N16-200 =	1005	mm2	OK									N12-400 =	283	mm2	OK			
		N12-200 =	565	mm2	NOT OK															

Appendix E – Douglas Partners Geotechnical Report and Borehole Data