Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Preliminary Desktop Assessment

Proposed Water Supply and Sewer Pipeline
Kings Hill, North Raymond Terrace

Prepared for
PM No 1 Pty Ltd

Project 81502.11
October 2019

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	81502.11	Document No.	R.001.Rev1
Document title	Report on Preliminary Desktop Assessment Proposed Water Supply and Sewer Pipeline		
Site address	Kings Hill, North Raymond Terrace		
Report prepared for	PM No 1 Pty Ltd		
File name	81502.11.R.001.Rev1		

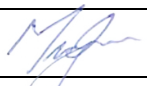
Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Michael Gawn	Stephen Jones	20 September 2019
Revision 1	Michael Gawn	Stephen Jones	10 October 2019

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	0	Wesley Chong, PM No 1 Pty Ltd
Revision 0	1	0	Adam Smith, APP Pty Ltd
Revision 1	1	0	Wesley Chong, PM No 1 Pty Ltd
Revision 1	1	0	Adam Smith, APP Pty Ltd

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		10 October 2019
Reviewer		10 October 2019

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Report on Preliminary Desktop Assessment
Proposed Water Supply and Sewer Pipeline
Kings Hill, North Raymond Terrace

1. Introduction

This report presents the results of a preliminary desktop assessment undertaken for a proposed water supply and sewer pipeline at Raymond Terrace. The investigation was commissioned in an email dated 12 September 2019 by Adam Smith of APP Pty Ltd, project managers for the project, acting on behalf of Wesley Chong of PM No 1 Pty Ltd and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal NCL190469 dated 30 July 2019.

It is understood that the pipeline will extend from Irrawang Street, Raymond Terrace to the proposed Kings Hill subdivision site over a distance of approximately 6.6 km.

Information on likely geotechnical subsurface conditions is required to assist with the application process. The scope of desktop assessment was to provide information on the following:

- Likely subsurface conditions along the alignment;
- Preliminary comments on excavatability and potential re-use of excavated material;
- The likelihood of fill along the alignment;
- Potential construction difficulties for the installation of the pipeline.

The desktop assessment included the following:

- Review of published geological maps, soil and land use maps, topographic data and previous DP site investigation records in the immediate area; and
- Site inspection of the pipeline alignment by a senior geotechnical engineer at accessible locations.

The purpose of the desktop assessment was to provide preliminary advice on the items outlined above together with assessment of site features to allow planning for intrusive investigations. No subsurface investigation was undertaken as part of this stage of the project.

For the purposes of the investigation the client provided DP with the following documents:

- Preliminary sewer and water alignment detailed plans, Job No NL120526, Drawings C1.01 and C2.01 to C2.05, prepared by Northrop;
- Preliminary water longitudinal section, Drawings C3.01 to C3.06, prepared by Northrop;
- Preliminary Site Investigation report for Kings Hill Urban Release Area, prepared by Arcadis and dated 7 August 2019.

2. Site Description

The pipeline alignment extends from the Kings Hill development area in the north to Irrawang Street, Raymond Terrace in the south, over a distance of approximately 6.6 km (refer Figure 1).

Figure 1: Proposed pipeline alignment (with key chainages)

A brief description of the areas through which the alignment passes together with approximate key chainages as shown on the Northrop drawings is provided in Table 1 below.

Table 1: Brief Description of Alignment and Environment

Approximate Chainages (m)	Surrounding Environment
00 to 500	Adjacent to existing parkland, with Irrawang Street and urban development to north
500 to 800	Along Irrawang Street with urban development on either side
800 to 1015	Along drainage gully
1015 to 1265	Across Adelaide Street and along edge of reserve
1265 to 2200	Along Adelaide Street with urban development on either side
2220 to 4800	Along James Rees Drive with urban development on northern and then western side and predominantly bushland on southern and then eastern side, with Pacific Highway beyond
4800 to 5300	Through farmland adjacent to Pacific Highway to Grahamstown Dam Spillway Weir crossing
5300 to 6032	Adjacent to Pacific Highway through rural land, crossing the northern spillway crossing
6032 to 6637	Along existing unsealed access road

Photos of relevant features along the alignment are provided in the attached Plates 1 to 17. The location and orientation of the photos is shown on Drawings 17 to 21.

3. Proposed Development

The proposed development includes the construction of a water supply pipeline and sewer pipeline extending from the Kings Hill development area to Irrawang Street, Raymond Terrace (refer Drawing 1).

The pipeline will be installed generally about 1.5 m to 2 m below existing surface levels, although several areas of deeper installation are required, as follows:

- Up to about 3.5 m for the sewer at about Ch 1060 (under Adelaide Street);
- Up to 3.5 m for the water supply pipeline from about Ch 5860 to Ch 6060 (north-east of the northern spillway crossing); and
- Up to 5 m to pass under the existing weir at Ch 5260 to Ch 5340.

The construction methodology for the pipeline is not known at this stage, but is likely to be constructed using trench installation techniques with some trenchless technology installations under main roads, the Grahamstown Spillway weir and the northern spillway.

4. Desktop Review

The desktop assessment included review of the following available information:

- Geological mapping;
- Soil landscape mapping;
- Acid sulfate soil risk mapping;
- NSW Office of Environment and Heritage website (eSpade);
- Registered groundwater bores; and
- Previous DP investigations.

The results of the desktop assessment are discussed below and are also shown on the attached drawings, as follows:

- Drawing 1 – Route Alignment;
- Drawings 2 to 6 – Route Alignment with regional geological mapping;
- Drawings 7 to 11 – Route Alignment with soil landscape mapping;
- Drawings 12 to 16 – Route Alignment with acid sulfate soil mapping; and
- Drawings 17 to 21 – Route Alignment with previous pertinent DP investigations, photo locationsa and orientations, anticipated terrain units and subsurface conditions.

4.1 Regional Geology

Drawings 2 to 6 show the alignment with the mapped statewide digital 1:250 000 geological mapping.

The mapping indicates the entire alignment is mapped as being within bedrock units, with the two distinct sections:

- approximately Ch 00 to Ch 4300 mapped as being underlain by Branxton Formation; and
- approximately Ch 4300 to Ch 6637 mapped as being underlain by Dalwood Group.

The Branxton Formation is of the Ufimian geological period and is characterised by conglomerate, sandstone and siltstone.

The Dalwood Group (undifferentiated) is of Permian age and is characterised by sandstone, siltstone, conglomerate, marl and basalt.

Reference to the NSW NCCA Quaternary Geological mapping indicates that quaternary deposits lies within close proximity to the pipeline alignment at the following locations:

- Approximately Ch 350 to Ch 500, where Pleistocene aged sand deposits are mapped to the west of the alignment;
- Approximately Ch 800 to Ch 1075, where backswamp organic muds as mapped within the low lying area to the north-west of the alignment;

- Approximately Ch 4800 to Ch 6140, where fluvial deposits, characterised by silt, clay, fluvial sand and gravels are mapped approximately 50 m to 100 m to the west of the alignment; and
- Approximately Ch 6030 to 6130, where Quaternary undifferentiated deposits are mapped, characterised by silt, clay and fluvial sand.

4.2 Soil Landscape Mapping

Drawings 7 to 11 show the alignment with the soil landscape mapping for the area.

The mapping indicates the majority of the alignment is mapped as being within the Bolwarra Heights Landscape Group, with the following exceptions:

- Approximately y Ch 310 to 490 – Shoal Bay Aeolian Group;
- Approximately Ch 1080 to 1265 - disturbed terrain;
- Approximately Ch 5200 to Ch 6637 – Wallalong Residual Group.

The Bolwarra Heights erosional soil landscape group is described as being Permian aged sediments, with a water erosion hazard, high localised run-on, seasonal waterlogging and localised steep slopes with mass movement hazard.

The Wallalong Residual soil landscape group is described as being sediments on the Permian Dalwood Group, with high water erosion hazard, high localised run-on, seasonal waterlogging and localised shallow soils. It is described as being of very high acidity.

The Shoal Bay Aeolian soil landscape group is described as being Pleistocene aged sandsheets with wind erosion hazard, localised swamps, permanent high water tables and seasonal waterlogging.

4.3 Acid Sulfate Soil Mapping

Drawings 12 to 16 show the alignment with the mapped acid sulfate soil risk mapping.

Reference to the Acid Sulfate Soil mapping indicates the alignment is not located within an area mapped as having known acid sulfate soils. Two areas of the alignment lie close to areas mapped as having a high probability of acid sulfate soils, as follows:

- Approximately Ch 800 to Ch 1075, associated with the mapped backswamp organic muds within the low lying area to the north-west of the alignment; and
- Approximately Ch 4900 to Ch 5400, where low lying ground is present to the west of the alignment.

Reference to the Port Stephens Council ePlanning Spatial Viewer indicates the alignment is mapped as being within Class 5 acid sulfate soils, with two sections mapped as being in close proximity to Class 3 acid sulfate soils (coresponding to the acid sulfate mapping and alignment chainages outlined above and shown on Drawings 12 to 16.

Within the Port Stepens Local Environmental Plan 2013, it states that 'development consent is required for the carrying out of works' in these classes of land as follows:

- Class 3 Works more than 1 metre below the natural ground surface, Works be which the watertable is likely to be lowered more than 1 metre below the natural ground surface.
- Class 5 Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below 5 metres Australian Height Datum and by which the watertable is likely to be lowered below 1 metre Australian Height Datum on adjacent Class 1, 2, 3 or 4 land.

4.4 NSW Office of Environment and Heritage website (eSpade)

A review of the NSW Office of Environment and Heritage website revealed that two soil lithology and characterisation tests have been undertaken along the pipeline route, as follows:

- Approximately Ch 4300, which encountered surficial loam over light to medium clay to 3 m depth; and
- Approximately Ch 6400, which encountered moderately heavy clay to 0.25 m depth.

4.5 Registered Groundwater Bores

A review of the NSW Office of Water registered groundwater bores information did not reveal and registered bores along the pipeline alignment.

4.6 Previous DP Investigations

DP has undertaken a number of previous investigations within the vicinity of the pipeline alignment. Drawings 17 to 21 show the location of these investigations along with a brief summary of conditions encountered.

Table 2: Summary of Relevant Previous DP Investigations

DP Investigation	Location/Type of Investigation	Approximate Chainage	Brief Summary of Subsurface Conditions
A	Kings Hill - Inspection and limited penetrometer	West of Ch 6637	Shallow rock within 1 m depth
B	Kings Hill	Near Ch 6637	Rock encountered at 0.9 m and 0.95 m depth
C	Grahamstown Dam spillway weir – numerous pits and bores to depths in excess of 5 m	Ch 5300	Residual clay to depths ranging from 0.4 m to greater than 4 m over low to high strength basalt bedrock
D	Kings Hill - Numerous pits in possible borrow area	Near Ch 6637	Residual clay over basalt at 0.4 m to greater than 3 m depth
E	Cutting on Pacific Highway – Inspection of cutting	Ch 4550 (very approximate)	Calcareous sandstone and siltstone exposed in cutting
F	Grahamstown Dam spillway weir – Bores for bridge to depths in excess of 5 m	Ch 5300	Clay over high strength basalt at depths ranging from 1 m to greater than 2.5 m
G	RFS Facility off James Rees Drive – several pits	Ch 3500	Residual clay over claystone bedrock at depths ranging from 1.05 m to 1.5 m
H	Residential Subdivision – numerous pits (approx. 180 m west of alignment)	Ch 2500	Fil then clay, rock at depths ranging from 0.2 m to greater than 2 m
I	Residential Subdivision – numerous pits	Ch 2500	Fill over residual clay to at least 1.5 m depth
J	Off Adelaide Street – several pits and bores (approx. 280 m west of alignment)	Ch 500	Residual clay over siltstone at about 1.9 m depth
K	Shopping Centre off Bourke Street – numerous deep bores, cone penetration tests (approx. 500 m west of alignment)	Ch 250	Soft clay up to 15 m depth with some clay layers (in quaternary alluvial mapped areas)
L	Adelaide Street – numerous deep bores (approx. 250 m west of alignment)	Ch 400	Soft clay to 10 m with medium dense sand below (in quaternary alluvial mapped areas)
M	Existing School – several pits	Ch 00	Firm to stiff clay to depths ranging from 1.3 m to 2 m, underlain by sandstone
N	Off Irrawang Street	Ch 190	Stiff clay to greater than 1.5 m depth

Notes to table:
DP investigation lettering shown on Drawings 17 to 21

5. Site Inspection

A site inspection of accessible locations along the proposed alignment was undertaken by a Principal Geotechnical Engineer on 12 September 2019. Photos taken during the inspection are presented on Plates 1 to 17 in Appendix B.

Table 3, below, provides a summary of the relevant site observations which inform the anticipated subsurface conditions along the alignment.

Table 3: Summary of Relevant Observations During Inspection

Photo No	Approximate Chainage	Comment
2	Ch 150	Residual clays exposed in slope
4	Ch 400	Fill embankment across broad gully, possible fill and alluvial soils
6	Ch 800	Fill possible along with weak soils in drainage gully
8	Ch 1100	Possible weak soil in low lying area west of Adelaide Street
11 and 12	Ch 2200	Probable residual soil in cut batter, with fill associated with former road upslope of batter
14	Ch 2500	Orange brown residual soil exposed in excavation to approximately 1.5 m depth
15	Ch 2700	Medium strength sandstone bedrock exposed in cutting
20	Ch 3620	Possible localised weak soil in broad gully
22	Ch 4030	Possible fill associated with road embankment along eastern side of road
25	Ch 4480	High strength volcanic rock exposed in cutting on eastern side of road
29 and 30	Ch 5550	Evidence of fill (buried metal sheets) within area north of Grahamstown Dam spillway weir
33	Ch 5800	High strength, fractured basalt exposed in access track cutting

Notes to table:
DP investigation lettering shown on Drawings 17 to 21

6. Identified Terrain Units

Based on the results of the desktop assessment and site inspection the alignment was subdivided into several terrain units, as shown on Drawings 17 to 21.

The extent of the terrain units and anticipated subsurface conditions are based on limited desktop and site inspection information and have not been ground-truthed at this stage. Therefore, they should be considered indicative only and used for planning of more detailed subsurface investigations.

A summary of the terrain units and key anticipated geotechnical parameters is presented in Table 4 below.

Table 4: Inferred Terrain Units

Inferred Terrain Unit	Approximate Chainage (m)	Terrain Characterisation	Anticipated Soil Profile
1	00 to 250 500 to 800 1265 to 2680 2970 to 4000	Rolling hills	Residual clay soils with rock possible within the upper 1 m to 2 m of the soil profile. Some localised fill possible and shallow fill associated with former development (i.e. roads, services, etc)
2	250 to 500 800 to 1265 4930 to 5230 6030 to 6130	Broad gullies and low lying areas	Possible weak soils (soft clays and loose sands) overlying residual clays
3	2680 to 2970 4000 to 4930 5700 to 6030 6130 to 6637	Cuttings and areas of exposed rock	Shallow rock with variable cover of residual clay
4	5230 to 5700	Flat Disturbed area beside Pacific Highway	Possible deep fill over residual clay and basalt rock

7. Anticipated Construction Difficulties and Recommended Additional Investigation

Based on the results of the desktop assessment and preliminary site inspection, the terrain units outlined in Table 4 of Section 6 were inferred along the alignment.

Terrain Unit 1 is likely to have residual clay soils over bedrock at depths possible ranging from 1 m to 2 m, although it is likely to vary considerably. Trench excavation is anticipated to be relatively straight forward in this unit, however, the bedrock may be of sufficient strength to present difficulties for conventional excavation equipment, particularly in the northern parts of the alignment (say beyond about Ch 1260).

Similarly Unit 3, which is predominantly in the northern part of the alignment (beyond about Ch 2680) exposed high strength bedrock, either of sedimentary of volcanic origin. Trench excavation into this material may be difficult.

Several areas of possible weak soil (Terrain Unit 2) were inferred within the southern part of the alignment. DP's experience with similar soils in the continuation of the broad gullies to the west of the mapped sections of Unit 2 indicates that deep, soft clay soils may be present. Trench support in this material is anticipated to be required and has in the past needed installation of trench shields ahead of excavation as well as dewatering to allow pipeline construction.

Based on the surface topography and the observations of anthropogenics buried in the ground surface, the area to the north of the Grahamstown Dam spillway weir may include fill to unknown depth (Unit 4). Depending on the depth, extent and nature of the fill, trench support may be needed and excavation could be difficult in this area.

No areas of the alignment are mapped as having a risk of acid sulfate soils, however, the Unit 2 area which may contain weak soils are within close proximity to high risk mapped areas.

Therefore, it is recommended that further investigations be undertaken within selected sections of the alignment to assess the following:

- The depth of soil and excavation conditions (Unit 1);
- The depth and strength of bedrock (Units 1 and 3);
- The presence of weak soils, shallow groundwater and possible acid sulfate soils (Unit 2);
- The extent and depth of fill (Unit 4);
- Aggressive soil conditions (all units);
- Underbore conditions and design parameters (at crossing requiring trenchless installation methods); and
- Design parameters for thrust blocks.

8. Limitations

Douglas Partners (DP) has prepared this report for this project at Kings Hill, North Raymond Terrace in accordance with DP's proposal NCL190469 dated 30 July 2019 dated and acceptance received from APP Pty Ltd, acting on behalf of PM No1 Pty Ltd dated 12 September 2019. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of APP Pty Ltd and PM No1 Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of conditions observed at the site only at the specific inspection locations and then only at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field inspection has been completed.

DP's advice is based upon the conditions observed during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

Assessment for the presence of soil or groundwater contamination was not part of the scope of assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Plates 1 to 17 – Site Photos

Photo 1: Looking north-east - residential soils anticipated

Photo 2: Brown residual clay soils exposed

Douglas Partners Geotechnics / Environment / Groundwater	**Proposed Pipeline**	PROJECT:	81502.11
	Kings Hill Land Development	Plate	1
	Raymond Terrace to Kings Hill	REV:	A
	Client: PM No 1 Pty Ltd	DATE:	12-Sep-19

Photo 3: Residual slope - looking north-east

Photo 4: Fill embankment associated with stormwater control - fill possible

Douglas Partners Geotechnics | Environment | Groundwater	**Proposed Pipeline**	PROJECT:	81502.11
	Kings Hill Land Development	Plate	2
	Raymond Terrace to Kings Hill	REV:	A
	Client: PM No 1 Pty Ltd	DATE:	12-Sep-19

Photo 5: Looking north-east down residual slope

Photo 6: View down drainage gully - fill possible with weak soils

Douglas Partners Geotechnics | Environment | Groundwater	**Proposed Pipeline**		PROJECT:	81502.11
	Kings Hill Land Development		Plate	3
	Raymond Terrace to Kings Hill		REV:	A
	Client	PM No 1 Pty Ltd	DATE:	12-Sep-19

Photo 7: Ponded water and fill at back of allotment - looking north

Photo 8: Broad gully with possible weak soils and shallow groundwater

Douglas Partners Geotechnics | Environment | Groundwater	**Proposed Pipeline**	PROJECT:	81502.11
	Kings Hill Land Development	Plate	4
	Raymond Terrace to Kings Hill	REV:	A
	Client: PM No 1 Pty Ltd	DATE:	12-Sep-19

Photo 9: Looking north-east at crest of hill - residual soils

Photo 10: Looking north-east up residual slope

Photo 11: Cut batter of probable residual soils - looking south-west

Photo 12: Former road alignment - possible fill

Photo 13: Looking north-east down broad gully - residual soils anticipated

Photo 14: Cutting of about 1.5 m depth with orange brown silty clay exposed

Photo 15: Medium strength sandstone exposed in cutting

Photo 16: Possible cut on eastern side or road with embankment fill on left

Photo 17: Looking north-east up residual slope

Photo 18: Residual soils, possible shallow rock (evidenced by cobbles near surface)

Photo 19: Looking north-east up slight incline (residual soils)

Photo 20: Localised weak soils possible in gully

Photo 21: Cleared area - possible fill

Photo 22: Shallow fill associated with road construction

Photo 23: Brown residual sandy clay exposed

Photo 24: Looking north along cutting

Photo 25: High strength volcanic rock exposed in cutting

Photo 26: Broad gully , looking north-east some fill possible associated with access track

Photo 27: Deep fill anticipated around spillway

Photo 28: Flat area north of spillway but possibly fill

Photo 29: Partially buried metal sheet in probably fill

Photo 30: Partially buried sheet of corrugated iron in probably fill

Photo 31: Draing about 1.5 m deep excavated into landform

Photo 32: Smaller spillway (fill anticipated immediately adjacent)

Photo 33: High strength, fractured basalt exposed in access road

Photo 34: Residual soils anticipated possibly with surficial fill

Appendix C

Drawing 1 – Overall Plan of Alignment

Drawings 2 to 6 – Route Alignment with regional geological mapping

Drawings 7 to 11 – Route Alignment with soil landscape mapping

Drawings 12 to 16 – Route Alignment with acid sulfate soil mapping

Drawings 17 to 21 – Route Alignment with Identified Terrain Units

.

Legend

- Proposed Pipeline Alignment
- Extents of Additional Drawings

Drawing adapted from plan by Northrop Engineers and NearMap

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: PM No 1 Pty Ltd		TITLE: **Overall Plan of Alignment**	PROJECT No: 81502.11
OFFICE: Newcastle	DRAWN BY: MPG	**Proposed Pipeline**	DRAWING No: 1
SCALE: 1:20,000 @A3	DATE: 19.09.19	**Raymond Terrace to Kings Hill**	REVISION: 0

Locality Plan

Legend

Pipeline Alignment

NSW NCCA Quaternary Geology

- Anthropogenic
- Coastal Barrier
- Estuarine Plain
- Alluvial Plain
- Undifferentiated

Bedrock Geology Units

0 100 200 300 400 m

Drawing adapted from plan by Northrop Engineers and NearMap image

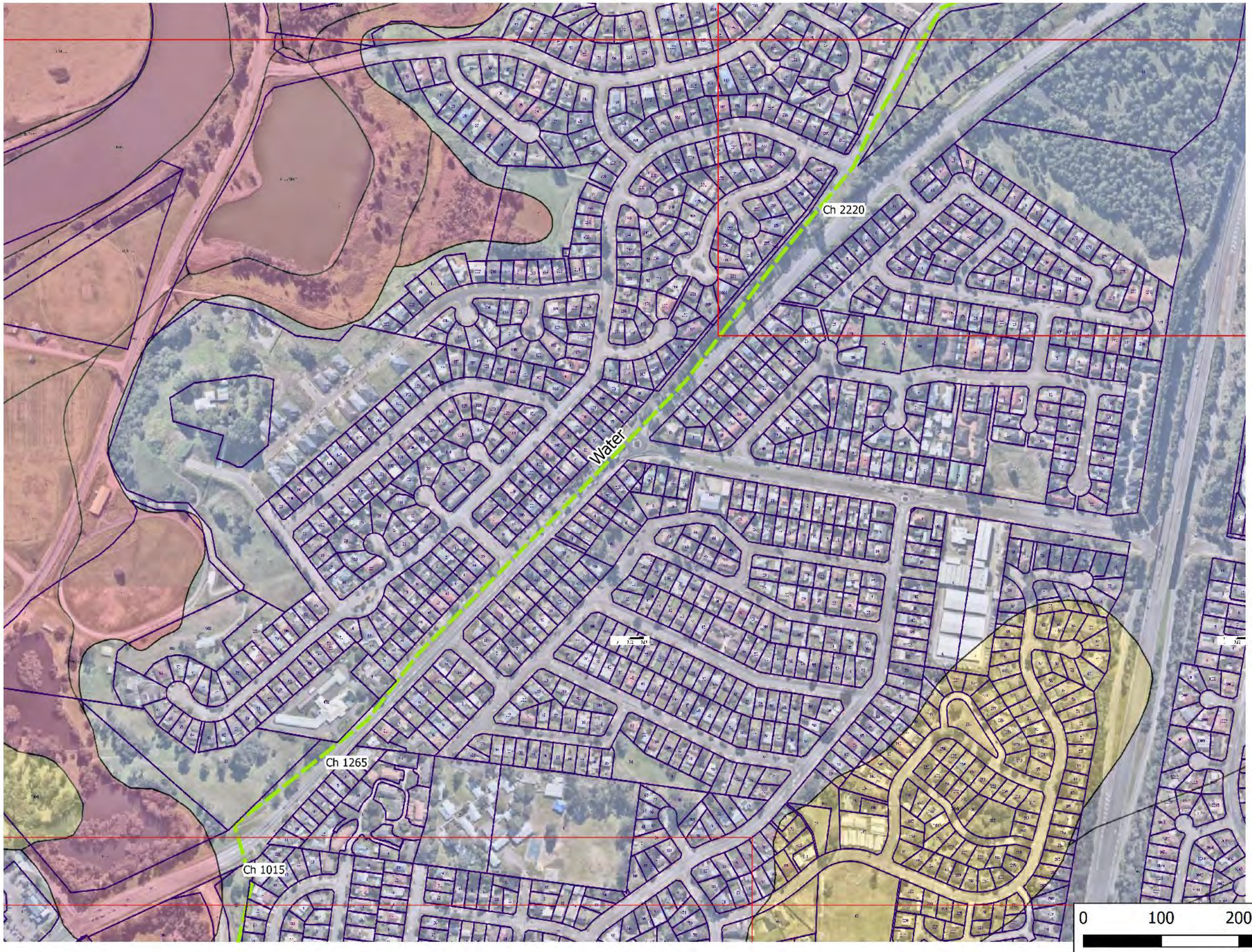
Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd		
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:5,000 @A3	DATE:	16.09.2019

TITLE: **Regional Geology**
Proposed Pipeline
Raymond Terrace to Kings Hill

N

PROJECT No:	81502.11
DRAWING No:	2
REVISION:	0



Locality Plan

Legend

Pipeline Alignment

NSW NCCA Quaternary Geology

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- Alluvial Plain
- Undifferentiated

Bedrock Geology Units

0 100 200 300 400 m

Drawing adapted from plan by Northrop Engineers and NearMap image

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: PM No 1 Pty Ltd		
OFFICE: Newcastle	DRAWN BY: MPG	
SCALE: 1:5,000 @A3	DATE: 16.09.2019	

TITLE: **Regional Geology**
Proposed Pipeline
Raymond Terrace to Kings Hill

N

PROJECT No:	81502.11
DRAWING No:	3
REVISION:	0

Locality Plan

Legend

Pipeline Alignment

NSW NCCA Quaternary Geology

- Anthropogenic
- Coastal Barrier
- Estuarine Plain
- Alluvial Plain
- Undifferentiated

Bedrock Geology Units

0 100 200 300 400 m

Drawing adapted from plan by Northrop Engineers and NearMap image

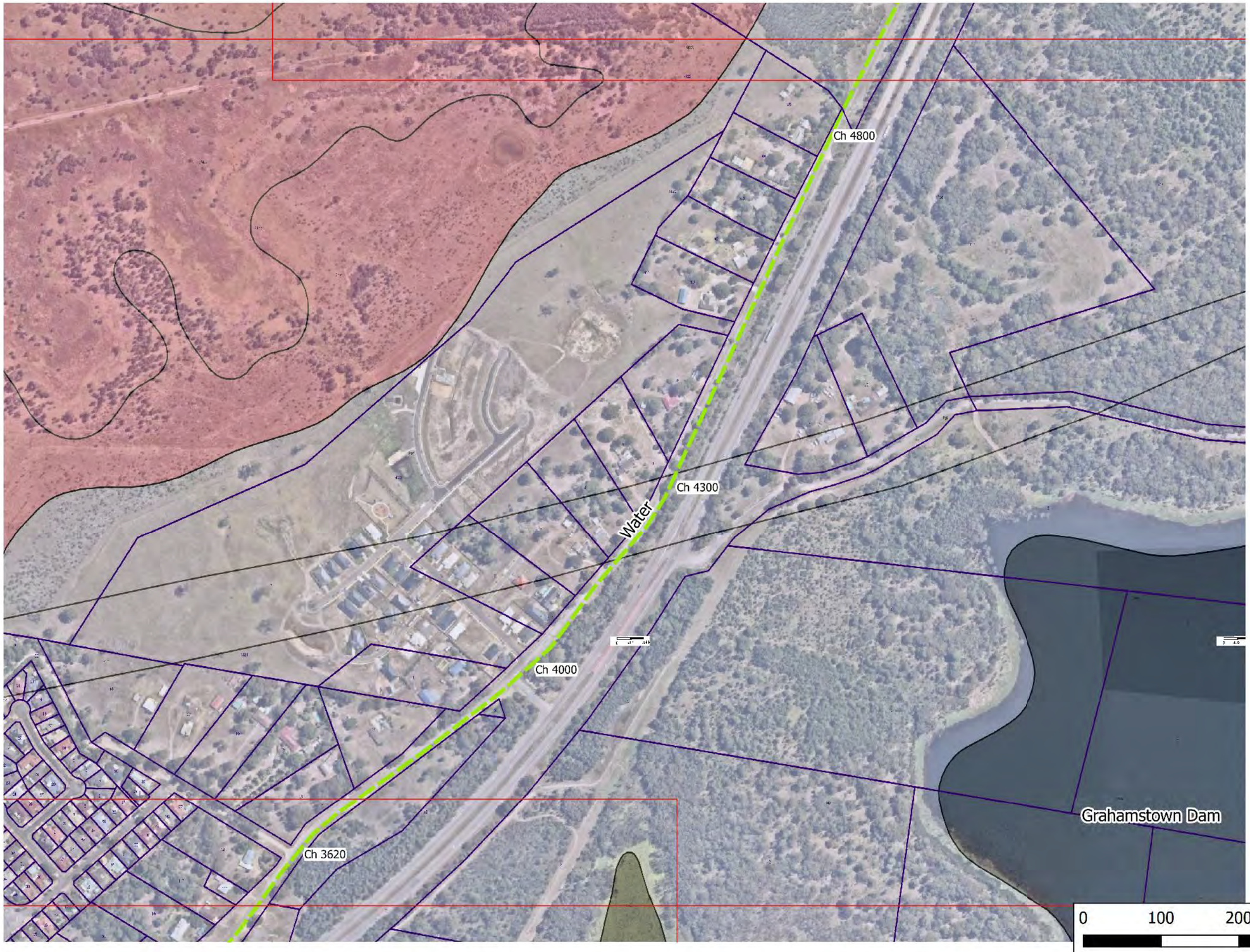
Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd		
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:5,000 @A3	DATE:	16.09.2019

TITLE: **Regional Geology**
Proposed Pipeline
Raymond Terrace to Kings Hill

N

PROJECT No:	81502.11
DRAWING No:	4
REVISION:	0



Locality Plan

Legend

Pipeline Alignment

NSW NCCA Quaternary Geology

- Anthropogenic
- Coastal Barrier
- Estuarine Plain
- Alluvial Plain
- Undifferentiated

Bedrock Geology Units

0 100 200 300 400 m

Drawing adapted from plan by Northrop Engineers and NearMap image

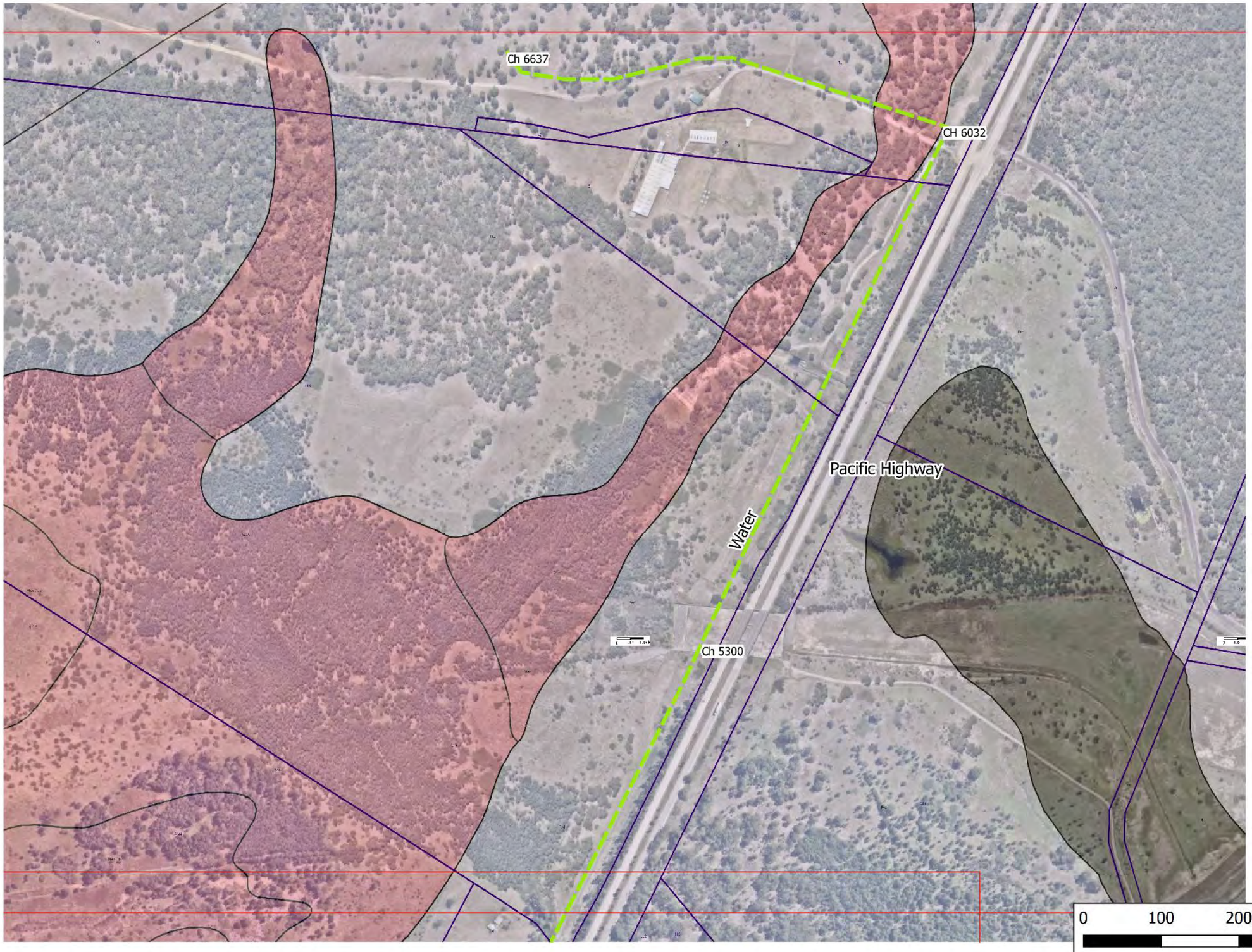
Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd		
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:5,000 @A3	DATE:	16.09.2019

TITLE: **Regional Geology**
Proposed Pipeline
Raymond Terrace to Kings Hill

N

PROJECT No:	81502.11
DRAWING No:	5
REVISION:	0



Locality Plan

Legend

Pipeline Alignment

NSW NCCA Quaternary Geology

- Anthropogenic
- Coastal Barrier
- Estuarine Plain
- Alluvial Plain
- Undifferentiated

Bedrock Geology Units

0 100 200 300 400 m

Drawing adapted from plan by Northrop Engineers and NearMap image

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd	TITLE:	**Regional Geology** **Proposed Pipeline** **Raymond Terrace to Kings Hill**
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:5,000 @A3	DATE:	16.09.2019

N

PROJECT No:	81502.11
DRAWING No:	6
REVISION:	0

Locality Plan

Legend

Pipeline Alignment

NSW Syd-Newc-Wgong Soils

- DISTURBED TERRAIN
- RESIDUAL
- COLLUVIAL
- EROSIONAL
- TRANSFERRAL
- ALLUVIAL
- ESTUARINE
- LACUSTRINE
- SWAMP
- BEACH
- AEOLIAN
- VESTIGIAL
- WATER

Drawing adapted from plan by Northrop Engineers and NearMap image

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd		
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:5,000 @A3	DATE:	16.09.2019

TITLE: **Soil Landscape Mapping**
Proposed Pipeline
Raymond Terrace to Kings Hill

N

PROJECT No:	81502.11
DRAWING No:	7
REVISION:	0

Locality Plan

Legend

Pipeline Alignment

NSW Syd-Newc-Wgong Soils

- DISTURBED TERRAIN
- RESIDUAL
- COLLUVIAL
- EROSIONAL
- TRANSFERRAL
- ALLUVIAL
- ESTUARINE
- LACUSTRINE
- SWAMP
- BEACH
- AEOLIAN
- VESTIGIAL
- WATER

Drawing adapted from plan by Northrop Engineers and NearMap image

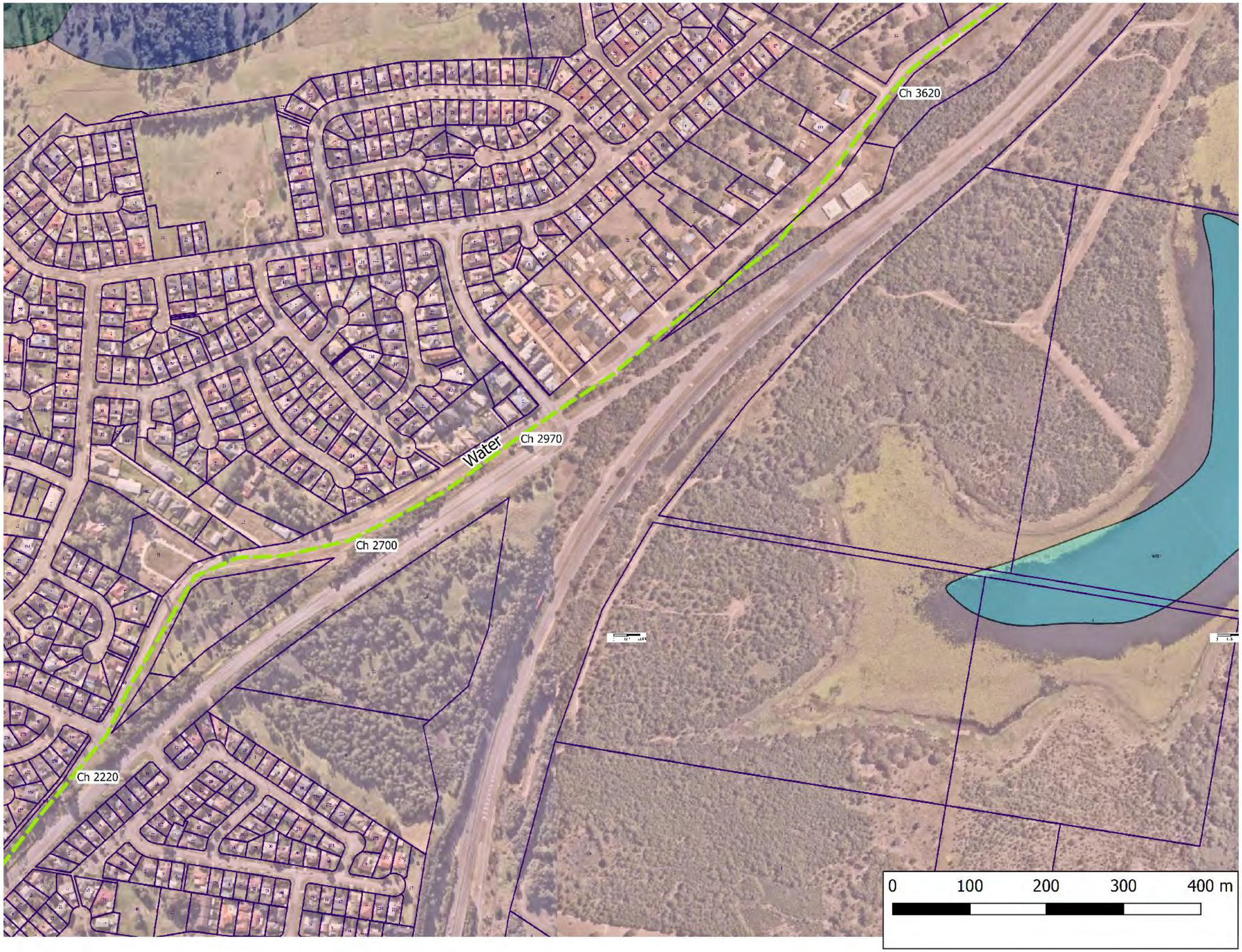
Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd		
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:5,000 @A3	DATE:	16.09.2019

TITLE: **Soil Landscape Mapping**
Proposed Pipeline
Raymond Terrace to Kings Hill

N

PROJECT No:	81502.11
DRAWING No:	8
REVISION:	0



Locality Plan

Legend

Pipeline Alignment

NSW Syd-Newc-Wgong Soils

- DISTURBED TERRAIN
- RESIDUAL
- COLLUVIAL
- EROSIONAL
- TRANSFERRAL
- ALLUVIAL
- ESTUARINE
- LACUSTRINE
- SWAMP
- BEACH
- AEOLIAN
- VESTIGIAL
- WATER

Drawing adapted from plan by Northrop Engineers and NearMap image

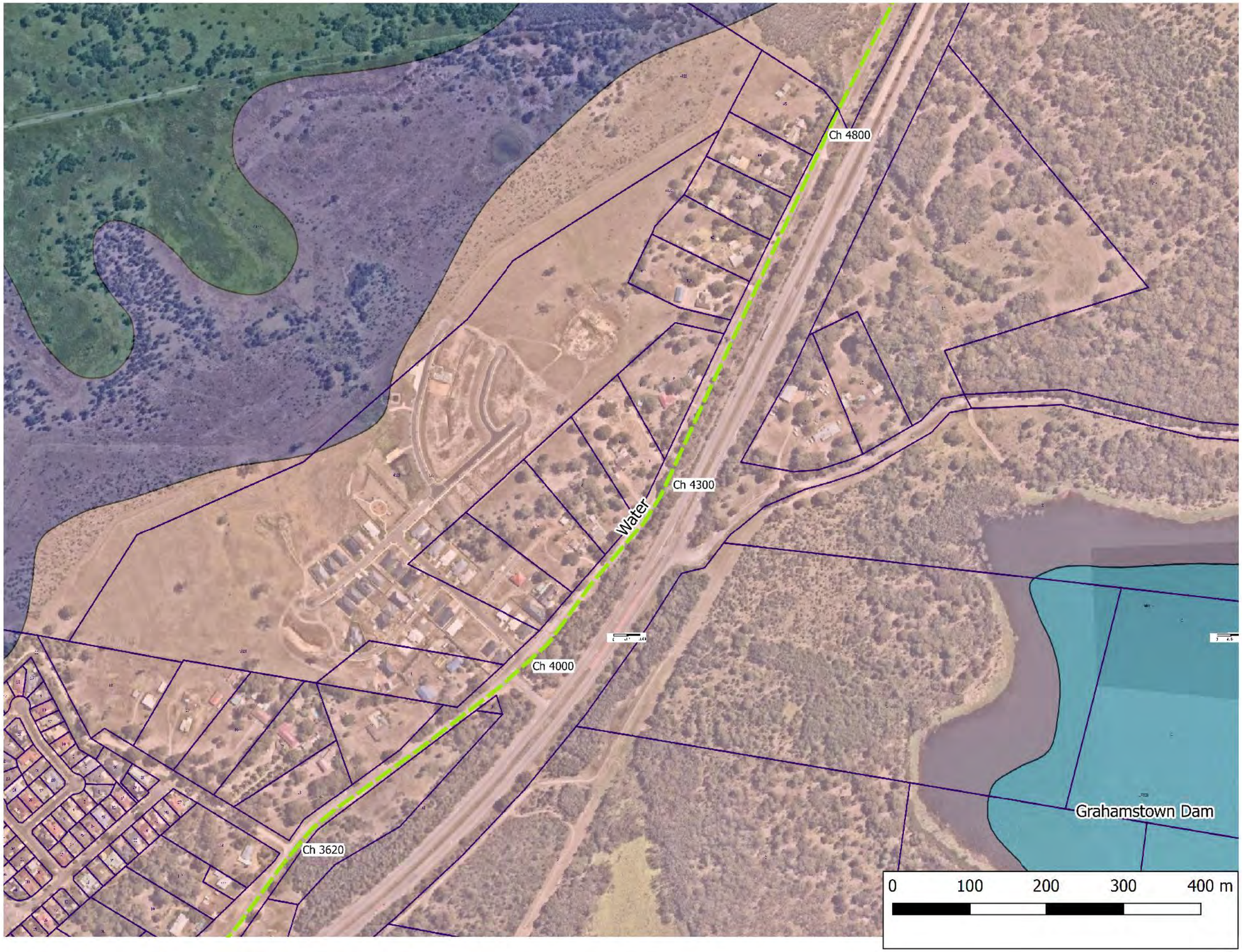
Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd		
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:5,000 @A3	DATE:	16.09.2019

TITLE: **Soil Landscape Mapping**
Proposed Pipeline
Raymond Terrace to Kings Hill

N

PROJECT No:	81502.11
DRAWING No:	9
REVISION:	0



Locality Plan

Legend

Pipeline Alignment

NSW Syd-Newc-Wgong Soils

- DISTURBED TERRAIN
- RESIDUAL
- COLLUVIAL
- EROSIONAL
- TRANSFERRAL
- ALLUVIAL
- ESTUARINE
- LACUSTRINE
- SWAMP
- BEACH
- AEOLIAN
- VESTIGIAL
- WATER

Drawing adapted from plan by Northrop Engineers and NearMap image

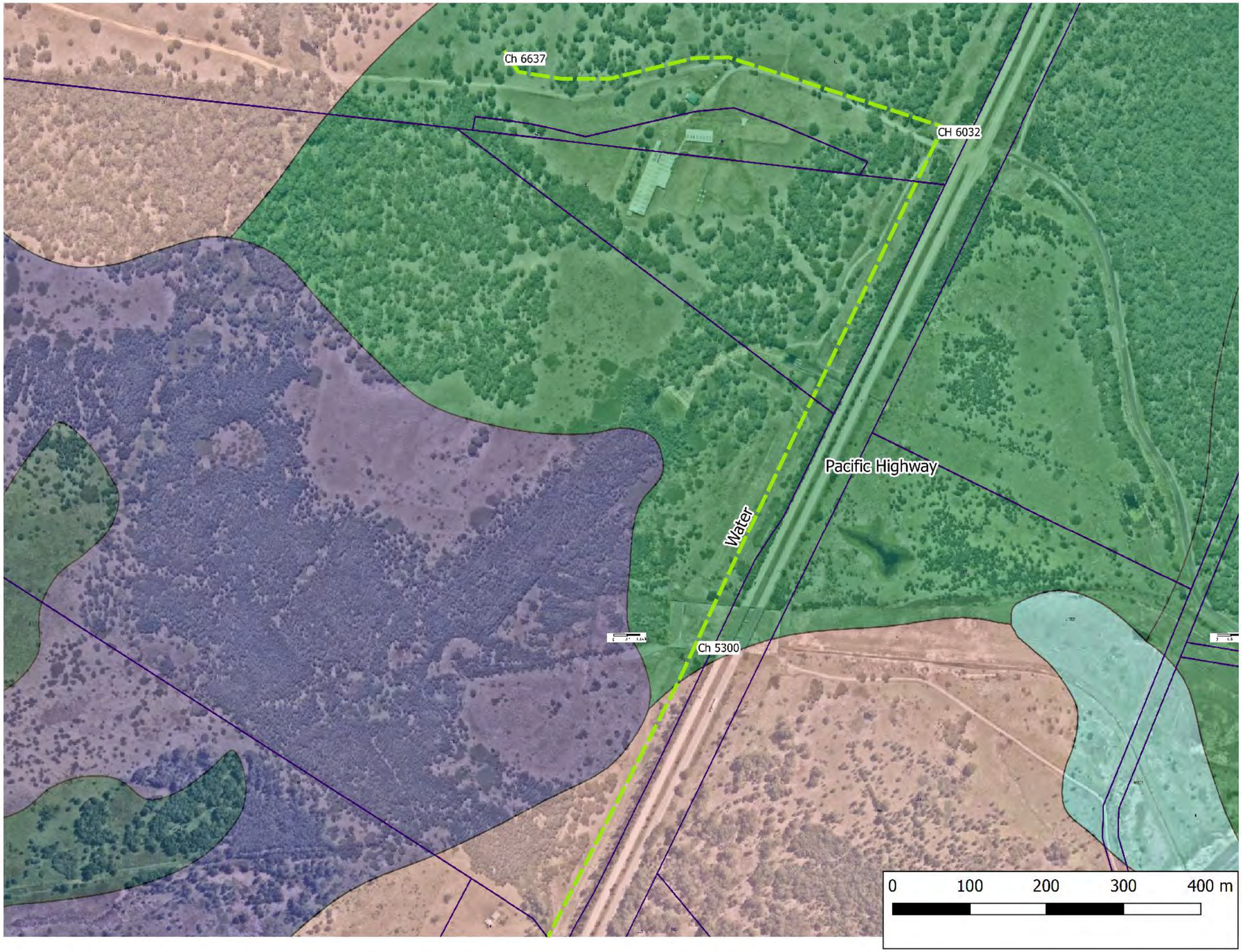
Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd		
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:5,000 @A3	DATE:	16.09.2019

TITLE: **Soil Landscape Mapping**
Proposed Pipeline
Raymond Terrace to Kings Hill

N

PROJECT No:	81502.11
DRAWING No:	10
REVISION:	0



Locality Plan

Legend

Pipeline Alignment

NSW Syd-Newc-Wgong Soils

- DISTURBED TERRAIN
- RESIDUAL
- COLLUVIAL
- EROSIONAL
- TRANSFERRAL
- ALLUVIAL
- ESTUARINE
- LACUSTRINE
- SWAMP
- BEACH
- AEOLIAN
- VESTIGIAL
- WATER

Drawing adapted from plan by Northrop Engineers and NearMap image

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd	TITLE:	**Soil Landscape Mapping**
OFFICE:	Newcastle	DRAWN BY:	MPG		**Proposed Pipeline**
SCALE:	1:5,000 @A3	DATE:	16.09.2019		**Raymond Terrace to Kings Hill**

N

PROJECT No:	81502.11
DRAWING No:	11
REVISION:	0

Locality Plan

Legend

Pipeline Alignment

NSW Acid Sulfate Soil Risk

- High probability of ASS occurrence
- Low probability of ASS occurrence
- No known ASS occurrence
- Beach
- Disturbed Terrain

Drawing adapted from plan by Northrop Engineers and NearMap image

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd	TITLE:	**Acid Sulfate Soil Mapping**
OFFICE:	Newcastle	DRAWN BY:	MPG		**Proposed Pipeline**
SCALE:	1:5,000 @A3	DATE:	16.09.2019		**Raymond Terrace to Kings Hill**

N

PROJECT No:	81502.11
DRAWING No:	12
REVISION:	0

Locality Plan

Legend

Pipeline Alignment

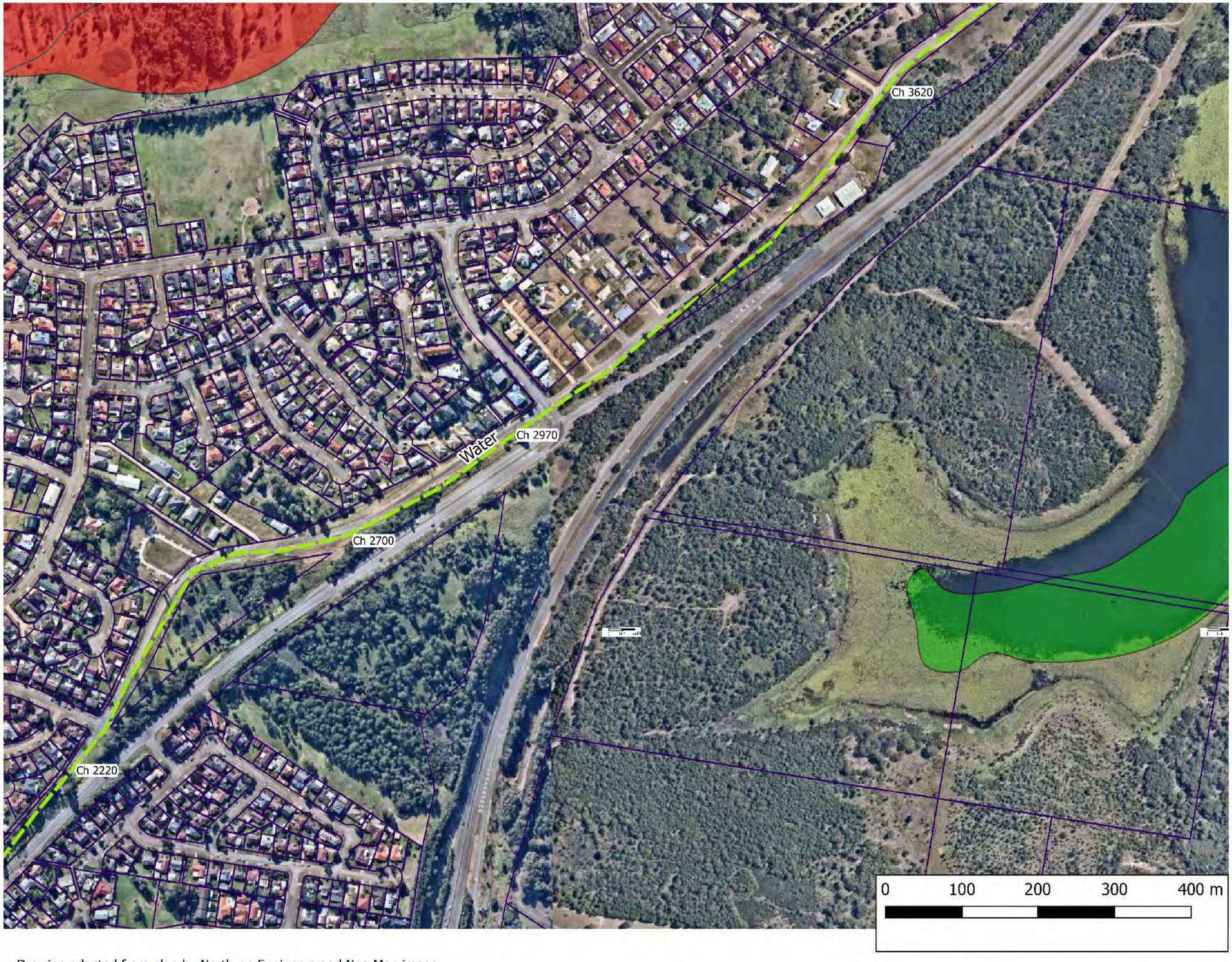
NSW Acid Sulfate Soil Risk

- High probability of ASS occurrence
- Low probability of ASS occurrence
- No known ASS occurrence
- Beach
- Disturbed Terrain

Drawing adapted from plan by Northrop Engineers and NearMap image

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: PM No 1 Pty Ltd		TITLE: **Acid Sulfate Soil Mapping**	PROJECT No: 81502.11
OFFICE: Newcastle	DRAWN BY: MPG	**Proposed Pipeline**	DRAWING No: 13
SCALE: 1:5,000 @A3	DATE: 16.09.2019	**Raymond Terrace to Kings Hill**	REVISION: 0



Locality Plan

Legend

Pipeline Alignment

NSW Acid Sulfate Soil Risk

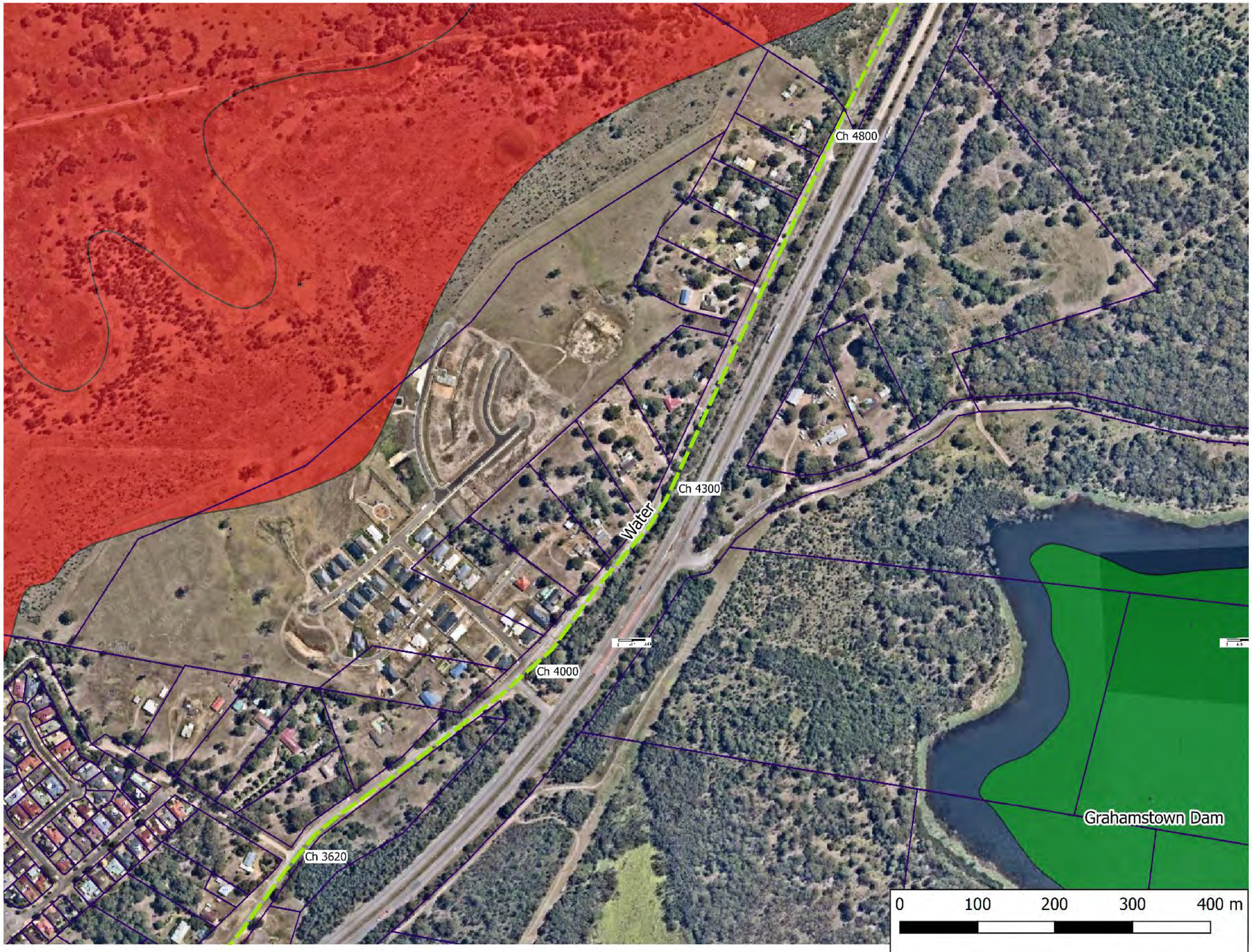
- High probability of ASS occurrence
- Low probability of ASS occurrence
- No known ASS occurrence
- Beach
- Disturbed Terrain

Drawing adapted from plan by Northrop Engineers and NearMap image

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd	TITLE:	**Acid Sulfate Soil Mapping**
OFFICE:	Newcastle	DRAWN BY:	MPG		**Proposed Pipeline**
SCALE:	1:5,000 @A3	DATE:	16.09.2019		**Raymond Terrace to Kings Hill**

PROJECT No:	81502.11
DRAWING No:	14
REVISION:	0



Locality Plan

Legend

Pipeline Alignment

NSW Acid Sulfate Soil Risk

- High probability of ASS occurrence
- Low probability of ASS occurrence
- No known ASS occurrence
- Beach
- Disturbed Terrain

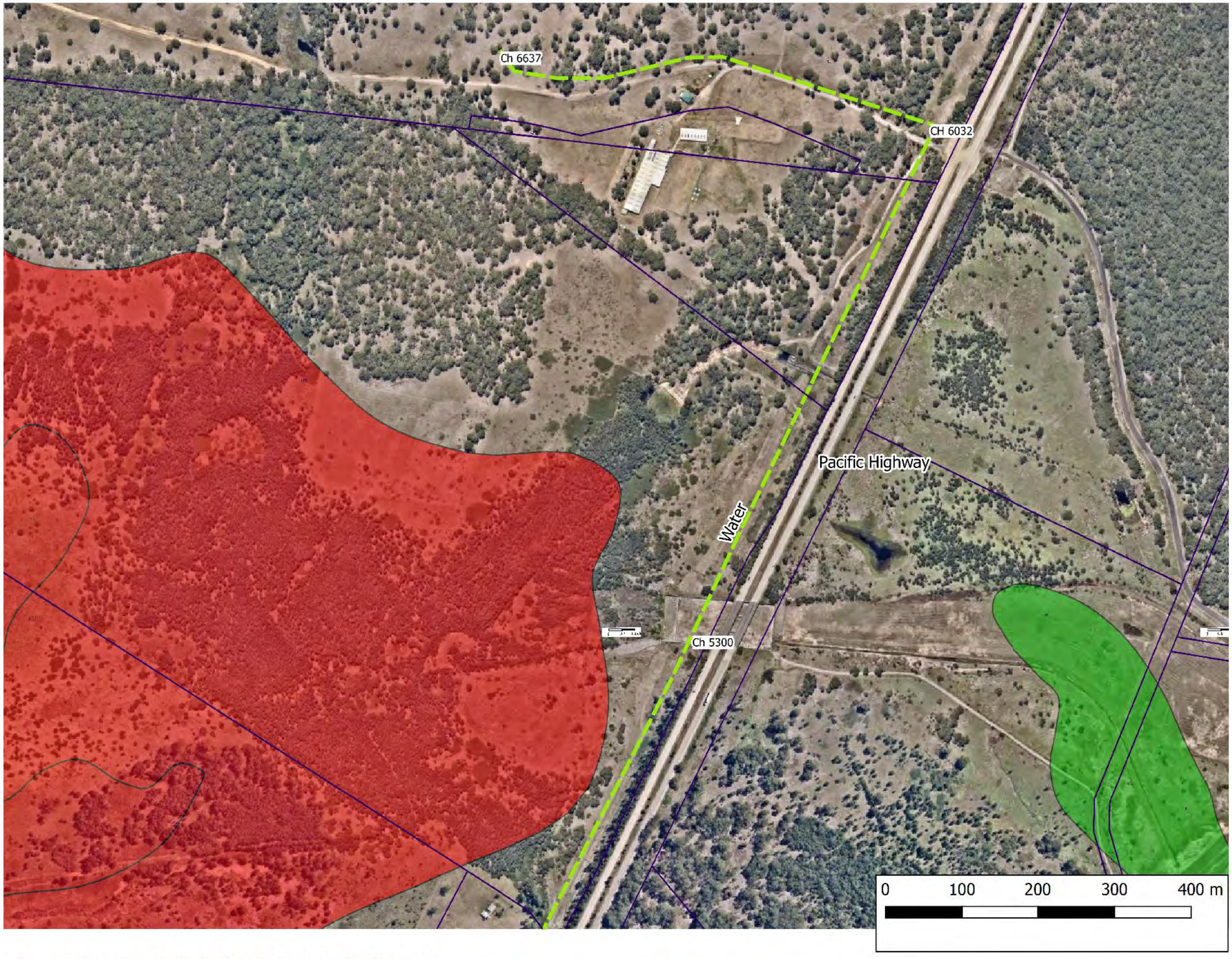
Drawing adapted from plan by Northrop Engineers and NearMap image

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd	TITLE:	**Acid Sulfate Soil Mapping**
OFFICE:	Newcastle	DRAWN BY:	MPG		**Proposed Pipeline**
SCALE:	1:5,000 @A3	DATE:	16.09.2019		**Raymond Terrace to Kings Hill**

N

PROJECT No:	81502.11
DRAWING No:	15
REVISION:	0



Locality Plan

Legend

Pipeline Alignment

NSW Acid Sulfate Soil Risk

- High probability of ASS occurrence
- Low probability of ASS occurrence
- No known ASS occurrence
- Beach
- Disturbed Terrain

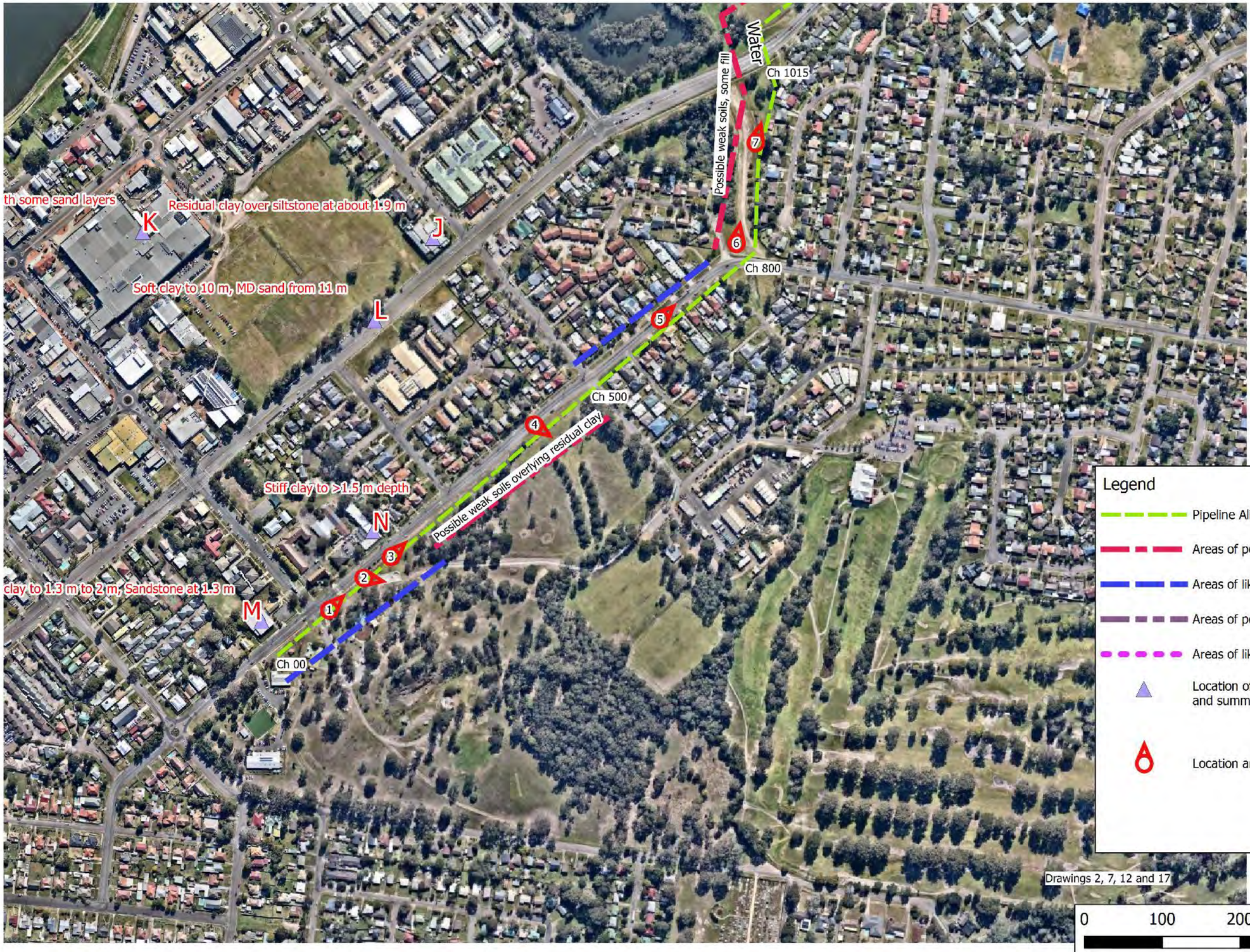
Drawing adapted from plan by Northrop Engineers and NearMap image

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	PM No 1 Pty Ltd		
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:5,000 @A3	DATE:	16.09.2019

TITLE: **Acid Sulfate Soil Mapping**
Proposed Pipeline
Raymond Terrace to Kings Hill

PROJECT No:	81502.11
DRAWING No:	16
REVISION:	0



Locality Plan

Legend

- Pipeline Alignment
- Areas of possible weak soils
- Areas of likely residual clay
- Areas of possible deep fill
- Areas of likely shallow rock
- Location of Previous DP reference Project (see report text) and summary of subsurface conditions
- Location and Orientation of Photos (see photo plates)

Drawing adapted from plan by Northrop Engineers and NearMap image

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd	TITLE:	**Anticipated Terrain Units and Subsurface Conditions**
OFFICE:	Newcastle	DRAWN BY:	MPG		**Proposed Pipeline**
SCALE:	1:5,000 @A3	DATE:	16.09.2019		**Raymond Terrace to Kings Hill**

PROJECT No:	81502.11
DRAWING No:	17
REVISION:	0

Locality Plan

Legend

- Pipeline Alignment
- Areas of possible weak soils
- Areas of likely residual clay
- Areas of possible deep fill
- Areas of likely shallow rock
- Location of Previous DP reference Project (see report text) and summary of subsurface conditions
- Location and Orientation of Photos (see photo plates)

0 100 200 300 400 m

Drawing adapted from plan by Northrop Engineers and NearMap image

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd		
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:5,000 @A3	DATE:	16.09.2019

TITLE: **Anticipated Terrain Units and Subsurface Conditions**
Proposed Pipeline
Raymond Terrace to Kings Hill

N

PROJECT No:	81502.11
DRAWING No:	18
REVISION:	0

Locality Plan

Legend

- Pipeline Alignment
- Areas of possible weak soils
- Areas of likely residual clay
- Areas of possible deep fill
- Areas of likely shallow rock
- Location of Previous DP reference Project (see report text) and summary of subsurface conditions
- Location and Orientation of Photos (see photo plates)

Drawings 4, 9, 14 and 19

0 100 200 300 400 m

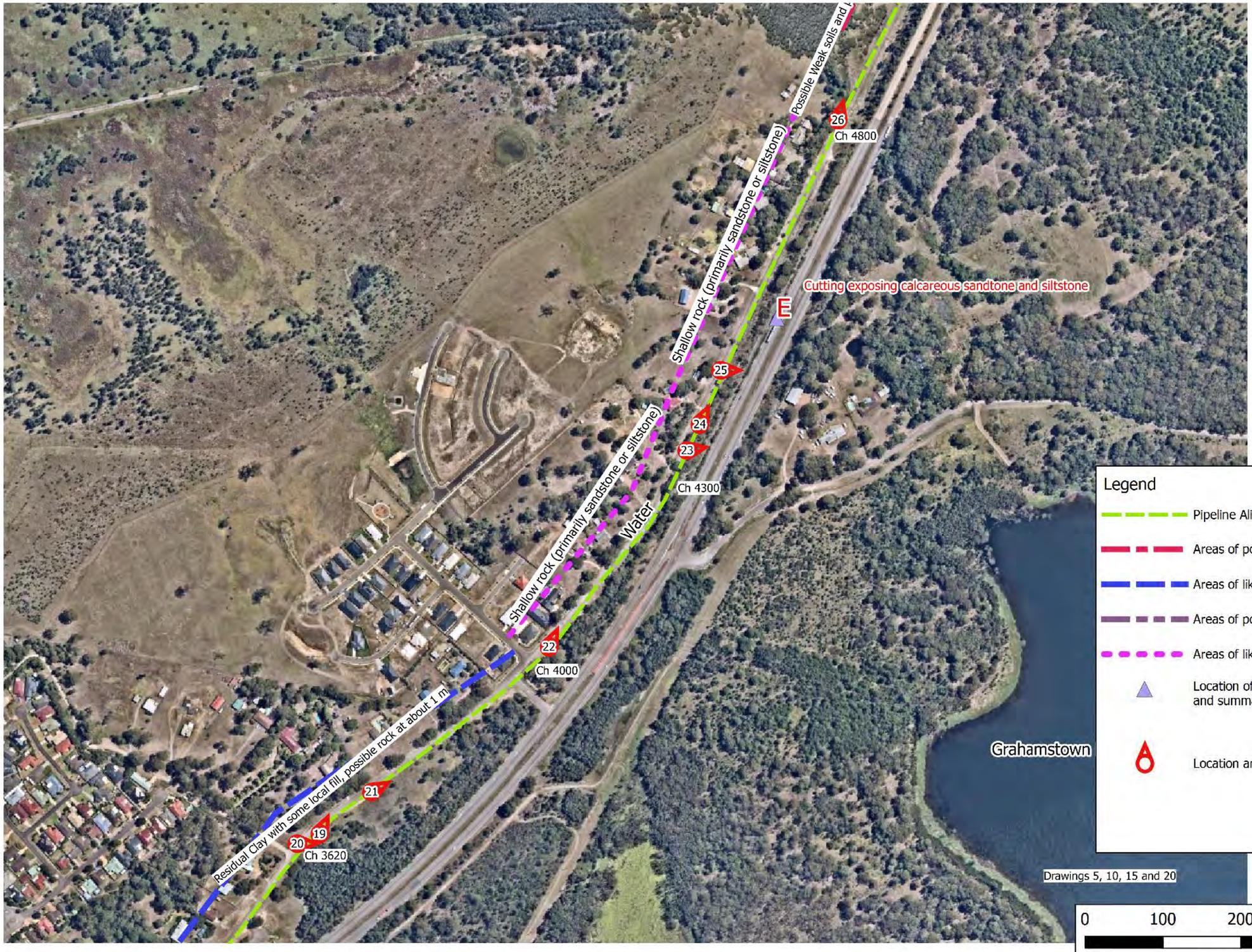
Drawing adapted from plan by Northrop Engineers and NearMap image

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd		
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:5,000 @A3	DATE:	16.09.2019

TITLE: **Anticipated Terrain Units and Subsurface Conditions**
Proposed Pipeline
Raymond Terrace to Kings Hill

PROJECT No:	81502.11
DRAWING No:	19
REVISION:	0



Locality Plan

Legend

- Pipeline Alignment
- Areas of possible weak soils
- Areas of likely residual clay
- Areas of possible deep fill
- Areas of likely shallow rock
- Location of Previous DP reference Project (see report text) and summary of subsurface conditions
- Location and Orientation of Photos (see photo plates)

Drawing adapted from plan by Northrop Engineers and NearMap image

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd	TITLE:	**Anticipated Terrain Units and Subsurface Conditions** **Proposed Pipeline** **Raymond Terrace to Kings Hill**
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:5,000 @A3	DATE:	16.09.2019

PROJECT No:	81502.11
DRAWING No:	20
REVISION:	0

Locality Plan

Legend

- Pipeline Alignment
- Areas of possible weak soils
- Areas of likely residual clay
- Areas of possible deep fill
- Areas of likely shallow rock
- Location of Previous DP reference Project (see report text) and summary of subsurface conditions
- Location and Orientation of Photos (see photo plates)

Drawing adapted from plan by Northrop Engineers and NearMap image

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	PM No 1 Pty Ltd	TITLE:	**Anticipated Terrain Units and Subsurface Conditions** **Proposed Pipeline** **Raymond Terrace to Kings Hill**
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:5,000 @A3	DATE:	16.09.2019

PROJECT No:	81502.11
DRAWING No:	21
REVISION:	0