PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL

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AMENDED IN RED

By: Andrew McKnight

Date: 17 MAY 2021

Queensland Government

calibre

ENGINEERING SERVICES REPORT

Aura North Central Location Precinct 11 (Part) to 12 (Part)



PREPARED BY CALIBRE PTY LTD
PREPARED FOR STOCKLAND DEVELOPMENT PTY LTD

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Note: Any references to the lot layout within this report refer Approved Plan of Development.

AMENDED IN RED

By: Andrew McKnight

Date: 17 MAY 2021

Queensland Government

Executive Summary

Calibre has been commissioned by Stockland Development Pty Ltd to prepare this Engineering Services Report in support of the submission of the Development Application over the subject site known as Aura Precincts 11 (Part) and 12 (Part) (DEV2017/906). The PDA Development Application is for a Development Permit for Reconfiguring a Lot, Material Change of Use and Operational Works.

This development application is presented in accordance with Aura's master planning approval and proposes to reconfigure the existing site into a combination of uses including approximately 1070 residential dwellings, two sports parks, open space, drainage reserve and community/commercial facilities.

The proposed engineering design incorporates the conditions and results of overarching site wide Infrastructure Agreements, Management Plans, Investigations, Approvals, Permits, and studies. Designs are also generally in accordance with standards and specifications referred to by the Sunshine Coast Council and Unitywater.

This report addresses the following concept design components:

Bulk Earthworks:	Including a strategy in accordance with the overarching and Federally Approved Construction and Environmental Management Plan (CEMP) for 1.1 million cubic metres of fill from within the development boundary.
Roads and Connectivity:	A transport network integrating a full range of road hierarchy, public transport planning, dedicated off road cycle tracks.
Servicing Strategy:	Providing an overview of the proposed water and sewer servicing strategy in addition to the existing master planning and Final Precinct Network Plan. Detail is also provided for network integration of electrical and telecommunication services.

The concept engineering design demonstrates that the site can be developed to address the regional and local flood impacts while meeting the service requirements for road access, stormwater quantity, water reticulation and sewerage reticulation over the application area.

The following sections of this report and corresponding engineering design have been prepared closely with Stockland Development Pty Ltd and in conjunction with the wider consultancy team and presents a large-scale urban development application that will maintain Aura as Australia's leading master planned community.

1 Introduction

Calibre has prepared this Engineering Services Report to accompany the submission of a PDA Development Application for Reconfiguring a Lot, Material Change of Use and Operational Works (Advertising Devices) over a portion of the greater Aura site known as Aura Precincts 11 (Part) and 12 (Part).

The application proposes to subdivide the site (approximately 246ha) into various land uses as defined in the proposed development layout. Refer to Appendix A for the proposed application extents and lot layout.

The concept urban designs presented with this application includes:

- Approximately 1070 residential dwellings;
- Two sports parks;
- Parks and open spaces;
- Community centres;
- Childcare centres; and
- Open Stormwater drainage channel.

The aim of the Engineering Services Report is to identify site opportunities and constraints and provide design solutions which comply with the relevant guidelines and demonstrate that the proposed development can be serviced for road access, stormwater drainage, water reticulation and sewerage reticulation while addressing the environmental and flood impacts.

1.1 Existing Planning and Approvals

Calibre's concept design has been developed in accordance with a number of Approvals, Planning Documents, Investigations and Studies.

These documents include but are not limited to:

- Caloundra South Priority Development Area Infrastructure Agreement – State Transport Infrastructure (STIA, 2015);
- Caloundra South Priority Development Area Infrastructure Agreement - Local Government Infrastructure (LGIA, 2015);
- Caloundra South Infrastructure Agreement (Water and Wastewater Infrastructure) (UWIA, 2017);
- Caloundra South Development: Flood Risk Management Strategy (BMT WBM, 2015);
- Caloundra South Water Quality Management Plan (BMT, May 2017);
- Environmental Management Plan (BMT, August 2017);
- Ultimate Caloundra South Traffic Model (MWH, 2015);
- Construction Environment Management Plan (Calibre, Oct 2017);
- Wallum Sedge Frog Management Plan (Stockland, 2017);
- Operational work for Waterway barrier works Preliminary Approval and Development Permit (partial only), subject to conditions (SARA, 2018);
- Additional Geotechnical Investigation, Aura Precincts 6-16 (Douglas Partners, August 2017);
- Infrastructure Master Plan (Water & Sewer) (Parsons Brinckerhoff, Aug 2016); and
- Aura Precincts 11 – 12 Stormwater Quality Management Plan (Design Flow July 2020).

2 Site Description

Precincts 11 and 12 are located in the North Central locality of the Aura development. The site is bound by Bells Creek (North) to the North, Precinct 10 to the East, proposed future urban development (to be undertaken by Stockland) to the South and Environmental Protection Zone and Aura Brook to the west. It is noted that the site forms part of the Aura Priority Development Area, the Master Plan of which has been approved by the (former) Urban Development Authority (ULDA reference No. DEV2011/200) now Economic Development Queensland (EDQ).

Please refer to Figure 1 following showing the site locality:



Figure 1: Site Locality Plan

The proposed development layout is indicated no the Overall Site Master Plan is included within Appendix A.

3 Bulk Earthworks Strategy

3.1 Constraints

The proposed application boundary is bordered by Bells Creek to the north, Precinct 10 in both the south and east, and the Aura Brook and Frog Habitat to the west. Within these confines, there are a number of considerations to be accounted for within the development strategy for the site. These considerations are detailed in the specific management plans noted in this report and are generally summarised below.

The overall constraints affecting the proposed works are shown indicatively on drawings 17-000934.3001-DA06 – DA07 included in Appendix B.

3.2 Earthworks Objectives

The proposed earthworks strategy within the development boundary comply with the above and the following objectives:

- Facilitate the Stockland development phasing and current ROL approvals;
- Be in accordance with the Aura Regional Flood Model – 2017 Revision prepared by BMT WBM;
- Be able to achieve objectives in the BMT Caloundra South Water Quality Management Plan;
- Comply with requirements of the BMT Environmental Management Plan;
- Satisfy the requirements of the Caloundra South Public Environment Report Supporting Document;
- Be in accordance with the approved Caloundra South Master Plan;
- Satisfy the Water Sensitive Urban Design objectives;
- Be in accordance with the Wallum Sedge Frog Management Plan;
- Be in accordance with the Operational work for Waterway barrier works Preliminary Approval and Development Permit (partial only);
- Optimise the use of developable area through efficient design;
- Efficient Design and utilisation of the natural topography of the site as best as possible; and
- Be economical and cost effective.

3.3 Wallum Sedge Frog Ponds and Staged Relocation

There are a number of Wallum Sedge Frog habitats to be retained across the precincts. Retained and recreated Wallum Sedge Frog habitat traverse the riparian zones of Bells Creek North and South.

It is important that the works within these precincts are phased in such a way where impacted habitat exists, recreated habitat can be delivered prior to the removal of existing habitat zones. Likewise, the phasing of the works needs to consider conveyance and discharge of stormwater (both construction and developed) to ensure that runoff does not compromise Wallum Sedge Frog habitat.

The location of the Wallum Sedge Frog habitats that are associated with precincts 7 to 16 are shown indicatively below and in Appendix D

The Wallum Sedge Frog habitat impact and relocation is a two-stage approach. Stage 1 has been completed in accordance with previous approved works. The proposed stage 2 relocation frog ponds within Bells Creek South Catchment are to be included in future works. Locations of the existing WSF constraints have been identified in coordination with Aura's environmental consultants. The contractor is to identify, delineate and manage all remaining WSF Phase 2 locations during the proposed works. For the detailed management strategy of the WSF, reference should also be made to the Wallum Sedge Frog Management Plan – August 2016 (WSFMP) submitted to the Department of Environment and Energy, in support of the underlying development.

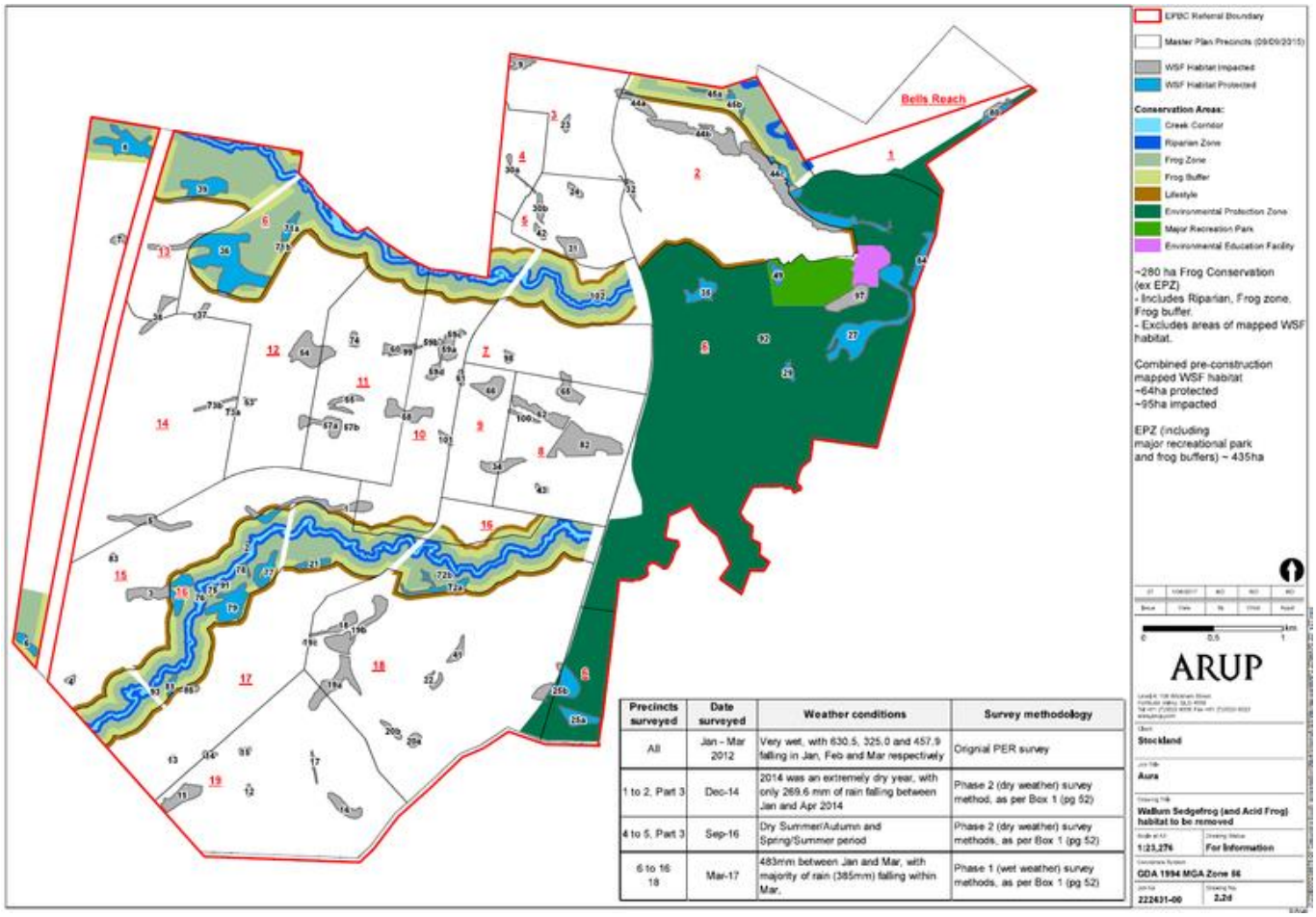


Figure 2: Wallum Sedge Frog Habitats

3.4 Waterways and Fish Passage

Reference has been made to the Department of State Development, Manufacturing, Infrastructure and Planning approval (1710-2004 SDA dated 28 February 2018) which provides a conditional approval for the proposed earthworks across the site. Drawing 005a (extracted below) identifies the DAF waterway barrier risk of impact mapping.

Mapping indicates that there is no declared fish habitat anywhere in the vicinity of Aura. There is, however, Waterway Barrier mapped tributaries within the subject precincts. The treatment and removal of these waterways is required to be strictly in accordance with the existing DAF approval conditions. Risk to impact to waterway barriers in accordance with the DAF waterway approval have been identified in the image below and in Appendix D.

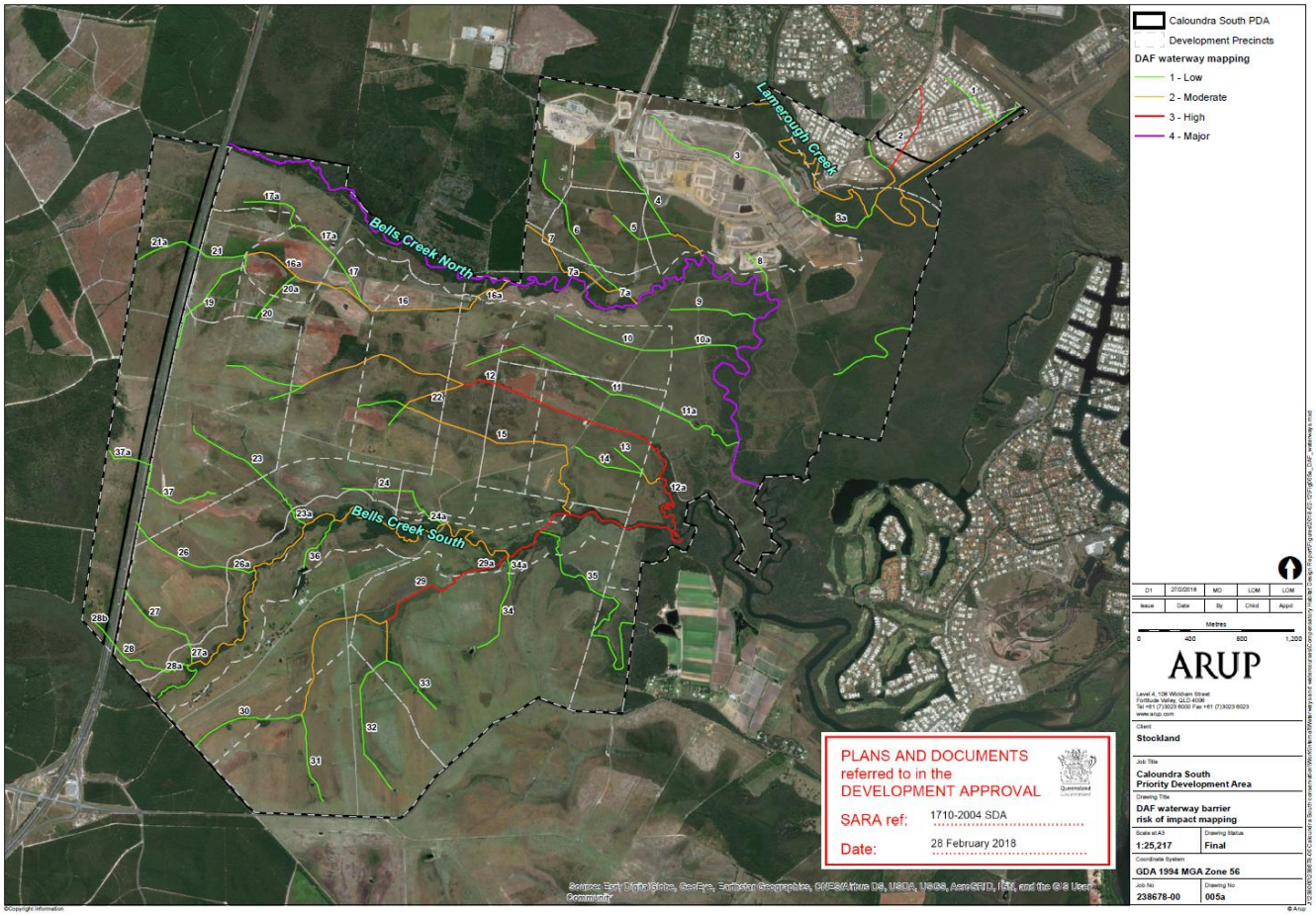


Figure 3: DAF Waterway Barrier Risk of Impact

The proposed outlet channel discharging treated flows from Water Sensitive Urban Design Basin N3 to Bells Creek North is a "Compensatory Fish Habitat", as per the Preliminary approval and Part Approval for Operational work for Waterway barrier works has been decided by the Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP), dated 28 February 2019 (ref: 1710-2004 SDA). Special consideration for the proposed fish habitat and passage is required in the design and modelling methodology. Further detail on the channel with be provided during detail design.

3.5 Vegetation

Vegetation management is detailed in the VMP prepared by ARUP. Within the subject precincts, there are no EPBC listed threatened flora species. In addition, no areas of native remnant vegetation were identified for retention. The Bells Creek North and South corridors, as well as the environmental Protection Zone to the east of the future Bells Creek Arterial have been identified for conservation and rehabilitation to improve habitat value.

Weed management throughout earthworks operations and rehabilitation works is important to ensure successful regeneration of native vegetation.

The mapping prepared by ARUP detailing the proposed Ecological Enhancement Strategy is shown below in Figure 4: ARUP Ecological Enhancement Strategy Mapping and in Appendix D.

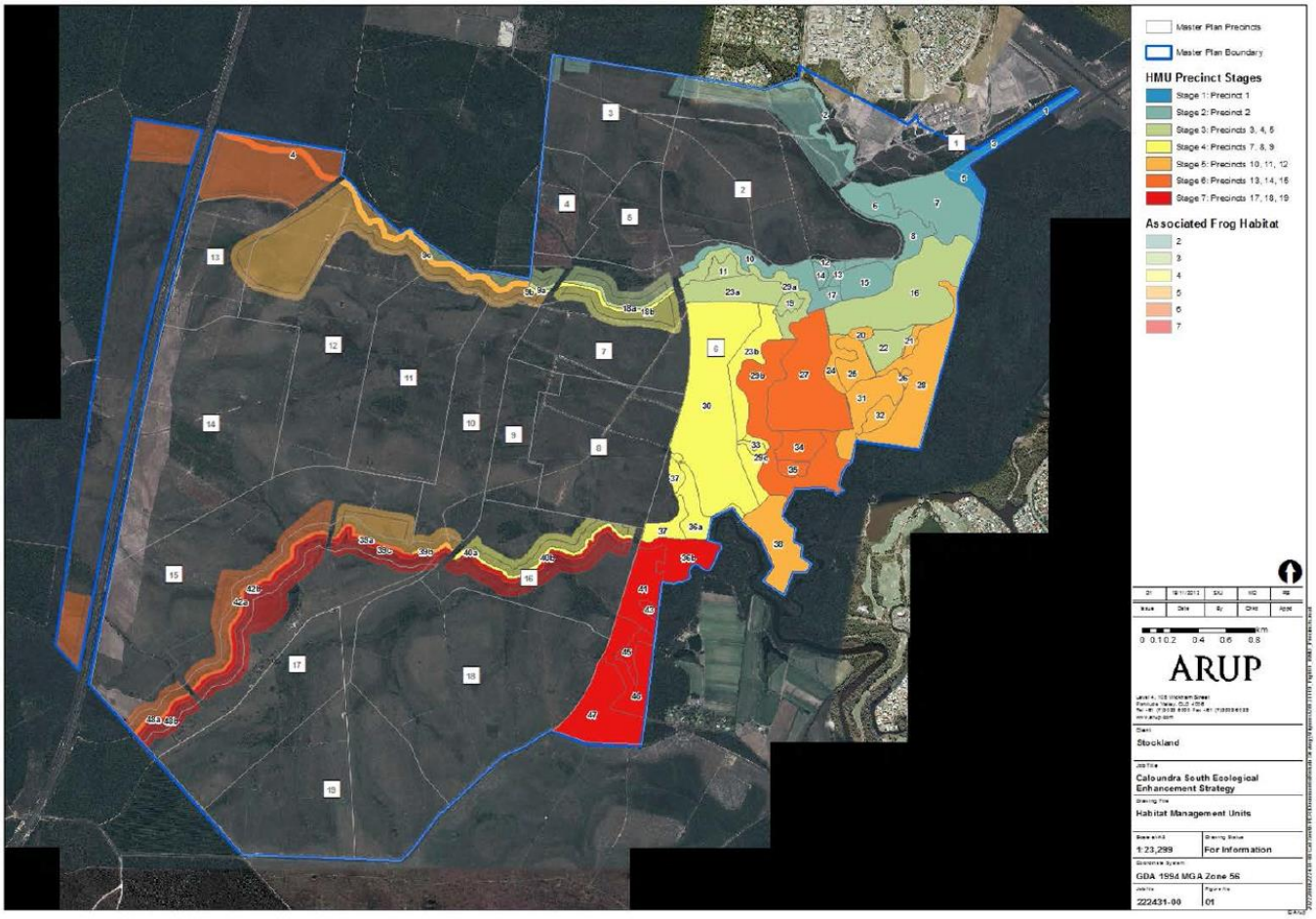


Figure 4: ARUP Ecological Enhancement Strategy Mapping

3.6 Groundwater

The site is underlain by relatively shallow groundwater. With significant alterations to existing levels proposed throughout these precincts, local groundwater levels will need to be closely monitored and managed throughout construction to ensure that adverse environmental impacts are avoided. The hierarchy for management of groundwater is structured below:

- Avoid;
- Reduce;
- Reuse;
- Treat; and
- Dispose.

BMT have been engaged by Stockland to undertake groundwater monitoring prior to and during construction. Indicative monitoring locations are shown below in Figure 5 and **Error! Reference source not found.**.

It is noted that a number of the existing monitoring bores are located within areas which could be affected by the works. BMT have been provided with details of the proposed development strategy and are currently considering what adjustments should be considered as a result of this strategy.

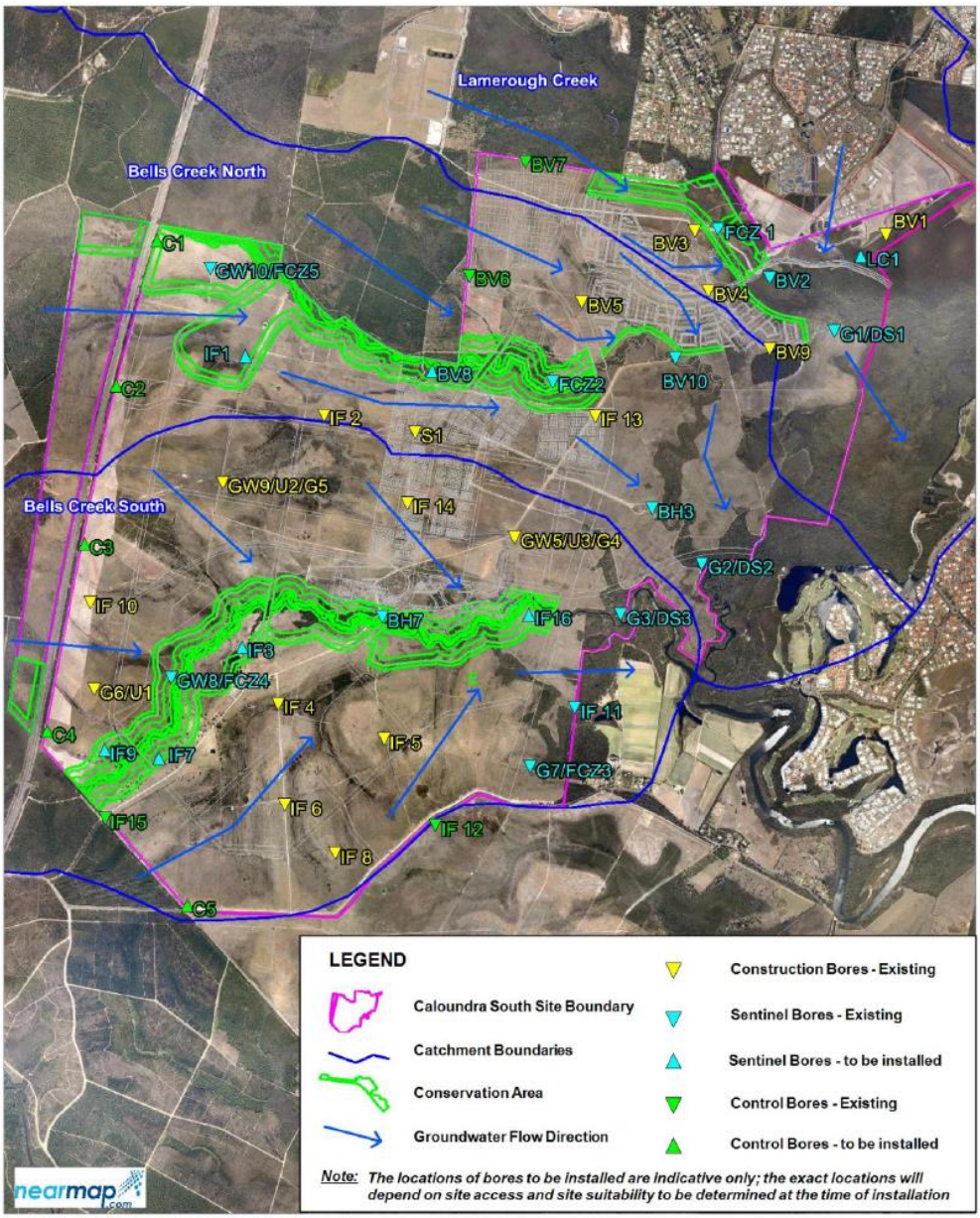


Figure 5: Groundwater Monitoring Locations

3.7 Water Quality Management

Protection of the downstream declared Ramsar wetland within Pumistone Passage is of critical importance to this project. A robust and well considered stormwater management strategy for both construction and operational phases is therefore a significant focus of the development strategy within these precincts. These strategies are considered in detail in DesignFlow Precincts 11 to 12 Stormwater Quality Management Plan (2017). The operational phase stormwater CEMP for these precincts defines in detail the specific construction phase water quality management requirements. These strategies establish objectives which are 'better' than best practise', exceeding SPP requirements.

It is anticipated that water quality management measures for these precincts will include:

- High Efficiency Sediment Basins during construction;
- Streetscape Biopods;
- Rainwater Tanks
- End of line Treatment systems (Sediment basins, Bioretention systems and Wetlands)

A concept Schematic diagram - Stormwater treatment strategy for the site is as presented below (Source – DesignFlow SQMP 2020 Figure 5 – Stormwater treatment train flow diagram)

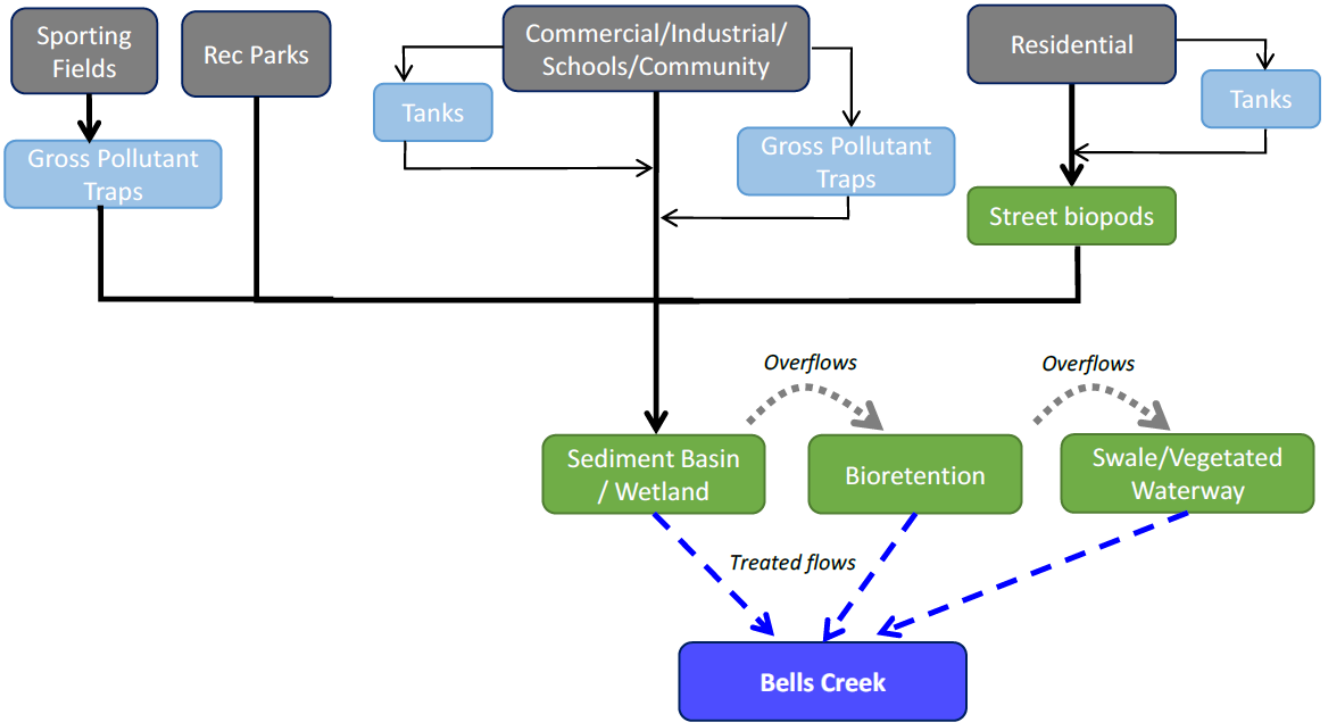


Figure 6: Stormwater Treatment Strategy

3.8 Geotechnical

Geotechnical investigation has been undertaken by Douglas Partners comprising broadscale investigation in 2014 and an Additional Geotechnical Investigation of Precincts 6 -16 in 2017 (report attached in Appendix C).

Key findings from these reports are summarised as follows:

- Broadly, the area is gently undulating of low relief, with the ground surface overall falling gradually from west to east with several localised knolls associated with the larger trending ridgeline on the western side of the Bruce Highway;
- Subsurface conditions generally comprise topsoil of between 100mm to 350mm overlying silty and clayey sands;
- It is anticipated that the majority of material won from excavations on site will generally be suitable for reuse as bulk filling provided they are placed in a controlled manner;
- Groundwater seepage was typically encountered between 1.2m and 2.8m depth;
- CBR testing (16 samples) returned results of between 0.5% to 18.0% with an average result of 7% across the greater Aura Development;
- Emerson class dispersion tests (8 samples) returned values of 5 and 6 on a scale of 1 to 8 indicating a slight potential for erosion;
- Topsoil depth varies from 0.1m to 0.35m. Quality of topsoil is poor and it is anticipated that treatment would be needed to improve nutrient value;
- Drainage for the site during construction is necessary to maintain site trafficability. Consideration for providing a working platform may be necessary in some instances;
- Recommended compaction factors in the calculation of fill volumes vary between 0.80 and 1.10 with the silty/ clayey sands which comprise the majority of the site being 0.80 to 0.85; and
- Site classification of 'Class S' would be anticipated under normal soil moisture conditions.

3.9 Earthworks Level Control

Regional flood levels have been established for Bells Creek North and South through modelling undertaken by BMT WBM. In general, these flood levels control the minimum earthworks levels at the stormwater outlets and embankments. Significant bulk earthworks operations are required to achieve flood immunity for the developed site. Refer to Drawing Number 17-000934.3001-DA05 for indicative cut / fill depths.

Cut (m^3)	25,067m^3
Fill (m^3)	1,409,895m^3
Note that the above figures are preliminary earthworks quantities and include a topsoil strip and respread balance of 169,000m3.	

Table 1 – Cut / Fill Estimate of Quantities

All material will be sourced from within the area in accordance with the proposed earthworks phasing. Local flood levels have been developed with consideration of the regional flood levels from the major waterways and proposed outlet levels for the end of line WSUD devices.

3.10 Adopted Standards and Design Principles

To comply with the Aura Regional Flood Model 2018 Revision (Report prepared by BMT WBM), the minimum habitable floor levels for allotments is based on providing 500mm freeboard to the 100-year ARI peak flood level with increased rainfall intensity and sea levels taken into account for climate change to a planning horizon of the year 2100.

As per previous stages in Aura, the flood planning level for earthworks fill levels includes a 350mm freeboard. The remaining 150mm freeboard will be achieved through slab construction to satisfy the habitable floor level requirements to provide a freeboard of 500mm as required. In approaching the freeboard requirements in this manner, the earthworks volumes across the site can be optimised therefore providing economically sustainable development whilst achieving the flood immunity requirements.

The concept bulk earthworks design provides appropriate flood immunity for various land uses in accordance with the master plan as flows:

- Allotments and roads are designed for immunity to the 100-year ARI peak flood level with climate change;
- Major and district sports parks have been designed for 20-year ARI flood immunity (with 100-year ARI flood immunity for structures); and
- Recreational areas have been designed for the 5-year ARI flood immunity (with 100-year ARI flood immunity for structures).

The design principles, which have been adopted for this concept bulk earthworks strategy, are:

- To be in accordance with flood immunity requirements set by regional flood levels along Bells Creek North;
- To be in accordance with local flood levels from the internal stormwater catchments;
- All allotments to be graded at minimum and 1 in 200 towards the road;
- Roads to have minimum grade of 0.3%;
- Cut/fill volumes to be developed to best match requirements of other Precincts;
- To be consistent with the Construction Environmental Management Plan by Calibre; and
- To be consistent with the Additional Geotechnical Investigation report for Aura Precincts 6-16 by Douglas Partners.

3.11 Proposed Earthworks Strategy

There are significant bulk earthworks operations required to achieve flood immunity for the developed site. Indicative cut and fill depths over the subject Precincts are shown indicatively on drawing 17000934.3001-DA05 in Appendix B. Bulk earthworks design contours are shown indicatively on 17000934.3001-DA06-DA07.

Based on conceptual modelling, fill levels within the subject precincts are anticipated to be in the order of up to 3.5m. Douglas Partners have been consulted in relation to the potential for creep settlement as a result of this filling and have advised that there is little concern in this regard.

There is approximately 130 thousand cubic metres of cut and 1.1 million cubic metres of fill across the subject ROL area. The shortfall of material will be sourced from future precincts in alignment with the Master Plan. It is envisaged that there will be efficiencies in the modelling of earthworks which can be realised once further development planning has occurred.

Prior to any earthworks taking place, translocation of frog habitat as well as extensive flora and fauna surveys are undertaken to ensure earthworks are undertaken in accordance with the Management Plans outlined in Section 1.1.

4 Roads and Connectivity

The proposed road hierarchy and connectivity planning has been undertaken in accordance with the LGIA (2015).

Urbis have undertaken a road hierarchy plan containing sub-arterial, trunk connector, neighbourhood connector, access streets, and laneways for the relevant precincts, this has been replicate on drawings 17-000934.3001-DA03 to 17-000934.3001-DA04 PwC have completed a detailed traffic report and modelling based on Urbis' road hierarchies and development yield to determine final design requirements for traffic, parking and intersections.

A detailed assessment of the Precinct 11 and 12 DA area traffic was previously undertaken by Calibre and documented with the report titled Precincts 11 and 12 (Part): Traffic Assessment (2017). However, to ensure consistency between the macro traffic modelling completed by PwC through Precinct 11 – 14 the Precinct 11 – 12 traffic analysis has been undertaken by PwC and is documented in the following report Aura Precinct 7-14 Traffic Modelling Refresh (PwC, 2021).

The assumptions in Precinct 7-14 traffic model have been reflected in the road heirachy, provided by appropriate lane types and intersections (signalised and unsignalized).

The Precincts are also fully serviced with pedestrian and off-road bicycle networks to comply with the LGIA (Map 11). The surrounding intersections will be assessed in detail as part of the detailed design for the relevant precincts. Urbis' road cross sections include Sub Arterials, Trunk Connectors, Neighbourhood Connectors, Access Streets and Laneways. This conforms with the relevant LGIA road profiles with the notable exception of:

- Widening footpaths adjacent to two lane cycle tracks (increased from 1.5m to 1.8m) to match previous approvals in the development; and
- Removal of on road cycle lanes and provision of off-road cycle tracks (contra-flow bicycle lanes), providing continuity throughout development.

Final assessment of the proposed road intersections and geometry will be assessed in detail as part of the detailed design for the relevant Precincts.

Laneways

The below figure illustrates the laneway configuration in Stage 1117.

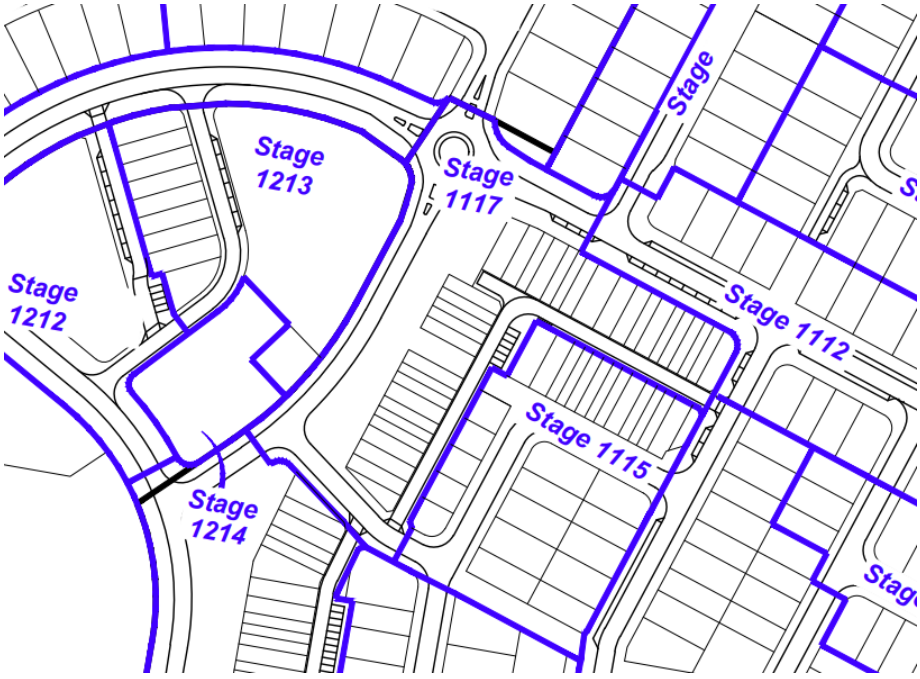


Figure 7: Stage 1117 Laneways

The laneway contained within Stage 1117 is estimated to have a traffic volume of circa 460 vehicles per day. For a Neighbourhood Lane EDQ PDA Guideline No. 06 indicates a maximum 500 vehicles per day. This laneway meets the required volumes for a laneway.

All laneways are designed to have a low speed environment, as per Sunshine Coast Planning Scheme Schedule SC6.17 the design speed is 20km/hr. A low speed environment reduces stopping distance and improves viewing time as approaching the higher order road.

Therefore, at this development approval phase it is determined that the layout presented is suitable for safe and effective movements.

The below figure illustrates the laneway configuration in Stage 1118.



Figure 8: Stage 1118 Laneways

The laneway contained within Stage 1118 is estimated to have a traffic volume of circa 290 vehicles per day. For a Neighbourhood Lane EDQ PDA Guideline No. 06 indicates a maximum 500 vehicles per day. This laneway meets the required volumes for a laneway.

All laneways are designed to have a low speed environment, as per Sunshine Coast Planning Scheme Schedule SC6.17 the design speed is 20km/hr. A low speed environment reduces stopping distance and improves viewing time as approaching the higher order road.

Therefore, at this development approval phase it is determined that the layout presented is suitable for safe and effective movements

5 Stormwater Quantity Management

5.1 Regional Flooding

A regional flood investigation was undertaken by BMT to assess the affects the proposed development would have on regional flooding. The subsequent report prepared by BMT, Aura Flood Risk Management Report 2020 has guided Calibre's civil design and stormwater modelling for the site.

From this, regional flood levels have been established for Bells Creek North and South. In general, these flood levels have directly influenced the minimum earthworks levels at the stormwater outlets and embankments. Significant bulk earthworks operations are required to achieve flood immunity for the developed site.

As previously mentioned, the minimum habitable floor levels for allotments is based on providing 500mm freeboard to the 100-year ARI peak flood level with increased rainfall intensity and sea levels taken into account for climate change to a planning horizon of the year 2100. The flood planning level for earthworks fill levels includes a 350mm freeboard. The remaining freeboard will be achieved through slab construction to satisfy the habitable floor level.

As the proposed development footprint sits over an existing natural flow path that connects Bells Creek North to Bells Creek South any filling within this channel would trigger impacts to the flood level. To determine a flood mitigation strategy BMT undertook an investigation in which it was recommended that a 40m wide diversion channel be constructed. This strategy is documented in Modelling of diversion channel from Bells Creek North to Bells Creek South (BMT, 2018). However, since this initial strategy was approved by EDQ, the development phasing has pivoted significantly to meet market demands. Therefor BMT have undertaken a subsequent investigation into a temporary basin located within Precinct 13. It has been concluded that a 200,000m^3 basin is a suitable interim mitigation strategy in-lieu of the previous diversion channel. Detailed findings of this investigation are documented within Flood Impact Assessment – Temporary detention basins proposed for Precinct 13 (BMT,2021).

5.2 Local Drainage

The Precincts 11 and 12 catchments discharge to Bells Creek (North) to the North and Aura Brook to the South in accordance with the Designflow Stormwater Quality Management Report. These flows follow an internal network of major drainage elements through a series of piped and surface flow channels. The lower order road network is designed to transport Q2 drainage flows through the piped system with the higher order roads designed to pipe Q10 flows. In locations where the road capacity is reached, the 100 year ARI flows will be piped. The stormwater quality basins are designed for 2 year ARI immunity throughout Aura.

Refer to the Stormwater Catchment and Layout Plans 17-000934.3001-DA12 and DA13 in Appendix B for the indicative catchments, channels, culvert crossings and conceptual outflow locations to the proposed WSUD devices.

As with other major infrastructure elements, location and details of stormwater drainage elements are conceptual only and subject to further detailed design for operational works.

5.3 Aura Brook

The Aura Brook has been approved under the Precinct 11 -14 DA DEV2018/987 and is not included as part of this application

6 Water and Wastewater Reticulation

The overall water and sewer servicing strategy for Aura has been previously prepared by Parsons Brinckerhoff in the Caloundra South Water Supply and Sewerage Infrastructure Master Plan (IMP).

As part of the delivery process for water and wastewater infrastructure, the Unitywater Infrastructure Agreement requires development of a Preliminary Precinct Network Plan (PPNP) to be reviewed and approved by Unitywater before a Final Precinct Network Plan (FPNP) can be agreed for delivery.

6.1 Water and Wastewater Reticulation

The proposed trunk water and sewer servicing within the subject precincts is detailed in the Preliminary Precinct Network Plan (PPNP), Aura – Precinct 6 (Part), 11 (Part) and 12 (Part) prepared by Calibre, March 2018 and the Final Precinct Network Plan (FPNP), Aura – Precinct 6 (Part), 11 (Part) and 12 (Part) prepared by Calibre, July 2019. The primary objective of this PPNP and FPNP process is to determine suitable staging of water and wastewater servicing strategies in support of the development. The proposed internal sewer and water networks are shown indicatively on concept drawings 17-000934-3001-DA08-DA11 in **Error! Reference source not found.**. Trunk watermains range from 200mm diameter to 600mm diameter PE pipe, whilst trunk sewer mains range from 150mm diameter to 300mm PE pipe.

All water and wastewater infrastructure are proposed to be designed generally in accordance with Unitywater Standards, the SEQ Water Supply and Sewerage Design and Construction Code or as otherwise agreed with Unitywater.

6.2 External Trunk Water Connection

Prior to any development within Precinct 13 or at 15,001EP, Unitywater will be required to provide a trunk watermain connection from an external 12ML reservoirs by means of an approximately 1.2km of dual DN600mm dia trunk main. The hydraulic configuration for this external trunk water main connection is currently under review by Unitywater.

The proposed Unitywater reservoir will be located west of the Bruce Highway, ultimately connecting back to Ewan Maddock Dam.

The external trunk water main that will feed Aura will be constructed east of the reservoir, across the Bruce Highway (refer to figure below. The alignment will turn north running adjacent to the proposed sports park.

The development connection to this external trunk feed is located on the Central Avenue just west of the future TMR interchange, indicated as Point H in the Figure below.

The current projected delivery date for the trunk feed is the end of 2023.

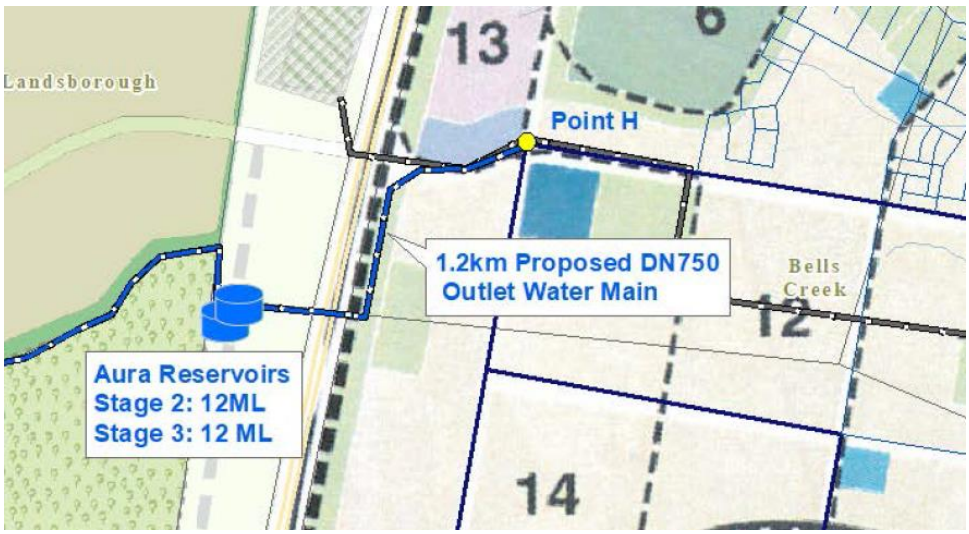


Figure 9: Indicative External Trunk Watermain Alignment

6.3 Trunk Sewer

The proposed internal wastewater network is shown indicatively on concept drawings 17-000934-3001-DA08-DA09 in Appendix B. As per the DA08 drawing the sewer depicted in this area drains to the trunk sewer located in Bells Creek North before ultimately discharging into SPS-LMT-117 (SPS-A). The sewer network shown on DA09 drains into the existing sewerage network constructed through Precinct 10 and flows ultimately to either SPS-LMT-118 (SPS-B). and SPS-LMT-117 (SPS-A). The trunk sewer pipe material and class will be maintained as per the previous trunk sewer designs, (PE100, PN10, SDR21) where possible and verified by structural design.

7 Utilities

The development will be serviced with electrical and telecommunications (National Broadband Network).

As per previous precincts with Aura the services are proposed to be co-located on a standard alignment within a corridor 0-900mm from the property boundary. Detailed design may determine that alternative alignments are required in some instances and these will be detailed on an as required basis.

These services will be provided in accordance with conditions of, and through agreement with, the relevant service providers.

Appendix A Development Layout

STOCKLAND DEVELOPMENT PTY LTD



LEGEND

GENERAL

- Precinct Boundary
- Staging Boundary
- Waterway - Centreline
- Waterway - Top of bank
- Lifestyle Buffer (30m Deep)

LAND USE

- Multiple Unit Dwelling Sites
- Community Use
- Private School
- Childcare Centre

OPEN SPACE

- Local Park
- Neighbourhood Park
- Environment Protection
- Local Linear Park
- Pedestrian Link
- Neighbourhood Sports Park

RESIDENTIAL

32 Deep Lots

- 10.0m - Villa
- 12.5m - Premium Villa
- 14.0m - Courtyard
- 15.0m - Traditional

30 Deep Lots

- 10.0m - Villa
- 12.5m - Premium Villa
- 14.0m - Courtyard
- 18.0m - Premium Traditional

28 Deep Lots

- 4m - Terrace
- 4.6m - Terrace
- 6.6m - Terrace
- 6.6m+ - End Terrace
- 7.5m - Terrace
- 8.5m+ - End Terrace
- 10.0m - Villa
- 12.5m - Premium Villa
- 14.0m - Courtyard
- 18.0m - Premium Traditional

25 Deep Lots

- 4m - Terrace
- 4.6m - Terrace
- 6.6m - Terrace
- 6.6m+ - End Terrace
- 6.2m - Front Loaded Terrace
- 10m+ - Front Loaded End Terrace
- 7.5m - Terrace
- 8.5m+ - End Terrace
- 10.0m - Villa
- 12.5m - Premium Villa
- 14.0m - Courtyard
- 18.0m - Premium Traditional

Urban Lots

- Urban Lot Type A
- Urban Lot Type B
- Urban Lot Type C & D

URBIS

Aura P11 & P12

CONCEPT AND STAGING

Scale 1:5,000 @ A3

0 50 100 250m

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This plan is conceptual and is for discussion purposes only. Subject to further detail study, Council approval, engineering input, and survey. Cadastral boundaries, areas and dimensions are approximate only. Figured dimensions shall take preference to scaled dimensions. No relevance should be placed on this plan for any financial dealings of the land.

PROJECT NO: BA4422
DATE: 03.03.2021
DRAWING NO: OP01
REV: 9

AURA NORTH CENTRAL LOCATION PRECINCT 11 (PART) TO 12 (PART)

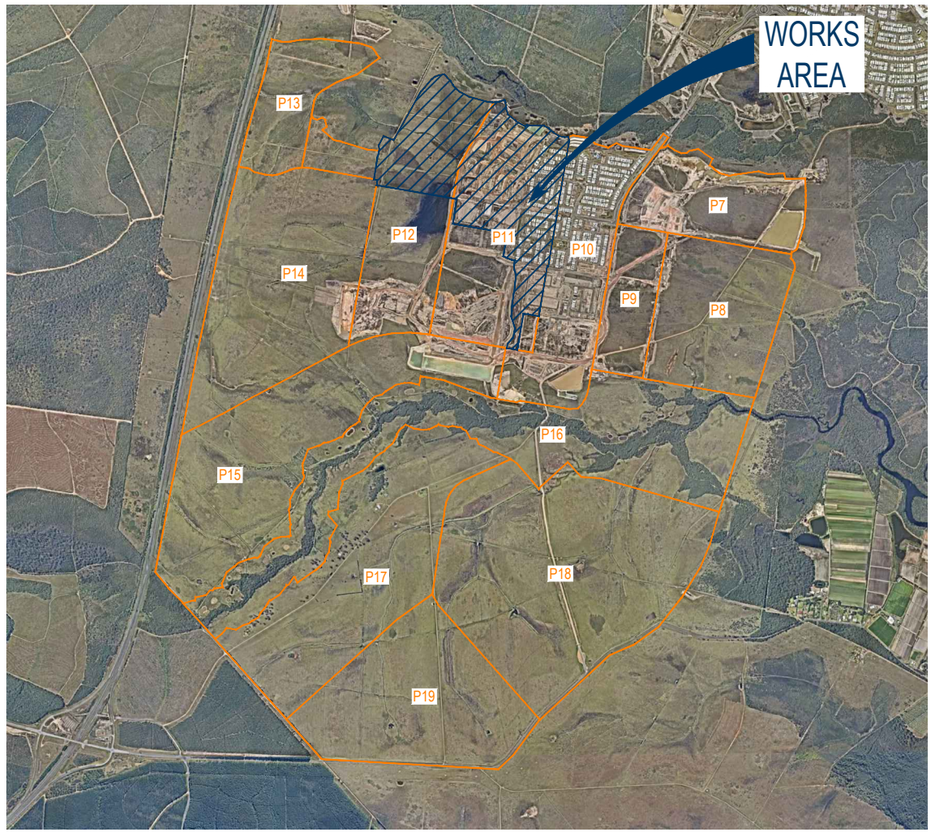
Appendix B Engineering Drawings

STOCKLAND DEVELOPMENT PTY LTD

AURA

PRECINT 11 AND 12
DEVELOPMENT APPLICATION

STOCKLAND DEVELOPMENTS PTY LTD



DRG NO	REVISION	DRAWING TITLE
3011-DA01	A	COVER SHEET AND LOCALITY PLAN
3011-DA02	B	OVERAL LAYOUT AND KEY PLAN
3011-DA03	B	PROPOSED ROAD HIERARCHY PLAN
~~3011-DA04~~	~~A~~	~~PROPOSED ROAD CROSS SECTIONS - REMOVED~~
3011-DA05	-	PROPOSED ROAD CROSS SECTIONS SHEET 1 OF 2
3011-DA06	-	PROPOSED ROAD CROSS SECTIONS SHEET 2 OF 2
3011-DA05	A	CUT FILL DEPTH RANGES PLAN
3011-DA06	A	BULK EARTHWORKS DETAIL PLAN SHEET 1 OF 2
3011-DA07	A	BULK EARTHWORKS DETAIL PLAN SHEET 2 OF 2
3011-DA08	B	SEWER RETICULATION LAYOUT PLAN SHEET 1 OF 2
3011-DA09	B	SEWER RETICULATION LAYOUT PLAN SHEET 2 OF 2
3011-DA10	A	WATER RETICULATION LAYOUT PLAN SHEET 1 OF 2
3011-DA11	A	WATER RETICULATION LAYOUT PLAN SHEET 2 OF 2
3011-DA12	B	STORMWATER CATCHMENT AND LAYOUT PLAN SHEET 1 OF 2
3011-DA13	B	STORMWATER CATCHMENT AND LAYOUT PLAN SHEET 2 OF 2
3011-DA14	B	CONCEPTUAL EROSION AND SEDIMENT CONTROL LAYOUT PLAN SHEET 1 OF 2
3011-DA15	B	CONCEPTUAL EROSION AND SEDIMENT CONTROL LAYOUT PLAN SHEET 2 OF 2
3011-DA16	A	CONCEPTUAL EROSION AND SEDIMENT CONTROL NOTES
3011-DA17	A	CONCEPTUAL EROSION AND SEDIMENT CONTROL DETAILS
3011-DA18	A	BIO RETENTION NOTES AND DETAILS SHEET 1 OF 3
3011-DA19	A	BIO RETENTION NOTES AND DETAILS SHEET 2 OF 3
3011-DA20	A	BIO RETENTION NOTES AND DETAILS SHEET 3 OF 3

08 MARCH 2021

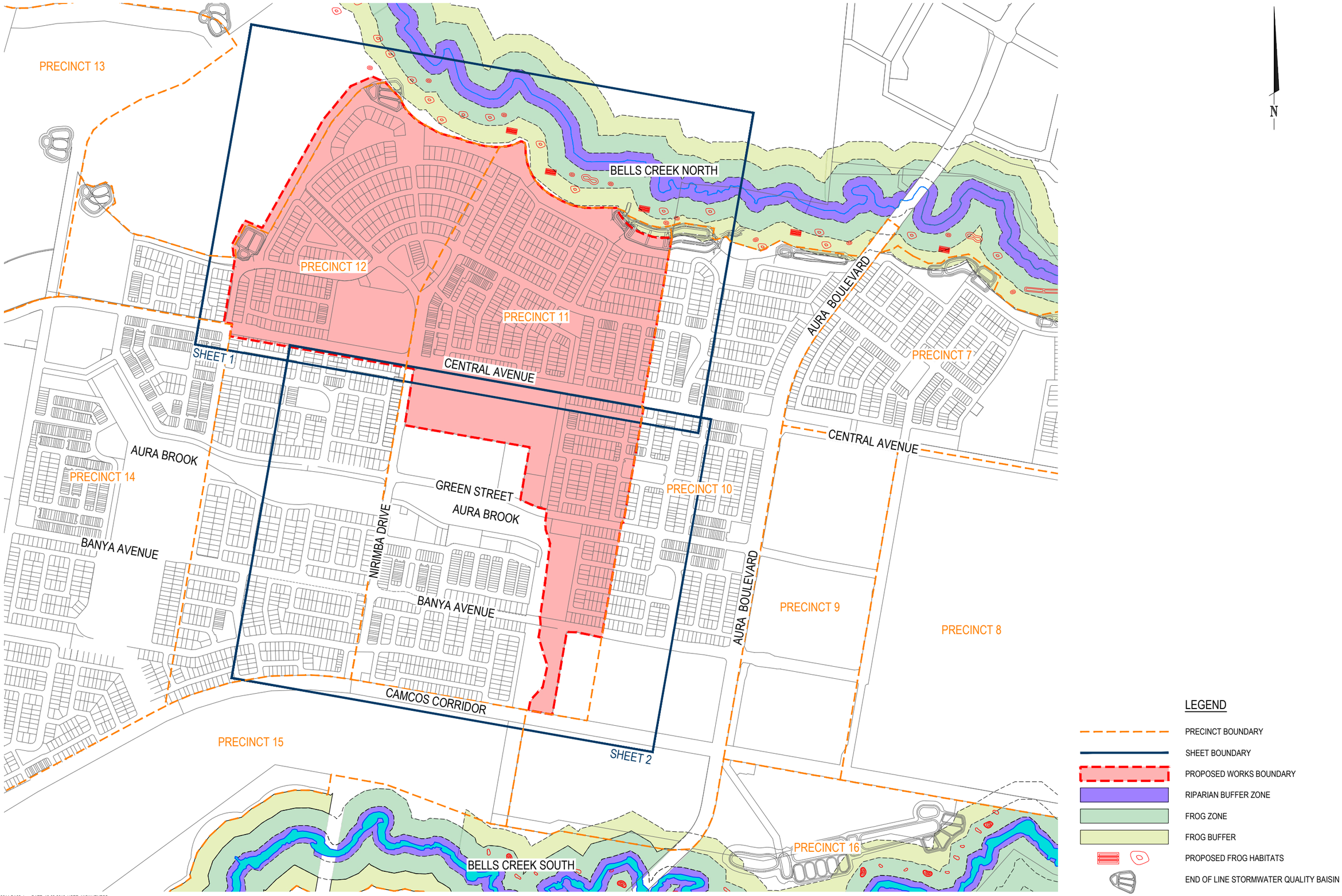
Stockland

AURA

FILE: H:\17000934 - AURA P7 - 10\000934-AURA\0000 OTHER WORKS\3011 - ROL P11 & 12\4_MODEL\AUTOCAD\3011-DA01.DWG LAST SAVED BY NICK VENESS

AURA
PRECINT 11 AND 12
DEVELOPMENT APPLICATION

Project No.:	Milestone:	Revision Date.:	Drawing No.:	Revision:
17-000934	ISSUED FOR APPROVAL	08.03.21	3011-DA01	B



FILE: 3011-DA02.dwg DATE: 18-03-2019 USER: NICK VENESS
XREFS: X-17-000934 - P11-12 DABASE, X-17-000934 - LOTS

FIRST ISSUE	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
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A	JM	JM	BG	MW	03.04.18	AMENDED TO SUIT NEW LOT LAYOUT
B	NV	NV	BG	MW	05.02.21	PRECINCT 11 AND 12 LOTS AMENDED
C	NV	NV	BG	MW	08.03.21	PRECINCT 12 LOTS AMENDED

AMENDMENTS

STATUS
ISSUED FOR APPROVAL

APPROVED
BY:
SIGN: DATE:

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SCALE 1:5000 (A1) SCALE 1:10000 (A3)

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

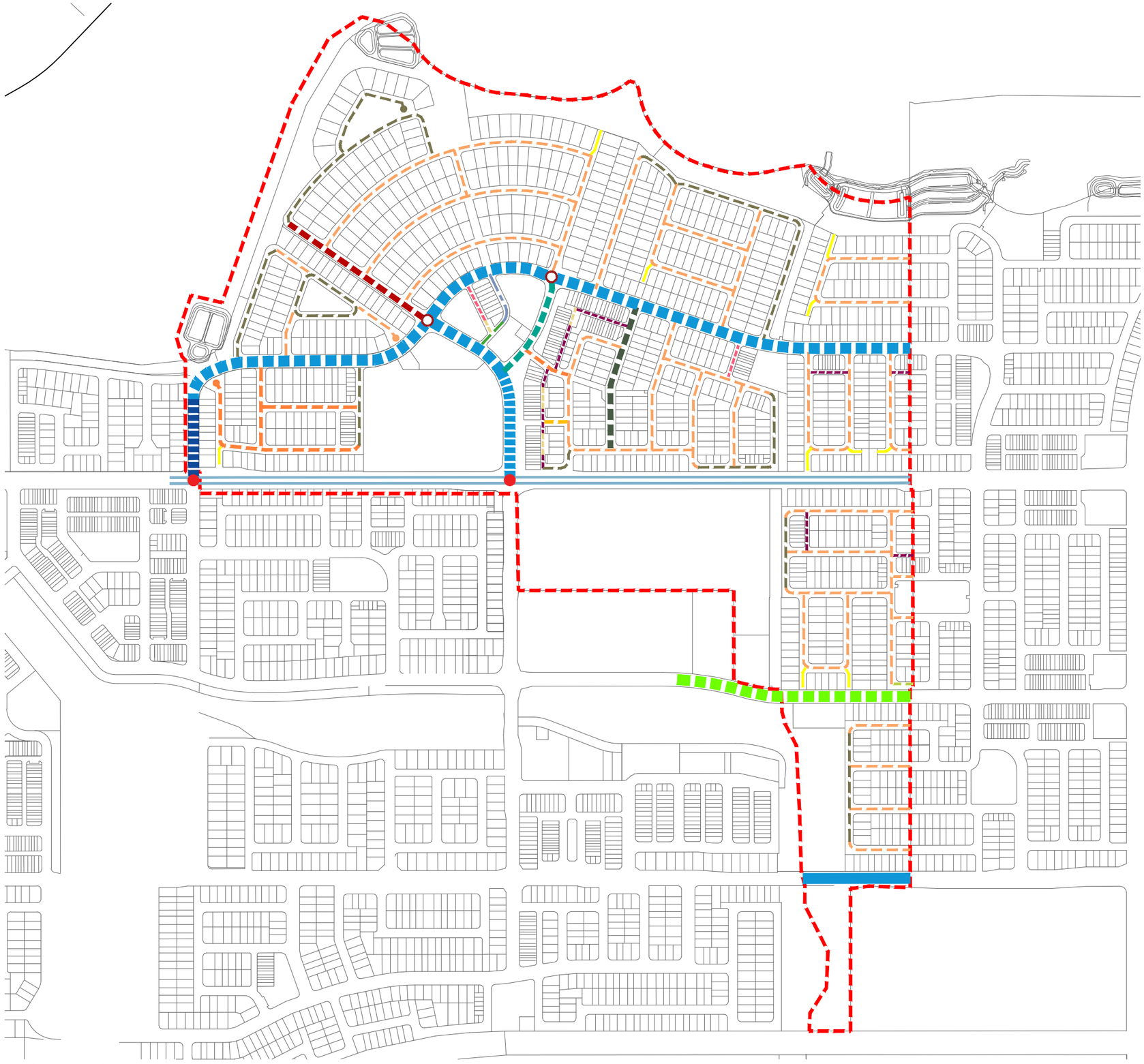
Calibre Professional Services Pty Ltd
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Maroochydore, QLD 4558
Telephone 07 5314 2520
Facsimile 07 5314 2522
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PROJECT
AURA
PRECINT 11 AND 12
DEVELOPMENT APPLICATION

DISCLAIMER
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DRAWING TITLE
OVERAL LAYOUT
AND KEY PLAN

PROJECT No.	DRAWING No.	REVISION
17-000934	3011-DA02	C



N

REFER DRG DA04A AND DA04B FOR TYPICAL ROAD CROSS SECTION

ROAD HEIRARCHY LEGEND

SUB-ARTERIAL ROADS

- SUB-ARTERIAL 2 - 29m (30.72m @ BUS BAYS)

CONNECTOR ROADS

- TRUNK CONNECTOR - 24m
- GREEN STREET - 23m
- NEIGHBOURHOOD CONNECTOR A - 22.5m
- NEIGHBOURHOOD CONNECTOR B - 22.5m
- NEIGHBOURHOOD CONNECTOR C - 18.0m

ACCESS STREETS

- ACCESS STREET ASYMMETRICAL A - 17.5m (PARKING BAYS ONE SIDE ONLY)
- ACCESS STREET ASYMMETRICAL B - 17.5m (PARKING BAYS ONE SIDE ONLY)
- ACCESS STREET - GREEN LINK A - 19.5m (NO PARKING BAYS WITH EXTRA VERGE ON ONE SIDE)
- ACCESS STREET - GREEN LINK B - 17.5m (NO PARKING BAYS)
- ACCESS STREET - URBAN - 17.5m (PARKING BAYS BOTH SIDES)
- ACCESS STREET - STANDARD - 15.5m/16.0m (16.0 IN PREMIUM AREAS ONLY)
- ACCESS STREET - ESPLANADE - 13.5m (6.5m PAVEMENT WITH PARKING BAYS BOTH SIDES)
- ACCESS STREET - ESPLANADE - 13.5m (5.5 PAVEMENT WITH NO PARKING BAYS)
- ACCESS LANE A - 11.3m
- ACCESS LANE B - 10.0m
- LANEWAY LINK - 14.8m
- LANEWAY - 10.5m
- LANEWAY - 8.0m
- CONCRETE DRIVEWAY - 4.5m
- SIGNALISED INTERSECTION
- ROUNDABOUT

FILE: 3011-DA03.dwg DATE: 01-02-2021 USER: NICK VENESS
XREFS: X-17-000934 - P11-12 DABASE, X-17-000934 - LOTS

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	B	NV	NV	BG	MW	05.02.21	PRECINCT 11 AND 12 LOTS AMENDED
	C	NV	NV	BG	MW	08.03.21	PRECINCT 12 LOTS AMENDED

STATUS: ISSUED FOR APPROVAL

APPROVED
BY:
SIGN: DATE:

SCALE

CLIENT: STOCKLAND DEVELOPMENTS PTY LTD

Stockland AURA

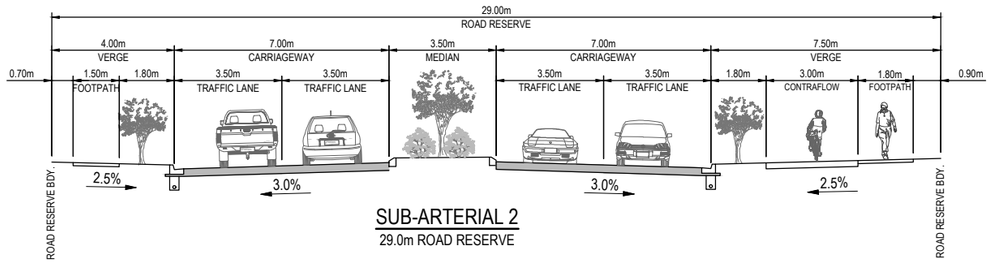
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PROJECT: PRECINT 11 AND 12 DEVELOPMENT APPLICATION

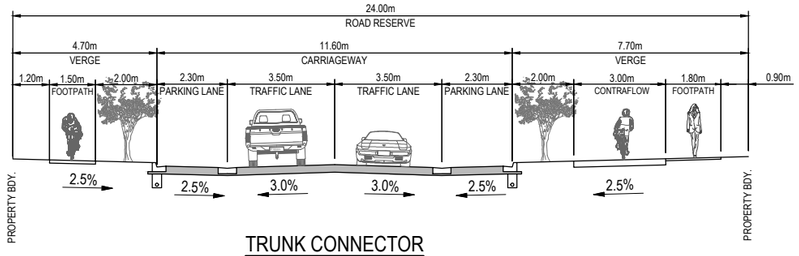
DISCLAIMER
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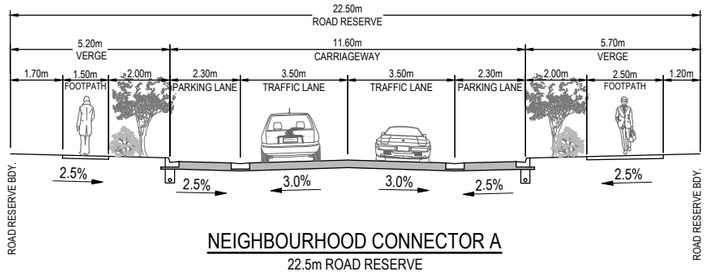
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17-000934	3011-DA03	C



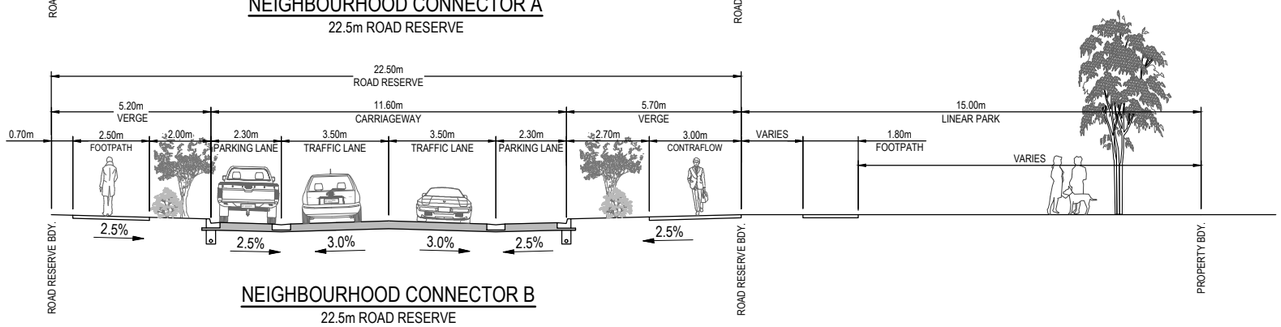
SUB-ARTERIAL 2
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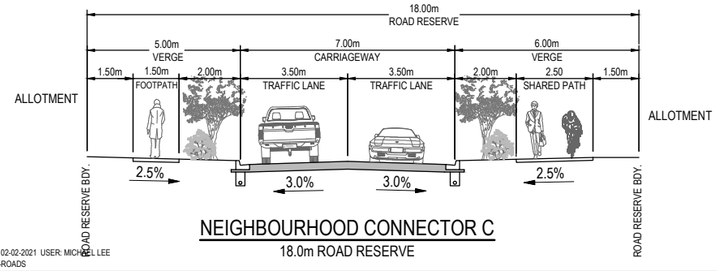
TRUNK CONNECTOR
24m ROAD RESERVE



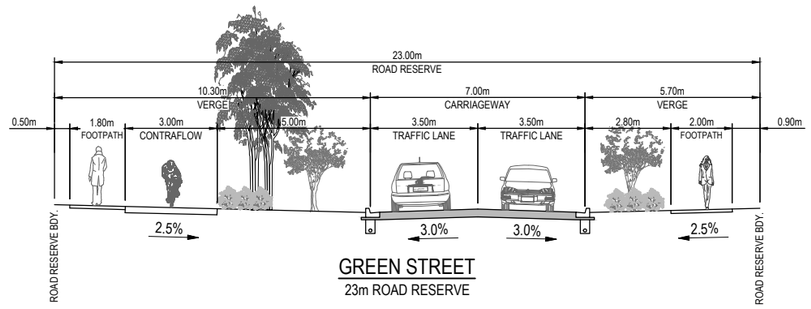
NEIGHBOURHOOD CONNECTOR A
22.5m ROAD RESERVE



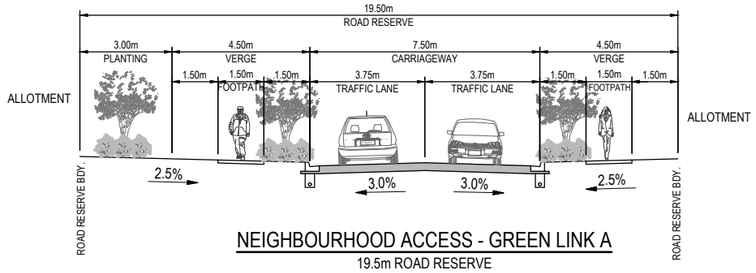
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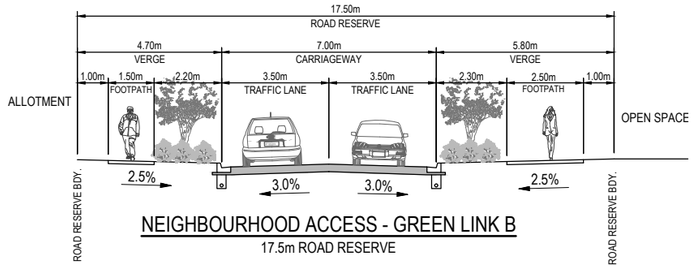
NEIGHBOURHOOD CONNECTOR C
18.0m ROAD RESERVE



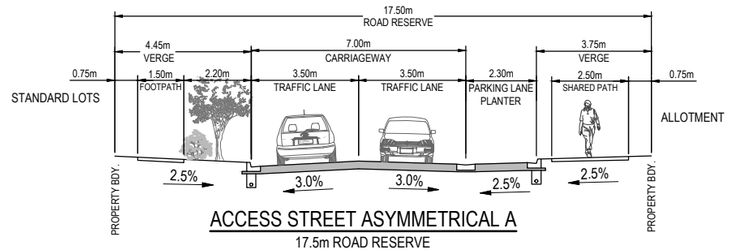
GREEN STREET
23m ROAD RESERVE



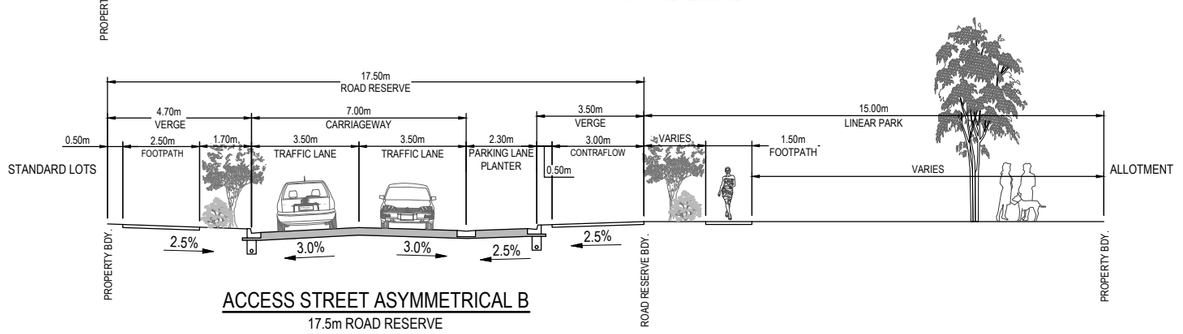
NEIGHBOURHOOD ACCESS - GREEN LINK A
19.5m ROAD RESERVE



NEIGHBOURHOOD ACCESS - GREEN LINK B
17.5m ROAD RESERVE



ACCESS STREET ASYMMETRICAL A
17.5m ROAD RESERVE



ACCESS STREET ASYMMETRICAL B
17.5m ROAD RESERVE

FILE: 3011-DA04A.dwg DATE: 02-02-2021 USER: MICHAEL LEE
XREFS: X-17-000934 - CEMP -ROADS

FIRST ISSUE	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
	BG	BG	BG	MW	06.02.21	

AMENDMENTS

STATUS: ISSUED FOR APPROVAL

APPROVED BY:

SIGN: DATE:

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SCALE 1:100 (A1) SCALE 1:200 (A3)

CLIENT: STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

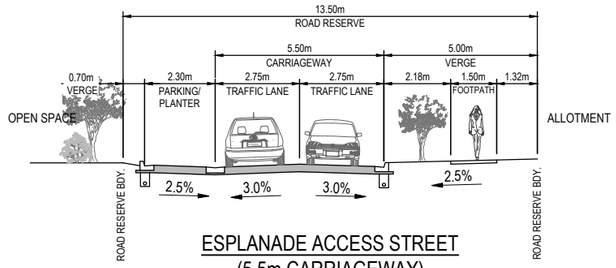
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PROJECT: AURA
PRECINT 11 AND 12
DEVELOPMENT APPLICATION

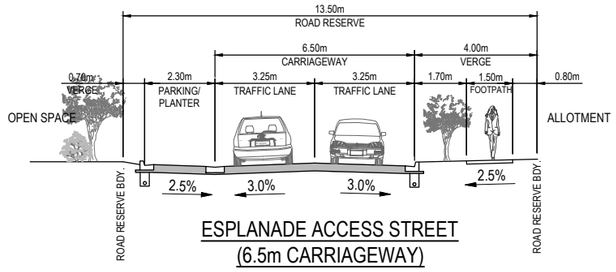
DISCLAIMER
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CROSS SECTIONS
SHEET 1 OF 2

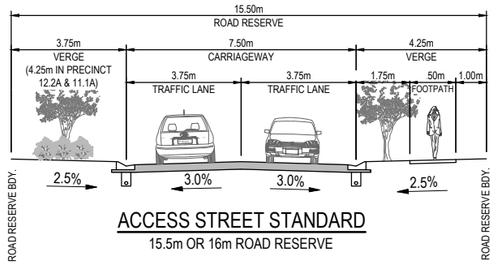
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17-000934	3011-DA04A	-



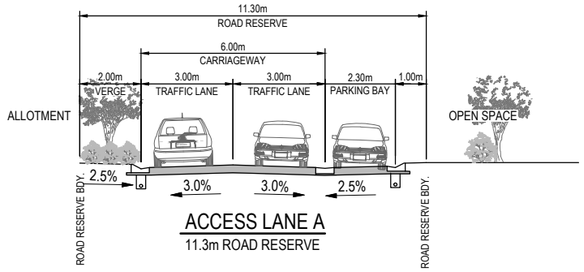
ESPLANADE ACCESS STREET
(5.5m CARRIAGEWAY)
13.5m ROAD RESERVE



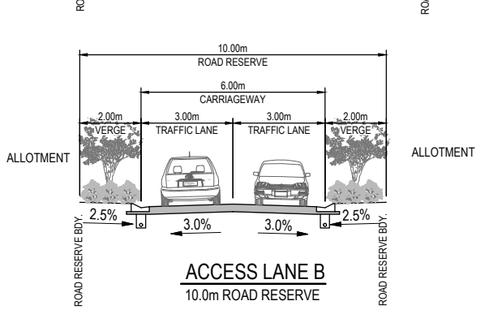
ESPLANADE ACCESS STREET
(6.5m CARRIAGEWAY)
13.5m ROAD RESERVE



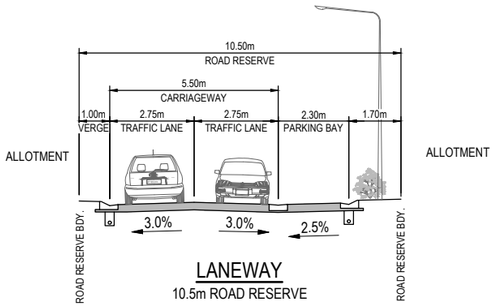
ACCESS STREET STANDARD
15.5m OR 16m ROAD RESERVE



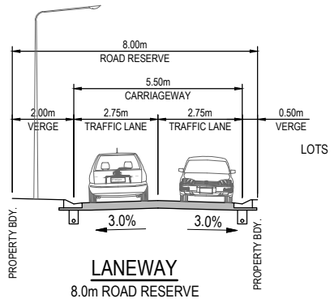
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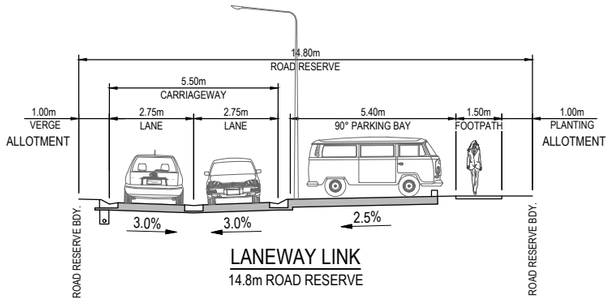
ACCESS LANE B
10.0m ROAD RESERVE



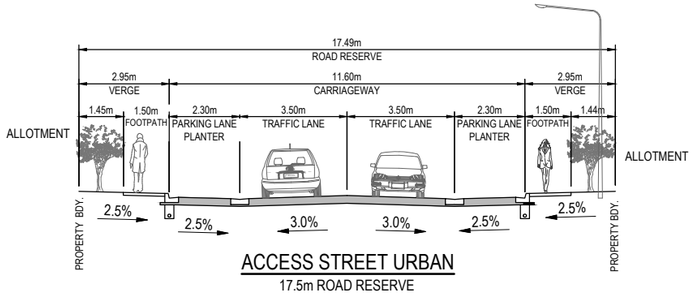
LANEWAY
10.5m ROAD RESERVE



LANEWAY
8.0m ROAD RESERVE



LANEWAY LINK
14.8m ROAD RESERVE



ACCESS STREET URBAN
17.5m ROAD RESERVE

FILE: 3011-DA04B.dwg DATE: 18-03-2019 USER: MICHAEL LEE
XREFS: X-17-000934 - CEMP -ROADS

FIRST ISSUE	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
	BG	BG	BG	MW	06.02.21	

AMENDMENTS

STATUS: ISSUED FOR APPROVAL

APPROVED
BY:
SIGN: DATE:

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SCALE 1:100 (A1) SCALE 1:200 (A3)

CLIENT
STOCKLAND
DEVELOPMENTS PTY LTD
Stockland AURA

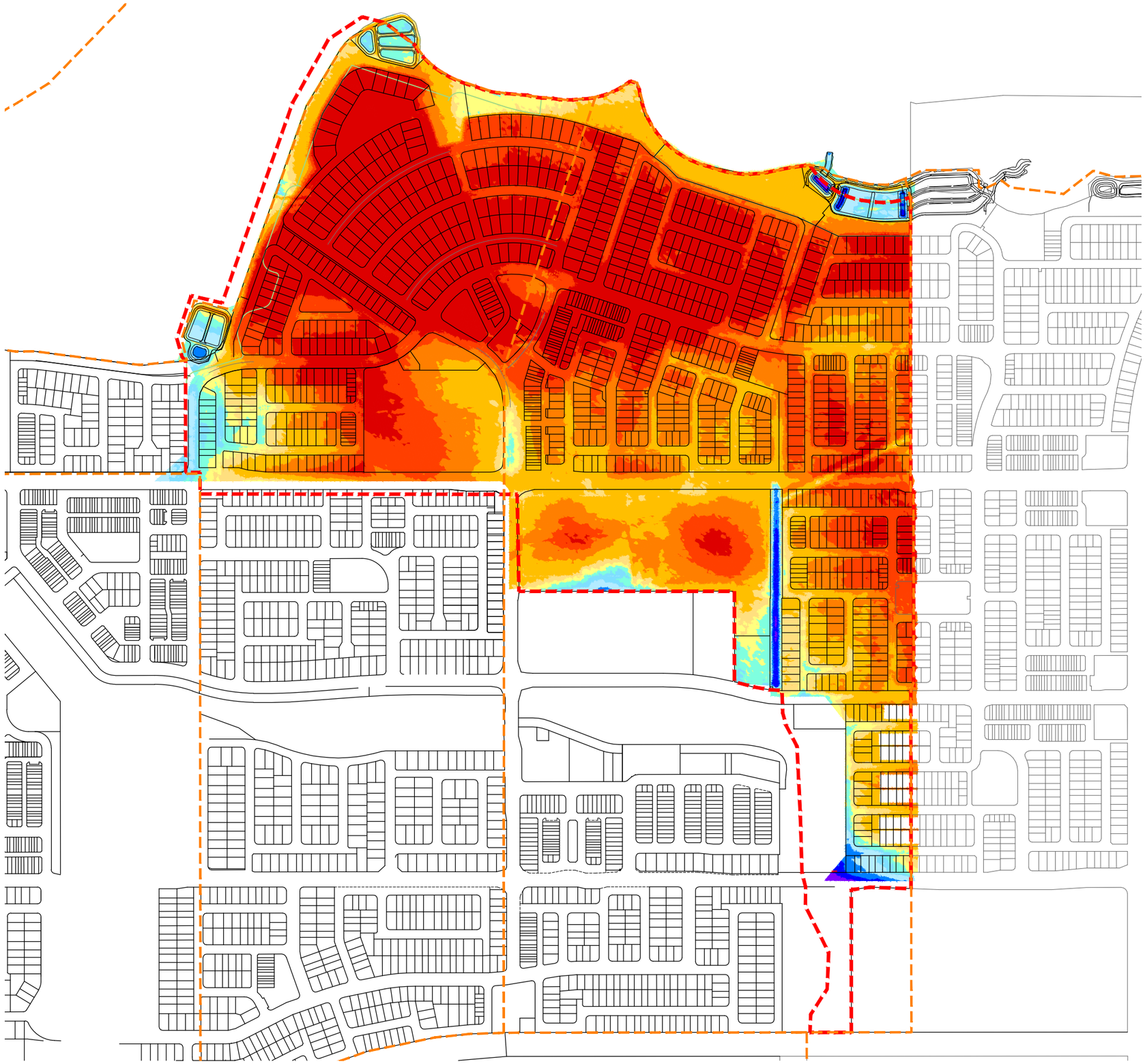
Calibre Consulting (QLD) Pty Ltd
Level 3, 16 Innovation Parkway
Birtinya QLD Australia 4575
Telephone 07 5314 2520
Facsimile 07 5314 2522
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PROJECT
AURA
PRECINT 11 AND 12
DEVELOPMENT APPLICATION

DISCLAIMER
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DRAWING TITLE
PROPOSED ROAD
CROSS SECTIONS
SHEET 2 OF 2

PROJECT No.	DRAWING No.	REVISION
17-000934	3011-DA04B	-



N

EARTHWORKS QUANTITIES

PRECINCT 11 & 12

CUT: 25,067m³

FILL: 1,409,895m³

TOTAL IMPORT: 1,384,828m³

NOTES:

1. EARTHWORKS VOLUMES HAVE BEEN OBTAINED USING THE FOLLOWING TINS 'SURVEY GRID' AND 'BULK EWKS DESIGN'.
2. THE SURVEY IS BASED ON LIDAR AND FINAL VOLUMES ARE DEPENDANT ON DETAILED SURVEY.
3. A BULKING FACTOR OF 0.85 HAS BEEN APPLIED TO THE IMPORT VALUE TO DETERMINE THE BORROW AREA VOLUME REQUIRED.

LEGEND

	OVER 3.0m OF CUT		1.0m - 1.5m OF FILL
	3.0m - 2.5m OF CUT		1.5m - 2.0m OF FILL
	2.5m - 2.0m OF CUT		2.0m - 2.5m OF FILL
	2.0m - 1.5m OF CUT		2.5m - 3.0m OF FILL
	1.5m - 1.0m OF CUT		3.0m - 3.5m OF FILL
	1.0m - 0.5m OF CUT		3.5m - 4.0m OF FILL
	0.5m - 0.0m OF CUT		4.0m - 4.5m OF FILL
	0.0m - 0.5m OF FILL		4.5m - 5.0m OF FILL
	0.5m - 1.0m OF FILL		OVER 5.0m OF FILL

FILE: 3011-DA05.dwg DATE: 02-02-2021 USER: NICK VENESS

XREFS: X-17-000934 - P11-12 DABASE, X-17-000934 - LOTS, X-17-000934.3011-CUTFILL

		DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
FIRST ISSUE		BG	BG	BG	MW	01.12.17	
AMENDMENTS	A	NV	NV	BG	MW	05.02.21	PRECINCT 11 AND 12 LOTS AMENDED
	B	NV	NV	BG	MW	08.03.21	PRECINCT 12 LOTS AMENDED

STATUS: ISSUED FOR APPROVAL

APPROVED BY:

SIGN: DATE:

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CLIENT: STOCKLAND DEVELOPMENTS PTY LTD

Stockland AURA

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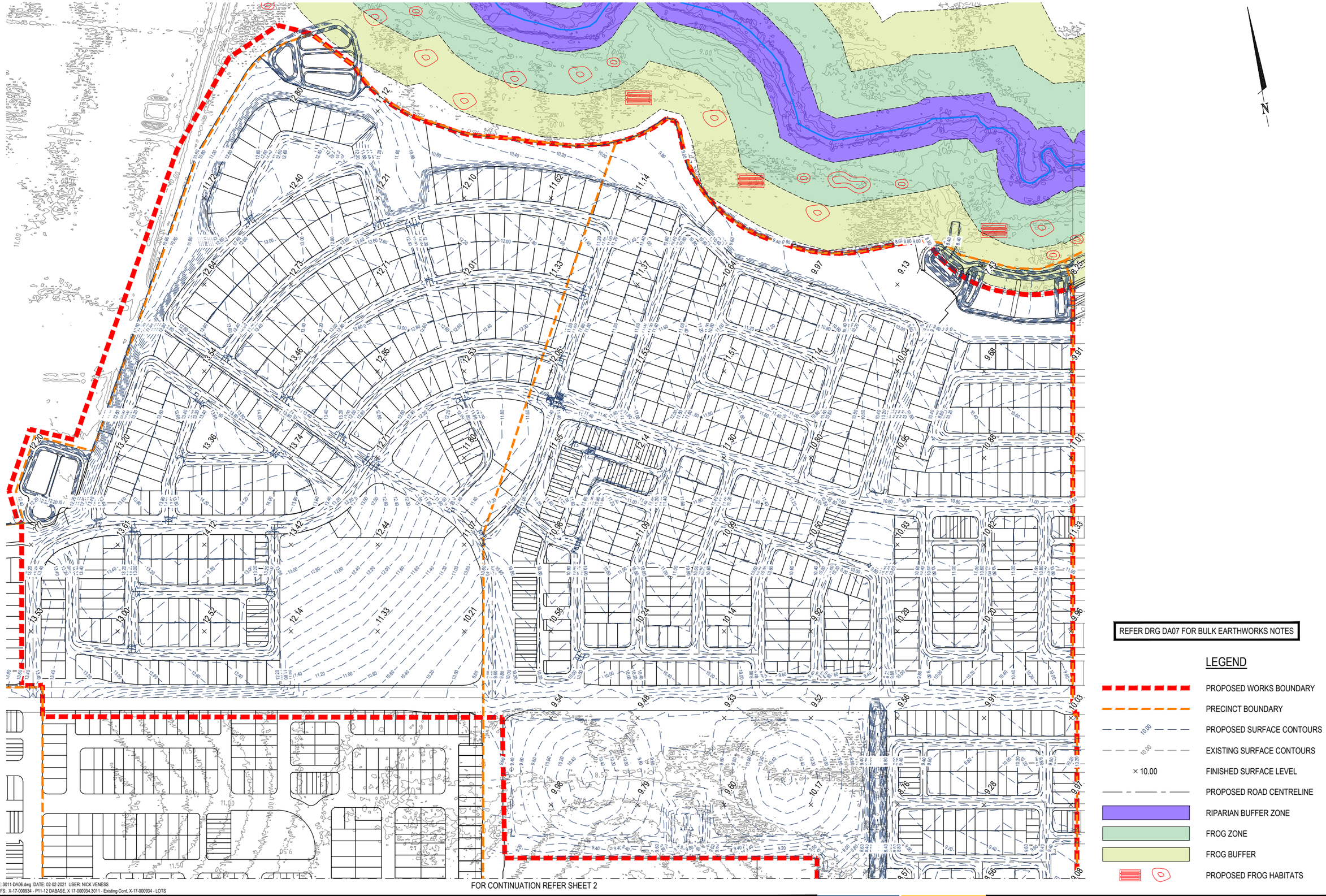
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PROJECT: AURA PRECINT 11 AND 12 DEVELOPMENT APPLICATION

DISCLAIMER
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DRAWING TITLE: CUT FILL DEPTH RANGES PLAN

PROJECT No.	DRAWING No.	REVISION
17-000934	3011-DA05	B



FILE: 3011-DA06.dwg DATE: 02-02-2021 USER: NICK VENESS
XREFS: X-17-000934 - P11-12 DABASE, X 17-000934.3011 - Existing Cont, X-17-000934 - LOTS

FIRST ISSUE	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
	BG	BG	BG	MW	01.12.17	
A	NV	NV	BG	MW	05.02.21	PRECINCT 11 AND 12 LOTS AMENDED
B	NV	NV	BG	MW	08.03.21	PRECINCT 12 LOTS AMENDED

AMENDMENTS

STATUS
ISSUED FOR APPROVAL

APPROVED
BY:
SIGN: DATE:

SCALE
0 20 40 60 80 100 120 140 160
SCALE 1:2000 (A1) SCALE 1:4000 (A3)

CLIENT
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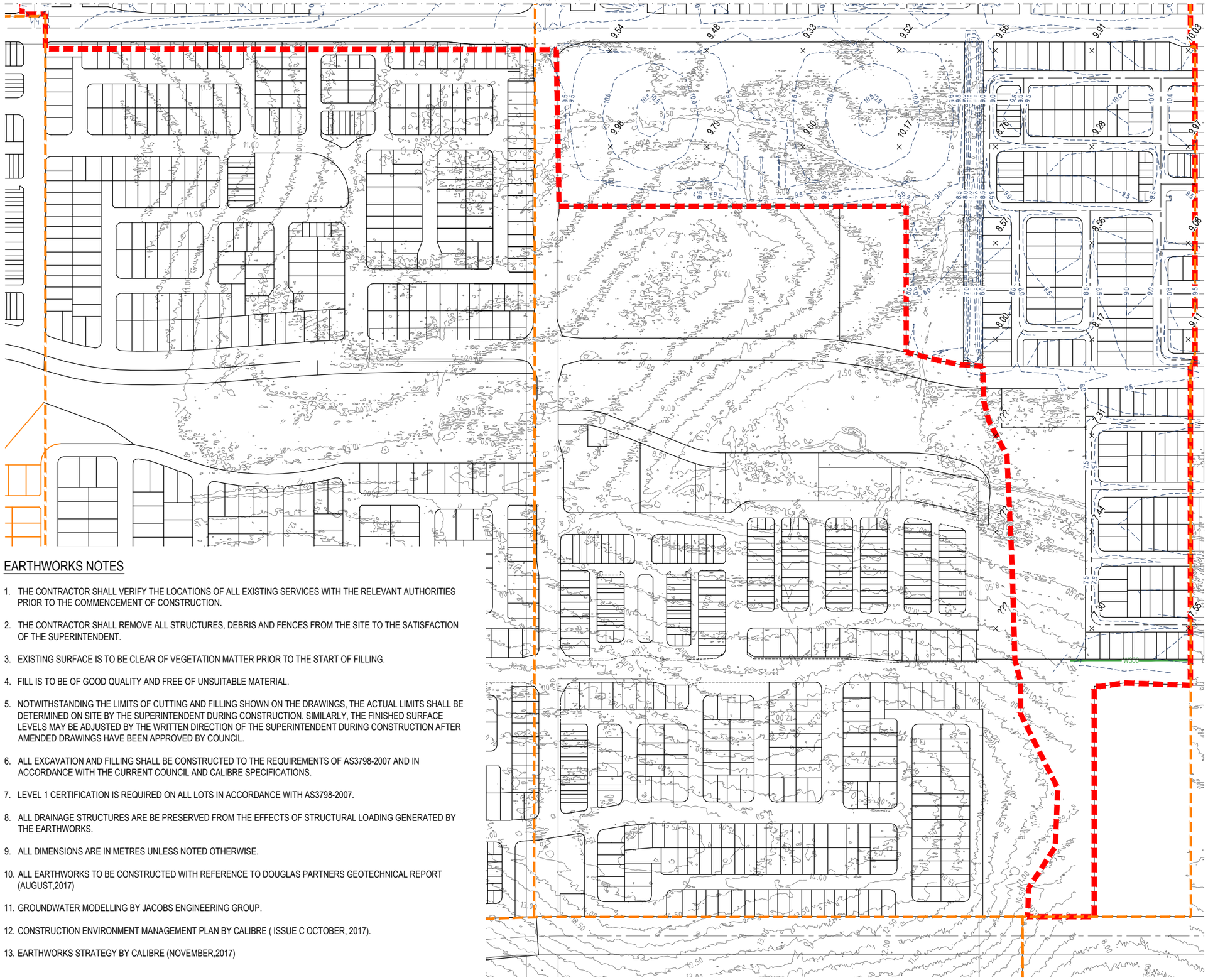
PROJECT
AURA
PRECINT 11 AND 12
DEVELOPMENT APPLICATION

DISCLAIMER
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DRAWING TITLE
BULK EARTHWORKS
DETAIL PLAN
SHEET 1 OF 2

PROJECT No.	DRAWING No.	REVISION
17-000934	3011-DA06	B

FOR CONTINUATION REFER SHEET 1



EARTHWORKS NOTES

1. THE CONTRACTOR SHALL VERIFY THE LOCATIONS OF ALL EXISTING SERVICES WITH THE RELEVANT AUTHORITIES PRIOR TO THE COMMENCEMENT OF CONSTRUCTION.
2. THE CONTRACTOR SHALL REMOVE ALL STRUCTURES, DEBRIS AND FENCES FROM THE SITE TO THE SATISFACTION OF THE SUPERINTENDENT.
3. EXISTING SURFACE IS TO BE CLEAR OF VEGETATION MATTER PRIOR TO THE START OF FILLING.
4. FILL IS TO BE OF GOOD QUALITY AND FREE OF UNSUITABLE MATERIAL.
5. NOTWITHSTANDING THE LIMITS OF CUTTING AND FILLING SHOWN ON THE DRAWINGS, THE ACTUAL LIMITS SHALL BE DETERMINED ON SITE BY THE SUPERINTENDENT DURING CONSTRUCTION. SIMILARLY, THE FINISHED SURFACE LEVELS MAY BE ADJUSTED BY THE WRITTEN DIRECTION OF THE SUPERINTENDENT DURING CONSTRUCTION AFTER AMENDED DRAWINGS HAVE BEEN APPROVED BY COUNCIL.
6. ALL EXCAVATION AND FILLING SHALL BE CONSTRUCTED TO THE REQUIREMENTS OF AS3798-2007 AND IN ACCORDANCE WITH THE CURRENT COUNCIL AND CALIBRE SPECIFICATIONS.
7. LEVEL 1 CERTIFICATION IS REQUIRED ON ALL LOTS IN ACCORDANCE WITH AS3798-2007.
8. ALL DRAINAGE STRUCTURES ARE BE PRESERVED FROM THE EFFECTS OF STRUCTURAL LOADING GENERATED BY THE EARTHWORKS.
9. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
10. ALL EARTHWORKS TO BE CONSTRUCTED WITH REFERENCE TO DOUGLAS PARTNERS GEOTECHNICAL REPORT (AUGUST,2017)
11. GROUNDWATER MODELLING BY JACOBS ENGINEERING GROUP.
12. CONSTRUCTION ENVIRONMENT MANAGEMENT PLAN BY CALIBRE (ISSUE C OCTOBER, 2017).
13. EARTHWORKS STRATEGY BY CALIBRE (NOVEMBER,2017)

LEGEND

- PROPOSED WORKS BOUNDARY
- PRECINCT BOUNDARY
- PROPOSED SURFACE CONTOURS (10.00)
- EXISTING SURFACE CONTOURS (10.00)
- × 10.00 FINISHED SURFACE LEVEL
- PROPOSED ROAD CENTRELINE

FILE: 3011-DA07.dwg DATE: 02-02-2021 USER: NICK VENESS
XREFS: X-17-000934 - P11-12 DABASE, X 17-000934.3011 - Existing Cont, X-17-000934 - LOTS

AMENDMENTS	FIRST ISSUE	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
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	A	NV	NV	BG	MW	05.02.21	PRECINCT 11 AND 12 LOTS AMENDED

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SCALE 1:2000 (A1) SCALE 1:4000 (A3)

CLIENT: STOCKLAND DEVELOPMENTS PTY LTD

Stockland AURA

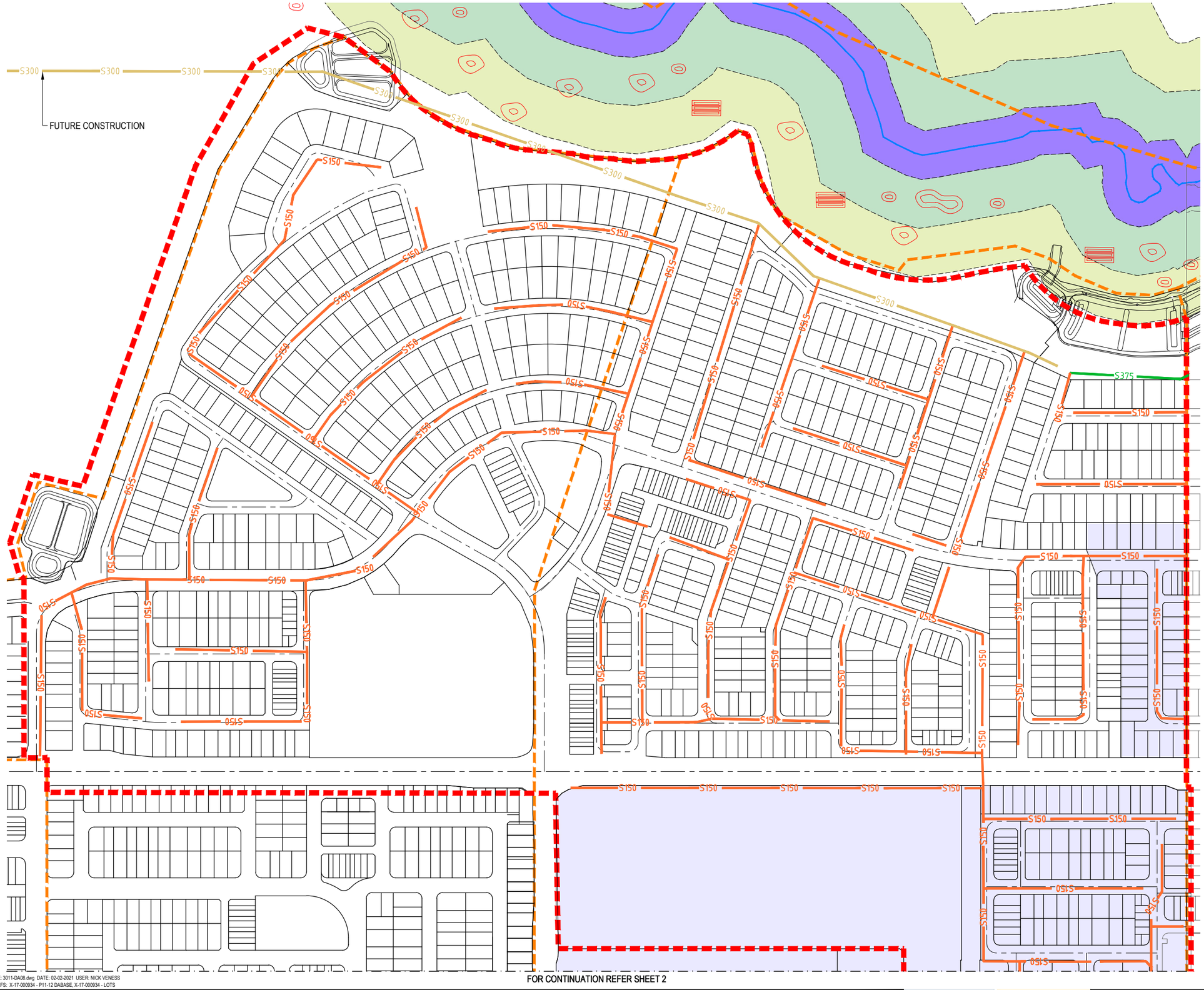
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PROJECT: AURA
PRECINT 11 AND 12
DEVELOPMENT APPLICATION

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DRAWING TITLE: BULK EARTHWORKS
DETAIL PLAN
SHEET 2 OF 2

PROJECT No.	DRAWING No.	REVISION
17-000934	3011-DA07	A



REFER DRG DA09 FOR SEWER RETICULATION NOTES

LEGEND

- PROPOSED WORKS BOUNDARY
- PRECINCT BOUNDARY
- S150 PROPOSED Ø150 SEWER MAIN
- S225 PROPOSED Ø225 SEWER MAIN
- S300 PROPOSED Ø300 SEWER MAIN
- S375 PROPOSED Ø375 SEWER MAIN
- S450 PROPOSED Ø450 SEWER MAIN
- S750 PROPOSED Ø750 SEWER MAIN
- RIPARIAN BUFFER ZONE
- FROG ZONE
- FROG BUFFER
- PROPOSED FROG HABITATS
- SERVICED IN PRECINCT 10

FOR CONTINUATION REFER SHEET 2

FILE: 3011-DA08.dwg DATE: 02-02-2021 USER: NICK VENESS
XREFS: X-17-000934 - P11-12 DABASE_X-17-000934 - LOTS

AMENDMENTS	ISSUE	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
	FIRST ISSUE	BG	BG	BG	MW	01.12.17	
	A	JM	JM	BG	MW	03.04.18	AMENDED TO SUIT NEW LOT LAYOUT
	B	NV	NV	BG	MW	05.02.21	PRECINCT 11 AND 12 LOTS AMENDED
	C	NV	NV	BG	MW	08.03.21	PRECINCT 12 LOTS AMENDED

STATUS: ISSUED FOR APPROVAL

APPROVED
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SIGN: DATE:

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CLIENT
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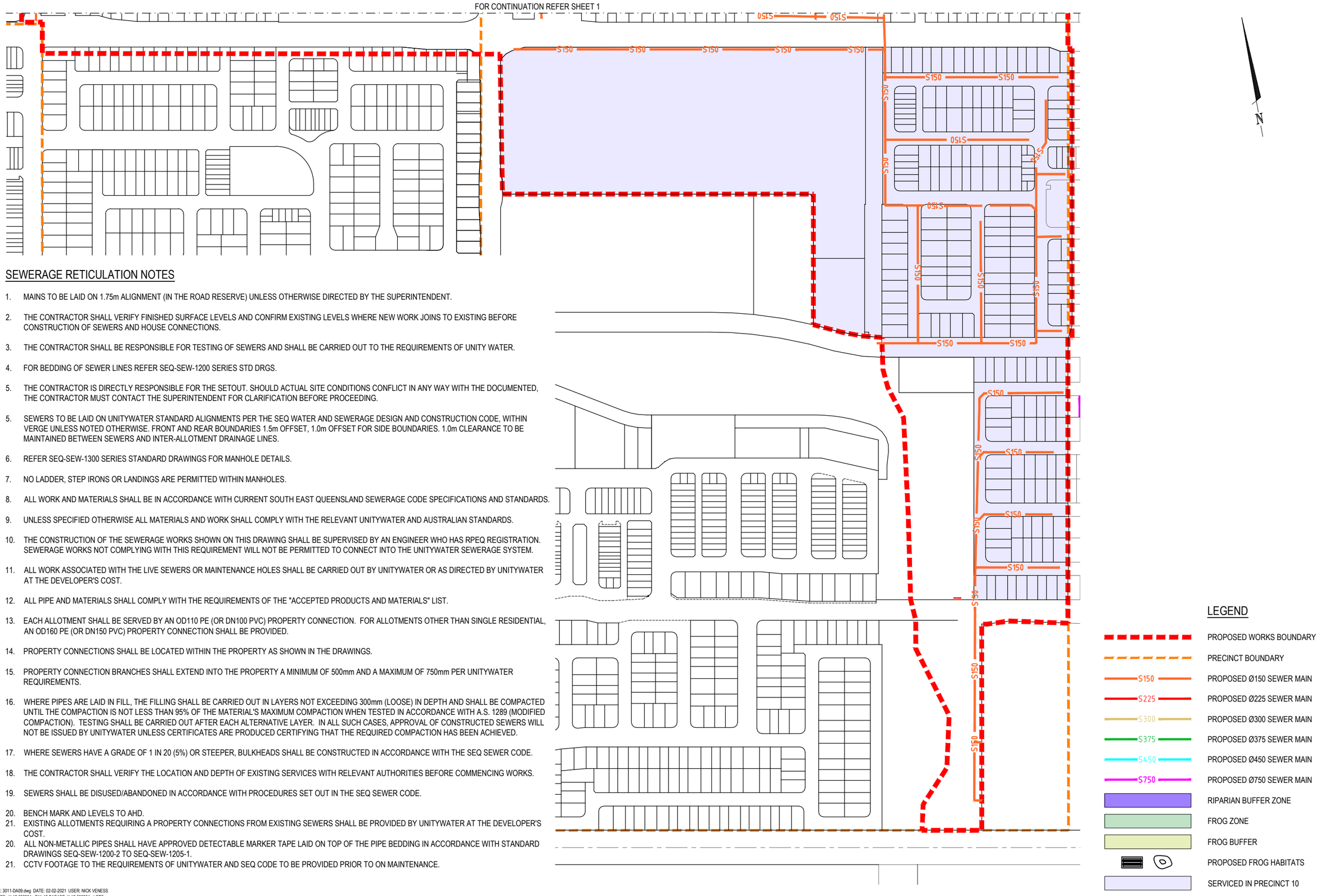
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PROJECT
AURA
PRECINT 11 AND 12
DEVELOPMENT APPLICATION

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DRAWING TITLE
SEWER RETICULATION
LAYOUT PLAN
SHEET 1 OF 2

PROJECT No.	DRAWING No.	REVISION
17-000934	3011-DA08	C



SEWERAGE RETICULATION NOTES

1. MAINS TO BE LAID ON 1.75m ALIGNMENT (IN THE ROAD RESERVE) UNLESS OTHERWISE DIRECTED BY THE SUPERINTENDENT.
2. THE CONTRACTOR SHALL VERIFY FINISHED SURFACE LEVELS AND CONFIRM EXISTING LEVELS WHERE NEW WORK JOINS TO EXISTING BEFORE CONSTRUCTION OF SEWERS AND HOUSE CONNECTIONS.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR TESTING OF SEWERS AND SHALL BE CARRIED OUT TO THE REQUIREMENTS OF UNITY WATER.
4. FOR BEDDING OF SEWER LINES REFER SEQ-SEW-1200 SERIES STD DRGS.
5. THE CONTRACTOR IS DIRECTLY RESPONSIBLE FOR THE SETOUT. SHOULD ACTUAL SITE CONDITIONS CONFLICT IN ANY WAY WITH THE DOCUMENTED, THE CONTRACTOR MUST CONTACT THE SUPERINTENDENT FOR CLARIFICATION BEFORE PROCEEDING.
5. SEWERS TO BE LAID ON UNITYWATER STANDARD ALIGNMENTS PER THE SEQ WATER AND SEWERAGE DESIGN AND CONSTRUCTION CODE, WITHIN VERGE UNLESS NOTED OTHERWISE. FRONT AND REAR BOUNDARIES 1.5m OFFSET, 1.0m OFFSET FOR SIDE BOUNDARIES. 1.0m CLEARANCE TO BE MAINTAINED BETWEEN SEWERS AND INTER-ALLOTMENT DRAINAGE LINES.
6. REFER SEQ-SEW-1300 SERIES STANDARD DRAWINGS FOR MANHOLE DETAILS.
7. NO LADDER, STEP IRONS OR LANDINGS ARE PERMITTED WITHIN MANHOLES.
8. ALL WORK AND MATERIALS SHALL BE IN ACCORDANCE WITH CURRENT SOUTH EAST QUEENSLAND SEWERAGE CODE SPECIFICATIONS AND STANDARDS.
9. UNLESS SPECIFIED OTHERWISE ALL MATERIALS AND WORK SHALL COMPLY WITH THE RELEVANT UNITYWATER AND AUSTRALIAN STANDARDS.
10. THE CONSTRUCTION OF THE SEWERAGE WORKS SHOWN ON THIS DRAWING SHALL BE SUPERVISED BY AN ENGINEER WHO HAS RPEQ REGISTRATION. SEWERAGE WORKS NOT COMPLYING WITH THIS REQUIREMENT WILL NOT BE PERMITTED TO CONNECT INTO THE UNITYWATER SEWERAGE SYSTEM.
11. ALL WORK ASSOCIATED WITH THE LIVE SEWERS OR MAINTENANCE HOLES SHALL BE CARRIED OUT BY UNITYWATER OR AS DIRECTED BY UNITYWATER AT THE DEVELOPER'S COST.
12. ALL PIPE AND MATERIALS SHALL COMPLY WITH THE REQUIREMENTS OF THE "ACCEPTED PRODUCTS AND MATERIALS" LIST.
13. EACH ALLOTMENT SHALL BE SERVED BY AN OD110 PE (OR DN100 PVC) PROPERTY CONNECTION. FOR ALLOTMENTS OTHER THAN SINGLE RESIDENTIAL, AN OD160 PE (OR DN150 PVC) PROPERTY CONNECTION SHALL BE PROVIDED.
14. PROPERTY CONNECTIONS SHALL BE LOCATED WITHIN THE PROPERTY AS SHOWN IN THE DRAWINGS.
15. PROPERTY CONNECTION BRANCHES SHALL EXTEND INTO THE PROPERTY A MINIMUM OF 500mm AND A MAXIMUM OF 750mm PER UNITYWATER REQUIREMENTS.
16. WHERE PIPES ARE LAID IN FILL, THE FILLING SHALL BE CARRIED OUT IN LAYERS NOT EXCEEDING 300mm (LOOSE) IN DEPTH AND SHALL BE COMPACTED UNTIL THE COMPACTION IS NOT LESS THAN 95% OF THE MATERIAL'S MAXIMUM COMPACTION WHEN TESTED IN ACCORDANCE WITH A.S. 1289 (MODIFIED COMPACTION). TESTING SHALL BE CARRIED OUT AFTER EACH ALTERNATIVE LAYER. IN ALL SUCH CASES, APPROVAL OF CONSTRUCTED SEWERS WILL NOT BE ISSUED BY UNITYWATER UNLESS CERTIFICATES ARE PRODUCED CERTIFYING THAT THE REQUIRED COMPACTION HAS BEEN ACHIEVED.
17. WHERE SEWERS HAVE A GRADE OF 1 IN 20 (5%) OR STEEPER, BULKHEADS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE SEQ SEWER CODE.
18. THE CONTRACTOR SHALL VERIFY THE LOCATION AND DEPTH OF EXISTING SERVICES WITH RELEVANT AUTHORITIES BEFORE COMMENCING WORKS.
19. SEWERS SHALL BE DISUSED/ABANDONED IN ACCORDANCE WITH PROCEDURES SET OUT IN THE SEQ SEWER CODE.
20. BENCH MARK AND LEVELS TO AHD.
21. EXISTING ALLOTMENTS REQUIRING A PROPERTY CONNECTIONS FROM EXISTING SEWERS SHALL BE PROVIDED BY UNITYWATER AT THE DEVELOPER'S COST.
20. ALL NON-METALLIC PIPES SHALL HAVE APPROVED DETECTABLE MARKER TAPE LAID ON TOP OF THE PIPE BEDDING IN ACCORDANCE WITH STANDARD DRAWINGS SEQ-SEW-1200-2 TO SEQ-SEW-1205-1.
21. CCTV FOOTAGE TO THE REQUIREMENTS OF UNITYWATER AND SEQ CODE TO BE PROVIDED PRIOR TO ON MAINTENANCE.

LEGEND

- PROPOSED WORKS BOUNDARY
- PRECINCT BOUNDARY
- S150 — PROPOSED Ø150 SEWER MAIN
- S225 — PROPOSED Ø225 SEWER MAIN
- S300 — PROPOSED Ø300 SEWER MAIN
- S375 — PROPOSED Ø375 SEWER MAIN
- S450 — PROPOSED Ø450 SEWER MAIN
- S750 — PROPOSED Ø750 SEWER MAIN
- RIPARIAN BUFFER ZONE
- FROG ZONE
- FROG BUFFER
- PROPOSED FROG HABITATS
- SERVICED IN PRECINCT 10

FILE: 3011-DA09.dwg DATE: 02-02-2021 USER: NICK VENESS
XREFS: X-17-000934 - P11-12 DABASE, X-17-000934 - LOTS

FIRST ISSUE	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
	BG	BG	BG	MW	01.12.17	
A	JM	JM	BG	MW	03.04.18	AMENDED TO SUIT NEW LOT LAYOUT
B	NV	NV	BG	MW	05.02.21	PRECINCT 11 AND 12 LOTS AMENDED

AMENDMENTS

STATUS: ISSUED FOR APPROVAL

APPROVED BY:

SIGN: DATE:

SCALE: 0 20 40 60 80 100 120 140 160
SCALE 1:2000 (A1) SCALE 1:4000 (A3)

CLIENT: STOCKLAND DEVELOPMENTS PTY LTD

Stockland AURA

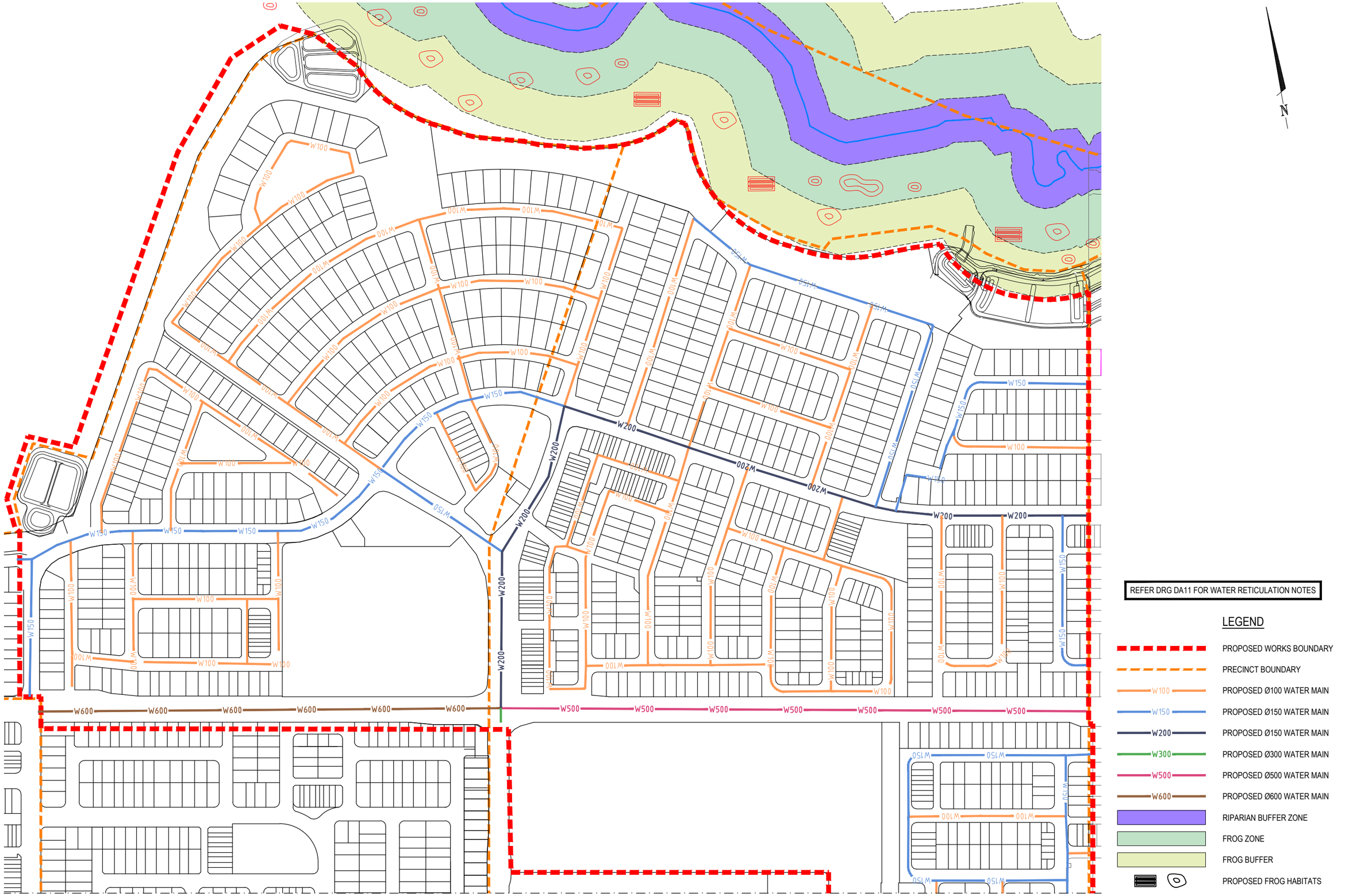
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PROJECT: AURA
PRECINT 11 AND 12
DEVELOPMENT APPLICATION

DISCLAIMER
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DRAWING TITLE: SEWER RETICULATION
LAYOUT PLAN
SHEET 2 OF 2

PROJECT No.	DRAWING No.	REVISION
17-000934	3011-DA09	B



FOR CONTINUATION REFER SHEET 2

FILE: 3011-DA10.dwg DATE: 02-02-2021 USER: NICK VENESS
XREFS: X-17-000934 - P11-12 DABASE, X-17-000934 - LOTS

FIRST ISSUE	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
	BG	BG	BG	MW	01.12.17	
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B	NV	NV	BG	MW	08.03.21	PRECINCT 12 LOTS AMENDED

AMENDMENTS

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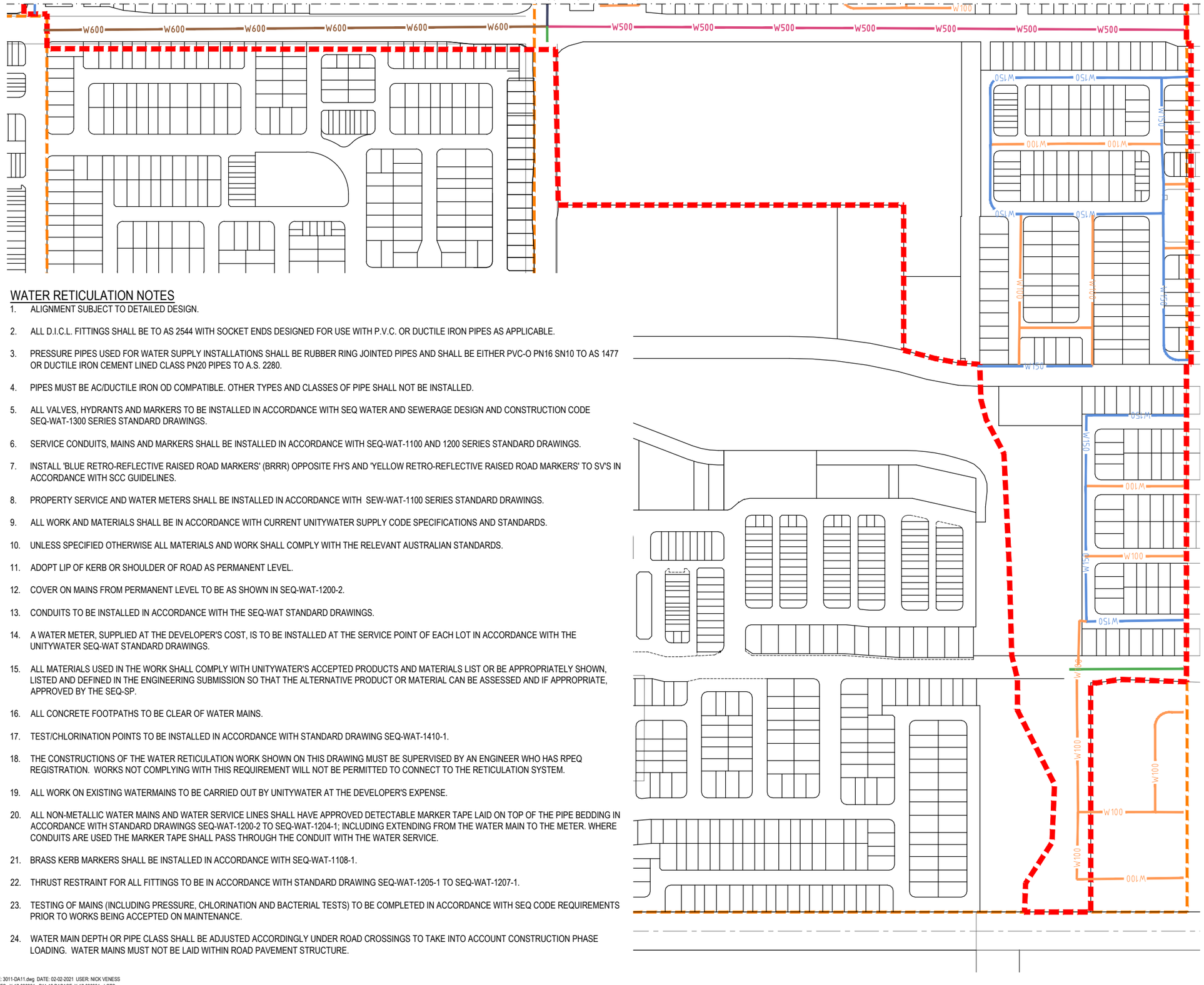
PROJECT
AURA
PRECINT 11 AND 12
DEVELOPMENT APPLICATION

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DRAWING TITLE
WATER RETICULATION
LAYOUT PLAN
SHEET 1 OF 2

PROJECT No.	DRAWING No.	REVISION
17-000934	3011-DA10	B

FOR CONTINUATION REFER SHEET 1



WATER RETICULATION NOTES

1. ALIGNMENT SUBJECT TO DETAILED DESIGN.
2. ALL D.I.C.L. FITTINGS SHALL BE TO AS 2544 WITH SOCKET ENDS DESIGNED FOR USE WITH P.V.C. OR DUCTILE IRON PIPES AS APPLICABLE.
3. PRESSURE PIPES USED FOR WATER SUPPLY INSTALLATIONS SHALL BE RUBBER RING JOINTED PIPES AND SHALL BE EITHER PVC-O PN16 SN10 TO AS 1477 OR DUCTILE IRON CEMENT LINED CLASS PN20 PIPES TO A.S. 2280.
4. PIPES MUST BE AC/DUCTILE IRON OD COMPATIBLE. OTHER TYPES AND CLASSES OF PIPE SHALL NOT BE INSTALLED.
5. ALL VALVES, HYDRANTS AND MARKERS TO BE INSTALLED IN ACCORDANCE WITH SEQ WATER AND SEWERAGE DESIGN AND CONSTRUCTION CODE SEQ-WAT-1300 SERIES STANDARD DRAWINGS.
6. SERVICE CONDUITS, MAINS AND MARKERS SHALL BE INSTALLED IN ACCORDANCE WITH SEQ-WAT-1100 AND 1200 SERIES STANDARD DRAWINGS.
7. INSTALL 'BLUE RETRO-REFLECTIVE RAISED ROAD MARKERS' (BRRR) OPPOSITE FH'S AND 'YELLOW RETRO-REFLECTIVE RAISED ROAD MARKERS' TO SV'S IN ACCORDANCE WITH SCC GUIDELINES.
8. PROPERTY SERVICE AND WATER METERS SHALL BE INSTALLED IN ACCORDANCE WITH SEW-WAT-1100 SERIES STANDARD DRAWINGS.
9. ALL WORK AND MATERIALS SHALL BE IN ACCORDANCE WITH CURRENT UNITYWATER SUPPLY CODE SPECIFICATIONS AND STANDARDS.
10. UNLESS SPECIFIED OTHERWISE ALL MATERIALS AND WORK SHALL COMPLY WITH THE RELEVANT AUSTRALIAN STANDARDS.
11. ADOPT LIP OF KERB OR SHOULDER OF ROAD AS PERMANENT LEVEL.
12. COVER ON MAINS FROM PERMANENT LEVEL TO BE AS SHOWN IN SEQ-WAT-1200-2.
13. CONDUITS TO BE INSTALLED IN ACCORDANCE WITH THE SEQ-WAT STANDARD DRAWINGS.
14. A WATER METER, SUPPLIED AT THE DEVELOPER'S COST, IS TO BE INSTALLED AT THE SERVICE POINT OF EACH LOT IN ACCORDANCE WITH THE UNITYWATER SEQ-WAT STANDARD DRAWINGS.
15. ALL MATERIALS USED IN THE WORK SHALL COMPLY WITH UNITYWATER'S ACCEPTED PRODUCTS AND MATERIALS LIST OR BE APPROPRIATELY SHOWN, LISTED AND DEFINED IN THE ENGINEERING SUBMISSION SO THAT THE ALTERNATIVE PRODUCT OR MATERIAL CAN BE ASSESSED AND IF APPROPRIATE, APPROVED BY THE SEQ-SP.
16. ALL CONCRETE FOOTPATHS TO BE CLEAR OF WATER MAINS.
17. TEST/CHLORINATION POINTS TO BE INSTALLED IN ACCORDANCE WITH STANDARD DRAWING SEQ-WAT-1410-1.
18. THE CONSTRUCTIONS OF THE WATER RETICULATION WORK SHOWN ON THIS DRAWING MUST BE SUPERVISED BY AN ENGINEER WHO HAS RPEQ REGISTRATION. WORKS NOT COMPLYING WITH THIS REQUIREMENT WILL NOT BE PERMITTED TO CONNECT TO THE RETICULATION SYSTEM.
19. ALL WORK ON EXISTING WATERMAINS TO BE CARRIED OUT BY UNITYWATER AT THE DEVELOPER'S EXPENSE.
20. ALL NON-METALLIC WATER MAINS AND WATER SERVICE LINES SHALL HAVE APPROVED DETECTABLE MARKER TAPE LAID ON TOP OF THE PIPE BEDDING IN ACCORDANCE WITH STANDARD DRAWINGS SEQ-WAT-1200-2 TO SEQ-WAT-1204-1; INCLUDING EXTENDING FROM THE WATER MAIN TO THE METER. WHERE CONDUITS ARE USED THE MARKER TAPE SHALL PASS THROUGH THE CONDUIT WITH THE WATER SERVICE.
21. BRASS KERB MARKERS SHALL BE INSTALLED IN ACCORDANCE WITH SEQ-WAT-1108-1.
22. THRUST RESTRAINT FOR ALL FITTINGS TO BE IN ACCORDANCE WITH STANDARD DRAWING SEQ-WAT-1205-1 TO SEQ-WAT-1207-1.
23. TESTING OF MAINS (INCLUDING PRESSURE, CHLORINATION AND BACTERIAL TESTS) TO BE COMPLETED IN ACCORDANCE WITH SEQ CODE REQUIREMENTS PRIOR TO WORKS BEING ACCEPTED ON MAINTENANCE.
24. WATER MAIN DEPTH OR PIPE CLASS SHALL BE ADJUSTED ACCORDINGLY UNDER ROAD CROSSINGS TO TAKE INTO ACCOUNT CONSTRUCTION PHASE LOADING. WATER MAINS MUST NOT BE LAID WITHIN ROAD PAVEMENT STRUCTURE.

LEGEND

- PROPOSED WORKS BOUNDARY
- PRECINCT BOUNDARY
- W100 — PROPOSED Ø100 WATER MAIN
- W150 — PROPOSED Ø150 WATER MAIN
- W200 — PROPOSED Ø150 WATER MAIN
- W300 — PROPOSED Ø300 WATER MAIN
- W500 — PROPOSED Ø500 WATER MAIN
- W600 — PROPOSED Ø600 WATER MAIN

FILE: 3011-DA11.dwg DATE: 02-02-2021 USER: NICK VENESS
XREFS: X-17-000934 - P11-12 DABASE, X-17-000934 - LOTS

AMENDMENTS	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
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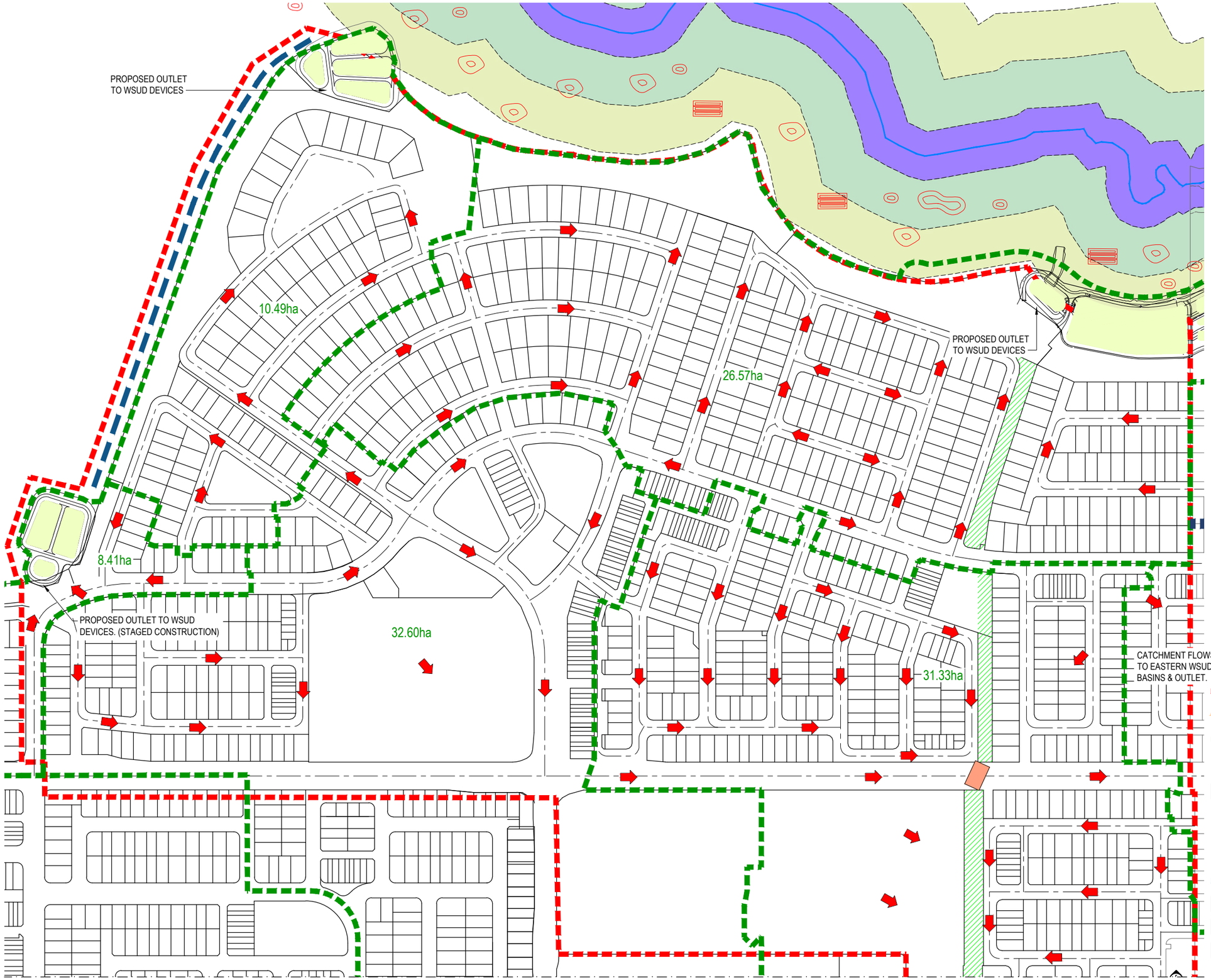
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PROJECT
AURA
PRECINT 11 AND 12
DEVELOPMENT APPLICATION

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DRAWING TITLE
WATER RETICULATION
LAYOUT PLAN
SHEET 2 OF 2

PROJECT No.	DRAWING No.	REVISION
17-000934	3011-DA11	A



NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE LATEST ISSUE OF DESIGN FLOW STORMWATER MANAGEMENT REPORT.
2. LOCATIONS AND DETAILS OF STORMWATER DRAINAGE CHANNEL AND WSUD ARE CONCEPTUAL ONLY. THEY ARE SUBJECT TO DETAILED DESIGN.
3. REFER TO BMT WBM BELLS CREEK NORTH REPORT FOR FURTHER DETAILS REGARDING FLOODING.

REFER DRG DA13 FOR STORMWATER DRAINAGE NOTES

LEGEND

- PROPOSED WORKS BOUNDARY
- PRECINCT BOUNDARY
- PROPOSED CATCHMENT BOUNDARY
- 9.6ha — PROPOSED CATCHMENT AREA
- END OF LINE WSUD TREATMENT BASINS. REFER DESIGN FLOW DOCUMENTATION FOR DESIGN
- CONCEPTUAL STORMWATER STRUCTURE LOCATIONS
- CONCEPTUAL OUTFLOW LOCATION
- INDICATIVE STORMWATER OUTLET CHANNEL
- RIPARIAN BUFFER ZONE
- FROG ZONE
- FROG BUFFER
- PROPOSED FROG HABITATS

FOR CONTINUATION REFER SHEET 2

FILE: 3011-DA12.dwg DATE: 02-02-2021 USER: NICK VENESS
XREFS: X-17-000934 - P11-12 DABASE, X-17-000934 - LOTS

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SCALE
0 20 40 60 80 100 120 140 160
SCALE 1:2000 (A1) SCALE 1:4000 (A3)

CLIENT
STOCKLAND DEVELOPMENTS PTY LTD
Stockland AURA

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Calibre Professional Services Pty Ltd
Level 4, Unit 401, 8 Market Lane,
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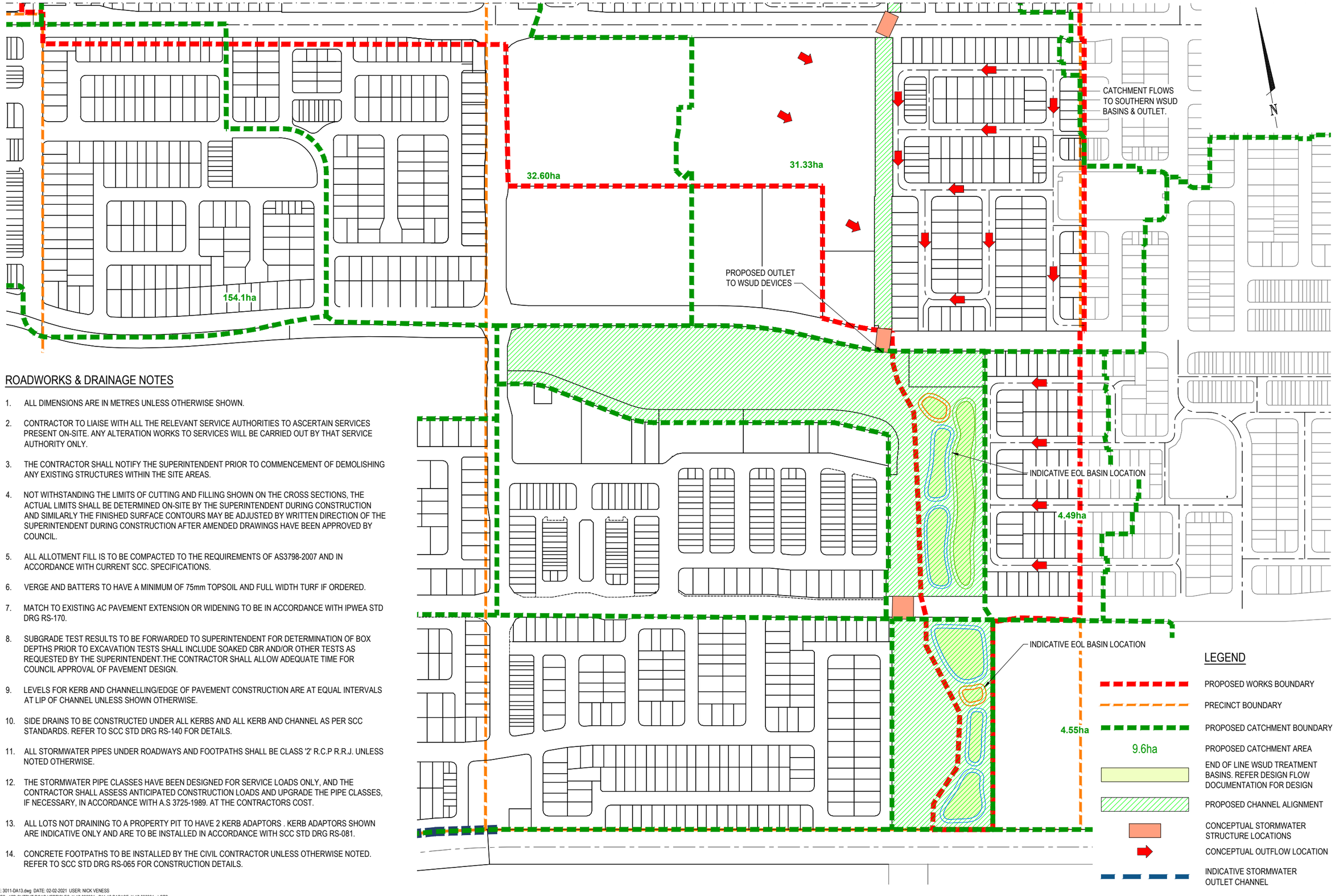
PROJECT
AURA
PRECINT 11 AND 12
DEVELOPMENT APPLICATION

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY, DO NOT SCALE.

DRAWING TITLE
STORMWATER CATCHMENT AND LAYOUT PLAN
SHEET 1 OF 2

PROJECT No.	DRAWING No.	REVISION
17-000934	3011-DA12	C

FOR CONTINUATION REFER SHEET 1



ROADWORKS & DRAINAGE NOTES

1. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SHOWN.
2. CONTRACTOR TO LIAISE WITH ALL THE RELEVANT SERVICE AUTHORITIES TO ASCERTAIN SERVICES PRESENT ON-SITE. ANY ALTERATION WORKS TO SERVICES WILL BE CARRIED OUT BY THAT SERVICE AUTHORITY ONLY.
3. THE CONTRACTOR SHALL NOTIFY THE SUPERINTENDENT PRIOR TO COMMENCEMENT OF DEMOLISHING ANY EXISTING STRUCTURES WITHIN THE SITE AREAS.
4. NOT WITHSTANDING THE LIMITS OF CUTTING AND FILLING SHOWN ON THE CROSS SECTIONS, THE ACTUAL LIMITS SHALL BE DETERMINED ON-SITE BY THE SUPERINTENDENT DURING CONSTRUCTION AND SIMILARLY THE FINISHED SURFACE CONTOURS MAY BE ADJUSTED BY WRITTEN DIRECTION OF THE SUPERINTENDENT DURING CONSTRUCTION AFTER AMENDED DRAWINGS HAVE BEEN APPROVED BY COUNCIL.
5. ALL ALLOTMENT FILL IS TO BE COMPACTED TO THE REQUIREMENTS OF AS3798-2007 AND IN ACCORDANCE WITH CURRENT SCC. SPECIFICATIONS.
6. VERGE AND BATTERS TO HAVE A MINIMUM OF 75mm TOPSOIL AND FULL WIDTH TURF IF ORDERED.
7. MATCH TO EXISTING AC PAVEMENT EXTENSION OR WIDENING TO BE IN ACCORDANCE WITH IPWEA STD DRG RS-170.
8. SUBGRADE TEST RESULTS TO BE FORWARDED TO SUPERINTENDENT FOR DETERMINATION OF BOX DEPTHS PRIOR TO EXCAVATION TESTS SHALL INCLUDE SOAKED CBR AND/OR OTHER TESTS AS REQUESTED BY THE SUPERINTENDENT.THE CONTRACTOR SHALL ALLOW ADEQUATE TIME FOR COUNCIL APPROVAL OF PAVEMENT DESIGN.
9. LEVELS FOR KERB AND CHANNELLING/EDGE OF PAVEMENT CONSTRUCTION ARE AT EQUAL INTERVALS AT LIP OF CHANNEL UNLESS SHOWN OTHERWISE.
10. SIDE DRAINS TO BE CONSTRUCTED UNDER ALL KERBS AND ALL KERB AND CHANNEL AS PER SCC STANDARDS. REFER TO SCC STD DRG RS-140 FOR DETAILS.
11. ALL STORMWATER PIPES UNDER ROADWAYS AND FOOTPATHS SHALL BE CLASS '2' R.C.P R.R.J. UNLESS NOTED OTHERWISE.
12. THE STORMWATER PIPE CLASSES HAVE BEEN DESIGNED FOR SERVICE LOADS ONLY, AND THE CONTRACTOR SHALL ASSESS ANTICIPATED CONSTRUCTION LOADS AND UPGRADE THE PIPE CLASSES, IF NECESSARY, IN ACCORDANCE WITH A.S 3725-1989. AT THE CONTRACTORS COST.
13. ALL LOTS NOT DRAINING TO A PROPERTY PIT TO HAVE 2 KERB ADAPTORS . KERB ADAPTORS SHOWN ARE INDICATIVE ONLY AND ARE TO BE INSTALLED IN ACCORDANCE WITH SCC STD DRG RS-081.
14. CONCRETE FOOTPATHS TO BE INSTALLED BY THE CIVIL CONTRACTOR UNLESS OTHERWISE NOTED. REFER TO SCC STD DRG RS-065 FOR CONSTRUCTION DETAILS.

FILE: 3011-DA13.dwg DATE: 02-02-2021 USER: NICK VENESS
XREFS: 12D OUTPUT ROAD VERTICLES, X-17-000934 - P11-12 DABASE, X-17-000934 - LOTS

AMENDMENTS	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
FIRST ISSUE	BG	BG	BG	MW	01.12.17	
A	JM	JM	BG	MW	03.04.18	AMENDED TO SUIT NEW LOT LAYOUT
B	NV	NV	BG	MW	05.02.21	PRECINCT 11 AND 12 LOTS AMENDED

STATUS: ISSUED FOR APPROVAL

APPROVED
BY:
SIGN: DATE:

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DRAWING TITLE
STORMWATER CATCHMENT AND LAYOUT PLAN
SHEET 2 OF 2

PROJECT No.	DRAWING No.	REVISION
17-000934	3011-DA13	B



FILE: 3011-DA14.dwg DATE: 02-02-2021 USER: NICK VENESS
XREFS: 120 OUTPUT ROAD VERTICLES, X-17-000934 - P11-12 DABASE, X-17-000934 - LOTS

AMENDMENTS	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
FIRST ISSUE	BG	BG	BG	MW	01.12.17	
A	JM	JM	BG	MW	03.04.18	AMENDED TO SUIT NEW LOT LAYOUT
B	NV	NV	BG	MW	05.02.21	PRECINCT 11 AND 12 LOTS AMENDED
C	NV	NV	BG	MW	08.03.21	PRECINCT 12 LOTS AMENDED

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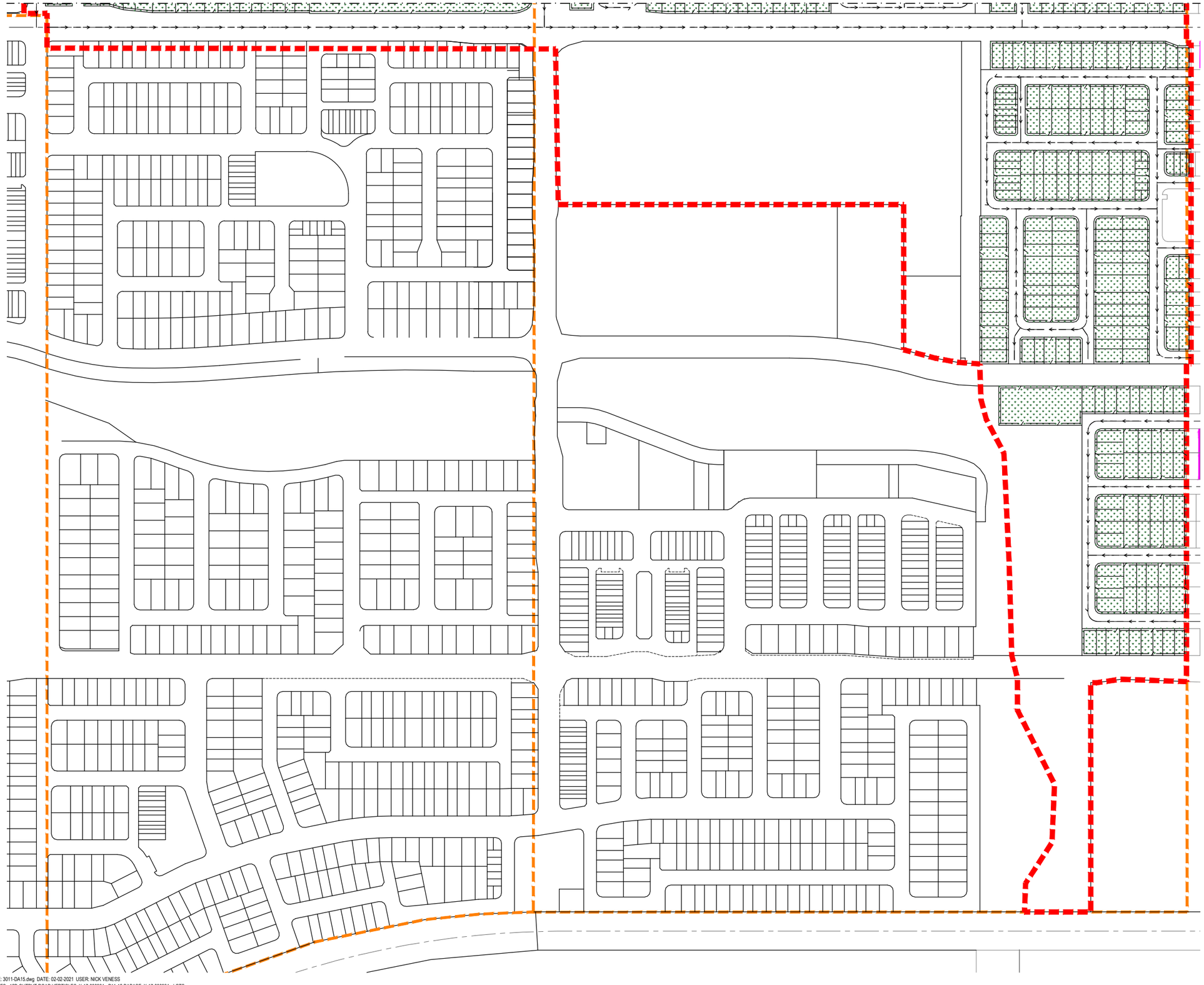
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DRAWING TITLE
CONCEPTUAL EROSION AND SEDIMENT CONTROL LAYOUT PLAN SHEET 1 OF 2

PROJECT No.	DRAWING No.	REVISION
17-000934	3011-DA14	C

FOR CONTINUATION REFER SHEET 1



N

LEGEND

- PROPOSED WORKS BOUNDARY
- PRECINCT BOUNDARY
- PROPOSED SEDIMENT FENCES

FILE: 3011-DA15.dwg DATE: 02-02-2021 USER: NICK VENESS
XREFS: 12D OUTPUT ROAD VERTICLES, X-17-000934 - P11-12 DABASE, X-17-000934 - LOTS

AMENDMENTS	DESIGN	DRAWN	CHECK	APPROVED	DATE	AMENDMENT DETAILS
FIRST ISSUE	BG	BG	BG	MW	01.12.17	
A	JM	JM	BG	MW	03.04.18	AMENDED TO SUIT NEW LOT LAYOUT
B	NV	NV	BG	MW	05.02.21	PRECINCT 11 AND 12 LOTS AMENDED

STATUS
ISSUED FOR APPROVAL

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DRAWING TITLE:
CONCEPTUAL EROSION AND
SEDIMENT CONTROL LAYOUT PLAN
SHEET 2 OF 2

PROJECT No.	DRAWING No.	REVISION
17-000934	3011-DA15	B

GENERAL NOTES

1. THIS DESIGN FOR EROSION AND SEDIMENT CONTROL IS CONCEPTUAL ONLY. THE CONTRACTOR SHALL MODIFY OR INSTALL ADDITIONAL/ ALTERNATIVE MEASURES DURING THE CONSTRUCTION AND MAINTENANCE PERIOD IN ORDER TO COMPLY WITH BEST PRACTICE STANDARDS IN ACCORDANCE WITH BUT NOT LIMITED TO CALIBRE CONSULTING'S SPECIFICATION 17 , THE MANUAL FOR EROSION AND SEDIMENT CONTROL (V1.2) AND ALL STATUTORY REQUIREMENTS.

2. PRESCRIBED WATER CONTAMINANTS (AS DEFINED IN THE ENVIRONMENTAL PROTECTION ACT 1994) MUST NOT BE RELEASED FROM THE SITE, OR BE LIKELY TO BE RELEASED SHOULD RAINFALL OCCUR, UNLESS ALL REASONABLE AND PRACTICABLE MEASURES ARE TAKEN TO PREVENT OR MINIMISE THE RELEASE AND CONCENTRATION OF CONTAMINATION. THESE MEASURES MUST INCLUDE AS A MINIMUM, BUT ARE NOT LIMITED TO, THE FOLLOWING:
   - A. ENSURE NON ESSENTIAL EXPOSURE OF SOIL IS PREVENTED BY: RESTRICTING THE EXTENT OF CLEARING TO THAT NECESSARY FOR ACCESS TO, AND SAFE CONSTRUCTION OF, THE APPROVED WORKS; PROTECTING VEGETATION IN ALL OTHER AREAS OF THE SITE; AND BY MINIMISING THE DURATION OF SOIL EXPOSURE BY:
     - STAGING THE WORKS TO MINIMISE THE AREA OF SOIL EXPOSED AT ANY ONE TIME;
     - EFFECTIVELY STABILISING CLEARED AREAS PRIOR TO RAINFALL IF WORKS ARE DELAYED OR WORKS ARE NOT INTENDED TO OCCUR IMMEDIATELY. SEE E&SC ADVICE NOTE 1;
     - EFFECTIVELY STABILISING AREAS AT FINISHED LEVEL WITHOUT DELAY AND PRIOR TO RAINFALL; AND
     - EFFECTIVELY STABILISING STEEP AREAS, SUCH AS STOCKPILES, BATTERS AND EMBANKMENTS, WHICH ARE NOT BEING ACTIVELY WORKED AND PRIOR TO RAINFALL.
   - B. WHERE IT IS NOT FEASIBLE TO EFFECTIVELY STABILISE CLEARED AREAS OF EXPOSED SOIL, SUCH AS AREAS BEING ACTIVELY WORKED, IMPLEMENT A FULL SUITE OF EROSION AND SEDIMENT CONTROLS TO MAXIMISE SEDIMENT CAPTURE IN THOSE AREAS AND TO MINIMISE EROSION SUCH THAT EROSION BY ALL FORMS OTHER THAN SPLASH (RAINDROP IMPACT) EROSION AND SHEET EROSION DOES NOT OCCUR; AND
   - C. IN AREAS OF EXPOSED SOIL WHERE IT IS NOT FEASIBLE TO EITHER EFFECTIVELY STABILISE THE SURFACE OR IMPLEMENT A FULL SUITE OF EROSION AND SEDIMENT CONTROLS, FOR EXAMPLE IN THE AREAS BEING ACTIVELY WORKED AND WHERE THE IMPLEMENTATION OF SOME EROSION AND SEDIMENT CONTROLS WOULD IMPEDE CONSTRUCTION ACTIVITIES, ENSURE CONTINGENCY MEASURES ARE AVAILABLE ON SITE AND ARE IMPLEMENTED, PRIOR TO RAIN, TO MAXIMISE SEDIMENT CAPTURE AND TO MINIMISE EROSION SUCH THAT EROSION BY ALL FORMS OTHER THAN SPLASH (RAINDROP IMPACT) EROSION AND SHEET EROSION DOES NOT OCCUR
   - D. EFFECTIVELY STABILISE ALL STOCKPILES, BATTERS AND EMBANKMENTS WITHOUT DELAY. WHERE IT IS NOT FEASIBLE TO EFFECTIVELY STABILISE A STOCKPILE, BATTER OR EMBANKMENT, SUCH AS AREAS BEING ACTIVELY WORKED, ENSURE THAT SEDIMENT CONTROLS ARE INSTALLED AND SURFACE STORMWATER FLOWS ARE MANAGED SUCH THAT EROSION OF STOCKPILES, BATTERS OR EMBANKMENTS IS NOT CAUSED BY CONCENTRATED STORMWATER FLOWS.
   - E. ENSURE CLEAN STORMWATER IS DIVERTED OR MANAGED AROUND OR THROUGH THE SITE WITHOUT INCREASING THE CONCENTRATION OF TOTAL SUSPENDED SOLIDS OR OTHER CONTAMINANTS IN THE FLOW AND WITHOUT CAUSING EROSION (ON SITE OR OFF SITE). IF IT IS NOT FEASIBLE TO DIVERT ALL AREAS DISCHARGING CLEAN STORMWATER AROUND OR THROUGH THE SITE, MANAGE THE CLEAN STORMWATER RUNOFF AS FOR CONTAMINATED STORMWATER RUNOFF, AND ENSURE THAT SEDIMENT BASINS ARE SIZED TO ACCOMMODATE THE ADDITIONAL VOLUME OF RUNOFF (SEE E&SC ADVICE NOTE 2).
   - F. ENSURE SHEET FLOWS OF STORMWATER ARE MANAGED SUCH THAT SHEET AND RILL EROSION IS PREVENTED OR MINIMISED.
   - G. ENSURE THAT ALL CONCENTRATED STORMWATER FLOWS INCLUDING DRAINAGE LINES, DIVERSION DRAINS, CHANNELS AND BATTER CHUTES ARE MANAGED ONTO, THROUGH, AND AT RELEASE POINTS FROM THE SITE IN ALL RAIN EVENTS UP TO AND INCLUDING THE AVERAGE RECURRENCE INTERVAL (ARI) EVENT OF 1 IN 2 YEAR ARI WITHOUT CAUSING WATER CONTAMINATION, SHEET, RILL OR GULLY EROSION, SEDIMENTATION, OR DAMAGE TO STRUCTURES OR PROPERTY
   - H. ENSURE MEASURES HAVE BEEN IMPLEMENTED SUCH THAT THE RUNOFF FROM ALL DISTURBED AREAS FLOWS TO A SEDIMENT BASIN OR BASINS. WHERE IT IS NOT FEASIBLE TO DIVERT RUNOFF FROM DISTURBED AREAS OF THE SITE TO A SEDIMENT BASIN, IMPLEMENT COMPENSATORY EROSION AND DRAINAGE CONTROLS PRIOR TO RAINFALL TO ENSURE THAT EROSION OF THOSE AREAS DOES NOT OCCUR, INCLUDING EROSION CAUSED BY EITHER SPLASH (RAINDROP IMPACT), SHEET, RILL OR GULLY EROSION PROCESSES (SEE E&SC ADVICE NOTE 3).
   - I. ENSURE EACH SEDIMENT BASIN HAS THE CAPACITY TO TREAT FLOWS TO CURRENT BEST PRACTICE STANDARDS (SEE E&SC ADVICE NOTE 4) AND AS A MINIMUM TO CONTAIN ALL THE STORMWATER RUNOFF FROM THE 80TH PERCENTILE 5 DAY RAINFALL DEPTH AND STORE 2 MONTHS SEDIMENT FROM THE RECEIVING CATCHMENT, AS DETERMINED USING THE REVISED UNIVERSAL SOIL LOSS EQUATION.
   - J. ENSURE SEDIMENT BASINS ARE MAINTAINED WITH SUFFICIENT STORAGE CAPACITY TO CAPTURE AND TREAT THE RUNOFF FOR THE DESIGN RAINFALL DEPTH OR EVENT. WHERE SEDIMENT BASINS ARE PROPOSED TO BE OVERSIZED FOR STORAGE OF CAPTURED WATER FOR RE-USE, INSTALL SURVEY MARKERS IN EACH SUCH BASIN TO INDICATE THE LEVEL THAT WATER WITHIN THE BASIN MUST BE LOWERED TO, IN ORDER TO MEET THE STORAGE CAPACITY SPECIFIED IN THE ABOVE REQUIREMENT.
   - K. ENSURE SEDIMENT BASINS ARE DEWATERED AS SOON AS PRACTICABLE AFTER EACH RAINFALL EVENT.
   - L. ENSURE THAT DURING DEWATERING, THE CONCENTRATION OF TOTAL SUSPENDED SOLIDS (TSS) DISCHARGED DOES NOT EXCEED 50MG/L AND THAT PH IS WITHIN THE RANGE OF 6.5-8.5. THE CONCENTRATION OF TSS RELEASED BY DEWATERING MAY ONLY EXCEED 50MG/L WHERE IT CAN BE DEMONSTRATED AND SUPPORTED THROUGH DOCUMENTATION THAT:
     - FURTHER SIGNIFICANT RAINFALL IS FORECAST TO OCCUR BEFORE THE TSS CONCENTRATION IS LIKELY TO BE REDUCED TO 50MG/L ; AND
     - RELEASING A HIGHER CONCENTRATION OF TOTAL SUSPENDED SOLID WILL RESULT IN A BETTER ENVIRONMENTAL OUTCOME BY PROVIDING STORAGE FOR THE CAPTURE AND TREATMENT OF RUNOFF FROM THE IMMINENT RAINFALL AND RUNOFF; AND
     - FLOCCULENT HAS BEEN APPLIED AND THE CONCENTRATION OF TSS IN THE CAPTURED WATER HAS ALREADY SIGNIFICANTLY DECREASED.
   - M. ENSURE SEDIMENT BASINS AND ASSOCIATED STRUCTURES SUCH AS INLETS, OUTLETS AND SPILLWAYS ARE STRUCTURALLY SOUND FOR 10 YEAR ARI RAINFALL EVENT.
   - N. ENSURE ACCUMULATED SEDIMENT FROM BASINS AND OTHER CONTROLS IS REMOVED AND DISPOSED OF APPROPRIATELY WITHOUT CAUSING WATER CONTAMINATION.
   - O. ENSURE SEDIMENT DOES NOT LEAVE THE SITE ON THE TYRES OF VEHICLES.

3. THE ENVIRONMENTAL PROTECTION ACT 1994 STATES THAT A PERSON MUST NOT CARRY OUT ANY ACTIVITY THAT CAUSES, OR IS LIKELY TO CAUSE, ENVIRONMENTAL HARM UNLESS THAT PERSON TAKES ALL REASONABLE AND PRACTICAL MEASURES TO PREVENT OR MINIMISE THE HARM. ENVIRONMENTAL HARM INCLUDES ENVIRONMENTAL NUISANCE. IN REGARD PERSONS AND ENTITIES, INVOLVED IN THE CIVIL, EARTHWORKS AND CONSTRUCTION PHASES OF THIS DEVELOPMENT, ARE TO ADHERE TO THEIR 'GENERAL ENVIRONMENTAL DUTY' TO MINIMISE THE RISK OF CAUSING ENVIRONMENTAL HARM.

   ENVIRONMENTAL; HARM IS DEFINED BY THE ACT AS ANY ADVERSE AFFECT, OR POTENTIAL ADVERSE AFFECT WHETHER TEMPORARY OR PERMANENT AND OF WHATEVER MAGNITUDE, DURATION OR FREQUENCY ON AN ENVIRONMENTAL VALUE AND INCLUDES ENVIRONMENTAL NUISANCE. THEREFORE, NO PERSON SHOULD CAUSE ANY INTERFERENCE WITH THE ENVIRONMENT OR AMENITY OF THE AREA BY REASON OF THE EMISSION OF NOISE, VIBRATION, SMELL, FUMES, SMOKE, VAPOR, STEAM, SOOT, ASH, DUST, WASTE WATER, WASTE PRODUCTS, GRIT, SEDIMENT, OIL OR OTHERWISE, OR CAUSE HAZARDS LIKELY IN THE OPINION OF THE ADMINISTERING AUTHORITY TO CAUSE UNDUE DISTURBANCE OR ANNOYANCE TO PERSONS OR AFFECT PROPERTY NOT CONNECTED WITH THE USE.

4. THE CONTRACTOR IS TO TAKE ALL NECESSARY PRECAUTIONS TO CONTROL EROSION AND DOWNSTREAM SEDIMENTATION DURING ALL STAGES OF CONSTRUCTION INCLUDING THE MAINTENANCE PERIOD.

5. WHERE IT IS REQUIRED TO SLASH EXISTING VEGETATION EITHER PRIOR TO THE COMMENCEMENT OF WORKS, DURING THE CONSTRUCTION WORKS AND / OR DURING THE MAINTENANCE PERIOD, SAID VEGETATION SHALL BE SLASHED TO A MINIMUM HEIGHT OF 75mm TO ASSIST WITH THE RETENTION OF SOILS ON SITE (I.E. ASSIST IN THE PREVENTION OF EROSION).

6. WHERE THE EXISTING VEGETATION WITHIN THE PROPOSED LOTS AND / OR PARKLAND IS DISTURBED AS A RESULT OF THE CONSTRUCTION WORKS, SAID EARTHWORKS ARE TO BE TOPSOILED AND EFFECTIVELY STABILISED WITHIN FIVE (5) DAYS, (EARLIER IF RAIN EXPECTED) OF FINAL ALLOTMENT EARTHWORKS. AN EFFECTIVELY STABILISED SURFACE IS DEFINED AS ONE THAT DOES NOT HAVE
   - VISIBLE EVIDENCE OF SOIL LOSS CAUSED BY SHEET, RILL OR GULLY EROSION
     OR
   - LEAD TO SEDIMENTATION, OR
   - LEAD TO WATER CONTAMINATION.

7. ALL CONSTRUCTION VEHICLES ARE TO ACCESS THE SITE VIA A SINGLE POINT OF ACCESS; THE POINT OF ACCESS, TOGETHER WITH THE MEASURES TO BE IMPLEMENTED, ARE TO BE AGREED WITH COUNCIL'S DESIGNATED REPRESENTATIVE ON SITE. THE PRINCIPLE AIM OF THE MEASURE(S) TO BE IMPLEMENTED IS / ARE TO LIMIT THE TRACKING OF DELETERIOUS MATERIALS ONTO THE SURROUNDING ROAD NETWORK.

8. THE CONTRACTOR SHALL PROVIDE GULLY INLET PROTECTION TO ALL GULLY INLET STRUCTURES LOCATED, DIRECTLY DOWNSTREAM OF THE PROPOSED DEVELOPMENT WORKS.

9. APPROPRIATE PROVISIONS ARE TO BE PROVIDED TO THE INTERFACE BETWEEN THE EXISTING ROADWAY PAVEMENTS AND THE NEW ROADWORK'S CONSTRUCTION. THE PROVISIONS SHALL ADDRESS WORKPLACE HEALTH AND SAFETY CONCERNS (I.E. RESTRICTING ACCESS BY THE GENERAL PUBLIC TO THE SITE).

10. THE LOCATION OF THE CONSTRUCTION VEHICLE COMPOUND, SITE OFFICE AND THE VEHICLE SERVICING AREA SHALL BE AGREED WITH COUNCIL'S DESIGNATED REPRESENTATIVE ON SITE, PRIOR TO THE COMMENCEMENT OF WORKS.

11. CLEARED VEGETATION IS TO NOT BE BURNED ON SITE, ALL VEGETATIVE WASTE(S) SHALL BE MULCHED AND THEREAFTER RETAINED ON SITE FOR USE AS PART OF THE EROSION AND SEDIMENTATION CONTROL STRATEGY OR THE LANDSCAPING / REVEGETATION WORKS. ALL STUMPS AND / OR OTHER ORGANIC MATTER NOT SUITABLE FOR MULCHING SHALL BE DISPOSED OF AT AN APPROVED WASTE DISPOSAL FACILITY.

12. SEDIMENT FENCE AND TURFING RUNNING DOWNSLOPES SHALL HAVE REGULAR FLOW DISSIPATERS AT 45° TO SLOPE AS DIRECTED CONSISTING OF SAND BAGS OR SIMILAR AS REQUIRED.

13. DURING THE CONSTRUCTION PROCESS INCLUDING THAT PERIOD DURING WHICH THE WORKS ARE "ON MAINTENANCE' SHOULD COUNCIL'S DESIGNATED REPRESENTATIVE REQUEST ADDITIONAL EROSION AND SEDIMENT CONTROL MEASURES BE IMPLEMENTED, SAID MEASURES SHALL BE IMPLEMENTED AT THE EARLIEST TIME POSSIBLE. NOTWITHSTANDING THE ABOVE REQUIREMENT ANY MEASURES REQUESTED TO BE IMPLEMENTED BY COUNCIL'S DESIGNATED REPRESENTATIVE SHALL BE IMPLEMENTED WITHIN 24 HOURS OF THE TIME OF THE REQUEST.

14. ALL ROOFWATER / SEWER RETICULATION TRENCHES EITHER ADJACENT TO EXISTING DEVELOPMENT OR PERPENDICULAR TO THE CROSSFALL OF THE LAND ARE TO BE TOPSOILED (75mm MINIMUM) AND TURFED. FOR A MINIMUM 900mm WIDTH.

15. THE CONTRACTOR SHALL CONSTRUCT LINED CUTOFF DRAINS IN WORK AREAS SO AS TO LIMIT SLOPE LENGTHS TO A MAXIMUM OF 80M.

16. THE CONTRACTOR IS RESPONSIBLE FOR ENSURING THAT NO RELEASE OR FLOW IS PERMITTED FROM THE SITE, THROUGHOUT THE EARTHWORKS AND CONSTRUCTION PERIOD TO ANY WATER WAYS OR STORMWATER DRAINLINES LEADING TO A WATERWAY OR AREA OF NATIVE VEGETATION UNLESS THE LEVELS OF TOTAL SUSPENDED SOLIDS DOES NOT EXCEED A CONCENTRATION OF 50 MGL.

17. ALL SEDIMENT CONTROL DEVICES SHALL BE MONITORED, CLEANED AND/OR REPAIRED WHENEVER THE ACCUMULATED SEDIMENT REDUCES THE CAPACITY BY 50%.

18. ALL PERIMETER BANK/SWALE SHALL HAVE UNINTERRUPTED POSITIVE GRADE TO AN OUTLET.

19. AT ALL TIMES THE CONTRACTOR SHALL MONITOR THE PREVAILING WEATHER CONDITIONS AND PROTECT OR STABILISE ANY DOWNSTREAM CONSTRUCTION AND GULLY INLETS.

20. CLEARING OF SITE AND STOCK PILE AREAS TO BE AS DIRECTED BY THE SUPERINTENDENT.

21. WHERE PRACTICAL THE CONTRACTOR SHALL DIVERT CLEAN WATER ENTERING THE SITE FROM EXTERNAL CATCHMENT(S) AND DIRECTED TO THE STORMWATER SYSTEM. THIS DISCHARGE POINT SHOULD BE ROCK LINED. REGULAR ROCK CHECK DAMS SHOULD BE POSITIONED ALONG THE VEGETATED DRAINAGE LINE LEADING TO THIS DISCHARGE POINT.

22. REGULAR INSPECTIONS AND MAINTENANCE OF VEHICLE WASHDOWN AREA, SITE AND STORAGE COMPOUND TO BE CARRIED OUT BY CONTRACTOR.

23. AREAS USED FOR STORAGE OF CHEMICALS USED FOR CONSTRUCTION PURPOSES SHALL HAVE STORMWATER CONTROL DEVICES ERECTED ADJACENT TO THEM (I.E. EARTH BUND AND SEDIMENT FENCES). UPON COMPLETION OF ROADWORKS WASTE PRODUCTS ARE TO BE DISPOSED OF AS PER LOCAL AUTHORITY GUIDELINES AND TEMPORARY DEVICES ARE TO BE REMOVED AND AREA REHABILITATED.

THE EROSION & SEDIMENT CONTROL PLAN IS A CONCEPT PLAN DEMONSTRATING AN APPROACH TO EROSION & SEDIMENTATION CONTROL FOR THE SITE. IT IS THE CONTRACTORS RESPONSIBILITY TO PROVIDE AN EROSION & SEDIMENT CONTROL DESIGN AND A COMPLETED DESIGN CERTIFICATE PRIOR TO COMMENCEMENT OF WORK. CERTIFICATION MUST BE UNDERTAKEN BY A SUITABLY QUALIFIED, EXPERIENCED PROFESSIONAL NOT DIRECTLY EMPLOYED BY THE PRINCIPAL.

FILE: 3011-DA16.dwg DATE: 02-02-2021 USER: NICK VENESS
XREFS:

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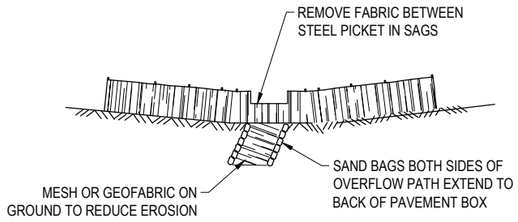
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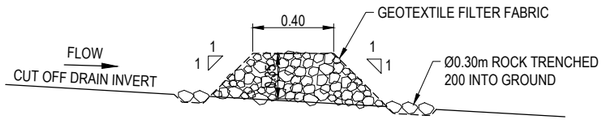
DRAWING TITLE: CONCEPTUAL EROSION AND SEDIMENT CONTROL NOTES

PROJECT No.	DRAWING No.	REVISION
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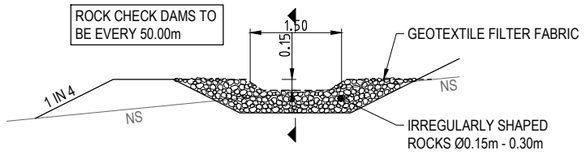
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INSTALL AT ALL SAG POINTS IN SILT FENCES
NOT TO SCALE



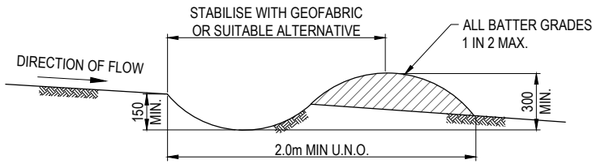
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NOT TO SCALE



TYPICAL ROCK CHECK DAM DETAIL

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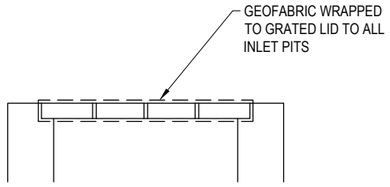
DIRTY WATER CUTOFF DRAIN DETAIL

NOT TO SCALE

CUTOFF DRAINS - MAINTENANCE PROGRAM

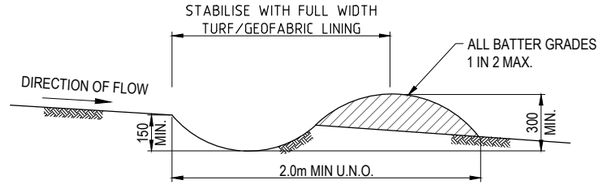
1. INSPECTIONS TO BE CARRIED OUT AFTER EACH RUNOFF EVENT.
2. SEDIMENT BUILD UP TO BE REMOVED DURING CONSTRUCTION AS REQUIRED BY THE SUPERINTENDENT.

NOTE: DRAIN TO BE CIRCULAR PARABOLIC OR TRAPEZOIDAL, V SHAPED IS NOT ACCEPTABLE. GRADIANT BETWEEN 1.0% TO 5.0%



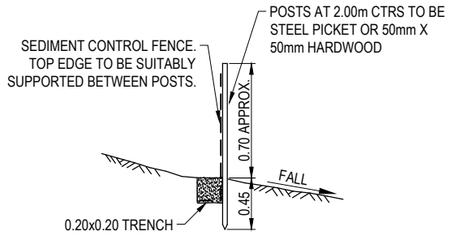
INLET GULLY DETAILS

NOT TO SCALE



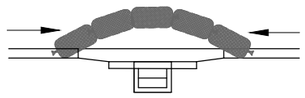
CLEAN WATER CUTOFF DRAIN DETAIL

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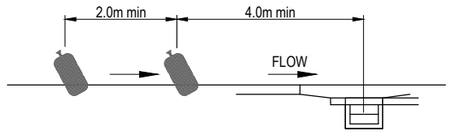
SEDIMENT FENCE DETAIL

NOT TO SCALE



SANDBAG AT SAG GULLIES

TO BE PROVIDED AT ALL SAG GULLIES
NOT TO SCALE



SANDBAG AT GULLIES ON GRADE

TO BE PROVIDED AT ALL ON GRADE GULLIES
NOT TO SCALE

THE EROSION & SEDIMENT CONTROL PLAN IS A CONCEPT PLAN DEMONSTRATING AN APPROACH TO EROSION & SEDIMENTATION CONTROL FOR THE SITE. IT IS THE CONTRACTORS RESPONSIBILITY TO PROVIDE AN EROSION & SEDIMENT CONTROL DESIGN AND A COMPLETED DESIGN CERTIFICATE PRIOR TO COMMENCEMENT OF WORK. CERTIFICATION MUST BE UNDERTAKEN BY A SUITABLY QUALIFIED, EXPERIENCED PROFESSIONAL NOT DIRECTLY EMPLOYED BY THE PRINCIPAL.

CONCEPTUAL SEDIMENT MANAGEMENT PROGRAM PHASE 2

DESCRIPTION OF WORKS

SEWER/ROOFWATER /STORMWATER /SERVICES	• EXCAVATED MATERIAL TO BE PLACED ON HIGH SIDE OF TRENCH AND TO PROTECT PIPE WORK AND DIRECT SURFACE MATERIAL AWAY FROM EXCAVATIONS. • EFFECTIVELY STABILISE AREAS IN ALLOTMENTS IMMEDIATELY AFTER COMPLETING THE SEWER AND ROOFWATER DRAINAGE CONSTRUCTION. • DEPRESS GROUND AROUND TEMPORARY FIELD INLETS TO CREATE SEDIMENT POND. • PROVIDE 2.0m TURF STRIPS OVER ROOFWATER AND SEWER TRENCHES.
STOCKPILE	• SEDIMENT FENCE TO BE ERECTED 5M FROM TOE OF BATTER ON LOW SIDE OF STOCKPILE. • STOCKPILE SITE TO BE CLEAR OF STAGE BOUNDARIES SO AS TO NOT CAUSE A NUISANCE TO ADJOINING PROPERTIES. • STOCKPILES NOT INTENDED TO BE WORKED FOR MORE THAN 10 DAYS ARE TO BE EFFECTIVELY STABILISED.
ROADWORKS	• SEDIMENT FENCES TO ALLOTMENTS TO BE RE-ERECTED AS REQUIRED. • KERB INLET PROTECTION TO BE PROVIDED TO ALL GULLIES. • INSTALL FULL WIDTH VERGE (INCLUDING BATTERS) TURFING FOLLOWING KERB AND CHANNEL INSTALLATION. • UTILISE UNDERGROUND DRAINAGE SYSTEM AS CONVEYANCE SYSTEM OF DIRTY WATER TO BASINS (WHERE APPROPRIATE) TO AVOID SCOUR OF ROAD BOX PROFILE.
ALLOTMENTS	• EFFECTIVELY STABILISE ALLOTMENTS. • SEDIMENT FENCES TO ALLOTMENTS TO BE RE-ERECTED. • PRIOR TO EFFECTIVE STABILISATION, TOP SOIL TO BE TESTED TO ENSURE SATISFACTORY CONDITIONS EXIST TO ACHIEVE THE REQUIRED EFFECTIVE STABILISATION. • CONTRACTOR TO AMELIORATE SOIL WHERE NECESSARY. • CUTOFF DRAINS TO LIMIT SLOPE LENGTHS TO LESS THAN 80m TO BE IMPLEMENTED.
MAINTENANCE	• THE SEDIMENT FENCES ARE TO BE INSPECTED WEEKLY AND FOLLOWING RAIN FALL EVENTS. ANY REPAIRS REQUIRED ARE TO BE EFFECTED IMMEDIATELY. • SEDIMENT AFTER RAIN OR CONSTRUCTION TRAFFIC IS TO BE CLEANED FROM STREETS AND ALLOTMENTS IMMEDIATELY AND CORRECTIVE ACTION TAKEN.

NOTES:

- REFER TO BULK EARTHWORKS DRAWINGS FOR PHASE 1 SEDIMENT AND EROSION DETAILS. 17-000934.1011 SET
- BASIN SIZING FROM BULK EARTHWORKS APPLICATION. BULK EARTHWORKS BASINS ARE TO BE UTILIZED DURING OPERATIONAL WORKS CONSTRUCTION.

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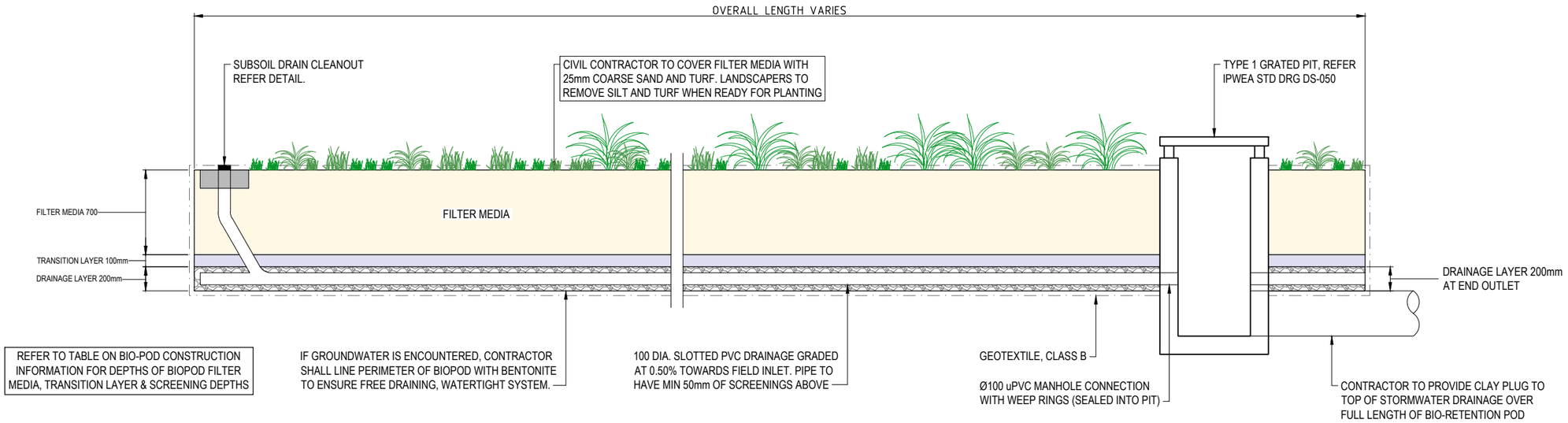
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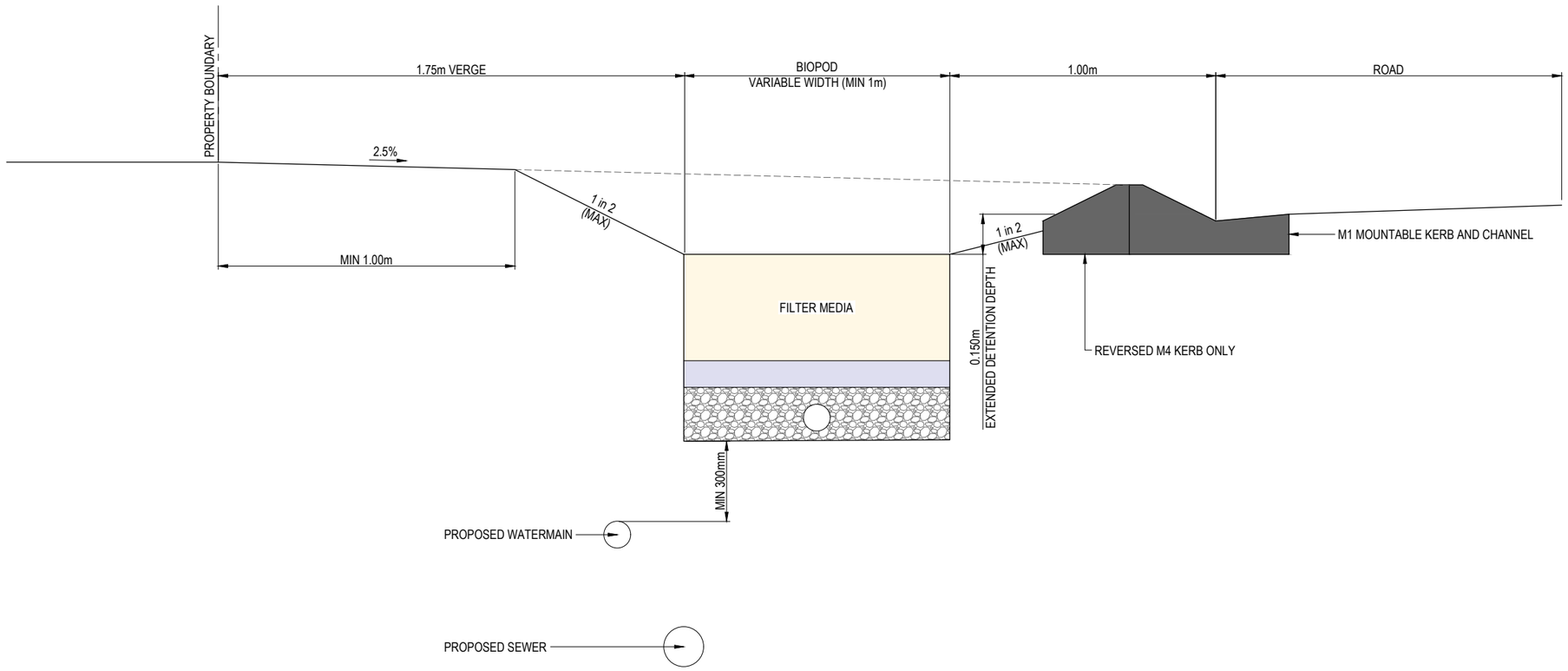
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TYPICAL BIOPOD WITH FIELD INLET PIT

1:20 @ A1 | 1:40 @ A3



TYPICAL BIO-RETENTION ROAD INTERFACE

1:10 @ A1 | 1:20 @ A3

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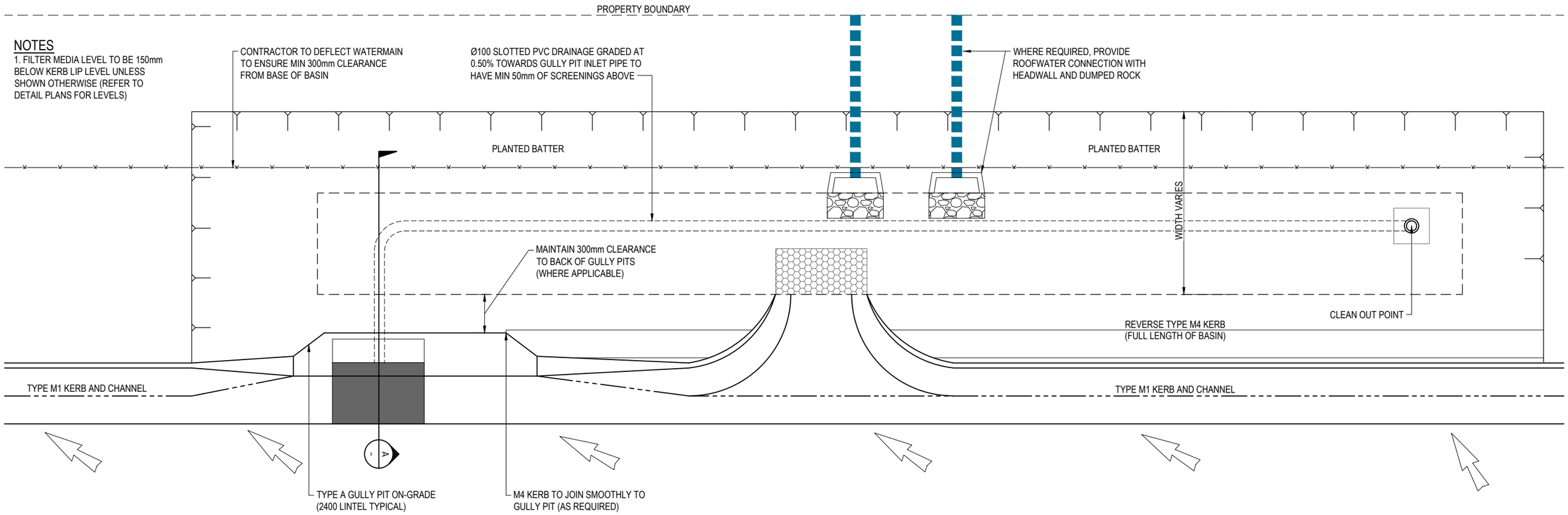
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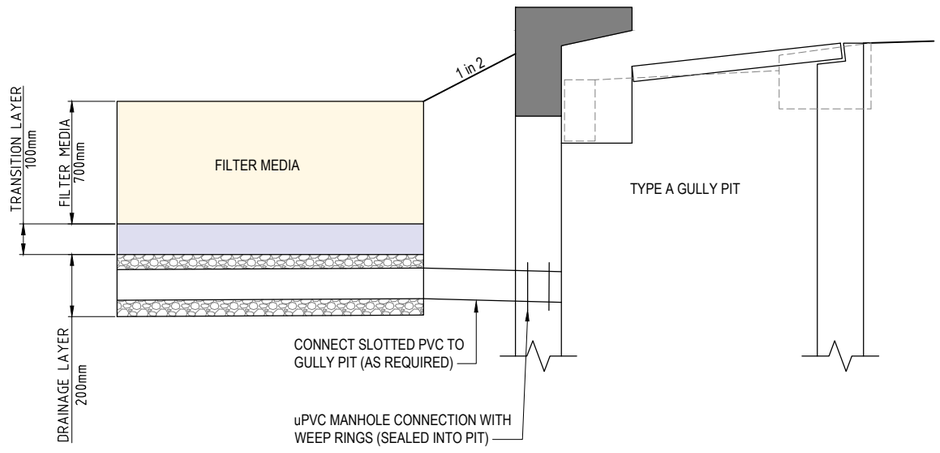
DRAWING TITLE: BIO RETENTION NOTES AND DETAILS SHEET 1 OF 3

PROJECT No.	DRAWING No.	REVISION
17-000934	3011-DA18	A



TYPICAL BIO-POD ARRANGEMENT WITH GULLY PIT

1:20 @ A1 | 1:40 @ A3



SECTION A
SCALE (A1): 1:10
SCALE (A3): 1:20

NOTE:
THIS DRAWING TO BE READ IN CONJUCTION WITH IPWEA STD DRG WSUD-005 & WSUD-007

NOTE:
THE CIVIL CONTRACTOR AND LANSCAPE CONTRACTOR SHALL CO-ORDINATE THEIR WORK TO ENSURE THAT THE CIVIL AND LANDSCAPING COMPONENTS OF ANY PARTICULAR BIO-POD ARE COMPLETED THE SAME DAY, SO AS TO AVOID EXPOSURE OF THE BIOPOD TO POTENTIAL SEDIMENT IMPACTS.

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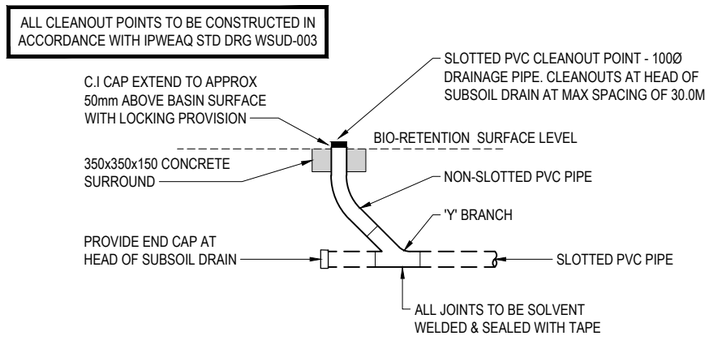
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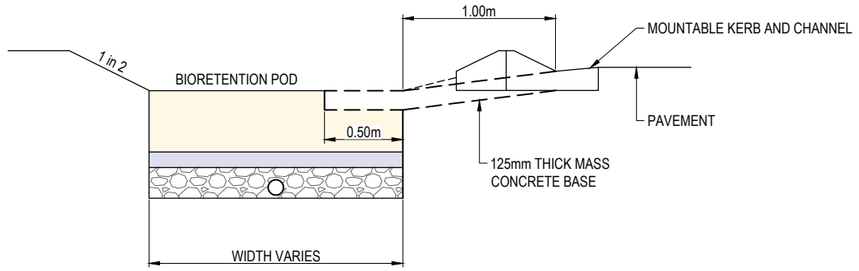
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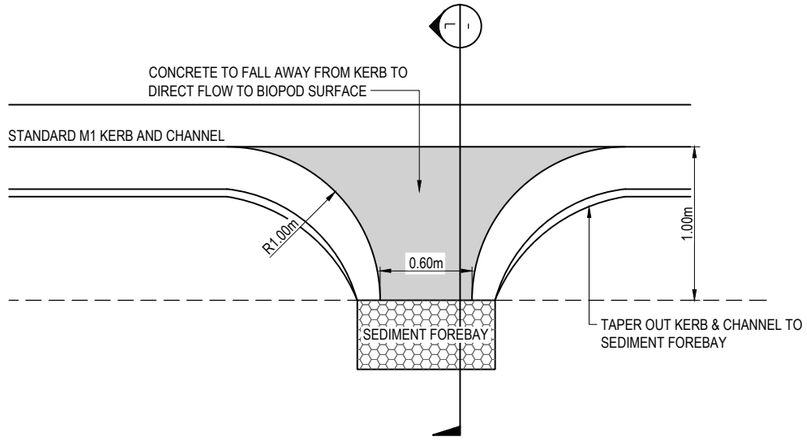
CLEANOUT POINT DETAIL

1:20 @ A1 | 1:40 @ A3



SECTION L-

SCALE (A1): 1:10
SCALE (A3): 1:20



KERB TURNOUT DETAILS

1:20 @ A1 | 1:40 @ A3

BIO-RETENTION/DETENTION BASINS CONSTRUCTION SEQUENCE AND NOTES:

1. ESTABLISH SEDIMENT AND EROSION CONTROL MEASURES IN CATCHMENT, INCLUDING SILT FENCES, SEEDING OF ALLOTMENTS, & FULL WIDTH VERGE TURFING.
2. SURVEY BASIN LOCATION.
3. INSTALL OVERFLOW PIT AND ENSURE PIT CREST IS AT DESIGN LEVEL. THIS PIT CREST WILL THEN BE USED AS A DATUM FROM WHICH OTHER LEVELS WITHIN THE BASIN WILL BE MEASURED. THE PIT REQUIRES HOLES FOR DRAINAGE PIPE CONNECTIONS WHICH CAN BE DRILLED AT THIS STAGE OR AFTER STEP 5 BELOW.
4. CONSTRUCT KERB TURNOUTS.
5. EXCAVATE SURROUNDING LANDFORM TO DESIGN SUBSOIL LEVEL (ACHIEVING SURROUNDING LEVEL AT THIS STAGE REDUCES THE NEED FOR EARTHWORKS ADJACENT TO THE BASIN AFTER THEY HAVE BEEN CONSTRUCTED).
6. EXCAVATE BASIN TO DESIGN DEPTH ENSURING BASE OF POD HAS MINIMUM 0.5% GRADE TOWARDS PIT. ENSURE BASE OF BASIN IS FREE FROM DEBRIS.

SUPERINTENDENT INSPECTION AND SIGN OFF REQUIRED BEFORE PROCEEDING.

7. LINE SYSTEM WITH GEOFABRIC, AND EXTEND GEOFABRIC A MINIMUM OF 500 MM BEYOND TOP OF EXCAVATION. THESE ARE THE FLAPS REFERRED TO IN ITEM 13 BELOW.
8. PLACE DRAINAGE LAYER (USING CLEAN 5-7mm AGGREGATE) TO DESIGN LEVEL.
9. NOTE THAT CORRECT FUNCTIONING OF THE DRAINAGE PIPES IS CRITICAL TO THE PERFORMANCE OF THE BIORETENTION SYSTEM. DIG TRENCHES IN DRAINAGE LAYER AND PLACE DRAINAGE PIPES. ENSURE PIPES ARE LAID AT MIN 0.5% SLOPE WITH NO LOCALIZED DEPRESSIONS VERIFIED USING LEVEL OR STRING LINE. ALL JOINTS AND JUNCTIONS IN PIPES TO BE SEALED. CONNECT CLEAN OUT POINTS ENSURING TOP OF CLEAN OUT POINTS ARE NOT LESS THAN 50mm BELOW OVERFLOW PIT CREST.

SUPERINTENDENT INSPECTION AND SIGN OFF REQUIRED BEFORE PROCEEDING.

10. COVER DRAINAGE PIPES WITH DRAINAGE MEDIA, ENSURING DESIGN COVER.
11. PLACE TRANSITION LAYER (USING ONLY PRESCRIBED DRAINAGE MATERIAL: TO DESIGN LEVEL (REFER DRAWINGS).

SUPERINTENDENT INSPECTION AND SIGN OFF REQUIRED BEFORE PROCEEDING.

12. PLACE FILTER MEDIA (USING ONLY PRESCRIBED MATERIAL) TO DESIGN LEVEL (REFER DRAWINGS). SPREAD MATERIAL USING EXCAVATOR BUCKET OR HAND TOOLS TO OBTAIN LIGHT AND EVEN COMPACTION OF FILTER MEDIA. DO NOT DRIVE OVER FILTER MEDIA WITH ANY VEHICLE AS EXCESSIVE COMPACTION CAN IMPEDE DRAINAGE THROUGH THE FILTER MEDIA. FILTER MEDIA SURFACE MUST BE LEVEL (HORIZONTAL) AND FREE FROM LOCAL DEPRESSIONS AND SET AT 150mm BELOW PIT CREST (TOLERANCES TO MEET THOSE IN TABLE BELOW OR KERB LEVEL. AS SOON AS FILTER MEDIA IS PLACED IT MUST BE IMMEDIATELY COVERED WITH 25MM COARSE SAND AND TURF WHICH MUST REMAIN IN PLACE AT ALL TIMES.THIS PROTECTIVE COVER IS ONLY TO BE REMOVED BY LANDSCAPERS IMMEDIATELY PRIOR TO PLANTING.
13. FLUSH DRAINAGE PIPES TO REMOVE ANY INITIAL INGRESS OF MATERIAL AND TO ENSURE ADEQUATE DRAINAGE.

FINAL SUPERINTENDENT INSPECTION AND SIGN OFF

NOTE THAT BETWEEN STEPS 5 – 16 ABOVE THE BASINS WILL BE SUSCEPTIBLE TO STORM DAMAGE. THEREFORE ONCE COMMENCED PODS MUST BE COMPLETED AS SOON AS POSSIBLE TO MINIMISE THE RISK OF STORM DAMAGE.
INSPECTION IS REQUIRED IF RAINFALL EVENT OCCURS BETWEEN CONSTRUCTION STEPS 5 – 16 ABOVE.

BIO RETENTION INSTALLATION STANDARD NOTES:

CONSTRUCTION OF THE BIOPODS TO FOLLOW STANDARDS AND PROCEDURES OUTLINED IN BIORETENTION TECHNICAL DESIGN GUIDELINE (WATER BY DESIGN) AND WSUD CONSTRUCTION AND ESTABLISHMENT GUIDELINES - SWALES, BIORETENTION SYSTEMS AND WETLANDS (WATER BY DESIGN). THE PLACEMENT OF DRAINAGE, TRANSITION AND FILTER MEDIA LAYERS MUST BE UNDERTAKEN CAREFULLY TO ENSURE CORRECT DEPTH, SLOPE AND COMPACTION:
DEPTH: FILTER MEDIA SHOULD BE INSTALLED AND COMPACTED IN TWO LIFTS FOR DEPTHS OVER 500mm.
SLOPE: THE TOP SURFACE OF THE DRAINAGE LAYER, TRANSITION LAYER AND FILTER MEDIA LAYER SHOULD BE FLAT. A SPREADER BAR SHOULD LEVEL THE SURFACE OF EACH LAYER.
COMPACTION: THE FILTER MEDIA MUST BE LIGHTLY COMPACTED DURING INSTALLATION TO PREVENT THE MIGRATION OF FINE PARTICLES. THIS CAN BE ACHIEVED WITH A SINGLE PASS OF A LIGHT ROLLER SUCH AS A DRUM LAWN ROLLER. A VIBRATING PLATE CAN ALSO BE USED TO COMPACT SMALL BIO RETENTION SYSTEMS OR 'POZITRACK' BOBCATS CAN BE USED FOR LARGE SYSTEMS. ENSURE ONLY ONE COMPACTING PASS IS MADE OVER THE MEDIA FOR LIGHT COMPACTION.

PROVIDE 1/100Ø STUB OUT OF PIT TO 1.0m PAST BIO-RETENTION BASIN TOP OF BANK FOR LANDSCAPE CONTRACTOR TO CONNECT TO. THIS WILL PROVIDE OUTLET FOR LANDSCAPE ARCHITECTS SURFACE PITS

CONTRACTOR TO ENSURE BIOFILTRATION FILTER MEDIA, TRANSITION LAYER AND DRAINAGE LAYER MEETS THE CRITERIA OUTLINED IN THE BIORETENTION TECHNICAL DESIGN GUIDELINE (WATER BY DESIGN) SECTION 4.3

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AURA NORTH CENTRAL LOCATION PRECINCT 11 (PART) TO 12 (PART)

Appendix C Geotechnical Report

STOCKLAND DEVELOPMENT PTY LTD

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Proposed Residential Subdivision
Precincts 7 – 15
167 Bells Creek Road, Bells Creek

Prepared for
Stockland Development Pty Limited

Project 80967
March 2014



Douglas Partners
Geotechnics / Environment / Groundwater

Document History

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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		March 2014
Reviewer		March 2014

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Report on Geotechnical Investigation
Proposed Residential Subdivision
Precincts 7 - 15, 167 Bells Creek Road, Bells Creek

1. Introduction

This report presents the results of a geotechnical investigation carried out by Douglas Partners Pty Ltd (DP) for Precincts 7 – 15 of the proposed residential subdivision at 167 Bells Creek Road, Bells Creek.

The investigation was undertaken at the request of Stockland Development Pty Limited (Stockland) following authorisation to proceed received on 29 January 2014, and was undertaken in general accordance with DP's proposal SSC130211A dated 15 January 2014.

It is understood that the proposed development will comprise a stage residential lot subdivision. Supporting infrastructure will include standard subdivisional roads, water, sewerage and stormwater. Given the undulating terrain of the site, bulk earthworks are expected to comprise cut and fills of varying heights.

The objective of the investigation was to provide a broad scale assessment of the subsurface conditions across the site in relation to civil infrastructure design (eg. earthworks, excavations, roads, service trenching etc.) to assist with the planning of the subdivision.

The investigation comprised the drilling and sampling of forty bores followed by laboratory testing, engineering assessment and reporting. The details of the field work and laboratory testing are presented in this report, together with comments and recommendations on the issues listed above.

This report should be read in conjunction with the notes entitled "About This Report" in Appendix A along with any other attached explanatory notes and should be kept in its entirety without separation of individual pages or sections.

2. Site Description

The proposed subdivision at 167 Bells Creek Road, Bells Creek is located over an area of approximately 2,310ha (Refer to Drawing 1) which formerly was used as a pine forest plantation that has since been cleared and is currently used for cattle grazing.

Precincts 7 - 15 for the proposed subdivision are located in the central portion of the subdivision and are bounded by Precincts 2 – 4 to the north and the subdivision boundary to west and east, and the northern tributary of Bells Creek to the south (Refer to Drawing 4). The area is gently undulating of low relief, with the ground surface overall falling gradually from west to east. Due to former forestry plantation use, localised deep rutting of the surface was encountered across many parts of the site with rotten stumps and timber debris scattered throughout. The area is covered with grasses, small shrubbery, and, in isolated areas, mature pine trees.

Typical conditions at the time of the investigation are shown in Figure 1 below.



Figure 1: Typical site conditions for Precincts 7 – 15

3. Regional Geology and Acid Sulfate Soil Conditions

Reference to the Geological Survey of Queensland's 1:100,000 series maps (refer Figure 2) indicates that Precincts 7 - 15 are occupied by two geological units. The low lying areas generally consist of Quaternary aged floodplain alluvium (Qa - yellow) which typically comprises *"clay, silt, sand, gravel"*. The remaining elevated areas consist of Triassic to Jurassic aged Landsborough Sandstone formation (RJl - green) typically comprising *"Lithofeldspathic labile and quartzose sandstone, siltstone, shale, minor coal, ferruginous oolite marker"*. The alluvium is expected to be underlain by the Landsborough Sandstone formation.

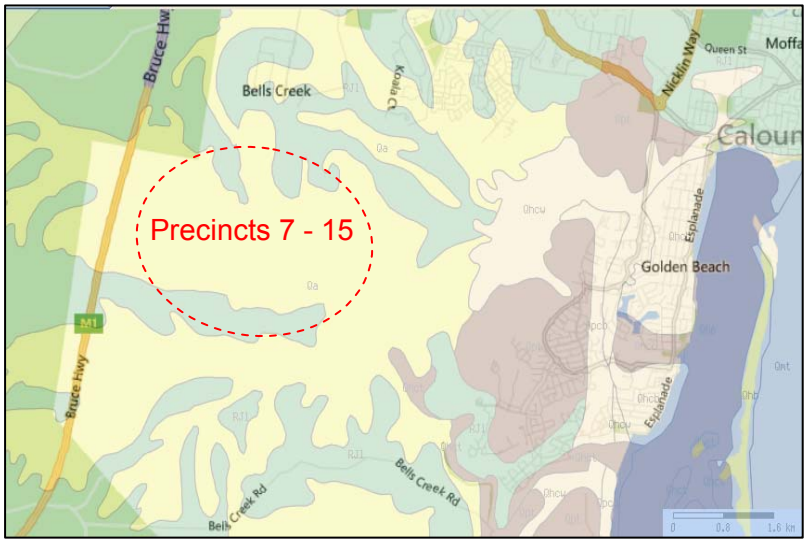


Figure 2: Extract from Geological Map 1:100,000 Series

Reference to the Acid Sulfate Soil Map produced by the Department of Natural Resources and Mines "Maroochy Caloundra Map 2" (refer to Figure 3) indicates that Precincts 7 – 15 are predominately located in an area of *"non ASS land"* with only localised areas of "*low probability of ASS occurrence"* and *"probable ASS occurring typically at depth in areas associated with Melaleuca species, wetlands and Casuarina glauca communities"* in the immediate vicinity of the Bells Creek tributary.

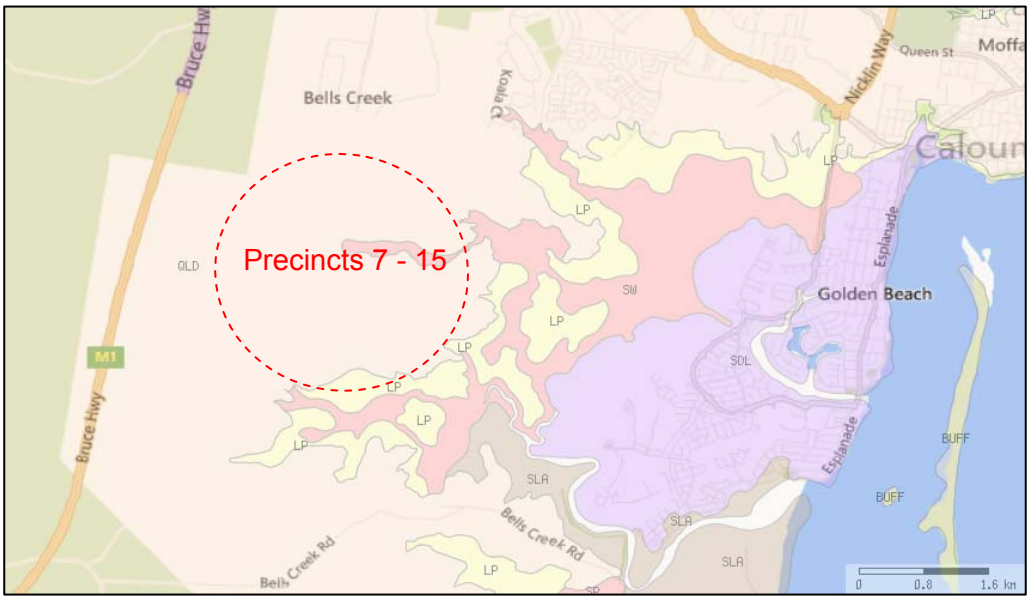


Figure 3: Extract from Maroochy Caloundra Acid Sulfate Soil Map 2

4. Field Work

The field work for Precincts 7 – 15 was carried out between 6 February and 12 February 2014 and comprised the drilling and sampling of forty bores (designated Bores 47 to 86). The test locations were set out with reference to nominated bore locations by Stockland by geotechnical personnel, with locations recorded using a hand held GPS. The approximate test locations are indicated on Drawing 4 attached in Appendix B.

The bores were drilled using a 4WD mounted Jacro 200 drilling rig using continuous flight augers fitted with a tungsten carbide (TC) bit to between 1.4 m and 6 m depth. Dynamic cone penetrometer (DCP) tests were carried out adjacent to the bores in order to assess the relative consistency of the near surface soils.

Strata identification was undertaken through observation of cutting returns and recovered samples. On completion, the bores were observed for groundwater seepage and then backfilled with spoil tamped into the holes.

The field work was undertaken by experienced geotechnical personnel who logged the bores and collected samples for visual and tactile assessment and for subsequent laboratory testing.

5. Field Work Results

The subsurface conditions encountered in the bores are described in detail on the borehole report sheets in Appendix C, together with accompanying notes which define the classification methods and descriptive terms used. The depths were measured below existing surface levels at the time of investigation.

In summary, the subsurface conditions encountered in Precincts 7 – 15 (eg.Bores 47 to 86) generally comprised localised **filling**, **topsoil**, overlying **sands** and **clays** which in turn were underlain by **sandstone** or **ironstone**. The subsurface conditions encountered are further described below:

- **Filling:** Gravel filling was encountered at the surface in Bore 59 to 0.1 m depth. The relative density of the gravel filling was 'loose. In the absence of 'Level 1' certification in accordance with AS 3798–2007 (Ref 4) relating to the placement of filling, the filling encountered in this bore should be considered as being 'uncontrolled'.
- **Topsoil:** Silty sand topsoil with organics was encountered at the surface in all bores except Bore 59 where it was encountered underneath the filling to between 0.1 m and 0.6 m depth. The variance observed in the topsoil layer is due to rutting from the previous pine plantation use. The average depth of the topsoil layer was typically 0.2 m to 0.3 m.
- **Sands:** Underlying the topsoil, silty sand was encountered in all of the bores except Bores 49, 79, and 86. Gravelly, silty, clayey sands and sands were encountered in Bores, 52, 53, 55, 58, 60, 69, 72, 81, 82, and 85. The sands were encountered to between 0.45 m and 3.0 m depth occasionally interbedded with clays. The sands were typically loose to medium dense and very loose and dense locally.
- **Clays:** Underlying the sands except in Bores 51, 54, and 69, silty and sandy clays were encountered to between 0.55 m and 6.0 m depth occasionally interbedded with the above sands. The consistency of the clays generally was stiff to very stiff grading hard locally. Gravelly sandy clays and silt were encountered locally in Bores 49, 63, and 74 within the above depths.
- **Sandstone/Ironstone:** Very low grading extremely low strength with depth ironstone was encountered in Bore 53 between 2.6 m and 3.1 m depth and again between 3.9 m and 5.7 m depth. Very low strength sandstone was encountered in Bores 79 and 84 between 0.55 m and 1.4 m and 4.45 m and 6.0 m depth, respectively. The sandstone in Bore 79 graded low strength at 1.4 m depth where auger refusal was observed.

Groundwater seepage was observed between 1.2 m and 2.55 m depth in Bores 47, 50, 51, 54, 56, 58, 59, 60, 62, 65, 81, and 83 within the sands and/or along the sand/clay interface. Groundwater seepage was also encountered between 1.9 m and 2.8 m depth in Bores 62 and 63 within the clay layer at depth. It should be noted, however, that groundwater levels are affected by climatic conditions and soil permeability, and will therefore vary with time.

6. Laboratory Testing

6.1 Shrink-Swell

Shrink-swell index tests were carried out on selected 'undisturbed' and remoulded bulk samples recovered from the bores within the same strata. The results of the testing are summarised in Table 1 below with the detailed test report sheets attached in Appendix D.

Table 1: Results of Shrink-Swell Testing

Bore No.	Depth (m)	Material	Unit Weight (t/m^3)	Average Moisture Content Before (%)	Moisture Content After (%)	Shrinkage (%)	Swell (%)	Shrink-Swell Index (% per ΔpF)
64	1.0	Clayey sand	2.22	10.4	11.5	0.3	0.0	0.2
64	0.6-1.0*	Sandy clay	2.1	11.1	13.3	1.6	0.1	0.9
66	1.5	Silty sandy clay	1.97	23.7	27.1	3.6	2.5	2.7
66	1.3-1.6*	Sandy clay	1.94	18.4	25	1.9	2.8	1.8
73	0.95-1.3*	Silty sandy clay	1.94	17.9	21.2	1.9	0.6	1.2
74	1-1.1	Gravelly sandy clay	1.84	21	28	3.1	0.0	1.7
74	1-1.5*	Clayey sand	2.07	16.8	19.1	0.8	0.2	0.5
84	1.0	Silty sandy clay	1.98	23.9	26.1	3.6	2.5	2.7
84	0.8-1.2*	Sandy clay	1.9	20.6	25.2	3.0	2.6	2.4

* = bulk sample remoulded near 98% Standard compaction at near optimum moisture content

The results of the shrink-swell index testing indicates that the initial field moisture content of the 'undisturbed' insitu samples are higher in the clays than the initial moisture content for the samples recompacted at near to optimum moisture content. The difference in moisture contents is reflected in the variation between the corresponding shrinkage index and subsequent shrink-swell results, with the wetter samples (eg.insitu) recording a higher shrink-swell index compared to the drier remoulded sample.

6.2 Moisture Content, Plasticity and Particle Size Distribution

Selected soil samples recovered from the bores were tested in the laboratory for engineering properties of moisture content, plasticity and particle size distribution. The results of this testing are summarised in Table 2. Detailed report sheets are attached in Appendix D.

Table 2: Results of Plasticity and Particle Size Distribution Testing

Bore No.	Depth (m)	Material	FMC (%)	Plasticity				Particle Size Distribution		
				LL (%)	PL (%)	PI (%)	LS (%)	% Gravel	% Sand	% Silt/Clay
52	0.3-0.9	Silty sand	6.8	18	15	3	1.5	1	66	33
53	0.7-1.2	Silty sand	9.1	18	15	3	2.5	0	68	32
54	1.5-1.7	Silty sand	-	16	14	2	1.0	0	81	19
55	0.8-1.4	Gravelly clayey sand	10.3	41	16	25	11.5	21	53	26
58	1.0-1.4	Silty sand	-	-	-	NP	0.2	0	85	15
63	1.6-1.9	Gravelly clayey sand	-	32	15	17	10	22	48	30
64	0.6-1.0	Silty sandy clay	13.7	30	11	19	11	0	49	51
65	0.2-0.6	Silty sand	-	13	11	2	0.5	0	70	30
66	1.3-1.6	Sandy clay	21.7	60	20	40	16.5	2	42	56
69	1.6-2.0	Sand	-	-	-	NP	0.0	0	96	4
72	0.75	Clayey sand	-	27	13	14	8.5	0	63	37
73	0.95-1.3	Silty sandy clay	18.6	54	19	35	15.5	1	47	52
74	1.0-1.5	Gravelly clayey sand	18.8	41	21	20	11	30	37	33
80	0.6	Sandy clay	-	23	10	13	8.0	0	49	51
84	0.8-1.2	Silty sandy clay	22.5	60	19	41	17	0	39	61

Where FMC = Field Moisture Content, LL = Liquid Limit, PL = Plastic Limit, PI = Plasticity Index, LS = Linear Shrinkage

Figure 4 indicates the clayey materials tested plotted above the 'A Line' with the plasticity ranging between low and medium plasticity for the clays and medium plasticity for more clayey sands. The tendency towards a linear trend indicates the clayey materials are likely to have derived from a consistent parent source (eg. residual soils derived from the underlying Landsborough Sandstone formation).

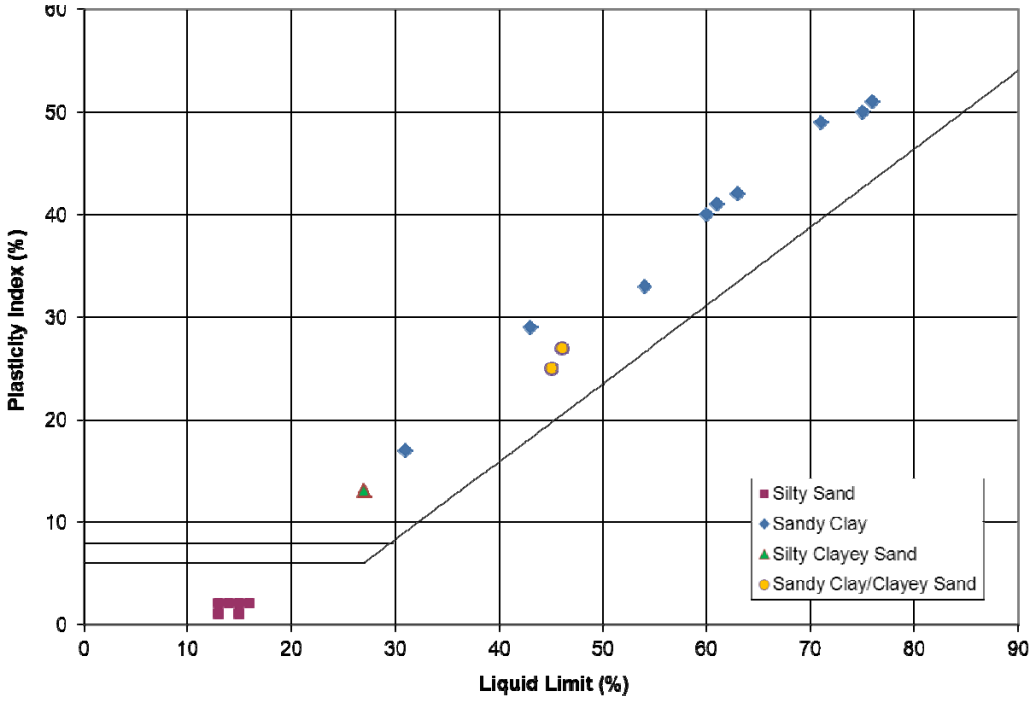


Figure 4: Plasticity Chart

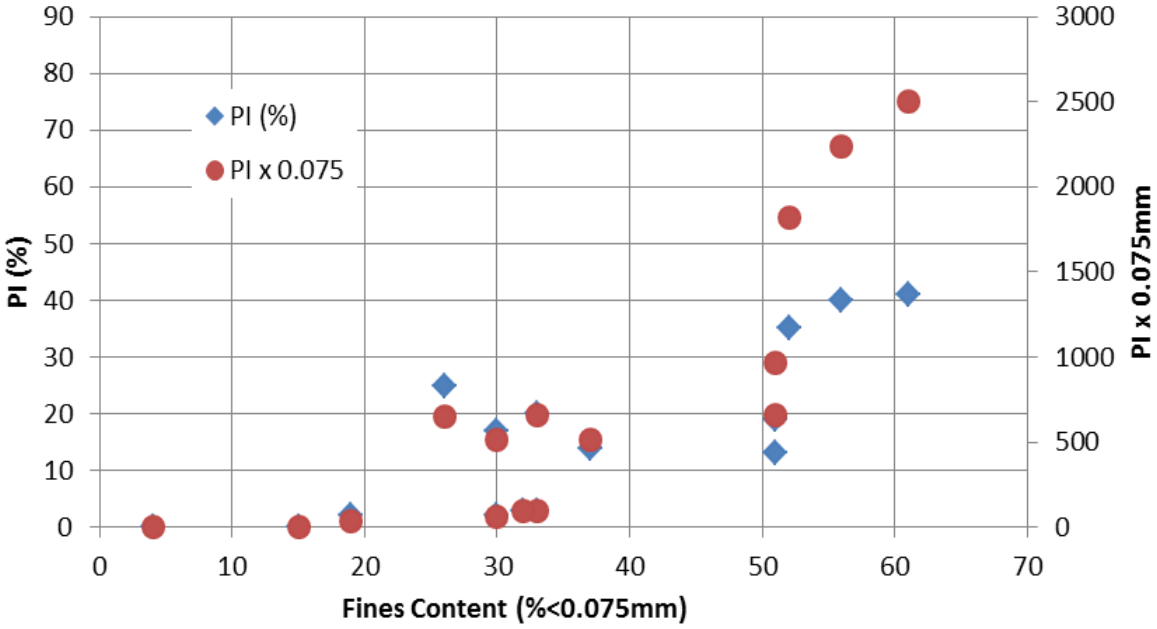


Figure 5: Plasticity v Fines Content

6.3 Compaction and Soaked CBR

Standard compaction and single point soaked California bearing ratio (CBR) tests were undertaken on selected bulk samples recovered from the bores. The samples were first screened over the 19 mm sieve, as required by the test standard, and were then compacted to a standard dry density ratio of 98% at near to optimum moisture content (OMC). The samples were soaked for four days under a 4.5 kg surcharge.

The results of the compaction and CBR testing are summarised in Table 3. Detailed report sheets are attached in Appendix D.

Table 3: Results of Compaction and CBR Testing

Bore No.	Depth (m)	Material	FMC (%)	OMC (%)	MV (%)	MDD (t/m^3)	Swell (%)	CBR (%)
52	0.3-0.9	Silty sand	6.8	11.0	-4.2	1.937	0.4	13
53	0.7-1.2	Silty sand	9.1	11.0	-1.9	1.942	0.4	18
55	0.8-1.4	Gravelly clayey sand	10.3	10.4	-0.1	2.012	0.6	9
64	0.6-1.0	Silty sandy clay	13.7	11.9	1.8	1.927	1.0	7
66	1.3-1.6	Sandy clay	21.7	19.1	2.6	1.683	5.0	2.5
73	0.95-1.3	Sandy clay	18.6	19.3	-0.7	1.678	2.1	7
74	1.0-1.5	Gravelly clayey sand	18.8	17.6	1.2	1.826	0.5	9
84	0.8-1.2	Silty sandy clay	22.5	21.9	0.6	1.614	3.7	2.5

Where FMC = Field Moisture Content; MV = Moisture Variation (FMC-OMC); MDD = Maximum Dry Density, OMC = Optimum Moisture Content

The results of the testing generally indicate that the field moisture content at the time of the investigation was generally on the wetter side of optimum moisture content.

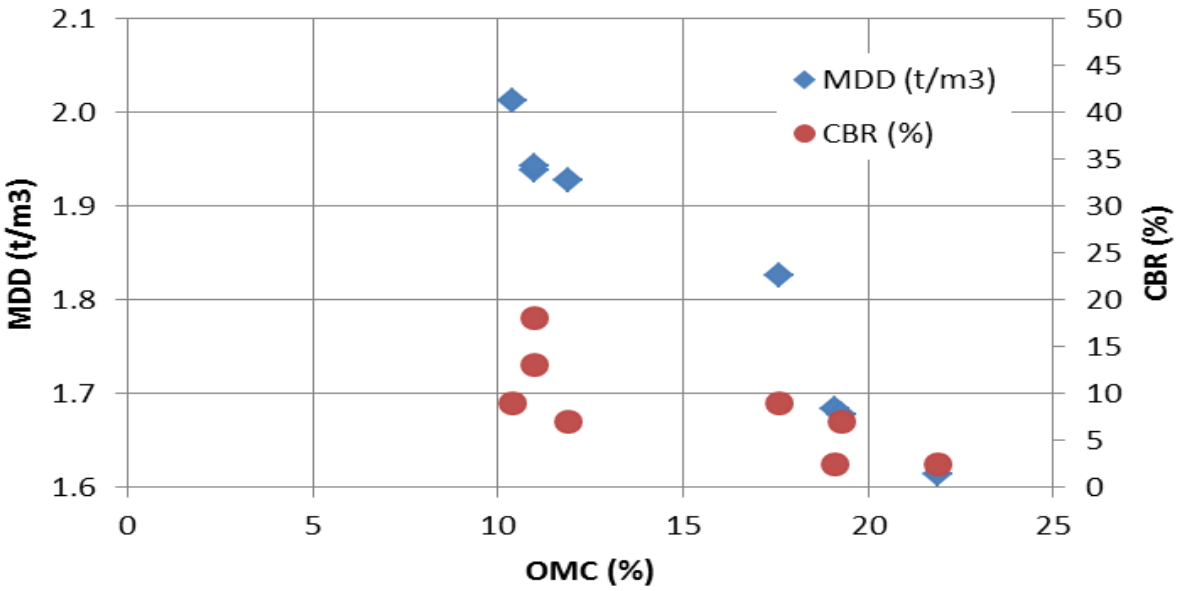


Figure 6: Compaction and CBR Results

6.4 Dispersivity

Combined Emerson class dispersion tests were performed on selected disturbed samples recovered from the bores. The results are summarised in Table 4 below. Detailed report sheets are attached in Appendix D.

Table 4: Results of Dispersivity Testing

Bore No.	Depth (m)	Material	Emerson Class
52	0.3-0.9	Silty sand	5
53	0.7-1.2	Silty sand	5
55	0.8-1.4	Gravelly clayey sand	6
64	0.6-1.0	Silty sandy clay	6
66	1.3-1.6	Sandy clay	6
73	0.95-1.3	Sandy clay	6
74	1.0-1.5	Gravelly clayey sand	6
84	0.8-1.2	Silty sandy clay	6

The results of the testing generally indicates that the samples tested were slightly to non-dispersive.

6.5 Acid Sulfate Soils

Preliminary field screening and chemical laboratory tests for acid sulfate soils (ASS) were carried out with reference to the QASSIT Guidelines (Ref 1), the Soil Management Guidelines (Ref 2) and the Laboratory Methods Guidelines (Ref 3).

Samples were recovered from selected bores in Precincts 7 – 15 at 0.25m depth intervals to 2.0 m depth and were screened by measurement of pH after the addition of distilled water (pH_f) and peroxide (pH_{fox}). The pH_f test provides a preliminary indication of past oxidation of sulphides resulting in the presence of actual acid sulfate soils (AASS). The pH_{fox} test provides a preliminary indication of the presence of unoxidised sulphides and therefore, potential acid sulfate soils (PASS).

Based on the results of the screening tests and visual inspection of the samples, selected samples were subjected to more rigorous Chromium Suite analytical testing. The results of this testing are discussed further in Section 7.6 and detailed report sheets are attached in Appendix D.

7. Comments

7.1 Earthworks

It is understood that earthworks for Precincts 7 – 15 will comprise cut and fills up to 6 m in height.

It is recommended site preparation and earthworks procedures be carried out in accordance with good practice including those outlined in AS 3798-2007 (Ref 4).

7.1.1 Trafficability

The field work for this investigation was carried out following a period of favourable dry weather conditions. Trafficability was considered to be good for the 4WD mounted drill rig.

The subsurface conditions encountered on site typically comprise silty and/or clayey sands overlying relatively impermeable clays at shallow depth. Following periods of wet weather, it is expected that moisture will tend to be perched in the sands above the clays and along the sand/clay interface. It should be noted that the silty and clayey sands in wet conditions are sensitive and will lose strength. The underlying clays will also soften during prolonged wet weather or changes in moisture condition.

Rubber tyred vehicles in particular will have trafficability problems during and after periods of rainfall or other increases in subgrade moisture content, and in some cases tracked plant may also experience some difficulty especially in areas where silt is at or near the surface (eg.Bore 49).

It will be essential to keep the site well drained during construction. The installation of drains to intercept seepage and facilitate drying out will be required should construction commence during or following an extended period of wet weather.

Conditioning of wet silty and clayey sands is typically difficult to achieve during periods of prolonged and intermittent rainfall events, where the moisture content of the subsurface soils are continually

allowed to be kept saturated from surface infiltration (eg.rain) as well as subsurface seepage. Drying out of the silty and clayey sands using surface and subsurface drains may take a number of weeks (or longer) of favourable weather conditions with little or no rainfall before any positive effect is achieved. Unfavourable, cooler climatic conditions (eg.winter) will also make the drying out process more difficult and lengthy to achieve.

Where filling is proposed, significant works to 'bridge' over these weakened soils using overburden gravel material, or rock fill, would be required if weather conditions are unfavourable. A granular working platform in low lying and poorly drained areas may also need to be considered.

7.1.2 Stripping

Any deleterious, soft, wet or highly compressible material or topsoil material rich in organics or root matter should be removed and only be reused as landscaping. Depth of topsoil (eg. stripping depth) was measured to between 0.1 m and 0.6 m (average 0.2 m to 0.3 m) in Precincts 7 – 15. The variance in the topsoil thickness is due to the surface rutting from the previous use as pine forestry plantation with topsoil thickness generally greater at the crest of the rutting.

It is suggested that an average 0.3 m stripping depth be allowed in estimates for the works. Stripping and grubbing depths due to the previous use as pine forestry plantation may vary significant locally in order to remove all root matter. Deep tyning (typically 0.3 m) of subgrade is recommended to detect grubbing depths to remove roots. Stripping depths will also varying in low-lying, poorly drained areas as well.

It is recommended that the stripped surface be inspected prior to commencing any filling operations.

7.1.3 Excavation

Based on the conditions encountered in the bores to the depths investigated, it is estimated that excavation of the natural soils and extremely low to very low strength sandstone could be undertaken using medium sized earthmoving equipment, such as drotts, backhoes or 15-20t (or larger) excavators.

Scrapers would likely need dozer push loading by dozers in the clays, siltstone and sandstone with pre-ripping to assist with production rates. Low strength materials (if encountered) would be more difficult to excavate (especially in confined excavations) and could require a larger excavator (30t+) with tiger teeth buckets with slowed excavation rates.

Excavations in the low strength sandstone will require larger equipment (eg. up to 30t excavators) fitted with a ripping tyne and/or rock breaker tools for confined trench excavations.

The assessment of excavation characteristics of soil has been based on the depth of penetration of the drilling rig using various bit attachments, which are attached to the solid spiral flight augers. It should be recognised that the excavatability estimates are based on materials encountered at the test locations only and that conditions may prove more difficult (or easier) for excavatability beyond these test locations and the depths drilled as part of this investigation.

7.1.4 Batter Slopes

Near vertical temporary excavations less than 1.5 m depth in dry, stiff (or stronger) clays are likely to be suitable for the short term installation of underground services provided there are no sensitive services or structures, or vehicular trafficked areas close to the excavation.

It should be noted that excavations in wet sands have the potential to 'collapse' unexpectedly in a trenching situation, particularly where groundwater seepage is encountered.

It is recommended that excavations in sands and all trench excavations deeper than 1.5 m be either positively supported (eg. shoring boxes, sheet piles, etc), benched or battered in combination with dewatering (if required) whenever personnel are to enter the trench.

Suitable unsurcharged temporary and permanent dry cut batter slopes for excavations up to 3 m in height are presented in Table 5. Where water seeps from the faces, batters will need to be considerably flatter.

Table 5: Cut Batter Slopes

Material	Safe Batter Slope (H:V)	
	Short Term	Long Term
Engineered filling* or natural sands	1.5:1	2:1
Natural stiff (or stronger) clays	1:1	2:1
Extremely low (or stronger) strength rock	1:1	1.5:1

Notes: * Depends on fill material type and level of compaction. Assumes a clayey fill material compacted under 'Level 1' Inspection and Testing.

For cuts greater than 3 m in depth, permanent slopes should be constructed at no steeper than 2.5H:1V.

The above temporary batter slopes are suggested with respect to slope stability only, and do not allow for lateral stress relaxation which may result in movement of nearby inground services or shallow footings. If such services or footings are settlement sensitive, and are located near the crest of the cut face, then the excavation may have to be positively supported.

Long term slopes may need to be flattened to 3H:1V or less, in order to allow vehicle access for maintenance of grass. It is recommended that all batters incorporate crest and toe drainage leading runoff into concrete lined longitudinal drains to reduce the risk of erosion of the batters. The batters should also be covered with topsoil and vegetation to provide long term erosion protection.

7.1.5 Re-Use of Cut Materials

It is considered that the majority of materials won from excavations on site, free of any organic and deleterious material, will generally be suitable for reuse as bulk filling provided the moisture content of the soils on placement approximates the optimum moisture content (OMC).

Soils containing organic and deleterious matter should be stripped from the construction area and stockpiled for landscaping purposes or spoiled from site. This material is not considered suitable for reuse as structural filling. Revegetation of borrow pits, batters and all exposed soils should be undertaken as the earthworks progress, using the topsoil and mulch salvaged during the initial clearing process.

The results of the laboratory testing indicate that the samples tested were mostly wet of OMC. Wet, saturated silty and clayey sand materials are considered unsuitable for immediate reuse as controlled fill without being appropriately moisture conditioned (eg. dried back to near optimum moisture content). To facilitate drying out of any wet silty or clayey sands, the material would need to be tyned or mixed with dry suitable materials won from excavations on site. This process would require days to achieve and would also require favourable weather conditions.

Difficulties with trafficability and workability are also likely where the medium to high plasticity clays are too far over optimum (eg. greater than 2% of OMC), thus will need moisture conditioning to dry back the material to near OMC. Where medium to high plasticity clays are proposed to be re-used as new structural filling, it is recommended that the cohesive material be placed at depth and granular material or weathered rock (if available) be placed close to subgrade level. This will reduce the effects of seasonal moisture change and foundation soil reactivity, and will also improve subgrade CBR for roads and surface trafficability.

Filling should not be allowed to be stockpiled for extended periods of time following excavation prior to placement as structural filling without moisture conditioning.

7.1.6 Compaction

Prior to the placement of filling, the stripped surface should be test rolled using a smooth drum roller with a minimum static weight of 12-tonne to detect the presence of any soft or loose spots. Areas demonstrating excessive movement under test rolling will be required to be either tyned, dried and recompacted or removed and replaced with compacted select fill. Treatment should be to a standard sufficient so that the subgrade passes test rolling and that compaction can be achieved in the first layer of filling. All earthworks should be carried out in accordance with AS 3798-2007.

The filling encountered in Bore 59 would need to be test rolled as above with no discernible movement being observed in order to avoid altering the site classification to ‘Class P’ (Problem site).

Approved bulk filling should be placed in layers not exceeding 0.3 m ‘loose’ thickness, with each layer compacted to a minimum dry density ratio of 95% relative to Standard compaction in proposed residential areas and 98% relative to Standard compaction in any proposed commercial areas. Where filling has significant clay content, moisture content within the filling should be maintained within 2% of OMC during and after compaction. The upper 0.3 m of pavement subgrade and unbound pavement gravels should be compacted to a minimum dry density ratio of 100% relative to Standard compaction and to within the same moisture content range as given above.

Care should be taken not to over-wet clayey soils as this can lead to problems associated with trafficability and workability. Clayey soils should not be over-compacted (eg. not more than 102% Standard) or placed too dry of OMC, as this can lead to future swelling and softening with changes to moisture content or inundation from water.

It is recommended that where filling is to be carried out over sloping ground (exceeding 10H:1V in slope), the slope should be benched to allow for the fill to be 'keyed' into the existing batters. These procedures will provide greater stability of the fill and allow for adequate compaction to be achieved throughout the full depth of the fill. Fill batters should also be overfilled and then cut back to the required design batter angles in order to maximise compaction of the material in the batter faces.

Field density testing should be carried out to check the standard of compaction achieved and the placement moisture content. The frequency of testing should be carried out in accordance with AS 3798-2007.

Level 1 inspection and testing of filling must be undertaken where the filling is to support buildings, pavements or settlement sensitive structures.

7.1.7 Volume Change and Settlement

Volume change is to be expected upon excavation and compaction of material, compared to the insitu volume of the material.

Excavation increases the volume of material during handling and stockpiling. The increase in volume (from ‘insitu’ to ‘loose’) is commonly referred to as the ‘bulking factor’. For clays, the bulking factor is typically between 1.3 and 1.4, and between 1.2 and 1.3 for sands.

Similarly, compaction results in a decrease in material volume. The compaction factor is the ratio of the insitu dry density to the maximum dry density. Based on the laboratory test results, the insitu dry density for the clay samples varied between 1.59 t/m^3 and 1.89 t/m^3. The maximum dry density relative to Standard compaction for the same clays samples varied between 1.61 t/m^3 and 1.93 t/m^3. The volume changes expected for the various soil types are shown in Table 6 below.

Table 6: Compaction Characteristics

Material	Bank Volume	Dried and Compacted Volume	Other losses	Compaction Factor
Stiff (or stronger) clays	1.0	0.90 – 0.95	0.05	0.85 – 0.90
Silty/Clayey sands	1.0	0.85 – 0.9	0.03 – 0.5	0.80 – 0.85

The above compaction factors are based on experience with similar conditions. These are estimates only and planning should allow for some variability in this factor (say+/- 0.1).

Where bulk filling is placed under controlled conditions, there is potential for ‘creep’ of the filling material as it settles over time under self-weight. Estimates of creep settlement of bulk filling under self-weight will vary in accordance with the depth of filling. This may lead to differential settlements where filling thickness are varied, such as over existing sloping ground.

Potential movements for such controlled filling are estimated as a percentage of the layer thickness. Such settlement may be in the order of 0.5% to 1% of the fill thickness. This range is presented for sensitivity checks and is dependent upon the nature of the filling. Where the filling predominately

comprises granular materials, a lower percentage is appropriate, and where the filling predominately comprises clayey material, a higher percentage is appropriate.

Typically, about half of the creep settlement in well compacted filling occurs within about one year of placement and most of the remainder over a period of about ten years.

7.1.8 Potential for Soil Dispersion

Emerson class tests provide an indication of potential dispersivity and sodicity. The Emerson class test involves the observed behaviour of an air-dried crumb of soil placed in distilled water. Based on whether the soil crumb breaks up (eg. slakes) and/or disperses is classified a number from 1 to 8, where 1 is the most dispersive and 8 the least dispersive.

Emerson class dispersion tests generally indicate the samples tested to have slight potential for erosion with Emerson class numbers of 5 and 6.

In order to preliminary assess the potential for sodic soils, the methodology adopted in the preliminary assessment of sodicity is that, where a sample comprises greater than 30% clay/silt sized particles and is dispersive (eg. Emerson class number of less than 4), then it is deemed to be a sodic soil. As discussed above, none of the samples tested as part of this investigation returned an Emerson class number of less than 4 and would thus not be considered to be sodic soils.

Some silty soils, while not classified as dispersive, may actually slake readily and as such are susceptible to piping, tunnelling and scouring erosional process.

It is recommended, as a minimum, erosion control measures during bulk earthworks construction and final design should include the following:

- ensure erosion and sediment control measures are in place prior to works commencing;
- stage works to minimise the area and the duration of exposure at any given time, including exposure to seasonal weather;
- stage works to install the permanent drainage network as soon as practical;
- divert water away from disturbed areas;
- divert clean water offsite at non-erosive velocities, minimising stormwater runoff velocities;
- direct site runoff to stabilised outlets designed for expected peak velocities;
- undertake stabilisation of temporary and permanent channels;
- undertake roughening of disturbed areas to encourage infiltration;
- develop a program for progressive revegetation and maintenance of exposed areas as they are completed; and,
- provide erosion control blankets and other methods depending on the steepness of slope and soil type.

7.2 Reactivity and Site Classification

The results of the laboratory testing were input into Douglas Partners' in-house program *REACTIVE*, to calculate the characteristic surface movement value (y_s) in general accordance with AS 2870-2011 (Ref 5). It should be noted that AS 2870-2011 provides recommended values of change in suction (Δ_u) and depth of suction (H_s) for major and regional centres throughout Australia. Based on published data by Fox (Ref 6), relating climatic conditions to suction, a value of 1.2 pF was adopted for Δ_u and 1.5 m for H_s in the *REACTIVE* calculations.

A cracking depth of 0.75 m based on $0.5H_s$ was also used in the analysis for natural soils in their current state. The designer should also consider the effects of earthworks on site classification (eg.reduced cracking depth).

The results of the analysis indicate that, provided 'abnormal' soil moisture conditions are not experienced, y_s values for the site are calculated to typically range between 20 mm and 45 mm, consistent with a site classification range of 'Class M' (moderately reactive) to 'Class H1' (highly reactive).

If 'abnormal' soil moisture conditions are experienced at the site, the site classification would change to 'Class P' (problem site) which would require more extensive foundation works or could result in adverse foundation performance. 'Abnormal' soil moisture conditions are defined in AS 2870 (Clause 1.3.3) and in summary comprise:

- Recent removal of buildings or structures likely to affect soil moisture conditions;
- Unusual moisture caused by drains, channels, ponds, dams or tanks;
- Recent removal of large trees;
- Growth of trees too close to a structure;
- Excessive or regular watering of gardens adjacent to the structure;
- Lack of maintenance of site drainage;
- Failure to repair plumbing leaks.

It should be noted that no assessment of the effect of soil moisture change by trees has been made in estimating the above y_s values (either with respect to the removal of established trees prior to development of building pads, or the proximity of established or new trees to proposed buildings). Reference to the requirements in AS 2870 should be made by the building designer in this regard. It should be further noted that the presence or removal of trees can result in additional surface movement, due to tree-induced suction changes and tree-induced centre heave. Such tree-induced movement is not included in the y_s calculations used to classify the site.

7.3 Foundations

7.3.1 Vertical Bearing Capacity of Materials

The extent of earthworks and the choice of footings will depend on development loads and what is considered acceptable in terms of settlement and cost.

Provided that site preparation is carried out in accordance with the recommendations in this report, otherwise with good practice, it is considered that high level pad and/or strip footings founded in either engineered filling, natural soils or weathered sandstone rock may be adopted. Slabs supported on high level foundations should be stiffened to suit the expected ground surface movements.

Based on the ground conditions encountered within the bores, high level footings may be preliminary designed for an allowable bearing pressure of 100 kPa for soils and 500 kPa for extremely low to very low strength sandstone rock. All footing excavations should be inspected by an experienced geotechnical engineer to confirm bearing pressures prior to casting of concrete.

Experience indicates that properly designed and constructed high level footings loaded as above are likely to undergo settlements in the order of 1% of the footing width.

Where development loads exceed the above allowable bearing pressures and/or the estimated settlements, then a suitable deep foundation type is expected to comprise bored piles founding into weathered sandstone rock.

For limit state design of piles in accordance with AS2159–2009 (Ref 7), the allowable end bearing values (working stress), as suggested above, should be multiplied by a factor of 2.5 in order to obtain the ultimate, unfactored geotechnical strength values ($R_{d,ug}$). The $R_{d,ug}$ values would then need to be multiplied by a suitable geotechnical strength reduction factor ($Ø_g$) to obtain the design geotechnical strength ($R_{d,g}$) of piles. In accordance with AS2159–2009, the $Ø_g$ value must be determined by the designer, but based on the anticipated site, design and installation risk factors, a $Ø_g$ value of 0.45 is considered likely for a low redundancy pile system.

Experience indicates that properly designed and constructed piles using the above parameters appropriately factored are likely to undergo settlements in the order of 1% of the pile diameter.

It is recommended that pile excavations be inspected by an experienced geotechnical engineer to ensure the design parameters adopted are suitable for the ground conditions and to ensure there is no soft or loose material remaining at the base of the excavations, or smear on the side walls.

7.3.2 Horizontal Bearing Capacity of Materials

The material providing horizontal resistance for pipeline thrust blocks would typically comprise engineered filling, natural soils or weathered sandstone rock. Based on the above mentioned ground conditions and in general accordance with the Water Supply Code of Australia (as produced by the Water Services Association of Australia), it is considered an allowable horizontal bearing pressure of 50 kPa could be adopted for the stiff (or stronger) clays and medium dense sands.

It is recommended that all thrust block excavations be inspected by an experienced geotechnical engineer to confirm bearing pressure prior to casting of concrete.

Ground movement of up to 10 mm could be expected for properly design and constructed thrust blocks sized using the allowable horizontal bearing pressures given above.

7.4 Retaining Walls

Retaining walls should be specifically engineer designed in accordance with AS 4678-2002 (Ref 8).

The design of flexible and rigid retaining walls could be undertaken using a triangular pressure distribution and the earth pressure parameters given in Table 6. Flexible walls are those which are free to rotate or tilt (such as cantilevered walls) and should be designed using active (K_a) earth pressure coefficient. Rigid walls are those which are restrained against rotation or tilt (eg.single anchored/propped walls) and should be designed using the at-rest earth pressure (K_o).

Passive resistance (K_p) at the toe of the wall should be ignored in the zone where future disturbance (eg. services trenches) could occur.

The effects of surcharge in the retained zone should be included by multiplying the vertical pressure developed by the surcharge by the appropriate lateral earth pressure coefficient given in Table 6. Allowance should also be made for the surcharge due to sloping crests if applicable.

Table 6: Earth Pressure Coefficients (non-sloping crest backfill)

Material	Unit Weight (kN/m^3)	Friction Angle (degrees)	Active K_a	At Rest K_o	Passive K_p
New engineered filling*, stiff (or stronger) natural clays	19	28	0.35	0.55	2.75
Medium dense sands	19	33	0.30	0.45	3.40

Notes: * Depends on fill material type and level of compaction. Assumes a clayey fill material compacted under 'Level 1' Inspection and Testing suspension.

Preference should be given to adopting thin soil layers and using small hand-controlled compaction equipment during backfilling against retaining walls. This is in order to limit the stress applied to the walls during construction. Should heavy compaction be required, then wall stresses will be well in excess of K_o and temporary propping should be used.

Clayey backfill should not be placed too dry of optimum moisture content, as this can lead to increased future swelling with changes to moisture content or inundation from water creating additional load on the back of the wall.

It is recommended that all retaining walls be drained for full height in order to minimise hydrostatic pressure build-up behind the wall. Additional guidelines on wall drainage are provided in Appendix G of AS 4678-2002.

7.5 Pavements

Subgrade conditions are expected to typically consist of controlled filling, natural sandy clays and silty sands.

The results of the laboratory testing indicate soaked CBR values range between 2.5% and 7% for the clayey materials and 9% and 18% for the sands. Insitu CBR values inferred from DCP test results indicate insitu CBR values at current moisture conditions typically greater than 3%.

The low CBR value in the sandy clay is a result of the softened material that swelled following saturation. Swell values of up to 5% were recorded for samples following soaking which returned CBR values typically of 2.5%

This saturated condition could occur in the long term if proper site drainage and maintenance procedures are not adopted. It is essential that sufficient drainage be installed and maintained in areas where there is potential for water to enter the subgrade. The provision of table drains, cross drains and, if necessary, subsurface drainage will reduce the influence of water on subgrade performance. If the subgrade is expected to be at or near its design strength at the time of construction, some form of treatment will be required in order for construction to proceed. In this case the material should be treated as a soft subgrade and some form of subgrade replacement will be required.

The higher laboratory CBR values achieved in some of the sands are under ideal preparation and lateral confinement conditions experienced as part of the laboratory test method and are not likely to be achieved in the field.
For preliminary design of flexible or rigid pavements, the values indicated in Table 7 are suggested. Because of the potential variability, it is recommended that the pavement subgrades be sampled and tested at the time of construction prior to finalising the pavement design thickness.

Table 7: Pavement Design Parameters

Subgrade Material	Soaked CBR (%)	Modulus of Subgrade Reaction (kPa/mm)
Sandy clays/clayey sands	3	25
Silty sands	10	55

Modulus of subgrade reaction values given above are for standard wheel load applications only. For loaded areas of different proportion or different load intensity to standard wheel loads, DP should be contacted for further advice.

For composite subgrades (eg. where imported filling is less than 1m thick) the Japan Road Association method of assessing a weighted subgrade strength should be used:

$$CBR_W = (D_F \times CBR_F^{0.33} + (1-D_F) \times CBR_S^{0.33})^3$$

where: CBR_W = weighted subgrade CBR (%)
D_F = depth of filling (m)
CBR_F = CBR of filling material (%)
CBR_S = CBR of natural subgrade (%)

7.6 Acid Sulfate Soils

7.6.1 What are Acid Sulfate Soils

Acid sulfate soils (ASS) are naturally occurring sediments and soils containing iron sulfides or sulfidic materials, often located over extensive low-lying coastal areas, predominately below RL 5 m AHD. These soils are generally found close to the natural ground surface, but may also be found at depth within the soil profile.

ASS includes actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS). AASS and PASS are often found within the same soil profile, with AASS generally overlying PASS. AASS are soils containing highly acidic soils resulting from the oxidation of soil materials that contained sulfides. PASS are soils that contain iron sulfides or sulfidic materials, which have not been oxidised.

7.6.2 Criteria for Evaluation of ASS

The criteria on which the results of screening tests (pH_f and pH_{fox}) were assessed as indicative of possible actual acid sulfate soils (AASS) or potential acid sulfate soils (PASS) were based on the QASSIT Guidelines as follows:

- pH_f of less than 4 indicates oxidation of sulfides has probably occurred in the past, indicating the presence of actual acidity (AASS). Only the surface sample (0.0 m – 0.25 m) from Bore 83 returned pH_f of less than 4, however, is likely to be as a consequence of the presence of organics.
- pH_f between 4 and 5.5 indicates the soils are acidic. This may be as a result of limited oxidation of sulfides, but may also be as a consequence of the presence of organic acids. All of the samples tested from Bores 51, 59, 64, 65, 70, 71, 78, and 82 and the majority of samples tested from Bores 77 and 83 returned pH_f values between 4 and 5.5.
- pH_f of greater than 5.5 indicates the soil has little or no actual acidity; however this can be common with PASS materials or marine-influenced samples. The majority of samples tested in Bores 60 and one sample tested from Bore 77 returned pH_f results greater than 5.5 indicating little or no actual acidity.

The pH_f test method does not detect acidity bound within sulfides; however the pH_{fox} test gives an indication of any potential acid release. Results of the pH_{fox} are summarised as follows:

- pH_{fox} of less than 3, plus a pH_{fox} reading at least one pH unit below pH_f, plus a strong reaction with peroxide, strongly indicates the presence of PASS. Near surface samples tested from the upper 1.0 m in Bores 59, 60, 64, 65, 70, 71, 78, 82, and 83 and all of the samples, except one, tested from Bore 51 returned pH_{fox} values of less than 3, and at least one pH unit below pH_f indicating potential for PASS.
- pH_{fox} between 3 and 4 indicates the possibility of PASS material and a pH_{fox} between 4 and 5 may indicate the presence of small amounts of sulfide or fine carbonates. A pH_{fox} value greater than 5 and little or no drop in pH value indicate the potential inability for the soil to generate acid; however, acid generation can be buffered by carbonate material in the sample. The remaining samples tested from the bores returned pH_{fox} values ranging between 3.0 and 4.4.

To provide confirmation of the above qualitative testing, quantitative analytical testing was carried out on selected samples, generally with the greatest difference in pH_f and pH_{fox} readings and strongest reaction using the Chromium Suite method.

- The chromium reducible sulfur values (S_{CR}) where greater than 0.01 %S indicates a significant level of sulfide, and where greater than 0.03 %S then the soil has a potential acidity level exceeding the QASSIT guideline value. None of the samples tested returned S_{CR} values greater than 0.01 %S, indicating no PASS.
- Where the total actual acidity (TAA) value exceeds 18 mol/t then the soil has an acidity level exceeding the QASSIT guideline value. Only one (Bore 83 at 0.25 m depth) of the six samples tested from the bores returned a TAA values greater 18 mol/t indicating the presence of acidity.
- Where the sulfur in KCl extract values (SKCl) is less than 0.02 %S, then the soil has little or no history of sulfide oxidation. A low SKCl combined with a low SCR indicates the soil is not an acid sulfate soil and further development of acid is likely to be low. All of the samples tested returned SKCl values less than 0.01%S.

Generally, the action criterion from the chromium suite of tests, which triggers a requirement for ASS disturbance to be managed, derived from the Soil Management Guidelines and the Laboratory Methods Guidelines 2003 are as follows:

- Net Acidity (TAA + S_{CR} + S_{NAS} – ANC/1.5) of greater than or equal to 0.03.% S for soils greater than 1000 tonnes of disturbance.

The limited laboratory test results indicate that the samples tested are slightly acidic. However, the measured acidity is not likely to be attributed to sulfides, but rather naturally occurring acidity.

7.6.3 Management and Treatment of Acidic Soils

The extreme pH changes that occur upon sulfidic oxidation (eg. oxidation of PASS) are often what cause the damage to a previously neutral environment and its surrounds. The acidity found naturally is not damaging to the environment and indeed the ecology. Some environments are naturally acidic and support ecologies adapted to those acidic conditions. Therefore, it is recommended that naturally occurring acidic materials should not be treated in order to remediate the pH.

However it is recommended that appropriate management of the natural acidity is carried out to reduce the risks of environmental impact in order to comply with the *general environmental duty* where appropriate.

8. References

1. Ahern, C R, Ahern, M R, and Powell, B, “Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998”, QASSIT, Department of Natural Resources, Resources Sciences Centre, Indooroopilly, October 1998.
2. Dear, S E, Moore, N G, Dobos, S K, Watling, K M, and Ahern, C R, “Soil Management Guidelines” in “Queensland Acid Sulfate Soil Technical Manual”, Department of Natural Resources and Mines, Indooroopilly, November 2002.
3. Ahern, C R, Sullivan, L A, and McElnea, A E “Laboratory Methods Guidelines 2003 – Acid Sulfate Soils” in “Queensland Acid Sulfate Soil Technical Manual”, Department of Natural Resources and Mines, Indooroopilly, August 2003.
4. Australian Standard AS 3798-2007 “Guidelines on Earthworks for Commercial and Residential Developments”, Standards Australia.
5. Australian Standard AS 2870-2011 “Residential Slabs and Footings”, Standards Australia
6. Fox E, “A Climate-Based Design Depth of Moisture Change Map of Queensland and the Use of Such Maps to Classify Sites Under AS 2870-1996”’ Australian Geomechanics, Vol 35, No 4, December 2000.
7. Australian Standard AS 2159-2009 “Piling – Design and Installation”, Standards Australia
8. Australian Standard AS 4678-2002, “Earth Retaining Structures” Standards Australia.

9. Limitations

Douglas Partners Pty Ltd (DP) has prepared this geotechnical report for Precincts 7 – 15 of the proposed residential subdivision at 167 Bells Creek Road, Bells Creek. This report is provided for the exclusive use of Stockland Development Pty Limited 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 the subsurface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface 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 testing has been completed.

This report must be read in conjunction with all of the attached notes 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 a factual report for interpretation by others rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

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.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

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.

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Additional Geotechnical Investigation

Proposed Subdivision
Aura Precincts 6-16, Bells Creek

Prepared for
Stockland Development Pty Ltd

Project 80967.05
August 2017



Douglas Partners
Geotechnics / Environment / Groundwater

Document History

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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		21 August 2017
Reviewer		21 August 2017

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Report on Additional Geotechnical Investigation
Proposed Subdivision
Aura Precincts 6-16, Bells Creek

1. Introduction

This report presents the results of an additional geotechnical investigation carried out by Douglas Partners Pty Ltd (DP) for Precincts 6 to 16 (the site) as part of the Aura development.

The investigation was undertaken at the request of Stockland Development Pty Limited (Stockland) following authorisation to proceed received on 4 July 2017, and was undertaken in general accordance with DP's proposal SSC170177 dated 30 June 2017.

DP previously undertook a broadscale geotechnical investigation for the proposed development in 2014. The aim of this additional geotechnical investigation is to provide additional information and provide greater coverage across the site to assist with the detailed earthworks planning. The results of the previous investigation have been used to supplement this additional investigation and been included for completeness where relevant.

This investigation comprised the drilling and sampling of 55 bores followed by laboratory testing, engineering assessment and reporting. The details of the field work and laboratory testing are presented in this report.

This report must be read in conjunction with the notes entitled "About This Report" in Appendix A along with any other attached explanatory notes and should be kept in its entirety without separation of individual pages or sections.

2. Site Description

Precincts 6 to 16 as part of the Aura development is centrally located as part of the overall development and is bounded by the northern tributary of Bells Creek to the north, Bells Creek to the south, the future alignment of Bells Creek Arterial Road to the east and the Bruce Highway to the west (refer Drawing 1 in Appendix B).

Broadly, the area is gently undulating of low relief, with the ground surface overall falling gradually from west to east with several localised knolls associated with the larger trending ridgeline on the western side of the Bruce Highway.

3. Regional Geology

Reference to the Geological Survey of Queensland's 1:100,000 series maps indicate that Precincts 6 to 16 is occupied by two geological units. The low lying areas generally consist of Quaternary aged floodplain alluvium which typically comprises *"clay, silt, sand, gravel".* The remaining elevated areas consist of the Triassic to Jurassic aged Landsborough Sandstone formation typically comprising *"Lithofeldspathic labile and quartzose sandstone, siltstone, shale, minor coal, ferruginous oolite marker".* The alluvium is expected to be underlain by the Landsborough Sandstone formation.

The natural subsurface conditions encountered typically during the field work generally comprised silty and clayey sands overlying sandy clays, with sandstone encountered locally at depth. The upper sand and clay soils are inferred to alluvial soils, with the lower clays likely to be residual soils derived from the underlying sandstone.

4. Field Work Methods

The field work as part of the initial geotechnical investigation carried out in early 2014 comprised the drilling and sampling of 40 bores (designated Bores 47 to 86) within the area of Precincts 6 to 16. As part of this investigation, an additional 55 bores (designated Bores 138 to 198) were drilled between 13 July and 4 August 2017. Proposed bore locations 153, 159, 163, 164, 165 and 170 were not accessible at the time of the investigation due to soft, boggy conditions and/or vegetation.

The bore locations were set out by experienced geotechnical personnel at the time of the investigation, with locations recorded using a hand held GPS. The approximate bore locations are indicated on Drawings 2 to 6 in Appendix B.

The bores were drilled using a 4WD mounted Jacro 200 drilling rig using continuous flight augers fitted with a tungsten carbide (TC) bit. Dynamic cone penetrometer (DCP) tests were carried out within the bores in order to assess the relative consistency of the subsurface soils.

Strata identification was undertaken through observation of cutting returns and recovered samples. On completion, the bores were observed for groundwater seepage and then backfilled with spoil tamped into the holes.

The field work was undertaken by experienced geotechnical personnel who logged the bores and collected samples for visual and tactile assessment and for subsequent laboratory testing.

5. Field Work Results

The subsurface conditions encountered in the bores are described in detail on the borehole logs in Appendix C, together with notes defining the classification methods and descriptive terms used. The depths were measured below existing surface levels at the time of investigation.

In summary, the subsurface conditions encountered in Precincts 6 to 16 generally comprised localised filling and topsoil overlying silty and clayey sands. In the eastern, low-lying part of the site, the sands were encountered to the termination of bores (in areas of proposed filling) at 3 m depth with interbedded layers of sandy clay locally. In the western, elevated parts of site, silty sand was encountered typically to between 1 m and 2 m depth, overlying sandy clay which continued to termination of bores (in areas of proposed cut) at 6 m depth.

The relative density of the sands was typically very loose to loose in the upper 1 m depth, grading medium dense with depth. Dense to very dense sands were encountered locally, typically at depth.

The strength consistency of the sandy clay encountered in the bores was typically stiff to very stiff. Firm, water softened clays were encountered locally at the sand/clay interface or where groundwater seepage was encountered.

As part of the initial investigation, ironstone was encountered in Bore 53 below 2.6 m depth. The ironstone was extremely weathered in parts. Very low strength sandstone was encountered in Bore 79 below 0.55 m depth and in Bore 84 below 4.45 m depth. The sandstone in Bore 79 graded low strength at 1.4 m depth where auger refusal was achieved at the time of investigation.

During the initial investigation, groundwater seepage was typically encountered between 1.2 m and 2.55 m depth within the sands or/and along the sand/clay interface. During this additional investigation groundwater seepage was generally encountered perched in the upper sands between 0.15 m and 0.6 m depth and at depth locally typically within the clays approximately 3.4 m to 4.55 m depth where ironstone gravel was encountered. It was noted that groundwater levels are affected by climatic conditions and soil permeability, and will therefore vary with time.

6. Laboratory Testing

6.1 Shrink-Swell

Shrink-swell index tests were carried out on selected 'undisturbed' recovered from the bores, as well remoulded bulk samples recovered from the bores within the same strata. The results of the testing are summarised in Table 1 with detailed material test reports in Appendix D.

Table 1: Results of Shrink-Swell Testing

Bore No.	Depth (m)	Material	Unit Weight (t/m^3)	FMC (%)	Shrinkage (%)	Swell (%)	Shrink-Swell Index (% per ΔpF)
64	1.0	Silty sandy clay	2.22	10.2	0.3	0.0	0.2
64	0.6-1.0*	Silty sandy clay	2.10	11.1	1.6	0.1	0.9
66	1.5	Sandy clay	1.97	23.9	3.6	2.5	2.7
66	1.3-1.6*	Sandy clay	1.94	18.3	1.9	2.8	1.8
73	0.95-1.3*	Silty sandy clay	1.94	18.0	1.9	0.6	1.2
74	1-1.1	Gravelly clayey sand	1.84	21.6	3.1	0.0	1.7
74	1-1.5*	Gravelly clayey sand	2.07	16.8	0.8	0.2	0.5
84	1.0	Silty sandy clay	1.98	23.9	3.6	2.5	2.7
84	0.8-1.2*	Silty sandy clay	1.90	20.4	3.0	2.6	2.4
160	3.0-3.19	Sandy clay	2.00	20.4	2.6	1.0	1.7
167	1.5-1.65	Sandy clay	1.96	21.7	3.4	2.6	2.6
176	1.5-1.66	Clayey sand	2.12	27.6	2.4	0.0	1.3
184	2.0-2.13	Sandy clay	1.97	23.8	3.4	2.9	2.7
187	2.0-2.2	Sandy clay	1.93	24.1	3.0	1.8	2.2
190	4.5-4.76	Sandy clay	1.83	30.3	5.8	0.1	3.3
191	1.5-1.7	Sandy clay	1.95	25.0	3.2	2.3	2.4

Notes: * = bulk sample remoulded near 98% Standard compaction at near optimum moisture content
FMC = Field moisture content

6.2 Plasticity and Particle Size Distribution

Selected samples recovered from the bores were tested in the laboratory for engineering properties of plasticity and particle size distribution for classification purposes. The results of this testing are summarised in Table 2 with detailed material test reports in Appendix D.

Table 2: Results of Plasticity and Particle Size Distribution Testing

Bore No.	Depth (m)	Material	FMC (%)	Plasticity				Particle Size Distribution (%)		
				LL (%)	PL (%)	PI (%)	LS (%)	Gravel	Sand	Silt/Clay
52	0.3-0.9	Silty sand	6.8	18	15	3	1.5	1	66	33
53	0.7-1.2	Silty sand	9.1	18	15	3	2.5	0	68	32
54	1.5-1.7	Silty sand	-	16	14	2	1.0	0	81	19
55	0.8-1.4	Gravelly clayey sand	10.3	41	16	25	11.5	21	53	26
58	1.0-1.4	Silty sand	-	-	-	NP	0.2	0	85	15
63	1.6-1.9	Gravelly clayey sand	-	32	15	17	10	22	48	30
64	0.6-1.0	Silty sandy clay	13.7	30	11	19	11	0	49	51
65	0.2-0.6	Silty sand	-	13	11	2	0.5	0	70	30
66	1.3-1.6	Sandy clay	21.7	60	20	40	16.5	2	42	56
69	1.6-2.0	Sand	-	-	-	NP	0.0	0	96	4
72	0.75-0.9	Clayey sand	-	27	13	14	8.5	0	63	37
73	0.95-1.3	Silty sandy clay	18.6	54	19	35	15.5	1	47	52
74	1.0-1.5	Gravelly clayey sand	18.8	41	21	20	11	30	37	33
80	0.6-0.9	Sandy clay	-	23	10	13	8.0	0	49	51
84	0.8-1.2	Silty sandy clay	22.5	60	19	41	17	0	39	61
150	1.7-1.83	Gravelly clayey sand	16.3	46	26	20	10.0	35	33	32
150	1.65-2.1	Gravelly clayey sand	18.6	43	22	21	10.0	19	42	39
150	4.1-4.4	Sandy clay	18.3	73	23	50	17.5	1	38	61
157	2.9-3.4	Sandy clay	27.4	69	19	50	16.0	0	29	71
160	3.0-3.8	Sandy clay	29.6	60	22	38	14.5	3	46	51
166	1.6-1.9	Sandy clay/clayey sand	14.1	33	12	21	9.0	0	60	40
167	0.4-0.7	Silty sand	12.9	17	15	2	0.5	1	71	28
167	1.5-1.9	Sandy clay	14.9	49	15	34	14.0	0	54	46
169	2.1-2.4	Sandy clay	23.0	90	26	64	19.5	3	31	66
175	1.7-2.2	Sandy clay	20.1	62	18	44	16.5	1	56	43

Table 2 Cont'd: Results of Plasticity and Particle Size Distribution Testing

Bore No.	Depth (m)	Material	FMC (%)	Plasticity				Particle Size Distribution (%)		
				LL (%)	PL (%)	PI (%)	LS (%)	Gravel	Sand	Silt/Clay
176	1.25-1.6	Clayey sand	17.5	40	17	23	10.5	8	49	43
184	0.8-1.3	Clayey sand	13.1	29	16	13	5.5	0	63	37
186	5.5-5.9	Sandy clay	27.5	89	23	66	19.5	0	35	65
187	1.5-2.0	Sandy clay	23.1	43	16	27	10.0	0	50	50
190	3.6-4.5	Sandy clay	36.8	65	22	43	16.0	0	43	57
196	1.1-1.4	Sandy clay	23.2	70	20	50	17.0	1	41	58
198	1.35-1.8	Sandy clay	28.7	86	27	59	19.0	1	32	67

Where FMC = Field Moisture Content, LL = Liquid Limit, PL = Plastic Limit, PI = Plasticity Index, LS = Linear Shrinkage, NP = Non-plastic

6.3 Compaction and Soaked CBR

Standard compaction and single point soaked California bearing ratio (CBR) tests were undertaken on selected bulk samples recovered from the bores. The samples were first screened over the 19 mm sieve, as required by the test standard, and were then compacted to 98% Standard dry density ratio at near to optimum moisture content (OMC). The samples were soaked for four days under a 4.5 kg surcharge.

The results of the compaction and CBR testing are summarised in Table 3 with detailed material test reports in Appendix D.

Table 3: Results of Compaction and CBR Testing

Bore No.	Depth (m)	Material	FMC (%)	OMC (%)	MV (%)	MDD (t/m^3)	Swell (%)	CBR (%)
52	0.3-0.9	Silty sand	6.8	11.0	-4.2	1.94	0.4	13
53	0.7-1.2	Silty sand	9.1	11.0	-1.9	1.94	0.4	18
55	0.8-1.4	Gravelly clayey sand	10.3	10.4	-0.1	2.01	0.6	9
64	0.6-1.0	Silty sandy clay	13.7	11.9	1.8	1.93	1.0	7
66	1.3-1.6	Sandy clay	21.7	19.1	2.6	1.68	5.0	2.5
73	0.95-1.3	Silty sandy clay	18.6	19.3	-0.7	1.68	2.1	7
74	1.0-1.5	Gravelly clayey sand	18.8	17.6	1.2	1.83	0.5	9
84	0.8-1.2	Silty sandy clay	22.5	21.9	0.6	1.61	3.7	2.5
150	1.65-2.1	Gravelly clayey sand	18.6	15.0	3.6	1.87	0.0	18
160	3.0-3.8	Sandy clay	29.6	17.0	12.6	1.73	5.0	2.0
167	1.5-1.9	Sandy clay	14.9	14.5	0.4	1.80	2.5	3.0
176	1.25-1.6	Clayey sand	17.5	14.0	3.5	1.85	0.5	9
184	0.8-1.3	Clayey sand	13.1	12.5	0.6	1.90	0.0	14
187	1.5-2.0	Sandy clay	23.1	15.5	7.6	1.77	8.0	0.5
190	3.6-4.5	Sandy clay	36.8	18.5	18.3	1.69	6.0	2.0
198	1.35-1.8	Sandy clay	28.7	21.5	7.2	1.67	6.5	1.0

Where FMC = Field Moisture Content; MV = Moisture Variation (FMC-OMC); MDD = Maximum Dry Density, OMC = Optimum Moisture Content

6.4 Dispersivity

Emerson class dispersion tests were performed on selected disturbed samples recovered from the initial investigation. The results are summarised in Table 4 with detailed material test reports in Appendix D.

Table 4: Results of Dispersivity Testing

Bore No.	Depth (m)	Material	Emerson Class
52	0.3-0.9	Silty sand	5
53	0.7-1.2	Silty sand	5
55	0.8-1.4	Gravelly clayey sand	6
64	0.6-1.0	Silty sandy clay	6
66	1.3-1.6	Sandy clay	6
73	0.95-1.3	Silty sandy clay	6
74	1.0-1.5	Gravelly clayey sand	6
84	0.8-1.2	Silty sandy clay	6

6.5 Agronomy

Agronomical testing was carried out by Bio-Track Pty Ltd on selected topsoil samples recovered from the bores. The results of the testing, along with an interpretive report by the laboratory is included in Appendix D. In summary, the report suggests the topsoil material has been leached of any significant nutrient value and the addition of fertilizer would be required.

6.6 Groundwater

Groundwater seepage was encountered in a number of the bores during this investigation. Field parameters were measured in the field using an Aquaread water quality meter in selected bores where groundwater seepage was encountered. The results are summarised in Table 5.

Table 5: Results of Groundwater Field Testing

Bore No.	pH	EC (µS/cm)	DO (% Sat)	TDS (mg/L)
158	6.5	425	66	274
168	6.4	221	72	144
189	6.3	252	81	163
191	6.3	160	-	103

7. Comments

7.1 Earthworks

7.1.1 Trafficability

The field work for the initial investigation was carried out following a period of favourable dry weather conditions and trafficability was considered to be good for the 4WD mounted drill rig. However, the field work for this investigation was carried out following less favourable weather conditions and trafficability was restricted in parts of the site with the upper silty sand material being wet and boggy. Proposed bore locations 153, 159, 163, 164, 165 and 170 were not accessible at the time of the investigation due to soft, boggy conditions and/or vegetation, with the drilling rig getting bogged at Bore 181 and at other locations between bores. A number of the bores were also shifted from their original proposed locations to locations which were accessible at the time.

The subsurface conditions encountered on site typically comprise silty and/or clayey sands overlying relatively impermeable clays at shallow depth. Following periods of wet weather, it is expected that moisture will tend to be perched in the upper sands above the clays and along the sand/clay interface. It should be noted that the silty and clayey sands in wet conditions are sensitive to vibrations or trafficking from heavy equipment and will lose strength.

Groundwater seepage was also encountered at depth within the bores, particularly where ironstone gravel was encountered within the clays. The underlying clays will also soften during prolonged wet weather or changes in moisture condition.

Rubber tyred vehicles in particular will have trafficability problems during and after periods of rainfall or other increases in subgrade moisture content as encountered during this recent investigation. In some cases tracked plant may also experience some difficulty especially in areas where silt is at or near the surface.

It will be essential to keep the site well drained during construction. The installation of drains to intercept seepage and facilitate drying out will be required should construction commence during or following an extended period of wet weather.

Conditioning of wet silty and clayey sands is typically difficult to achieve during periods of prolonged and intermittent rainfall events, where the moisture content of the subsurface soils are continually allowed to be kept saturated from surface infiltration (eg.rain) as well as subsurface seepage. Drying out of the silty and clayey sands using surface and subsurface drains may take considerable time of favourable weather conditions with little or no rainfall before any positive effect is achieved. Unfavourable, cooler climatic conditions (eg.winter) will also make the drying out process more difficult and lengthy to achieve.

Where filling is proposed, significant works to ‘bridge’ over these weakened soils using overburden gravel material, or rock filling, would be required if weather conditions are unfavourable. A granular working platform in low lying and poorly drained areas may also need to be considered.

7.1.2 Stripping

Any deleterious, soft, wet or highly compressible material or topsoil material rich in organics or root matter should be removed and only be reused as landscaping. Depth of topsoil (eg. stripping depth) was measured to between 0.1 m and 0.6 m (average 0.2 m). The variance in the topsoil thickness is due to the surface rutting from the previous use as pine forestry plantation with topsoil thickness generally greater at the crest of the rutting and in the low lying parts of the site to the east.

It is suggested that an average 0.2 m stripping depth be allowed in estimates for the works. Stripping and grubbing depths due to the previous use as pine forestry plantation may vary significant locally in order to remove all root matter. Deep tyning (typically 0.3 m) of subgrade is recommended to detect grubbing depths to remove roots. Stripping depths will also varying in low-lying, poorly drained areas as well.

It is recommended that the stripped surface be inspected prior to commencing any filling operations.

7.1.3 Excavation

Based on the conditions encountered the subsurface conditions typically encountered silty and clayey sands, and stiff to hard sandy clay. Sandstone was encountered locally in Bores 79 and 84 as part of the initial investigation. It is estimated that excavation of the natural soils and extremely low to very low strength sandstone could be undertaken using medium sized earthmoving equipment, such as drotts, backhoes or 15-20t (or larger) excavators.

Scrapers would likely need dozer push loading by dozers in the very stiff (or stronger) clays and sandstone with pre-ripping to assist with production rates. Low strength materials (if encountered) would be more difficult to excavate (especially in confined excavations) and could require a larger excavator (30t+) with tiger teeth buckets with slowed excavation rates.

Excavations in the low strength sandstone will require larger equipment (eg. up to 30t excavators) fitted with a ripping tyne and/or rock breaker tools for confined trench excavations.

The assessment of excavation characteristics of soil has been based on the depth of penetration of the drilling rig using various bit attachments, which are attached to the solid spiral flight augers. It should be recognised that the excavatability estimates are based on materials encountered at the bore locations only and that conditions may prove more difficult (or easier) for excavatability beyond these bore locations and the depths drilled as part of this investigation.

7.1.4 Batter Slopes

Near vertical temporary excavations less than 1.5 m depth in dry, stiff (or stronger) clays are likely to be suitable for the short term installation of underground services provided there are no sensitive services or structures, or vehicular trafficked areas close to the excavation.

It should be noted that excavations in wet sands have the potential to ‘collapse’ unexpectedly in a trenching situation, particularly where groundwater seepage is encountered.

It is recommended that excavations in wet sands and all trench excavations deeper than 1.5 m be either positively supported (eg. shoring boxes, sheet piles, etc), benched or battered in combination with dewatering (if required) whenever personnel are to enter the trench.

Suitable unsurcharged temporary and permanent dry cut batter slopes for excavations up to 3 m in height are presented in Table 6. Where water seeps from the faces, batters will need to be considerably flatter.

Table 6: Batter Slopes

Material	Safe Batter Slope (H:V)	
	Short Term	Long Term
Engineered filling* or natural sands	1.5:1	2:1
Natural stiff (or stronger) clays	1:1	2:1
Extremely low (or stronger) strength rock	1:1	1.5:1

Notes: * Depends on fill material type and level of compaction. Assumes a clayey fill material compacted under 'Level 1' Inspection and Testing.

For cuts greater than 3 m in depth, permanent slopes should be constructed at no steeper than 2.5H:1V.

Filled batters should also be overfilled and then cut back to the required design batter angles. This will provide greater stability of the filling and allow for adequate compaction to be achieved throughout the full depth of the filling.

The above temporary batter slopes are suggested with respect to slope stability only, and do not allow for lateral stress relaxation which may result in movement of nearby inground services or shallow footings. If such services or footings are settlement sensitive, and are located near the crest of the cut face, then the excavation may have to be positively supported.

Long term slopes may need to be flattened to 3H:1V or less, in order to allow vehicle access for maintenance of grass. It is recommended that all batters incorporate crest and toe drainage leading runoff into concrete lined longitudinal drains to reduce the risk of erosion of the batters. The batters should also be covered with topsoil and vegetation to provide long term erosion protection.

7.1.5 Re-Use of Cut Materials

It is considered that the majority of materials won from excavations on site, free of any organic and deleterious material, will generally be suitable for reuse as bulk filling provided the moisture content of the soils on placement approximates the optimum moisture content (OMC).

Soils containing organic and deleterious matter should be stripped from the construction area and stockpiled for landscaping purposes or spoiled from site. This material is not considered suitable for reuse as structural filling. Revegetation of borrow pits, batters and all exposed soils should be undertaken as the earthworks progress, using the topsoil and mulch salvaged during the initial clearing process.

The results of the laboratory testing indicate that the samples tested as part of this investigation were mostly wet of OMC. Difficulties with trafficability and workability are expected where material are too far over optimum. Materials which are up to 2% to 3% wet of OMC may be reused immediately as during the course of excavation, handling and placement of these material will dry out to some extent. However, wet silty and clayey sand or clayey materials greater than 3% to 4% wet of OMC are considered unsuitable for immediate reuse as controlled filling without being appropriately moisture conditioned (eg. dried back to near optimum moisture content). To facilitate drying out of any wet material, the material would need to be tyned and exposing the surface material to sun and wind or mixed with dry suitable materials won from excavations on site. These processes involve a considerable amount of double handling and favourable weather conditions.

For borrow areas where groundwater seepage is encountered, attention must be given to pit design and excavation methods to allow for adequate drainage outfall both within, and from, the borrow pit. Otherwise, the pit may be inundated by groundwater seepage or from rainfall. Where this occurs, the direction of pit operation and floor level control may be relevant in preventing water from ponding in the pit base.

It is also recommended that the cohesive material be placed at depth and granular material or weathered rock (if available) be placed close to subgrade level. This will reduce the effects of seasonal moisture change and foundation soil reactivity, and will also improve subgrade CBR for roads.

Filling should not be allowed to be stockpiled for extended periods of time following excavation prior to placement as structural filling without moisture conditioning.

7.1.6 Compaction

Prior to the placement of filling, the stripped surface should be test rolled using a smooth drum roller with a minimum static weight of 12-tonne to detect the presence of any soft or loose spots. Areas demonstrating excessive movement under test rolling will be required to be either tyned, dried and recompacted or removed and replaced with compacted select filling. Treatment should be to a standard sufficient so that the subgrade passes test rolling and that compaction can be achieved in the first layer of filling.

Approved bulk filling should be placed in layers not exceeding 0.3 m ‘loose’ thickness, with each layer compacted to a minimum dry density ratio of 95% relative to Standard compaction in proposed residential areas and 98% relative to Standard compaction in any proposed commercial areas. Where filling has significant clay content, moisture content within the filling should be maintained within 2% of OMC during and after compaction. The upper 0.3 m of pavement subgrade and unbound pavement gravels should be compacted to a minimum dry density ratio of 100% relative to Standard compaction and to within the same moisture content range as given above.

Care should be taken not to over-wet clayey soils as this can lead to problems associated with trafficability and workability. Clayey soils should not be over-compacted (eg. not more than 102% Standard) or placed too dry of OMC, as this can lead to future swelling and softening with changes to moisture content or inundation from water.

It is recommended that where filling is to be carried out over sloping ground (exceeding 10H:1V in slope), the slope should be benched to allow for the filling to be 'keyed' into the existing batters. These procedures will provide greater stability of the filling and allow for adequate compaction to be achieved throughout the full depth of the filling. Filled batters should also be overfilled and then cut back to the required design batter angles in order to maximise compaction of the material in the batter faces.

Field density testing should be carried out to confirm the standard of compaction achieved and the placement moisture content has been achieved. The frequency of testing should be carried out in accordance with AS 3798-2007 (Ref 1) and distributed reasonably evenly throughout the full depth and area of filling.

To ensure adequate performance of the earthworks, careful Level 1 inspection and testing of filling must be undertaken by an experienced Geotechnical Inspection and Testing Authority (GITA) where the filling is to support buildings, pavements or settlement sensitive structures. The GITA needs to have competent personnel on site at all times while earthworks operations are undertaken. Because of the significant engineering implications for the earthworks, it is recommended that the GITA be required to include an experienced geotechnical engineer (with RPEQ registration) to oversee the inspection and testing. DP is suitably qualified to conduct earthworks testing and supervision services that will be required during earthworks construction.

7.1.7 Volume Change and Settlement

Volume change is to be expected upon excavation and compaction of material, compared to the insitu volume of the material.

Excavation increases the volume of material during handling and stockpiling. The increase in volume (from ‘insitu’ to ‘loose’) is commonly referred to as the ‘bulking factor’. For clays, the bulking factor is typically between 1.3 and 1.4, between 1.2 and 1.3 for sands, and between 1.4 and 1.6 for weathered sandstone.

Similarly, compaction results in a decrease in material volume. The compaction factor is the ratio of the insitu dry density to the maximum dry density. Based on the laboratory test results, the insitu dry density ranged between 1.4 t/m^3 and 2.0 t/m^3. The maximum dry density relative to Standard compaction varied between 1.6 t/m^3 and 2.0 t/m^3. The volume changes expected for the various soil types are shown in Table 7.

Table 7: Compaction Characteristics

Material	Bank Volume	Dried and Compacted Volume	Other losses	Compaction Factor
Stiff (or stronger) clays	1.0	0.90 – 0.95	0.05	0.85 – 0.90
Silty/Clayey sands	1.0	0.85 – 0.9	0.03 – 0.05	0.80 – 0.85
Weathered sandstone	1.0	1.05-1.20	0.05 – 0.1	1.0 – 1.10

The above compaction factors are based on experience with similar conditions. These are estimates only and planning should allow for some variability in this factor (say+/- 0.1).

Where bulk filling is placed under controlled conditions, there is potential for 'creep' of the filling material as it settles over time under self-weight. Estimates of creep settlement of bulk filling under self-weight will vary in accordance with the depth of filling. This may lead to differential settlements where filling thickness are varied, such as over existing sloping ground.

Potential movements for such controlled filling are estimated as a percentage of the layer thickness. Such settlement may be in the order of 0.5% to 1% of the filling thickness. This range is presented for sensitivity checks and is dependent upon the nature of the filling. Where the filling predominately comprises granular materials, a lower percentage is appropriate, and where the filling predominately comprises clayey material, a higher percentage is appropriate.

Typically, about half of the creep settlement in well compacted filling occurs within about one year of placement and most of the remainder over a period of about 10 to 20 years.

7.1.8 Potential for Soil Dispersion

Emerson class tests provide an indication of potential dispersivity. The Emerson class test involves the observed behaviour of an air-dried crumb of soil placed in distilled water. Based on whether the soil crumb breaks up (eg. slakes) and/or disperses is classified a number from 1 to 8, where 1 is the most dispersive and 8 the least dispersive.

Emerson class dispersion tests generally indicate the samples tested to have slight potential for erosion with Emerson class numbers of 5 and 6.

Some silty soils, while not classified as dispersive, may actually slake readily and as such are susceptible to piping, tunnelling and scouring erosional process.

It is recommended, as a minimum, erosion control measures during bulk earthworks construction and final design should include the following:

- ensure erosion and sediment control measures are in place prior to works commencing;
- stage works to minimise the area and the duration of exposure at any given time, including exposure to seasonal weather;
- stage works to install the permanent drainage network as soon as practical;
- divert water away from disturbed areas;
- divert clean water offsite at non-erosive velocities, minimising stormwater runoff velocities;
- direct site runoff to stabilised outlets designed for expected peak velocities;
- undertake stabilisation of temporary and permanent channels;
- undertake roughening of disturbed areas to encourage infiltration;
- develop a program for progressive revegetation and maintenance of exposed areas as they are completed; and
- provide erosion control blankets and other methods depending on the steepness of slope and soil type.

7.2 Reactivity and Site Classification

The results of the laboratory testing were input into Douglas Partners' in-house program *REACTIVE*, to calculate the characteristic surface movement value (y_s) in general accordance with AS 2870-2011 (Ref 2). It should be noted that AS 2870-2011 provides recommended values of change in suction (Δ_u) and depth of suction (H_s) for major and regional centres throughout Australia. However, based on published data by Fox (Ref 3), relating climatic conditions to suction, a value of 1.2 pF was adopted for Δ_u and 1.5 m for H_s in the *REACTIVE* calculations. This is based on a "wet coastal" climatic zone.

A cracking depth of 0.75 m based on $0.5H_s$ was also used in the analysis for natural soils in their current state. The designer should also consider the effects of earthworks on site classification (eg. reduced cracking depth).

The results of the analysis indicate that, provided 'abnormal' soil moisture conditions are not experienced, y_s values for the silty sand on site are calculated to typically be less than 20 mm, consistent with 'Class S' conditions. For a full clay profile in areas of filling and/or cut with a reduced cracking depth, y_s values are calculated to typically be in the order of 30 mm to 55 mm, consistent with 'Class M' and 'Class H1' conditions. These values would be reduced where the thickness of clay is reduced by placing non-reactive filling material (ie. a maximum shrink-swell index value (Iss) of 1.0% per pF or less) over the clays or where weathered sandstone is encountered within the upper 1.5 m.

If 'abnormal' soil moisture conditions are experienced at the site, the site classification would change to 'Class P' (problem site) which would require more extensive foundation works or could result in adverse foundation performance. 'Abnormal' soil moisture conditions are defined in AS 2870 (Clause 1.3.3) and in summary comprise:

- Recent removal of buildings or structures likely to affect soil moisture conditions;
- Unusual moisture caused by drains, channels, ponds, dams or tanks;
- Recent removal of large trees;
- Growth of trees too close to a structure;
- Excessive or irregular watering of gardens adjacent to the structure;
- Lack of maintenance of site drainage;
- Failure to repair plumbing leaks.

It should be noted that no assessment of the effect of soil moisture change by trees has been made in estimating the above y_s values (either with respect to the removal of established trees prior to development of building pads, or the proximity of established or new trees to proposed buildings). Reference to the requirements in AS 2870 should be made by the building designer in this regard. It should be further noted that the presence or removal of trees can result in additional surface movement, due to tree-induced suction changes and tree-induced centre heave. Such tree-induced movement is not included in the y_s calculations used to classify the site.

7.3 Foundations

The extent of earthworks and the choice of footings will depend on development loads and what is considered acceptable in terms of settlement and cost.

Provided that site preparation is carried out in accordance with the recommendations in this report, otherwise with good practice, it is considered that high level pad and/or strip footings founded in either controlled engineered filling or natural soils be adopted. Slabs supported on high level foundations should be stiffened to suit the expected ground surface movements.

Based on the ground conditions encountered within the bores, high level footings may be preliminary designed for an allowable bearing pressure of 100 kPa for engineered filling or competent natural soils. Higher bearing capacities may be adopted where weathered rock is encountered. All footing excavations should be inspected and tested by an experienced geotechnical engineer from DP to confirm bearing pressures prior to casting of concrete.

Experience indicates that properly designed and constructed high level footings loaded as above are likely to undergo settlements in the order of 1% of the footing width.

7.4 Pavements

Subgrade conditions are expected to typically consist of controlled filling, natural silty and clayey sands, and sandy clays.

The results of the laboratory testing indicate soaked CBR values range between 0.5% and 7% for the sandy clays and between 9% and 18% for the silty and clayey sands.

The higher laboratory CBR values achieved in some of the sands are under ideal preparation and lateral confinement conditions experienced as part of the laboratory test method and are not likely to be achieved in the field. Therefore it is suggested that a maximum value of 10% be used for these sands based on experience with similar soils.

The low CBR value in the sandy clay is a result of the softened material that swelled following saturation. Swell values of between 2.5% and 8% were recorded for samples following soaking which returned CBR values of less than 3%. This saturated condition could occur in the long term if proper site drainage and maintenance procedures are not adopted. It is essential that sufficient drainage be installed and maintained in areas where there is potential for water to enter the subgrade.

It is recommended that a controlled subgrade be established over any untreated insitu subgrade material with a CBR value of less than 3%, or where swell values greater than 2.5% occur. A minimum cover of 0.6 m is recommended for swell values of between 2.5% and 5.0%, and up to 1.0 m for swell values greater than 5%.

Following the improvement to the subgrade, a modulus of subgrade reaction (k) of 25 kPa/mm or a CBR value of 3% could be used for design. Where no granular filling is placed over the silty clay subgrade, the lower bound CBR values are recommended. Soaked CBR testing will need to be carried out at the time of construction to confirm subgrade CBR design values.

For composite subgrades (eg. where imported filling is less than 1m thick) the Japan Road Association method of assessing a weighted subgrade strength should be used:

$$CBR_W = (D_F \times CBR_F^{0.33} + (1-D_F) \times CBR_S^{0.33})^3$$

where: CBR_W = weighted subgrade CBR (%)
D_F = depth of filling (m)
CBR_F = CBR of filling material (%)
CBR_S = CBR of natural subgrade (%)

Stabilisation of subgrade soils with lime may also be considered in order to increase CBR values, but also to reduce plasticity and movements due to changes in moisture content, and to reduce moisture sensitivity. For lime to be effective, the material being treated must contain clay particles or pozzolanic materials that will react with the lime. Generally, soils with a plasticity index of greater than 10 will respond better with the addition of lime. CBR values should be limited to a design CBR value of 10% following stabilisation with lime. Trials at the time of stabilisation will be required to determine the optimum liming rates, expected to typically range between 2% and 4%.

8. References

1. Australian Standard AS 3798-2007 “Guidelines on Earthworks for Commercial and Residential Developments”, Standards Australia.
2. Australian Standard AS 2870-2011 “Residential Slabs and Footings”, Standards Australia
3. Fox E, “A Climate-Based Design Depth of Moisture Change Map of Queensland and the Use of Such Maps to Classify Sites Under AS 2870-1996”’ Australian Geomechanics, Vol 35, No 4, December 2000.

9. Limitations

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The results provided in the report are indicative of the subsurface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface 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 testing has been completed.

DP's advice is based upon the conditions encountered 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.

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.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

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.

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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.

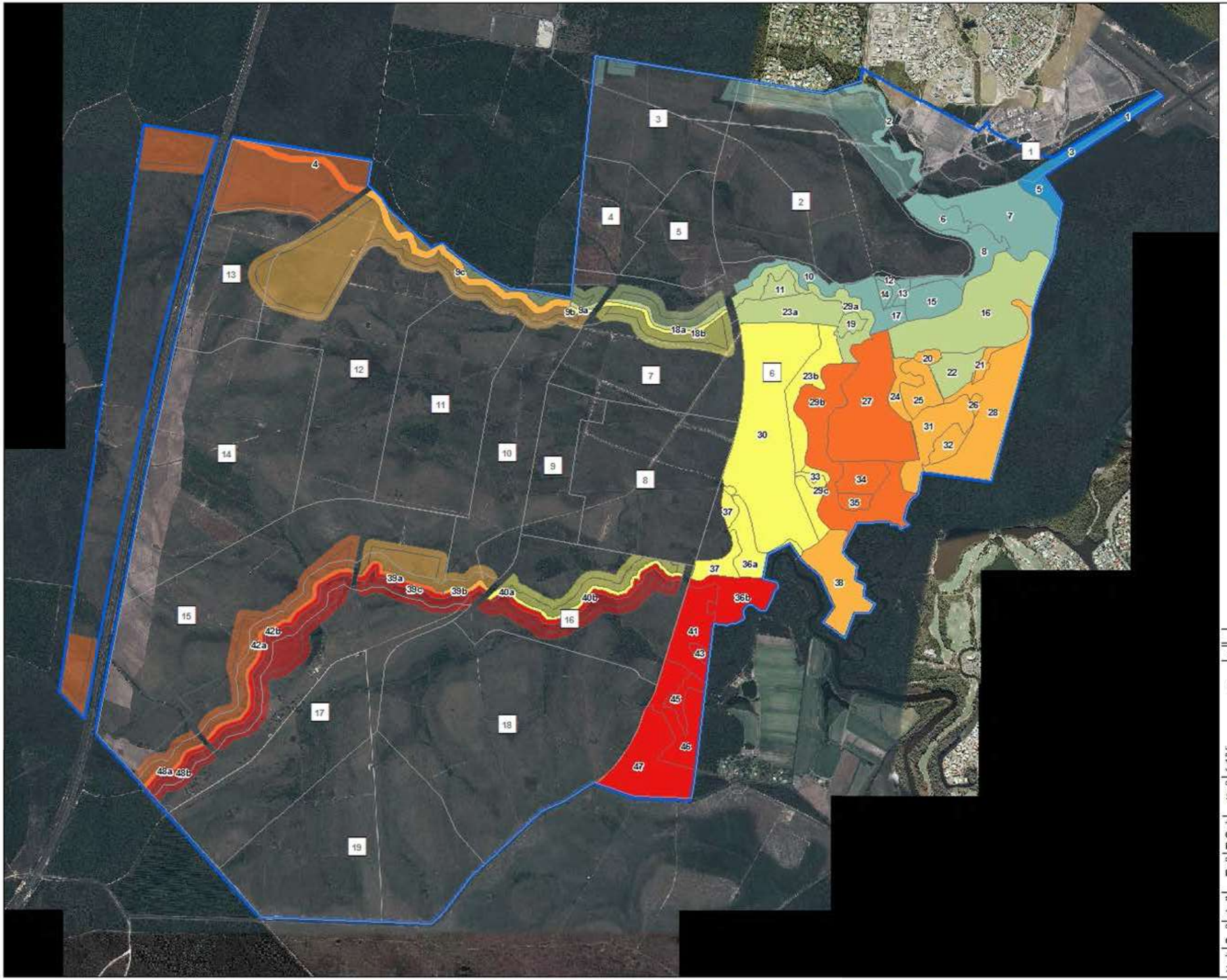
Site Inspection

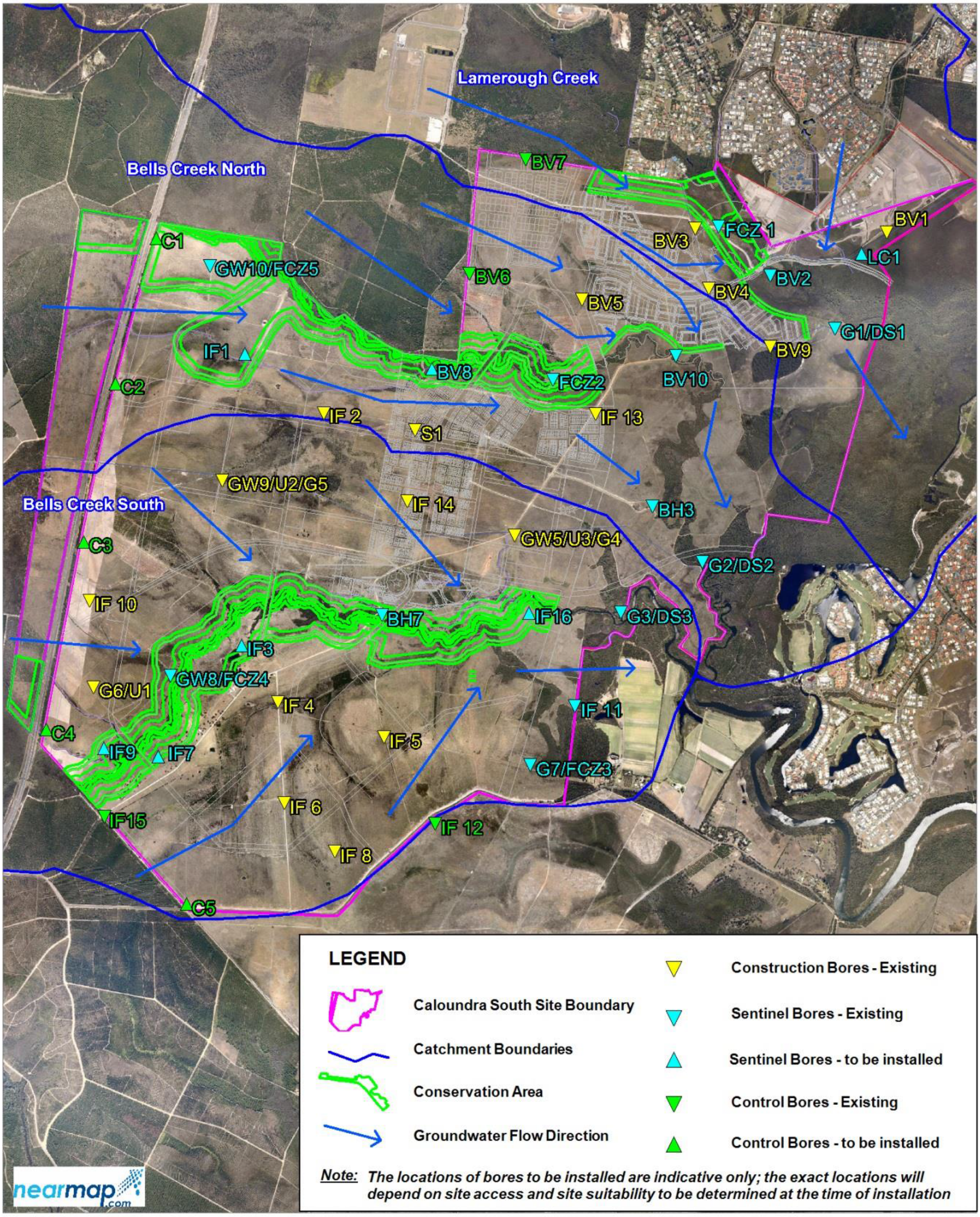
The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

AURA NORTH CENTRAL LOCATION PRECINCT 11 (PART) TO 12 (PART)

Appendix D Environmental

STOCKLAND DEVELOPMENT PTY LTD


Master Plan Precincts
Master Plan Boundary
HMU Precinct Stages
Stage 1: Precinct 1
Stage 2: Precinct 2
Stage 3: Precincts 3, 4, 5
Stage 4: Precincts 7, 8, 9
Stage 5: Precincts 10, 11, 12
Stage 6: Precincts 13, 14, 15
Stage 7: Precincts 17, 18, 19
Associated Frog Habitat
2
3
4
5
6
7
0 0.1 0.2 0.4 0.6 0.8 km
ARUP
Stockland
Caloundra South Ecological Enhancement Strategy
Habitat Management Units
1:23,299
For Information
GDA 1994 MGA Zone 56
222431-00
01



Title:

Groundwater Monitoring Bore Network

Figure: **5-3**

Rev: **A**

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N

0 km 0.5 1

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Aura Regional Flood Model - 2017 Revision - Addendum Report

Reference: R.B20047.025.02.Flooding_2017_addendum.docx
Date: October 2017
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Document Control Sheet

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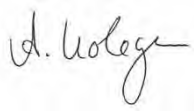
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Title:	Aura Regional Flood Model - 2017 Revision - Addendum Report
Project Manager:	Anne Kolega
Author:	Richard Sharpe
Client:	Stockland
Client Contact:	Paul McDonald
Client Reference:	

Synopsis: **This report documents inclusion of design refinements in the Aura regional flood model.**

REVISION/CHECKING HISTORY

Revision Number	Date	Checked by		Issued by	
0	13 October 2017	Anne Kolega		Richard Sharpe	
1	24 October 2017	Anne Kolega		Teegan Burke	
2	31 October 2017	Anne Kolega		Teegan Burke	

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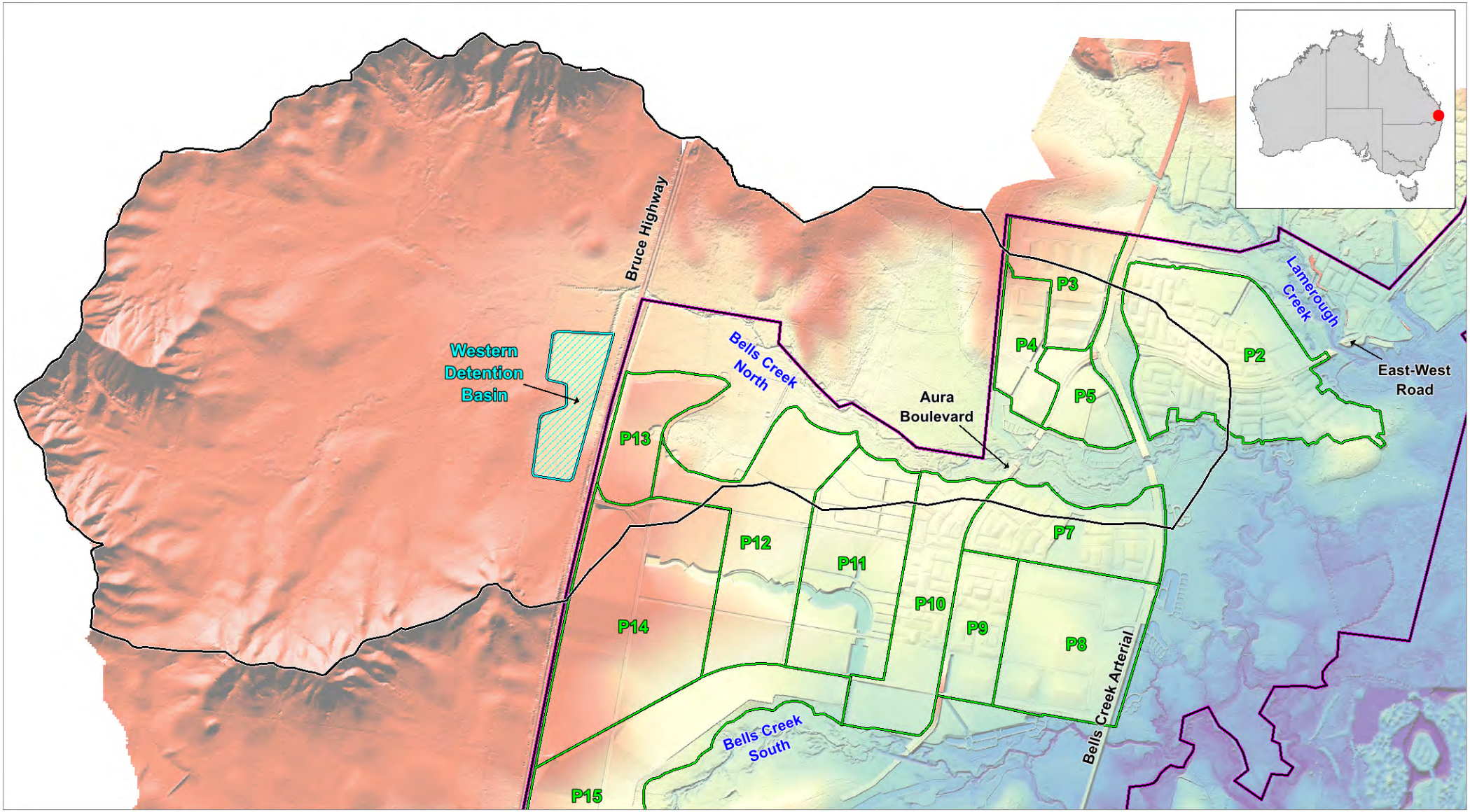
1 Introduction

In October 2015, BMT WBM issued a comprehensive report on regional flood modelling for Stockland's proposed Aura development: *Caloundra South Development: Flood Risk Management Strategy* (BMT WBM, 2015). The BMT WBM 2015 report was prepared in support of a Reconfiguration of Lot (RoL) application for the Aura Town Centre (Precincts 7-9, see Figure 1-1), and provided comprehensive documentation of the hydraulic and hydrologic model development and parametrisation.

The BMT WBM 2015 report was followed by a technical memo in August 2016 (*Aura Town Centre Revised Flood Modelling; from: Richard Sharpe, dated 23 August 2016*). The technical memo formed an addendum to the BMT WBM 2015 report, again in support of an RoL application for the proposed Aura Town Centre area. The technical memo documented the outcomes of the regional flooding assessment in light of revisions made to the proposed Aura Town Centre area. The technical memo and BMT WBM 2015 report were used as a basis for the approval, granted by EDQ in November 2016, for the proposed Aura Town Centre area.

Subsequent to the previous technical memo, substantial work has been undertaken on refining the regional flood model to bring the model up to date with the development design. The initial trigger for the refinement, was to provide design flood levels prior to tender for the detailed design for Precinct 3-5 area. Further revision was undertaken in support of further concept design on waterway crossings and drainage strategies for the Precinct 11-15 area. This 2017 addendum report documents the model and proposed design revisions, and the flood modelling outcomes. The report is intended to be an addendum to the BMT WBM 2015 report. For detailed information in regard to the regional flood modelling, that is not documented in this report, the reader is referred to the BMT WBM 2015 report.

Due to the project legacy, flood estimation used in the models is based on the 1987 revision of *Australian Rainfall and Runoff* and *CRC Forge*. For consistency with previous reporting, the Average Recurrence Interval (ARI) terminology is used in this report to describe flood magnitude and frequency.



Proposed Elevation (m AHD)

0 2 4 6 8 10 12 14 16 >18

Priority Development Area

Bells Creek North Catchment

Precinct Boundaries

Title:

Aura Site and Precinct Layout

Figure: 1-1

Rev: A

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2 Hydrologic Model Revisions

2.1 Overview

The hydrologic modelling has been revised periodically during the Aura project progression as more detail with regard to the proposed drainage design in the various precincts have been developed by Stockland's appointed civil designers. The 2016 technical memo summarised the latest updates to the hydrologic model in the Town Centre area (Precincts 7-10). No further revisions have been made to the hydrologic modelling in the Town Centre area.

Two new hydrologic models were developed using XP-RAFTS: one for the Precinct 2-5 area and another for the Precinct 11-15 area. The hydrologic models were set up to account for:

- The anticipated rainfall losses relating to the proposed land uses;
- The anticipated hard standing areas (percentage impervious) relating to the proposed land uses;
- The anticipated surface roughness relating to the proposed land uses; and
- The sub-catchment characteristics (area and slope) formed by the proposed drainage strategy and terrain.

The landuse and sub-catchment delineation is discussed in the following Sections. An overview of the adopted percentage impervious is listed in Table 2-1.

Table 2-1 Hydrologic Model Landuse Parameters

Landuse	Impervious
Residential	70%
Commercial	90%
Industrial	90%
School	70%
Community	70%
Emerging Community	90%
Urban	90%
Sports Fields	0%
Parks	0%
Roads	100%
Drainage Reserve	0%
Rail	60%

2.2 Precincts 2-5

The most current drainage design details for Precincts 2-5 were supplied to BMT WBM by Stockland's appointed civil designers. These details were used to develop a new hydrologic model of the proposed drainage. The proposed sub-catchments were utilised to develop the model (see

Figure 2-1). Model parameters were obtained from the overall plan of development (for proposed land use) and ground models of the proposed development.

2.3 Precincts 11-15

The drainage design for Precinct 11-15 area is at concept design stage. Proposed sub-catchments were provided to BMT WBM to develop a hydrologic model of the area. Again, the model parameters were obtained from the overall plan of development (for proposed land use) and ground models of the proposed development. The sub-catchment delineation and land use is shown in Figure 2-2.



LEGEND

Sub-catchment Boundaries

Title:

Precincts 2-5 Hydrologic Model Layout

Figure: 2-1

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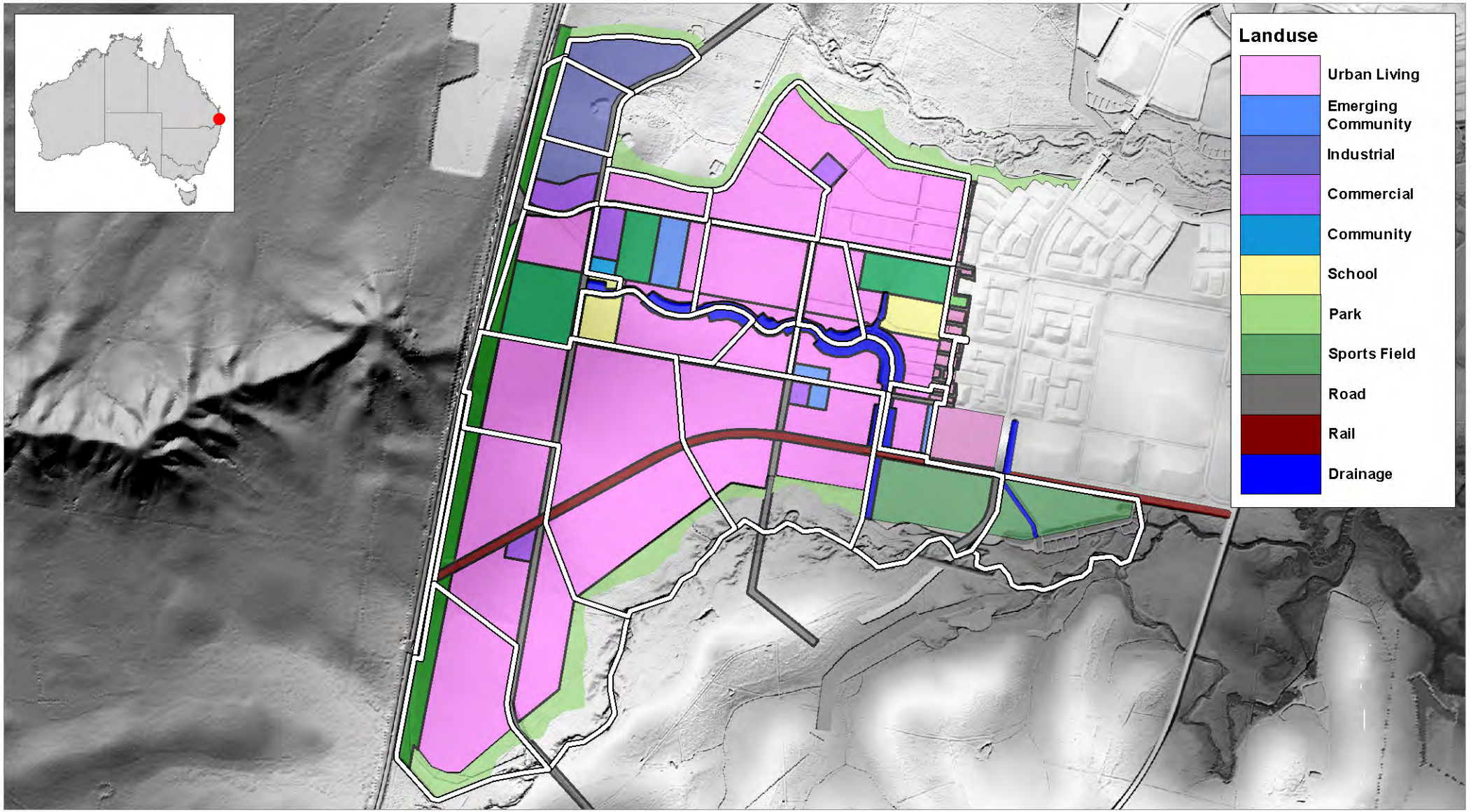
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LEGEND

Sub-catchment Boundaries

Title:

Precincts 11-15 Hydrologic Model Layout

Figure: 2-2

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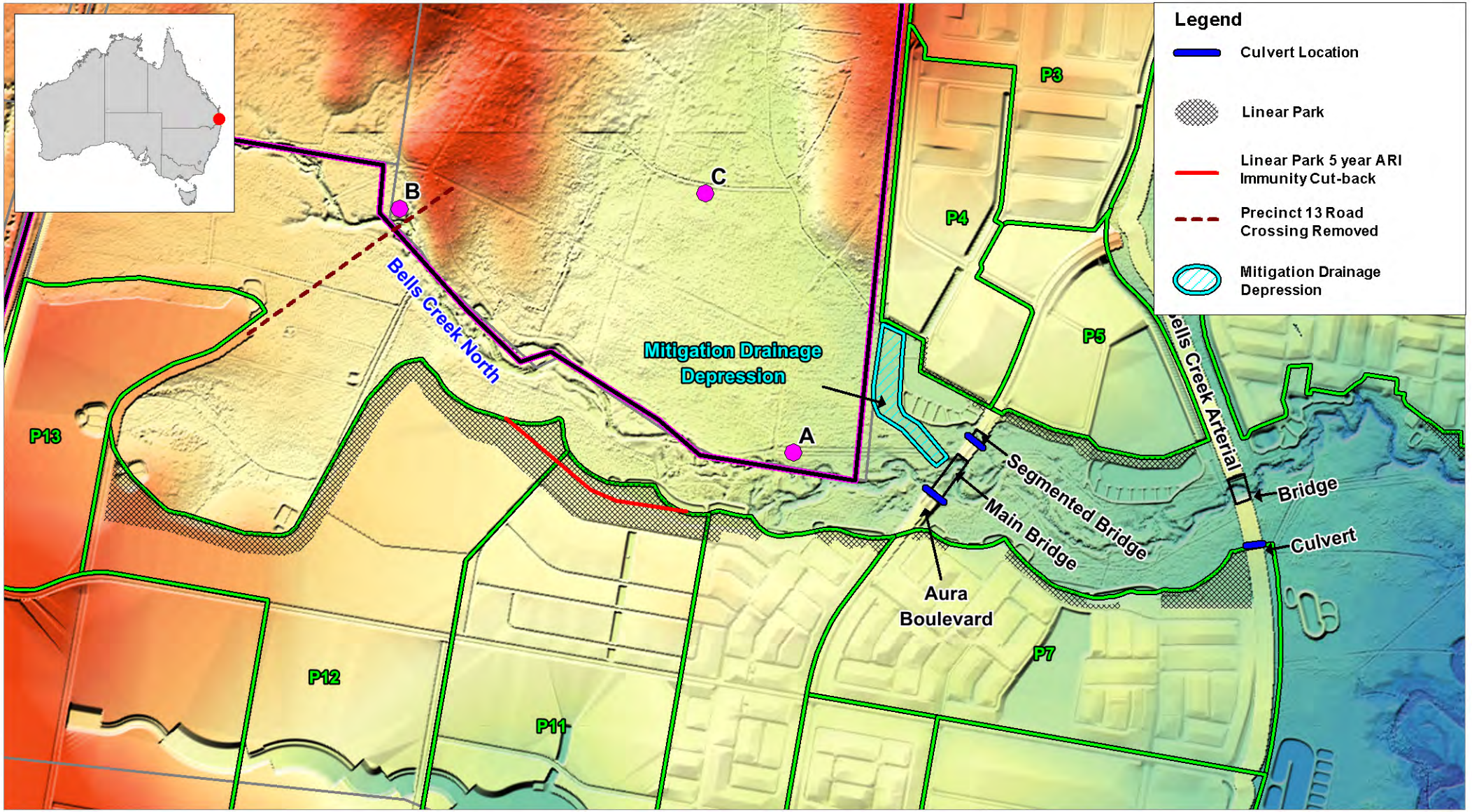
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3 Hydraulic Model Refinements

The hydraulic modelling was based on the TUFLOW model reported on in the technical memo (BMT WBM, 2016), which, in turn, was based on the model reported in the BMT WBM 2015 report. The model is based on a 5m x 5m regular rectangular computational grid across the Aura Priority Development Area (PDA). The following refinements were made to the model:

- As constructed survey of the east-west road crossing over Lamerough Creek was included in the TUFLOW model. A culvert crossing on the western side (Precinct 2) of the bridge was also included. This culvert is intended to facilitate frog passage, but will also convey flood waters in a large flood.
- The model was updated to reflect the latest design for Precinct 2. This area has undergone detailed design since the previous revision of the model. The drainage design and bulk earthworks model was incorporated into the TUFLOW model. The bulk earthworks included the end of line treatment devises.
- The latest drainage design and bulk earthworks model for Precinct 3-5 were included in the model. The bulk earthworks included the proposed end of line treatment devises.
- The latest drainage design and bulk earthworks model for Precinct 11-15 were included in the model. The bulk earthworks included the proposed end of line treatment devises.
- The results from the hydrologic models for Precincts 2-5 and Precincts 11-15 (see Section 2) were used as inflows in the hydraulic model, replacing the pre-existing flows over corresponding portions of the catchment.
- The concept design for the Bells Creek Arterial (BCA) crossing over Bells Creek North was included in the model. The model was optimised a number of times with different bridge and culvert arrangements. The ultimate adopted arrangement was a 65m wide bridge span (at the soffit level) with an average soffit level of 7.80mAHD (which is above the 100 year ARI flood level) and a set of four 1.5m diameter culverts to the south of the bridge. A 1m in 1m slope was assumed for the abutment batter, and 5m wide pedestrian/cycle underpasses at the 2 year ARI flood level (5.1mAHD) were included on both the north and south side of the bridge.
- The design of the Aura Boulevard crossing over Bells Creek North was refined. A number of bridge and culvert arrangements were explored. The final adopted arrangement was a 120m wide main bridge and a 20m wide segmented bridge north of the main bridge, both with a soffit level of 8.0mAHD which is above the 100 year ARI flood level. A 5m wide underpass was included on the southern side of the main bridge at the 2 year ARI flood level (7.3mAHD). Box culverts (2.1m x 2.1m) were included for frog passage on the southern side of both the segmented and main bridge (i.e. two frog passage culverts, one to the north and one to the south of the Bells Creek North waterway).
- The bridge crossing over Bells Creek North that connects to Precinct 13 was removed.
- A small pedestrian bridge over Bells Creek North that links the footpath between Precinct 5 and 7 was included. The footpath was assumed to be level with existing ground levels across the floodplain.

- Linear parks that run along the edges of the development were enforced into the model terrain at a 5 year ARI flood level. The 5 year immunity was cut back across a portion of linear park on the southern bank of Bells Creek North near Precinct 11 and 12, as shown in Figure 3-1. This cutback was implemented to prevent increasing flood levels on the northern bank of Bells Creek North external to the PDA.
- A large drainage depression has been included to the west of Aura Boulevard and north of Bells Creek North to mitigate increases in flood levels external to the PDA. Various path locations and sizes were tested. A 50m wide depression was adopted in the location shown in Figure 3-1.
- The model has been set up to run one of either two cases: either include or exclude the western detention basin (WDB), located west of the Bruce Highway on land owned by Stockland. The modelling discussed in this report discusses both these cases.
- More recent LiDAR was included in the northern side of the Pelican Waters development, which is east of the Aura development. The more recent data better represents the current Pelican Waters canal configuration. This was implemented in response to a comment in EDQ's most recent peer review of the Aura regional flood model. This change is external to the PDA and was implemented for both the pre-developed case and proposed post-developed case.



Proposed Elevation (m AHD)

0 2 4 6 8 10 12 14 16 >18

Priority Development Area

Precinct Boundaries

Reference Points

Title:

Aura Site and Precinct Layout

Figure: 3-1

Rev: A

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4 Hydraulic Model Results

4.1 Flood Impacts Compared to Pre-Approved

4.1.1 Overview

The change in the 100 year ARI peak flood level (for the current climate) from the 2016 technical memo (which was previously approved by EDQ) to the current post-development case is shown in Figure 4-1 for the case where the WDB is excluded and in Figure 4-2 for the case where the WDB is included. Note that the BMT WBM 2015 report and the 2016 technical memo excluded the WDB. Hence, the large reduction in flood level when including the WDB. The discussion that follows is based on the 100 year ARI flood level changes depicted in these figures.

4.1.2 Pelican Waters Canals

Figure 4-2b presents identical data to Figure 4-2 (i.e. the change in the 100 year ARI peak flood level (for the current climate) from the 2016 technical memo to the current post-development case with WDB), but zoomed out to include the mapped impact results in the Pelican Waters vicinity. As shown in Figure 4-2b, there has been some increase in flood level within the Pelican Waters canals. This is attributed to the inclusion of updated topography in the current post-development case model, based on more recent LiDAR data of the area. The previously approved model for the 2016 technical memo was produced prior to this LiDAR update, and hence does not include the same topography revision.

There is no adverse flood impact in the Pelican Waters area due to the current proposed development. Rather, the increase in level shown on the mapping in Figure 4-2b is a result of the revision to underlying base topography since the 2016 technical memo results were produced.

Note that the topographic updates in the vicinity of Pelican Waters were added to the pre-development case model, and the comparison between this model's results and the current post-development case model results show no adverse impact in the Pelican Waters area, as shown in impact mapping in Section 4.2.

4.1.3 Excluding the Western Detention Basin

The following sections describe the changes in peak flood levels in three separate areas. The areas are shown in Figure 4-1.

Based on the results provided below the proposed design without the WDB is not recommended.

Area 1: West of the Bruce Highway: The upper catchment for this small waterway is relatively small, and the 100 year ARI flood level at the Bruce Highway is over 0.5m lower compared to the Bells Creek North flood level. The 100 year ARI flood level for this watercourse is approximately 1.8m below the Bruce Highway road level in the current adopted flood model. Therefore, despite the 0.35m increase in flood level, the flood level is well below the highway. The reason for this increase in flood level, is a change in the configuration of a drain on the eastern side of the culverts under the highway, which reduced the driving head through the culverts and increasing the upstream flood level.

Area 2: Road crossing across Bells Creek North: Removing the road crossing that extends across Bells Creek North from Precinct 13 has generally reduced flood levels in Bells Creek North in the

vicinity of the highway – apart from some increases in flood level on the southern bank which are related to the drain reconfiguration discussed above. Immediately east (downstream) of where this crossing was located, flood levels have increased due to there no longer being an afflux across the structure.

Area 3: Aura Boulevard crossing over Bells Creek North: There has been a reduction in flood storage and flow area in this area caused, in part, by the linear park 5 year ARI flood immunity, but mostly from the end of line treatment devices from Precinct 3-5. This has caused increased flood levels west of Aura Boulevard, which affects flood levels external to the PDA (located on Council's land). This is further discussed in Section 4.3.

The results shown have been improved from initial model iterations by implementing the following mitigation strategy:

- Portions of the 5 year ARI flood immunity across the linear park area were cut back.
- A large drainage depression has been inserted along the PDA boundary to assist water arriving from the northern drainage path with flowing around the end of line treatment device into Bells Creek North.
- The end of line treatment device was reconfigured to improve conveyance of flood water in this area.
- A segmented bridge was included on the northern side of the main bridge to assist with conveyance of flood water across Aura Boulevard near the end of line treatment device – in the original model there was a set of culverts in this location.

Immediately downstream (east) of the Aura Boulevard crossing, the flood levels are lower due to the greater hold up of flood water upstream.

Area 4: Upstream (west) of the Bells Creek Arterial (BCA): Flood levels have increased as a result of the end of line treatment device from Precincts 3-5 and the change in the BCA crossing configuration. The BCA bridge has been narrowed from 100m to 65m and a set of four culverts (1.5m diameter) have been included to the south of the bridge. This arrangement was adopted to spread the cross-flow and direct a portion of the water flowing across the BCA further south, away from Precinct 2. This was necessary to avoid increasing flood levels on the southern side of Precinct 2. This causes an increase in flood levels in a portion of the environmental protection zone east of the BCA.

4.1.4 Including the Western Detention Basin

Area 1: West of the Bruce Highway: Again, there is an increase in the flood level in the small waterway south of Bells Creek North on the western side of the highway. In this case, the increase in flood level is due to water from the Bells Creek North catchment spilling over into the smaller waterway catchment across the western detention basin.

The WDB creates a large additional flood storage volume for Bells Creek North on the western side of the highway. This reduce the flood levels on the western side of the highway, and reduces the driving head through the culverts under the highway. Therefore, there is less flow across the highway

and lower flood levels along Bells Creek North in general. A benefit of this is that there are reduced flood levels external to the PDA.

With the WDB, there are no increases in flood levels west of Aura Boulevard.

The flood level increases external to the PDA on Council owned land are discussed in 4.3.

4.2 Flood Impacts Compared to the Pre-development Case

This section describes the change in the 100 year ARI peak flood level (for the current climate) from the pre-developed case to the current post-development case as reflected in the refined flood model.

Flood impact maps for the 100, 50 and 5 year ARI flood events for with and without the WDB are shown in Figure 4-3 to Figure 4-10.

Note that topographic updates to the Pelican Waters area, based on more recent LiDAR data, have been included in both the pre-developed and current post-development case models. In the previous reports, flood impacts external to the PDA were identified at three locations. These three locations and the post-developed model results are as follows:

- Upstream of the highway on Bells Creek North: In the current model, there is no longer an impact in this area, in particular with the WDB.
- On Council owned land on the northern bank of Bells Creek North to the west of Precinct 3-5; this is further described in Section 4.3.
- Upstream of the BCA crossing over Lamerough Creek. The affected land is zoned as *Environmental Management and Conservation* for which development is discouraged. The flood impacts have reduced slightly in this area.

4.3 Flood Summary on Council Land

Table 2-1 presents selected flood information, including the area of inundation, the peak flood levels and depth, and the duration of inundation at three selected reference points, on Council owned land north of Bells Creek North. The reference points are shown in Figure 4-1. Table 2-1 demonstrates that the current post-development case has lower flood levels and depth, a smaller area of inundation and a similar duration of inundation compared to the pre-approved case. The time of inundation is slightly longer with the WDB (than without), as expected. The time of inundation is dependent on the design event rainfall. The time of inundation is an approximation based on the model result output intervals of 0.5 hours and therefore less accurate than the water level and depth information.

Table 4-1 Summary of Flood Data

Description	Location	Pre-Developed Case (Oct 2015)	Town Centre Approved Case (Aug 2016)	P2-P13 Design case (Oct 2017) With WDB	P2-P13 Design case (Oct 2017) Without WDB	Comment
Area of inundation (m²)	Lot of land	461,171	605,572	570,107	609,306	The area of inundation in the P2-P13 Design case with WDB is significantly smaller (by approx. 35,000 m²) than in the Town Centre Approved Case. The area of inundation in the P2-P13 Design case without WDB is larger than the Town Centre approved case (by approx. 4,000 m²).
Peak Flood Level (mAHD)	Point A	7.95	8.10	8.07	8.12	The water level in the P2-P13 Design case with WDB is 30mm lower than in the Town Centre Approved Case.
	Point B	11.61	12.01	11.62	11.69	The water level in the P2-P13 Design case with and without the WDB is 39mm and 32mm lower than in the Town Centre Approved Case.
	Point C	8.63	8.69	8.67	8.69	The water level in the P2-P13 Design case with and without WDB is 20mm lower or the same as in the Town Centre Approved Case
Peak Flood Depth (m)*	Point A	0.36	0.51	0.48	0.52	The peak water depth in the P2-P13 Design case with and without the WDB is the same or lower than in the Town Centre Approved Case.

Description	Location	Pre-Developed Case (Oct 2015)	Town Centre Approved Case (Aug 2016)	P2-P13 Design case (Oct 2017) With WDB	P2-P13 Design case (Oct 2017) Without WDB	Comment
	Point B	0.50	0.90	0.51	0.57	The peak water depth in the P2-P13 Design case with and without the WDB is the lower than in the Town Centre Approved Case.
	Point C	0.11	0.17	0.15	0.17	The peak water depth in the P2-P13 Design case with the WDB is the same as in the Town Centre Approved Case.
Time of Inundation** (hours)	Point A	9.4	11.4	12.2	11.5	The time of inundation in the P2-P13 Design case with the WDB is similar as in the Town Centre Approved Case, however it is slightly longer compare to the pre-developed case.
	Point B	13.6	14.2	14.7	13.7	
	Point C	10.4	13.2	12.3	13.1	

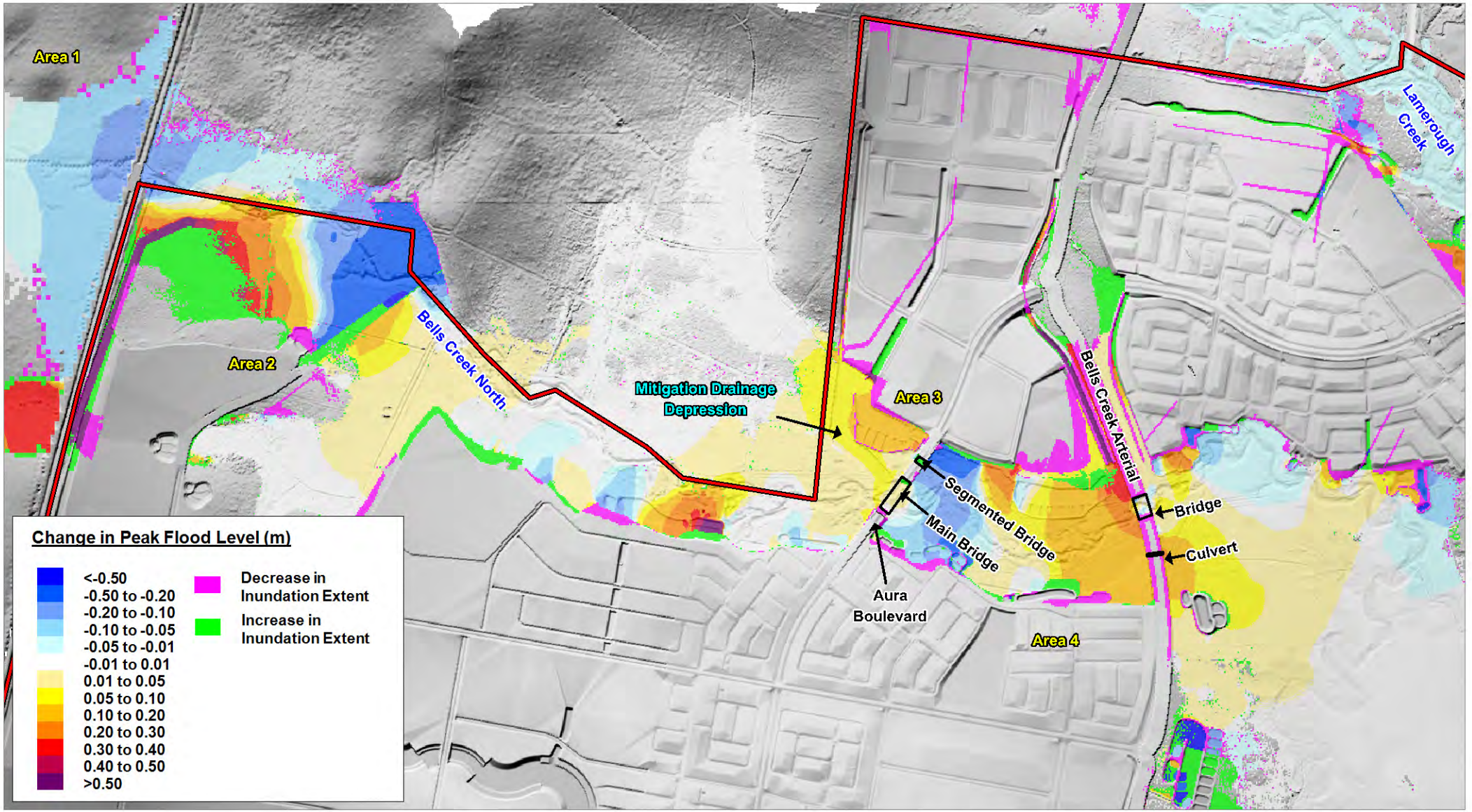
**The depth is based on the ground elevations extracted from the P2-P13 design case model for the reference points: A: 7.59 mAHD, B 11.12 mAHD, C: 8.53mAHD*

***The time of inundation is dependent on the design event rainfall. The time of inundation is an approximation based on the model result output intervals and therefore less accurate than the water level and depth information.*

4.4 Flood Planning Level

The flood planning level, which is used to determine the required minimum fill level for the Aura development, is based on the 100 year ARI peak flood level with increased rainfall intensity and sea levels to account for climate change to a planning horizon of the year 2100 – see BMT WBM (2015) for details. The flood planning level for fill levels includes a 350mm freeboard, with finished slab levels expected to be an additional 150mm higher, giving a freeboard to habitable floor level of 0.5m.

The 100 year ARI peak flood level for with and without the western detention basin is shown in Figure 4-11 and Figure 4-12. It is anticipated that these results will be used to check the current bulk earthworks model, and alterations will be made to the bulk earthworks model to achieve the minimum fill levels if/where required.



LEGEND

Priority Development Area

Title:

100 year ARI Current Design Minus Approved Design Without the Western Detention Basin

Figure: **4-1**

Rev: **A**

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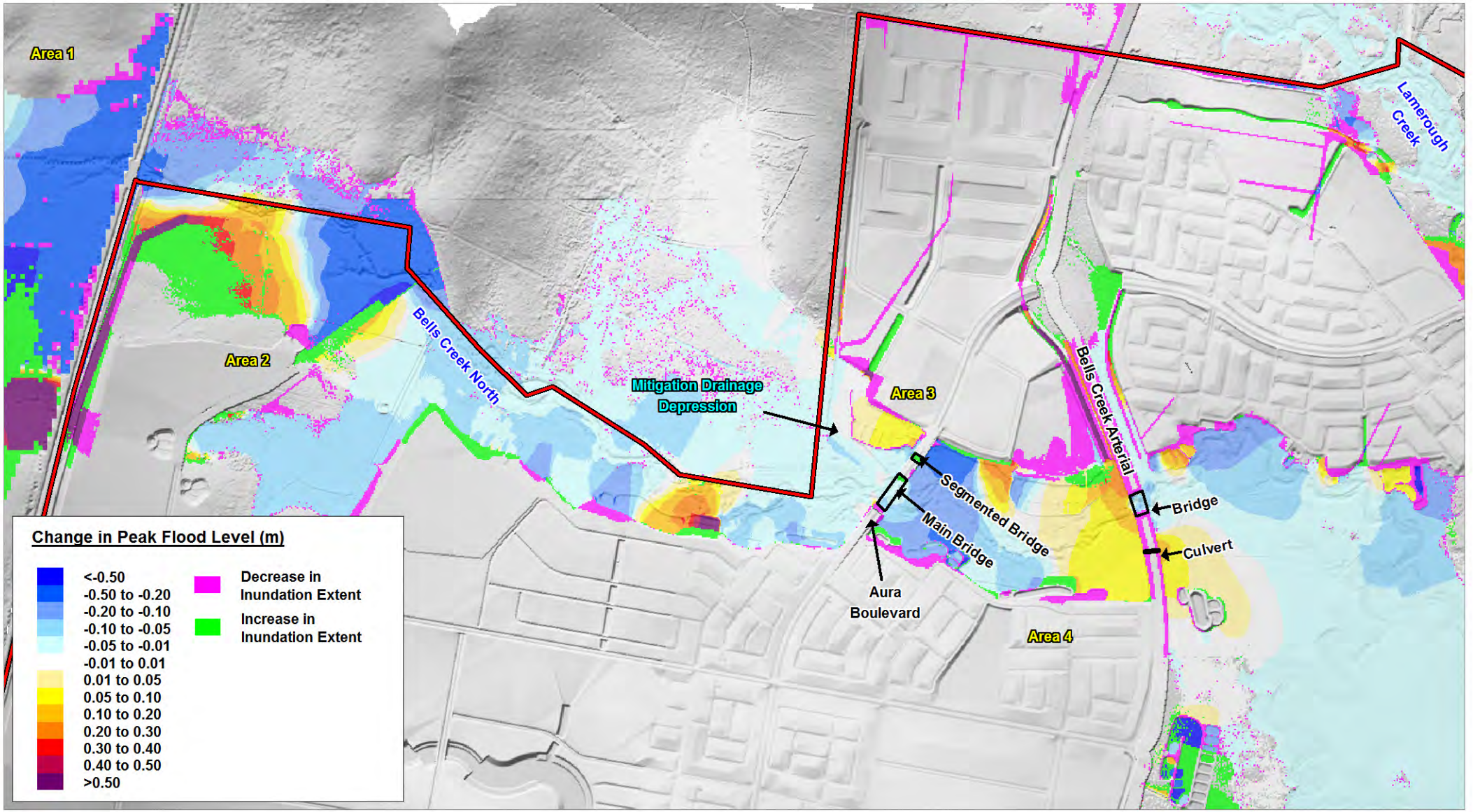
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LEGEND

Priority Development Area

Title:

100 year ARI Current Design Minus Approved Design With the Western Detention Basin

Figure: **4-2**

Rev: **A**

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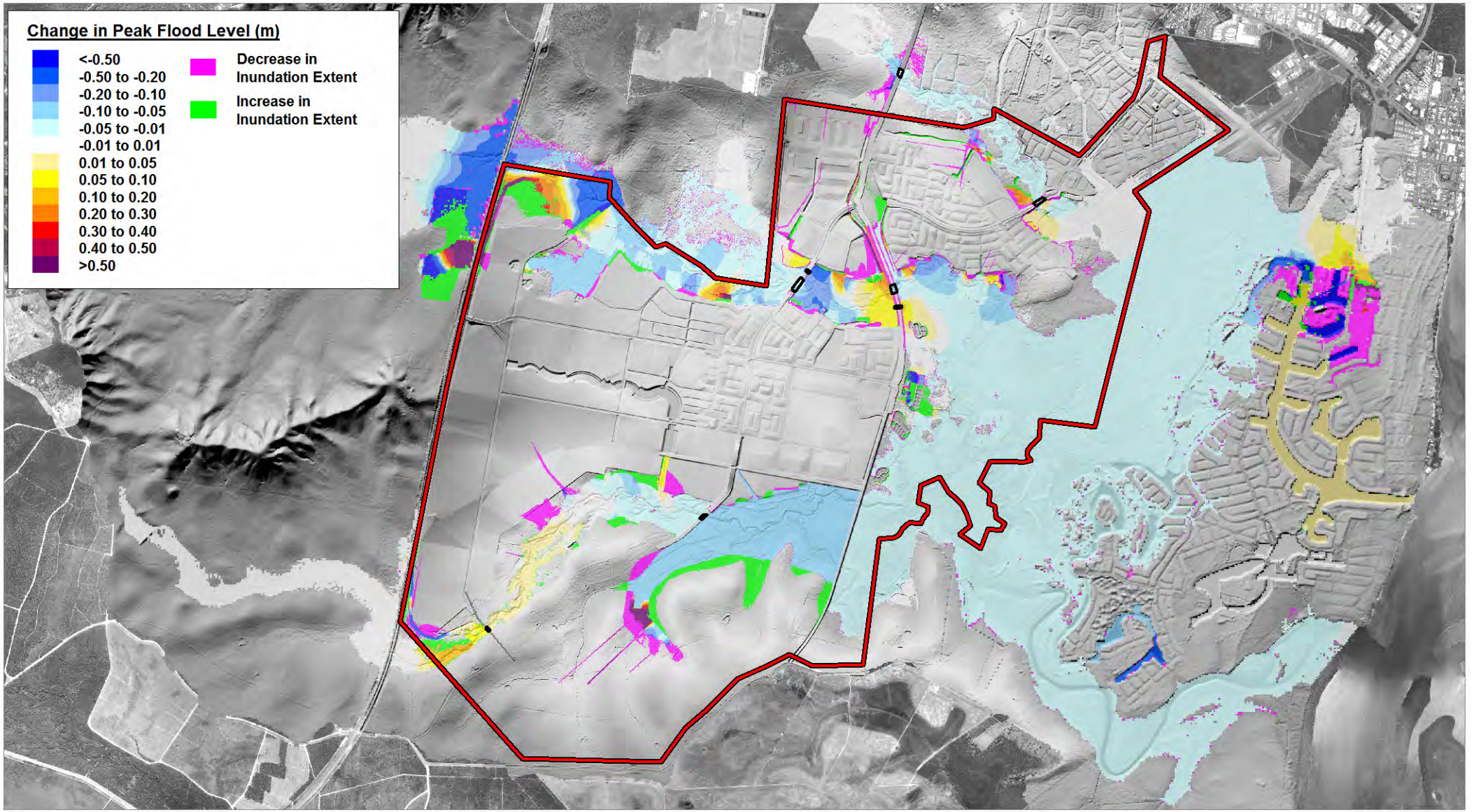
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LEGEND

Priority Development Area

Title:

100 Year ARI Difference in Peak Flood Levels With the Western Detention Basin (Zoomed Out)

Figure: **4-2b**

Rev: **A**

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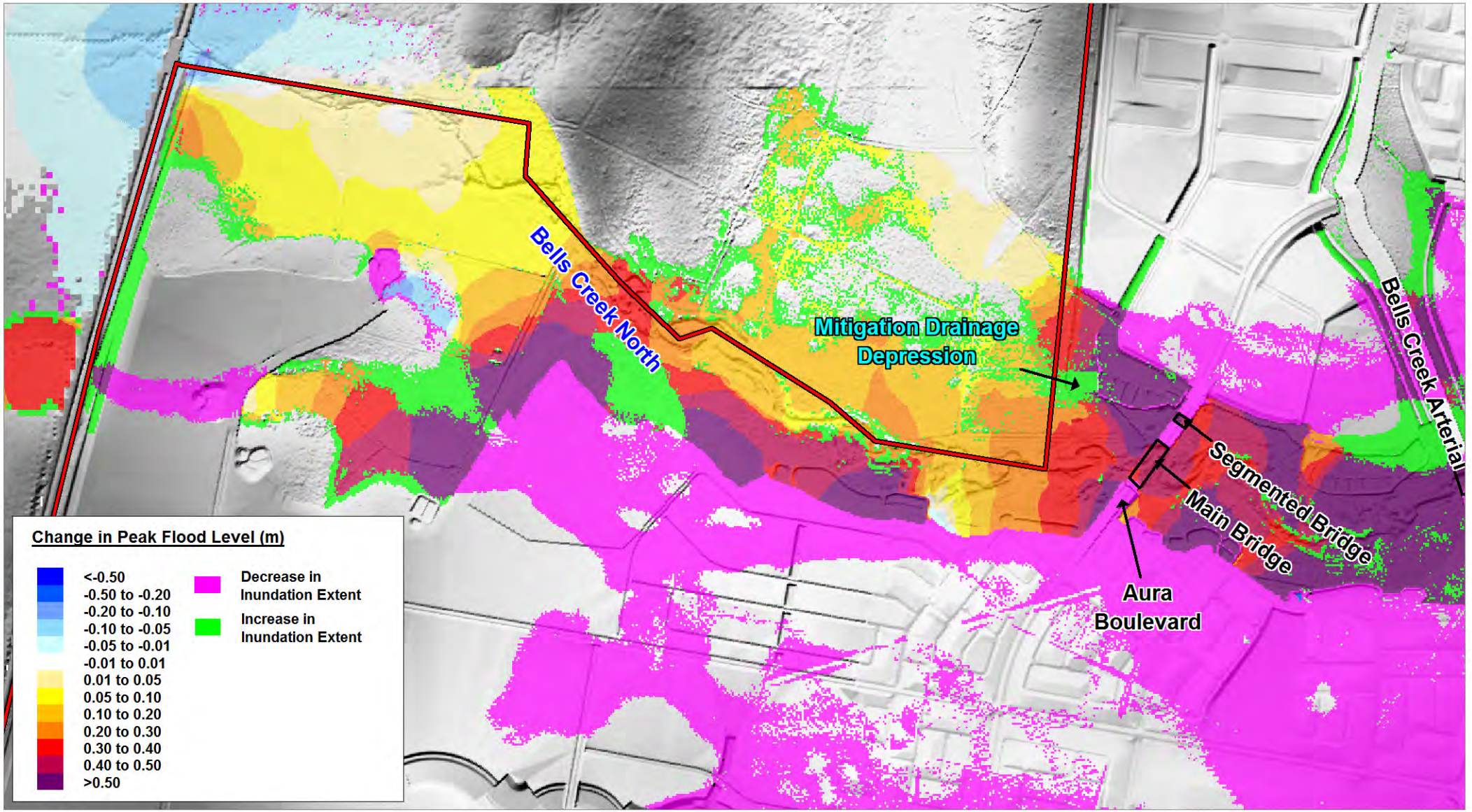
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LEGEND

Priority Development Area

Title:

100 Year ARI Difference in Peak Flood Levels at Bells Creek North Without the Western Detention Basin

Figure: **4-3**

Rev: **A**

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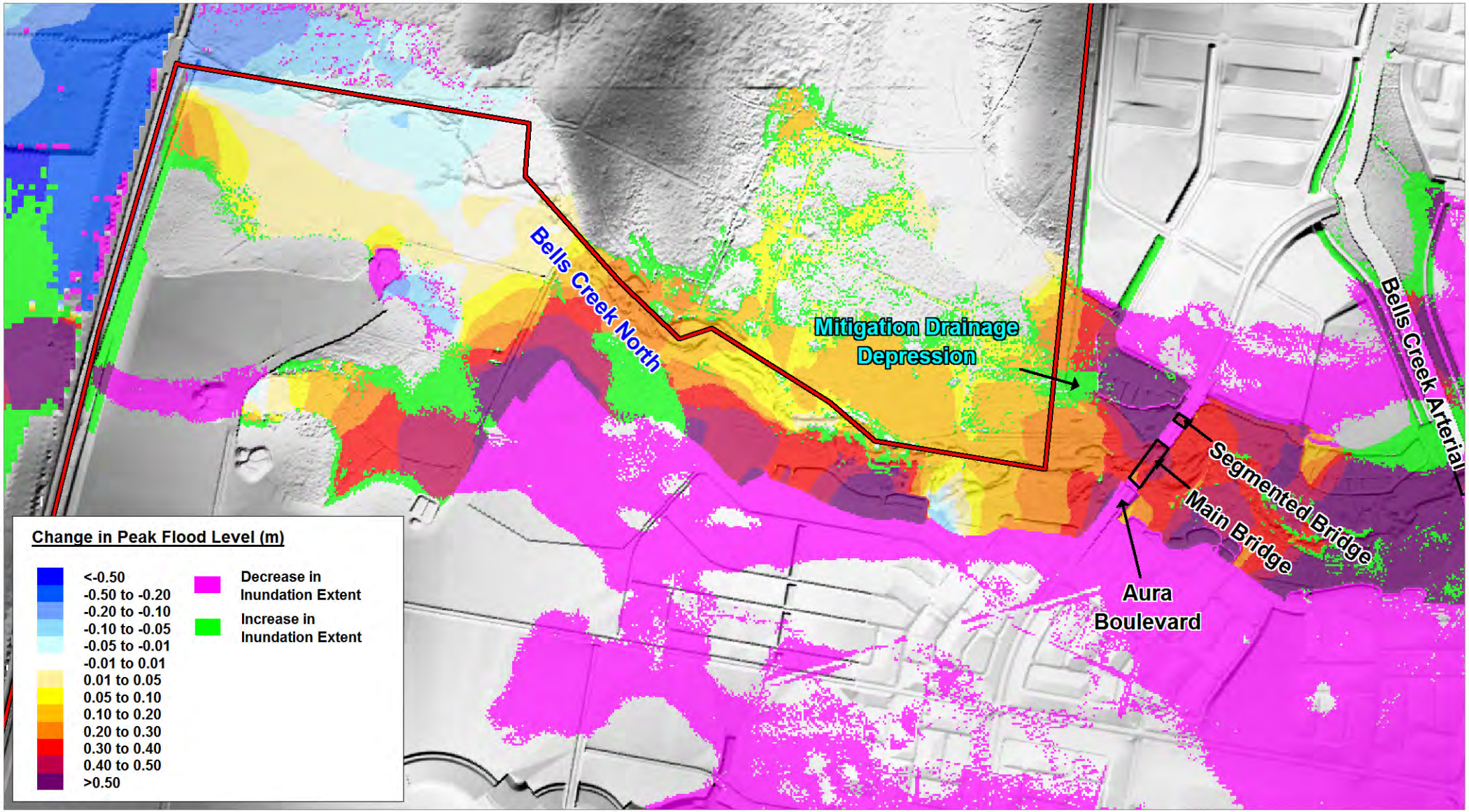
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LEGEND

Priority Development Area

Title:

100 Year ARI Difference in Peak Flood Levels at Bells Creek North With the Western Detention Basin

Figure: **4-4**

Rev: **A**

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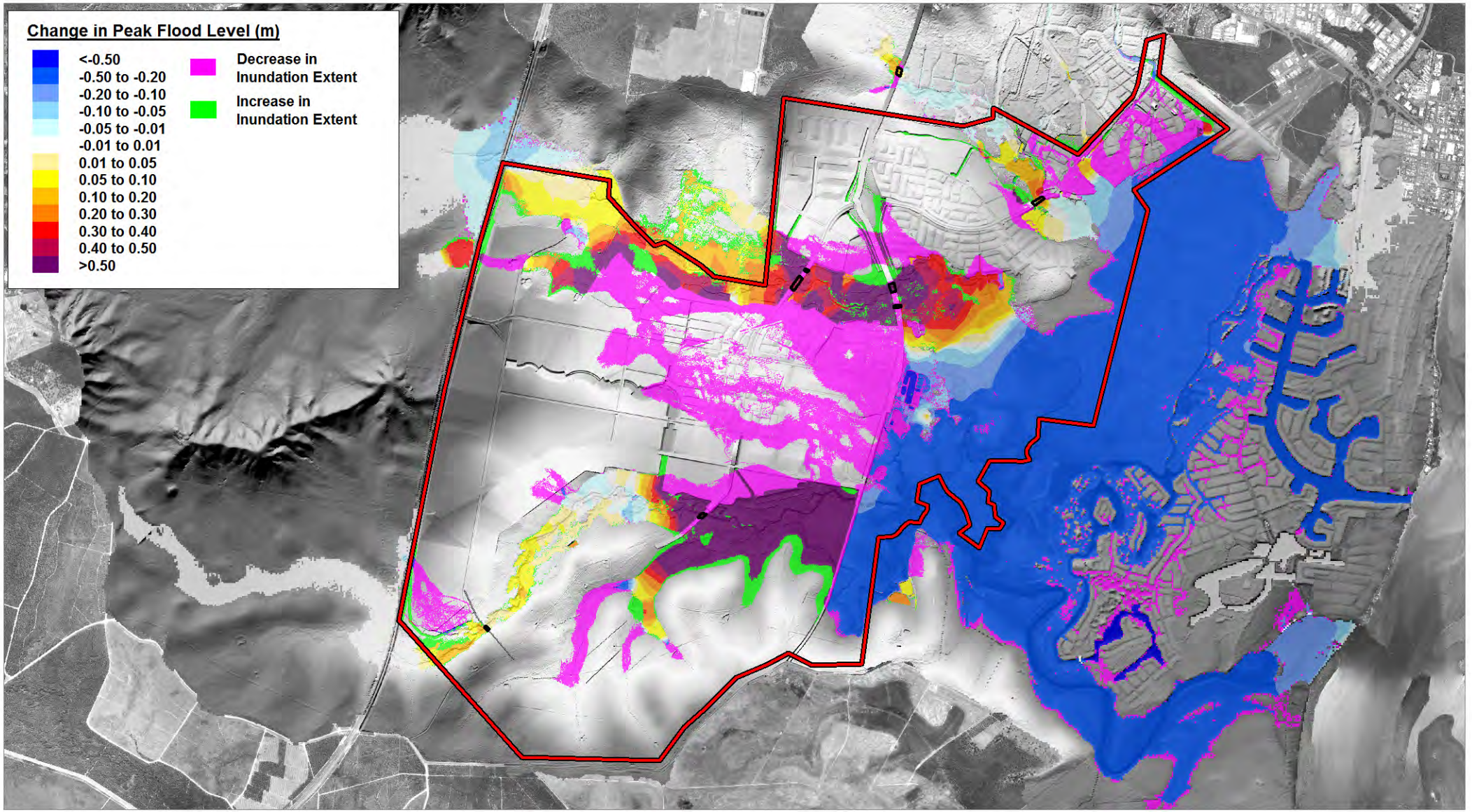
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LEGEND

Priority Development Area

Title:

100 Year ARI Difference in Peak Flood Levels Without the Western Detention Basin

Figure: **4-5**

Rev: **A**

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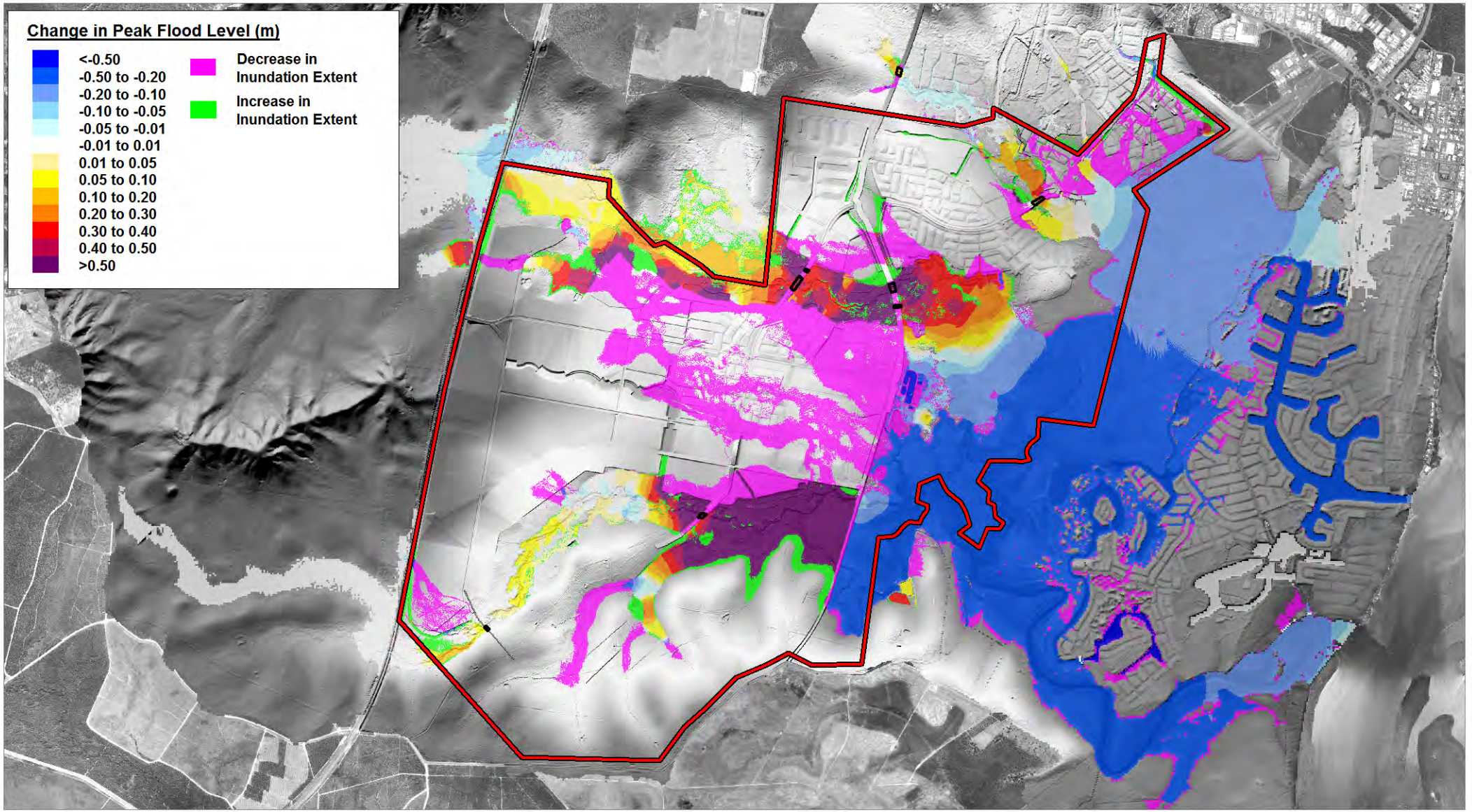
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LEGEND

Priority Development Area

Title:

50 Year ARI Difference in Peak Flood Levels Without the Western Detention Basin

Figure: **4-6**

Rev: **A**

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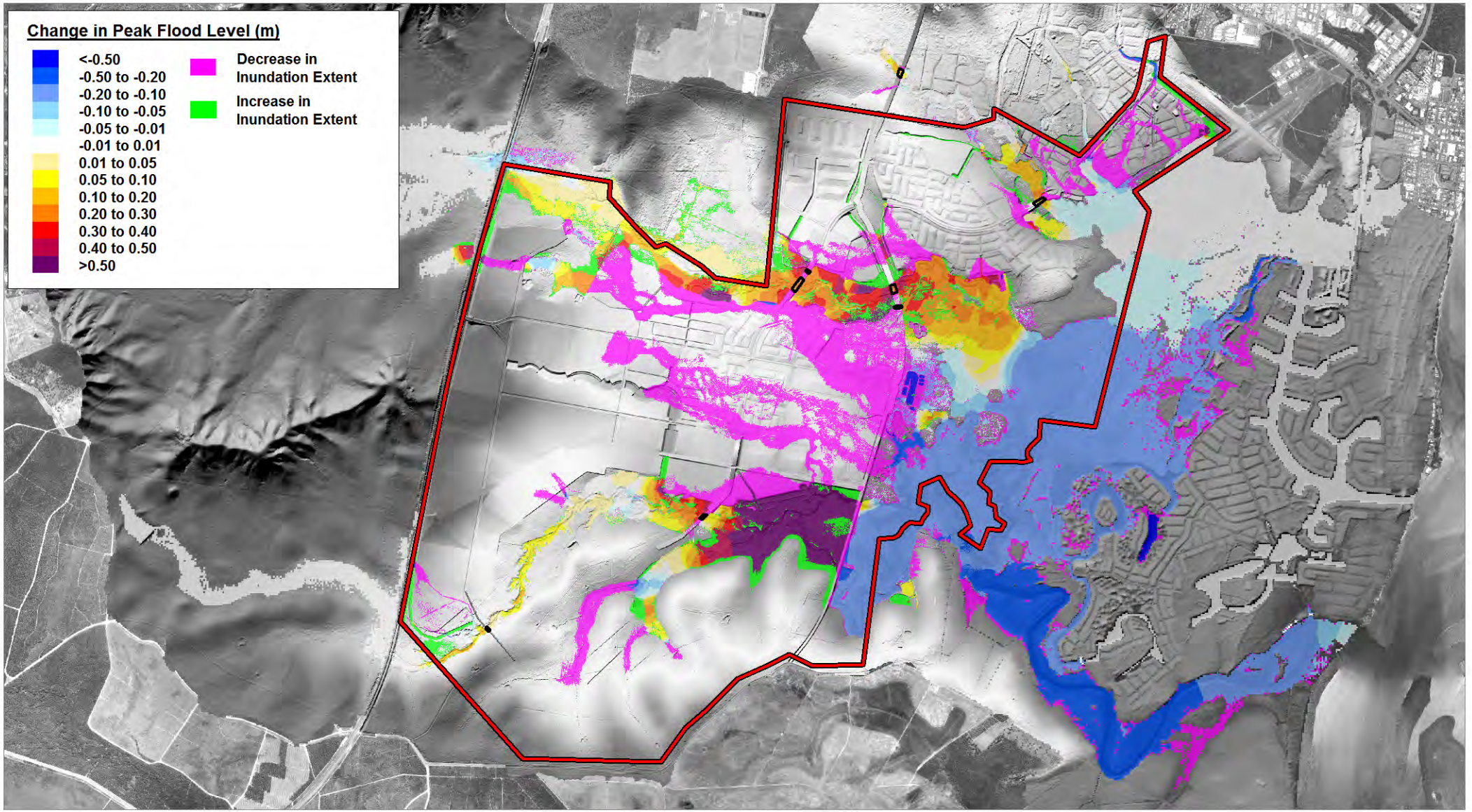
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LEGEND

Priority Development Area

Title:

5 Year ARI Difference in Peak Flood Levels Without the Western Detention Basin

Figure: **4-7**

Rev: **A**

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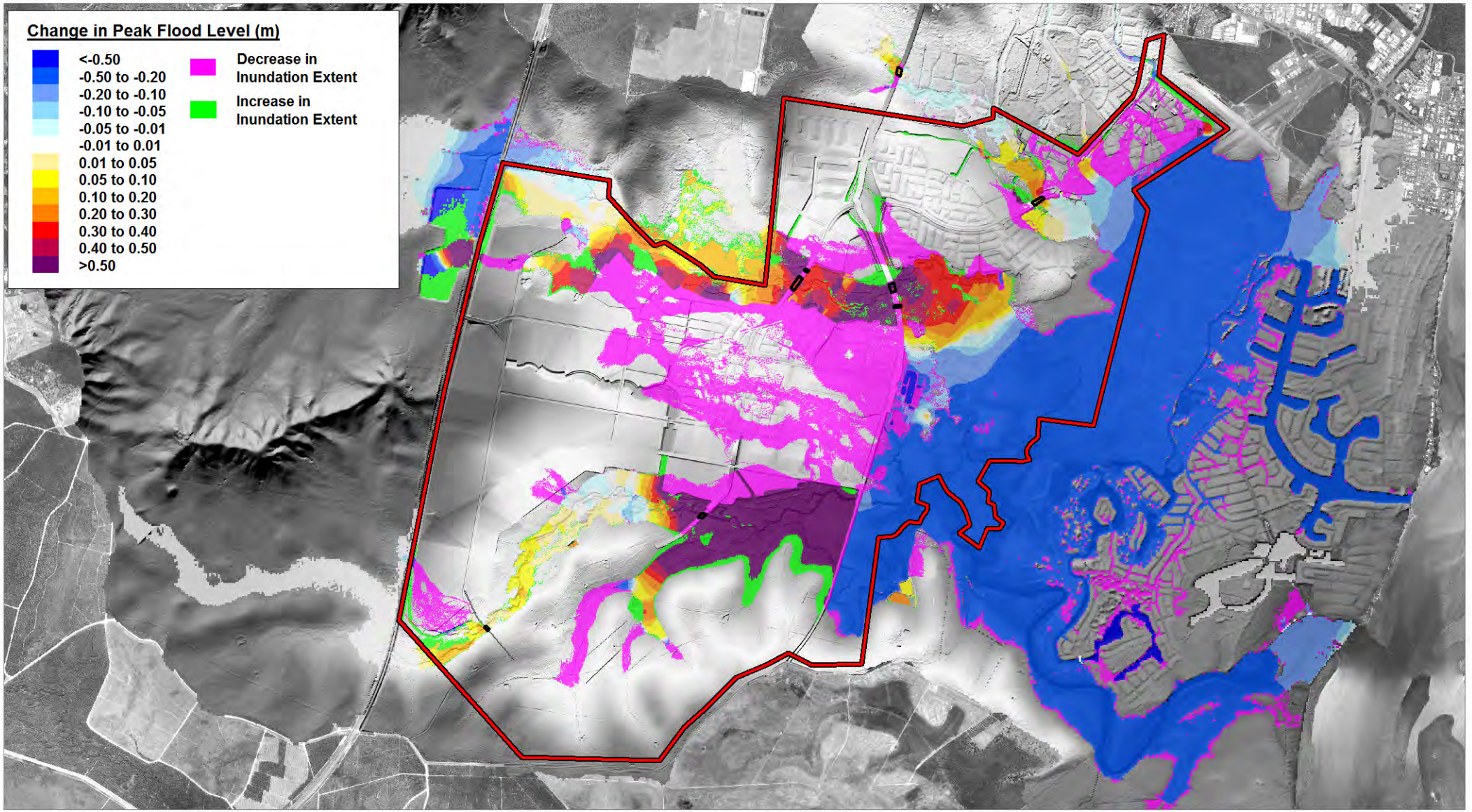
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LEGEND

Priority Development Area

Title:

100 Year ARI Difference in Peak Flood Levels With the Western Detention Basin

Figure: **4-8**

Rev: **A**

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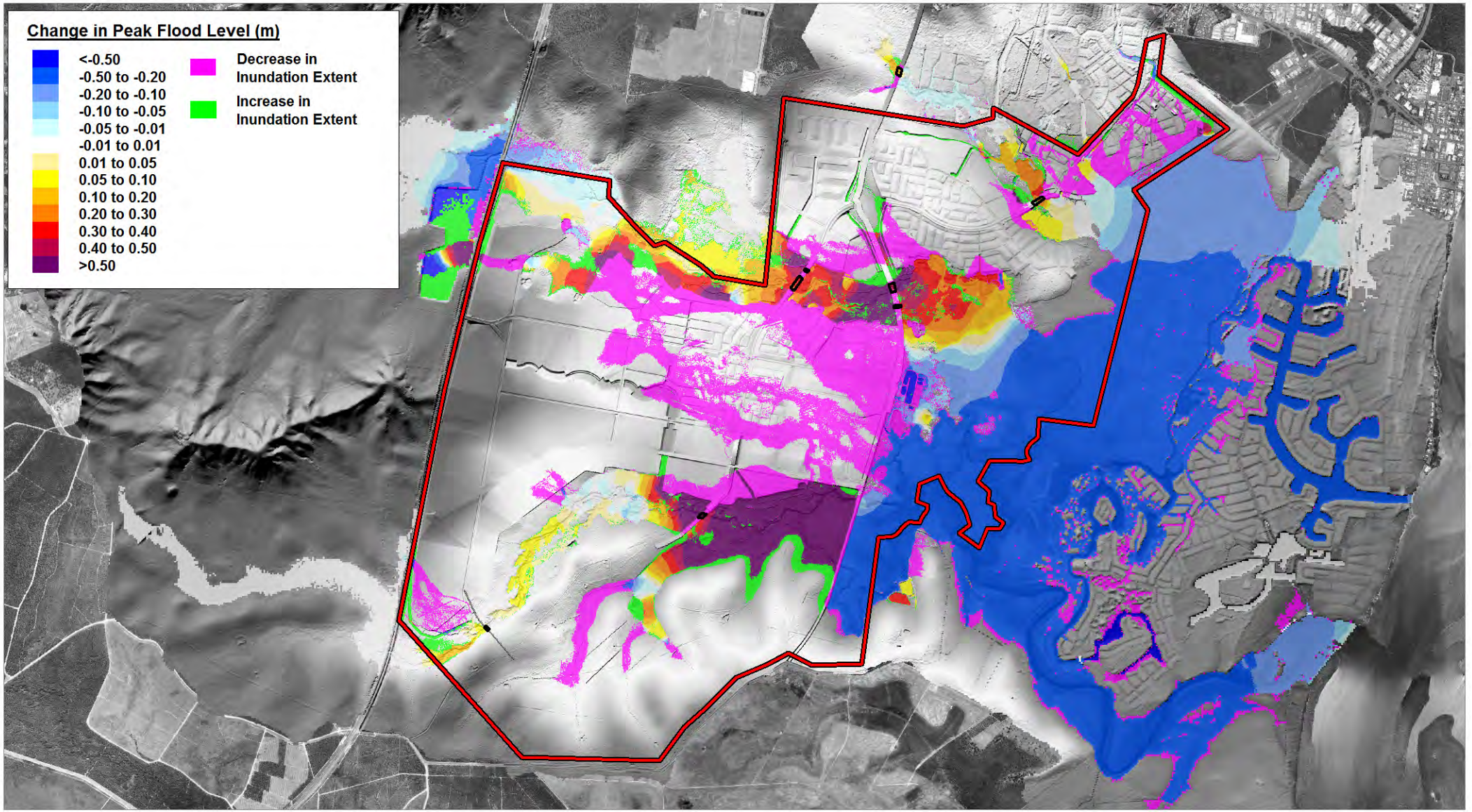
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LEGEND

Priority Development Area

Title:

50 Year ARI Difference in Peak Flood Levels With the Western Detention Basin

Figure: **4-9**

Rev: **A**

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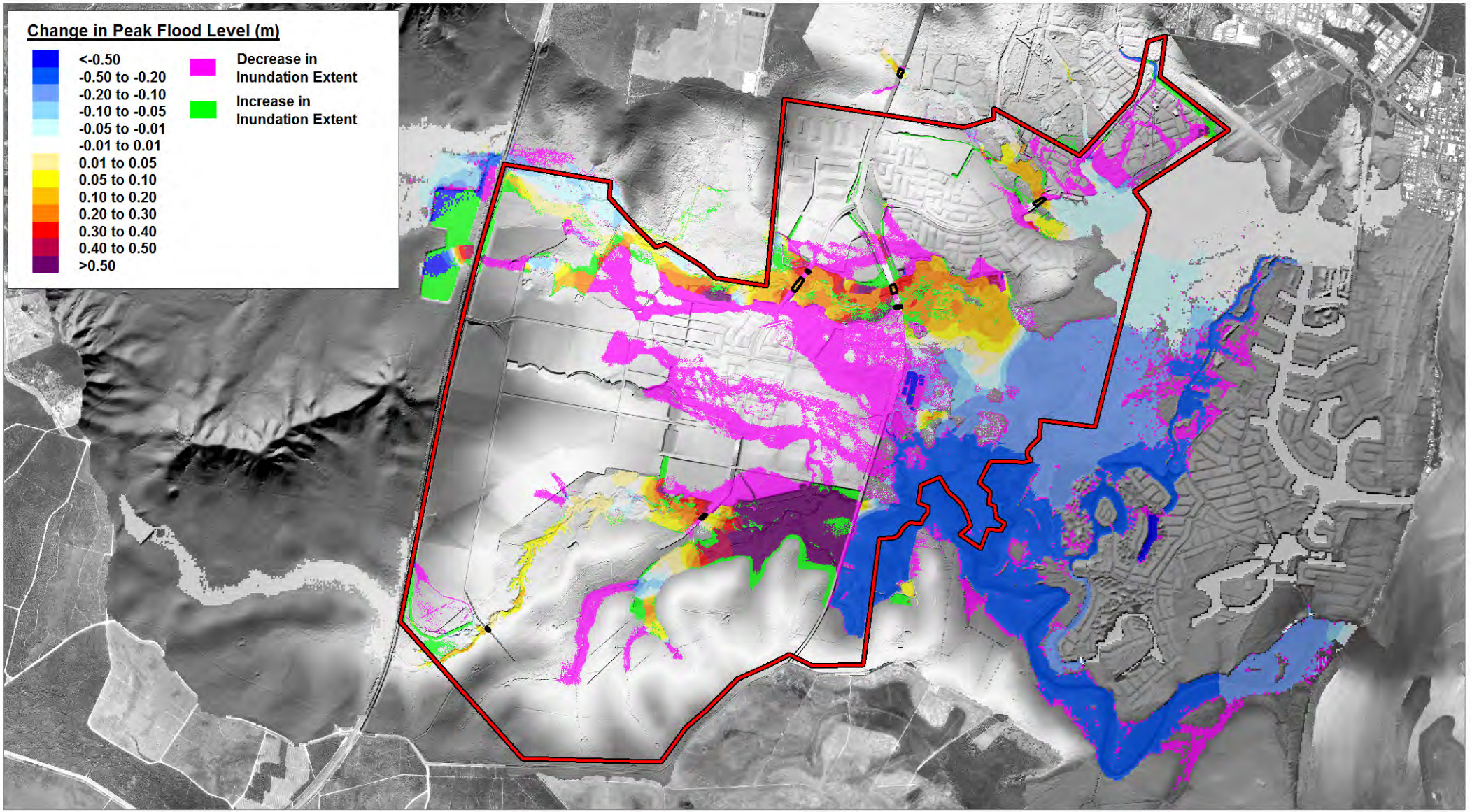
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LEGEND

Priority Development Area

Title:

5 Year ARI Difference in Peak Flood Levels With the Western Detention Basin

Figure: **4-10**

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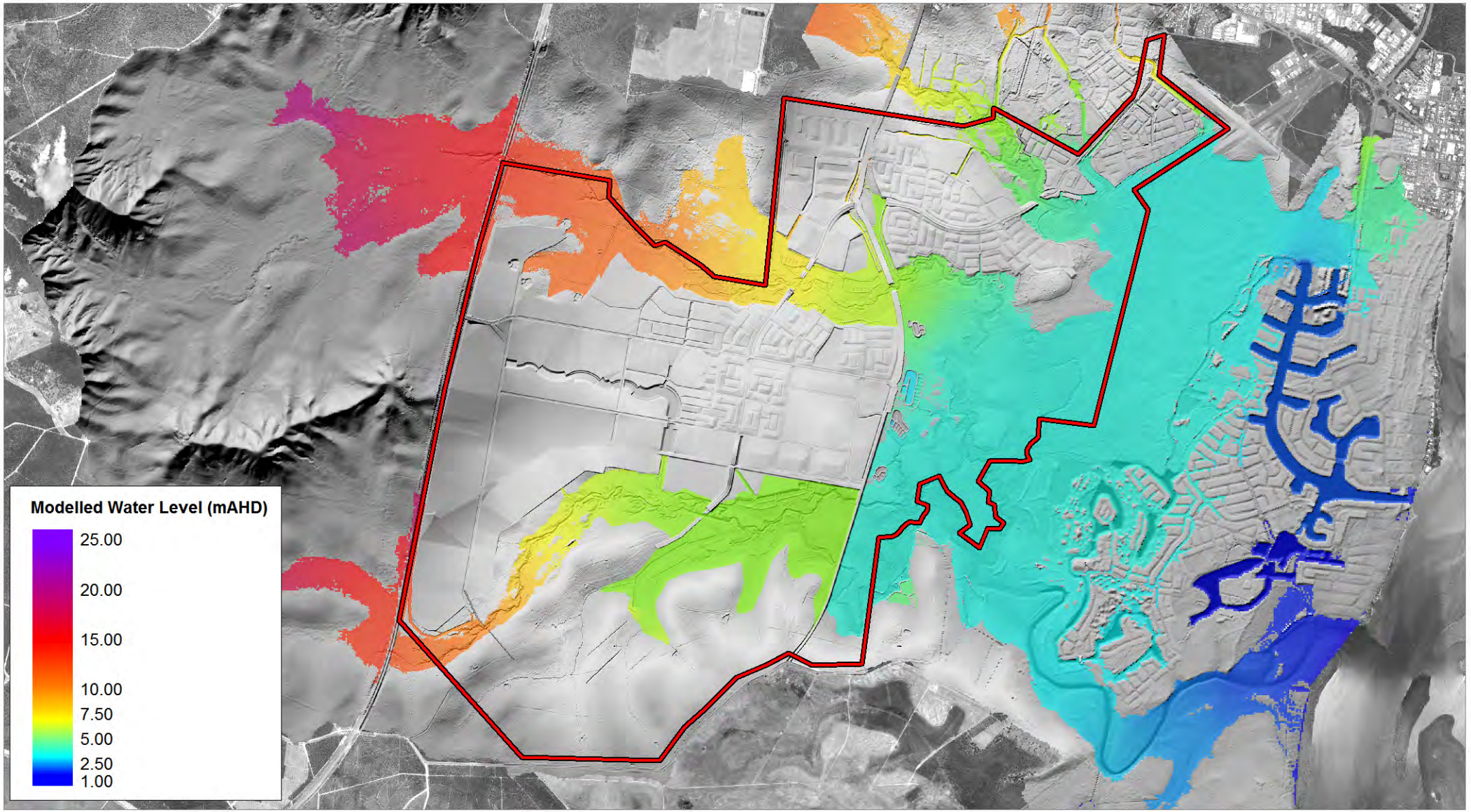
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LEGEND

Priority Development Area

Title:

Developed Case 100 Year ARI Flood Level With Climate Change Without the Western Detention Basin

Figure: **4-11**

Rev: **A**

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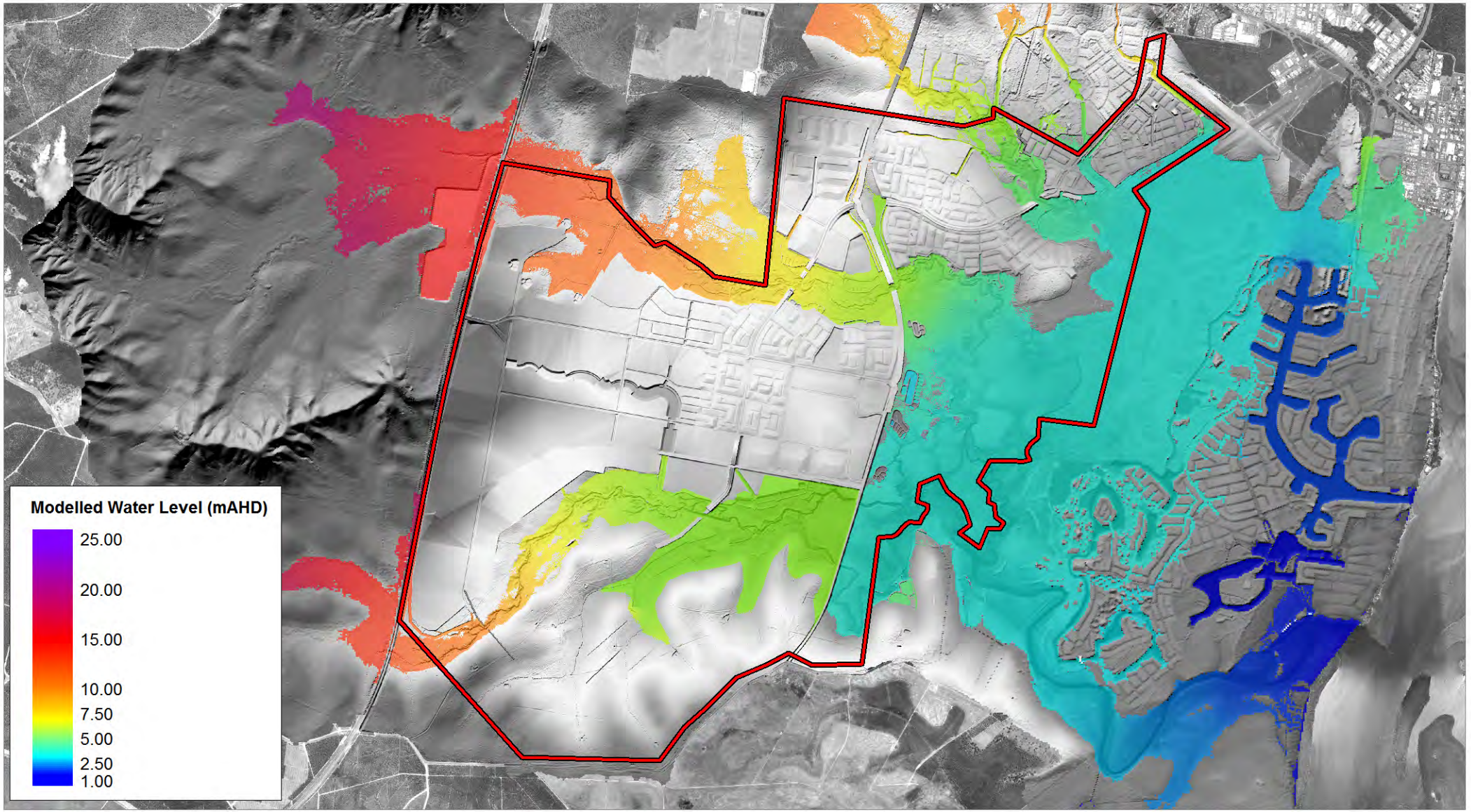
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LEGEND

Priority Development Area

Title:

Developed Case 100 Year ARI Flood Level With Climate Change With the Western Detention Basin

Figure: **4-12**

Rev: **A**

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5 References

BMT WBM, 2015, *Caloundra South Development: Flood Risk Management Strategy*.

BMT WBM, 2016, *Technical Memo: Aura Town Centre Revised Flood Modelling.*



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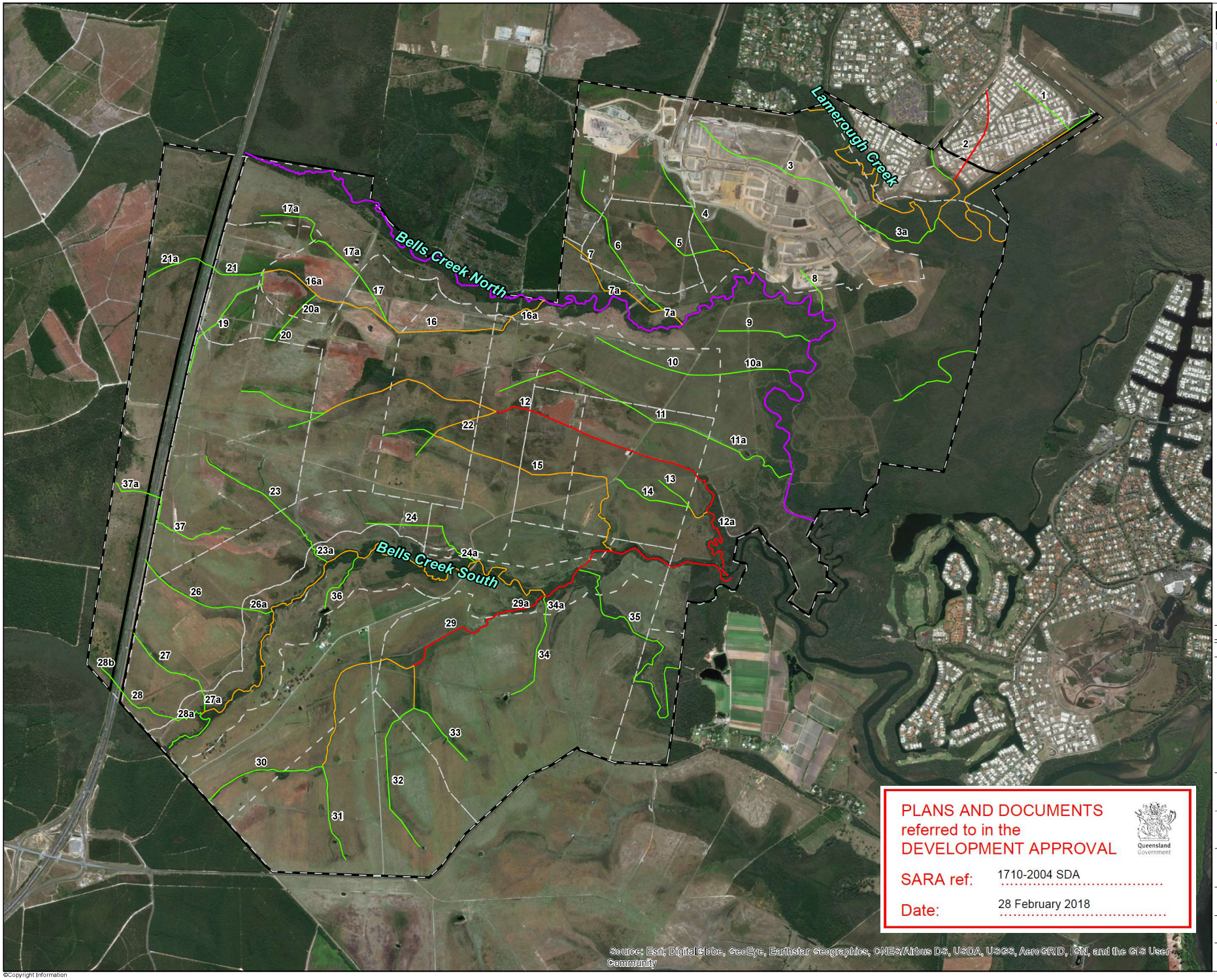
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Email vancouver@bmtwbm.com
Web www.bmtwbm.com



Caloundra South PDA

Development Precincts

DAF waterway mapping

- 1 - Low
- 2 - Moderate
- 3 - High
- 4 - Major

PLANS AND DOCUMENTS referred to in the DEVELOPMENT APPROVAL

Queensland Government

SARA ref: 1710-2004 SDA

Date: 28 February 2018

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Issue	Date	By	Chkd	Appd
D1	27/2/2018	MD	LOM	LOM

Metres

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Fortitude Valley, QLD 4006
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Client: **Stockland**

Job Title: **Caloundra South Priority Development Area**

Drawing Title: **DAF waterway barrier risk of impact mapping**

Scale at A3	Drawing Status
1:25,217	Final

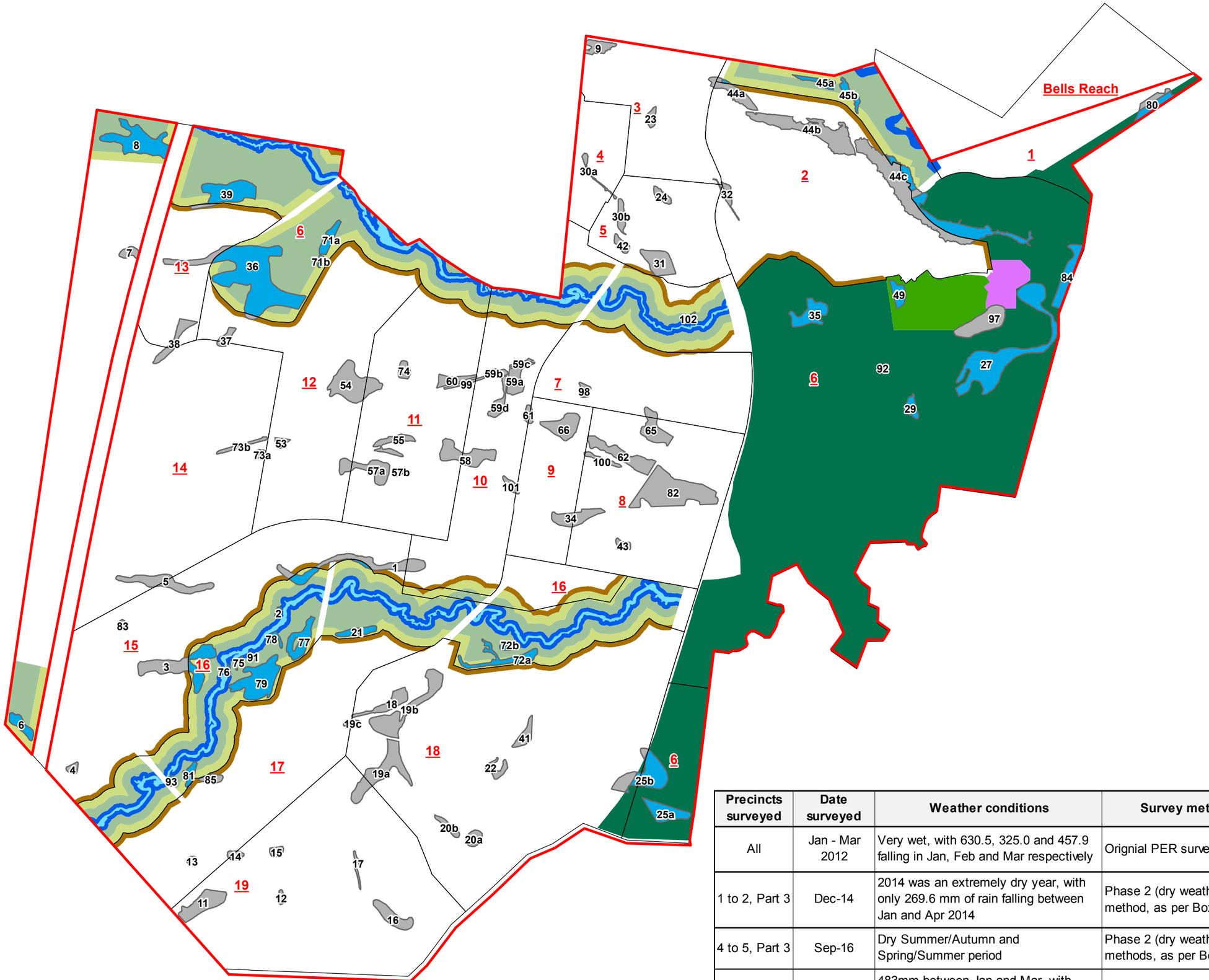
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Job No	Drawing No
238678-00	005a

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EPBC Referral Boundary

Master Plan Precincts (09/09/2015)

WSF Habitat Impacted

WSF Habitat Protected

Conservation Areas:

- Creek Corridor
- Riparian Zone
- Frog Zone
- Frog Buffer
- Lifestyle
- Environmental Protection Zone
- Major Recreation Park
- Environmental Education Facility

~280 ha Frog Conservation (ex EPZ)
- Includes Riparian, Frog zone, Frog buffer.
- Excludes areas of mapped WSF habitat.

Combined pre-construction mapped WSF habitat
~64ha protected
~95ha impacted

EPZ (including major recreational park and frog buffers) ~ 435ha

Precincts surveyed	Date surveyed	Weather conditions	Survey methodology
All	Jan - Mar 2012	Very wet, with 630.5, 325.0 and 457.9 falling in Jan, Feb and Mar respectively	Orignial PER survey
1 to 2, Part 3	Dec-14	2014 was an extremely dry year, with only 269.6 mm of rain falling between Jan and Apr 2014	Phase 2 (dry weather) survey method, as per Box 1 (pg 52)
4 to 5, Part 3	Sep-16	Dry Summer/Autumn and Spring/Summer period	Phase 2 (dry weather) survey methods, as per Box 1 (pg 52)
6 to 16 18	Mar-17	483mm between Jan and Mar, with majority of rain (385mm) falling within Mar.	Phase 1 (wet weather) survey methods, as per Box 1 (pg 52)

Issue	Date	By	Chkd	Appd
27	1/06/2017	MD	MD	MD

0 0.5 1 km

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Client: **Stockland**

Job Title: **Aura**

Drawing Title: **Wallum Sedgefrog (and Acid Frog) habitat to be removed**

Scale at A3: **1:23,276**

Drawing Status: **For Information**

Coordinate System: **GDA 1994 MGA Zone 56**

Job No: **222431-00**

Drawing No: **2.2d**

J:\238000\236678-00 Caloundra South conservation\Work\Internal\GIS\Workspace\MAP\2.2D\MAP2.2D_v27.mxd

© Arup

WSF habitat impacted: 23.2 ha
WSF habitat recreated: 30.5 ha

AWC

Figure 2: Stage two planned WSF habitat impact and associated re-creation.

Legend

- Precinct Boundaries
- WSF created compensatory habitat
- Retained habitat
- Future habitat to be removed (future development stages)

Permissable WSF Habitat loss under Stage 2:

- Harvest Topsoil
- Translocate

Conservation corridors:

- Creek corridor
- Frog buffer
- Frog zone
- Riparian zone

0 100 200 300 m

Date - 14/6/2016
A3 Scale - 1:13,000

Project: Projected WSF habitat impact adn assoicated recreation

SOURCE:
Aerial - NearMap Pty Ltd 2016
WSF Habitat mapping - EcoSmart 2017
Conservation Corridors - ARUP 2017
WSF Habitat recreation - AWC 2017

Care was taken in the creation of this map. AWC should be consulted as to the suitability of the information shown herin prior to the commencement of any works based on the information provided. AWC cannot accept any responsibility for errors, omissions or positional accuracy. There are no warranties, expressed or implied as tot he suitability of this map for a particular purpose. However, notification of any errors will be appreciated.

WSF habitat impacted: 27.5 ha
WSF habitat recreated: 29.2 ha

AWC

Figure 1: Stage one planned WSF habitat impact and associated re-creation.

Legend

- Precinct boundaries
- WSF created compensatory habitat
- Retained habitat
- Future habitat to be removed (future development stages)

Permissable WSF Habitat loss under Stage 1:

- Harvest Topsoil
- Translocate

Conservation corridors:

- Creek corridor
- Frog buffer
- Frog zone
- Riparian zone

0 100 200 300 m

Date - 13/6/2016
A3 Scale - 1:12,000

Project: Projected WSF habitat impact adn assoicated recreation

SOURCE:
Aerial - NearMap Pty Ltd 2016
WSF Habitat mapping - EcoSmart 2017
Conservation Corridors - ARUP 2017
WSF Habitat recreation - AWC 2017

Care was taken in the creation of this map. AWC should be consulted as to the suitability of the information shown herin prior to the commencement of any works based on the information provided. AWC cannot accept any responsibility for errors, omissions or positional accuracy. There are no warranties, expressed or implied as tot he suitability of this map for a particular purpose. However, notification of any errors will be appreciated.



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