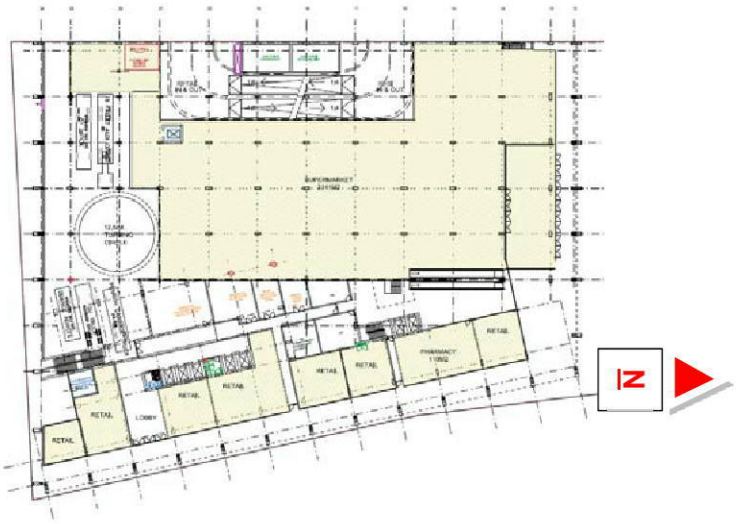
Lot 3003 on DP1184498, Thornton Penrith



Stormwater Management Development Application Report

Author: Glen James

Approver: Andrew Tweedie

Report no: 17-450-01 **Revision:** 01 **Date:** March 2017

This report has been prepared for St Hilliers in accordance with the terms and conditions of appointment. AT&L (ABN 96 130 882 405) cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.

This report is based upon a desktop review and relies upon information supplied by utility providers and Council. To the extent that the report incorporates such material, AT&L takes no responsibility for any loss or damage caused by any error or omission arising from reliance on it.

Please note that utility providers reserve the right to change their decision in relation to network deployment within the development without prior notice. Additionally, it is our experience that utility providers will not reserve capacity. For this reason, they operate on a first come first serve basis.

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Document information

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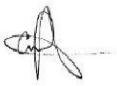
Document registration

Document title	Civil Development Application Report – Stage 1
Document file name	17-450-01-Thornton_Penrith_Report
Section	Civil Engineering
Document author	Glen James

Finalisation signatures

The design described in this report is considered to have been finalised.

Signature		**Date**
Andrew Tweedie Civil Engineer		28/03/17
Glen James Lead Designer /Engineer (Author)		28/03/17
Anthony McLandsborough Director		28/03/17

Notes: The finalisation signatures shown above do not provide evidence of approval to the design. Approval signatures are shown on the title sheet of the design plans.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Contents

APPENDIX

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Figures

Tables

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

1 Introduction

This Civil Infrastructure Development Application Report supports the proposed 'Thornton Lot 3003 Development' located on 184 Lord Sheffield Circuit, Penrith. Refer to Figure 1 for location of the proposed development.

AT&L have been engaged by St Hilliers to prepare a Development Application (DA) Stormwater Management Report on the civil and stormwater management requirements for the proposed development.

The development is in the Penrith City Council (PCC) local government area, and this report is written to comply with Penrith City Council Development Control Plan (DCP) 2014 and Penrith City Council Local Environmental Plan (LEP) 2010.

Figure 1: Locality Plan (Courtesy of Near Map)

The proposed development is situated across 2 main stages which comprise of:

- The site is located on 184 Lord Sheffield Circuit (Lot 3003 on DP 1184498) and is approximately 6,303m^2 in area. The existing site comprises of a large pavement hardstand, which is primarily used as a temporary car park for the adjacent train station; and

Existing vehicular access to the site is via Dunshea Street to the west. The site is zoned Local Centre B2 under the provisions of Penrith City Council LEP 2010.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

2 Project Description

2.1 Lot 3003

The proposed development (Stage 1) located on 184 Lord Sheffield Circuit involves the construction of:

- Two basement levels;
- Two buildings for mixed-use retail and commercial on the ground floor and level 1; and
- Residential apartments from level 2 upwards.

Refer to Figure 2 for architectural site layout for the proposed buildings layout.

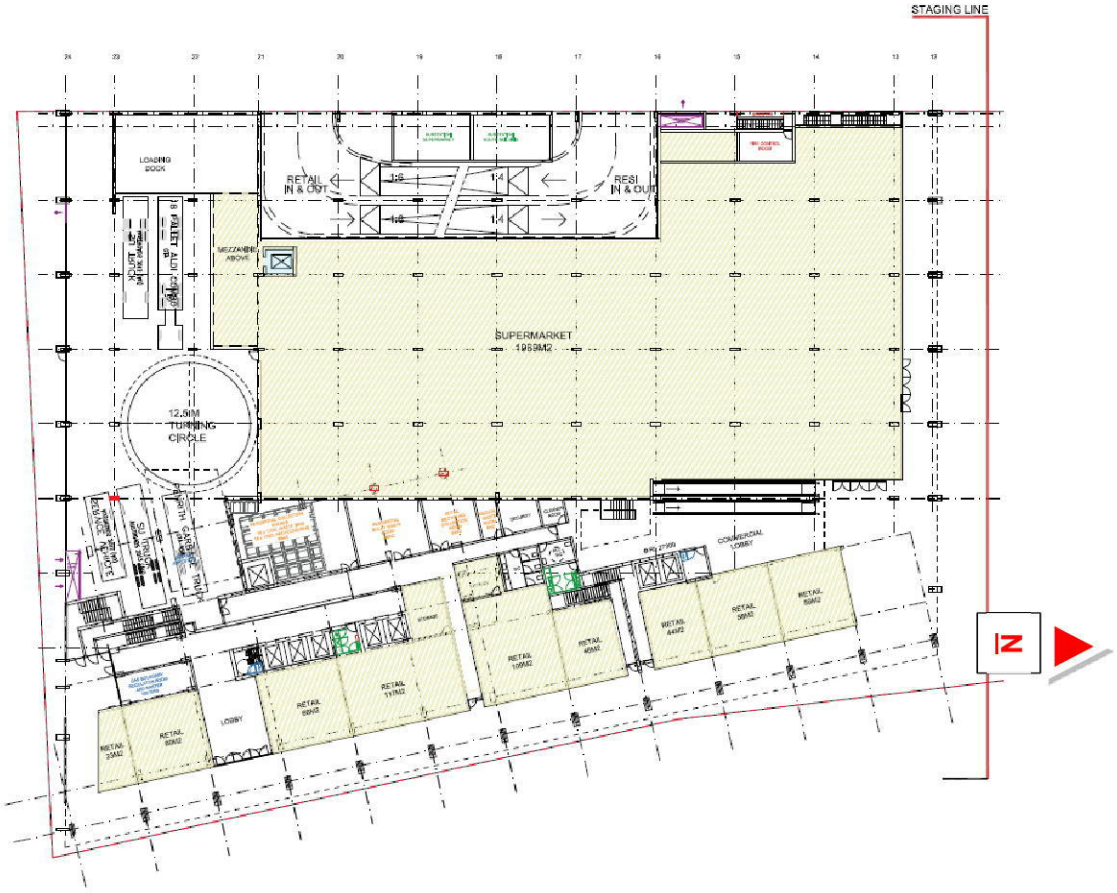


Figure 2: Proposed Lot 3003 Architectural Layout (Courtesy of Crone Architecture)

The site generally falls from the southwest corner at RL 27.27 to the northeast corner at RL 26.35. Refer to the survey drawings within Appendix A for all features on site along with existing site levels.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

2.2 Scope of Report

This report should be read in conjunction with the following AT&L Development Application drawings 17-450 drawings dated March 2017, located within Appendix B.

This report has been prepared to satisfy the requirements and conditions of the following documents:

- Penrith City Council (PCC) DCP June 2014;
- Penrith City Council LEP 2010; and
- OEH's *Managing Urban Stormwater: Soils and Construction Guideline.*

It includes:

- Stormwater Management:
    - Piped and Overland Flows;
    - Rainwater Harvesting.
- Dial Before You Dig (DBYD) information; and
- Infrastructure Services, including:
    - Sewer;
    - Water Supply (Potable);
    - Electricity;
    - Gas; and
    - Telecommunications.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

3 Stormwater Management

3.1 Existing Stormwater Drainage

This site is part of a recently released UrbanGrowth precinct which aims to increase developable area in the Greater Sydney area. Accordingly, the existing site is relatively new and the existing carpark would be considered temporary in-nature until it is ultimately developed. Subsequently, there is no existing stormwater drainage located within the property.

However, the future stormwater needs of the site have been catered for by the designers of the precinct and stormwater connection stubs have been provided within Lord Sheffield Circuit (refer to Appendix A for details).

3.2 Proposed Site Stormwater Drainage

All proposed stormwater drainage from the development will be designed in accordance with the relevant PCC requirements and guidelines.

As per our discussions with Penrith City Council on 28th February 2017, there is a regional wetland and basing located within the precinct, resulting in Water Sensitive Urban Design (WSUD) and On Site Detention (OSD) not to be required as part of this development. Refer to Appendix C for Council Correspondence.

Refer to the Civil Drawings in Appendix B for layout and details for the proposed stormwater network across the site. Stormwater generated within the proposed site will be discharged to the surrounding street network in accordance with PCC guidelines.

3.3 Hydrology

- Pipe drainage shall be designed to accommodate the 20-year ARI storm event (5% AEP) in accordance with PCC requirements;
- The combined piped and overland flow paths shall be designed to accommodate the 100-year ARI storm event.
- Where trapped low points are unavoidable and potential for flooding private property is a concern, an overland flow path capable of carrying the total 100-year ARI storm event shall be provided. Alternatively, the pipe and inlet system may be upgraded to accommodate the 100 year ARI storm event;
- Rainfall intensities shall be as per the Intensity-Frequency-Duration table in accordance with the PCC rainfall data;
- Times of concentration for each sub catchment shall be determined using the kinematic wave equation. Minimum time of concentration is 5 mins and the maximum is 20 mins. Runoff coefficients shall be calculated in accordance with AR&R. The fraction impervious shall be determined from analysis of the sub catchments;
- Runoff coefficients shall be calculated in accordance with the ARR&R. The fraction impervious shall be determined from analysis of the sub-catchments;

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

- Flow width in gutter shall not exceed 2.0m for the minor design storm event.
- Velocity depth ratios shall not exceed 0.4 for all storms up to and including the 100 year ARI event.
- Bypass from any pit on grade shall not exceed 15% of the total flow at the pit; and
- All pits deeper than 1.8m to be reinforced.

3.4 Hydraulics

- A hydraulic grade line HGL design method shall be adopted for all road pipe drainage design. The HGL shall be shown on all drainage long sections;
- The minimum pipe size shall be 375mm diameter RCP (external) and 150mm uPVC (internal);
- Maximum spacing between pits shall not exceed 75m;
- The minimum pipe grade shall be 1% (external) and 0.5% (internal);
- All pipes shall be Rubber Ring Jointed unless noted otherwise;
- The minimum cover over pipes shall be 450mm in grassed areas and 600mm within carriageways;
- Where minimum cover cannot be achieved due to physical constraints the pipe class shall be suitably increased;
- All trafficable pipes shall be a minimum Class 3 Reinforced Concrete Pipes or Fibre Reinforced Cement equivalent;
- The pipe friction coefficients to be adopted shall be:

Materials	Manning's – n	Colebrook-White – k	Min. Pipe Class
RCP	0.012	0.3	3
FRC	0.011	0.15	3

Table 1 - Pipe Details

- All pipes classes shall be designed for the ultimate service loads and where applicable, construction loads will be designed for;
- Pipes discharging to the overland flow path shall adopt a minimum tailwater level equivalent to respective overland flow level;
- Pit Loss coefficients shall be calculated in accordance with Missouri Charts;
- A minimum 150mm freeboard shall be maintained between pit HGL and pit surface levels;
- Overland flow paths shall maintain a minimum of 300mm freeboard to all habitable floor levels; and
- Pits deeper than 1.2m shall contain step irons at 300 mm centers.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

3.5 Rainwater Tanks

Rainwater tanks will be implemented within the proposed development in accordance with the 'North Penrith Stages 2B-3B Water Cycle Management Strategy Report Incorporating Water Sensitive Urban Design Techniques' by J. Wyndham Price for Landcom.

Refer to hydraulics plans by S4B in Appendix F and BASIX report in Appendix E for rainwater tank details and capacity.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

4 Overland Flows and Flooding

Penrith City Council has identified the flood level for the site as RL 25.4m AHD, making the minimum habitable floor level RL 25.90m AHD (refer to Appendix C for details). As detailed in the survey in Appendix A, the site does not fall below this level making the site flood immune.

To cater for localised overland flows the minimum habitable floor level has been set at a minimum 300mm above adjacent back of kerb level, in accordance with industry best practises.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

5 Sedimentation and Erosion Control

5.1 Sedimentation and Erosion Control (Construction)

Soil and Water Management Plans (SWMP) has been prepared in accordance with the NSW Department of Housing Publication titled: Managing Urban Stormwater- Soils and Construction (2004) and the relevant PCC guidelines for the whole site.

5.2 Sources of Pollution

The activities and aspects of the works that have potential to lead to erosion, sediment transport, siltation and contamination of natural waters include:

- Earthworks undertaken immediately prior to rainfall periods;
- Work areas that have not been stabilised;
- Extraction of construction water from waterways during low rainfall periods;
- Clearing of vegetation and the methods adopted, particularly in advance of construction works;
- Stripping of topsoil, particularly in advance of construction works;
- Bulk earthworks and construction of pavements;
- Works within drainage paths, including depressions and waterways;
- Stockpiling of excavated materials;
- Storage and transfer of oils, fuels, fertilisers and chemicals;
- Maintenance of plant and equipment;
- Ineffective implementation of erosion and sediment control measures;
- Inadequate maintenance of environmental control measures; and
- Time taken for the rehabilitation / revegetation of disturbed areas.

5.3 Potential Impacts

The major potential impacts on the riparian environment relate to erosion of distributed areas or stockpiles and sediment transportation. Potential adverse impacts from erosion and sediment transportation can include:

- Loss of topsoil;
- Increased water turbidity;
- Decreased levels of dissolved oxygen;
- Changed salinity levels;
- Changed pH levels;
- Smothering of stream beds and aquatic vegetation;
- Reduction in aquatic habitat diversity;
- Increased maintenance costs; and
- Decrease in waterway capacity leading to increased flood levels and durations;

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

5.4 Construction Methodology

The following construction methodology will be followed to minimise the impact of sedimentation due to construction works:

- Diversion of "clean" water away from the disturbed areas and discharge via suitable scour protection;
- Provision of hay bale type flow diverters to catch drainage and divert to "clean" water drains;
- Diversion of sediment-laden water into temporary sediment control basins to capture the design storm volume and undertake flocculation (if required);
- Provision of construction traffic shaker grids and wash-down to prevent vehicles carrying soils beyond the site;
- Provision of catch drains to carry sediment-laden water to sediment basins;
- Provision of silt fences to filter and retain sediments at source; and
- Where future construction and building works are not proposed, the rapid stabilisation of disturbed and exposed ground surfaces with hydro-seeding.

5.5 Site Inspection and Maintenance

The inspection and maintenance requirements outlined in this section will need to be carried out as long as either earthworks or quarrying is being conducted and all areas re-established.

The Contractor's site Superintendent will inspect the site after every rainfall event and at least weekly, and will:

- Inspect and assess the effectiveness of the SWMP and identify any inadequacies that may arise during normal work activities or from a revised construction methodology. Construct additional erosion and sediment control works as necessary to ensure the desired protection is given to downstream lands and waterways;
- Ensure that drains operate properly and to effect any repairs;
- Remove spilled sand or other materials from hazard areas, including lands closer than 5 metres from areas of likely concentrated or high velocity flows especially waterways and paved areas;
- Remove trapped sediment whenever less than design capacity remains within the structure;
- Ensure rehabilitated lands have affectively reduced the erosion hazard and to initiate upgrading or repair as appropriate;
- Maintain erosion and sediment control measures in a fully functioning condition until all construction activity is completed and the site has been rehabilitated; and
- Remove temporary soil conservation structures as the last activity in the rehabilitation.

5.6 Conclusion

With the proposed Lot 3003 and future Lots 3004-3005 being larger than 2,500m^2 in disturbed area, a sediment basin would generally be required. However, due to the nature of the proposed site being basement and majority hardstand to install a basin it is considered unnecessary.

The erosion control measures proposed for the site will comply with the requirements PCC and The Department of Environment, Climate Change and Water (DECC).

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

The proposed SWMP will ensure that the best management practice is applied to the development site in controlling and minimising the negative impacts of soil erosion.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

6 Services

This development will incorporate full servicing for all the buildings across the Thornton Development.

6.1 Sydney Water

6.1.1 Water Supply

From DBYD information obtained there is an existing 150mm oPVC potable water main owned and operated by Sydney Water along the eastern verge of Lord Sheffield Circuit to the east of the site. There is also 150 SCL potable water main located along the eastern verge of Dunshea Street to the west of the site.

Advice will need to be sought with a Water Services Coordinator (WSC) on connection into the water main or any others within the vicinity of the site (or any potential upgrades required if/any). Refer to DBYD records within Appendix D.

Approval will need to be sought with Sydney Water prior to connecting into this main.

6.1.2 Sewerage

From DBYD information there is an existing 225mm diameter PVC sewer pipe owned and operated by Sydney Water along the eastern verge of Dunshea Street, north-west of the site. There is also an existing 225mm diameter PVC concrete encased sewer pipe south-east of the site.

Advice will need to be sought with a Water Services Coordinator (WSC) on connection into the sewer main or any others within the vicinity of the site. Refer to DBYD records within Appendix D

Approval will need to be sought with Sydney Water prior to connecting into any sewer main.

6.2 Communications

From DBYD records indicate that there is an existing Telstra telecommunications cables traversing the site, which will need to be realigned. The proposed development is serviced by the NBN network. Refer to DBYD records within Appendix D for details.

Confirmation will need to be sought with the telecommunications authorities for all connections

6.3 Gas

DBYD records indicate that there is an existing 32mm 210 kPa gas network main along the eastern verge of Dunshea Street, west of the site. And a 50mm 210 kPa gas network gas main along the eastern verge of Lord Sheffield Circuit to the east of the site. Refer to DBYD records within Appendix D for details.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Approval will need to be sought from Jemena as owners of these gas mains for all connections into their network.

6.4 Electrical

From DBYD records there are existing Low Voltage electrical ducts owned by Endeavour Energy within the southern verge of Lord Sheffield Circuit to north of the site, eastern verge of Dunshea Street to the west and also along the western verge of Lord Sheffield Circuit to the east. Refer to DBYD records within Appendix D for details.

There are existing High Voltage ducts located within the centre of Lord Sheffield Circuit to the north and east of the site. Refer to Appendix D for details.

Confirmation will need to be sought with the electrical authorities for all connections

6.5 Conclusion

This section demonstrates that services including sewer, water, power, telecommunications and gas can be made available to the site (subject to confirmation from the relevant service providers).

Internal reticulation will be coordinated at the Construction Certificate (CC) stage of works and applications to the relevant authorities made.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Conclusion

As highlighted within this report all civil/stormwater infrastructure for the Thornton Development Stage 1 and 2 in Penrith and has been designed in accordance with the PCC Development Control Plan and Stormwater Guidelines.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Appendix A

Detailed Site Survey

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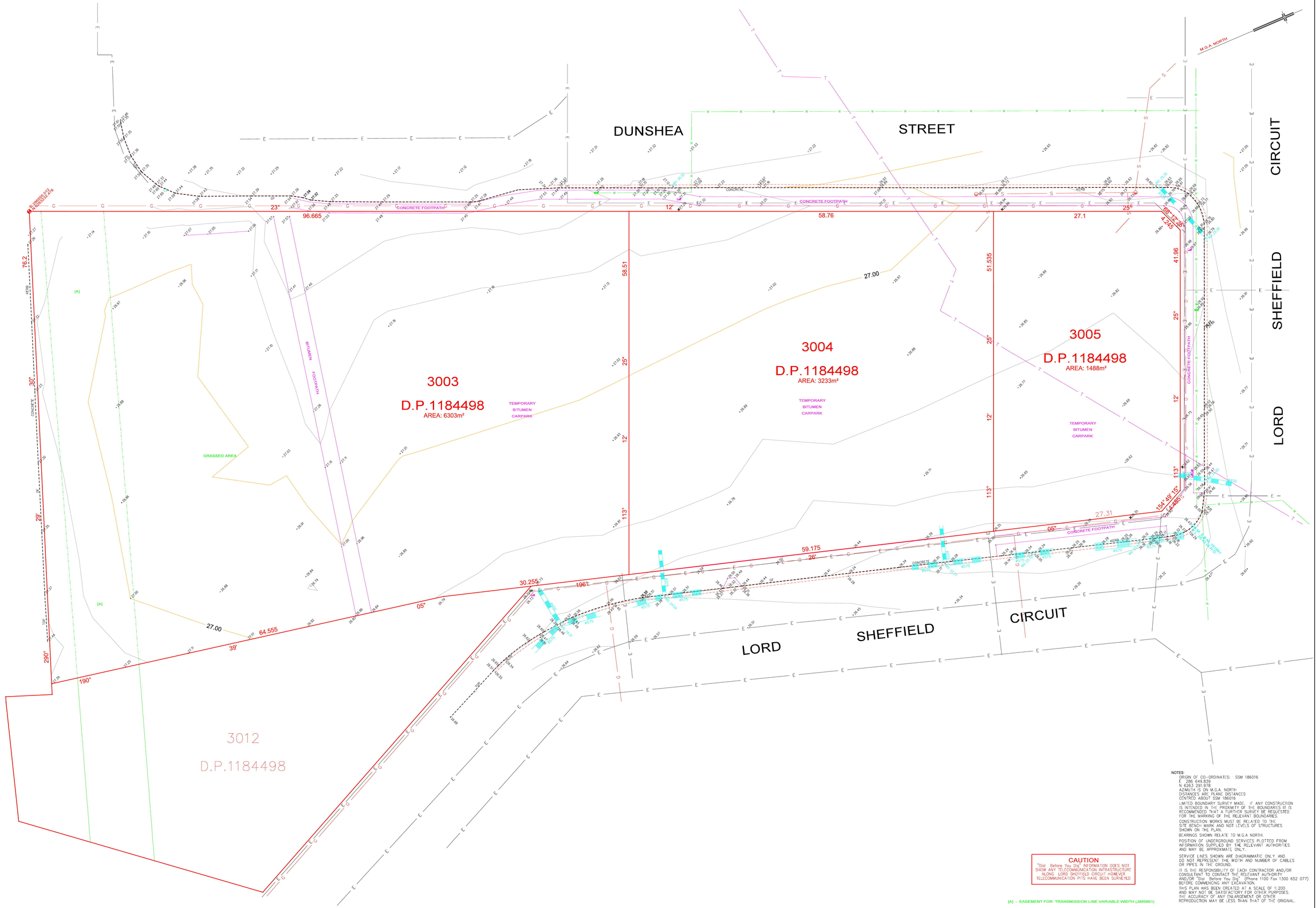
Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017



NOTES:

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REV.	DATE	AMENDMENTS
B	03-02-2017	EXTRA DETAIL ADDED
A	01-02-2017	M.G.A. COORDINATE ADDED

0 — REDUCTION RATIO 1: 200 @ A0 — 20

DATUM : AUSTRALIAN HEIGHT DATUM

CONTOUR INTERVAL : 0.2m

ORIGIN OF LEVELS : P.M. 29972 R.L.25.477 (A.H.D.)

RYGATE SURVEYORS
SURVEYING SINCE 1893

Rygate & Company Pty Limited
P.W. Rygate & West
ABN 61 001 204 897

Suite 904 Level 9, 89 York St Sydney NSW 2000
p: +61 2 9262 6800
f: +61 2 9262 6843
e: surveyors@rygate.com.au
w: rygate.com.au

SUBDIVISION | STRATA PLANS | STRATUM SUBDIVISION | LEASE PLANS | TOPOGRAPHIC SURVEYS | GPS SURVEYS | 3D MODELLING | RACECOURSE DESIGN | PROJECT MANAGEMENT | SUN SHADOW DIAGRAMS

SURVEYOR	DRAWN	CHECKED	APPROVED
D.I.	R.M.		

CLIENT: ST HILLIERS

LOCALITY: PENRITH

L.G.A.: PENRITH

PLAN

SHOWING LIMITED DETAIL AND LEVELS OVER LOTS 3003, 3004 & 3005 D.P.1184498

REFERENCE No.	PLAN No.	DATE	SHEET No.
77405	77405.dgn	16/03/2016	1 OF 1 SHEETS

CAUTION
"Dial Before You Dig" INFORMATION DOES NOT SHOW ANY TELECOMMUNICATION INFRASTRUCTURE ALONG LORD SHEFFIELD CIRCUIT HOWEVER TELECOMMUNICATION PITS HAVE BEEN SURVEYED.

[A] - EASEMENT FOR TRANSMISSION LINE VARIABLE WIDTH (J885861)

NOTES:
ORIGIN OF CO-ORDINATES: SSM 186016
E 286 649.839
N 6263 291.978
AZIMUTH IS ON M.G.A. NORTH
DISTANCES ARE PLANE DISTANCES
CENTRED ABOUT SSM 186016
LIMITED BOUNDARY SURVEY MADE. IF ANY CONSTRUCTION IS INTENDED IN THE PROXIMITY OF THE BOUNDARIES IT IS RECOMMENDED THAT A FURTHER SURVEY BE REQUESTED FOR THE MARKING OF THE RELEVANT BOUNDARIES.
CONSTRUCTION WORKS MUST BE RELATED TO THE SITE BENCH MARK AND NOT LEVELS OF STRUCTURES SHOWN ON THE PLAN.
BEARINGS SHOWN RELATE TO M.G.A NORTH.
POSITION OF UNDERGROUND SERVICES PLOTTED FROM INFORMATION SUPPLIED BY THE RELEVANT AUTHORITIES AND MAY BE APPROXIMATE ONLY.
SERVICE LINES SHOWN ARE DIAGRAMMATIC ONLY AND DO NOT REPRESENT THE WIDTH AND NUMBER OF CABLES OR PIPES IN THE GROUND.
IT IS THE RESPONSIBILITY OF EACH CONTRACTOR AND/OR CONSULTANT TO CONTACT THE RELEVANT AUTHORITY AND/OR "Dial Before You Dig" (Phone 1100 Fax 1300 652 077) BEFORE COMMENCING ANY EXCAVATION.
THIS PLAN HAS BEEN CREATED AT A SCALE OF 1:200 AND MAY NOT BE SATISFACTORY FOR OTHER PURPOSES. THE ACCURACY OF ANY ENLARGEMENT OR OTHER REPRODUCTION MAY BE LESS THAN THAT OF THE ORIGINAL.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Appendix B

Civil Development Application Drawings

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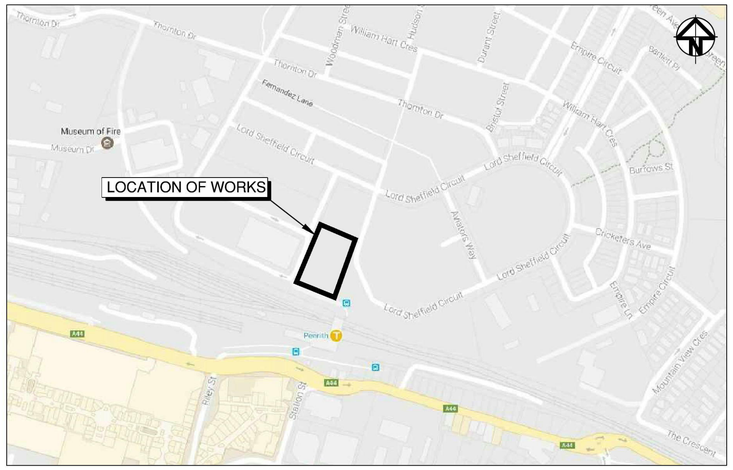
Version: 1, Version Date: 28/04/2017

LOT 3003 ON DP1184498 - THORNTON, PENRITH

STAGE 1 PROPOSED CIVIL WORKS DEVELOPMENT APPLICATION

DRAWING LIST



LOCALITY PLAN

N.T.S

LEGEND

EXISTING

EXISTING BOUNDARY

EXISTING EASEMENT

PROPOSED

VC — VEHICULAR CROSSING. REFER PENRITH CITY COUNCIL STANDARD DRAWING SD1004 FOR DETAILS.

STORMWATER PIT, LINE & NUMBER

STORMWATER SURFACE INLET PIT

F 27.41 — PROPOSED SURFACE LEVEL

SERVICES LEGEND

EXISTING SERVICES

EXISTING ELECTRICAL

EXISTING TELSTRA

EXISTING GAS

EXISTING WATER

EXISTING SEWER

EXISTING STORMWATER

DIAL BEFORE YOU DIG www.1100.com.au

SITEWORKS NOTES

1. ORIGIN OF LEVELS:- REFER SURVEY NOTES.
2. CONTRACTOR MUST VERIFY ALL DIMENSIONS AND EXISTING LEVELS ON SITE PRIOR TO COMMENCEMENT OF WORK. ANY DISCREPANCIES TO BE REPORTED TO AT & L.
3. MAKE SMOOTH CONNECTION WITH EXISTING WORKS.
4. ALL TRENCH BACKFILL MATERIAL SHALL BE COMPACTED TO THE SAME DENSITY AS THE ADJACENT MATERIAL.
5. ALL SERVICE TRENCHES UNDER VEHICULAR PAVEMENTS SHALL BE BACKFILLED WITH SAND TO 300mm ABOVE PIPE. WHERE PIPE IS UNDER PAVEMENTS BACKFILL REMAINDER OF TRENCH TO UNDERSIDE OF PAVEMENT WITH SAND OR APPROVED GRANULAR MATERIAL COMPACTED IN 150mm LAYERS TO MINIMUM 98% MODIFIED MAXIMUM DRY DENSITY IN ACCORDANCE WITH AS 1289 5.2.1. (OR A DENSITY INDEX OF NOT LESS THAN 75)
6. PROVIDE 10mm WIDE EXPANSION JOINTS BETWEEN BUILDINGS AND ALL CONCRETE OR UNIT PAVEMENTS.
7. ASPHALTIC CONCRETE SHALL CONFORM TO RMS. SPECIFICATION R116.
8. ALL BASECOURSE MATERIAL SHALL BE IGNEOUS ROCK QUARRIED MATERIAL TO COMPLY WITH RMS. FORM 3051 (UNBOUND), RMS. FORM 3052 (BOUND) COMPACTED TO MINIMUM 98% MODIFIED DENSITY IN ACCORDANCE WITH AS 1289 5.2.1
   FREQUENCY OF COMPACTION TESTING SHALL NOT BE LESS THAN 1 TEST PER 50m^3 OF BASECOURSE MATERIAL PLACED.
9. ALL SUB-BASE COURSE MATERIAL SHALL BE IGNEOUS ROCK QUARRIED MATERIAL TO COMPLY WITH RMS. FORM 3051, 3051.1 AND COMPACTED TO MINIMUM 95% MODIFIED DENSITY IN ACCORDANCE WITH A.S 1289 5.2.1
   FREQUENCY OF COMPACTION TESTING SHALL NOT BE LESS THAN 1 TEST PER 50m^3 OF SUB-BASE COURSE MATERIAL PLACED.
10. AS AN ALTERNATIVE TO THE USE OF IGNEOUS ROCK AS A SUB-BASE MATERIAL IN (9) A CERTIFIED RECYCLED CONCRETE MATERIAL COMPLYING WITH RMS. FORM 3051 AND 3051.1 WILL BE CONSIDERED. SUBJECT TO MATERIAL SAMPLES AND APPROPRIATE CERTIFICATIONS BEING PROVIDED TO THE SATISFACTION OF AT & L.
11. SHOULD THE CONTRACTOR WISH TO USE A RECYCLED PRODUCT THIS SHALL BE CLEARLY INDICATED IN THEIR TENDER AND THE PRICE DIFFERENCE BETWEEN AN IGNEOUS PRODUCT AND A RECYCLED PRODUCT SHALL BE CLEARLY INDICATED.
12. WHERE NOTED ON THE DRAWINGS THAT WORKS ARE TO BE CARRIED BY OTHERS, (eg. ADJUSTMENT OF SERVICES), THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE CO-ORDINATION OF THESE WORKS.

STORMWATER DRAINAGE NOTES

1. STORMWATER DESIGN CRITERIA:
   (A) AVERAGE RECURRENCE INTERVAL:
   1:100 YEARS ROOFED AREAS TO SURCHARGE PIT
   1:5 YEARS EXTERNAL PAVEMENTS
   (B) RAINFALL INTENSITIES:
   TIME OF CONCENTRATION: 5 MINUTES
   1:100 YEARS= 220 mm/hr
   1:5 YEARS= 134 mm/hr
   (C) RUNOFF COEFFICIENTS:
   ROOF AREAS: C_{100} =1.0
   EXTERNAL PAVEMENTS: C_{100} =1.0
2. PIPES 300 DIA. AND LARGER TO BE REINFORCED CONCRETE CLASS '2' APPROVED SPIGOT AND SOCKET WITH RUBBER RING JOINTS. U.N.O.
3. PIPES UP TO 300 DIA SHALL BE SEWER GRADE uPVC WITH SOLVENT WELDED JOINTS.
4. EQUIVALENT STRENGTH VCP OR FRC PIPES MAY BE USED.
5. ALL STORMWATER DRAINAGE LINES UNDER PROPOSED BUILDING SLABS TO BE uPVC PRESSURE PIPE GRADE 6. ENSURE ALL VERTICALS AND DOWNPIPES ARE uPVC PRESSURE PIPE, GRADE 6 FOR A MIN OF 3.0m IN HEIGHT.
6. PIPES TO BE INSTALLED TO TYPE HS3 (ROAD) HS2 (LOTS) SUPPORT IN ACCORDANCE WITH AS 3725 (2007) IN ALL CASES BACKFILL TRENCH WITH SAND TO 300mm ABOVE PIPE. WHERE PIPE IS UNDER PAVEMENTS BACKFILL REMAINDER OF TRENCH TO UNDERSIDE OF PAVEMENT WITH SAND OR APPROVED GRANULAR MATERIAL COMPACTED IN 150mm LAYERS TO MINIMUM 98% STANDARD MAXIMUM DRY DENSITY IN ACCORDANCE WITH AS 1289 5.2.1. (OR A DENSITY INDEX OF NOT LESS THAN 75)
7. ALL INTERNAL WORKS WITHIN PROPERTY BOUNDARIES ARE TO COMPLY WITH THE REQUIREMENTS OF AS 3500 3.1 (2006) AND AS/NZS 3500 3.2 (2010).
8. PRECAST PITS MAY BE USED EXTERNAL TO THE BUILDING SUBJECT TO APPROVAL BY AT & L.
9. ENLARGERS, CONNECTIONS AND JUNCTIONS TO BE PREFABRICATED FITTINGS WHERE PIPES ARE LESS THAN 300 DIA.
10. WHERE SUBSOIL DRAINS PASS UNDER FLOOR SLABS AND VEHICULAR PAVEMENTS, UNSLOTTED uPVC SEWER GRADE PIPE IS TO BE USED.
11. CARE IS TO BE TAKEN WITH LEVELS OF STORMWATER LINES. GRADES SHOWN ARE NOT TO BE REDUCED WITHOUT APPROVAL.
12. GRATES AND COVERS SHALL CONFORM TO AS 3996.
13. ALL INTERNAL PIT DIMENSIONS TO CONFORM TO AS3500.3 TABLE 7.5.2.1
14. AT ALL TIMES DURING CONSTRUCTION OF STORMWATER PITS, ADEQUATE SAFETY PROCEDURES SHALL BE TAKEN TO ENSURE AGAINST THE POSSIBILITY OF PERSONNEL FALLING DOWN PITS.
15. ALL EXISTING STORMWATER DRAINAGE LINES AND PITS THAT ARE TO REMAIN ARE TO BE INSPECTED AND CLEANED. DURING THIS PROCESS ANY PART OF THE STORMWATER DRAINAGE SYSTEM THAT WARRANTS REPAIR SHALL BE REPORTED TO THE SUPERINTENDENT/ENGINEER FOR FURTHER DIRECTIONS.

SURVEY NOTES

THE EXISTING SITE CONDITIONS SHOWN ON THE FOLLOWING DRAWINGS HAVE BEEN INVESTIGATED BY RYGATE SURVEYORS, BEING REGISTERED SURVEYORS. THE INFORMATION IS SHOWN TO PROVIDE A BASIS FOR DESIGN. AT & L DOES NOT GUARANTEE THE ACCURACY OR COMPLETENESS OF THE SURVEY BASE OR ITS SUITABILITY AS A BASIS FOR CONSTRUCTION DRAWINGS.

SHOULD DISCREPANCIES BE ENCOUNTERED DURING CONSTRUCTION BETWEEN THE SURVEY DATA AND ACTUAL FIELD DATA, CONTACT AT & L.

THE FOLLOWING NOTES HAVE BEEN TAKEN DIRECTLY FROM THE ORIGINAL SURVEY DOCUMENTS.

ORIGIN OF CO-ORDINATES: SSM 186016
E 286 649.839
N 6263 291.978
AZIMUTH IS ON M.G.A. NORTH
DISTANCES ARE PLANE DISTANCES
CENTRED ABOUT SSM 186016

LIMITED BOUNDARY SURVEY MADE. IF ANY CONSTRUCTION IS INTENDED IN THE PROXIMITY OF THE BOUNDARIES IT IS RECOMMENDED THAT A FURTHER SURVEY BE REQUESTED FOR THE MARKING OF THE RELEVANT BOUNDARIES.

CONSTRUCTION WORKS MUST BE RELATED TO THE SITE BENCH MARK AND NOT LEVELS OF STRUCTURES SHOWN ON THE PLAN.

BEARINGS SHOWN RELATE TO M.G.A NORTH.

POSITION OF UNDERGROUND SERVICES PLOTTED FROM INFORMATION SUPPLIED BY THE RELEVANT AUTHORITIES AND MAY BE APPROXIMATE ONLY.

SERVICE LINES SHOWN ARE DIAGRAMMATIC ONLY AND DO NOT REPRESENT THE WIDTH AND NUMBER OF CABLES OR PIPES IN THE GROUND.

IT IS THE RESPONSIBILITY OF EACH CONTRACTOR AND/OR CONSULTANT TO CONTACT THE RELEVANT AUTHORITY AND/OR "Dial Before You Dig" (Phone 1100 Fax 1300 652 077) BEFORE COMMENCING ANY EXCAVATION.

THIS PLAN HAS BEEN CREATED AT A SCALE OF 1:200 AND MAY NOT BE SATISFACTORY FOR OTHER PURPOSES. THE ACCURACY OF ANY ENLARGEMENT OR OTHER REPRODUCTION MAY BE LESS THAN THAT OF THE ORIGINAL.

KERBING NOTES

1. ALL CONCRETE TO HAVE A MINIMUM COMPRESSIVE STRENGTH OF25 MPa U.N.O IN REINFORCED CONCRETE NOTES.
2. ALL KERBS, GUTTERS, DISH DRAINS AND CROSSINGS TO BE CONSTRUCTED ON 100mm GRANULAR BASECOURSE COMPACTED TO MINIMUM 95% MODIFIED DRY DENSITY (AS 1289 5.2.1).
3. EXPANSION JOINTS (E.J) TO BE FORMED FROM 10mm COMPRESSIBLE CORK FILLER BOARD FOR THE FULL DEPTH OF THE SECTION AND CUT TO PROFILE. EXPANSION JOINTS TO BE LOCATED AT DRAINAGE PITS, ON TANGENT POINTS OF CURVES AND ELSEWHERE AT MAX 12m CENTRES EXCEPT FOR INTEGRAL KERBS WHERE THE EXPANSION JOINTS ARE TO MATCH THE JOINT LOCATIONS IN THE SLABS.
4. WEAKENED PLANE JOINTS TO BE MIN 3mm WIDE AND LOCATED AT 3m CENTRES EXCEPT FOR INTEGRAL KERBS WHERE THE WEAKENED PLANE JOINTS ARE TO MATCH THE JOINT LOCATIONS IN THE SLABS.
5. BROOMED FINISH TO ALL RAMPED AND VEHICULAR CROSSINGS. ALL OTHER KERBING OR DISH DRAINS TO BE STEEL FLOAT FINISHED.
6. IN THE REPLACEMENT OF KERB AND GUTTER :-
   EXISTING ROAD PAVEMENT IS TO BE SAWCUT 900mm U.N.O FROM THE LIP OF GUTTER. UPON COMPLETION OF THE NEW KERB AND GUTTER NEW BASECOURSE AND SURFACE TO BE LAID 600mm WIDE U.N.O.

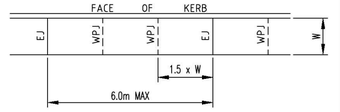
   EXISTING ALLOTMENT DRAINAGE PIPES ARE TO BE BUILT INTO THE NEW KERB AND GUTTER WITH 100mm DIA HOLE.

   EXISTING KERB AND GUTTER IS TO BE COMPLETELY REMOVED WHERE NEW KERB AND GUTTER IS SHOWN.

JOINTING NOTES

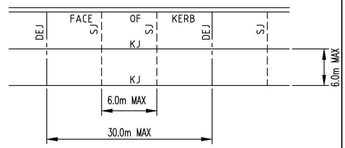
PEDESTRIAN PAVEMENT JOINTS

1. ALL PEDESTRIAN PAVEMENTS ARE TO BE JOINTED AS FOLLOWS. (U.N.O)
2. EXPANSION JOINTS ARE TO BE LOCATED WHERE POSSIBLE AT TANGENT POINTS OF CURVES AND ELSEWHERE AT MAX. 6.0m CENTRES.
3. WEAKENED PLANE JOINTS ARE TO BE LOCATED AT A MAX. SPACING OF 1.5 x WIDTH OF THE PAVEMENT.
4. WHERE POSSIBLE JOINTS SHOULD BE LOCATED TO MATCH KERBING AND OR ADJACENT PAVEMENT JOINTS.
5. PEDESTRIAN PAVEMENT JOINT DETAIL.



VEHICULAR PAVEMENT JOINTS

6. ALL VEHICULAR PAVEMENTS TO BE JOINTED AS FOLLOWS. (U.N.O)
7. KEYED CONSTRUCTION JOINTS SHOULD GENERALLY BE LOCATED AT A MAX OF 6.0m CENTRES
8. SAWN JOINTS SHOULD GENERALLY BE LOCATED AT A MAX OF 6.0m CENTRES WITH DOWELED EXPANSION JOINTS AT MAX 30.0m CENTRES
9. VEHICULAR PAVEMENT JOINT DETAIL.



EXISTING UNDERGROUND SERVICES NOTES

THE LOCATIONS OF UNDERGROUND SERVICES SHOWN IN THIS SET OF DRAWINGS HAVE BEEN PLOTTED FROM SURVEY INFORMATION AND SERVICE AUTHORITY INFORMATION. THE SERVICE INFORMATION HAS BEEN PREPARED ONLY TO SHOW THE APPROXIMATE POSITIONS OF ANY KNOWN SERVICES AND MAY NOT BE AS CONSTRUCTED OR ACCURATE.

AT & L CAN NOT GUARANTEE THAT THE SERVICES INFORMATION SHOWN ON THESE DRAWINGS ACCURATELY INDICATES THE PRESENCE OR ABSENCE OF SERVICES OR THEIR LOCATION AND WILL ACCEPT NO LIABILITY FOR INACCURACIES IN THE SERVICES INFORMATION SHOWN FROM ANY CAUSE WHATSOEVER.

CONTRACTORS SHALL TAKE DUE CARE WHEN EXCAVATING ONSITE INCLUDING HAND EXCAVATION WHERE NECESSARY.

CONTRACTORS ARE TO CONTACT THE RELEVANT SERVICE AUTHORITY PRIOR TO COMMENCEMENT OF EXCAVATION WORKS.

CONTRACTORS ARE TO UNDERTAKE A SERVICES SEARCH, PRIOR TO COMMENCEMENT OF WORKS ON SITE. SEARCH RESULTS ARE TO BE KEPT ON SITE AT ALL TIMES.

EROSION AND SEDIMENT CONTROL NOTES

GENERAL INSTRUCTIONS

1. THE SITE SUPERINTENDENT/ENGINEER WILL ENSURE THAT ALL SOIL AND WATER MANAGEMENT WORKS ARE LOCATED AS DOCUMENTED.
2. ALL WORK SHALL BE GENERALLY CARRIED OUT IN ACCORDANCE WITH
   a. LOCAL AUTHORITY REQUIREMENTS
   b. EPA REQUIREMENTS
   c. NSW DEPARTMENT OF HOUSING MANUAL "MANAGING URBAN STORMWATER, SOILS AND CONSTRUCTION", 4th EDITION, MARCH 2004.
3. MAINTAIN THE EROSION CONTROL DEVICES TO THE SATISFACTION OF THE SUPERINTENDENT AND THE LOCAL AUTHORITY.
4. WHEN STORMWATER PITS ARE CONSTRUCTED, PREVENT SITE RUNOFF ENTERING UNLESS SEDIMENT FENCES ARE ERECTED AROUND PITS.
5. CONTRACTOR IS TO ENSURE ALL EROSION & SEDIMENT CONTROL DEVICES ARE MAINTAINED IN GOOD WORKING ORDER AND OPERATE EFFECTIVELY. REPAIRS AND OR MAINTENANCE SHALL BE UNDERTAKEN AS REQUIRED, PARTICULARLY FOLLOWING STORM EVENTS.

LAND DISTURBANCE

6. WHERE PRACTICAL, THE SOIL EROSION HAZARD ON THE SITE WILL BE KEPT AS LOW AS POSSIBLE. TO THIS END, WORKS SHOULD BE UNDERTAKEN IN THE FOLLOWING SEQUENCE:
   (A) INSTALL A WIND FENCE ALONG THE BOUNDARIES AS SHOWN ON PLAN. REFER DETAIL.
   (B) INSTALL A SEDIMENT FENCE ALONG THE BOUNDARIES AS SHOWN ON PLAN. REFER DETAIL.
   (C) CONSTRUCT STABILISED CONSTRUCTION ENTRANCE TO LOCATION AS DETERMINED BY SUPERINTENDENT/ENGINEER. REFER DETAIL.
   (D) INSTALL SEDIMENT BASIN AS SHOWN ON PLAN
   (E) INSTALL SEDIMENT TRAPS AS SHOWN ON PLAN.
   (F) UNDERTAKE SITE DEVELOPMENT WORKS IN ACCORDANCE WITH THE ENGINEERING PLANS. WHERE POSSIBLE, PHASE DEVELOPMENT SO THAT LAND DISTURBANCE IS CONFINED TO AREAS OF WORKABLE SIZE.

EROSION CONTROL

7. DURING WINDY WEATHER, LARGE, UNPROTECTED AREAS WILL BE KEPT MOIST (NOT WET) BY SPRINKLING WITH WATER TO KEEP DUST UNDER CONTROL.
8. FINAL SITE LANDSCAPING WILL BE UNDERTAKEN AS SOON AS POSSIBLE AND WITHIN 20 WORKING DAYS FROM COMPLETION OF CONSTRUCTION ACTIVITIES.

SEDIMENT CONTROL

9. STOCKPILES WILL NOT BE LOCATED WITHIN 2 METRES OF HAZARD AREAS, INCLUDING LIKELY AREAS OF CONCENTRATED OR HIGH VELOCITY FLOWS SUCH AS WATERWAYS. WHERE THEY ARE BETWEEN 2 AND 5 METRES FROM SUCH AREAS, SPECIAL SEDIMENT CONTROL MEASURES SHOULD BE TAKEN TO MINIMISE POSSIBLE POLLUTION TO DOWNSLOPE WATERS, E.G. THROUGH INSTALLATION OF SEDIMENT FENCING.
10. ANY SAND USED IN THE CONCRETE CURING PROCESS (SPREAD OVER THE SURFACE) WILL BE REMOVED AS SOON AS POSSIBLE AND WITHIN 10 WORKING DAYS FROM PLACEMENT.
11. WATER WILL BE PREVENTED FROM ENTERING THE PERMANENT DRAINAGE SYSTEM UNLESS IT IS RELATIVELY SEDIMENT FREE, I.E. THE CATCHMENT AREA HAS BEEN PERMANENTLY LANDSCAPED AND/OR ANY LIKELY SEDIMENT HAS BEEN FILTERED THROUGH AN APPROVED STRUCTURE.
12. TEMPORARY SOIL AND WATER MANAGEMENT STRUCTURES WILL BE REMOVED ONLY AFTER THE LANDS THEY ARE PROTECTING ARE REHABILITATED.

OTHER MATTERS

13. ACCEPTABLE RECEPTORS WILL BE PROVIDED FOR CONCRETE AND MORTAR SLURRIES, PAINTS, ACID WASHINGS, LIGHT-WEIGHT WASTE MATERIALS AND LITTER.
14. ANY EXISTING TREES WHICH FORM PART OF THE FINAL LANDSCAPING PLAN WILL BE PROTECTED FROM CONSTRUCTION ACTIVITIES BY:
   (A) PROTECTING THEM WITH BARRIER FENCING OR SIMILAR MATERIALS INSTALLED OUTSIDE THE DRIP LINE
   (B) ENSURING THAT NOTHING IS NAILED TO THEM
   (C) PROHIBITING PAVING, GRADING, SEDIMENT WASH OR PLACING OF STOCKPILES WITHIN THE DRIP LINE EXCEPT UNDER THE FOLLOWING CONDITIONS.
   (I) ENCROACHMENT ONLY OCCURS ON ONE SIDE AND NO CLOSER TO THE TRUNK THAN EITHER 1.5 METRES OR HALF THE DISTANCE BETWEEN THE OUTER EDGE OF THE DRIP LINE AND THE TRUNK, WHICH EVER IS THE GREATER
   (II) A DRAINAGE SYSTEM THAT ALLOWS AIR AND WATER TO CIRCULATE THROUGH THE ROOT ZONE (E.G. A GRAVEL BED) IS PLACED UNDER ALL FILL LAYERS OF MORE THAN 300 MILLIMETRES DEPTH
   (III) CARE IS TAKEN NOT TO CUT ROOTS UNNECESSARILY NOR TO COMPACT THE SOIL AROUND THEM.

DRAFT

Issue	Description	Date
P1	ISSUED FOR INFORMATION	28-03-17

100mm on Original

Bar Scales

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Client: StHilliers

Scales		Drawn	GB
AS SHOWN		Designed	GB
Grid	MGA	Checked	AT
Height Datum	AHD	Approved	

Project: LOT 3003 ON DP1184498 THORNTON, PENRITH

Title: COVER SHEET, NOTES, LEGENDS AND DRAWING LIST

Civil Engineers and Project Managers

at&l

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North Sydney NSW 2060
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info@atl.net.au

Status: PRELIMINARY ONLY NOT TO BE USED FOR CONSTRUCTION

A1

Drawing No.	Project No.	Issue
DAC101	17-450	P1

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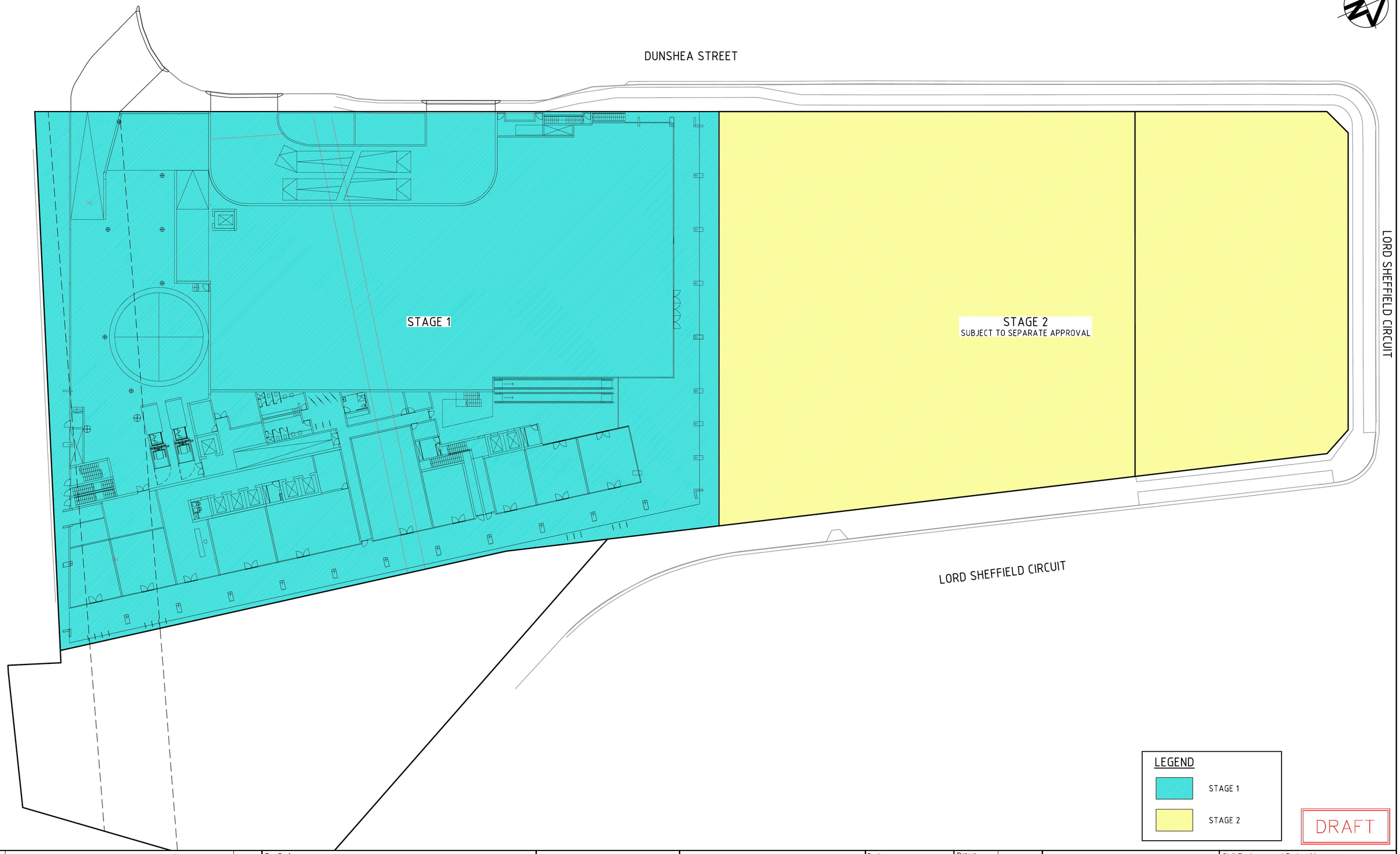
Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017



DRAFT

Issue	Description	Date
P1	ISSUED FOR INFORMATION	28-03-17

100mm on Original

Bar Scales

0 5 10 15 20 25m

1 : 250 @ A1 1 : 500 @ A3

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Client

StHilliers

Scales		Drawn	GB
1 : 250 @ A1		Designed	GB
Grid	MGA	Checked	AT
Height Datum	AHD	Approved	

Project

LOT 3003 ON DP1184498
THORNTON, PENRITH

Title

GENERAL ARRANGEMENT PLAN

Civil Engineers and Project Managers

at&l

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Status

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A1

Drawing No.	Project No.	Issue
DAC102	17-450	P1

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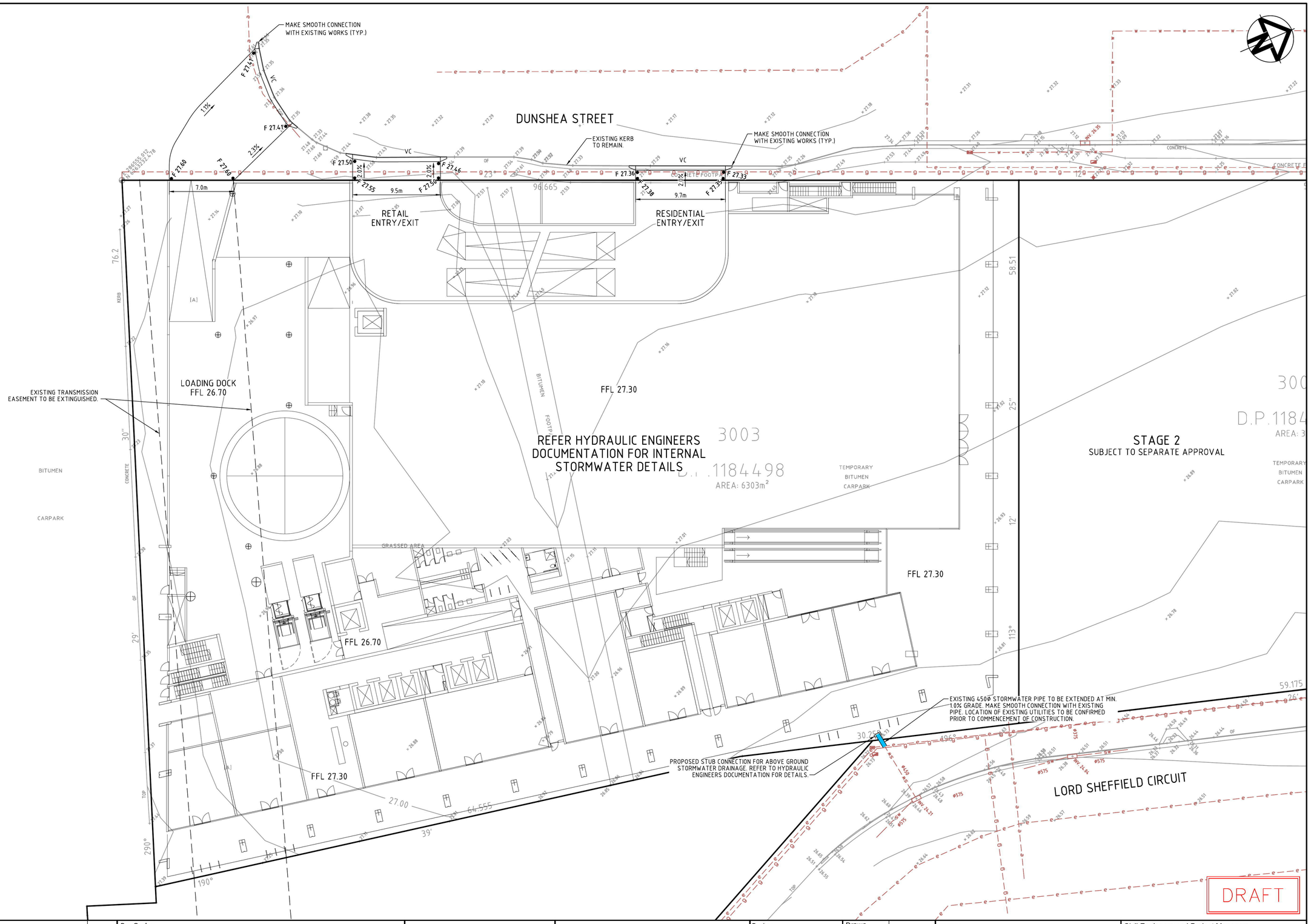
Version: 1, Version Date: 28/04/2017



Issue	Description	Date
P1	ISSUED FOR INFORMATION	28-03-17

Bar Scales

0 5 10 15 20 25m

1 : 250 @ A1 1 : 500 @ A3

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Client: StHilliers

Scales		Drawn	GB
1 : 200 @ A1		Designed	GB
Grid	MGA	Checked	AT
Height Datum	AHD	Approved	

Project: LOT 3003 ON DP1184498 THORNTON, PENRITH

Title: SITEWORKS AND STORMWATER DRAINAGE PLAN

Civil Engineers and Project Managers
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Drawing No.	Project No.	Issue
DAC105	17-450	P1

100mm on Original

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Version: 1, Version Date: 28/04/2017

DUNSHEA STREET

LORD SHEFFIELD CIRCUIT

LOCATION OF SITE ACCESS TO SUIT CONSTRUCTION STAGING.

INDICATIVE SITE OFFICE AND SHEDS

INDICATIVE TEMPORARY STOCKPILE

STAGE 1
CONTRACTORS TO PROVIDE EROSION AND SEDIMENT CONTROL MEASURES WITHIN BASEMENT EXCAVATION

STAGE 2
SUBJECT TO SEPARATE APPROVAL

LORD SHEFFIELD CIRCUIT

LEGEND

- EXTENT OF STAGE 1 BASEMENT EXCAVATION
- STABILISED SITE ACCESS AND TRUCK WASH DOWN AREA (SD 6-14)
- TEMPORARY SITE ACCESS GATE
- SEDIMENT FENCE (SD 6-8)
- BARRIER FENCE
- MESH AND GRAVEL INLET FILTER (SD 6-11)
- GEOTEXTILE INLET (SD 6-12)

DRAFT

Issue	Description	Date
P1	ISSUED FOR INFORMATION	28-03-17

100mm on Original

Bar Scales

0 5 10 15 20 25m

1 : 250 @ A1 1 : 500 @ A3

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Client: StHilliers

Scales	1 : 250 @ A1
Grid	MGA
Height Datum	AHD
Drawn	GB
Designed	GB
Checked	AT
Approved	

Project
LOT 3003 ON DP1184498
THORNTON, PENRITH

Title
SEDIMENTATION AND EROSION CONTROL PLAN

Civil Engineers and Project Managers
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Status
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Drawing No.	Project No.	Issue
DAC110	17-450	P1

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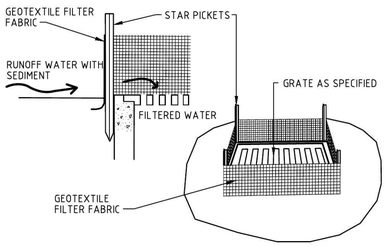
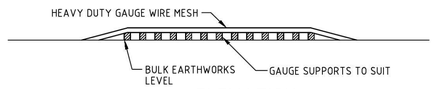
Version: 1, Version Date: 28/04/2017

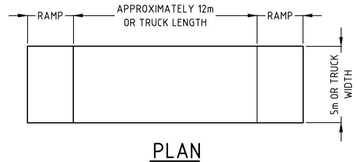


GEOTEXTILE FILTER PIT SURROUND

NTS



ELEVATION

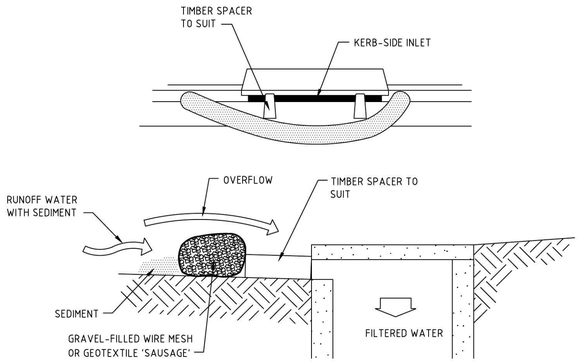


PLAN

TEMPORARY CONSTRUCTION EXIT (WASH DOWN DETAIL)

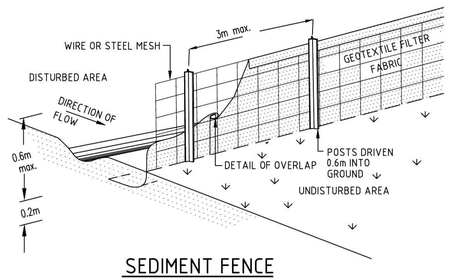
SCALE 1:200

THE EXIT SHALL BE MAINTAINED IN A CONDITION WHICH PREVENTS TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHTS OF WAY. THIS MAY REQUIRE REPAIR AND OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ALL SEDIMENT SPILLED, DROPPED, WASHED OR TRACKED ONTO PUBLIC RIGHTS OF WAY MUST BE REMOVED IMMEDIATELY.



MESH AND GRAVEL INLET FILTER

NTS



SEDIMENT FENCE

NTS

DRAFT

Issue	Description	Date
P1	ISSUED FOR INFORMATION	28-03-17

100mm on Original

Bar Scales

0 5 10 15 20m

1 : 200 @ A1 1 : 400 @ A3

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Client: StHilliers

Scales	AS SHOWN	Drawn	GB
		Designed	GB
Grid	MGA	Checked	AT
Height Datum	AHD	Approved	

Project: LOT 3003 ON DP1184498 THORNTON, PENRITH

Title: SEDIMENTATION AND EROSION CONTROL DETAILS

Civil Engineers and Project Managers
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Drawing No.	Project No.	Issue
DAC111	17-450	P1

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Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Appendix C

Council Correspondence

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Glen James

From: Fred Shockair <Fred.Shockair@penrith.city>
Sent: Wednesday, 1 March 2017 2:08 PM
To: Glen James
Subject: RE: Lots 3003-3005 on DP1184498

Hi Glen

As part of the subdivision the applicant submitted a flood report which was approved by the Department of planning. The flood level for the site is 25.40m AHD (all ground levels were built at or above that level). The minimum level of habitable floors is 25.9mAHD

Regards

Fred Shockair
Senior Engineer - Major Developments

E Fred.Shockair@penrith.city
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www.penrithcity.nsw.gov.au

PENRITH
CITY COUNCIL

Follow us

From: Glen James [mailto:Glen@atl.net.au]
Sent: Wednesday, 1 March 2017 1:59 PM
To: Fred Shockair <Fred.Shockair@penrith.city>
Cc: Andrew Tweedie <andrewt@atl.net.au>
Subject: RE: Lots 3003-3005 on DP1184498

Hi Fred,
Thanks for sending that through

Is there any flooding information available for the lots mentioned previously? Or do we need to complete flood information application form attached?

Cheers Glen

Regards,
Glen James
Civil Engineer

at&l

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

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M 0411 257 008
F 02 9923 1055
glen@atl.net.au
www.atl.net.au

From: Fred Shockair [mailto:Fred.Shockair@penrith.city]
Sent: Tuesday, 28 February 2017 3:32 PM
To: Glen James <Glen@atl.net.au>
Subject: RE: Lots 3003-3005 on DP1184498

Hi Glen

As discussed OSD and WSUD has been installed for the entire subdivision , hence no OSD and WSUD required for this development.

Fred Shockair
Senior Engineer - Major Developments

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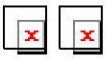

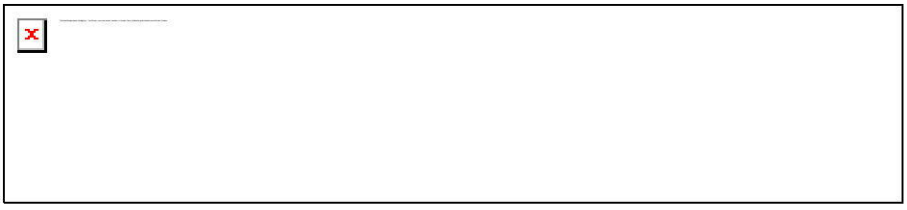

From: Glen James [mailto:Glen@atl.net.au]
Sent: Tuesday, 28 February 2017 2:25 PM
To: Fred Shockair <Fred.Shockair@penrith.city>
Cc: Andrew Tweedie <andrewt@atl.net.au>
Subject: Lots 3003-3005 on DP1184498

Hi Fred,

As discussed if you could confirm via return email that the proposed development located in Penrith consisting of Lots 3003-3005 on DP 1184498 do not require OSD and WSUD prior to discharging to the adjacent street network, as this is already catered for in the regional basin/wetland by others.

Thanks Glen

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Regards,
Glen James
Civil Engineer

Level 7, 153 Walker Street
North Sydney NSW 2060

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M 0411 257 008
F 02 9923 1055
glen@atl.net.au
www.atl.net.au

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Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

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Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Appendix D

Dial Before you Dig (DBYD)

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Job No 1955631

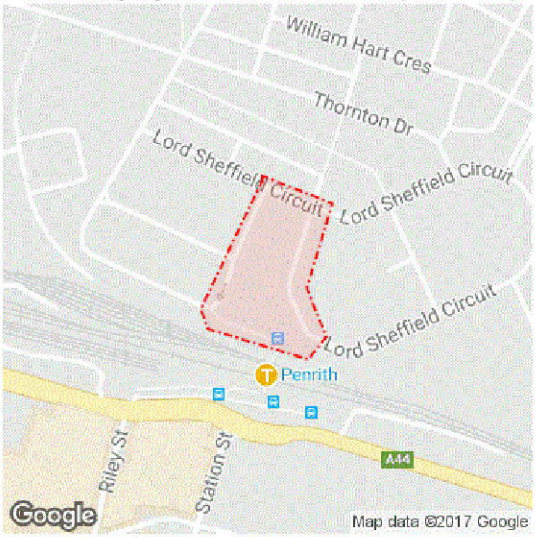
Phone: 1100
www.1100.com.au

Caller Details

Contact:	Mr Glen James	**Caller Id:**	1525029	**Phone:**	02 9439 1777
Company:	At&L	**Mobile:**	0411257008	**Fax:**	Not Supplied
Address:	Suite 702 154 Pacific Highway Greenwich NSW 2065	**Email:**	glen@atl.net.au		

Dig Site and Enquiry Details

WARNING: The map below only displays the location of the proposed dig site and does not display any asset owners' pipe or cables. The area highlighted has been used only to identify the participating asset owners, who will send information to you directly.



User Reference: Thonton Pen
Working on Behalf of:
Private

Enquiry Date:	**Start Date:**	**End Date:**
02/03/2017	13/03/2017	16/10/2017

Address:
Lord Sheffield Circuit
Penrith NSW 2750

Job Purpose: Excavation
Onsite Activity: Manual Excavation
Location of Workplace: Both
Location in Road: CarriageWay,Footpath,Nature Strip

- Check that the location of the dig site is correct. If not you must submit a new enquiry.
- Should the scope of works change, or plan validity dates expire, you must submit a new enquiry.
- Do NOT dig without plans. Safe excavation is your responsibility. If you do not understand the plans or how to proceed safely, please contact the relevant asset owners.

Notes/Description of Works:
Not Supplied

Your Responsibilities and Duty of Care

- If plans are not received within 2 working days, contact the asset owners directly & quote their Sequence No.
- ALWAYS perform an onsite inspection for the presence of assets. Should you require an onsite location, contact the asset owners directly. Please remember, plans do not detail the exact location of assets.
- Pothole to establish the exact location of all underground assets using a hand shovel, before using heavy machinery.
- Ensure you adhere to any State legislative requirements regarding Duty of Care and safe digging requirements.
- If you damage an underground asset you MUST advise the asset owner immediately.
- By using this service, you agree to Privacy Policy and the terms and disclaimers set out at **www.1100.com.au**
- **For more information on safe excavation practices, visit www.1100.com.au**

Asset Owner Details

The assets owners listed below have been requested to contact you with information about their asset locations within 2 working days. Additional time should be allowed for information issued by post. It is **your responsibility** to identify the presence of any underground assets in and around your proposed dig site. Please be aware, that not all asset owners are registered with the Dial Before You Dig service, so it is **your responsibility** to identify and contact any asset owners not listed here directly.
** Asset owners highlighted by asterisks ** require that you visit their offices to collect plans.
# Asset owners highlighted with a hash require that you call them to discuss your enquiry or to obtain plans.

Seq. No.	Authority Name	Phone	Status
59327863	Endeavour Energy	0298534161	NOTIFIED
59327865	Jemena Gas West	1300880906	NOTIFIED
59327867	NBN Co, NswAct	1800626762	NOTIFIED
59327866	Sydney Water	132092	NOTIFIED
59327864	Telstra NSW, Central	1800653935	NOTIFIED

END OF UTILITIES LIST

Lodge Your Free Enquiry Online – 24 Hours a Day, Seven Days a Week

To: Mr Glen James
Phone: 02 9439 1777
Fax: Not Supplied
Email: glen@atl.net.au

Dial before you dig Job #:	11955631
Sequence #	59327867
Issue Date:	03/02/2017
Location:	Lord Sheffield Circuit,Penrith,NSW-2750

DIAL BEFORE YOU DIG www.1100.com.au

Some impact.

No onsite action required.

Location of Underground Telecommunications Facilities

We thank you for your enquiry. In relation to your enquiry at the above address:

- **nbn's** records indicate that there **MAY BE** underground fibre optic/telecommunications facility/facilities (owned or controlled by nbn) in the vicinity of the location identified above ("Location").
- **nbn** indicative plan/s are attached with this notice ("Indicative Plans").
- The Indicative Plan/s show general depth and alignment information only and are not an exact, scale or accurate depiction of the location, depth and alignment of the fibre optic/telecommunications facilities shown on the Indicative Plan/s.
- In particular, the fact that the Indicative Plans show that a facility is installed in a straight line, or at uniform depth along its length cannot be relied upon as evidence that the facility is, in fact, installed in a straight line or at uniform depth.
- You should read the Indicative Plans in conjunction with this notice and in particular, the notes below.
- The information contained in the Indicative Plans is valid for 28 days from the date of issue set out above.You are expected to make your own inquiries and perform your own investigations (including engaging appropriately qualified plant locators at your cost to locate **nbn** telecommunications facilities during any activities you carry out on site).

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

We thank you for your enquiry and appreciate your continued use of the Dial Before You Dig Service. If you are planning to excavate and require further information, please contact **nbn** on 1800 626 762. For any enquiries related to moving assets or Planning and Design activities, please email the **nbn** at RelocationWorks@nbnco.com.au.

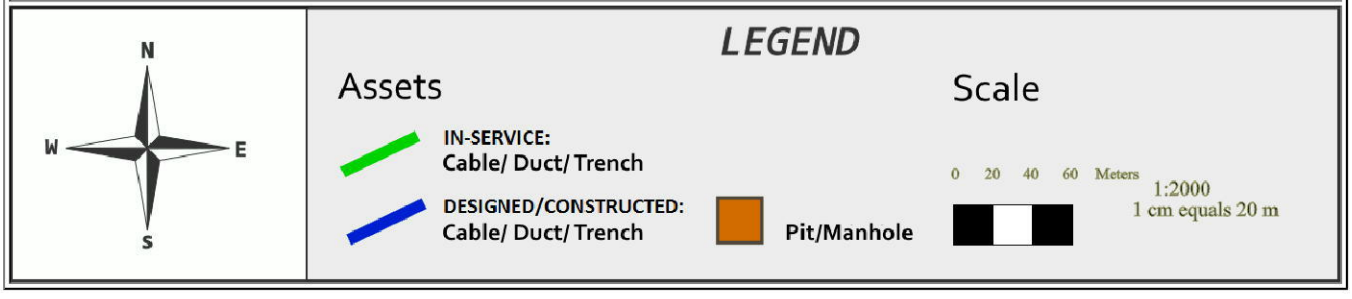
Notes:

1. You are now aware that there are items of telecommunications facilities in the vicinity of the above property that could be damaged as a result activities carried out (or proposed to be carried out) by you in the vicinity of the Location.
2. You should have regard to section 474.6 and 474.7 of the *Criminal Code Act 1995* (Cth) which deals with the consequences of interfering or tampering with a telecommunications facility. Only persons authorised by **nbn** can interact with **nbn** network facilities.
3. Any information provided is valid only for **28 days** from the date of issue set out above.

Indicative Plans

1

2



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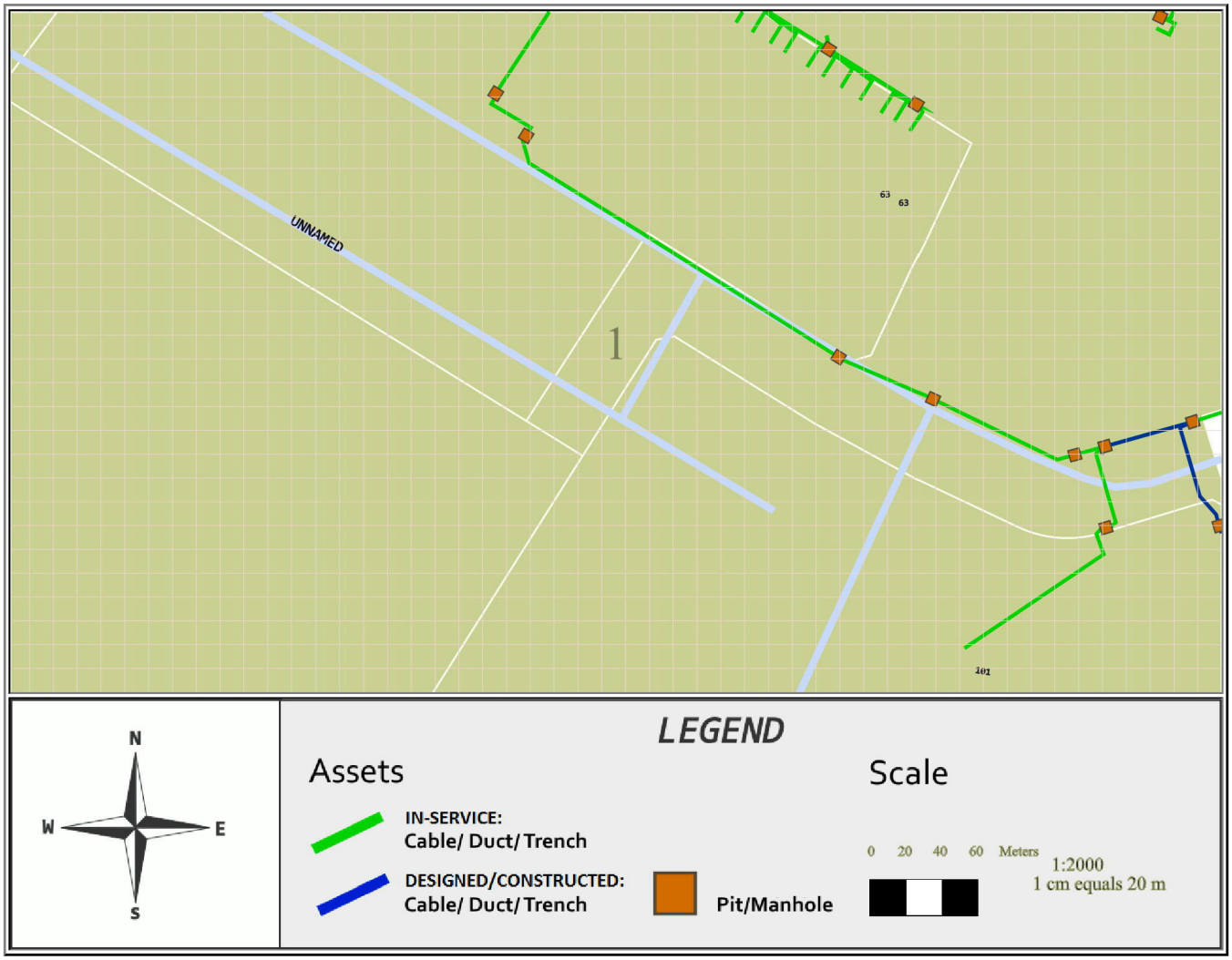

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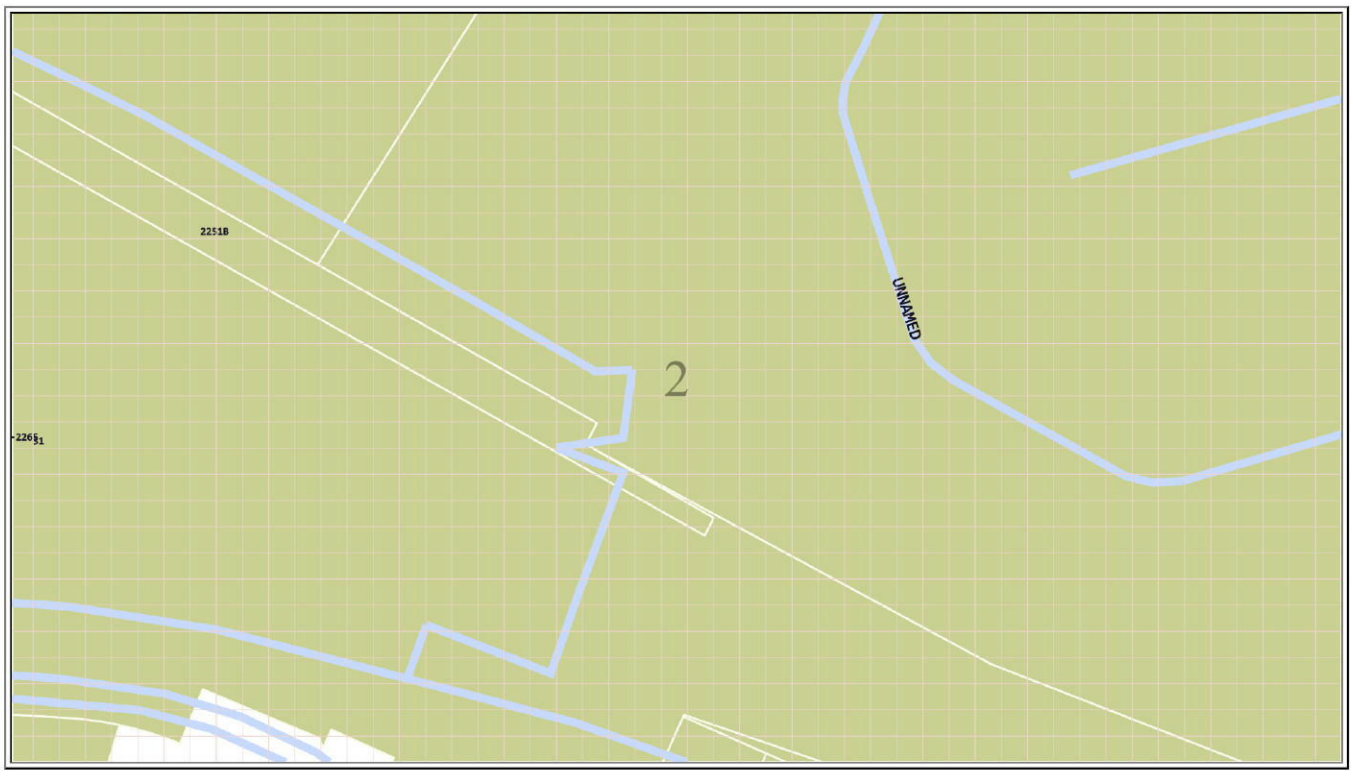

Referral Conditions

The following are conditions on which **nbn** provides you with the Indicative Plans. By receiving,accepting or relying upon the plans(including the Indicative Plans), you are agreeing to these conditions. These conditions are in addition (and not in replacement of) any duties and obligations you have under applicable law.

1. **nbn** does not accept any responsibility for any inaccuracies of its plans. You are expected to make your own inquiries and perform your own investigations (including engaging appropriately qualified plant locators at your cost to locate **nbn™** telecommunications facilities during any activities you carry out on site).
2. You should not assume that fibre optic cables follow straight lines or are installed at uniformed depths along their lengths, even if they are indicated on plans provided to you. Careful onsite investigations are essential to locate the exact position of cables.
3. In carrying out any works in the vicinity of **nbn** facilities, you must maintain the following minimum clearances:
    - 300mm when laying assets inline, horizontally or vertically
    - 500mm when operating vibrating equipment, for example: jackhammers or vibrating plates;and
    - 1000mm when operating mechanical excavators.
    - Adherence to clearances as directed by other asset owner's instructions
4. You are aware that there are inherent risks and dangers associated with carrying out work in the vicinity of underground facilities (such as nbn fibre optic, copper and coaxial cables, to nbn assets).Damage to underground electric cables may result in:

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

- Injury from electric shock or severe burns, with the possibility of death.
- Interruption of the electricity supply to wide areas of the city.
- Damage to your excavating plant.
- Responsibility for the cost of repairs.

5. You must take all reasonable precautions to avoid damaging nbn facilities. These precautions may include ,but not limited to, the following:
    - All excavation sites should be examined for underground cables by careful hand excavation. Cable cover slabs if present must not be disturbed. Hand excavation needs to be undertaken with extreme care to minimise the likelihood of damage to the cable, for example, the blades of hand equipment should be aligned parallel to the line of the cable rather than digging across the cable.
    - If any undisclosed underground cables are located, notify nbn immediately.
    - All personnel must be properly briefed, particularly those associated with the use of earth-moving equipment, trenching, boring and pneumatic equipment.
    - The safety of the public and other workers must be ensured.
    - All excavations must be undertaken in accordance with all relevant legislation and regulations.
6. You will be responsible for all damage to nbn facilities that are connected whether directly, or indirectly with work you carry out (or work that is carried out for you or on your behalf) at the Location. This will include, without limitation, all losses expenses incurred by nbn as a result of any such damage.
7. You must immediately report any damage to **nbn™** network that you are/become aware of. Notification may be by telephone - 1800 626 762.
8. Except to the extent that liability may not be capable of lawful exclusion, nbn and its servants and agents and the related bodies corporate of nbn and their servants and agents shall be under no liability whatsoever to any person for any loss or damage (including indirect or consequential loss or damage) however caused (including, without limitation, breach of contract negligence and/or breach of statute) which may be suffered or incurred from or in connection with this information sheet or any Plans attached hereto. Except as expressly provided to the contrary in this information sheet or the attached Indicative Plans, all terms, conditions, warranties, undertakings or representations (whether expressed or implied) are excluded to the fullest extent permitted by law.

All works undertaken shall be in accordance with all relevant legislations, acts and regulations applicable to the particular state or territory of the Location. The following table lists all relevant documents that shall be considered and adhered to.

State/Territory	Documents
National	Work Health and Safety Act 2011
	Work Health and Safety Regulations 2011
	Safe Work Australia - Working in the Vicinity of Overhead and Underground Electric Lines (Draft)
	Occupational Health and Safety Act 1991
NSW	Electricity Supply Act 1995

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

	Work Cover NSW - Work Near Underground Assets Guide
	Work Cover NSW - Excavation Work: Code of Practice
VIC	Electricity Safety Act 1998
	Electricity Safety (Network Asset) Regulations 1999
QLD	Electrical Safety Act 2002
	Code of Practice for Working Near Exposed Live Parts
SA	Electricity Act 1996
TAS	Tasmanian Electricity Supply Industry Act 1995
WA	Electricity Act 1945
	Electricity Regulations 1947
NT	Electricity Reform Act 2005
	Electricity Reform (Safety and Technical) Regulations 2005
ACT	Electricity Act 1971

Thank You,

Network Operations Centre - Assurance

Date: 03/02/2017

This document is provided for information purposes only. This document is subject to the information classification set out on this page. If no information classification has been included, this document must be treated as UNCLASSIFIED, SENSITIVE and must not be disclosed other than with the consent of nbn co. The recipient (including third parties) must make and rely on their own inquiries as to the currency, accuracy and completeness of the information contained herein and must not use this document other than with the consent of nbn co.

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Version: 1, Version Date: 28/04/2017

If further clarification is required, please contact:
Endeavour Energy
Phone: (02) 9853 4161 (8:00am-4:30pm Mon-Fri)
Emergency Phone Number: 131 003

Endeavour Energy

DBYD Underground Search Report
Date: 02/03/2017

DBYD Sequence No: 59327863 **DBYD Job No:** 11955631

ENDEAVOUR ENERGY ASSETS AFFECTED

To:	Mr Glen James		Company:	At&L	
Address:	Suite 702 154 Pacific Highway, Greenwich, NSW 2065				
Cust. ID:	1525029	Email:	glen@atl.net.au		
Phone:	02 9439 1777	Mobile:	0411257008	Fax:	Not Supplied
Enquiry Location:	Lord Sheffield Circuit, Penrith, NSW 2750				

Our Search has shown that **UNDERGROUND ASSETS ARE PRESENT** on our plans within the nominated enquiry location. This search is based on the graphical position of the excavation site as denoted in the DBYD customer confirmation sheet.

WARNING

- **All electrical apparatus shall be regarded as live until proved de-energised.** Contact with live electrical apparatus will cause severe injury or death.
- In accordance with the *Electricity Supply Act 1995*, you are obliged to report any damage to Endeavour Energy Assets immediately by calling **131 003**.
- The customer must obtain a new set of plans from Endeavour Energy if work has not been started or completed within twenty **(20)** working days of the original plan issue date.
- The customer must contact Endeavour Energy if any of the plans provided have blank pages, as some underground asset information may be incomplete.
- Endeavour Energy underground earth grids may exist and their location **may not** be shown on plans. Persons excavating are expected to exercise all due care, especially in the vicinity of padmount substations, pole mounted substations, pole mounted switches, transmission poles and towers.
- Endeavour Energy plans **do not** show any underground customer service mains or information relating to service mains within private property.
- Asbestos or asbestos-containing material may be present on or near Endeavour Energy's underground assets.
- Organo-Chloride Pesticides (OCP) may be present in some sub-transmission trenches.
- All plans must be printed and made available at the worksite where excavation is to be undertaken. Plans must be reviewed and understood by the crew on site prior to commencing excavation.

SUPPLEMENTARY MATERIAL

Material	Purpose	Location
DBYD Cover Letter	Endeavour Energy DBYD response Cover Letter	Attached
DBYD Important Information & Disclaimer	Endeavour Energy disclaimer, responsibilities and information on understanding plans	Attached
DBYD Response Plans	Endeavour Energy DBYD plans	Attached
Work Cover NSW *"Work near underground assets: Guide"*	Guideline for anyone involved in construction work near underground assets	Contact Work Cover NSW for a copy
Work Cover NSW *"Excavation work: Code of practice"*	Practical guidance on managing health and safety risks associated with excavation	URL [Click Here]
Safe Work Australia *"Working in the vicinity of overhead and underground electric lines guidance material"*	Provides information on how to manage risks when working in the vicinity of overhead and underground electric lines at a workplace	URL [Click Here]
Endeavour Energy Safety Brochures & Guides	To raise awareness of dangers of working on or near Endeavour Energy's assets	URL [Click Here]

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Endeavour Energy
Phone: (02) 9853 4161 (8:00am-4:30pm Mon-Fri)
Emergency Phone Number: 131 003

WARNING

This excavation is in the vicinity of Endeavour Energy's Transmission, Pilot, Communication or Fibre Optic Cables

Please Notify

ENDEAVOUR ENERGY

Between 7.15am - 4.00pm

on

02 9853 7121 or 0407 468 626

Transmission Mains North

4 WORKING days **before commencing Excavation**

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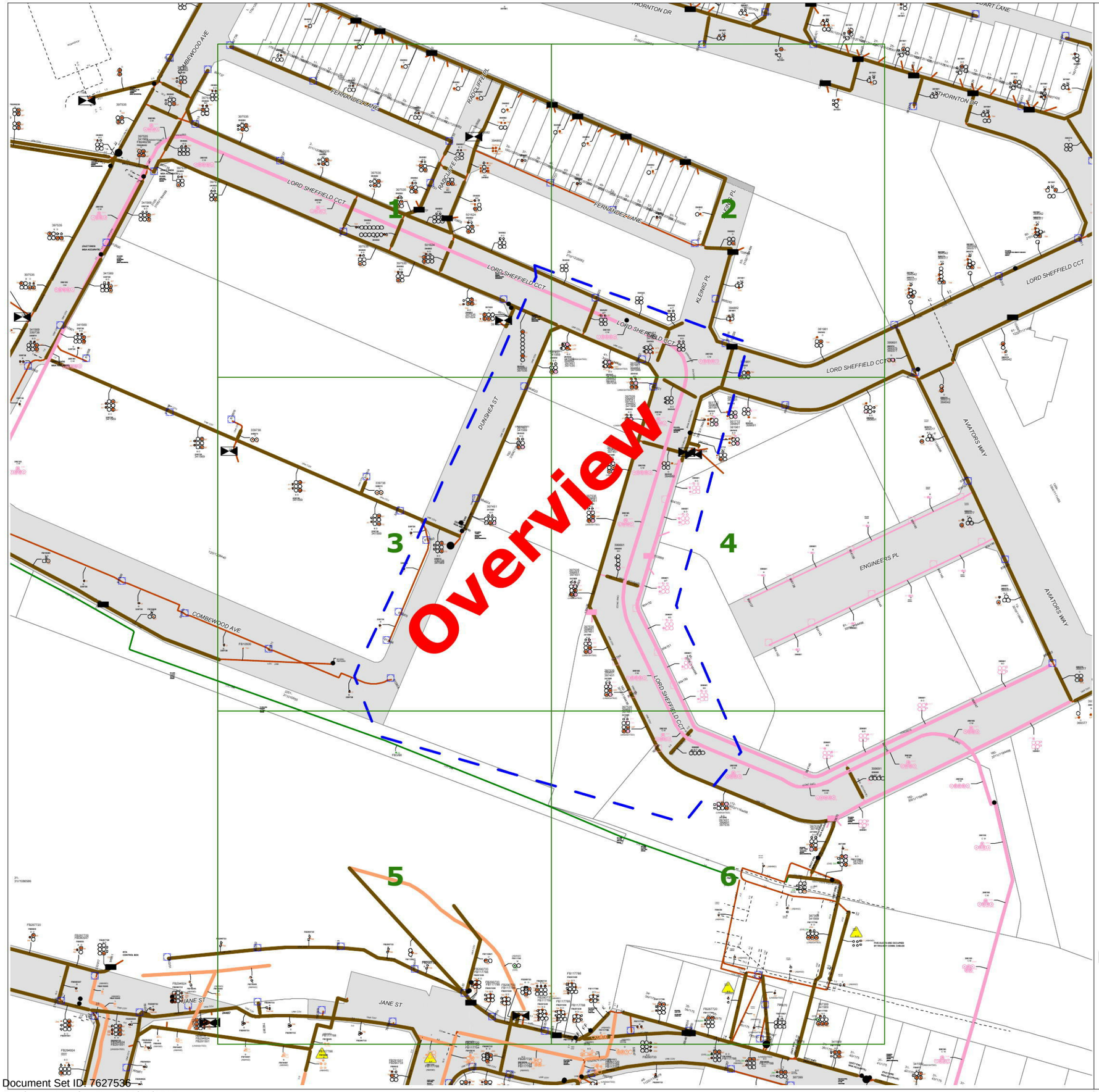

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INFORMATION PROVIDED BY ENDEAVOUR ENERGY

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- Depth of underground assets may vary significantly from information provided on plans as a result of changes to road, footpath or surface levels subsequent to installation.
- Such plans have been prepared solely for use by Endeavour Energy staff for design, construction and maintenance purposes.
- All enquiry details and results are kept in a register.

DISCLAIMER

Whilst Endeavour Energy has taken all reasonable steps to ensure that the information contained in the plans is as accurate as possible it will accept no liability for inaccuracies in the information shown on such plans.

WARNING
THIS EXCAVATION IS IN THE VICINITY OF ENDEAVOUR ENERGY TRANSMISSION, PILOT, COMMUNICATION OR FIBRE OPTIC CABLES
PLEASE RING **9853 7121** or **MOB. 0407 468 626**
4 WORKING DAYS BEFORE COMMENCING WORK

LEGEND

- Street light column (or)
- Padmount substation
- Overground pillar (O.G.Box) (or)
- Underground pit
- Duct run
- Cable run
- Typical duct section
- Asbestos warning

N

NOT TO SCALE

DBYD Sequence No.:	59327863
Issued Date:	02/03/2017

Cadastre: © Land and Property Information 2015, 2016

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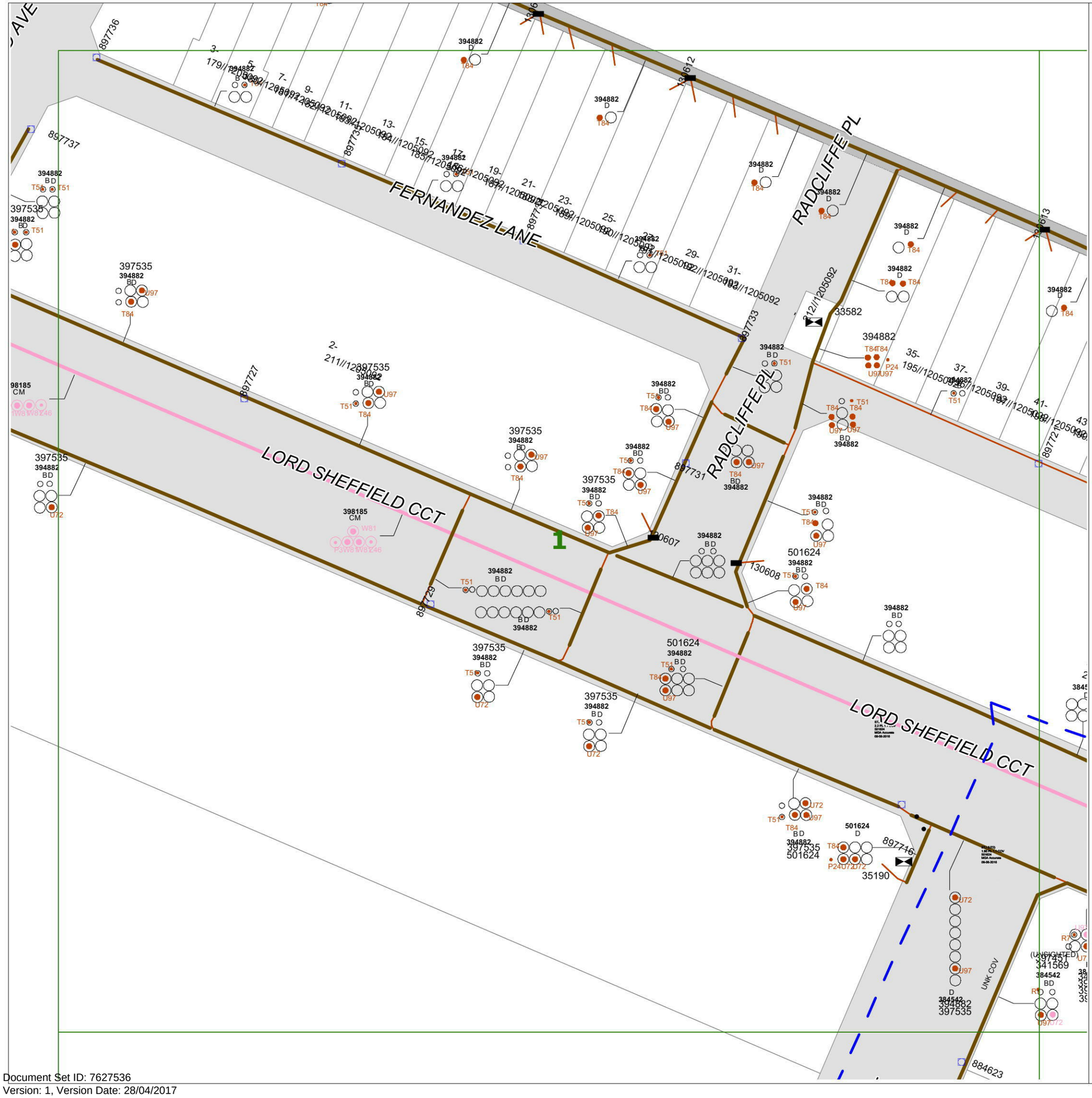

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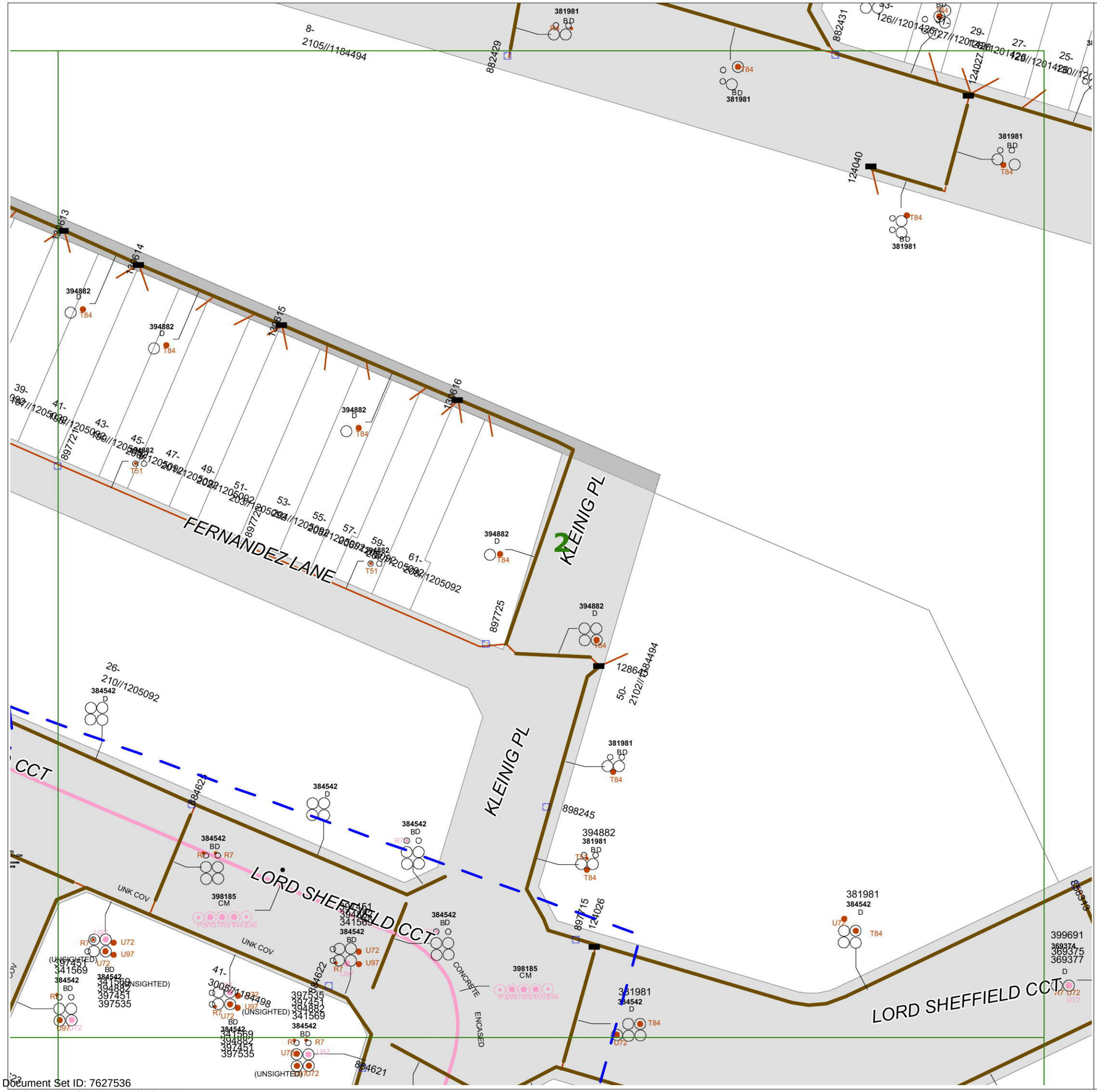

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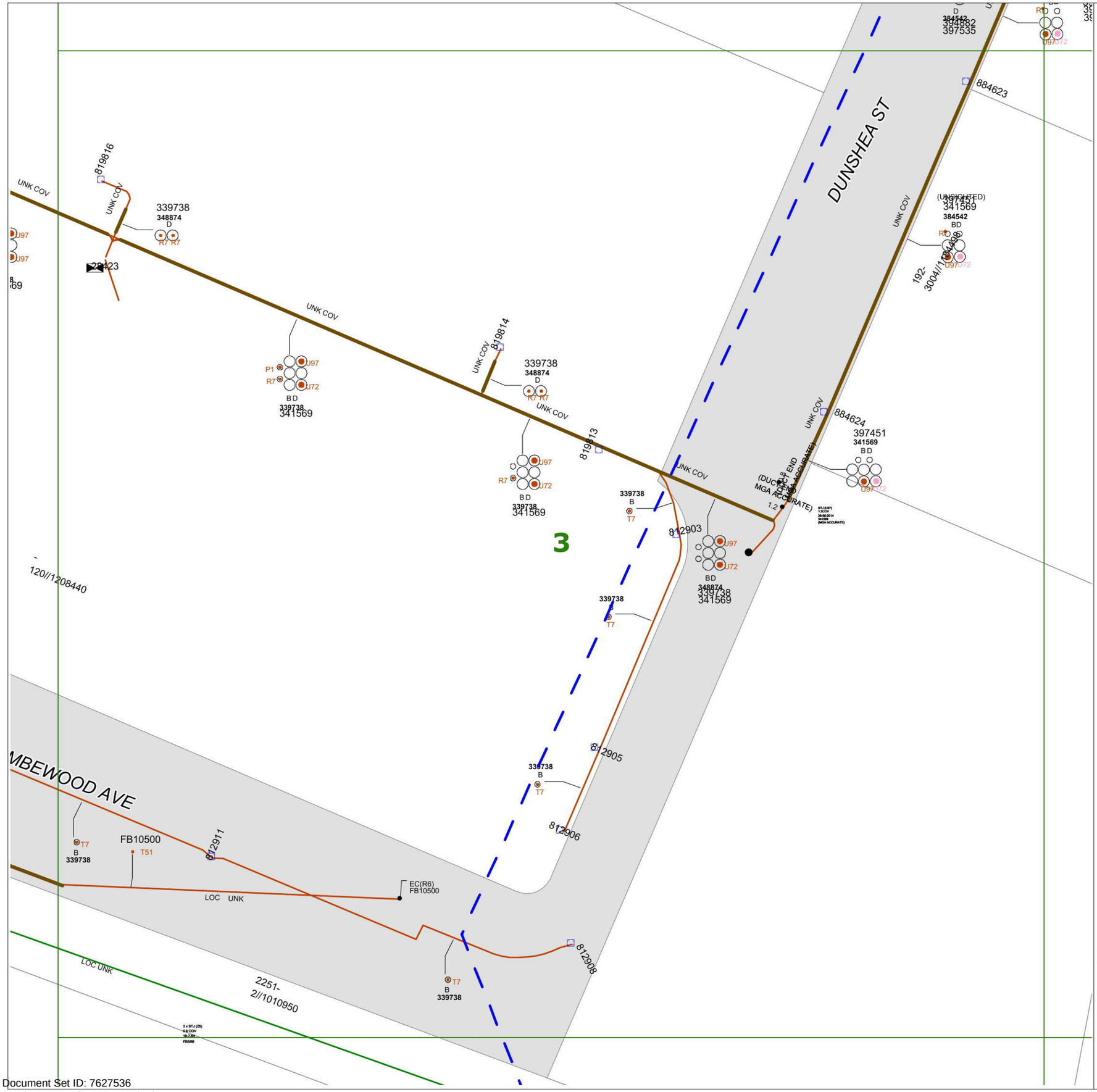

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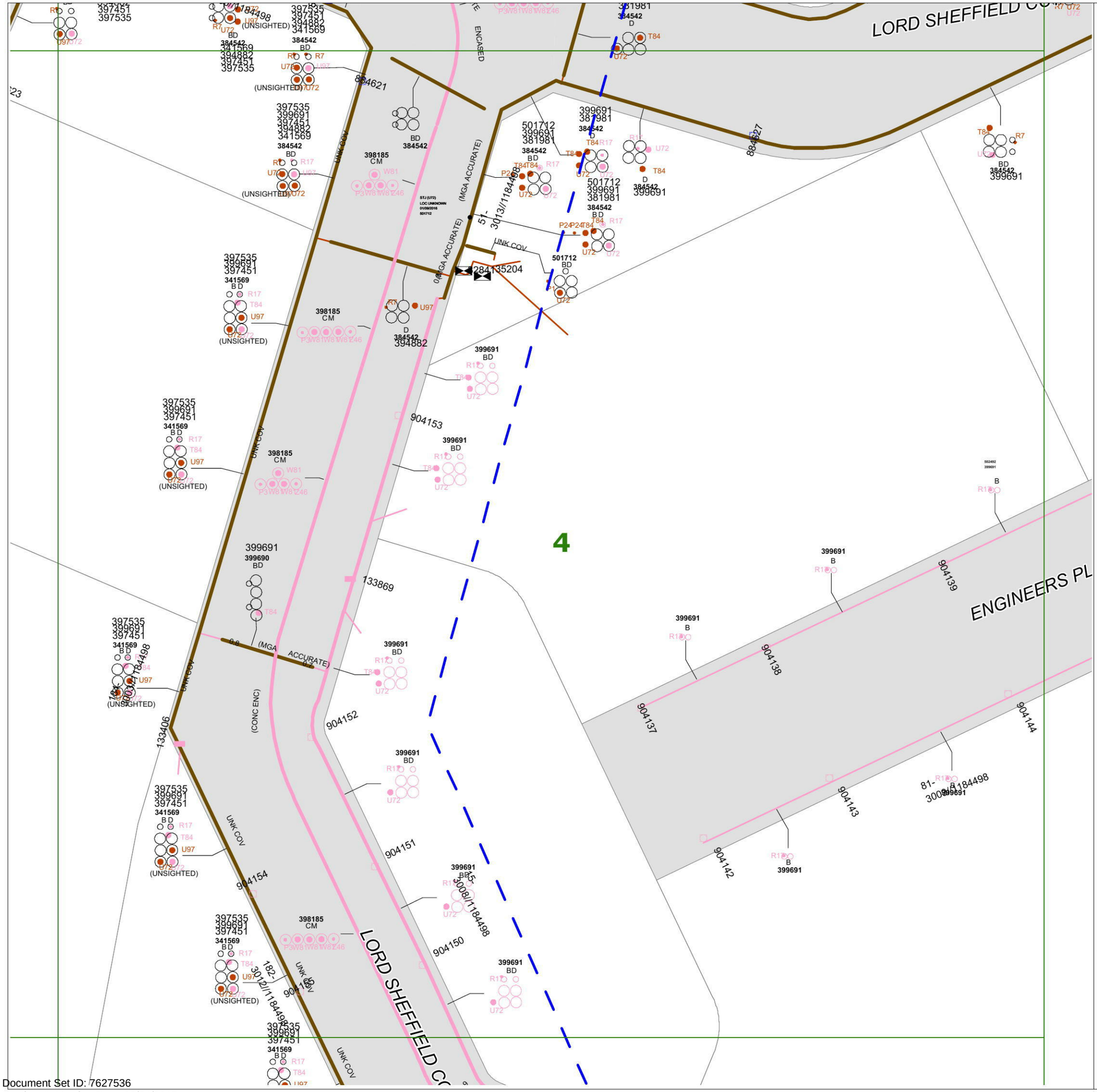

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- The customer must obtain a new set of plans from Endeavour Energy if work has not been started or completed within twenty **(20)** working days of the original plan issue date.
- The customer must contact Endeavour Energy if any of the plans provided have blank pages, as some underground asset information may be incomplete.
- Endeavour Energy underground earth grids may exist and their location **may not** be shown on plans. Persons excavating are expected to exercise all due care, especially in the vicinity of padmount substations, pole mounted substations, pole mounted switches, transmission poles and towers.
- Endeavour Energy plans **do not** show any underground customer service mains or information relating to service mains within private property.
- Asbestos or asbestos-containing material may be present on or near Endeavour Energy's underground assets.
- Organo-Chloride Pesticides (OCP) may be present in some sub-transmission trenches.
- All plans must be printed and made available at the worksite where excavation is to be undertaken. Plans must be reviewed and understood by the crew on site prior to commencing excavation.

INFORMATION PROVIDED BY ENDEAVOUR ENERGY

- Any plans provided pursuant to this service are intended to show the approximate location of underground assets relative to road boundaries, property fences and other structures at the time of installation.
- Depth of underground assets may vary significantly from information provided on plans as a result of changes to road, footpath or surface levels subsequent to installation.
- Such plans have been prepared solely for use by Endeavour Energy staff for design, construction and maintenance purposes.
- All enquiry details and results are kept in a register.

DISCLAIMER

Whilst Endeavour Energy has taken all reasonable steps to ensure that the information contained in the plans is as accurate as possible it will accept no liability for inaccuracies in the information shown on such plans.

WARNING
THIS EXCAVATION IS IN THE VICINITY OF ENDEAVOUR ENERGY TRANSMISSION, PILOT, COMMUNICATION OR FIBRE OPTIC CABLES
PLEASE RING **9853 7121** or **MOB. 0407 468 626**
4 WORKING DAYS BEFORE COMMENCING WORK

LEGEND

- Street light column
- Padmount substation
- Overground pillar (O.G.Box)
- Underground pit
- Duct run
- Cable run
- Typical duct section
- Asbestos warning

N

NOT TO SCALE

DBYD Sequence No.:	59327863
Issued Date:	02/03/2017

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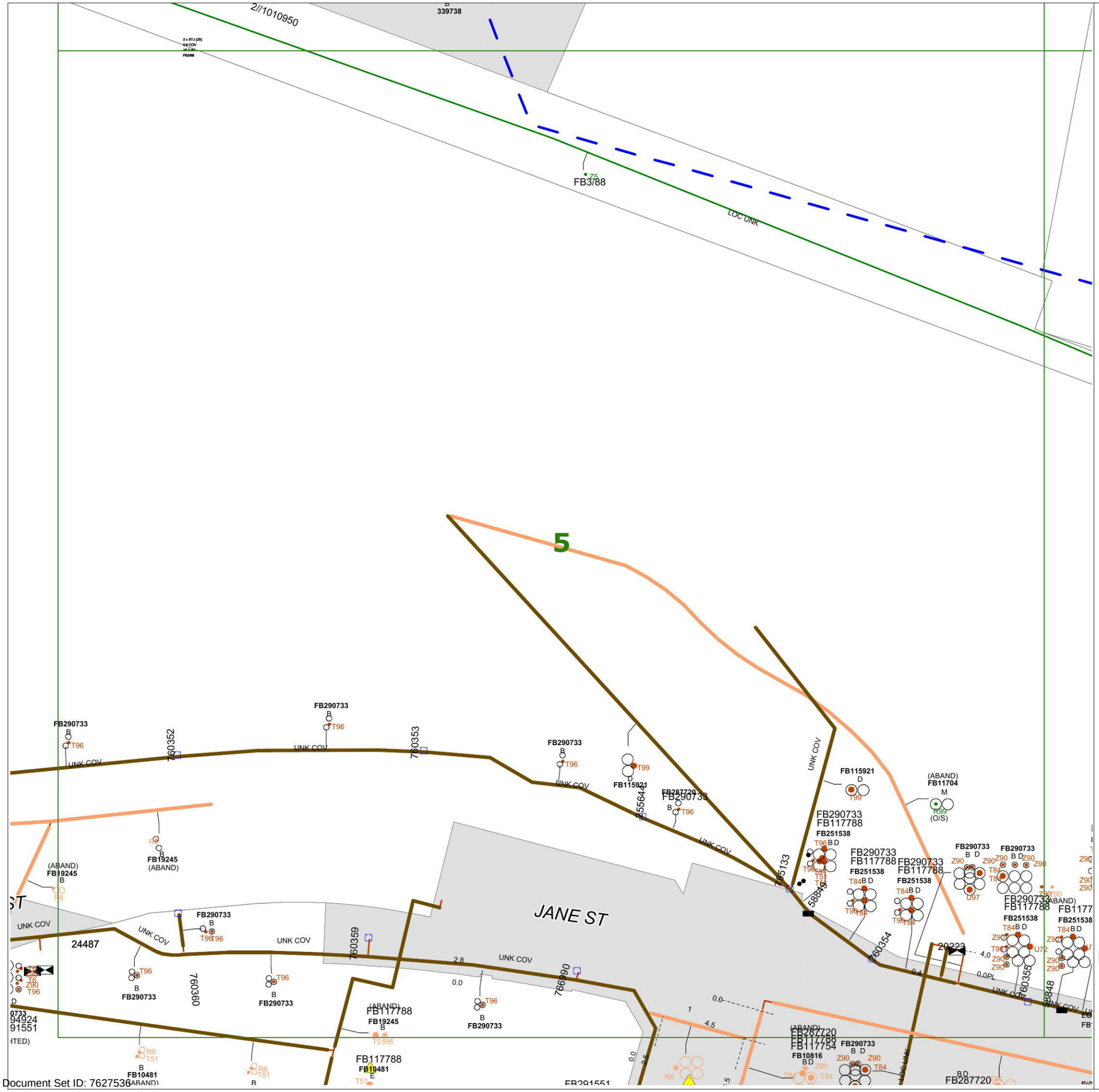

Endeavour Energy

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NOT TO SCALE

DBYD Sequence No.:	59327863
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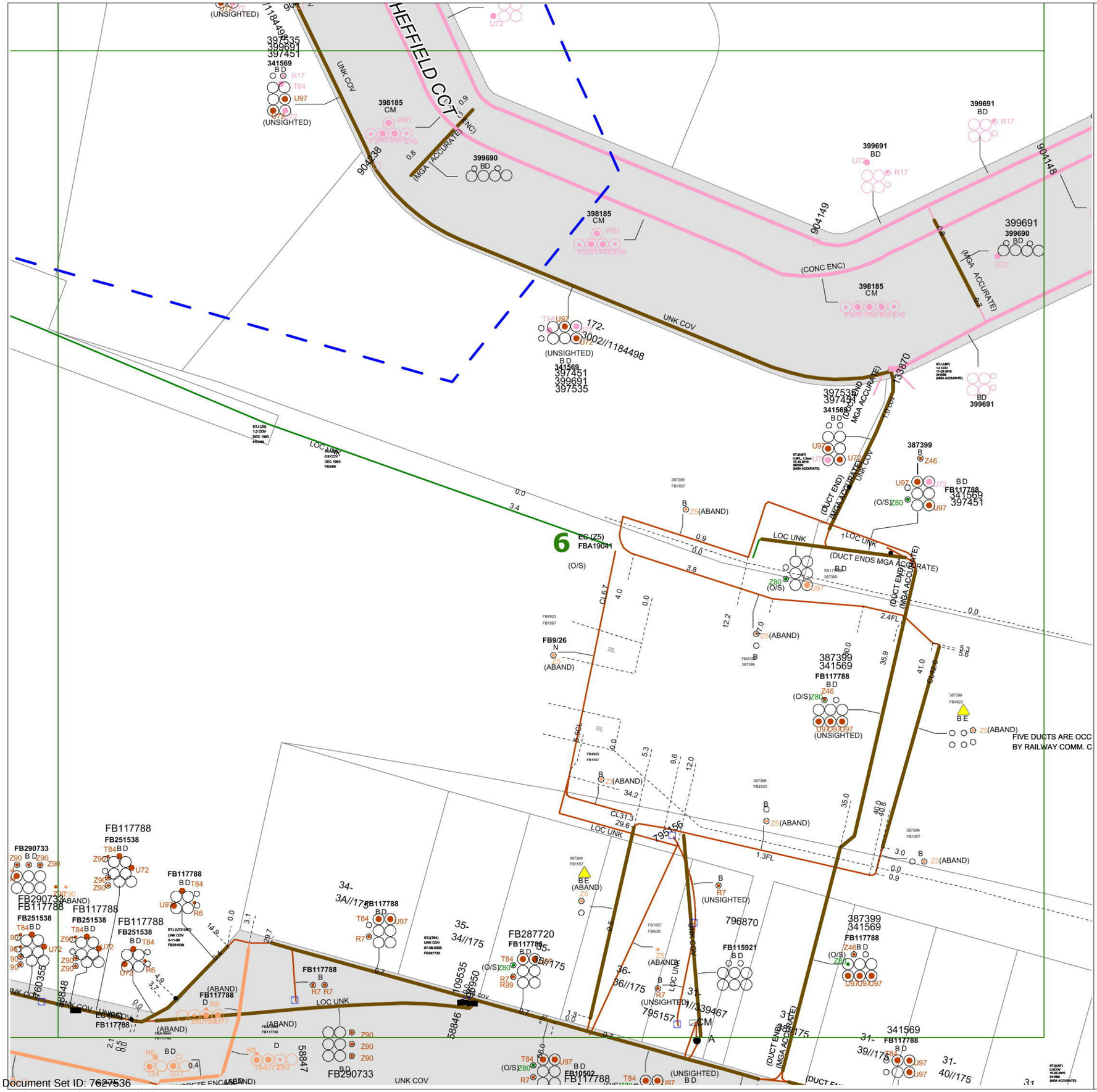
Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017



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N

NOT TO SCALE

DBYD Sequence No.:	59327863
Issued Date:	02/03/2017

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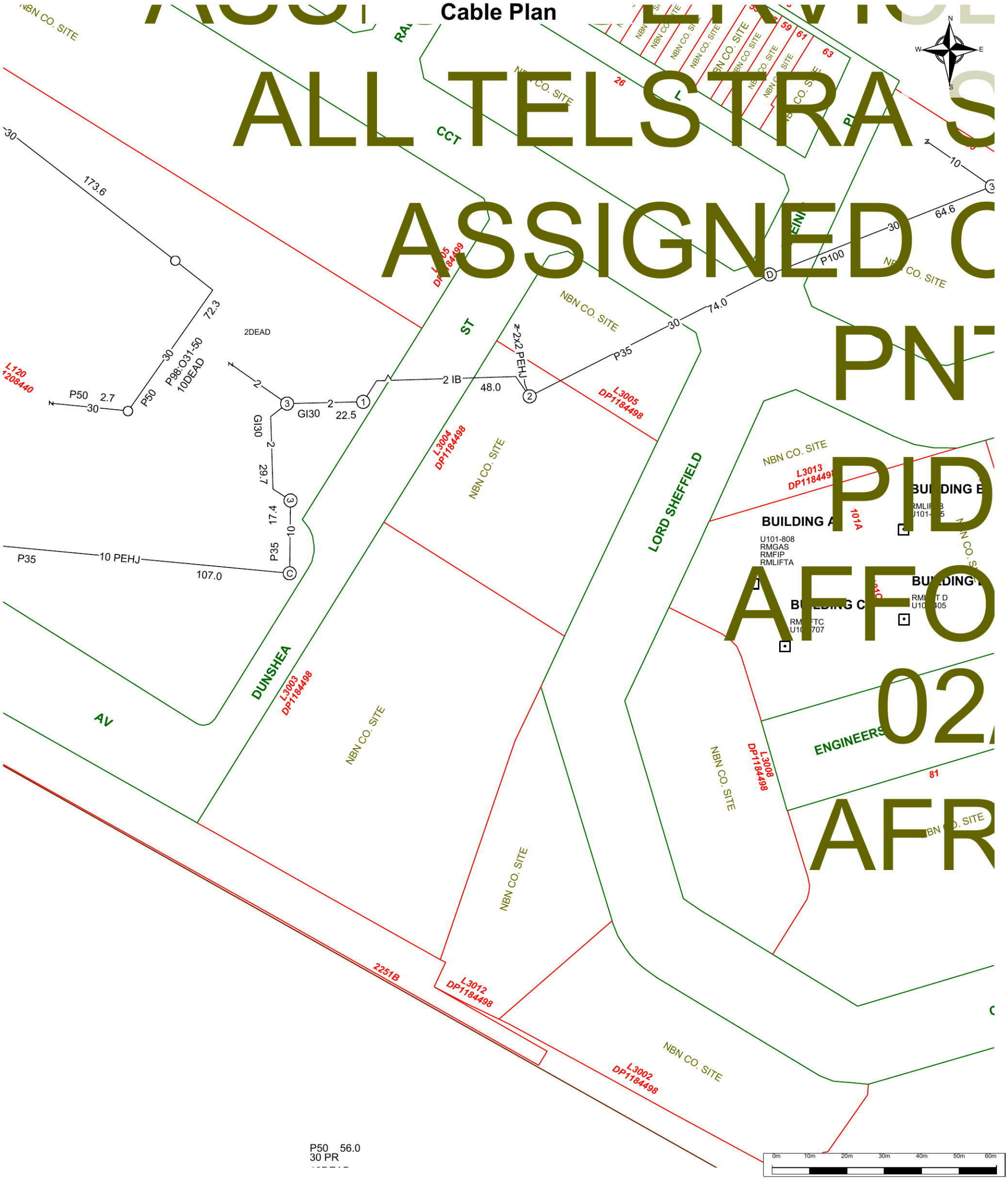
Cable Plan



ALL TELSTRA
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For all Telstra DBYD plan enquiries - email - Telstra.Plans@team.telstra.com For urgent onsite contact only - ph 1800 653 935 (bus hrs)	Sequence Number: 59327864
TELSTRA CORPORATION LIMITED A.C.N. 051 775 556	Please read Duty of Care prior to any excavating
Generated On 02/03/2017 11:10:29	

WARNING - Due to the nature of Telstra underground plant and the age of some cables and records, it is impossible to ascertain the precise location of all Telstra plant from Telstra's plans. The accuracy and/or completeness of the information supplied can not be guaranteed as property boundaries, depths and other natural landscape features may change over time, and accordingly the plans are indicative only. Telstra does not warrant or hold out that its plans are accurate and accepts no responsibility for any inaccuracy shown on the plans.

It is your responsibility to locate Telstra's underground plant by careful hand pot-holing prior to any excavation in the vicinity and to exercise due care during that excavation.

Please read and understand the information supplied in the duty of care statement attached with the Telstra plans. TELSTRA WILL SEEK COMPENSATION FOR LOSS CAUSED BY DAMAGE TO ITS PLANT.

Telstra plans and information supplied are valid for 60 days from the date of issue. If this timeframe has elapsed, please reapply for plans.

If further clarification is required, please contact:
Endeavour Energy
Phone: (02) 9853 4161 (8:00am-4:30pm Mon-Fri)
Emergency Phone Number: 131 003

BEFORE COMMENCING EXCAVATION YOU MUST READ AND UNDERSTAND ALL INFORMATION PROVIDED IN THE DBYD RESPONSE AND LISTED BELOW

BACKGROUND

Endeavour Energy is able to make available plans of its underground assets to persons who intend to undertake excavation works in Endeavour Energy's distribution area. Any plans provided to you are made available subject to the provisions set out below, in the provided plans, and in the Endeavour Energy DBYD response Cover Letter.

We have set out below important information regarding the recommended procedures that should be followed when using this service and also the extent of our responsibility in respect of any plans provided. It is very important that you read and understand all the information and disclaimers provided below before excavating.

Information Provided by Endeavour Energy:

- Any plans provided pursuant to this service are intended to show the approximate location of underground assets relative to road boundaries, property fences and other structures at the time of installation.
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DISCLAIMER

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CUSTOMER REQUESTS AND RESPONSIBILITIES

- Endeavour Energy expects to be able to provide relevant plans within 48 hours after a request is made.
- If the enquiry falls within the Transmission Mains area, additional notification requirements shall be complied with as per the instructions in the response Cover Letter.
- Endeavour Energy retains copyright over all plans and details provided in response to a customer's request.
- Persons excavating are expected to exercise all due care in the vicinity where underground assets are indicated and will be held responsible for any damage to any underground assets (including any Endeavour Energy property) or any other loss caused (including consequential losses) as a result of such excavations.
- All underground assets should be visually located by soft digging (pot holing) or hand digging.
- A person who undertakes excavation work is subject to duties and responsibilities under the *Work Health and Safety Act 2011* and *Work Health and Safety Regulation 2011*. Please refer to the Work Cover NSW "*Work near underground assets: Guide*" and "*Excavation work: Code of practice*" which contain practical advice for working near underground utility services.
- Any damage to Endeavour Energy's assets must be immediately reported on **131 003**.
- In all cases of electric shock or suspected electric shock the victim shall immediately be transported to hospital or medical centre for treatment.
- If conduit material cannot be identified, it should be assumed to contain asbestos material.
- Endeavour Energy plans are frequently updated to record changes to underground assets. All plans are valid for **20** working days from the date of issue.

If further clarification is required, please contact:
Endeavour Energy
Phone: (02) 9853 4161 (8:00am-4:30pm Mon-Fri)
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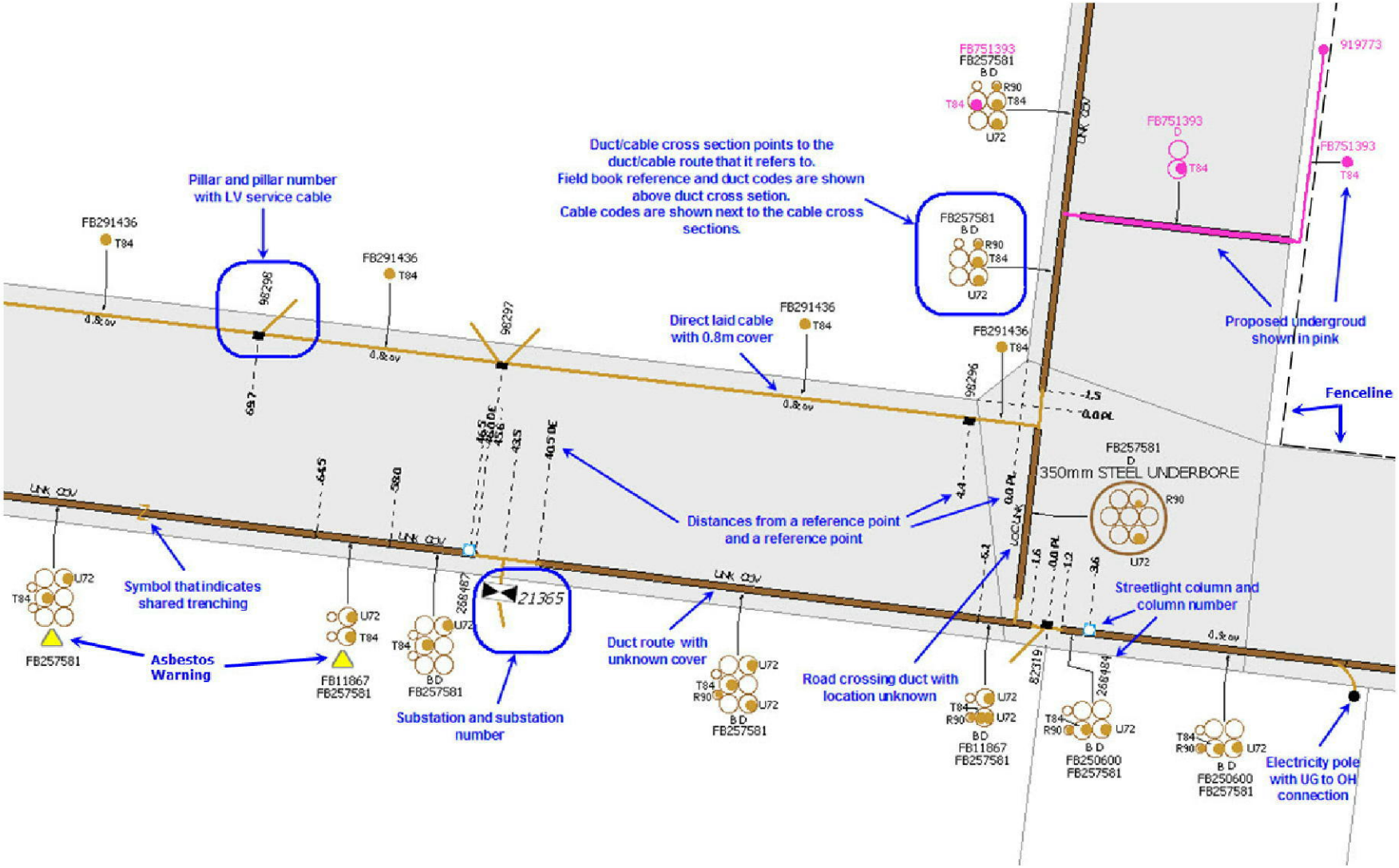
EXAMPLE OF HOW TO READ ENDEAVOUR ENERGY PLANS



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Endeavour Energy
Phone: (02) 9853 4161 (8:00am-4:30pm Mon-Fri)
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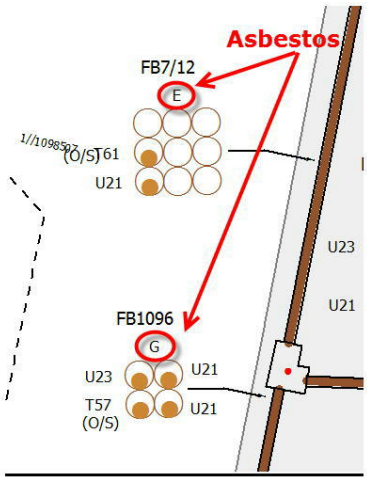
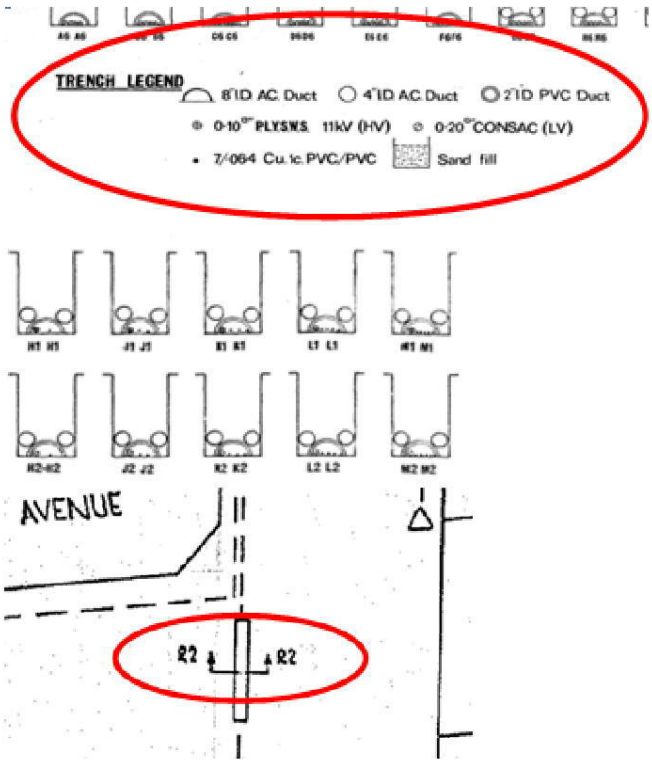
IDENTIFYING ASBESTOS DUCTS

1. Duct codes **E, F** and **G** identify Fibro Conduits

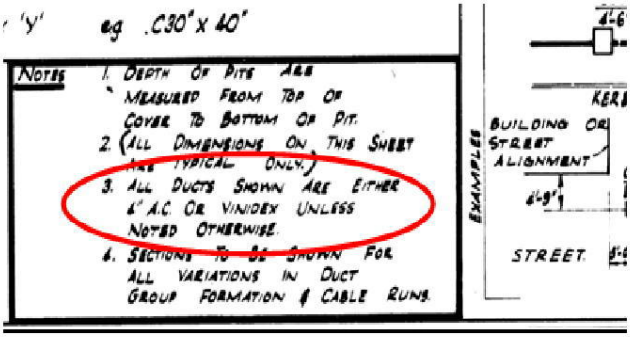


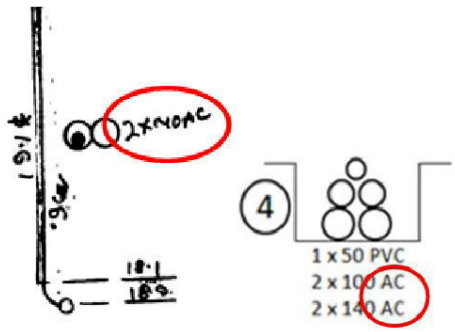
2. The duct codes **G,H,J,K,L,M Q,R,S,T,U,V,W & X** under each configuration are used on old Blue Mountains drawings to identify Asbestos



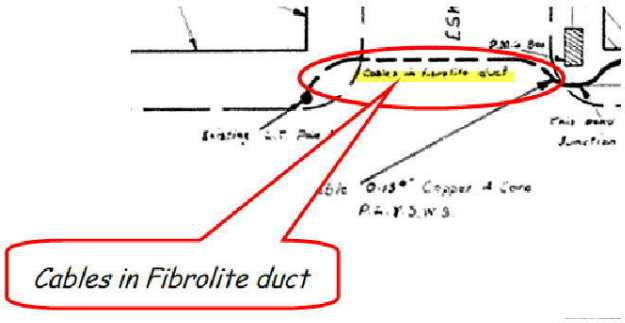
If underground details have not been captured and drawings are used, the method for identifying asbestos ducts and standards are different for the different utilities that amalgamated with Endeavour Energy. Using Reticulation Drawings, there are numerous ways to determine if a duct route has asbestos ducts, refer to following examples:

3. **AC** (Asbestos Cement) acronym





4. **Fibrolite** (asbestos) ducts



5. Yellow **triangle** identifies Fibro Conduits

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Endeavour Energy
Phone: (02) 9853 4161 (8:00am-4:30pm Mon-Fri)
Emergency Phone Number: 131 003

STANDARD UNDERGROUND SYMBOLS / LABELS

NOTE: *If symbology has not been provided on the plan use symbols as shown below.*

SYMBOLS & ACRONYMS

- or — Street light column
- Padmount substation
- or — Overground pillar (O.G.Box)
- Underground pit
- Duct run
- Cable run
- Typical duct section
- Typical underbore section
- Blocked duct
- Cable section
- Asbestos warning
- STJ, PBJ, TTJ
- **STJ** Straight through joint
- **PBJ** Parallel branch joint
- **TTJ** Transition through joint
- Underground to overhead pole
- **SL** Streetlight conductor
- **SC** Service cable
- **SE** Cable sealed end
- **SF** Service Feeder
- **OS** Out of Service
- **O.A.M.** Over awning main
- **U.A.M.** Under awning main
- **N.I.S.** Not in service
- Fence/dimensioning
- Shared trenching
- Service point of attachment

DUCT CODE LABLES

B = 50 mm PVC

D = 125mm PVC

E = 100mm Fibro Conduit (Asbestos)

F = 140mm Fibro Conduit (Asbestos)

G = 150mm Fibro Conduit (Asbestos)

DEPTH & LOCATION LABELS

0.5- 0.7 COV = 0.5m – 0.7m

0.9 COV = 0.9m Depth

UNK COV = Depth Unknown

LOC UNK = Location Unknown

0.9 PL = Located 0.9m from Property Line

Guide to reading Sydney Water DBYD Plans

February 2015

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Asset Information

Legend

Sewer

- Sewer Main (with flow arrow & size type text) — 225 PVC
- Disused Main
- Rising Main
- Maintenance Hole (with upstream depth to invert) — 1.7
- Sub-surface chamber
- Maintenance Hole with Overflow chamber
- Ventshalft EDUCT — VSE
- Ventshaft INDUCT — VS
- Property Connection Point (with chainage to downstream MH) — 10.8
- Concrete Encased Section — Concrete Encased
- Terminal Maintenance Shaft — TMS
- Maintenance Shaft — MS
- Rodding Point — RP
- Lamphole
- Vertical — VENT
- Pumping Station — SP0882
- Sewer Rehabilitation

Pressure Sewer

- Pressure Sewer Main
- Pump Unit (Alarm, Electrical Cable, Pump Unit) — A
- Property Valve Boundary Assembly
- Stop Valve
- Reducer / Taper
- Flushing Point — FP

Vacuum Sewer

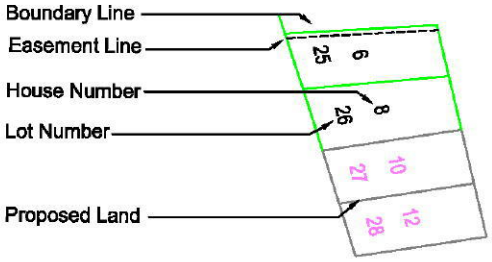
- Pressure Sewer Main
- Division Valve
- Vacuum Chamber
- Clean Out Point

Stormwater

- Stormwater Pipe
- Stormwater Channel
- Stormwater Gully
- Stormwater Maintenance Hole

Property Details

- Boundary Line
- Easement Line
- House Number
- Lot Number
- Proposed Land



- Sydney Water Heritage Site (please call **132 092** and ask for the **Heritage Unit**)

Water

- WaterMain - Potable (with size type text) — 200 PVC
- Disconnected Main - Potable
- Proposed Main - Potable
- Water Main - Recycled
- Special Supply Conditions - Potable
- Special Supply Conditions - Recycled
- Restrained Joints - Potable
- Restrained Joints - Recycled
- Hydrant
- Maintenance Hole
- Stop Valve
- Stop Vale with By-pass
- Stop Valve with Tapers
- Closed Stop Valve
- Air Valve
- Valve
- Scour
- Reducer / Taper
- Vertical Bends
- Reservoir
- Recycled Water is shown as per Potable above. Colour as indicated

Private Mains

- Potable Water Main
- Recycled Water Main
- Sewer Main
- Symbols for Private Mains shown grey

Asset Information

Pipe Types

ABS	Acrylonitrile Butadiene Styrene	**AC**	Asbestos Cement
BRICK	Brick	**CI**	Cast Iron
CICL	Cast Iron Cement Lined	**CONC**	Concrete
COPPER	Copper	**DI**	Ductile Iron
DICL	Ductile Iron Cement (mortar) Lined	**DIPL**	Ductile Iron Polymeric Lined
EW	Earthenware	**FIBG**	Fibreglass
FL BAR	Forged Locking Bar	**GI**	Galvanised Iron
GRP	Glass Reinforced Plastics	**HDPE**	High Density Polyethylene
MS	Mild Steel	**MSCL**	Mild Steel Cement Lined
PE	Polyethylene	**PC**	Polymer Concrete
PP	Polypropylene	**PVC**	Polyvinylchloride
PVC - M	Polyvinylchloride, Modified	**PVC - O**	Polyvinylchloride, Oriented
PVC - U	Polyvinylchloride, Unplasticised	**RC**	Reinforced Concrete
RC-PL	Reinforced Concrete Plastics Lined	**S**	Steel
SCL	Steel Cement (mortar) Lined	**SCL IBL**	Steel Cement Lined Internal Bitumen Lined
SGW	Salt Glazed Ware	**SPL**	Steel Polymeric Lined
SS	Stainless Steel	**STONE**	Stone
VC	Vitrified Clay	**WI**	Wrought Iron
WS	Woodstave		

Further Information

Please consult the Dial Before You Dig enquiries page on the Sydney Water website

For general enquiries please call the Customer Contact Centre on **132 092**

In an emergency, or to notify Sydney Water of damage or threats to its structures, call 13 20 90 (24 hours, 7 days)

Document Set ID: 7627526
Version: 1, Version Date: 28/04/2017

IMPORTANT INFORMATION - DIAL BEFORE YOU DIG

Attention: You must read the information below

The material provided or made available to you by Sydney Water (including on the Sydney Water website) in relation to your Dial Before You Dig enquiry (**Information**) is provided on each of the following conditions, which you are taken to have accepted by using the Information:

1 The Information has been generated by an automated system based on the area highlighted in the "Locality Indication Only" window on your Caller Confirmation. It is your responsibility to ensure that the dig site is properly defined when submitting your Dial Before You Dig enquiry and, if the Information does not match the dig site, to resubmit your enquiry for the correct dig site.

2 Neither Sydney Water nor Dial Before You Dig make any representation or give any guarantee, warranty or undertaking (express or implied) as to the currency, accuracy, completeness, effectiveness or reliability of the Information. The Information, including Sydney Water plans and work-as-executed diagrams, amongst other things:

(a) may not show all existing structures, including Sydney Water's pipelines, particularly in relation to newer developments and in relation to structures owned by parties who do not participate in the Dial Before You Dig service;

(b) may be out of date and not show changes to surface levels, road alignments, fences, buildings and the like;

(c) is approximate only and is therefore not suitable for scaling purposes; and

(d) does not show locations of property services (often called house service lines) belonging to or servicing individual customers, which are usually connected to Sydney Water's structures.

3 You are responsible for, amongst other things:

(a) exposing underground structures, including Sydney Water's pipelines, by pot-holing using hand-held tools or vacuum techniques so as to determine the precise location and extent of structures before any mechanical means of excavation are used;

(b) the safe and proper excavation of and for underground works and structures, including having regard to the fact that asbestos cement pipelines, which can pose a risk to health, may form part of Sydney Water's water and sewerage reticulation systems;

(c) protecting underground structures, including Sydney Water's pipelines, from damage and interference;

(d) maintaining minimum clearances between Sydney Water's structures and structures belonging to others;

(e) ensuring that backfilling of excavation work in the vicinity of Sydney Water's structures complies with Sydney Water's standards contained on its website or otherwise communicated to you;

(f) notifying Sydney Water immediately of any damage caused or threat of damage to Sydney Water's structures;

(g) ensuring that plans are approved by Sydney Water (usually signified by stamping) prior to landscaping or building over or in the vicinity of any Sydney Water structure; and

(h) ensuring that the Information is used only for the purposes for which Sydney Water and Dial Before You Dig intended.

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Version: 1, Version Date: 28/04/2017

4 You acknowledge that you use the Information at your own risk. In consideration for the provision of the Dial Before You Dig service and the Information by Sydney Water and Dial Before You Dig, to the fullest extent permitted by law:

(a) all conditions and guarantees concerning the Information (whether as to quality, outcome, fitness, care, skill or otherwise) expressed or implied by statute, common law, equity, trade, custom or usage or otherwise are expressly excluded and to the extent that those statutory guarantees cannot be excluded, the liability of Sydney Water and Dial Before You Dig to you is limited to either of the following as nominated by Sydney Water in its discretion, which you agree is your only remedy:

(i) the supplying of the Information again; or

(ii) payment of the cost of having the Information supplied again;

(b) in no event will Sydney Water or Dial Before You Dig be liable for, and you release Sydney Water and Dial Before You Dig from, any Loss arising from or in connection with the Information, including the use of or inability to use the Information and delay in the provision of the Information:

(i) whether arising under statute or in contract, tort or any other legal doctrine, including any negligent act, omission or default (including wilful default) by Sydney Water or Dial Before You Dig; and

(ii) regardless of whether Sydney Water or Dial Before You Dig are or ought to have been aware of, or advised of, the possibility of such loss, costs or damages;

(c) you will indemnify Sydney Water and Dial Before You Dig against any Loss arising from or in connection with Sydney Water providing incorrect or incomplete information to you in connection with the Dial Before You Dig service; and

(d) you assume all risks associated with the use of the Dial Before You Dig and Sydney Water websites, including risk to your computer, software or data being damaged by any virus, and you release and discharge Sydney Water and Dial Before You Dig from all Loss which might arise in respect of your use of the websites.

5 "**Sydney Water**" means Sydney Water Corporation and its employees, agents, representatives and contractors. "**Dial Before You Dig**" means Dial Before You Dig Incorporated and its employees, agents, representatives and contractors. References to "**you**" include references to your employees, agents, representatives, contractors and anyone else using the Information. References to "**Loss**" include any loss, cost, expense, claim, liability or damage (including arising in connection with personal injury, death or any damage to or loss of property and economic or consequential loss, lost profits, loss of revenue, loss of management time, opportunity costs or special damages). To the extent of any inconsistency, the conditions in this document will prevail over any other information provided to you by Sydney Water and Dial Before You Dig.

In an emergency, or to notify Sydney Water of damage or threats to its structures, call 13 20 90 (24 hours, 7 days)

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Further information and guidance is available in the Building Development and Plumbing section of Sydney Water's website at www.sydneywater.com.au, where you will find the following documents under 'Dial Before You Dig':

- Avoid Damaging Water and Sewer Pipelines
- Water Main Symbols
- Depths of Mains
- Guidelines for Building Over/Adjacent to Sydney Water Assets
- Clearances Between Underground Services

Or call **13 20 92** for Customer Enquires.

Note: The lodging of enquiries via **www.1100.com.au** will enable you to receive colour plans in PDF format 24 hours a day, 7 days a week via email.

This communication is confidential. If you are not the intended recipient, please destroy all copies immediately. Sydney Water Corporation prohibits unauthorised copying or distribution of this communication.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

A3

DBYD Address:
n/a Lord Sheffield Circuit
Penrith NSW 2750

DBYD Job No: 11955631

DBYD Sequence No: 59327866

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SYDNEY WATER CORPORATION

Scale: 1:1500

Date of Production: 02/03/2017

Plan 1 of 1

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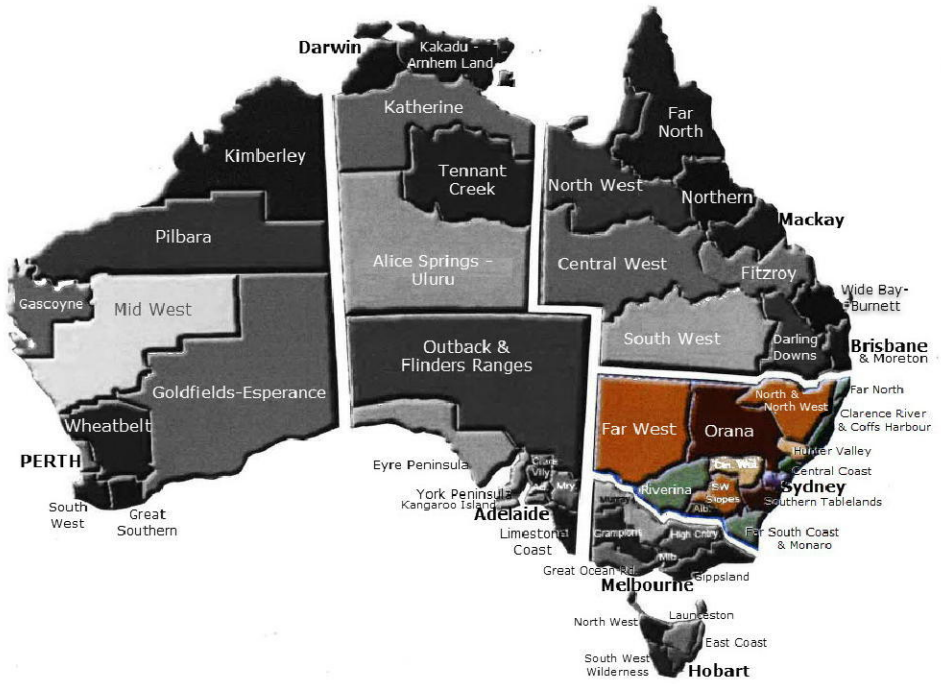
Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017



TELSTRA ACCREDITED PLANT LOCATORS – NEW SOUTH WALES. CENTRAL REGION

Region NSW Central

Telstra plans are intended to be indicative only. A plant location service (Telstra accredited) is required to identify the exact location of the plant and ensure that the asset is protected during construction work. It is your responsibility as part of your "Duty of Care" to engage an Accredited Plant Locator.

***Optic fibre cable locations** must be performed by a locator with Telstra optic fibre location accreditation.

Locators with Telstra optic fibre cable location accreditation are indicated by either a 'yes' in the 'Fibre' column or the DBYD Certified Locator Symbol.

DIAL BEFORE YOU DIG CERTIFIED LOCATOR

Please contact a Telstra accredited locator from the pages following (fees apply).

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Telstra Accredited Plant Locators – New South Wales. CENTRAL

NSW Central.

Company Name & service areas	*Fibre	Contact	
Abitek Pty Ltd		02 4580 9883 0413 327 243 02 4580 9884 abitek@bigpond.com	Phone Mobile Fax Email Web
Action Locating Sydney, Newcastle, Wollongong	YES	02 9671 5600 0415 228 466 info@actionlocating.com.au	Phone Mobile Fax Email Web
Advanced Ground Locations Newcastle, Hunter Valley, Central Coast		02 4930 3195 0412 497 488 02 4930 3222 steve_agl@hotmail.com www.advancedgroundlocations.com	Phone Mobile Fax Email Web
All About Pipes All of NSW	YES	1300 634 200 0408 790 010 02 9606 2325 work@allaboutpipes.com.au www.allaboutpipes.com.au	Phone Mobile Fax Email Web
Aquabend Utility Detection Central Coast, Upper Hunter, Hunter Valley, Mid North Coast and surrounding areas.	YES	0488 925 432 aquabend@hotmail.com	Phone Mobile Fax Email Web
ATTAIN Solutions Campbeltown, Tahmoor, Camden, Narellan, Castle Hill, Kellyville, Blacktown, Rouse Hill, Penrith, Liverpool and surrounding areas.	YES	1300 294 969 0438 922 200 brad@attain.com.au www.attain.com.au	Phone Mobile Fax Email Web
Australian Locating Services Pty Ltd All of ACT & NSW		1300 761 545 0412 227 434 02 9531 2169 admin@locating.com.au www.locating.com.au	Phone Mobile Fax Email Web
Australian Subsurface Pty Ltd All of ACT & NSW		0427 879 600 admin@australiansubsurface.com www.australiansubsurface.com	Phone Mobile Fax Email Web
Australian Underground Utility Locations Eurobodalla Shire, Bega Valley Shire, Snowy River Shire, Batemans Bay to Vic border, Far South Coast NSW		0418 329 370 moceanfabrications@gmail.com www.auul.com.au	Phone Mobile Fax Email Web
Australian Utilities Management Pty Ltd		0424 537 952 bookings@ausutuilities.net.au www.ausutilities.net.au	Phone Mobile Fax Email Web
Bradmac Locating Services Pty Ltd Sydney Metro, Bathurst, Lithgow, Mudgee, Mittagong, Campbeltown		0434 157 409 brad.mac@bigpond.com	Phone Mobile Fax Email Web
Brandon Construction Services Pty Ltd Sydney metro & surrounding districts, other country NSW areas on request		0438 044 008 liam.bolger@hotmail.com	Phone Mobile Fax Email Web
Cardno ACT Sydney, Wollongong, Nowra, Newcastle, Central Coast and Coffs Harbour		1300 224 664 02 8783 8492 cardnoaus@cardno.com.au	Phone Mobile Fax Email Web

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Telstra Accredited Plant Locators – New South Wales. CENTRAL

Chris Bates & Associates Mid North Coast, Newcastle, Hunter Valley and Central Coast		02 4928 1519 0408 427 391 chrisbatesandassociates@yahoo.com.au	Phone Mobile Fax Email
Coastal Cable Locators Pty Ltd Wollongong to Eden, Braidwood, Bungendore, Goulburn		02 4457 1258 0427 975 777 02 4457 1258 skomalley@bigpond.com	Phone Mobile Fax Email Web
Down Under Detection Services		02 9371 7744 downunderdetections@bigpond.com	Phone Mobile Fax Email
Down Under Pipeline Surveys Pty Ltd	NO	02 4653 1286 0418 675 374 02 4653 1747 office@dups.com.au www.dups.com.au	Phone Mobile Fax Email Web
Durkin Construction Pty Ltd All Areas		02 9712 0308 0452 202 212 02 9647 1984 info@durkinconstruction.com.au www.durkinconstruction.com.au	Phone Mobile Fax Email Web
Dynamic Excavations Brisbane, Gold Coast, Toowoomba, Sunshine Coast, Northern NSW, Ballina, Sydney and surrounding districts		07 5564 8142 0418 596 066 marco@dynamicexcavations.com.au www.dynamicexcavations.com.au	Phone Mobile Email Web
Electrostar NSW North West including Tablelands (Armidale, Glenn Innes) Hunter Valley, Newcastle to Grafton	YES	0429 620 999 0428 658 707 02 6762 0213 admin@electrostar.com.au www.electrostar.com.au	Phone Mobile Fax Email Web
Epoca Environmental Pty Ltd Sydney Metro, All of NSW & ACT	YES	02 4739 2465 0430 606 948 evelyn@epocaenvironmental.com.au www.epocaenvironmental.com.au	Phone Mobile Fax Email Web
G B Geotechnics (Australia) Pty Ltd All areas of New South Wales	NO	02 9890 2122 0403 153 651 jamie@gbgoz.com.au	Phone Mobile Fax Email Web
G MAC LOCATING Dubbo, Young, Wagga, Yass, Goulburn, Bathurst, Orange, Temora, West Wyalong & most NSW country regions		0488 520 482 0408 822 428 enquiries@gmaclocating.com.au	Phone Mobile Fax Email Web
Geoscope Utility Detection Services Pty Ltd Sydney areas and parts of NSW		0432 296 323 info@geoscopelocating.com.au www.geoscopelocating.com.au	Phone Mobile Fax Email Web
Geotrace Pty Ltd All Areas, Hills District, Sydney, Wollongong, Newcastle, ACT, Sutherland, Bankstown, Richmond, Burwood, Rose Bay, Balmain		02 8824 6654 0417 147 945 02 8824 5637 info@geotrace.com.au www.geotrace.com.au	Phone Mobile Fax Email Web
Ground Scan Locating Cenral West and surrounding districts		0414 640 640 02 6332 2599 gscan1@bigpond.com	Phone Mobile Fax Email Web
Hunter Ground Search Central Coast, Newcastle, Hunter Valley, Mid North Coast and west to Tamworth, Liverpool Plains and Dubbo.		02 4953 1244 0418 684 819 02 4953 1233 huntergroundsearch@bigpond.com	Phone Mobile Fax Email Web

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Telstra Accredited Plant Locators – New South Wales. CENTRAL

Hunter Smith Management Pty Ltd NSW & ACT	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	02 8090 2695 0422 224 761 hntersmith@iprimus.com.au www.hsmlocating.com.au	Phone Mobile Fax Email Web
Hydro Digga All of NSW, ACT & South East Qld	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	0447 774 000 locator@hydrodigga.com	Phone Mobile Fax Email Web
Landmark Surveys Pty Ltd Southern NSW and ACT areas	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	02 6280 9608 0413 832 038 phil@landmarksurveys.com.au www.landmarksurveys.com.au	Phone Mobile Fax Email Web
Laneyrie Electrical Pty Ltd Helensburgh to Ulladulla, Southern Highlands	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	02 4237 9865 0412 079 079 02 4237 9939 bindy@laneyrieelectrical.com.au www.laneyrieelectrical.com.au	Phone Mobile Fax Email Web
Locate & Map Pty Ltd Sydney, Wollongong and the Central Coast	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	0431 191 669 tim@locateandmap.com.au www.locateandmap.com.au	Phone Mobile Fax Email Web
Locaters Pty Ltd Sydney, Penrith, Richmond, Macarthur, Wollongong	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	02 8214 8911 info@locaters.com.au www.locaters.com.au	Phone Mobile Fax Email Web
Locating Services Pty Ltd Hawesbury, Canberra and all of NSW.	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	0403 065 510 sam.romano1@outlook.com	Phone Mobile Fax Email Web
Lower Mountains Electrical Blue Mountains, Penrith, Hawksbury, Lithgow and surrounding areas	NO	0414 446 422 info@lowermountainselectrical.com.au	Phone Mobile Fax Email
Lynco Pty Ltd t/as Lyntet Communications Dubbo depot, covering Forbes, Grenfell, Parkes, Bourke, Bourke North, Nyngan, Coonabarabran, Coonamble, Mudgee, Narromine, Wellington, Orange, Molong, Yeoval, Coolah, Dunedoo, Gilgandra, Mendooran	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	0409 811 673 lyntet@bigpond.com.au	Phone Mobile Fax Email Web
Meek Design & Construction Pty Ltd Bathurst, Orange, Lithgow, Oberon and surrounding areas	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	0419 633 483 02 9012 0186 ron@meekdesign.com.au	Phone Mobile Fax Email Web
Mr Mac Group Bathurst, Orange, Yass and Goulburn.	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	0447 818 260 locatemrmac@gmail.com	Phone Mobile Fax Email Web
Newcastle Locating Services Newcastle, Hunter Valley, Upper Hunter Valley, Port Stephens	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	02 4933 5160 0410 698 599 02 4933 5150 afarcas@bigpond.com	Phone Mobile Fax Email Web
On Point Utility Locating Pty Ltd Sydney, Parramatta, Penrith, Wollongong, Central Coast, Highlands, Goulburn, Blue Mountains	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	1300 ON POINT 0405 149 529 info@onpointlocating.com.au www.onpointlocating.com.au	Phone Mobile Fax Email Web
Online Pipe & Cable Locating Pty Ltd Sydney, Newcastle, Canberra, Central Coast, Wollongong, Blue Mountains and Port Macquarie	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	1300 665 384 0418 402 234 02 9676 6127 office@onlinepipe.com.au	Phone Mobile Fax Email Web

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Telstra Accredited Plant Locators – New South Wales. CENTRAL

Optical Fibre Technologies Sutherland, Sydney Metro, All Areas	YES	02 9153 0533 0402 354 322 02 9153 0833 opticaltek@aol.com	Phone Mobile Fax Email Web
Peter Ellsmore and Associates Wollongong, Illawarra, South Coast & Southern Highlands	YES	02 4253 5616 0439 423 708 02 4253 5660 Ian.brown@ellsmore.com.au www.ellsmore.com.au	Phone Mobile Fax Email Web
Pipesure Australia Pty Ltd Sydney and surrounding areas	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	02 9625 9222 02 9625 9200 info@pipesure.com.au	Phone Mobile Fax Email Web
Riverina Cable Location Pty Ltd Wagga Wagga and surrounding areas	YES	02 6931 6565 0428 958 632 desdammefencing@msn.com	Phone Mobile Fax Email Web
RPS Australia East Pty Ltd Sydney regions and surrounding areas	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	02 8270 8300 0437 348 346 02 9248 9810 stanley.tan@rpsgroup.com.au	Phone Mobile Fax Email Web
Rubicof Pty Ltd Gosford, Newcastle, Taree	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	02 4990 5718 0418 683 451 02 4991 2600 rubicof@optusnet.com.au	Phone Mobile Fax Email Web
Rutherford Electrical Engineering Services	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	02 4932 7344 02 4932 5219 kmaher@ruthelect.com.au	Phone Mobile Fax Email Web
Signal Support Services Pty Ltd Goulburn, Southern Highlands, Canberra.	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	02 4821 8334 0418 237 668 ted@signalsupport.com.au	Phone Mobile Fax Email Web
SureSearch NSW = Sydney, Penrith, Richmond, Wollongong, Katoomba, Macarthur, Central Coast, Newcastle Maitland, Hunter Valley, Port Macquarie	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	1300 884 520 0408 221 046 info@suresearch.com.au www.suresearch.com.au	Phone Mobile Fax Email Web
Steger & Associates Registered Land Surveyors NSW & ACT	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	02 6296 4089 02 6296 4090 enquiries@leachsteger.com.au	Phone Mobile Fax Email Web
TR Civils ACT – Southern Tablelands, Goulburn, Snowy Mountains areas	YES	02 6249 6818 0412 479 957 admin@trcivils.com.au	Phone Mobile Fax Email Web
Utility I.D. – Underground Service & Cable Locators All areas Queensland and New South Wales	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	0401 202 515 info@utilityid.com.au www.utilityid.com.au	Phone Mobile Fax Email Web
Utility Locating Services	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	0404 087 555	Phone Mobile Fax Email Web
Utility Mapping (Aust) Pty Ltd Sydney and surrounding areas	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	1300 MAPPING sydney@utilitymapping.com.au www.utilitymapping.com.au	Phone Mobile Fax Email Web

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Telstra Accredited Plant Locators – New South Wales. CENTRAL

Vac Group Operations Pty Ltd t/as Earthspy	DIAL BEFORE YOU DIG CERTIFIED LOCATOR	1300 822 834 0447 466 331 www.vacgroup.com.au	Phone Mobile Fax Email Web
Vertex Power & Process NSW areas – Broken Hill, Menindee, Wilcannia, Ivanhoe & surrounding areas. SA areas – Eastern regions of SA including Olary Mingary & Cockburn.	YES	08 8088 4301 0428 154 450 08 8087 5729 admin@vertexpp.com.au www.vertexpp.com.au	Phone Mobile Fax Email Web

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Network Protection

Assets Affected

In reply to your enquiry, there are gas mains at the location of your intended work as per the attached map. For an explanation of the map, please see the key below. The following excavation guidelines apply.

Excavation Guidelines:

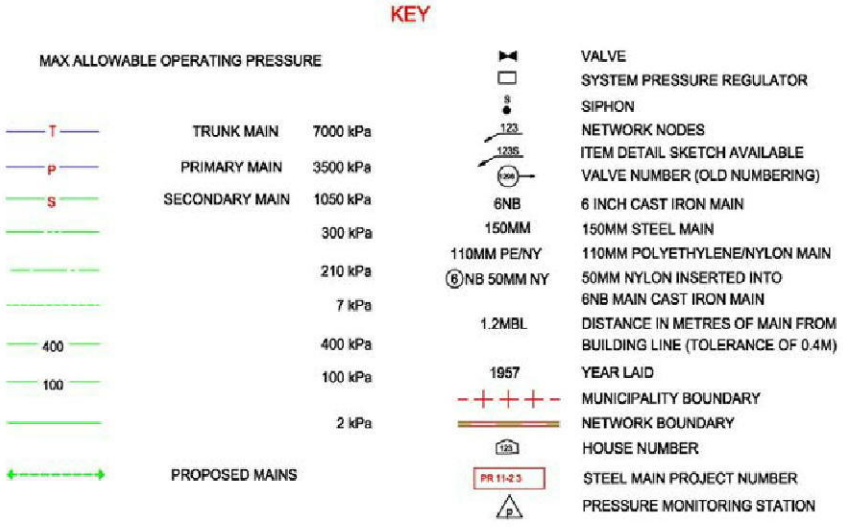
It is essential the location of gas pipe/s are confirmed by carefully pot-holing by hand excavation prior to proceeding with mechanical excavation in the vicinity of gas pipes. If you cannot locate the gas main, contact the local depot.

In accordance with clause 34(5) of the Gas Supply (Safety and Network Management) Regulation 2013 (NSW), you should be informed that all excavation, (including pot-holing by hand to confirm the location of pipes) should be performed in accordance with "***Work Near Underground Assets Guideline"*** *published in 2007 by the Work Cover Authority.*

A copy of this Guideline is available at: www.workcover.nsw.gov.au

DBYD Administration 1300 880 906

KEY



Warning: The enclosed plans show the position of Jemena Gas Networks (NSW) Ltd's underground gas mains and installations in public gazetted roads only. **Individual customers' services and services belonging to other third parties are not included** on these plans. These plans have been prepared solely for the use of Jemena Gas Networks (NSW) Ltd and Jemena Asset Management Pty Ltd (together "**Jemena**") and any reliance placed on these plans by you is entirely at your own risk. The plans may show the position of underground mains and installations relative to fences, buildings etc., as they existed at the time the mains etc were installed. The plans may not have been updated to take account of any subsequent change in the location or style of those features since the time at which the plans were initially prepared. Jemena makes no warranty as to the accuracy or completeness of the enclosed plans and does not assume any duty of care to you nor any responsibility for the accuracy, adequacy, suitability or completeness of the plans or for any error, omission, lack of detail, transmission failure or corruption in the information provided. Jemena does not accept any responsibility for any loss that you or anyone else may suffer in connection with the provision of these plans, however that loss may arise (including whether or not arising from the negligence of Jemena, its employees, agents, officers or contractors). The recipient of these plans must use their own care and diligence in carrying out their works and must carry out further surveys to locate services at their work site. Persons excavating or carrying out other earthworks will be held responsible for any damage caused to Jemena's underground mains and equipment. In accordance with the Work Near Underground Assets Guideline published in 2007 by Work Cover Authority, Jemena recommends that you carry out potholing by hand to accurately confirm the location of gas mains and installation prior to commencing excavations.

In case of Emergency Phone 131 909 (24 hours)

Admin
1300 880 906

IT'S HOW WE CONNECT

DUTY OF CARE

TELSTRA CORPORATON ACN 051 775 556

IMPORTANT:

When working in the vicinity of telecommunications plant you have a "Duty of Care" that must be observed. Please read and understand all the information and disclaimers provided below.

Telstra network is complex and requires expert knowledge to interpret information, to identify and locate components, to pothole underground assets for validation and to safely work around assets without causing damage. If you are not an expert and/or qualified in these areas then you should not be attempting these activities. Telstra will seek compensation for damages caused to its property and losses caused to Telstra and its customers.

The 4 essential steps that must be undertaken to prevent damage to Telstra assets are listed below. Construction activities must not commence without first undertaking these 4 steps. If your project is dependent on the position of the underground network then it is recommended you validate the position of the network prior to finalising your design.

(The following pages contain more detail on each step below and the contact details to seek further advice. AS5488-2013 is the Australian Standard for the Classification of Subsurface Utility Information.)

1 Dial Before You Dig -Telstra Plans :

The essential first step in preventing damage -

You must have current Telstra plans via the DBYD process. Telstra advises that the accuracy of the information provided by Telstra conforms to Quality Level D as defined in AS5488-2013. This means the information is indicative only, not a precise location. **The actual location may differ substantially from that shown on the plans** - refer to steps 2 & 3 to determine actual location prior to commencing construction.

2 Telstra Accredited Plant Locator :

The essential second step in preventing damage -

To be able to trace and identify individual subsurface cables and ducts requires access to Telstra pits and manholes. Only a Telstra Accredited Plant Locator (TAPL) is authorised to access Telstra network for locating purposes. A TAPL can interpret plans, validate visible assets and access pits and manholes to undertake electronic detection of underground assets prior to further validation. All Telstra assets must be located, validated and protected prior to commencing construction. If you are not authorised to do so by Telstra, you should not be accessing Telstra network or locating Telstra network.

3 Validation :

The essential third step in preventing damage -

All Telstra assets must be positively identified (i.e. validated), by physically sighting them. For underground assets this can be done by potholing by hand or using non-destructive vacuum extraction methods (Refer to 'validation' as defined in AS5488-2013 QL-A). **Underground assets located by electronic detection alone (step 2), are not deemed to be 'validated' and should not be used for construction purposes.** Some TAPL's can assist with non-destructive potholing for validation purposes. **If you cannot validate the Telstra network you should not proceed with construction**. Telstra will seek compensation for damages caused to its property and losses caused to Telstra and its customers.

4 Protection :

The essential fourth step in preventing damage -

Telstra assets must be protected to avoid damage from construction activities. Minimum working distances around Telstra network must be maintained. These distances are provided in this document. Telstra can also provide advice and assistance in regards to protection – refer to the following pages.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

STEP 1 – Dial Before You Dig -Telstra Plans:

The actual location of Telstra assets may differ substantially from that shown on the plans. Telstra does not warrant or hold out that its plans are accurate and accepts no responsibility for the accuracy shown on the plans. Steps 2 and 3 must also be undertaken to determine actual location of network.

- Telstra DBYD plans are not suitable for displaying Telstra network within a Telstra exchange site. For advice on Telstra network within a Telstra exchange site contact Telstra Plan Services.
- Telstra owns and retains the copyright in all plans and details provided in conjunction with the applicant's request. The applicant is authorised to use the plans and details only for the purpose indicated in the applicant's request. The applicant must not use the plans or details for any other purpose.
- Telstra plans or other details are provided only for the use of the applicant, its servants, agents or Telstra Accredited Plant Locators. The applicant may not give the plans or details to any parties other than these, and may not generate profit from commercialising the plans or details.
- Please contact Telstra Plan Services immediately should you locate Telstra assets not indicated on these plans.
- Telstra, its servants or agents shall not be liable for any loss or damage caused or occasioned by the use of plans and or details so supplied to the applicant, its servants and agents, and the applicant agrees to indemnify Telstra against any claim or demand for any such loss or damage.
- Please ensure Telstra plans and information provided remains on-site at all times throughout the inspection, location and construction phase of any works.
- Telstra plans are valid for 60 days after issue and should be replaced if required after the 60 days.

- **Emergency situations - receiving Telstra plans** Telstra's automated mapping system (TAMS) will provide a fast response for emergency situations (faster than an operator can provide manually via a phone call - see below for fast response requirements). Automated responses are normally available 24/7.

  To receive a fast automated response from Telstra your request must **-**

  - Be a web request lodged at DBYD (**www.1100.com.au**). The request will be then forwarded to Telstra.
  - Contain your current email address so you can receive the automated email response.
  - Be for the purposes of 'mechanical excavation' or other ground breaking DBYD activity. (Requests with activity types such as conveyancing, planning & design or other non-digging activities may not be responded to until the next business day).
  - Be for an area less than 350 metres in size to obtain a PDF map (over 350 metres will default to DWF due to size) this does not include congested CBD areas where only DWF may be supplied.
  - Be for an area less than 2500 metres in size to obtain a DWF map (CBD's less)

- **Data Extraction Fees.** In some instances a data extraction fee may be applicable for the supply of Telstra information. Typically a data extraction fee may apply to large projects or requests to be supplied in non-standard formats. For further details contact Telstra Plan Services.

- **Electronic plans - PDF and DWF maps** If you have received Telstra maps via email you will have received the maps as either a PDF file (for smaller areas) or DWF file (for larger area requests). All requests over approximately *350m or in congested CBD areas can only be supplied in DWF format. There are size limits on what can be provided. (* actual size depends on geographic location of requested area). If you are unable to launch any one of the softcopy files for viewing and printing, you may need to download and install one or more of the free viewing and printing products such as Adobe Acrobat Reader (for PDF files) or Autodesk Design Review (for DWF files) available from the internet

  - **Pdf files -** PDF is the default softcopy format for all requests for areas up to approx *350m in length. (*depends on geographic location of request). The PDF file is nominally formatted to A3 portrait sheet however it can be printed on any size sheet that your printer supports, e.g. either as the full sheet or selected areas to suit needs and legibility. (to print a selected area zoom up and print 'current view') If there are multiple layers of Telstra network you may receive up to 2 sheets in the single PDF file attachment supplied. There are three types or layers of network normally recorded - local network, mains cables or a combined layer of local and mains (usually displayed for rural or semi-rural areas). If mains cable network is present in addition to local cables (i.e. as separate layer in a particular area), the mains will be shown on a separate sheet. The mains cable information should be read in conjunction with the local cable information.

  - **DWF files** – DWF is the default softcopy format for all requests for areas that are over 350m in length. Maximum length for a DWF automated response is approx 2500m - depending on geographic

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

location of request (manually-processed plans may provide larger coverage). The DWF files differ from PDF in that DWF are vector files made up of layers that can be turned on or off and are not formatted to a specific sheet size. This makes them ideal for larger areas and for transmitting electronically.

- ***How to view Telstra DWF files –***
  Telstra DWF files come with all layers turned on. You may need to turn individual layers on or off for viewing and printing clarity. Individual layer names are CC (main cable/conduit), DA (distribution area network) and sometimes a combined layer - CAC. Layer details can be viewed by either picking off the side menu or by selecting 'window' then 'layers' off the top menu bar. Use 'layers' to turn individual layers off or on (double click or right click on layer icon).
- ***How to print Telstra DWF files –***
  DWF files can be printed on any size sheet – either their entirety or by selected areas of interest. Some DWF coverage areas are large and are not suited to printing legibly on a single A4 sheet - you may need several prints if you only have an A4 printer. Alternatively, an A3, A1 or larger printer could be used. To print, zoom in or out and then, by changing the 'print range' settings, you can print what is displayed on your screen to suit your paper size. If you only have a small printer, e.g. A4, you may need to zoom until the text is legible for printing (which is why you may need several prints). To print what is displayed on your screen the 'view' setting should be changed from 'full page' to 'current view'. The 'current sheet' setting should also be selected. You may need to print layers separately for clarity and legibility. (Details above on how to turn layers on or off)
- ***How to change the background colour from white to black (when viewing) Telstra DWF files –***
  If using Autodesk Design Review the background colour can be changed by selecting 'Tools' then 'options' then 'sheet'. Tick the box 'override published paper colours' and select the colour required using the tab provided.

STEP 2 - Telstra Accredited Plant Locator (TAPL):

Utilising a TAPL is an essential part of the process to identify network and to trace subsurface network prior to validating. A TAPL can provide plan interpretation, identification and electronic detection. This will assist in determining the position of subsurface assets prior to potholing (validating). Some TAPL's can also assist in validating underground detected network. Electronic detection is only an indication of the existence of underground network and can be subject to interference from other services and local conditions. Electronic detection should not be used solely to determine location for construction purposes. The electronic (indicative) subsurface measurements must be proven by physically sighting the asset (see step 3 - Validation).

- All TAPL's locating Telstra network must be able to produce a current photo ID card issued by Telstra. A list of TAPL's is provided with the Telstra Dial Before You Dig plans.
- Telstra does not permit external parties (non-Telstra) to access or conduct work on our network. Only Telstra staff, Telstra contractors or locators whom are correctly accredited are authorised to work on or access our manholes, pits, ducts, cables etc. This is for safety as well as for legal reasons.

  It is a criminal offence under the *Criminal Code Act 1995* (Cth) to tamper or interfere with communication facilities owned by a carrier. Heavy penalties may apply for breach of this prohibition, and any damages suffered, or costs incurred by Telstra as a result of any such unauthorised works may be claimed against you.

- Optic fibre cable locations must be performed by a locator with Telstra optic fibre cable location accreditation. The locators with optic fibre cable location accreditation are indicated by a 'yes' in the column headed 'Fibre' in the lists of locators that are published with the Telstra DBYD plans. Telstra Accredited Plant Locators that are DBYD Certified Locators are also fibre accredited. Inspection of photo ID cards will confirm whether locators are just copper accredited or copper + fibre accredited.
- The details of any contract, agreement or retainer for site assistance to locate telecommunications plant shall be for you to decide and agree with the Telstra Accredited Plant Locator engaged. Telstra is not a party to any contract entered into between you and a Telstra Accredited Plant Locator.
- Payment for the site assistance will be your responsibility and payment details should be agreed before the engagement is confirmed.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

- Telstra does not accept any liability or responsibility for the performance of or advice given by a Telstra Accredited Plant Locator. Accreditation is an initiative taken by Telstra towards the establishment and maintenance of competency standards. However, performance and the advice given will always depend on the nature of the individual engagement.
- Neither the Telstra Accredited Plant Locator nor any of its employees are an employee or agent for Telstra. Telstra is not liable for any damage or loss caused by the Telstra Accredited Plant Locator or its employees.

- **Electronically derived subsurface measurements (e.g. depths/alignments by locating devices)**

  All locator provided measurements for Telstra assets must have the AS5488-2013 quality level specified - (e.g. QL-A, B, C or D). These quality levels define the accuracy of subsurface information and are critical for determining how the information is later used – for example if suitable for excavation purposes.

  1) ***An example of a subsurface measurement with no quality level specified – (i.e. not to be used)***

     Telstra cover - **0.9m**

     *The measurement above has no AS5488-2013 quality level specified and **should not** be provided by a locator or used for design or construction. This is because it is not known whether the measurement is actual or derived (where 'actual' means validated and 'derived' means assumed and not validated, e.g. electronic or other). Typically damages occur by constructors incorrectly using unvalidated measurements as actual measurements.*

  2) ***An example of a subsurface measurement with quality level B specified –***

     Telstra cover - **0.9m** (QL-B)

     Where (QL-B) complies with AS5488-2013 QL-B (for example an electronic location that complies with QL-B)

     (Note QL-B means it has not been validated and should not be used for construction purposes around Telstra network, however it would assist further investigation to determine the actual location)

  3) ***An example of a subsurface measurement with the quality level A specified –***

     Telstra cover - **0.6m** (QL-A)

     Where (QL-A) complies with AS5488-2013 QL-A (and is deemed suitable for excavation purposes). *In this example the asset has been electronically located first, (QL-B) and then physically exposed (QL-A).*

     Note -Telstra will seek compensation for damages caused to it its property and losses caused to Telstra and its customers if unvalidated subsurface measurements are used for construction and subsequently result in damage to Telstra assets. Only measurements conforming to AS5488-2013 (QL-A) are deemed by Telstra to be validated measurements.

- **Rural landowners** Where Telstra-owned cable crosses agricultural land, Telstra may provide on-site assistance with cable location. **You must contact Telstra Plan Services to determine eligibility and to request the service**.

  Please note the following –

  - If eligible, the location assistance must be approved and organised by Telstra. Telstra will not pay for a location that has not been approved and facilitated by Telstra (Telstra is not responsible for payment assistance when a customer engages a locator directly).
  - The exact location, including depth of cables**,** must be validated by potholing, which may not be covered by this service.
  - This service is nominally only available to assist private rural land owners.
  - This service nominally covers one hour on-site only. Any time required in addition to Telstra-funded time can be purchased directly from the assigned Telstra Accredited Plant Locator.
  - This service does not apply to previously located network at the same location (i.e. it is a once off).
  - This service does not apply to other carriers' cables (marked as 'OC' on Telstra plans).

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

STEP 3 – *Validation:

After utilising a Telstra Accredited Plant Locator and prior to commencing construction, any electronically detected underground network must be positively identified (validated) by physically sighting it. This can be done by careful hand digging or using non-destructive water jet methods to expose the network.

*Validation as defined in AS5488-2013 (QL-A).

Manual potholing needs to be undertaken with extreme care and by employing techniques least likely to damage cables. For example, align shovel blades and trowels parallel to the cable rather than digging across the cable. Some Telstra Accredited Plant Locators are able to provide or assist with non-destructive potholing methods to enable validation of underground cables and ducts.

If you cannot validate the underground network then you should not proceed with construction. Telstra will seek compensation for damages caused to its property and losses caused to Telstra and its customers.

Important note: *The construction of Telstra's network dates back over many years. Some of Telstra's pits and ducts were manufactured from asbestos-containing cement. You must take care in conducting any works in the vicinity of Telstra's pits and ducts. You must refrain from in any way disturbing or damaging Telstra's network infrastructure when conducting your works. We recommend that before you conduct any works in the vicinity of Telstra infrastructure that you ensure your processes and procedures eliminate any possibility of disturbing, damaging or interfering in any way with Telstra's infrastructure. Your processes and procedures should incorporate appropriate measures having regard to the nature of this risk. For further information -*

http://ucm.in.telstra.com.au/about/media/emergencies-incidents/asbestos/index.htm?ssSourceSiteId=consumer-advice

STEP 4 – Protection:

You must maintain the following minimum clearance distances between construction activity and the validated position of Telstra plant.

Jackhammers/Pneumatic Breakers	*Not within 1.0m of **actual validated location.***
Vibrating Plate or Wacker Packer Compactor	*Not within 0.5m of **actual validated location** of Telstra ducts.* *300mm compact clearance cover before compactor can be used across Telstra ducts.*
Boring Equipment (in-line, horizontal and vertical)	*Not within 2.0m of **actual validated location**.* *Constructor to hand dig or use non-destructive water jet method (pothole) and expose plant.*
Heavy Vehicle Traffic (over 3 tonnes)	*Not to be driven across Telstra ducts (or plant) with less than 600mm cover.* *Constructor to check actual depth via hand digging.*
Mechanical Excavators, Farm ploughing and Tree Removal	*Not within 1.0m of **actual validated location.*** *Constructor to hand dig or use non-destructive water jet method (pot-hole) and expose plant.*

- For blasting or controlled fire burning please contact Telstra Plan Services for advice.
- If conducting roadworks all existing Telstra pits and manholes should be a minimum of 1.2m in from the back of kerb after the completion of your work.
- After the completion of any ground work in footways (or under roads), all Telstra conduits must have a depth of cover which is compliant with the current specifications of the road owner e.g. the local council or road

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

authority. Depth specification will vary across different authorities in different states. For clarification please contact Telstra Network Integrity.

- For clearance distances relating to Telstra pillars, cabinets and RIMs/RCMs please contact Telstra Plan Services.

- If Telstra plant is situated wholly or partly where you plan to work (i.e. in conflict), then Telstra's Network Integrity Group must be contacted to discuss possible engineering solutions.
  Please phone **1800 810 443** or email NetworkIntegrity@team.telstra.com

- You are not permitted to relocate or alter or repair any Telstra assets or network under any circumstances.

  It is a criminal offence under the *Criminal Code Act 1995* (Cth) to tamper or interfere with communication facilities owned by a carrier. Heavy penalties may apply for breach of this prohibition, and any damages suffered, or costs incurred by Telstra as a result of any such unauthorised works may be claimed against you.

  Only Telstra and its contractors may access and conduct works on Telstra's network (including its plant and assets). This requirement is to ensure that Telstra can protect the integrity of its network, avoid disruption to services and ensure that the relocation meets Telstra's requirements.

- If Telstra relocation or protection works are part of the agreed solution, then payment to Telstra for the cost of this work shall be the responsibility of the principal developer, constructor or person for whom the work is performed. The principal developer or constructor will be required to provide Telstra with the details of their proposed work showing how Telstra's plant is to be accommodated and these details must be approved by the Regional Network Integrity Manager prior to the commencement of site works.
  Please phone 1800 810 443 or email NetworkIntegrity@team.telstra.com
  Further information -
  https://www.telstra.com.au/consumer-advice/digging-construction/relocating-network-assets

  ### Damage to Telstra's network must be reported immediately -
  https://service.telstra.com.au/customer/general/forms/report-damage-to-telstra-equipment

- You will be held responsible for all plant damage that occurs or any impacts to Telstra's network as a result of your construction activities. This includes interfering with plant, conducting unauthorised modification works and interfering with Telstra's assets in a way that prevents Telstra from accessing or using its assets in the future.

- Telstra reserves all rights to recover compensation for loss or damage to its cable network or other property including consequential losses.

FURTHER INFORMATION:

NATURAL DISASTERS

Natural Disasters include (amongst other things) earthquakes, cyclones, floods and tsunamis.
In the case of such events, urgent requests for plans or information relating to the location of Telstra network can be made directly to Telstra Network Integrity Team Managers as follows:

NSW – John McInerney 0419 485 795

QLD – Glenn Swift 0419 660 147

VIC/TAS - David Povazan 0417 300 947

SA/NT - Mick Weaver 0419 828 703

WA - Angus Beresford-Peirse 0419 123 589

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

TELSTRA PLAN SERVICES - for all Telstra Dial Before You Dig related enquiries

Email - Telstra.Plans@team.telstra.com

Phone - 1800 653 935 (general enquiries, business hours only)

*Telstra DBYD plan information -	Shalin	07 3455 2997
	Anthony	07 3455 2365
Advice on preventing damage -	Glen	07 3455 1011
	Lachlan	07 3455 3132
Accredited plant locator enquiries -	Mike	0477 377 036
	Taylor	0477 365 666
Road closures -	Megan	07 3455 0834
	Lachlan	07 3455 3132
Telstra easements -	Glen	07 3455 1011

**Please note* - *to make a Telstra plan enquiry the plans must be current (within 60 days of issue). If your plans have expired you will need to submit a new request via DBYD prior to contacting Telstra Plan Services.*

Information for new developments (developers, builders, home owners)
Telstra Smart Communities - https://www.telstra.com.au/smart-community

Asset relocations
Please phone 1800 810 443 or email NetworkIntegrity@team.telstra.com

https://www.telstra.com.au/consumer-advice/digging-construction/relocating-network-assets

Telstra offers free Cable Awareness Presentations, if you believe you or your company would benefit from this offer please contact Network Integrity on 1800 810 443 or NetworkIntegrity@team.telstra.com

PRIVACY NOTE

Your information has been provided to Telstra by DBYD to enable Telstra to respond to your DBYD request. Telstra keeps your information in accordance with its privacy statement entitled "Protecting Your Privacy" which can be obtained from Telstra either by calling 1800 039 059 or visiting our website at www.telstra.com.au/privacy

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

LEGEND

IT'S HOW WE CONNECT

For more info contact a Telstra Accredited Locater or Telstra Plan Services 1800 653 935

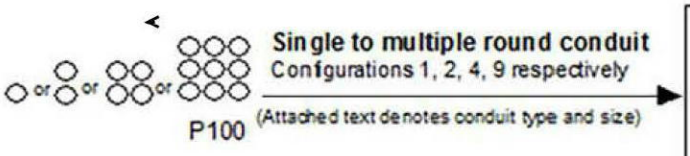
Exchange
(major cable present)

Footway access chamber
(can vary from 1-lid to 12-lid)

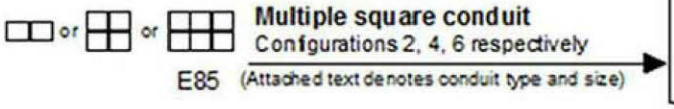
Pillar/cabinet
(above the ground / free standing)

Above ground complex equipment housing (eg RIM)
Please Note: This equipment is powered by 240V electricity.

OC **other carrier**



Single to multiple round conduit
Configurations 1, 2, 4, 9 respectively
(Attached text denotes conduit type and size)



Multiple square conduit
Configurations 2, 4, 6 respectively
(Attached text denotes conduit type and size)

Some examples of conduit type and size:
A - Asbestos cement, P - PVC / plastic, C - Concrete, GI - Galvanised iron, E - Earthenware.
Conduit sizes *nominally* range from 20mm to 100mm.

P50	50mm PVC conduit
P100	100mm PVC conduit
A100	100mm asbestos cement conduit
E 85	85mm square earthenware conduit

Cable jointing pit
(number indicating pit type)

Elevated cable joint
(above ground joint on buried cable)

Telstra Plant in shared utility trench

Aerial Cable
(above ground)

Aerial Cable
(attached to joint use pole e.g. power)

Direct buried cable

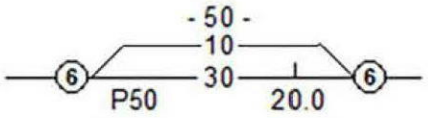
M **Marker post installed**

TR **Buried transponder**

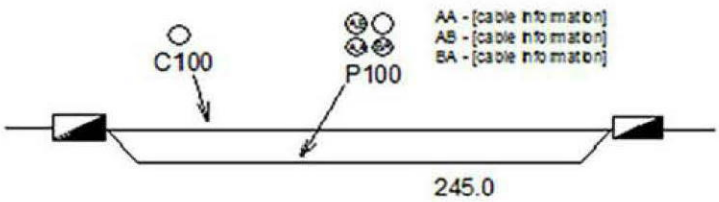
MT **Marker, transponder**

SMOF **Optical fibre cable direct buried**

Some examples of how to read Telstra plans:



One 50mm PVC conduit (P50) containing a 50-pair and a 10-pair cable between two 6-pits, 20.0m apart, with a direct buried 30-pair cable along the same route.



Two separate conduit runs between two footway access chambers (manholes) 245m apart. A nest of four 100mm PVC conduits (P100) containing assorted cables in three ducts (one being empty) and one empty 100mm concrete duct (C100) along the same route.

WARNING: Telstra plans and location information conform to Quality Level 'D' of the Australian Standard AS 5488 - Classification of Subsurface Utility Information. As such, Telstra supplied location information is indicative only. Spatial accuracy is not applicable to Quality Level D. Refer to AS 5488 for further details. Telstra does not warrant or hold out that its plans are accurate and accepts no responsibility for any inaccuracy shown on the plans. FURTHER ON SITE INVESTIGATION IS REQUIRED TO VALIDATE THE EXACT LOCATION OF TELSTRA PLANT PRIOR TO COMMENCING CONSTRUCTION WORK. A plant location service is an essential part of the process to validate the exact location of Telstra assets and to ensure the asset is protected during construction works. The exact position of Telstra assets can only be validated by physically exposing it. Telstra will seek compensation for damages caused to its property and losses caused to Telstra and its customers.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Appendix E

BASIX Reports

AT&L
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REVISION 02

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Appendix F

Hydraulic Plans

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REVISION 02

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Appendix G

Precinct Water Cycle Management

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ABN 96 130 882 405
REVISION 02

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

North Penrith Stages 2B-3B

Water Cycle Management Strategy Report Incorporating Water Sensitive Urban Design Techniques

Prepared for:

Landcom

October, 2012
9470Rpt1B

Prepared by:

J. WYNDHAM PRINCE

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& PROJECT MANAGERS

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SUSTAINABLE CERTIFICATION
AS/NZS 4801 : 2001 Endorsed OHS Management System

Document Set ID: 7627536
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J. WYNDHAM PRINCE

CONSULTING CIVIL INFRASTRUCTURE ENGINEERS & PROJECT MANAGERS

NORTH PENRITH STAGES 2B-3B WATER CYCLE MANAGEMENT STRATEGY INCORPORATING WATER SENSITIVE URBAN DESIGN TECHNIQUES

- DOCUMENT CONTROL SHEET -

Issue No	Amendment	Prepared By Date	Checked By and Date	Approved By and Date
A	Draft	GH, JC, MB, DG (28-9-12)	DC (28-9-12)	
B	DA Issue	GH, JC, MB, DN, DG (11-10-12)	DC (12-10-12)	
C	DA Issue 2	GH, JC, MB, DN, DG (17-10-12)	DC (17-10-12)	DC (17-10-12)
D	Minor amendments	GH (29-10-12)	DC (8-10-12)	DJ (13-11-12)
	Signatures:			
	File Location:	J:\9470 - North Penrith Stages 2B 3 - PM\Water Balance\9470Rpt1D.doc		

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Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

J. WYNDHAM PRINCE

CONSULTING CIVIL INFRASTRUCTURE ENGINEERS
& PROJECT MANAGERS

NORTH PENRITH STAGES 2B-3B
WATER CYCLE MANAGEMENT STRATEGY INCORPORATING WATER SENSITIVE URBAN DESIGN TECHNIQUES

- CONTENTS -

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

- LIST OF PLATES-

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

- LIST OF TABLES-

- LIST OF APPENDICES-

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

1 INTRODUCTION

The North Penrith development site is a former army barracks area and is located just to the north of Penrith's CBD. The total site consists of approximately 40 hectares of land, which is being redeveloped as residential and commercial lots. Stage 1 of the development is currently under construction. An application has been lodged for development of Stage 2A. Landcom has engaged J. Wyndham Prince Pty Ltd to prepare a Water Cycle Management Strategy to support a development application for Stages 2B-3B (incorporating Stages 2B, 2C, 2D, 3A and 3B).

This report details the procedures used and presents the results of investigations undertaken by J. Wyndham Prince Pty Ltd in developing a Water Cycle Management Strategy that incorporates the principles of Water Sensitive Urban Design (WSUD) to integrate with and support a development application to the Department of Planning and Infrastructure for Stages 2B-3B.

The objective of this investigation is to identify the stormwater issues to be taken into account in the detailed planning, design and development of the North Penrith Stages 2B-3B site. The investigation builds on previous studies to confirm appropriate options and locations for the control of the quantity and quality of stormwater leaving the site, and to identify the land areas required to implement the recommended options. The investigations also include a detailed water balance assessment to ensure that the proposed central water feature and wetland are viable from both a water quality and water reuse perspective.

This investigation addresses engineering considerations whilst placing a strong focus on creating enhanced bio-diversity, ecological health and positive water quality benefits within the proposed stormwater elements to provide an integrated "natural" resource for the incoming residents.

The investigation involved the following specific tasks:

- Liaise with Landcom and Penrith City Council to determine their specific requirements for development of the site.
- Review the previous Stormwater Strategy prepared for the site and identify any modifications or enhancements required for the development Stage 2B-3B site to achieve Landcom's vision for the site.
- Undertake a hydrologic analysis to determine the peak 2, 5, 20 and 100 year ARI pre development and post development flows.
- Determine the minimum detention storage requirements to restrict post development flows to pre development levels and the capacity of downstream stormwater infrastructure.
- Undertake a water quality analysis and determine the minimum treatment device areas required to achieve Office of Environment and Heritage water quality targets.
- Prepare preliminary engineering concept designs for any measures required to achieve the water quality and quantity objectives.
- Undertake a detailed water balance assessment to ensure that the central water feature and wetland are viable from both a water quality and water reuse perspective.
- Prepare a Water Cycle Management Concept Plan.
- Prepare a Water Cycle Management Strategy Report Incorporating Water Sensitive Urban Design Techniques to support the development application for the North Penrith Stage 2B-3B site, detailing the investigations, findings, calculations and design details.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

2 PREVIOUS RELEVANT REPORTS

A number of previous reports have been prepared for the North Penrith development site. Two of the reports by Worley Parson's form part of the approved Concept Plan and are summarised below.

2.1 North Penrith – Drainage, Stormwater and Groundwater Management Report (Worley Parsons, 2011)

This report described the objectives and proposed strategies for managing stormwater within the North Penrith development and Stage 1. Stormwater drainage is addressed through provision of a piped network with a 5 year ARI capacity. Water quality is addressed through a treatment train approach, including gross pollutant traps, bioretention systems, ponds and wetlands. Water quantity is addressed through provision of a detention basin incorporated with the central water feature and main wetland.

2.2 North Penrith – Regional Flooding Assessment (Worley Parsons, 2010)

This report was prepared to establish how the proposed North Penrith development conforms to the NSW Government's Floodprone Land Policy, whether the development can integrate into the SES regional evacuation strategy and how the development will manage the structural damage risk. The report presented the regional flooding results for the 100, 200, 500 and 1000 year ARI and PMF events. The minimum habitable floor level for the North Penrith development was determined to be RL 25.9m AHD (100 year ARI flood level plus 0.5m freeboard).

An additional report was also prepared by Egis Consulting which is relevant to the North Penrith site and is summarised below.

2.3 North Penrith Stormwater Masterplan (Egis Consulting, 2002)

This report detailed a flood evacuation strategy and supporting plan which concluded that a residential development would have an acceptable evacuation plan for regional floods up to the PMF in consideration of the Hawkesbury/Nepean Floodplain Management Strategy.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

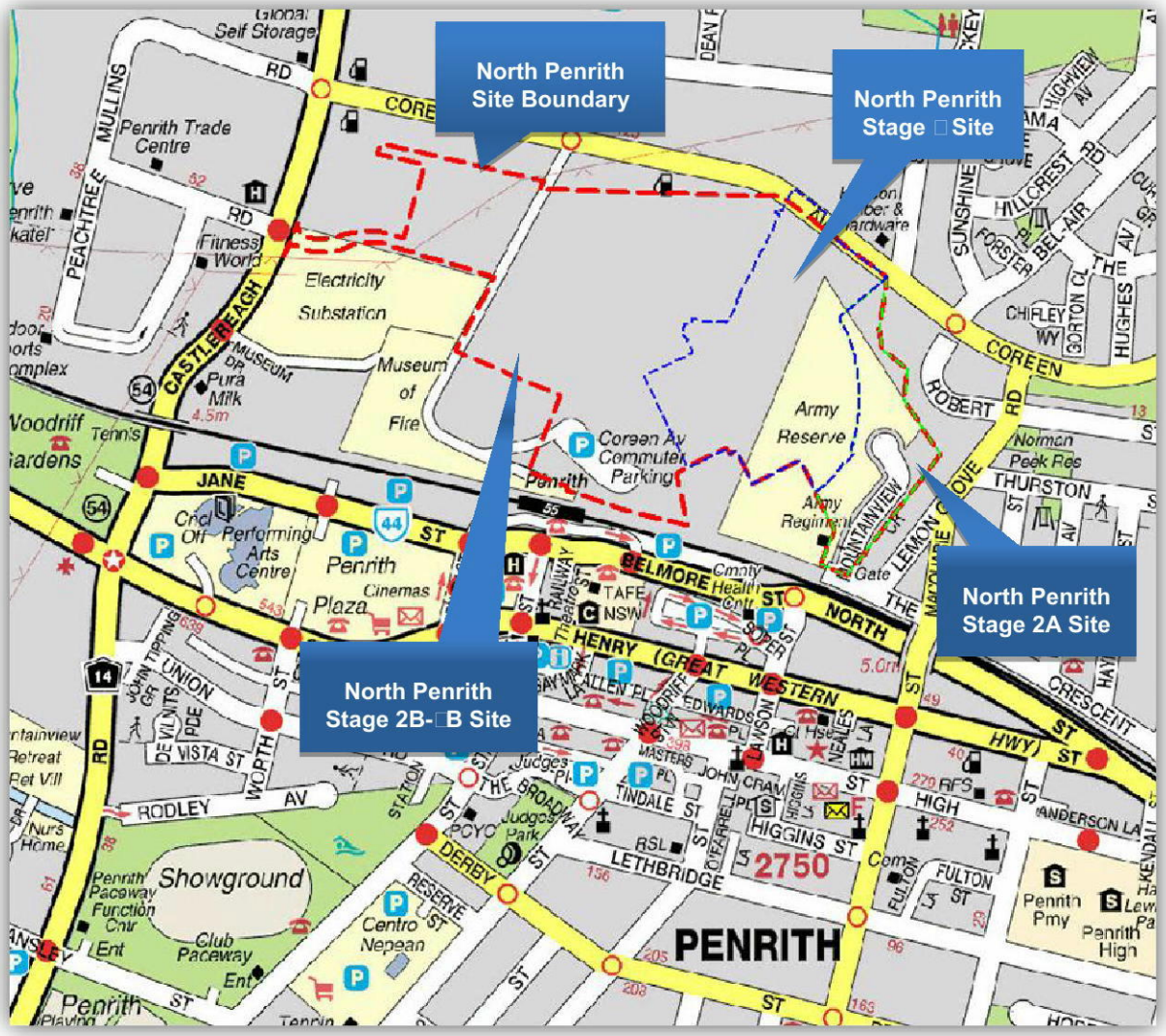
3 THE SITE

The North Penrith development, which totals approximately 40 hectares, is located immediately north of the Penrith CBD and western rail line. The site is bounded by Coreen Avenue to the north, existing residential development to the east and existing commercial and industrial development to the west. The main access to the development site is via Castlereagh Road and Coreen Avenue.

The site is a former army barracks. All former buildings associated with this use have been removed and the Stage 1 and Stage 2A developments are currently under construction. The site is characterised by its very flat nature, with grades generally around or less than 1□.

The Stage 2B-3B site is approximately 24 hectares and forms the western portion of the North Penrith development site.

The location of the North Penrith site and the various stages is indicated on Plate 3.1 below and is shown in more detail on Figure 1.



(Source: UBD)

Plate 3.1 Location of the North Penrith Development Site

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

3.1 Existing Drainage Configuration

The North Penrith site is extremely flat but generally grades to the west and north-west. There are two discharge points from the site. The first is a 2 x 900mm diameter culvert under Coreen Avenue and the second is an existing open channel at the north-west boundary of the site, which discharges to Boundary Creek and then ultimately to the Nepean River.

The existing drainage configuration and flow directions within the North Penrith site are shown on Plate 3.2. The existing drainage catchments are shown on Figure 2.

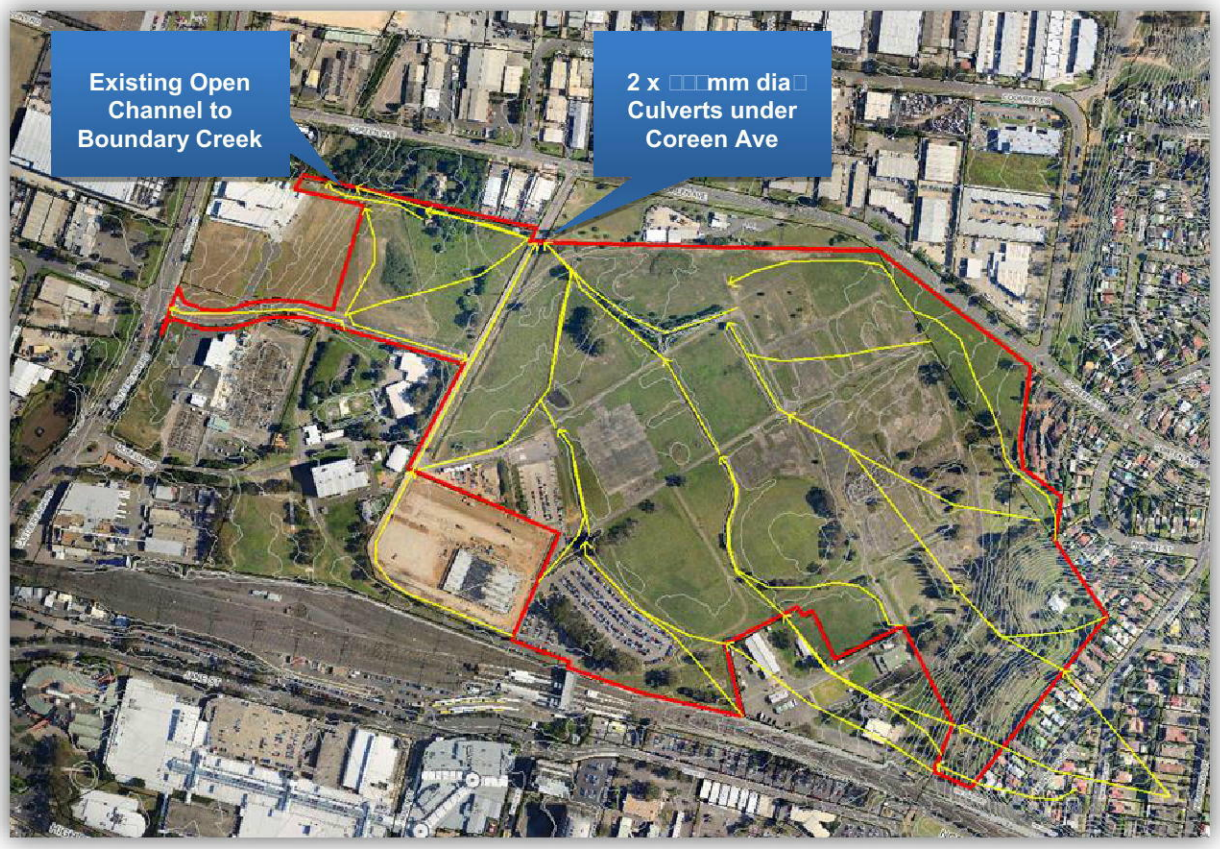


PLATE 3.2 DIRECTION OF FLOWS UNDER EXISTING CONDITIONS

3.2 The Proposed Development

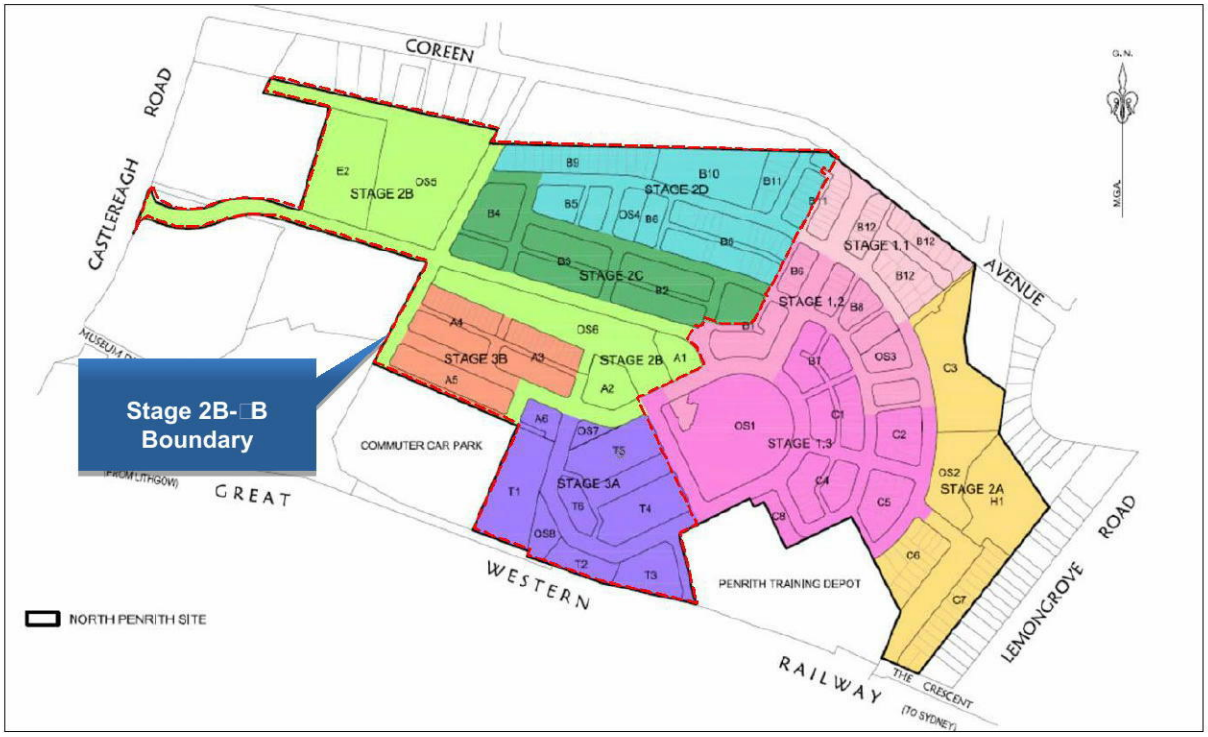
With an overall area of approximately 24 ha, the Stage 2B-3B subdivision of the North Penrith site by Landcom will involve the creation of approximately 800 residential allotments, the construction of a central water feature for water quality control, a combined water quantity control detention basin and water quality wetland and dedication of new roads.

The combined wetland / detention basin, which is designed to retard peak post development, flows up to the 100 year ARI to pre development levels. The combined wetland / detention basin is located to the north-west of the Stage 2B-3B site.

A water recirculation system will be incorporated within the North Penrith development, which pumps water from a sand filter, located immediately downstream of the wetland / detention basin, back to the top of the central water feature. The recirculation system is integral to the development's overall water quality system and also assists in reducing the risk of algal problems. A detailed description of the wetland / central water feature and recirculation system operation is included in Section 5.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

The proposed North Penrith Stage 2B-3B development is shown below in Plate 3.3. The developed case catchment boundaries are shown on Figure 3.



(Source: Landcom)

PLATE 3.3 PROPOSED NORTH PENRITH DEVELOPMENT LAYOUT PLAN INCLUDING STAGES 2B – 3B

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

4 WATER CYCLE MANAGEMENT STRATEGY CONCEPT

The Water Cycle Management Strategy proposed for the North Penrith development focuses on minimising the impacts of the development on the total water cycle and maximising the environmental, social and economic benefits achievable by utilising responsible and sustainable stormwater management practices. The Water Cycle Management Strategy has been prepared with consideration of the following documents and guidelines:

- Engineering Guide for Development (Penrith City Council, 1997)
- North Penrith Design Guidelines 2012
- Australian Runoff □uality (Engineers Australia, 2005)
- Australian Rainfall and Runoff (Institution Of Engineers Australia, 1987)
- Draft NSW MUSIC Modelling Guidelines (Sydney Metropolitan Catchment Management Authority, 2010)
- NSW Climate Impact Profile (Department of Environment and Climate change and water, 2012)
- Impacts of Climate Change on Urban Stormwater Infrastructure in Metropolitan Sydney (Sydney Metropolitan Catchment Management Authority 2012)
- Managing Urban Stormwater (Draft); Environmental (Office of Environment and Heritage (Former Department of Environment and Climate Change, 2007))

To maintain stormwater quality at the required levels, a “treatment train” approach is proposed where various types of pollutants are removed by a number of different elements arranged in series.

The following sections describe each of the elements of the stormwater treatment train for the North Penrith site.

4.1 Water Efficiency

4.1.1 *On Lot Treatment*

- Implementation of water efficient fittings and appliances in all dwellings (dual flush toilet, AAA shower heads, water efficient taps and plumbing).
- Minimisation of impervious areas through acceptable development controls.
- The provision of rainwater tanks on each allotment, along with implementation of the above water efficient devices, will satisfy the requirements of BASI□ and connection of the water tank for internal uses (toilet flushing) will ensure any requirements are met and additional benefits are realised.

4.2 Water Quality

4.2.1 *Street Level Treatment*

Gross Pollutant Traps (GPTs) to remove litter, vegetative matter, free oils and grease and coarse sediments prior to discharge to a downstream treatment device. GPTs will be located at all discharge points to the central water feature and wetland to not only form an important part of the water quality treatment train but to also reduce the visual impacts that gross pollutants will have on the central water feature / wetland features.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

4.2.2 *Subdivision / Development Treatment*

Subdivision scale treatment measures will be incorporated within the development to reduce the total suspended solids and nutrient loads generated from the site and include:

- Central water feature ponds and feature Wetlands
- Main Wetland
- Sand Filter

A detailed description of the central water feature and wetland system operation is included in Section 5.

Refer to Appendix A for a detailed description of the water quality elements listed above and the assumptions used in the water quality modelling. The proposed water cycle management strategy plan is shown on Figure 4.

4.3 Water Quantity

4.3.1 *Subdivision / Development Treatment*

Peak storm flow attenuation up to the 100 year ARI event is addressed through the provision of a detention basin, incorporated with the main wetland and central water feature, to restrict peak post development flows to pre development levels for storm events up to the 100 year ARI.

4.3.2 *Volumetric Reduction*

The central water feature includes a 0.3m extended detention zone to increase the long term viability of the wetland system, this together with the inclusion of BASI compliant rainwater tanks within all lots, will reduce the runoff volume from within the developed site. The proposed recirculation within the wetland, central water feature and the stormwater reuse associated with toilet flushing and garden irrigation that will occur within the lots, will assist in management of the volumetric changes associated with urban development of the site.

4.4 Key Features

ey features of the proposed water cycle management strategy for the North Penrith site are as follows:

Social:

- Integration of a constructed wetland and central water feature with the overall landscape strategy for the estate to create an integrated-natural resource for the incoming and wider community.
- Enhanced visual amenity.
- Flood affectation and public safety issues identified and controlled.
- Provision of aesthetic soft design forms that enhance urban and environmental amenity.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Environmental:

- Limited downstream and in-channel discharge peaks and velocities to avoid scouring, siltation and flora and fauna impacts
- Enhanced ecological health and biodiversity within the central water feature and wetland.
- Provision of gross pollutant traps, central water feature ponds, constructed wetlands and sand filter to achieve water quality targets.
- Provision of ponds and wetlands capable of sustaining aquatic ecosystems.
- Limitation of frequent wetting flows and peak velocities to avoid creek bed/bank erosion and sedimentation. Peak storm flow attenuation is addressed through provision of a local detention basin located within the North Penrith site.
- A holistic and interdisciplinary approach to the management of urban salinity, using an approach to construction, stormwater management, building and landscaping practices, consistent with the WSROC Western Sydney Salinity Code of Practice.
- Provision of extensive deep rooted vegetation in strategic areas to intercept ground water flows and increase evapotranspiration rates in excess of those currently being experienced on the site.
- Extensive revegetation of allotments, streetscapes, central water feature and the constructed wetland to manage urban salinity and provide habitat.
- Provision of BASI compliant rainwater tanks within the development to reduce reliance on potable water supplies by using stormwater as a resource.

Economic:

- Minimisation of land take consistent with the achievement of environmental and social objectives.
- Proposed water quality improvement measures that keep recurrent maintenance tasks and costs to a minimum.

The water cycle management strategy proposed for the North Penrith development site is functional; delivers the required technical performance; lessens environmental degradation and pressure on downstream ecosystems and infrastructure; and provides for a 'soft' sustainable solution for stormwater management within the release area.

The water cycle management concept is illustrated on Figure 4.

4.5 Construction Stage

Erosion and sediment control measures are to be implemented during the construction phase in accordance with the requirements of Penrith City Council and the guidelines set out by Landcom (the "Blue Book" Ref. 9).

The operation of constructed wetland, central water feature and sand filter are sensitive to the impact of sedimentation. We recommend that the appropriate Erosion and Sediment control be maintained until the majority of site building works are completed. Alternatively, a very high level of at source control on individual allotments during the building and site landscaping works, which is regularly inspected by either Landcom or Council officers, would be required.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

4.6 Interim Treatment Measures

The constructed wetlands, central water feature and sand filter should be protected as much as practical throughout the civil and housing construction phases of the development.

Before the commencement of construction activity, silt fence should be installed on the upslope of the wetland and adjacent to the drainage paths that lead to the wetland. Damaged silt fence should be replaced or repaired immediately.

Stockpiling of materials adjacent to the wetlands and ponds should be avoided as much as practicable. Any stockpiled material should be protected with silt fencing and straw bales. Stockpiled material should be seeded or covered to help prevent erosion as soon as practicable .

At Construction Certificate stage, a detailed management strategy for the wetland and central water feature will be prepared, including details of protection measures to be implemented during the civil and housing construction stages.

4.7 Long Term Management

Regular maintenance of the stormwater quality treatment devices is required to control weeds, remove rubbish, and monitor plant establishment and health.

Proper management and maintenance of the water quality control systems will ensure long-term, functional stormwater treatment. A separate site-specific Operation and Maintenance (O □ M) Manual will be prepared for the system. The O □ M Manual will provide information on the Best Management Practices (BMP's) for the long-term operation of the treatment devices. The manual will provide site-specific management procedures for:

- Maintenance of the GPT structures including rubbish and sediment removal.
- Management of the central water feature and wetlands including plant monitoring, replanting guidelines, monitoring and replacement of the filtration media within the sand filter and general maintenance (i.e. weed control, sediment removal).
- The operation of the water recirculation and destratification system for the management of algae.

An overview of the contents, structure and information to be included in the detailed O□M Manual is included in Section 6.

4.8 Stormwater Monitoring Programme

A stormwater monitoring programme should be implemented to ensure wetland and central water feature continues to operate as efficiently as possible and that the public health and safety is protected. The monitoring programme developed for the site will be included in the Operation and Maintenance Manual.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

5 WETLAND AND CENTRAL WATER FEATURE SYSTEM DESIGN OVERVIEW

The proposed Wetland and Central Water Feature system at North Penrith services both the total water quality and quantity requirements for the for the North Penrith residential development (51 ha including upstream catchment).

The system will also provide passive recreation, aesthetic vistas and an environment designed to create habitat for indigenous flora and fauna (aquatic and terrestrial) within the local area.

5.1 Water Quality Functions

The central water feature receives piped stormwater flows up to the 5 year ARI event. The piped flows are passed through proprietary GPTs before discharging into the central water feature at various points. A twin GPT structure at the head of the central water feature has been built as part of Stage 1. All other GPT's are located on JWP Plan No's 9470 DA 16-20 are proposed to be built in Stages 2A and 2B.

The stormwater from Stage 1 discharged into the top of central water feature via the GPT's and flow in a westerly direction towards the Wetland.

The conveyed flows from the central water feature are likely to have velocities of less than 1 m/s and will be conveyed through a set of culverts under Combewood Drive and ultimately discharged into the wetlands. Flows up to the 3 month ARI event are then diverted to the east and west perimeter through a shallow macrophyte channel. These channels have been designed to maximise macrophyte growth and maximise contact time with the stormwater flow. Both channels direct stormwater to the north and then discharge into the wetland deep water zone.

The wetland and eastern section of the central water feature have been designed to have 0.3 m of extended detention for water quality, before flows exit through the discharge control structures. The system is designed to have a three (3) days hydraulic residence time and this is achieved by an appropriately sized orifice and pipe located in the north western outlet control device.

As noted in Section 9, a single pass through the central water feature / wetland system falls short of providing the required nutrient and suspended solids removal from the developed catchment. This shortfall has been addressed by recirculating stormwater via a pump and rising main to the head of the central water feature. This recirculation provides a second pass through the wetland and central water feature system. The water quality model determined that only two passes of the capture stormwater is required to achieve the nutrient and suspended solids removal requirements for the developed catchment. The recirculation is via a pipe with an intake situated at the southern end of the deep water zone within the wetland. The pipe intake is set at RL 21.3. The wetland Static Water Level is 23.67, thus a 2.37m drawdown of the wetland is possible to replenish flows in the central water feature and create recirculation of the entire system. Before flows are pumped to the head of the central water feature, stormwater from the wetland is the passed via a appropriately sized pipe into the 210 m□sand filter with a base level of RL 21.0. Flows between the wetland and sand filter are controlled via an automated solenoid valve. The size of the sand filter has been optimised to provide a flow rate into the pump well of 50 L/s.

A pump capable of delivering 50 L/s to the top of the central water feature will be contained within a pump housing and controlling switches will be housed in a cabinet beside the housing. The rising main from the pump will discharge into the two (2) upper central water features cells. Discharging 10 L/s, both sides of the highest pond cell and a further 15 L/s both sides of the second highest pond cell. Discharges into the pond will be via directional jets to produce current (water movement) and positive displacement within the central water feature.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

5.2 Water Quantity Functions

The central water feature receives, via the road network, major flows up to the 100 year ARI event. The flows are conveyed to the west through culverts under Combewood Drive and into the wetland. All stormwater flows up to and including the 100 year ARI local event are detained by outlet structures within the wetland .The storage volume required is provided within the footprint of the wetland / central water feature system. Excess run off from the site are discharged via two (2) outlet structure that form part of the wetland. The first discharge control outlet is a piped outlet which will begin to operation when the water level within the wetland reaches RL 24.0. This discharge control device is located on the north eastern edge of the wetland. Flows are conveyed via twin 900mm dia. pipes to Coreen Avenue.

The second discharge control device is located in the North Western corner of the wetland and begins operation at RL 24.2. Flows are controlled by a 14 m long weir structure. Stormwater flows are then passed through the downstream channel and continue under Coreen Avenue and ultimately to Boundary Creek. The required detention storage for the site is 12,000m^3, however the detention provided within the system has been designed to meet downstream flow constraints and thus a larger storage volume in excess of 20,000 m^3 has been provided (refer to Section 6 for further details).

5.3 Algae Risk

Open water bodies such as the wetland and central water feature, are subject to the risk of algae blooms. This risk is highest from spring to autumn. The contributing factors include high water temperature, nutrient loads, turbidity of the water column, long periods without storm flushing flows, extended periods of sunlight and still wind conditions.

The proposed wetland and central water feature system has been designed with the following strategies to limit algae blooms:

- The central water feature and wetland have been designed with deep water areas. Up to 3.9 m within the wetland and up to 3.3 m within the central water feature. This will aid in keeping water temperatures lower in summer than if shallow wetland and central water feature designs were proposed. When the colder water located at the base of the central water feature is mixed with warmer surface water, a lower homogenous water column temperature will be attained.

- To further cool water temperature within the wetland and central water feature water bodies, water is drawn from the deepest section within the wetland and passed through a sand filter. The sand filter will provide further cooling of the recirculated water, before being discharged at the head of the system. Aeration of the water as it passes through the different pond levels within the central water feature will further cool the water.

- Water movement through the system is provided by the pumped flows. The discharging rising mains will be nozzled to provide directional current. Additionally, directional current and aeration of the main central water feature will be achieved by aerator mixer pumps located near the pedestrian bridge.

- The amount of macrophyte vegetation within a pond has a direct relationship with the available nutrients suspended within the water column for algae growth. 80□ of the wetland surface area has been designed for macrophyte vegetation. Most of the northern side of the central water feature and a few designated areas on the south will have fringing macrophyte vegetation. It is anticipated that the large foot print of vegetation will increase nutrients removal and reduce the risk of algae blooms.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

- All recirculated flows will be via the sand filter. The sand filter has been designed to have alternating wet and dry periods. The sand filter will provide reduction of algae being transported from the wetlands to the central water feature via filtration through the sands. Algae rafts accumulating on the surface of the sand filter will be exposed to drying, desiccation and eventually will die.

- Shading of the central water feature by appropriate tree planting on the northern edge of the central water feature will further aid in controlling algae proliferation.

5.4 Conclusion

The proposed central water feature and wetland system have been designed to provide an integrated solution for water quality and quantity requirements for the North Penrith development. As part of the design process involving Penrith City Council, structures and access points for the ongoing maintenance of the system have been included. The control of conditions that favour algae bloom in open water bodies has also been considered and designed into the proposal. The system will not only provide functional infrastructure, but will provide a valuable environmental and aesthetic asset for the inhabitants and broader community of North Penrith.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

6 OPERATION AND MAINTENANCE

6.1 Introduction

The management of stormwater discharges relies on a number of different Stormwater Treatment Measures (STMs) arranged in series (sometimes referred to as a "Treatment Train") to control both the quantity and quality of stormwater entering the receiving environment. At the North Penrith site these STMs consist of:

i. Gross Pollutant Traps
ii. Central Water feature ;
iii. Constructed Wetlands;
iv. Sand Filter.

Stormwater entering these STMs particularly the Central Water feature, wetland and sand filter must be pre-treated to remove coarse sediment and gross pollutants as these contaminants are capable of impairing the performance of these STM's and increasing their maintenance liability. This pre-treatment is provided by Gross Pollutant Traps on each of the discharged point to the central water feature.

Each of the four (4) STM practices referred to above rely on physical, chemical and biological mechanisms, in varying degrees, to achieve their design objectives. Table 6.1 links operational mechanisms, common to most STMs, with the pollutant specifically targeted by that mechanism. Consequently, the maintenance goal for the STM is to maintain their operational mechanisms such that the control of the target pollutant is optimised.

TABLE 6.1 OPERATIONAL MECHANISMS AND TARGET POLLUTANTS (USEPA 1997)

Target Pollutant	Operational Mechanisms of the STM
All	• Increased Hydraulic Residence Time (HRT) • Low turbulence • Fine, dense herbaceous plants • Medium-fine textured media
Phosphorus	• High soil exchangeable aluminium (Al) and/or iron (Fe) content • Addition of precipitating agents
Nitrogen	• Alternating aerobic and anaerobic conditions • Low levels of toxicants • Circumneutral pH (around 7)
Metals	• High soil organic content • High soil Cation Exchange Capacity (CEC) • Circumneutral pH (around 7)
Organic Matter (OM)	• Aerobic conditions • High light • High soil organic content • Low levels of toxicants • Circumneutral pH (around 7)

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Thorough and consistent maintenance of each of the operational mechanisms of the STM's must be carried out routinely in order for them to achieve their pollutant control objective. A detailed Operation and Maintenance Manual will be be prepared prior to completion of the STM construction works. The Manual will include descriptions of each of these operational mechanisms and provide field orientated Inspection Checklists which should be used as the basis for a Work Instruction to effect repairs and cleaning, as required.

The following sections provide an overview of the Operation and Maintenance tasks that will be outlined in more detail in the comprehensive manual, which will formas part of the relevant future Construction Certificate application/s.

6.2 Gross Pollutant Traps (GPTs)

Gross Pollutant Traps are the first element in the "Treatment Train" of STMs. They remove the light litter and, by default, much of the coarse sediment from the runoff. In so doing they protect the integrity of the larger vegetative (i.e. wetland) and media filtration (i.e. sand filter) practices from high sediment loads and light litter.

They can be specifically designed to fit with site specific constraints or they can be purchased as proprietary devices modified to fit the location. Most GPTs use either a centrifugal (e.g. CDS) or direct screening (e.g. Baramy) technologies to remove the bed load or positively buoyant pollutants. Once the solid pollutants are separated from the liquid portion of the runoff they are stored in either a wet sump (e.g. CDS) or dry sump (e.g. Baramy) Separation Chamber.

6.2.1 *Operation*

"The descriptions of GPTs and sediment traps are divided into five operating types:

- **drainage entrance treatments:** grate entrance systems, side entry pits and gully pit traps
- **direct screening devices:** litter collection baskets, release nets, trash racks, return flow litter baskets, and channel nets
- **non-clogging screens:** circular and downwardly inclined screens
- **floating traps:** flexible floating booms, floating debris traps
- **sediment traps:** sediment settling basins and ponds, circular settling tanks, hydrodynamic separators."

(Engineers Australia, 2005)

PLATE 6.1 EMPTYING THE BASKET CONTAINING THE SOLIDS IN A WET SUMP GPT

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

6.2.2 *Maintenance*

GPTs rely on their screens being clean and the separation chamber having sufficient capacity to capture and retain the solid pollution contained within the design flow. Consequently Maintenance can be referred to as either:

Routine Cleaning

- Wet Sump – decant supernatant and dispose of at a licensed liquid waste facility;
- Dry Sump and Wet Sump – remove solid waste in accordance with the manufacturers guidelines;
- Dispose of solid waste to a licensed solid waste facility or recycling centre;
- Fill in the Gross Pollutant Trap Cleaning Report and provide copies to the owner and other relevant authorities.

Corrective Maintenance

- Repair access ramps;
- Repair any damage to inlet and outlet structures;
- Repair any visible erosion especially if it represents “piping”;
- Repair all damage to infrastructure including fencing, gates, grates, lids, locks and security systems.

Maintenance Considerations □Engineers Australia□2□□□□

- Special equipment such as cranes, tip trucks, eduction;
- Specialised equipment/training necessary to check device e.g. Confined Spaces;
- Trade waste licence;
- Overhead restrictions e.g. power, obstructions;
- Liquid waste removal;
- Isolation of device e.g. tidal or backwater affectation;
- Traffic control;
- Road load limits;
- Draining of solid waste before removal to land fill;
- Odour management;
- Work health and safety;
- Insects and vermin living in device;
- Trapped animals.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

6.3 Central Water Feature

The Central Water Feature consists of three (3) open water bodies incorporating a permanent water storage, Extended Detention one (ED) on top of a permanent storage volume and allows recirculation of water stored within the downstream wetland.

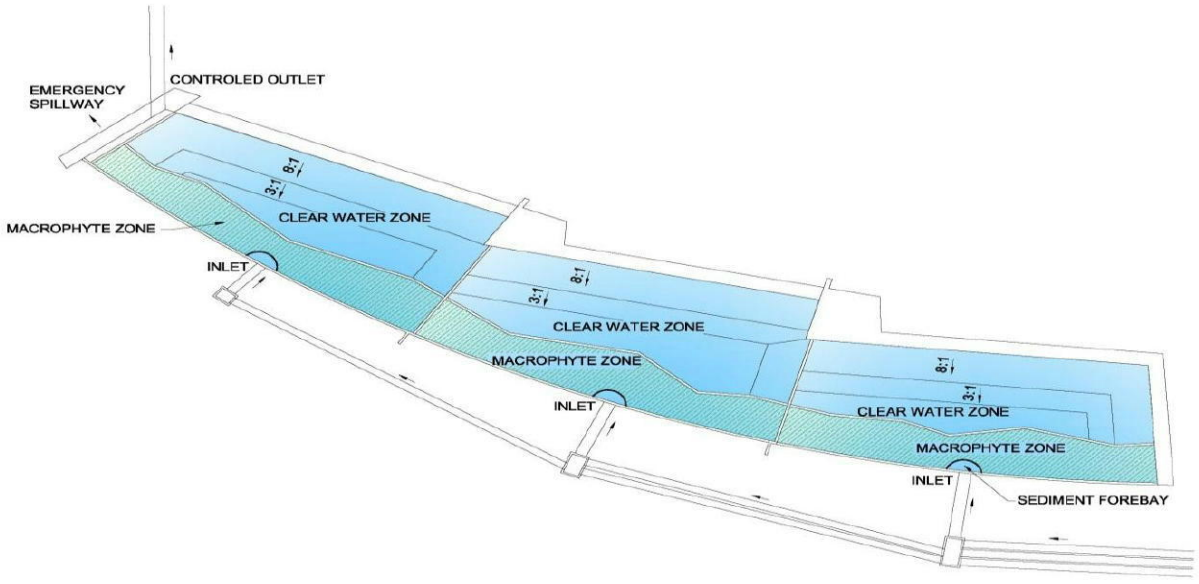


PLATE 6.2 TYPICAL SCHEMATIC OF A CENTRAL WATER FEATURE

These STMs retain water permanently and often have a recreational component associated with their installation e.g. visual, wildlife habitat, model boating. It will be dominated by open water and features a series of broadwalks and viewing areas and may have a narrow littoral zone of fringing vegetation.

6.3.1 *Operation*

The Central Water Feature is designed to have a permanent water storage that promotes a Hydraulic Residence Time (HRT) of sufficient length to promote the appropriate pollutant removal mechanisms.

The Central Water feature has inlets from the local drainage network and outlet to the downstream with three (3) Permanent water cells controlled to maintain the Static Water Level (SWL) and achieve the desired storage volume under flood conditions and to maintain maximise viability form a water balance perceptive

Fringing vegetation will be strategically planted or develop over time. This vegetation will help promote the Pollutant Removal Mechanisms and allow as described previously differentiate between the water and inhibit public access to the deeper water zone.

Fountains, aerators and mixers are proposed to be installed as underwater infrastructure to assist with the control of Blue Green Algae and breakdown thermal stratification within the water column.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

6.3.2 *Maintenance*

Routine Maintenance Activities

- Grass mowing of embankments;
- Replace vegetation where coverage has diminished and bare earth has become visible;
- Removal and dispose of light litter and debris, especially from structures;
- Weed removal;
- Replanting of littoral zone as needed;
- Report on any nuisance insects especially mosquitoes;
- Remove sediment accumulated in inlet zones;
- Repair visible erosion hazards;
- Report on the operation of any pumping, fountains and aeration systems;
- Repair any damage that threatens the integrity of any of the Public and Operational Safety and Security systems;
- Check and report on static water level.

Corrective Maintenance Activities

- Pond dewatering to remove accumulated sediment (generally when the permanent water storage volume has been reduce by 20);
- Repair any damage to inlet and outlet structures as well as pumps and aerators used for aeration;
- Repair any visible erosion especially if it represents “piping” or preferential seepage along any pipes that cross through the embankments;
- Repair all damage to infrastructure including fencing, gates, grates, lids, locks and security systems;
    - Check for and repair any leaks if water levels reported in Routine Maintenance Inspections continually fall (in excess of evapo-transpiration estimates) between rainfall events.

6.4 Constructed Wetland

Constructed wetlands are shallow water storages that are dominated by hydrophytic (emergent aquatic plants or macrophytes). They are sometimes referred to as Wetland Treatment Systems (WTS) due to the variety of different natural processes that occur within them.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

PLATE 6.3 CONSTRUCTED WETLAND (FOREBAY, MARSH AND OPEN POND)

The proposed wetlands at North Penrith has a small open water body with a fringe marsh system within a series the diversion channel at the inlet. Macrophytes generally occupy in excess of 50□ of the total surface area.

6.5 Operation

The wetland for North Penrith has been designed to have a permanent open pond with fringing macrophytes, similar to a central water feature. However the most obvious difference between the two (2) systems is the shallow marsh systems that dominate the wetland. The permanent water storage promotes a Hydraulic Residence Time (HRT) of sufficient length to promote physical settlement of particulate matter and the shallow marsh promotes the biological process that are very efficient at removing the fine particulates and many of the soluble pollutants from the water column.

Permanent water level control set at the Static Water Level (SWL) of R.L 23.67 m maintains the desired storage volume for recirculation. Details of the detention component of the wetland are provided in Section 7 of this report.

6.5.1 Maintenance

Routine Maintenance Activities

- Grass mowing of embankments;
- Removal of tree and shrubs from embankments and repair of any animal burrows;
- Replace vegetation where coverage has diminished and bare earth has become visible;
- Removal and dispose of light litter and debris, especially from structures;
- Weed removal;
- Replanting of littoral zone and marsh zones as needed;
- Report on any nuisance insects especially mosquitoes;

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

- Remove sediment accumulated in inlet zones;
- Repair visible erosion hazards;
- Report on the operation of any pumping, fountains and aeration systems;
- Repair any damage that threatens the integrity of any of the Public and Operational Safety and Security systems.

Corrective Maintenance Activities

- Dewatering of the marsh systems to remove accumulated sediment (generally when the permanent water storage volume has been reduce by 20);
- Repair any damage to inlet and outlet structures as well as pumps and aerators used for recirculation and aeration;
- Repair any visible erosion especially if it represents “piping” or preferential seepage along any pipes that cross through the embankments;
- Repair all damage to infrastructure including fencing, gates, grates, lids, locks and security systems.

6.6 Sand Filter

Sand filters are depressed (generally 300mm to 600mm) flat media beds with a temporary water storage component. Sand filters are effective in removing several common pollutants from storm water runoff. They consist of a sand or gravel bed which provides very limited flow rate control (i.e. high flow rates) and rely on the stormwater moving vertically downward through the media. Sand filters are able to achieve high removal efficiencies for sediment, biochemical oxygen demand (BOD) and fecal coliform bacteria. They also assist in removing some nutrients.

PLATE 6.4 SAND FILTER

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

6.6.1 *Operation*

The Sand filters at North Penrith is intended to provide a final filtration and temperature reduction to the recirculated water from the wetland prior to it being delivered to the Central Water Feature . The filter material is designed to have a permeability that allows the stormwater to percolate through to the lower drainage layer and under drains, from where will be recirculated back to the central water feature. Its operation feature include the capturing particulates on the surface of the sand or gravel media layer and as the water flows through the media, the particulates can be captured through direct collision, surface charge attraction or diffusion.

6.6.2 *Maintenance*

Routine Maintenance Activities

- Grass mowing of embankments;
- Removal of tree and shrubs from embankments and repair of any animal burrows;
- Removal and dispose of light litter and debris, especially from structures;
- Weed removal;
- Report on any nuisance insects especially mosquitoes;
- Remove sediment accumulated on the surface or within the media;
- Repair visible erosion hazards;
- Report on the operation of any pumping systems;
- Repair any damage that threatens the integrity of any of the Public and Operational Safety and Security systems.

Corrective Maintenance Activities

- Removal and replacement of the top layers of sand, gravel and/or filter fabric if it becomes clogged i.e. reduced infiltration and permeability ;
- Repair any damage to inlet and outlet structures;
- Repair any visible erosion especially if it represents “piping” or preferential seepage along any pipes that cross through embankments;
- Repair all damage to infrastructure including fencing, gates, grates, lids, locks and security systems.

6.7 Recirculation and Aeration System

The central water feature and wetland system, as designed, has little natural water movement apart from that generated by major inflows during storm events. Water will be recirculated via a pump and rising main to the head of the central water feature. The pump, capable of delivering a flow rate of 50 litres per second, will be contained within an above ground pump housing together with the necessary controlling switches. Two aerators are also incorporated in the system to assist in maintaining a constant water temperature throughout the water column.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

6.7.1 *Maintenance*

Routine Maintenance Activities

- Run pump and aerators for at least of 30 min per week or as recommended by the manufacturer every month;
- Inspect pump and aerators for any leaks and vibrations;
- Check aerators for electricity leakage in accordance with the manufacturers specification.

Corrective Maintenance Activities

- Remove and service pump and aerators as required.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

7 WATER QUANTITY MANAGEMENT

7.1 Hydrological Analysis

Water quantity management for this study is undertaken using P-RAFTS modelling software package. P-RAFTS is a non-linear runoff routing model that generates runoff hydrographs from rainfall data.

P-RAFTS modelling has been undertaken in this study to establish the peak flows considering both existing and developed conditions of North Penrith site and to determine the size of mitigation measures required to restrict developed case flows to existing levels. Details and discussion of this modelling are included in Sections 7.2 to 7.6 below.

7.2 Catchments

A 3D digital terrain model (DTM) was developed based on Airborne Laser Survey (ALS) provided for existing conditions. The upstream existing catchment was defined based on aerial contours derived from existing ALS data, while consideration was also given to the existing road and pipe networks. The catchment delineation was found to be generally consistent with the previous report (Worley Parsons, 2011), with a total upstream catchment area of 51 Ha. The overall existing catchment was then further divided in twenty (20) sub-catchments which range in size from 0.3 to 6 Ha.

The proposed development area has been divided into twenty six (26) sub-catchments based on design contours and the design road and pipe networks. Developed sub-catchment sizes range from 0.2 to 3.3 ha, the details are included in Appendix B.

Existing and developed case catchment layouts are shown on Figures 2 and 3, respectively.

The existing and developed P-RAFTS model layouts are illustrated in Plate 7.1 and 7.2.

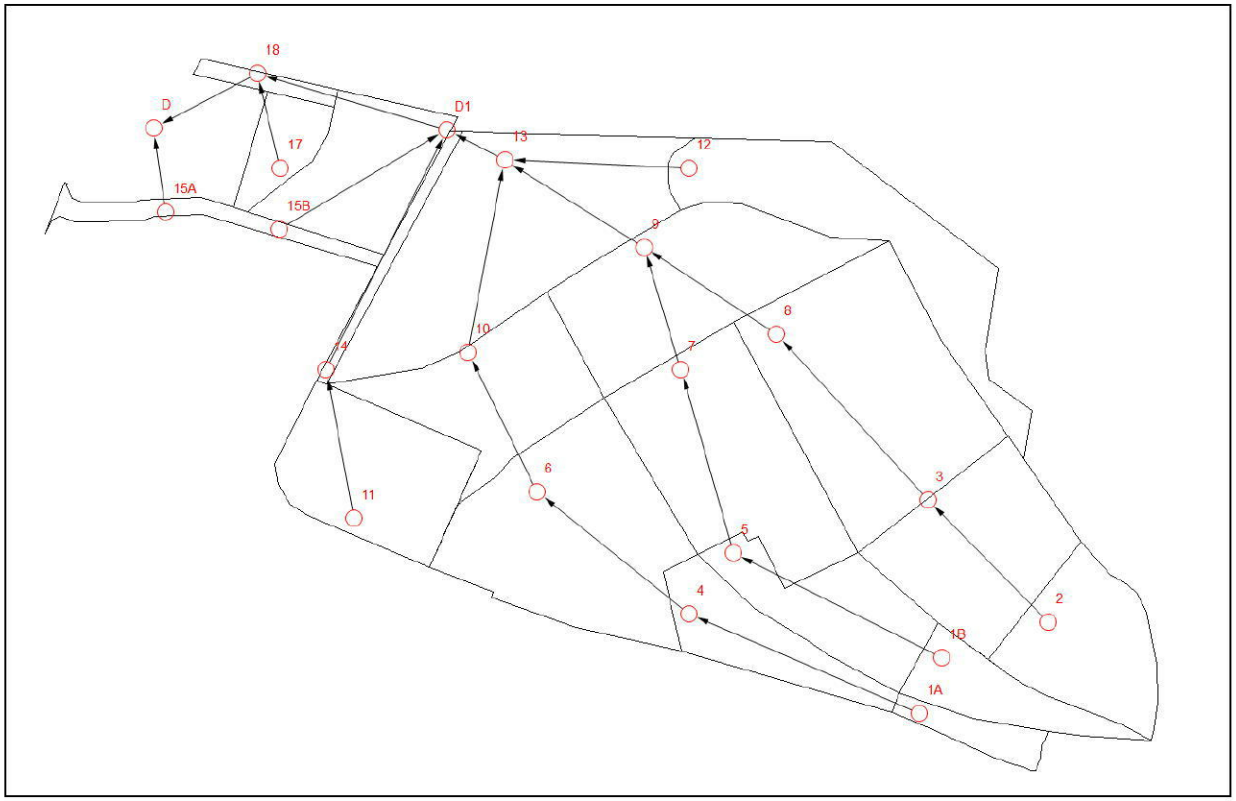


PLATE 7.1 XP-RAFTS EXISTING CASE MODEL LAYOUT

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

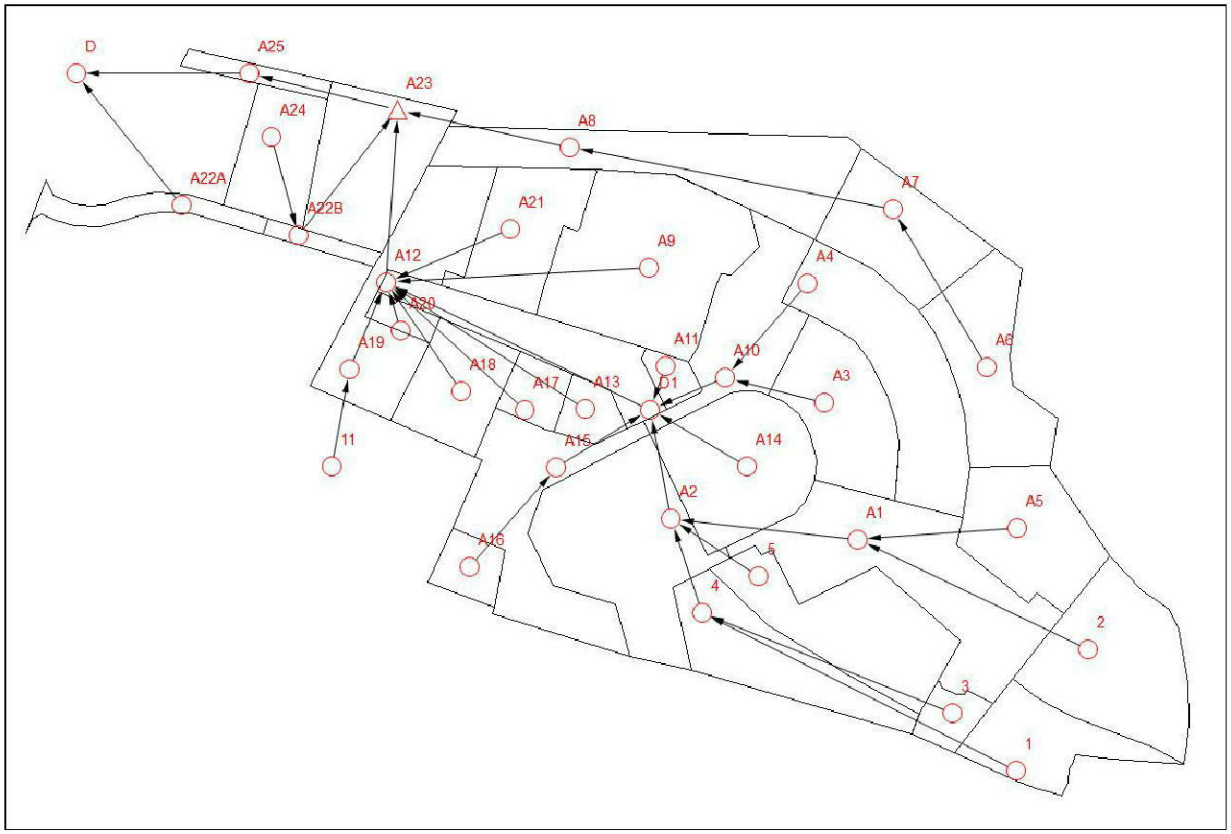


PLATE 7.2 XP-RAFTS DEVELOPED CASE MODEL LAYOUT

7.3 Modelling Parameters

As part of the P-RAFTS modelling for the North Penrith site the following parameters were adopted:

Design rainfall intensity-frequency-duration IFD) has been adopted as per Council guidelines (Penrith City Council, 2010). Refer to summary Table B-1 in **Appendix B**.

Rainfall Loss Parameters - The initial and continuing loss method was applied in accordance with Australian Rainfall and Runoff (IE Aust, 1987). Rainfall loss parameters were adopted based on previous experience on similar projects in the Penrith areas. The adopted parameters are included in Table B-2 in **Appendix B**.

Slope - Catchment slopes have been estimated from existing survey contours (for the existing model) and design contours (for developed model) and range from 0.1 to 6.5 . The majority of catchment slopes determined for both scenarios is less than 1 as the whole site is very flat. A detailed summary of catchment slopes is provided in Tables B-4a and B-4b in **Appendix B**

Area - Catchment areas were measured digitally in MapInfo software package and are summarised in Tables B-4a and B-4b in **Appendix B**.

Fraction Impervious – Fraction impervious parameters were applied to various land uses across the overall catchment. These were applied in accordance with Council guidelines (Penrith City Council, 2010) and assigned based on aerial imagery, Land and Property Management Authority (LPMA) data and the proposed development. Refer to Table B-3 in **Appendix B**.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Manning's PERN value – The type of land use has an effect on the runoff by providing some "resistance" to the flow. The "resistance" effect in XP-RAFTS is simulated by a storage delay coefficient called "Pern". Table B-5 in **Appendix B** lists the standard Pern (n) values used in the model.

Lag Links – Durations of lag links were based on velocities along flowpaths, which were estimated at 1 to 1.5 m/s. Refer to Table B-6a and B-6b in **Appendix B**.

7.4 Basin Discharge Control Structure Design

In order to restrict post development flows back to existing levels for events up to the 100 year ARI storm, a detention basin is proposed to be incorporated with the wetland area to manage the flows.

There are two discharge points available adjacent to the proposed basin/wetland. The basin can discharge into the existing culverts (2 x 900mm dia pipes) under Coreen Avenue as well as to an existing open channel to the north-west of the site, which discharges into Boundary Creek.

A complex multi-staged outlet control structure is proposed for the detention basin. Modelling of the outlet structure is beyond the capability of □P-RAFTS. The hydraulic software package □P-STORM was therefore used to model the basin outlet arrangements. A stage / discharge relationship was determined by assessing a series of discharges through the system and calculating the headwater required to force a certain flow rate through the system.

The detention basin and outlet configuration was designed not only to adequately detain discharges for the developed site but also so that peak post development discharges do not to exceed the current capacity of the existing downstream infrastructure (open channel and culverts under Coreen Avenue).

The proposed wetland / detention basin will manage discharges up to the 100 year ARI event. For details of the wetland / detention basin arrangements refer to JWP engineering plans Ref 9470 DA16-20.

7.5 Tailwater Effects

The North Penrith site is affected by regional flooding from the Nepean River. When regional flooding occurs in conjunction with local storm events at the site, the basin performance will also be affected. In order to properly assess the detention basin performance, the tailwater impact needs to be incorporated into the modelling. The hydraulic performance of the outlet arrangement for the basin, including tailwater effects, has been modelled in □P-STORM.

Based on North Penrith Urban Area – Redundant Defence Lands Stormwater Masterplan (Egis, 2002) flow / discharge relationships were applied as tailwater conditions at the two existing discharge points: the culverts under Coreen Avenue and the open channel to Boundary Creek (refer to Tables B-7a and B-7b in Appendix B). These relationships were derived from the 5 year, 20 year and 100 year ARI flood levels determined at these two locations.

7.6 Discharge Estimates and Basin Performance

The proposed basin was designed to have a maximum storage of 24,340 m3 (RL 25.2m) and its 100 year ARI local top water level (TWL) is RL 24.94 m (see Table 7-2). The detention basin is incorporated with the water quality wetland, with the detention volume component located above the wetland static water level and extended detention zone (RL 24.0 m). Due to the size of the wetland required to meet the water quality targets, the basin storage volume provided is subsequently larger than is required to restrict 100 year ARI peak post development flows to existing levels. Refer to JWP engineering plans 9470 DA16-20 for concept design drawings of the proposed basin / wetland system.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Discharge estimates were derived for the existing and developed catchments for storms with Average Recurrence Intervals (A.R.I.'s) of 2, 5, 20 and 100 years. The discharges from the basin have been designed not to exceed the capacity of the open channel and existing culverts under Coreen Avenue. A range of storm durations from 15 minutes to 24 hours were analysed to determine the critical storm duration for each sub-catchment.

P-RAFTS modelling was undertaken to determine the estimated peak discharges exiting the North Penrith site from the upstream catchments for the pre and post development conditions. These peak discharges are shown in Table 7.1 below:

TABLE 7.1 PRE & POST DEVELOPMENT PEAK DISCHARGES

ARI Storm Event	Pre-development		Post-development		Post/Pre Development Ratio
	Peak Inflow (m^3/s)	Storm Duration (min)	Peak Inflow (m^3/s)	Storm Duration (min)	
2 year ARI	4.10	120	2.02	120	0.5
5 year ARI	5.90	120	2.37	120	0.4
20 year ARI	8.50	120	3.56	120	0.4
100 year ARI	11.4	120	5.14	120	0.5

The performance of the proposed detention basin system is illustrated in the following Table 7.2:

TABLE 7.2 DETENTION BASIN PERFORMANCE

ARI Storm Event	Peak Inflow (m^3/s)	Storm Duration (min)	Peak Outflow (m^3/s)	Storm Duration (min)	Storage used (m^3)	Stage used RL (m)
2 year ARI	7.03	20	1.99	120	5708	24.31
5 year ARI	9.33	20	2.35	120	9828	24.52
20 year ARI	12.5	20	3.54	120	14003	24.73
100 year ARI	16.2	20	5.10	120	18578	24.94

7.7 Discussion of Modelling Results

The results of the hydrologic modelling for the North Penrith site, as summarised in Tables 7.1 and 7.2, show that:

- The proposed detention basin is adequate to restrict peak post development discharges to below existing levels.
- Approximately 18,580m3 (76) of the available 24,340m3 of storage capacity in the basin is used in the peak 100 year ARI event.

The detention basin will provide a benefit to Penrith Council as it assists in reducing peak flows to the capacity of existing infrastructure.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

8 FLOODING

The following sections have been provided to address Clause C6 of the Concept Plan approval, which states the following:

C6 Flooding

Prior to the determination of any development approval for infrastructure works in Stage 2, the proponent shall submit a further assessment of flooding behaviour that includes:

1) *An assessment of the impact of filling on site on flood levels at adjoining properties; and*
2) *An assessment of the impact of climate change on flooding behaviour, changes to temperature, rainfall and evaporation and the impact this may have on flood levels on and adjoining the site and the stormwater management strategy.*

8.1 Local Flooding

The North Penrith development site has very little upstream catchment draining to it. Local flooding is therefore primarily limited to stormwater runoff from the development site only. Flows up to the 5 year ARI will be conveyed through the site via the stormwater pipe network. Flows in excess of the 5 year ARI (up to the 100 year ARI) will be conveyed by an overland flow network, which includes the roads and central water feature. The overland flow network will be designed to ensure that flows are conveyed safely in accordance with the Floodplain Development Manual (2005) and Penrith City Council requirements.

The development incorporates a detention basin to reduce peak post development flows to existing levels or the capacity of the downstream drainage infrastructure. Therefore, peak flows at the downstream boundary of the site will not increase as a result of the development and, hence, there will be no significant adverse impact on flood levels downstream of the site as a result of the development.

8.2 Regional Flooding

The site is partially affected by regional flooding from the Nepean River. The 100 year ARI regional flood (R.L. 25.4) affects only a small portion to the north west of the site, while the regional PMF (R.L. 31.0) affects the majority of the site.

In order to provide sufficient grade to drain the site and reduce the flood hazard for extreme events some filling is required. A Regional Flood Assessment was undertaken by Worley Parsons (2010). The assessment concluded that:

- The minimum habitable floor level was to be the 100 year ARI plus 0.5m freeboard (R.L. 25.9m AHD).
- The north western area of the site to be filled up to 1.5m in the lower areas to ensure the flood risk in floods rarer than the 100 year ARI would reduce the risk of substantial property damage to socially acceptable and sustainable levels.
- The proposed filling will meet Council's criteria by not causing any significant changes to flood behaviour, no potential for cumulative flood impacts, no significant adverse impacts on surrounding development and local drainage problems.

The filling works for Stages 2B-3B are generally consistent with the previous assessment undertaken by Worley Parsons (2010) and, hence, will not have significant adverse impacts on surrounding development.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

8.3 Climate Change

The potential impacts of climate change are outlined in a document titled Impacts of Climate Change on Urban Stormwater Infrastructure in Metropolitan Sydney, Sydney Metropolitan Catchment Management Authority (January 2011). In summary the impacts are:

Summer runoff depths are expected to increase by a maximum of 26□.

The 40-year 24-hour duration rainfall intensity is expected to increase by a maximum of 12□.

The net average annual runoff is expected to fluctuate with an overall minor increase.

Part of the standard freeboard requirement includes a component to account for climate variability. It is anticipated that any increases in flood levels as a result of climate change can be accommodated in the minimum 0.5m freeboard allowance to the dwelling floor levels.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

9 WATER BALANCE

9.1 Introduction

One of the main objectives of the North Penrith development is the provision of a central water feature and wetland. As part of the design of stages 2B-3B, J. Wyndham Prince undertook a detailed water balance assessment to ensure that both the central water feature and wetland were viable from both a water quality and water reuse perspective.

Algae risk in open water bodies is an ongoing concern and as part of the design process best management practices and techniques have been incorporated into the design of the water bodies to provide the best possible management of algae blooms during the warmer months of the year (see Section 9.3).

The viability of the central water feature and wetland will be influenced by the volume of rain runoff generated from the catchment. An important component of the runoff volume generated from the development is the inclusion of rainwater tanks within each proposed lot.

9.2 Assumptions and Considerations

As part of the concept approval, a detailed investigation has been completed by Worley Parsons titled “North Penrith – Drainage, Stormwater and Groundwater Management Report” (Worley Parsons, 2011).

This report provided a number of critical input variables to this current assessment. Details of the elements of the Worley Parsons report, together with the details of our assumptions and considerations are provided below.

- Runoff from precipitation falling on the 43.7 ha catchment (Worley Parsons Table 11, p.31) has been assumed as the only source of inflow.
- Daily rainfall and monthly evaporation data provided by the Bureau of Meteorology (BOM), for the Proposed Reservoir Station (No. 067019) for the period between 2nd February 1887 and 22nd January, 2008.
- Full development of the site (60 Pervious Urban Catchment) using a volumetric runoff coefficient of 0.57 (Worley Parsons Table 7, p. 25).
- Evaporation has been based on the Bureau of Meteorology (BOM) information for Prospect Reservoir, adjusted seasonally to account for climate change projections as recommended by the Office of Environment and Heritage (OEH). Daily rainfall values for Prospect Reservoir between 2 Feb, 1887 and 22 Jan, 2008 have been adopted.
- Reuse estimates have been based on a permanent population within the development of 2,430 people (900 dwelling x 2.7 person per dwelling) and the use of rainwater, to flush toilets only, at 40L/day/person. Total usage equal to 97,200 L/day.
- Unless otherwise specified, all of the following modelling results have been carried out on the assumption that the wetland and central water feature are on continuous water body. Consequently, the drawdown of the top water level (TWL), as a result of evaporation and/or reuse, refers to the anticipated decrease in TWL of the combined water bodies.

9.3 Algae Risk

The design and formation of the wetland and central water feature, that formed part of the Worley Parsons design (Worley Parsons, 2011), is in our opinion too shallow and is likely to be subjected to significant algal risks (both blue-green and filamentous). The engineering design presented on the DA plans has been configured to assist in minimising the algal risk.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Notwithstanding the possibility of algae blooms, we have assessed the likely management tools required to provide best practice management of the water bodies to reduce the likelihood of their occurrence and provide an acceptable level of control. Regardless of these tools a comprehensive algal risk management plan which is informed by a comprehensive monitoring strategy for the system will most likely be required by Penrith City Council.

The general criteria used to indicate the possibility of an impending blue-green algal bloom relate to: Warm water temperatures; Low dissolved oxygen; and an alkaline pH. Other criteria include nutrient levels in excess of the AN□ECC 2000 guidelines and extended periods of sunlight with mild to still wind conditions.

Strategies that have been used to limit algal blooms in the design are:

- Continual water movement through the system – this would involve the use of pumps to move water from the wetland up to the head of each of the central water feature cells. See JWP engineering plan 9470 DA16-20 for details of the recirculation system.
- Destratification – mechanical infrastructure used to mix the upper and lower layers of the water column and provide a homogenous water body with similar temperature, dissolved oxygen, pH and nutrient levels throughout.
- Shading – restrict extended periods of sunlight through the use of strategically placed vegetation and structures to provide shade, especially in spring and summer. Care should be taken to ensure that these shade structures do not present a windbreak.

9.4 Water Balance Assessment

The Water Balance Assessment has been undertaken using rainfall data from 2 Feb, 1887 to 22 Jan, 2008 or 121 years of rainfall for the Prospect Reservoir. As mentioned previously, the water balance assessment included rainwater tanks and reuse.

To enable the reuse and the impacts that the rainwater tanks will have on the Water Balance Assessment, we have simplified the assessment with the volume of the rainwater tanks and the potential reuse of this captured stormwater for toilet flushing into a daily loss rate. The assumption that approximately 2,430 people (2.7 people, per 900 proposed dwellings estimated) would use an upper limit of 40 L/day/person which results in an estimated loss rate to reuse of 97,200 L/day.

Considering this use and the runoff from 121 years of rainfall the water balance assessment has concluded that:

- The wetlands and central water feature could be expected to be close to full on average 69□ of the days each year.
- There is a 0.1□ probability that a maximum drawdown of 0.85 m across both water bodies (wetland and central water feature) would occur within a 12-month period.
- There is a 50□ probability that a drawdown, across both water bodies, in excess of 0.6 m could be expected to occur within any 12-month period for a maximum duration of about three (3) weeks. Spring and summer are the seasons within which a drawdown of this magnitude would most likely occur. Longest period of continual drawdown in excess of 0.2 m was approximately 30-weeks.
- There is a 100□ probability that a maximum drawdown, across both water bodies, in excess of 0.5 m could be expected to occur within any 12-month period. Spring and summer are the seasons within which a drawdown of this magnitude would most likely occur. However, numerous instances where drawdowns of this magnitude were identified during autumn and winter. Longest period of continual drawdown of between 0.5 m and 0.6 m was approximately 30-weeks whilst periods in excess of 3-weeks were not uncommon.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

- On average approximately 157,000 m^3/yr of runoff from the site can be expected to be discharged directly into Boundary Creek during rainfall events.
- If the wetland were to provide "top up" water for the central water feature, i.e. the stored water within the wetland is used to maintain the TWL in the central water feature regardless of the impact on the TWL within the wetland, then the TWL in the wetland could be expected to draw down by between 1.5 m and 2 m whilst the central water feature would remain full. The probability of this level of drawdown in any 12-month period could be expected to be as high as 50□ whilst the probability that it would draw down by 1 m in any 12-month period could be expected to be 100□.

Evaporation from the surface of both water bodies was based on the BOM seasonal Potential Evaporation values for Prospect Reservoir, modified to account for the seasonal variations projected by OEH attributed to their Climate Change projections. Evaporation was not calculated for those days on which rainfall had been recorded. Evaporation from the water bodies was based on the TWL surface area and no account was taken of the reduction in total volume evaporated as the surface area of the water bodies reduced i.e. shallow water is likely to evaporate at a greater rate than deeper water (as the TWL decreases with evaporation so does the surface area of the water body which in turn reduces the surface area from which evaporation can occur).

9.4.1 *Comments and Conclusion*

The Water Balance investigation has identified that a drawdown of up to 1.5 m (worst case scenario) in the wetland is possible and has been confirmed as an acceptable management tool to ensure the viability of the central water feature. The water balance has concluded that there is sufficient stormwater runoff from within the North Penrith development site to maintain the TWLs in the central water feature only.

The system can operate and be viable with only stormwater runoff from the site provided that the wetland becomes the sacrificial source of top up water for the Central Water Feature. Further water balance assessment will be undertake as part of the Construction Certificate development to confirm the viability of the system once detailed design of the system is completed.

9.5 Impacts Of Climate Change

Accounting for climate change in water balance calculations is a complex process which requires the extrapolation of projections of changes to seasonal precipitation and potential evapotranspiration (PET) to be scaled down to a daily time step. At present the algorithms to account for this have not been developed. DECCW (2010/171) "NSW Climate Change Impact Profile" does provide some guidance on projected changes to both seasonal precipitation and evaporation, and these have been adopted for this assessment. The only decrease projected for total precipitation is in winter months whilst only summer and spring evaporation are anticipated to increase by up to 20□.

Consequently for the purposes of this water balance assessment the existing BOM daily precipitation has been adopted and BOM PET values for Spring and Summer have been increased by 20□. It is anticipated that this adjustment will provide an over estimation of the draw down that may be experienced within the wetland / central water feature system, based on the 2050 Climate Change projections.

This assessment has been based on the current OEH projections for Climate Change Impacts on rainfall / runoff volumes and evaporation rates. It is subject to change as more confidence in the projections becomes available. However, it is our opinion that the values adopted in this assessment represent a considered approach to addressing Climate Change impacts on the proposed water bodies within this development and provide an insight into the possible fluctuations in TWLs which may be expected within the proposed water bodies.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

10 WATER QUALITY ANALYSIS

The water quality analysis for this study was undertaken using the model MUSIC (Model for Urban Stormwater Improvement Conceptualisation) Version 5 (CRCCH - 2005). This water quality modelling software was developed by the Cooperative Research Centre (CRC) for Catchment Hydrology, which is based at Monash University and was first released in July 2002.

The model provides a number of features relevant for the development:

- It is able to model the potential nutrient reduction benefits of gross pollutant traps, constructed wetlands, grass swales, bio-retention systems, sedimentation basins, infiltration systems and it incorporates mechanisms to model stormwater re-use as a treatment technique;
- It provides mechanisms to evaluate the attainment of water quality objectives;

The MUSIC modelling was undertaken to demonstrate that the water cycle management system proposed for the North Penrith site will result in a reduction in overall post-development pollutant loads.

10.1 Catchments

A MUSIC model was established for the proposed stormwater management system for the North Penrith Precinct. The proposed catchment is 40 ha and is split into urban, industrial / commercial and drainage reserve areas to represent each post development subcatchment within the Precinct. The general arrangement of the MUSIC model is shown in Appendix A.

The assumed catchment densities for the Precinct are detailed in Table 10.1:

TABLE 10.1 CATCHMENT DENSITIES ASSUMPTIONS

Adopted Average No. of Lots per Hectare	20 lots
Population per Dwelling	2.7 persons
Average Percentage Impervious of the Lots	90%
Average Roof Area per Dwelling	200 m^2

The majority of the catchment will discharge to the water quality elements prior to discharge to the central water feature and the wetland.

As with any computer model, a number of standard parameters are used in the establishment of the modelling components. Rainwater tanks, GPTs, wetlands, ponds and a sand filter were used as water quality elements in the treatment train to achieve the target reductions of pollutants. Details of the standard parameters used in this study are presented in Appendix A. The technical parameters associated with the MUSIC model node elements together with soil/groundwater assumptions are also presented in Appendix A.

10.2 MUSIC Modelling Philosophy and Parameters

Rainwater tanks are proposed to be provided for each household and industrial/commercial development capturing roof water for re-use within the Precinct and there are to be GPT's as primary treatment devices located throughout the development prior to discharging stormwater flows into all ponds or wetlands to ensure gross pollutants do not impact the operation of the secondary devices prior to discharge to the downstream drainage system.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

The central water feature forms the basis of the fringe wetlands and ponds capturing the majority of the site prior to discharging into the wetland at the downstream of the site drainage system. To prevent stagnation in the central water features, a pump system is proposed to recirculate the water through the central water feature ponds again, which also provides for additional treatment of flows. Prior to recirculation, the pumped flows will pass through a sand filter, which will provide further treatment. The recirculation system is proposed to operate at 50 l/s for a continuous period of 6 hours/day 7 days/week during the summer months (October through to April), a solenoid will control the recirculation flows during the rest of the year, essentially whenever storm flows are discharging through the system. The MUSIC model was set up to simulate the site treatment system, including a single recirculation cycle, with a second pass through the central water feature system to the main wetland, then discharging from the site.

The contributing catchments to each device within the Precinct are shown in Appendix A.

10.3 Rainfall Data

The MUSIC model is able to utilise rainfall data based on 6 minute, hourly, 6 hourly and daily time steps. A 6 minute time step was used in the analysis which was chosen in accordance with the recommendations for selecting a time step within the MUSIC User's Manual.

The nearest rainfall station to the site with a reasonable period of 6 minute rainfall data for a suitably representative period of rainfall for the site was:

Station No	Location	Years of Record	Type of Data
67033	Richmond RAAF	1980 - 1990	6 minute

The mean annual rainfall in the data set is 831mm, while the mean annual rainfall available from the Bureau of Meteorology's long term data for the station closest to the site (Orchard Hills) is 812mm.

10.4 Rainwater Tanks

For the purpose of this water quality assessment, it is assumed that the developments will have a reasonable demand for reuse, for things such as toilet flushing, irrigation of landscaped areas, vehicular washing and other appropriate uses, 3 kL rainwater tanks are being adopted for all individual residential lots throughout the Precinct. The rainwater tank parameters adopted in the assessment are provided in Appendix A.

10.5 Treatment Device Performance

The location and indicative sizes of the proposed treatment devices are shown on Figure 4. A summary of the proposed treatment devices sizes and respective total catchment areas are presented in Table10.2 below.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

TABLE 10.2 TREATMENT DEVICE SIZES

Stormwater Treatment Device	Sandfilter	Wetlands		Ponds	
	Filter Bed Area m	Wetland Area m	Volume m	Pond Area m	Volume m
Central Water Feature Wetland		1480	740		
Pond 1				805	1280
Pond 2				1125	1785
Pond 3				5820	9240
Main Wetland		9400	10000		
Recirc Sandfilter	210				
Total	**2**	**88**			**2**

10.6 Pollutant Load Estimates

The pollutant loads at the discharge points from the wetland/detention basin after the initial treatment run is shown in Table 10.3.

TABLE 10.3 ESTIMATED MEAN ANNUAL POLLUTANT LOADS AND REDUCTIONS - MAIN WETLAND AFTER INITIAL PASS

Pollutant	Total Developed Source Nodes kg/yr	Minimum Reduction Required kg/yr	Total Residual Load from Site kg/yr	Total Reduction Achieved kg/yr	Total Reduction Achieved
TSS	50,600	43,010	14,100	36,500	**2**
TP	95.8	62.3	38.3	57.5	
TN	615	277	361	254	
ross Pollutants	7,640	6,876	0.0	7,640	

The results of pollutant removal performance through the sand filter for the recirculated flows (up to 50 l/s) is shown in Table 10.4, and the resulting pollutant removal performance through one full cycle of recirculation (at 50 l/s) through the central water feature system and wetland at the discharge point from the site is shown in Table 10.5.

TABLE 10.4 ESTIMATED MEAN ANNUAL POLLUTANT LOADS AND REDUCTIONS - RECIRCULATION FLOWS THROUGH SAND FILTER

Pollutant	Total Developed Source Nodes kg/yr	Minimum Reduction Required kg/yr	Total Residual Load from Site kg/yr	Total Reduction Achieved kg/yr	Total Reduction Achieved
TSS	50,600	43,010	10,100	40,500	**8**
TP	95.8	62.3	29.3	66.5	
TN	615	277	307	308	
ross Pollutants	7,640	6,876	0.0	7,640	

Locations of junctions within the Precinct are shown in the layout plan in Appendix A.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

TABLE 10.5 ESTMATED MEAN ANNUAL POLLUTANT LOADS/REDUCTIONS RECIRCULATION FLOWS THROUGH CENTRAL WATER FEATURE AND WETLAND SYSTEM TO SITE DISCHARGE POINT (ONE CYCLE)

Pollutant	Total Developed Source Nodes (kg/yr)	Minimum Reduction Required (kg/yr)	Total Residual Load from Site (kg/yr)	Total Reduction Achieved (kg/yr)	Total Reduction Achieved (%)
TSS	50,700	43,095	7,400	43,300	**8**
TP	96.0	62.4	24.9	71.1	
TN	617	278	264	353	**2**
ross Pollutants	7,670	6,903	35.8	7,634	

10.7 Discussion of Modelling

The performance of the proposed water quality management strategy for the North Penrith Defence Lands Precinct shows that the treatment train proposed will meet the requirements specified within OEH's water quality objectives (OEH, 2009) after one recirculation pass through the treatment system.

The expectation is that the system will be continually subject to recirculation and that a considerable portion of the stormwater flows will be repeatedly retreated by the central water feature-wetland system, providing a higher level of treatment performance than is reported.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

11 SUMMARY & CONCLUSION

The Water Cycle Management Strategy incorporating WSUD techniques has been prepared for the North Penrith Stage 2B-3B development to support the DA process for the site. The strategy has been prepared to conform with the statutory requirements and industry best practice for stormwater management in this catchment.

The Water Cycle Management Strategy consists of a treatment train consisting of on lot treatment, street level treatment and subdivision / development treatment measures. The structural elements proposed for the development consists of:

- 3,000 litre rainwater tanks on each allotment.
- Proprietary GPT units at each stormwater discharge point.
- A central water feature consisting of macrophyte zones of total approximate area 1,480m^2 and three ponds of total area 7,750m^3 .
- A constructed wetland of total area 9,400m□.
- A sand filter of total area 210m^2.
- A detention basin of approximate total volume 24,340m^3.

Provision of the proposed detention basin within the development will ensure that peak post development discharges are restricted to less than the pre development levels.

The results of the water balance and water quality investigations identify that the wetland and central water feature are sustainable with stormwater runoff generated from the site and do not require an external top up source of water supply.

The wetland and central water feature will be subject to the risk of algal blooms, particularly from spring to autumn. The engineering design incorporates the following best management practices and initiatives to address the algal risk:

- Incorporation of deep water areas will aid in keeping water temperatures lower in summer.
- Installation of a mechanical recirculation system to allow water to be recirculated from the sand filter to the central water feature.
- Water movement through the system, which is provided by the pumped flows.
- An aeration system is to be incorporated which assists in keeping the water temperature lower and circulation.
- The wetland has been designed with 80□ coverage of macrophyte vegetation.

Provision of the proposed water quality treatment devices within the development will ensure that the post development stormwater discharges will meet the Office of Environment and Heritage's and Landcom's water quality objectives for the North Penrith development.

The provision of WSUD elements within the North Penrith development will assist in minimising the impact of urbanisation on the waterway stability of the downstream waterways.

The proposed Water Cycle Management Strategy for the developed site provides a basis for the detailed design and development of the site to ensure that the environmental, urban amenity, engineering and economic objectives for stormwater management and site discharge are achieved.

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

12 REFERENCES

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Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

APPENDIX A – MUSIC WATER QUALITY RESULTS AND DETAILS

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

MUSIC MODELLING LANDUSE PARAMETERS

Details of the soil / groundwater parameters adopted for the MUSIC modelling undertaken for this development are presented in Table A1 below. The adopted Annual Pollutant event mean concentrations are also presented in Table A2 below:

Table A1 ADOPTED SOIL / GROUNDWATER PARAMETERS FOR THE SITE [1]

	Units	Parks & Landscaped	Urban
Impervious Area Parameters			
Rainfall threshold (Road 1, Roofs 0.5)	mm/day	1.4	1.4
Pervious Area Parameters			
Soil storage capacity	mm	210	170
Initial storage	% of capacity	30	30
Field capacity	mm	80	70
Infiltration capacity coefficient - a		175	210
Infiltration capacity coefficient - b		3.1	4.7
Groundwater Properties			
Initial depth	mm	10	10
Daily recharge rate	%	35	50
Daily baseflow rate	%	20	4
Daily deep seepage rate	%	0	0

* Roofed and Road catchments have been assumed to be 100% impervious

Table A2 ADOPTED ANNUAL POLLUTANT EVENT MEAN CONCENTRATIONS [2]

Pollutant	Roofed*		Road*		Remaining Urban		Parks & Landscaped	
	Base Flow (mg/l)	Storm Flow (mg/l)	Base Flow (mg/l)	Storm Flow (mg/l)	Base Flow (mg/l)	Storm Flow (mg/l)	Base Flow (mg/l)	Storm Flow (mg/l)
TSS	0	20	0	270	16	141.2	6	40
TP	0	0.13	0	0.5	0.14	0.18	0.03	0.08
TN	0	2	0	2.2	1.3	1.68	3.3	0.9

* Roofed and Road catchments have been assumed to be 100% impervious

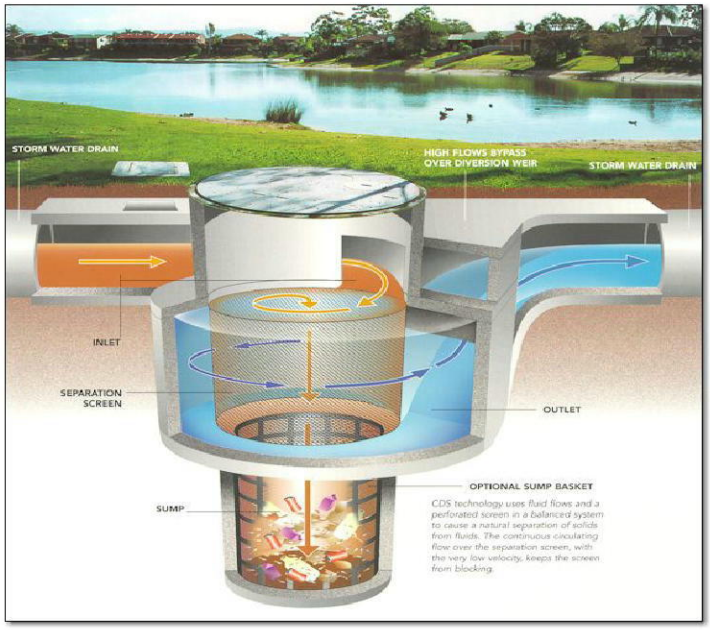
1 CRC for Catchment Hydrology (2005). MUSIC Model for Urban Stormwater Improvement Conceptualisation – User Guide Version 3

2 Department of Environment and Climate Change. Technical Note – Interim Recommended Parameters for Stormwater Modelling – North-West and South-West Growth Centres

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

GROSS POLLUTANT TRAPS (GPT'S)

GPT devices are typically provided at the outlet to stormwater pipes. These systems operate as a primary treatment to remove litter, vegetative matter, free oils and grease and course sediments prior to discharge to a downstream (Secondary and Tertiary) treatment devices. They can take the form of trash screens or litter control pits, filter pit inserts and wet sump gross pollutant traps. Council approved GPT units are to be provided at the end of stormwater pipes servicing urbanised catchments prior to discharging to the receiving waters.



Gross pollutant traps are available in various sizes and the performances of these devices vary substantially. To ensure flexibility in the detailed design phase of any development project, J. Wyndham Prince adopt a generic GPT node in its Water Quality Modelling.

Music Modelling Parameters

Within MUSIC transfer functions are used to calculate the stormwater effluent concentration of the stormwater flowing into the device, using a simple graphical relationship between the inflow and outflow concentration. MUSIC allows the user to describe the performance of the generic node by using a graphically based transfer function editor, for each of the pollutant types – Gross Pollutants (GP), Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN). The adopted values for modelling of GPT's for this development are presented in Table A3 below.

As the there is currently no adopted Australian method of measuring comparable performance of various GPT devices, and the products can range from basic trash screens to sophisticated proprietary devices, the TSS and nutrient removal performance of the systems has been conservatively adopted as zero. Individual products may achieve substantially improved performance over these adopted targets.

Table A3 ADOPTED GPT PERFORMANCE PARAMETERS

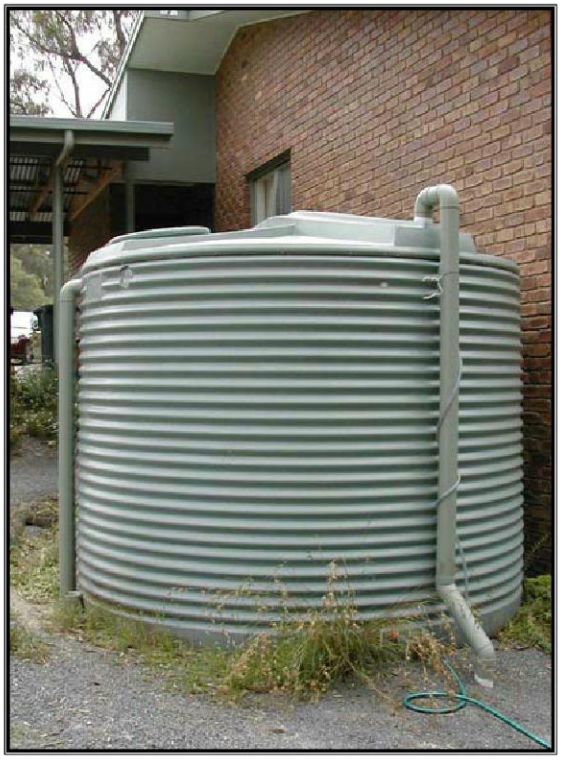
Pollutant Type	Remove Efficiency
GP	90%
TSS	0%
TP	0%
TN	0%

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

RAINWATER TANKS

Rainwater tanks are sealed tanks designed to contain rainwater collected from roofs. Rainwater tanks provide the following main functions:

- Allow the reuse of collected rainwater as a substitute for mains water supply, for use for toilet flushing, laundry, or garden watering (facilitate attainment of BASIX compliance).
- Provide some on-site detention, thus reducing peak flows and reducing downstream velocities; (when designed with additional storage capacity above the overflow);
- Provide captured stormwater for internal hot water supply (in some instances).



The water collected can be reused as a substitute for mains water supply either indoors (toilet flushing and laundry) or outdoors (garden watering). Rainwater tanks can be either above ground or underground. Above ground tanks can be placed on stands to prevent the need of installing a pump to distribute the water. Such systems are referred to as gravity systems. Pressure systems require a pump and can be either above or below ground tanks.

Tanks can be constructed of various materials such as Colorbond, galvanised iron, polymer or concrete.

Music Modelling Performance Criteria

The expected sediment and nutrient removal performance of the proposed devices was determined using the default equations and parameters provided in the MUSIC model. The water quality reduction mechanisms in MUSIC are based on an exponential decay equation referred to as the k -C* curve. The adopted MUSIC modelling parameters for Rainwater tanks are presented in Table A4.

Table A4 ADOPTED RAINWATER TANK PERFORMANCE PARAMETERS

	Rainwater Tanks	
Pollutant	**k (m/yr)**	**C* (mg/L)**
TSS	400	12.000
TP	300	0.130
TN	40	1.400

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Re use Assumptions

Residential water demand is estimated based on the values presented in Draft NSW MUSIC Modelling Guidelines by BMT WBM and CMA (2010). The external and internal usage for typical rural and urban residential households is indicated in Table A5 below.

For the current assessment, rainwater tanks are assumed to store sufficient water for toilet and laundry (internal use) and all external uses. A total of **2.7** occupants per dwelling has been adopted. A maximum of 80% of the physical rainwater tank volume is adopted for modelling in order to allow for top up from Sydney Water supply during dry periods. A summary of the parameters adopted in the MUSIC modelling undertaken for the site are presented in Table A6. We have conservatively adopted re-use rates lower than that suggested by the CMA in the modelling, which result in lower pollutant removal efficiencies.

TABLE A5 RESIDENTIAL WATER USAGE FOR VARIOUS OCCUPANCY AND END USE SCENARIOS[3]

	RURAL DWELLING				URBAN DWELLING			
	solely reliant on rainwater tanks				mains water supply is reticulated			
End Use	**Annual Internal Use in Kilolitres (kL/yr/dwelling)**							
No of Occupants	1 to 2	3	4	5	1 to 2	3	4	5
Toilet	31	44	57	71	46	66	86	106
Toilet + Laundry	60	88	115	142	91	131	172	212
Toilet + Laundry + Hot Water	110	159	206	256	164	237	309	384
Toilet + Laundry + Hot Water + Other	122	175	230	283	183	263	343	424
End Use	**Daily Internal Use in Kilolitres (kL/day/dwelling)**							
Toilet	0.085	0.120	0.155	0.195	0.125	0.180	0.235	0.290
Toilet + Laundry	0.165	0.240	0.315	0.390	0.250	0.360	0.470	0.580
Toilet + Laundry + Hot Water	0.300	0.435	0.565	0.700	0.450	0.650	0.845	1.045
Toilet + Laundry + Hot Water + Other	0.335	0.480	0.630	0.775	0.500	0.720	0.940	1.160
Annual External Use	112 kL/year/dwelling							

TABLE A6 ADOPTED RESIDENTIAL WATER USAGE

Contributing Catchment to Rainwater Tank (33% of Average Roof Area, m²)	67
Active Storage Volume (m³)	2.4
Rainwater Tank Top Up	Below 20% capacity
Internal Reuse Rate (Laundry + Toilets), kL/day/dwelling	0.25
External Reuse Rate, kL/year/dwelling	50
Rainwater Tank Bypass (m³/s)	0.002

[3] Catchment Management Authority & BMT WBM, Sydney (2010). Draft NSW MUSIC Modelling Guidelines

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

A summary of the parameters adopted in the MUSIC modelling undertaken for each allotment in the site site are presented in Table A7, the resulting parameters adopted for each catchment are presented in Table A8.

TABLE A7 ADOPTED RAINWATER TANK PARAMETERS (PER LOT)

Parameter	Amount	Unit
Low level Overflow	0	l/s
High level Overflow (per Dwelling)	2	l/s
Active Storage Volume	2.4	m^3
Depth Above Overflow	0.2	m^3
Surface Area	1.6	m^2
Overflow Pipe Diameter	50	mm
Residential Dwellings per Hectare	20	houses/ha
Daily Re-Use (Interior)	0.25	kl/day
Annual Re-Use (Exterior)	50	kl/year

TABLE A8 ADOPTED RAINWATER TANK PARAMETERS (EACH CATCHMENT)

Catchment Designation	Dwellings (No.)	Total Roofed Area (ha)	Roof Area Captured for Re-Use (ha)	High Level Bypass (m^3/s)	Tank Volume (m^3)	Tank Area (m^2)	Overflow Pipe Diameter (mm)	Annual Demand (kL/yr)	Daily Demand (kL/day)
C1	35	0.70	0.233	0.070	84	56	296	1750	8.75
C4	40	0.80	0.267	0.080	96	64	316	2000	10.00
C4a	10	0.20	0.067	0.020	24	16	158	500	2.50
C5	25	0.50	0.167	0.050	60	40	250	1250	6.25
C6	55	1.10	0.367	0.110	132	88	371	2750	13.75
C7	135	2.70	0.900	0.270	324	216	581	6750	33.75
C9	5	0.10	0.033	0.010	12	8	112	250	1.25
C12	20	0.40	0.133	0.040	48	32	224	1000	5.00
C13	65	1.30	0.433	0.130	156	104	403	3250	16.25
C14	105	2.10	0.700	0.210	252	168	512	5250	26.25
C15	50	1.00	0.333	0.100	120	80	354	2500	12.50
C16	30	0.60	0.200	0.060	72	48	274	1500	7.50

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

CENTRAL WATER FEATURE PONDS

The Central Water Feature Ponds consists of an open water body with an extended detention zone typically from 100-300 mm deep designed to detain and treat first flush flows from the upstream catchment. Ornamental ponds are generally provided as an aesthetic amenity for the community and are typically located within focal open space areas. The overall depth of ornamental ponds are typically 1.5 – 2.5 m deep.

Music Modelling Parameters

The general feature and standard configuration of ornamental ponds are shown in Table A9 below:

Table A9 ADOPTED POND SYSTEM MUSIC FEATURES

	Ponds
Storage	
Surface Area (m^2)	various
Extended Detention Depth	0.3
Evaporative Loss as % of PET	100
Outlet	
Equivalent Pipe Diameter (mm)	50
Overflow Weir Width (m)	5
Notional Detention Time (hrs)	78.4

Performance Criteria

The expected sediment and nutrient removal performance of the proposed devices was determined using the default equations and parameters provided in the MUSIC model. The water quality reduction mechanisms in MUSIC are based on an exponential decay equation referred to as the k - C* curve and the adopted values are presented in Table A10.

Table A10 ADOPTED POND PERFORMANCE PARAMETERS

	Pond	
Pollutant	**k (m/yr)**	**C* (mg/L)**
TSS	400	12.000
TP	300	0.090
TN	40	1.000

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

WETLAND

The Wetland consists of an open water body with a specified area of macrophyte plants along a shallow fringe and an extended detention zone typically from 100 to 300 mm deep designed to detain and treat first flush flows from the upstream catchment. Wetlands are generally provided as an aesthetic amenity for the community and are typically located within focal open space areas. The deep water zones of wetlands are typically 1.5 – 2.5 m deep, with shallow fringes to allow the proliferation of macrophyte vegetation.

Music Modelling Parameters

The general feature and standard configuration of wetlands are shown in Table A11 below:

Table A11 ADOPTED WETLAND SYSTEM MUSIC FEATURES

	Canal Wetlands	Main Wetland
Storage		
Surface Area (m^2)	varies	6800
Extended Detention Depth (m)	Varies, generally 0.3	0.3
Permanent Pool Volume (m^3)	varies	10000
Evaporative Loss as % of PET	100	100
Outlet		
Equivalent Pipe Diameter (mm)	60	210
Overflow Weir Width (m)	3	5
Notional Detention Time (hrs)	4	10

Performance Criteria

The expected sediment and nutrient removal performance of the proposed devices was determined using the default equations and parameters provided in the MUSIC model. The water quality reduction mechanisms in MUSIC are based on an exponential decay equation referred to as the k - C* curve and the adopted values are presented in Table A12.

Table A12 ADOPTED WETLAND PERFORMANCE PARAMETERS

	Wetland	
Pollutant	**k (m/yr)**	**C* (mg/L)**
TSS	1500	6.000
TP	100	0.060
TN	150	1.000

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

SAND FILTER

A Sand Filter is proposed to be located immediately downstream of the main Wetland accepting discharges for the recirculation system prior to being pumped to the head of the canal system. The device will form part of the treatment train and will be appropriately sized to help achieve the required OEH Stormwater treatment targets. Discharges through the sand filter will be controlled by the pump system at 0.05 m³/s

Music Modelling Parameters

The general feature and standard configuration of ornamental pond are shown in Table A13 below:

Table A13 ADOPTED SAND FILTER SYSTEM MUSIC FEATURES

	Sand Filter
Storage	
Extended Detention Depth	0.3
Infiltration	
Filter Area (m^2)	210
Filter Depth (m)	0.5
Filter Particle Effective Diameter (mm)	0.60
Saturated Hydraulic Conductivity (mm/h)	1200
Outlet	
Overflow Weir Width (m)	2

Performance Criteria

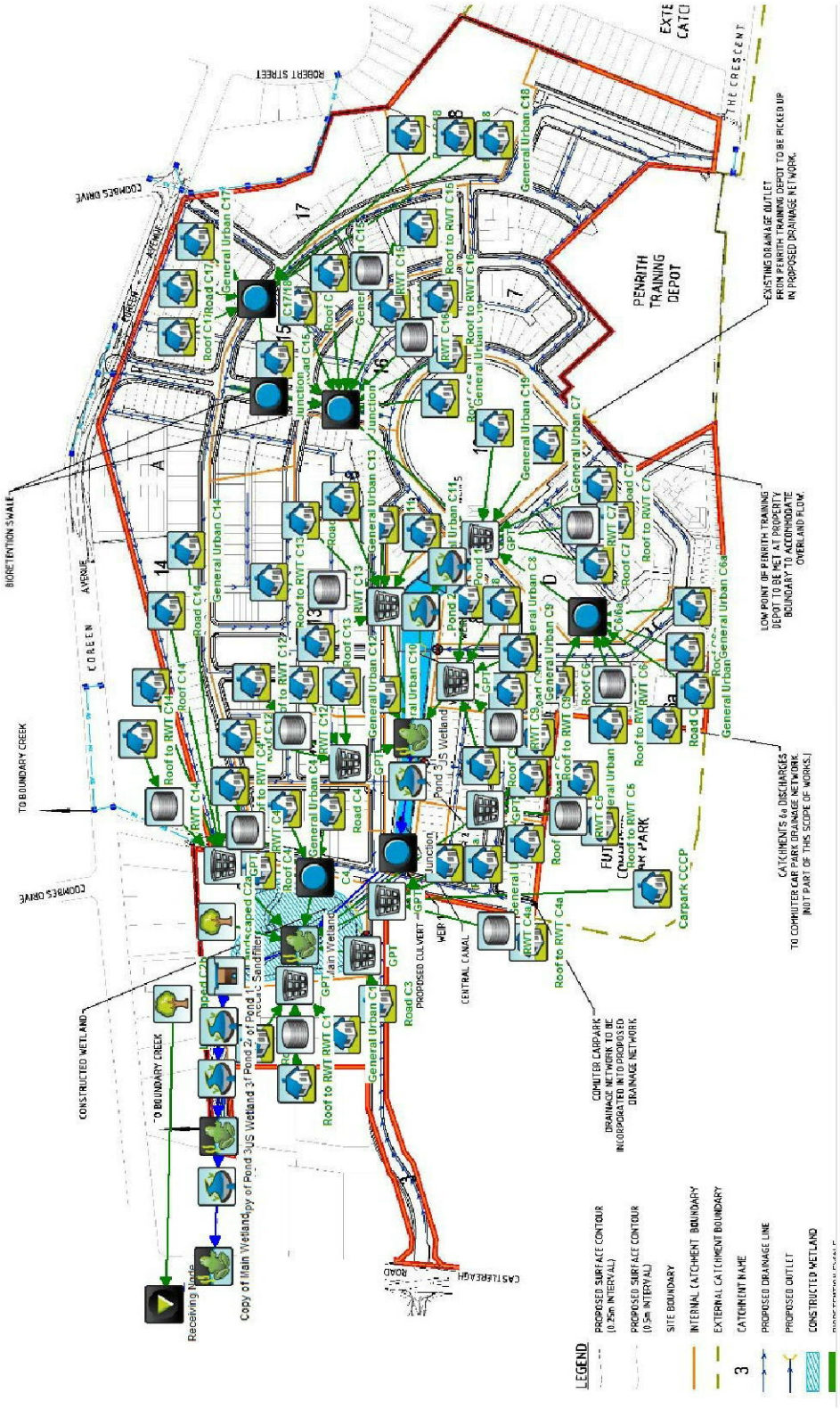
The expected sediment and nutrient removal performance of the proposed devices was determined using the default equations and parameters provided in the MUSIC model. The water quality reduction mechanisms in MUSIC are based on an exponential decay equation referred to as the k - C* curve and the adopted values are presented in Table A14.

Table A14 ADOPTED SAND FILTER PERFORMANCE PARAMETERS

	Sand Filter	
Pollutant	**k (m/yr)**	**C* (mg/L)**
TSS	8000	20.000
TP	6000	0.130
TN	500	1.400

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

MUSIC MODEL LAYOUT



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Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

MUSIC MODEL CATCHMENTS

The adopted catchment areas and assumed percentage imperviousness used for the source nodes are presented below in Table A15.

Table A15 ADOPTED MUSIC MODEL CATCHMENT PARAMETERS

						MUSIC INPUTS					
Catchment Designation	Total Catchment Area (ha)	Assumed %Impervous (%)	Impervious Area (ha)	Pervious Area (ha)	Roofed Area (ha)	Roof to Tank for Re-Use (ha)	Roof Bypassing Tank (ha)	Roads (ha)	General Urban (ha)	General Urban Imperviousness (%)	Landscaped (ha)
C1	1.2	96%	1.15	0.05	0.70	0.233	0.467		0.50	90%	
C2a	1.3	10%	0.13	1.17							1.30
C2b	1.0	10%	0.10	0.90							1.0
C3	0.8	100%	0.80	0.00				0.80			
C4	2.1	91%	1.92	0.18	0.80	0.267	0.533	0.80	0.50	64%	
C4a	0.3	88%	0.26	0.04	0.20	0.067	0.133		0.10	64%	
CCCP	3.0	100%	3.00	0.00				3.00			
C5	1.2	94%	1.12	0.08	0.50	0.167	0.333	0.40	0.30	74%	
C6	3.1	96%	2.98	0.12	1.10	0.367	0.733	1.30	0.70	83%	
C6a	0.4	95%	0.38	0.02	0.20		0.200		0.20	90%	
C7	7.3	95%	6.90	0.40	2.70	0.900	1.800	2.80	1.80	78%	
C8	0.4	96%	0.38	0.02	0.20		0.200		0.20	92%	
C9	0.4	90%	0.36	0.04	0.10	0.033	0.067	0.20	0.10	60%	
C10	1.5	40%	0.60	0.90					1.50	40%	
C11	0.3	97%	0.29	0.01	0.20		0.200		0.10	90%	
C12	1.0	92%	0.92	0.08	0.40	0.133	0.267	0.40	0.20	60%	
C13	3.8	86%	3.26	0.54	1.30	0.433	0.867	1.40	1.10	51%	
C14	4.4	90%	3.98	0.42	2.10	0.700	1.400	0.90	1.40	70%	
C15	2.9	88%	2.54	0.36	1.00	0.333	0.667	1.00	0.90	60%	
C16	1.7	93%	1.58	0.12	0.60	0.200	0.400	0.80	0.30	60%	
C17	1.9	85%	1.62	0.28	0.90		0.900	0.30	0.70	60%	
C18	1.8	29%	0.52	1.28	0.10		0.100	0.10	1.60	20%	
Totals	41.8	83%	34.81	6.99	13.10	3.833	9.267	14.20	12.20		2.30

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

APPENDIX B – XP-RAFTS PARAMETERS

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Table B-1 IFD Rainfall Intensity

Duration (minutes)	100 Year ARI Rainfall Intensity (mm/hour)
10	168
15	140
20	122
30	99
45	79
60	67
90	53
120	44.4
180	34.8
270	27.2
360	22.8
540	17.9
720	15
1080	12
1440	10.2
2160	8.09
2880	6.8
4320	5.24

Table B-2 Loss Parameters

Pervious		Impervious	
Initial Loss (mm)	Continuous Loss (mm/ hr.)	Initial Loss (mm)	Continuous Loss (mm/ hr.)
10	2.5	1	0

Table B-3 Fraction Impervious for Runoff Coefficients

Land Use	f
Public Recreation Areas/ Open Space	0.5
Residential Lot Only	0.85
Water bodies	1
Half Width Road Reserve	0.95
Industrial Areas/ Commercial Areas	0.95

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Table B-4a Catchment Breakup for Existing Condition

EXISTING CONDITION					
Catchment ID	Area	Percent Impervious	Pervious Area	Impervious Area	Slope
	(Ha)	(%)	(Ha)	(Ha)	(%)
1A	0.6	70	0.18	0.42	6.5
1B	1.3	65	0.46	0.85	4.4
2	2.5	75	0.63	1.88	1.9
3	3.3	20	2.64	0.66	5.6
4	1.7	85	0.26	1.45	2.2
5	2.2	50	1.10	1.10	2.4
6	5	50	2.50	2.50	0.3
7	4.3	15	3.66	0.65	0.3
8	5.8	80	1.16	4.64	1.2
9	4	20	3.20	0.80	0.7
10	2.9	70	0.87	2.03	0.5
11	3	25	2.25	0.75	0.3
12	3.8	5	3.61	0.19	0.8
13	6	5	5.70	0.30	0.2
14	0.4	90	0.04	0.36	0.5
15A	0.5	90	0.05	0.45	0.2
15B	0.3	90	0.03	0.27	0.6
16	2.3	5	2.19	0.12	0.1
17	0.8	5	0.76	0.04	0.3
18	0.3	5	0.29	0.02	1.1

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Table B-4b Catchment Breakup for Proposed Condition

DEVELOPED CONDITION					
Catchment ID	Area	Percent Impervious	Pervious Area	Impervious Area	Slope
	(Ha)	(%)	(Ha)	(Ha)	(%)
A1	4	85	0.6	3.4	3.0
A10	1.7	85	0.3	1.4	0.9
A11	0.2	85	0.0	0.2	1.0
A12	1.4	55	0.6	0.8	1.0
A13	0.4	85	0.1	0.3	0.8
A14	2.1	5	2.0	0.1	1.0
A15	2.2	80	0.4	1.8	0.3
A16	0.5	85	0.1	0.4	1.0
A17	0.4	85	0.1	0.3	0.8
A18	1.2	85	0.2	1.0	0.6
A19	2.1	85	0.3	1.8	0.6
A2	2.9	85	0.4	2.5	0.4
A20	0.2	85	0.0	0.2	0.6
A21	1.5	85	0.2	1.3	0.5
A22A	0.5	90	0.1	0.5	0.4
A22B	0.2	90	0.0	0.2	0.7
A23	1.9	55	0.9	1.0	0.3
A24	1.2	90	0.1	1.1	1.0
A25	0.3	5	0.3	0.0	1.1
A3	1.7	85	0.3	1.4	0.8
A4	2.5	85	0.4	2.1	0.6
A5	1.8	10	1.6	0.2	5.1
A6	1.9	90	0.2	1.7	0.7
A7	1.7	85	0.3	1.4	0.9
A8	2.7	85	0.4	2.3	0.9
A9	3.3	80	0.7	2.6	0.8

Table B-5 Manning's PERN Values

Parameter	Catchment Condition	Adopted Value
PERN	Pervious	0.025
PERN	Impervious	0.015

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Table B-6a Summary of Links – Existing Condition

EXISTING CONDITION			
Lag Link	Flow path Length (m)	Assumed Velocity (m/s)	Lag Time (min)
1B-5	264	1.5	2.9
9-13	211	1.0	3.5
3-8	305	1.0	5.1
2-3	173	2.0	1.4
1A-4	306	1.5	3.4
5-7	234	1.0	3.9
4-6	232	1.0	3.9
7-9	137	1.0	2.3
15-14	169	1.0	2.8
11-14	326	1.0	5.4
6-10	141	1.0	2.3
8-9	141	1.0	2.4
10-13	287	1.0	4.8
12-13	256	1.0	4.3
d1-16	235	1.0	3.9
d1-18	134	1.5	1.5
17-18	70	1.5	0.8

Table B-6b Summary of Links – Proposed Condition

DEVELOPED CONDITION			
Lag Link	Flow path Length (m)	Assumed Velocity (m/s)	Lag Time (min)
24-22B	134	1.0	2.2
22B-23	174	1.0	2.9
23-25	147	1.0	2.5
CROSS A12	339	1.0	5.7
A16-A15	255	1.0	4.3
A4-A10	311	1.0	5.2
A3-A10	206	1.0	3.4
A1-A2	195	1.0	3.3

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017

Table B-7a: Tailwater condition at Coreen Avenue discharge point

Flow(m^3/s)	Stage (m)
0	22.85
5.24	24.62
5.65	24.69
6.38	24.84

Table B-7b: Tailwater condition at Boundary Creek discharge point

Flow(m^3/s)	Stage (m)
0	23.4
5.5	24.84
7	25

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FIGURES

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LEGEND

- NORTH PENRITH SITE BOUNDARY
- NORTH PENRITH STAGE 1 SITE BOUNDARY
- NORTH PENRITH STAGE 2A SITE BOUNDARY
- NORTH PENRITH STAGES 2B-3B SITE BOUNDARY

Aerial Photograph Date: 2012 (supplied courtesy of NearMap Pty Ltd)

Notes:

N
W E
S

Scale 1: 4,000

100 0 100 m

Figure 1

North Penrith Stages 2B-3B

Site Layout and Staging Plan

File Name: 9470Fig1_Site Layout Plan
Date : 7/9/12 Issue A

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Version: 1, Version Date: 28/04/2017

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LEGEND

- NORTH PENRITH SITE BOUNDARY
- 0.5m INTERVAL EXISTING CONTOUR
- EXISTING CATCHMENT BOUNDARY

N
W E
S

Scale 1: 4,000

100 0 100 m

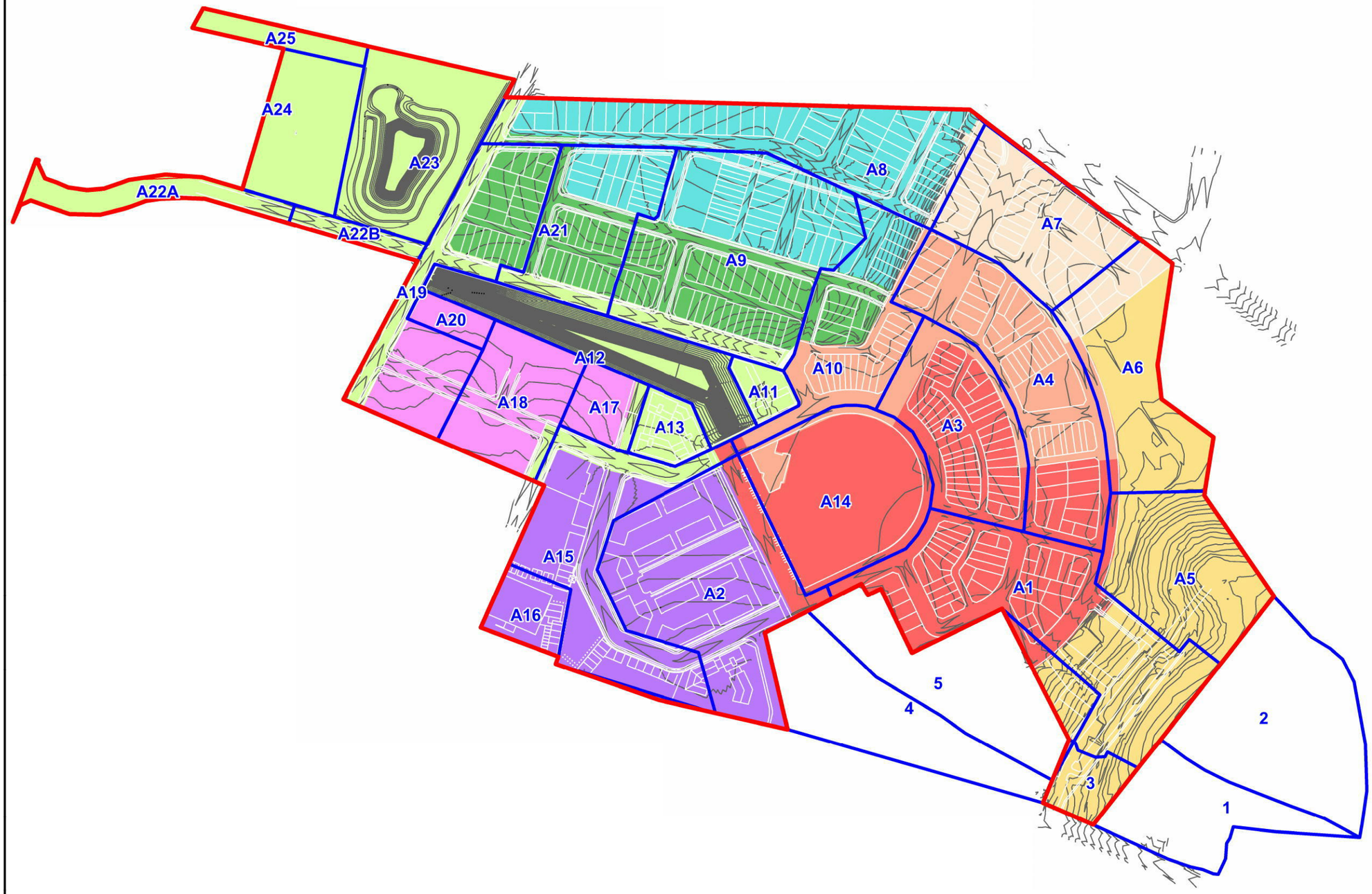
Figure 2

North Penrith Stages 2B - 3B

Existing Catchment Plan

File Name: 8470Fig2_Ext Catchment Plan
Date : 03/09/2012 Issue : A

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017



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LEGEND

- NORTH PENRITH SITE BOUNDARY
- 0.25m INTERVAL CONTOUR
- DEVELOPED CATCHMENT BOUNDARY

N
W E
S

Scale 1: 4,000 @ A3

100 0 100 m

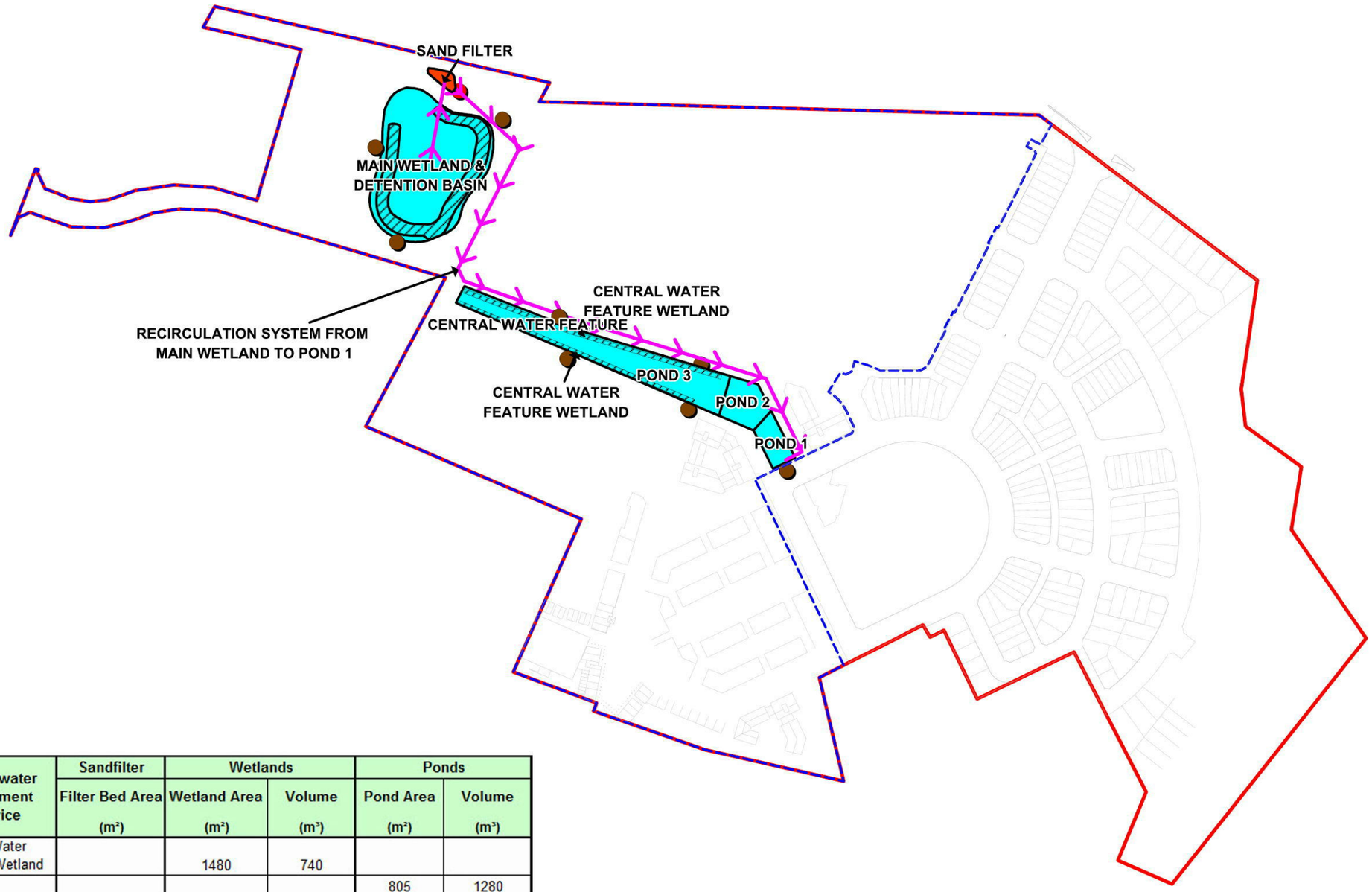
Figure 3

North Penrith Stages 2B - 3B

Developed Catchment Plan

File Name: 9470Fig3_Dev_Catchment_Plan
Date : 10/09/2012 Issue : B

Document Set ID: 7627536
Version: 1, Version Date: 28/04/2017



Stormwater Treatment Device	Sandfilter	Wetlands		Ponds	
	Filter Bed Area (m²)	Wetland Area (m²)	Volume (m³)	Pond Area (m²)	Volume (m³)
Central Water Feature Wetland		1480	740		
Pond 1				805	1280
Pond 2				1125	1785
Pond 3				5820	9240
Main Wetland		9400	10000		
Recirc Sandfilter	210				
Total	**210**	**10880**	**10740**	**7750**	**12305**

LANDCOM

PO Box [illegible] PENRIT[illegible] WESTFIELD NSW 2[illegible]
P [illegible]2[illegible]2[illegible]
F [illegible]2[illegible]2[illegible]8
W www[illegible]wprince[illegible]com[illegible]au
E [illegible]wp[illegible]wprince[illegible]com[illegible]au

LE[illegible]END

- NORTH PENRITH SITE BOUNDARY
- STAGE 2B - 3B SITE BOUNDARY
- INDICATIVE LOCATION OF GROSS POLLUTANT TRAP
- POND
- WETLAND
- SAND FILTER
- RECIRCULATION CONDUIT FROM SAND FILTER TO HEAD OF CANAL

N
W E
S

Scale [illegible]: [illegible] A[illegible]

100 0 100 m

Figure [illegible]

North Penrith Stages 2B - [illegible]B

Proposed Water Cycle Management Plan

File Name: 9470Fig4[illegible]WCMP
Date : 03/09/2012 Issue : B

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