FEASIBILITY STUDY

FOR CLARENCE CITY COUNCIL

Lauderdale Urban Expansion

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Executive Summary

This report considers the feasibility of rezoning land at Lauderdale from Rural Living to General Residential. It is the first of three stages in preparing land for General Residential development. The following two stages are the Statutory Approval and Hearings Representations required in the process of rezoning land. This first stage determines the sustainable land capability for future use and development, following analysis of existing and additional professional studies.

There are seven components to this first stage:

- Civil Engineering;
- Environmental Assessment;
- Cultural Heritage;
- Social Services and Facilities;
- Planning and Urban Design;
- Traffic Engineering; and
- Financial Modelling

Civil Engineering

The study area has significant hydraulic challenges associated with its elevation and the consequential impacts of stormwater run-off, coastal inundation and sea level rise. It is important to highlight that providing Council with a sustainable solution for long term management is an essential component of the brief, in addition to being practical from an engineering and cost perspective. To that end, simple solutions such as creating new streets that were frequently flooded in the future and likely to damage Council assets were ruled out early. Fortunately, flood modelling showed no consequential impact on existing residential areas outside of the study area as a result of placing fill in the study area. Therefore, two platforms, separated by Mannata and Ringwood Roads, could be created and linked together, and linked to Acton Road, to create a robust solution based on high rainfall and climate change scenarios.

There are existing and ongoing future requirements for stormwater to cross the site and be drained to either the canal or Ralphs Bay. An assessment of the impact on lot yield of open drains verses underground culverts was conducted and it was found that a combination of the two was the best solution (page 25). It is worth noting that the underground culverts are sized to cater for a 1:100-year flood, thus no overland flow paths are required for cross site storm water, although there are smaller overland flow paths typical of all subdivisions. It is estimated that approximately 50 extra lots can be made available if the piped stormwater drainage solution is adopted. The additional cost to provide underground drainage is therefore approximately $30,000 and $46,000 per lot for the 20 year and 100 year ARI scenarios respectively. Given a development cost of approximately $48,000 per lot (for roads, sewer, stormwater, water, power, telco, design, administration and surveying) and a sale price around $140,000, providing underground drainage appears economically viable for both the 100 and 20 year ARI scenarios. Note that other costs such as filling and land purchase are not included as they will be required regardless of the adopted drainage solution.

Approximately 635,000 cubic meters of fill will be required to bring the site up to 3m AHD and be clear of expected future inundation levels as a result of high rainfall and sea level rise. It has been assumed that the southern platform would be filled first, requiring over 30,000 truck movements over a period of about twelve months. This will potential have a significant impact on the existing community and road infrastructure and will need to be managed accordingly. Potential mitigation strategies are outlined in section 6.1.2.

Environmental Assessment

Welling Consulting completed a natural values assessment of the study area earlier this year. The survey area is characterised by a narrow diversity of vegetation communities in a highly degraded state. A significant population of threatened flora species, Tall Blowngrass (*Lachnagrostis robusta*), was recorded in the degraded saltmarsh vegetation in the southern end of the site. The saltmarsh remnants also provide marginal roosting habitat for the curlew sandpiper and eastern curlew, listed under Commonwealth legislation. The remnants are small and fragmented and therefore not considered critical habitat, making the loss of the remnants unlikely to be a significant impact under the federal *Environmental Protection and Biodiversity Conservation Act*. A development of the site would be subject to a Permit to Take under the *Threatened Species Protection Act* for the Tall Blowngrass and a self-assessment under the *Environmental Protection and Biodiversity Conservation Act* for the two Commonwealth listed shorebirds - eastern curlew and curlew sandpiper.

Cultural Heritage

An Aboriginal heritage assessment was completed for the site by consultants Anne McConnell and Caleb Pedder of Cultural Heritage Management, Archaeology & Quaternary Geoscience. A total of eight archaeological sites were located within the study area comprising seven isolated artefacts discoveries and two artefact scatters. The identified relics were found to have low historical significance, but represent historical Holocene occupation and use of the landscape, which is of social value to the Tasmanian Aboriginal community. The assessment concluded that there are no constraints in relation to subdivision of the study area with respect to the recognition or protection of broader Aboriginal heritage values. It is unlikely any permits to destroy will be required under the *Aboriginal Relics Act*, unless new relics are discovered through the construction process.

Social Services and Facilities

The subject site has good access to social services and facilities. It is serviced by various small retailers including grocery stores (Hill Street Grocer, Bangalee Store, Butcher), formal and informal dining options (The Sand Bar, The Lab, Canal Café & Pizza, Frito Misto, Foreshore Tavern), a florist, pharmacy and real estate agent. There is also a local doctors surgery and skin care clinic. Employment areas are located within a 30-minute commute from the subject site. Some parts of the site have easy walking access to Roches beach which is a significant natural asset.

Planning and Urban Design

The site has been considered both at a strategic planning and local urban design level.

The *Southern Tasmanian Regional Land Use Strategy* (STRLUS) establishes the urban growth boundary setting a 20-year supply limit of residential land release from 2015 to 2035 based on an equal ratio of infill to greenfield development. The subject site is not within the current Urban Growth Boundary and as such the Urban Growth Boundary would need to be amended for a rezoning to occur. The STRLUS was based on the 2006 Census and the Demographic Change Advisory Council (DCAC) projections. The Department of Treasury and Finance released updated projections in 2014 which were approximately 10% below the STRLUS projected population. This means that there is likely to be an oversupply of residential land of about 71 hectares within the STRLUS Urban Growth Boundary, exceeding the land area of the study area (56 ha). The actual area of land zoned Particular Purpose-Urban Growth or General Residential located within the Greenfield Precincts is approximately 883 ha. Of this land, approximately 273 ha (approximately 30%) has development approval for subdivision. Thus an increase to the area of greenfield residential land in the STRLUS Urban Growth Boundary would appear unjustified. That said, if existing areas of proposed residential land within STRLUS were removed from the Urban Growth Boundary, or there were substantial increases in population growth predicted by the 2016 Census or government there may be strategic merit for including the subject area in a future iteration of the STRLUS.

Planisphere assessed the local urban design aspects of the subject site. Due to the site's

location between existing residential, recreation and business precincts, it is essential that the future development design promotes a connected and seamless layout. In particular, there is an opportunity to increase the permeability of the site for both existing and future residents. There are opportunities within the site to:

- Utilise the existing drainage lines as possible active and green corridors to link into the existing wetlands and surrounding green spaces.
- Allow for ease of movement into the study area and from the study area to the surrounds.
- Reflect the surrounding lot sizes and layout where possible, so as not to detract from the existing character of the area.
- Use existing/surrounding road networks as possible entry/exit connections into the study area subdivision layout.
- Provide enhanced access to established bike trials and walking paths.
- Harness views through the placement of open space and pocket parks.
- Face lot frontages onto green corridors, pocket parks and streets.

Three concepts were explored. A Water Sensitive Urban Design Development Concept which established a road network around the existing drainage lines and used them to create linear corridors that run North to South through the site area. A second concept designed around interlocking and interweaving cul-de-sac and a combination of lot sizes in the layout. The third, 'Big Loop', concept promotes a choice of route both internally and externally with minimal use of cul-de-sacs. The final layout selected is a refined version of the 'Big Loop' concept, which has incorporated refinements from the civil engineers, traffic engineer and urban designers. This design has increased the available lot yield from the 'Big Loop' concept plan from 525 residential lots to 583 residential lots.

Traffic Engineering

The North and South development areas will both access onto Mannata/Ringwood Road and onto the South Arm Highway. An alternative exit to Acton Road and a high connection between the two areas is provided such that the development will have emergency access during a flood event. Existing roads that will be affected by the subdivision include South Arm Secondary Road, Acton Road, Ringwood Road to Mannata Street. There will also be redistribution impacts on Balook Street and Bangalee Street. The development is expected to generate approximately 4,875 vehicles/day, with 10% occurring in morning and afternoon peak hour.

A roundabout control with auxiliary approach lanes will be required at the junction of Acton Road and South Arm Secondary Road to service expected future traffic activity from the subdivision. A further roundabout will be required at the Ringwood Road and South Arm Secondary Road junction. There will be a need for the installation of a CHR treatment on Acton road at the subdivision road junction. The narrower western end of Balook Street to the west of Terrina Street would require widening from around 7.7m to 8.3m to be consistent with the adjacent road standards. Ringwood Road will need to be upgraded with kerb and gutter as well as footpaths both sides of the road and a width between kerb faces of 11.0m.

Financial Modelling

The financial modelling is based on the final layout plan which has a yield of 583 residential lots. The basic variables of the modelling are the acquisition price of existing land, the construction cost and the sale price of the created lots. These are discussed in more detail below. The Net Present Value Analysis stages the acquisition and construction costs and deducts this from the lot sales price to achieve the Net Present Value Rate which has a multiplier applied to it to allow for developer risk/profit. A small 10% contingency has been applied to the development costs but this would not include a number of costs that have been excluded (including road/intersection land acquisition or services relocation, decontamination, legal conveyancing, marketing, real-estate and finance costs).

Applying a 10% Hurdle Rate, a median sales price of $150,000 per lot, a median acquisition price of $525,000 and a fill supply cost of $20 per cubic metre returns a negative NPV value of -$8,085,282 and thus is not feasible. The Net Present Value can be brought positive by altering these variables within a reasonable range, but given they are largely outside the control of the developer and there are number of exclusions likely to drive up the project cost, to do so would result in high risk project. The exception to this is perhaps the cost of fill. $20 per cubic metre is a representative commercial rate for such large quantities. If fill is sourced for free it would presumably be in a piecemeal fashion over an extended period of time. This would increase the laying and compaction rate as well as delaying any revenue obtained through lot sales. This would likely still result in a negative Net Present Value.

There is scope to refine the lot layout to increase the yield by 5% but this would not substantially improve the feasibility. The cost for provision of standard infrastructure for an urban residential development has been estimated at approximately $48,000 per lot. This is consistent with other similar developments where these costs generally range between $40,000 - $50,000 per lot.

It is also worth noting there is an assumption in the feasibility assessment that the developer would only need to pay half the cost of the South Arm Highway/Acton Road ($1.5M) and Ringwood Road/South Arm Highway ($0.9M) intersections given these would benefit other users. The actual split is dependent on timing of the development and the State Growth budget allocations at that time. The cost of moving underground/overhead services and land acquisition costs for road widening have both been excluded, but may prove a significant cost which will not be known until the detailed design stage of the proposal.

Rezoning land within the study area to General Residential is technically achievable but would require upgrades to infrastructure and significant amounts of fill. The strategic framework review demonstrates that rezoning the land does not align with the current regional strategy for residential development. The project is financially unfeasible due to the cost of providing adequate fill and infrastructure upgrades in addition to the cost of property acquisition, and subsequent sales values of the improved lots.

It may be possible to undertake the development through a piecemeal approach by each property owner, however, this would significantly add to the overall development cost and brings in issues associated with infrastructure upgrades such as drainage culverts and road works. This infrastructure could be constructed by Council and funds recouped via a headworks charge (assuming such a mechanism is available to Council). However, it is anticipated that such a headworks charge would be cost prohibitive to small scale development. The site development staging in the modelling assumptions provides the best case scenario in terms of financial feasibility.

1. Introduction

JMG Engineers & Planners has been engaged by Clarence City Council to investigate the feasibility of urban expansion at Lauderdale. This report examines the development potential of approximately 56 ha of land at Lauderdale, including a critical analysis of the constraints affecting the study area and the parameters that ought to guide any future development of the land.

The aim of this study is to determine the feasibility of the sustainable further development of residential land located outside the established urban growth boundary in Lauderdale, adjacent to existing general residential land and the local business zoned land.

Based on an assessment of infrastructure, natural hazards, strategic policy framework and best practice urban design principles, a concept subdivision and civil infrastructure solution for the land has been prepared.

The feasibility assessment then costs the required infrastructure that would be required to facilitate future development of the study area and considers this against likely sales revenue to establish the viability of the project.

Figure 1-1 - Location Plan

2. Study Area & Location

The study area encompasses approximately 56 hectares of land in 31 freehold titles, as shown in Figure 2-1.

Except for one TasWater-owned title all properties are in private tenure. The majority of properties within the study area have been developed with single dwellings.

The study area has access from South Arm Road (southwest), Acton Road (west), Balook Street (east), Mannata Street and Ringwood Road (south). South Arm Road is the main arterial road providing access to Lauderdale and the South Arm peninsula.

Surrounding land use and development includes urban residential, a retirement village, the Lauderdale Primary School, the Roscommon Reserve (public open space) and commercial development on South Arm Road.

All properties within the study area are currently zoned Rural Living, as shown in Figure 2-2. The study area forms part of a larger area of Rural Living zoning that extends to the west and is contiguous with the General Residential zoned land.

Lauderdale is a coastal suburb situated in the Clarence municipality with a population of approximately 2,300.

Figure 2-1 - Study Area

Figure 2-2 - Zoning Plan

3. Civil Infrastructure

3.1 Earthworks

Development of this area to allow for residential development will require the placement of large volumes of fill material in order to ensure the site is not subject to inundation.

Preliminary earthworks modelling shows that the northern part of the study area will require approximately 185,000 m^3 of fill and the southern part of the study area will require approximately 450,000 m^3 of fill.

Earthworks modelling has been done using Lidar data collected as part of the Climate Future project in 2008. While it is understood that large volumes of fill have been placed in the southern area since this data was collected, there are a number of reasons that this concept design has been based on the 2008 information and is discussed further later in this report.

3.1.1 Fill Requirement for Urban Development

Australian Standard AS 3798-2007 covers the requirement for the planning, design and placement of earthworks for residential developments. Factors which must be considered in planning such a large infill project as is required for Lauderdale include fill source material, rehabilitation, temporary drainage and erosion and siltation. All of these factors will need to be considered for this project.

There are a number of specific requirements for the placement and compaction of fill material which need to be considered as part of the planning of the development. These include:

- All material brought into the site needs to be sourced from locations which do not contain any existing contamination issues;
- Records of the fill material source and placement of fill within the development need to be kept;
- All material must comply with the EPA Tasmania requirement for Class 1 material;
- Fill material containing fragments greater than 600 mm should not be placed in areas where future trenches, piles or footings are to be constructed;
- Granular fill should be used in areas which may become wet during construction.

The placement of existing fill material within the study area has created a number of issues which need to be addressed. These issues are covered by Section 2, Part (o) of AS 3798 and, where records of the placement are not available, include:

- The risk that imported material has come from a contaminated source;
- That fill has not been adequately compacted; and
- That fill has been placed over unstripped ground which may be subject to settlement in the future when underlying vegetation decays.

Where the source and placement of material has not been documented, the Standard recommends that a thorough site investigation be undertaken including test pits, test rolling and testing for contamination. The analysis of such results could require additional rework of this material and in the worst case the complete removal of materials.

It is for the above reasons that the concept design has excluded this existing material from the fill quantities on the basis that some or all of it will require reworking to comply with residential fill standards.

3.1.2 Fill Placement and Compaction

Due to difficulties in controlling the quality of fill associated with small scale importation (which is currently occurring), it is recommended that fill be sourced as a large-scale operation using an experienced civil contractor. This will enable all the records required, including compaction, to be fully documented. These records will then be available for

future lot developers providing evidence that the site/s will be suitable for their intended use.

AS 3798 stipulates the required compaction for residential sites, specifying a minimum density ratio at standard compaction of 95%. Furthermore, material to be placed under future roadways must be supplied, placed and tested in accordance with the Department of State Growth Standard Contract Documents and Specification Section R22 Earthworks.

During all earthworks, temporary drainage measures need to be put in place to ensure that material does not become saturated during wet weather events. Furthermore, run-off during earthworks and establishment of vegetation needs to be controlled to prevent damage to the environment.

Potential Impacts on Community

Importing 635,000 cubic meters of fill will have an impact on the community in terms of:

- Increased truck movements;
- Noise, dust and visual presentation; and
- Potential road damage.

It is proposed that the southern area will be filled first to enable this area to be developed. In this way drainage infrastructure can be constructed in preparation for development of the northern area. The 450,000 cubic meters of fill required would generate approximately 30,000 truck movements. Assuming this is done in the first year of the project, this equates to a truck every 4 to 5 minutes based on 250 working days and a nine-hour day. A similar situation would exist for the northern area. The management of these truck movements would have to be carefully considered and planned to ensure minimal traffic impact. Controls could include:

- Restrictions on time of day for works (7am to 8am, 9am to 3pm, 6pm to 8pm);
- One way movements (in from Ringwood Road, out from North Terrace); and
- Coordination of movements to ensure a steady flow and no delays.

The above control measures will go some way to minimizing noise, dust and visual impacts. However, it may be necessary to include other measures such as:

- Public consultation and input into conditions;
- No filling on high wind days; and
- Visual screening.

If filling is undertaken over a select period of time, it will be easier to establish impact on existing roads and it may be necessary to seek a developer contribution to any road works required to be brought forward to service the development (such as resealing).

There are a number of issues associated with such large quantities of fill that would have to be thoroughly investigated and documented as part of a Construction Management Plan (CMP) to be approved by Council prior to start of works.

3.2 Stormwater Drainage

The subject area is intersected with two significant drainage channels. Drain NT1 services a catchment of approximately 141Ha and channels runoff from the eastern side of Lauderdale, through Roscommon Wetlands and down a formed concrete lined open drain from Balook Street to 12 North Terrace (Figure 3-1).

Drain NT2 serves a catchment of approximately 117Ha and channels runoff from the western side of Lauderdale (Figure 3-2), under Ringwood Road and the developed area of Roches Beach Living (RBL) retirement village to 12 North Terrace. From here it joins NT1 and flows via a DN900 culvert to South Arm Highway where flows enter twin DN600 culverts under the Highway to Ralphs Bay. Prior to entering the DN900 culvert an area of low lying land has formed a natural detention basin. Historically, this detention basin has attenuated flows potentially reducing downstream flooding. In recent years the basin has been progressively filled, substantially reducing its effectiveness. Refer to SK01 and SK02 in Appendix A.

3.2.1 Drainage Analysis

Analysis of the drainage system is required to establish the following:

1. Design of new drainage system with consideration of the proposed urban expansion areas
2. Effect of proposed urban expansion on existing properties in terms of inundation depths.

To achieve the scope, a hydraulic model was established using HEC-RAS with the following parameters.

- Urban expansion area filled to at least 3m AHD with a road network on the fill (SK04 and SK05 in Appendix A details the required fill depths).
- Existing open drains retained within 15-20m wide drainage/open space corridors. Existing drains were modelled with the following cross section:
  - NT1 - 1200mm wide by 60mm deep concrete lined shallow v-drain with grass batters at 1 in 7 grade.
  - NT2 - 1500mm wide by 150mm high concrete base with grass batters at 1 in 7 grade
- Replacing the open drains with underground drains was also investigated.
- Remove detention storage behind North Terrace and allow development in this area
- Provide additional drain to Ralphs Bay adjacent to existing DN900 culvert
- Allow flooding of Mannata Street or raise height and install box culvert
- Provide alternative overland route around Balook Street cul-de-sac head or increase culvert capacity under Balook Street.
- Ignore Roscommon wetlands detention storage as there is no low level drain to ensure that the storage area is empty prior to the start of a rainfall event
- Replace existing 600x300 box culvert under Ringwood Road and connect directly to existing 2250x450 box culvert under RBL.

Figure 3-1 - Existing 2250 x 450 box culvert at RBL.

Figure 3-2 - Existing open drain, NT2

Figure 3-3 - Existing 1500x500 box culvert at CH.130 on NT2

Figure 3-4 - Existing Culvert inlet from wetlands at Balook Street. Start of NT1

Figure 3-5 - Existing 3 x DN375 culverts under Balook Street

Figure 3-6 - Existing 3 x DN375 culverts under Mannata Street

Figure 3-7 - Existing concrete lined open drain, NT1.

Figure 3-8 - Existing DN900 culvert at 12 North Terrace

3.2.2 Rainfall and Runoff

Once the hydraulic model was developed, runoff flow rates were established to provide maximum flows through various parts of the network. Book VIII of Australian Rainfall and Runoff (ARR) was used to establish flow rates and in particular the constant in the Rational Method formula, C.

Developed areas were assumed to be 50% impervious and undeveloped areas upstream of the urban expansion area were assumed at 1% impervious to make an allowance for occasional dwellings and hardstand/road. The rate of 50% impervious was based on an assessment of existing adjacent properties of similar lot size and is deemed to be realistic rather than conservative.

For critical flows lower in the catchment, short duration, high intensity events on the immediate catchment were considered, however these were not found to produce higher flows than considering the entire catchment.

Rainfall intensities were increased by 20% from those published by the Bureau of Meteorology (BOM) to allow for the most probable climate change scenario in the year 2100 (Pitt&Sherry, 2012 (page 7)).

It should be noted that, in general, a realistic approach to calculation of design flow rates has been adopted. Conservative contingencies have been kept to a minimum in order to

provide the most cost effective drainage solution. Other methods (such as the Turner Method in Book IV of ARR) will yield different results that may result in higher runoff rates and subsequent drainage infrastructure costs. Further consideration will be required if detailed design is undertaken.

Appendix A details the calculations and drawing SK03 details the catchments. A summary is provided below in Table 1.

Table 1 - Summary of maximum flow rates at particular Chainages in the network. Flows are inclusive of 20% extra due to climate change.

Location			Flows at various ARI's (L/s)						
			ARI (years)						
River	Chainage	Description	1	2	5	10	20	50	100
NT2	1245	Upper end of NT2 drain	368	514	762	932	1161	1550	1855
	760	Ringwood Road	530	731	1054	1268	1557	2047	2422
	300	New drain from Manata Rd	614	841	1193	1422	1733	2258	2655
NT1 and 2	280	Confluence of NT1 and NT2	1143	1560	2194	2600	3152	4087	4787
NT1	1664	Upper end of NT1 drain	466	639	910	1086	1325	1730	2036
	600	Manatta Rd	515	704	993	1179	1432	1861	2183

3.2.3 Sea Level backwater effects

The drains discharge to Ralphs Bay. High sea levels will affect flooding of low lying areas either by direct inundation from the sea or by not allowing flood waters to discharge freely to Ralphs Bay. The following scenarios were modelled for their effect on inundation.

Table 2 - Sea Level and flooding event modelling scenarios.

Scenario	Rainfall event Probability in year 2100 (ARI, yrs)	Sea Level (m, AHD)	Sea Level Probability in year 2100 (ARI, yrs)
1 - High Rainfall	1:5 to 1:100	1.1	1:0.0014 (Mean High High Water - expected to occur twice a day)
2 - High Sea Level	1:1 and 1:2	2.9	1:100 (0.9m SLR including wave run-up and setup)

The above scenarios are deemed to cover 1 in 100-year rainfall and sea level rise events for the year 2100. The scenario of high rainfall and high sea level has not been considered as it is seen as overly conservative. The probability of a 1 in 100 year ARI rainfall event and a 1 in 100 year ARI sea level event occurring simultaneously would possibly be in the order of a 1 in 1000 year ARI event or greater.

3.2.4 Results

Model calibration

In order to validate results the model was run with all existing culverts in place and no sea level rise backwater effects. Results were compared with previous studies done by JMG and Pitt&Sherry. Levels at critical cross sections are summarised below in Table 3.

Table 3 - Comparison of predicted flood levels for model calibration

Location	JMG, 2016	JMG, 2012	P&S, 2012
Entrance to DN900 culvert	1.66	1.5	1.59
Roscommon wetlands	2.34	NA	2.49

In addition, JMG (2012) estimate that overtopping of the drain under Roches Beach Living will occur somewhere between a 1 in 5 and 1 in 10-year event. This is consistent with the developed modelling results.

It is clear that there are discrepancies in modelling results most likely due to differing assumptions of catchment characteristics and modelling techniques. Absolute level values should be taken in context and are deemed to have an accuracy of +/- 150mm, which is consistent with the accuracy of LIDAR data used to create the model. However, comparison of results from the same model can be used with much greater certainty. That is, if a mitigation technique results in lowering water levels, this can be relied on.

Scenario 1 – High Rainfall

Current culverts

The model was run with the scenario outlined in Table 2 above with current culverts in place. Long section water profile plots are shown in Figures A-C of Appendix A.

Upsized culverts

In order to reduce flooding under this scenario it is proposed to increase culvert sizes as follows:

- Balook Street 3 x DN375 RCP's upsized to a 5m wide by 450mm deep box or provide overland channel around cul-de-sac to bypass the cul-de-sac culvert
- Mannata Street 3 x DN375 RCP's upsized to a 5m wide by 375mm deep box culvert
- Ringwood Road 600 x 300mm box culvert upsized to same as that under RBL (2250x450mm box).
- Existing 2250 x 450mm box culvert under RBL retained as this is hard to replace.
- Access Road Culvert at CH. 130 upsized to 3.6m wide by 600mm deep box culvert
- Additional 3900 x 900mm box culvert adjacent DN900 to South Arm Highway
- Additional 3000 x 600mm box culvert under South Arm Highway.

Long section water profile plots of the revised network are shown in Figures D-F of Appendix A.

The proposed increase of culvert capacity ensures that flood waters will drain directly to the sea for rainfall events up to 1 in 100 year ARI for the year 2100. Inundation extents are shown in Figure 3-9 below.

Options to limit inundation depths at Roches Beach Living

Ground level at RBL is as low as 1.8m AHD with floor levels of habitable buildings above 2.2m AHD. Rainfall events above a 1 in 5 year ARI will overtop Ringwood Road and flood the site to a level of around 2.18m. If this is not acceptable, mitigation options include:

Option 1

Raising Ringwood Road and Mannata Street to 3m AHD. This provides enough head water depth at the upstream end of the culvert under Roches Beach Living to drive the water through the culvert rather than overtopping the road for events greater than 1 in 20 year ARI (Figure G of Appendix A). The major issue with this option is that Roches Beach Living will become lower than the entire surrounding area, effectively forming a basin. Water will have to be pumped out during high rainfall events, which presents significant operational risk.

Option 2

Providing a cut off drain to divert flows from above the Urban Expansion area (contour 3.6m AHD) directly to Ralphs Bay through 424 South Arm Highway. This reduces the catchment area above the urban expansion area to approximately 23 Ha from 75Ha. Also, approximately 3Ha of the 17Ha urban catchment above Ringwood Road is diverted to the 424 South Arm Highway drain. The respective flow rates are detailed in Table 4 and profile plots for each catchment are shown in Figure H and I of Appendix A. Note that these plots are inclusive of all upsized culverts detailed above. Levels at the lower detention basin (12 North Terrace) do not change significantly.

Relying on a catch drain to reduce flows through an urban area may be problematic. It is likely that over the years the drain will become blocked and not maintained. The effectiveness of the drain is also limited. For these reasons, this mitigation option is not recommended but could be implemented at a later date if required.

Option 3

Increase culvert capacity under RBL by adding a 3.6m x 0.6m box culvert to the existing 2.25 x 0.45m box culvert. This decreases the recurrence interval for overtopping Ringwood Road to a 1 in 50-year event or greater (Figure J of Appendix A).

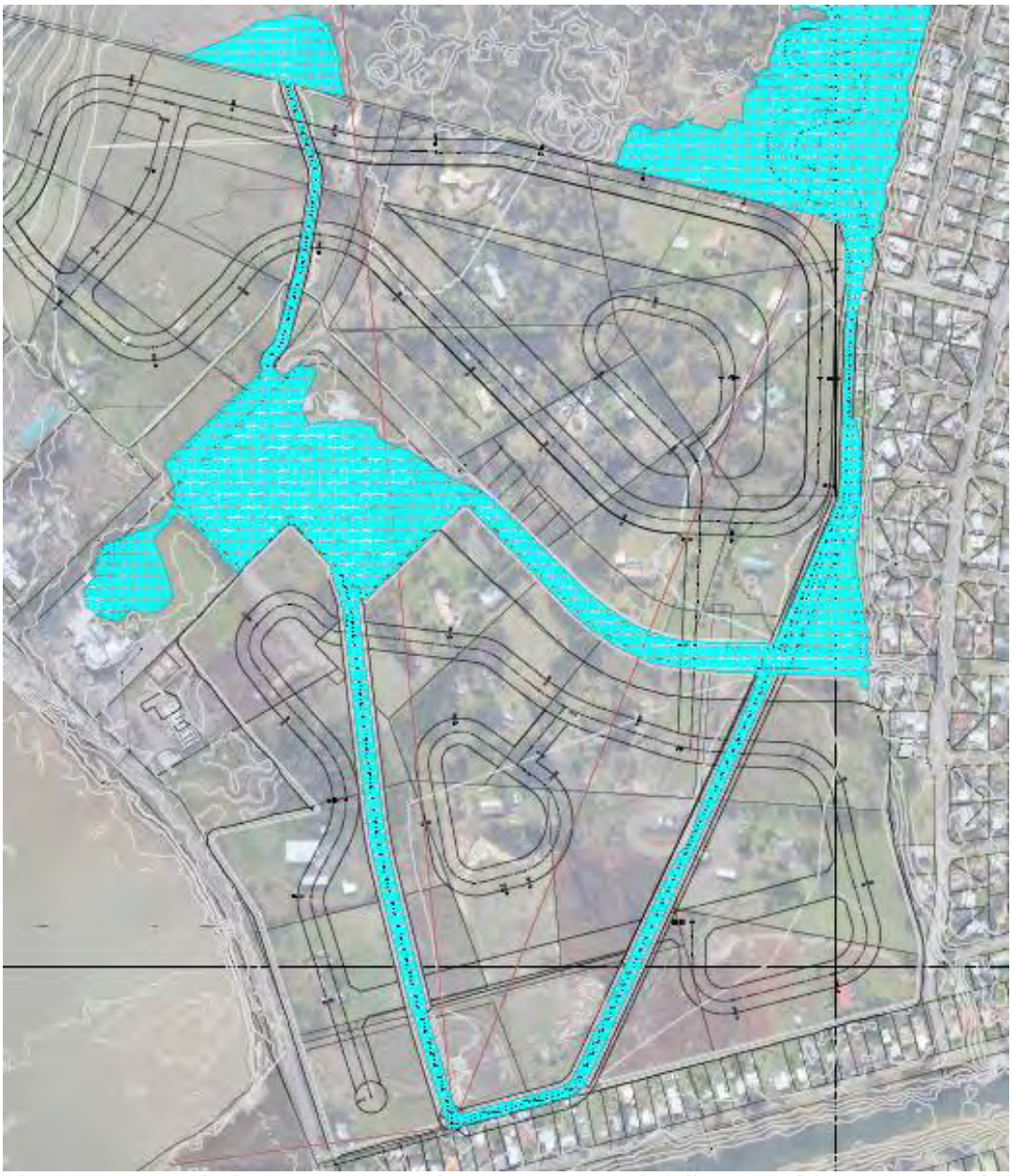

Figure 3-9 - Inundation extent for a 1 in 100 year ARI rainfall event with year 2100 rainfall intensities and Mean High High Water (MHHW) sea levels (1.1m AHD). Note that the only residential area effected is Roches Beach Living.

Table 4 - Modelled flow rates for a reduced catchment by constructing a catch drain above 3.6m AHD and diverting flows to 424 South Arm Highway and directly to Ralphs Bay.

Location			Flows at various ARI's (L/s)						
			ARI (years)						
River	**Chainage**	**Description**	**1**	**2**	**5**	**10**	**20**	**50**	**100**
NT2	1245	Upper end of NT2 drain	107	148	218	266	330	439	523
	760	Ringwood Road	231	318	458	551	677	890	1053
	300	New drain from Manata Rd	319	436	619	738	899	1172	1378
NT1 and 2	280	Confluence of NT1 and NT2	921	1257	1768	2096	2541	3294	3858
NT1	1664	Upper end of NT1 drain	244	334	475	567	691	900	1059
	600	Manatta Rd	303	414	584	694	843	1096	1285

Scenario 2 – High Sea Level

Under scenario 2, a 2.9m sea level will inundate the entire drainage system except for the very top end of NT2, which is up to 500mm above sea level as shown in Figure K of Appendix A.

Mitigation options for a high sea level scenario are straight forward for the proposed urban expansion area (fill the area to a level above future sea level) but much more difficult for existing low lying areas. With back water levels of 2.9m AHD water will break out of the open drains where the top of bank levels are below sea level. These areas are shown in Figure 3-10 below. Note that significant inundation of existing properties occurs with depths up to 1.5m. The proposed Urban Expansion Area is not affected if ground levels are raised over 3m AHD.

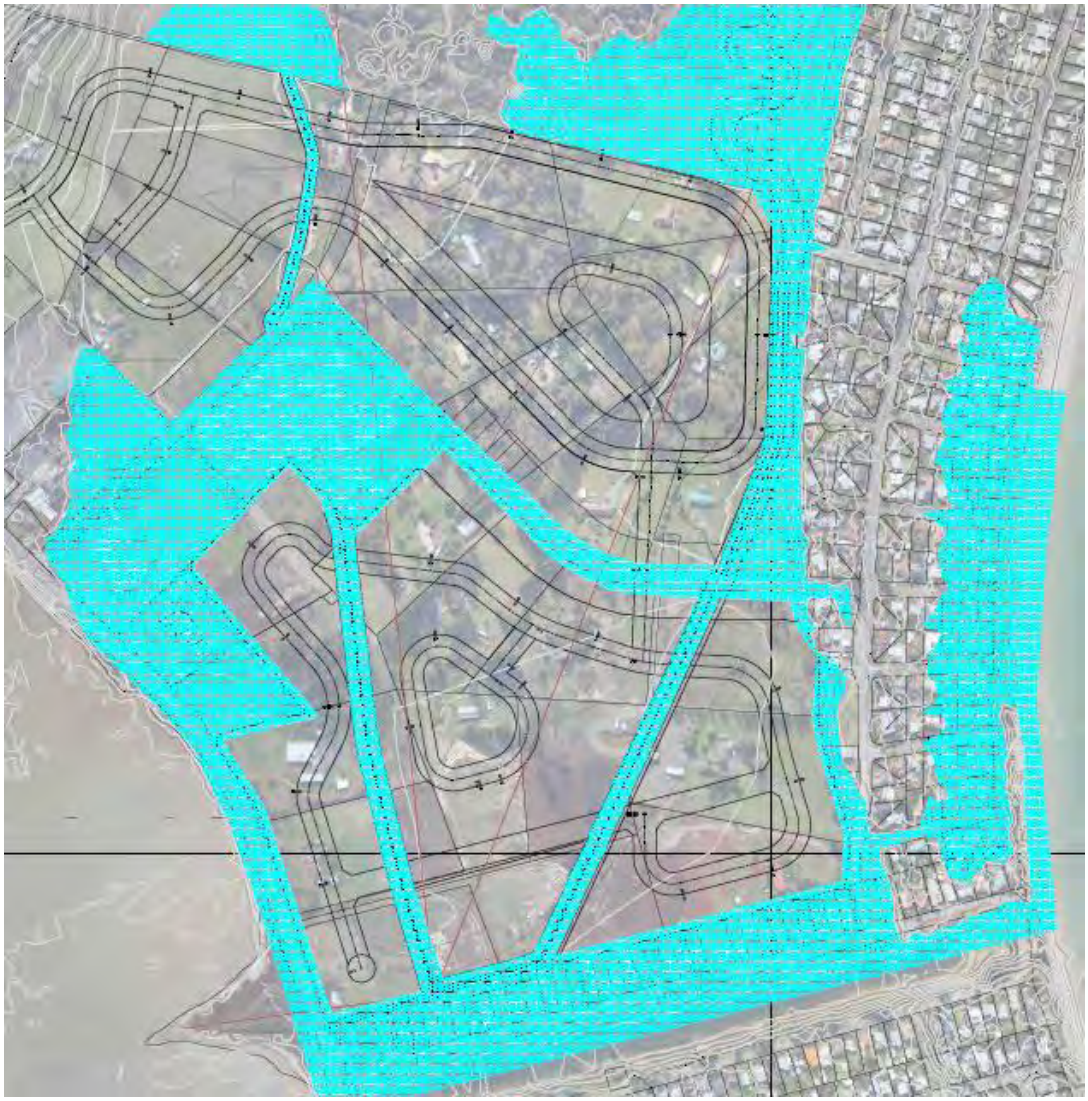

Figure 3-10 - Map showing inundation areas for Scenario 2 - High Sea Level (2.9m AHD).

Effect of proposed urban expansion on existing areas - Inundation

Inundation of low lying areas is an existing issue in Lauderdale. Previous studies have investigated the extent of inundation and discussed mitigation options. One of the major drainage constraints is insufficient capacity of the existing DN900 culvert from 12 North Terrace to South Arm Highway. Providing an additional 3000 x 600mm box culvert at this location ensures that the "natural" lower detention basin is free draining. This decreases water levels in this area from the projected 1.9m AHD to 1.7m AHD for a year 2100, 1 in 100 year ARI rainfall event.

Providing the drain has an embankment height higher than (say) 2m AHD and water is confined to the drain, flooding of properties on North Terrace should not occur. Note that these properties are as low as 1.2m AHD and will be below the water surface profile within the drain to the rear of the properties.

Lowering this level to 1.7m has the additional benefit of lowering backwater levels at Mannata Street and therefore increasing culvert capacity. Although Mannata Street is still overtopped in most rainfall events, levels are reduced from 2.1m to 2.0m for the 1 in 100-year event.

Flooding levels at Balook Street are largely unaffected by the urban expansion proposal, with levels remaining around the 2.5m AHD mark. This is due to no change to the upstream catchment as a result of the development. Filling of the urban expansion area will remove the existing overland flow path around Balook Street cul-de-sac and high flows will overtop the road. It is recommended to upgrade the culvert to 5m wide by 450 deep, which will reduce overtopping events to 1 in 2 years ARI or greater. The road should be made capable of being a ford for events greater than the culvert capacity. Overtopping levels will be dependent on final drain/road profiles but would not be expected to be more than 300mm for a 1 in 100 year ARI event or 200mm for a 1 in 20 year ARI event. Appropriate signage will be required.

Assuming that future fill over the existing 1500 x 500mm box culvert at the access road (CH.130 on NT2) creates an embankment with a top of around 2m AHD, the culvert is well undersized. Increasing this culvert to 4m wide reduces upstream flooding to below 2.15m AHD at RBL (and Ringwood Road), which is similar to current expected flood levels.

The culvert under RBL can be increased to 4.5m x 0.6m (or an additional 3m x 0.6m culvert) to cater for the 1 in 100 year ARI event although this is of little benefit as it is likely that inundation will occur at RBL anyway because it is lower than the surrounding area. RBL have an onsite detention pond and pump station to transfer flood waters to the drainage network. This is only designed to take onsite runoff and not that from upstream flooding. Provided that this pump station is operable in a flooding event and the culvert is increased to 4.5m x 0.6m then RBL will be protected from inundation.

Stormwater Detention

A potential mechanism to control runoff quantity is to limit runoff to pre-development levels for a certain storm event (usually 1 in 20 year ARI) by way of stormwater detention. If a development is in the upper reaches of a catchment that has known capacity issues further down the network, this can be an effective way to reduce flood peaks. However, if a development is in the lower reaches of a catchment it can sometimes be beneficial to allow peak flow to leave the site and clear the downstream network prior to the main flood peak passing the site from upstream. If detention is utilised in these circumstances, it can actually increase peak flows rather than reduce them as flows are discharged to the network when the peak flow passes the site rather than ahead of it.

Providing detention storage in very flat ground (such as Lauderdale) can be challenging because a large area is required to achieve the necessary volume. In addition, detention storage for this site would be below 2.9m AHD and would therefore be ineffective under a 1 in 100 year ARI sea level scenario.

Given that the Urban Expansion Area is at the bottom of the catchment and detention is unlikely to be effective for events greater than a 1 in 20 year ARI storm it is recommended to simply provide sufficient capacity in the stormwater network to cater for runoff. Pipes

should be designed for 20 year ARI flows and the entire network should effectively drain the area for a 100 year ARI flow.

If issues arise in the future due to unforeseen increase in rainfall intensities, detention could be utilised upstream of the urban expansion area to reduce flows through it.

Replace open drain with underground pipes

Wide open drains take up a large amount of land. Land that could be used for alternative purposes such as residential or more usable open space. The existing open drains cut the lower development area into three sections that do not provide for efficient land use.

An alternative drainage arrangement is shown in Figure 3-11 below. This arrangement reduces the required pipe lengths (and therefore costs) as much as possible to ascertain economic feasibility.

Figure 3-11 - Alternative drainage arrangement utilising underground pipes (box culverts) rather than retaining existing open drainage channels. The dark blue dashed lines are proposed conduits and the light blue dashed lines are existing conduits. The light blue solid line to the east is the existing open drain / linear park.

The associated costs and calculations for the provision of an underground drainage system are detailed in Appendix A and summarised in Table 5 below.

Table 5 - Costs associated with providing underground drainage system to allow surface development. Q20, Q100 costs are associated with required infrastructure for the 20 and 100 year ARI rainfall events respectively.

Summary - Required box culverts	Q20		Supply and install rate ($/m)	Q20 Cost	Q100		Supply and install rate ($/m)	Q100 Cost
Western drain (through RBL)	Breadth (m)	Depth (m)			Breadth (m)	Depth (m)		
Upstream Ringwood Road	2.1	0.6	1880	$ 507,600	2.7	0.6	2510	$ 677,700
Downstream RBL	3	0.6	2680	$1,072,000	4.5	0.6	3930	$1,572,000
Eastern Drain (Manatta Road)								
Downstream Manata Road	2.7	0.6	2510	$1,179,700	4.2	0.6	3760	$1,767,200
Procure easement through 52 North Tce				$ 40,000				$ 50,000
Extra over for road crossing and outfall				$ 50,000				$ 60,000
TOTAL				**$2,849,300**				**$4,126,900**

To provide the same level of service in an open drain solution the following infrastructure and associated cost is required (Table 6).

Table 6 - Costs associated with providing open drain solution for both 20 year and 100 year ARI scenarios. These costs assume open drains in their current location utilising existing formation and concrete lining where possible.

Open drain costs	Quantity	Rate ($)	Q20 cost	Q100 cost
Concrete base	500	100	$ 50,000	$ 50,000
Excavation and forming drain	500	200	$ 100,000	$ 100,000
Balook Street culvert upgrade to 5m x 450mm	1	125000	$ 125,000	
Balook Street culvert upgrade to 6m x 450mm	1	150000		$ 150,000
Additional 2.25m x 450mm culvert under RBL	1	347800	$ 347,800	
Additional 3.6m x 600mm culvert under RBL	1	555000		$ 555,000
20m long under new road culverts 3m x 0.6m	6	50000	$ 300,000	
20m long under new road culverts 4.2m x 0.6m	6	70000		$ 420,000
Additional 3m x 600mm culvert from 12 North Tce to Ralphs Bay	1	420000	$ 420,000	
Additional 4m x 600mm culvert from 12 North	1	560000		$ 560,000
TOTAL			**$1,342,800**	**$1,835,000**

It is estimated that approximately 50 extra lots can be made available if the piped solution is adopted. The additional cost to provide underground drainage is therefore approximately $30,000 and $46,000 per lot for the 20 year and 100 year ARI scenarios respectively. Given a development cost of approximately $48,000 per lot (for roads, sewer, stormwater, water, power, telco, design, administration and surveying) and a sale price around $140,000, providing underground drainage appears economically viable for both the 100 and 20 year ARI scenarios. Note that other costs such as filling and land purchase are not included as they will be required regardless of the adopted drainage solution.

Effect of underground drainage solution on surrounding areas

Once again, the main drainage issue will be focused on RBL. The capacity of the existing 2250 x 450 culvert is only about 1 in 5 year ARI for the fully developed scenario. Events greater than this will result in overland flow down Mannata Street to the eastern drain NT1 as well as causing flooding of low lying areas in RBL.

If the culvert under RBL is increased to the same capacity as the required underground system upstream (4.5m x 0.6m) then flows up to the 1 in 100 year ARI event will be retained within the piped network. Events greater than this will not be able to enter the piped network at its upstream end and will flow overland down Ringwood Road and Mannata Street. The lowest overland flow outlet level is down Ringwood Road, through 464 and 476 South Arm Road before heading over South Arm Road at number 488. The overflow level at 464 South Arm Road is 2.2m AHD. Once flood waters reach this level at RBL, they

will start to flow to Ralphs Bay. For this reason, flood levels are not expected to exceed approximately 2.3m AHD as long as sea levels are below this level. Existing ground levels around Mannata/Bangalee intersection are approximately 3m AHD and therefore will not be effected by the urban expansion in terms of inundation.

To avoid overland flows from the eastern drain NT1 heading either through the urban expansion area to North Terrace or down Mannata Street and Ringwood Road and over South Arm Road to Ralphs Bay it is recommended to provide underground drainage to cater for the 1 in 100 year ARI event. Overland flow paths through the urban expansion area to the south of Mannata Street should be above 2.5m AHD to ensure that flows head down Ringwood Road rather than to the very low lying areas on North Terrace.

Maintenance of underground drains

Flat drains have a tendency to silt up over time and become less effective. It will be necessary to periodically inspect all drains and clear blockages as required. The use of pressure jet washers will be required and therefore regular access and inspection points will be necessary.

3.2.5 Geology and Groundwater

An overview of the Geology of the area is provided below. The information has been extracted from a report prepared by W C Cromer Pty. Ltd for the Lauderdale Sewerage Scheme (*Geotechnical Report, Lauderdale Sewerage Infrastructure, Lauderdale - Rokeby - January 2009*).

General description

Lauderdale is underlain by unconsolidated Quaternary- and probably Tertiary-age sediments including beach and Aeolian sand, near-shore marine sands, and backswamp and estuarine sand, silt and clay. Lower ground is underlain by Tertiary-age sediments, and the higher ground is underlain by Permian-age sandstone and siltstone intruded by Jurassic-age dolerite.

The unconsolidated sediments at Lauderdale comprise:

- two upper units up to about 6m thick (and locally more) of loose grey sand and shelly sand over loose to stiff, bright olive green sand, clayey sand, silt and clay over
- at least two lower units of mottled orange and grey, stiff to hard, clay, silty clay and clayey silt.

The combined thickness of the four units is at least 24m, but may be much more. The uppermost units include the Aeolian and beach sands which form an arcuate strip bordering Roches Beach, and extending up to 200m or so inland. This strip and the boundary line with the estuarine silty sands and clays is shown in Appendix A.

Of importance to surface runoff from the areas is the significant difference in permeability with catchment west of the boundary line being significantly less permeable than the Aeolian and beach sands to the east. The bulk of the catchment for the Urban Expansion Area lies within the less permeable western soils and therefore runoff can be expected to be higher than in the existing urbanised area to the east. This has been factored into the rainfall and runoff calculations.

Groundwater

The hydrogeology of the Lauderdale area was studied extensively in the 1990's firstly as part of the environmental management plan to extend the Lauderdale tip, and later to assess the impact, if any, of domestic wastewater disposal on groundwater quality north of the canal. These and other investigations are summarised by Cromer (2009).

Groundwater is present at shallow depth throughout the unconsolidated Quaternary sediments at Lauderdale, and in the adjacent Tertiary sediments near the Lauderdale School. It is also probably present in the older Permian sediments and Jurassic dolerite, but at greater depths.

In the unconsolidated Quaternary materials at Lauderdale four types of groundwater are recognised (Cromer 2009, cited above):

- Type 1. This is a low salinity water (electrical conductivity <2,000µS/cm) in the arcuate coastal Aeolian and beach sand bordering Roches Beach
- Type 2. This groundwater is moderate salinity leachate (electrical conductivity <5,000µS/cm) beneath the former Lauderdale tip, which is on the southern side of the Lauderdale Canal and not in the area covered by this report.
- Type 3. This high salinity groundwater occurs beneath the low-lying salt marshes extending from the rear of the beach system west to Ralphs Bay. Near surface electrical conductivities may exceed 50,000µS/cm (compared to sea water conductivities around 35,000µS/cm) but probably decrease with depth. This groundwater type is present in the low lying area to the north of North Terrace (64,000µS/cm) with decreasing values upstream at the Main Sewage Pumping Station (13,100µS/cm).
- Type 4. This groundwater is a moderate salinity water (electrical conductivity 3,000 – 5,000µS/cm) present in the silt and clay sediments rising gently inland to the west from Roches Beach, and to the north from near the Lauderdale Tavern and north of Ringwood Road and Mannata Street. The urban expansion area falls within this groundwater type.

W C Cromer Pty. Ltd was subsequently engaged by Clarence City Council to undertake a desktop review of Acid Sulfate Soils (ASS), geology and groundwater in the study area (Cromer, 2016). Acid Sulfate Soils have been addressed in Section 4.4, the geology is largely unchanged from that cited above and a summary of engineering/groundwater issues are below.

- All proposed and in-situ fill should be sampled and shown to be Fill Material in terms of Table 2 of DPIPWE's Information Bulletin 105 *Classification and Management of Contaminated Soil for Disposal* (November 2012). Some fill material may not be suitable for sensitive uses such as child play areas or garden beds.
- Filled areas will create a water table within them likely to be higher than the water table in surrounding areas. This will cause additional seepage into adjacent low lying areas such as Mannata Street, Ringwood Road and the rear of properties on North Terrace. However, the seepage flows are not expected to be significant.
- Settlement of imported material can be mitigated by adequate compaction during placement. However, settlement of underlying material may need to be addressed and subsurface investigations should be undertaken prior to placement of fill.
- Groundwater quality is unlikely to be a significant engineering issue
- Raised water tables in filled areas will be largely unaffected by rising sea level. Groundwater levels in low lying areas will rise as sea level rises, and by similar amounts. Coastal defenses such as sea walls or impermeable barriers will have no effect on this as water will pass through the permeable sediments below.

In summary, groundwater is unlikely to be a significant engineering issue with the proposed filling and urbanization of the study area. However, Cromer (2016) suggests the following mitigation tasks.

- Sample existing fill for contamination
- Sample and analyze future fill at its source for potential contamination
- Undertake geotechnical and hydrogeological investigations to assess subsurface conditions

These costs have been included in the financial analysis.

3.2.6 Drainage Recommendations

Based on the preceding analysis the following recommendations are made with respect to drainage:

1. The Urban Expansion area must be raised to above 3m AHD and adequate drainage provided to ensure the area is not subject to inundation. Improved drainage will mitigate adverse impacts on the surrounding areas as a result of fill.

   Approximately 185,000m^3 will be required in the northern area and 450,000m^3 in the southern area. It is noted that these are very large volumes and will require management during filling operations (refer Section 6.1).

2. A new road network must be designed and constructed to Council Standard Details.

3. Swale/bioretention drains are to be provided for water treatment discharging to underground pipe network to ensure drainage during high rainfall events.

   Swale/bioretention drains will provide an effective treatment for urban stormwater and can be cost effectively integrated into the road network with relative ease.

   Properties adjacent to these swales will discharge stormwater into the swales.

   Examples of swale/bioretention drain are shown in Figure 3-12 below.

Figure 3-12 - Examples of roadside swales to treat runoff

4. Replace all major open drains with underground drains except for the existing linear park and drain between Balook Street and Mannata Street (far east of the upper expansion area).

   Replacing open drains with underground drains is expected to yield an additional 50 lots. This increase in lot yield will provide $4.7M additional revenue after the additional cost of $2.3M in drainage is accounted for. Underground drains capable of accommodating 100-year Average Recurrence Interval (ARI) runoff for year 2100 are required. The underground drain development requirements are summarised below:

   a. Western drain (NT2) upstream of Ringwood Road – 2.7m x 0.6m box culvert
   b. Additional 3m x 0.6m box culvert under Roches Beach Living (RBL) or remove and replace exiting culvert with 4.5m x 0.6m culvert
   c. Western drain (NT2) below RBL to outfall – 4.5m x 0.6m box culvert
   d. Eastern Drain (NT1) below and including Mannata Street- 3.9m x 0.6m box culvert
   e. Upsize culverts under Balook Street to 5m x 0.45m box culvert and allow overtopping of the road for events greater than 1 in 2 years ARI. Reinforce road to be capable of taking the overtopping flows (ford).

This stormwater approach has been adopted in the final urban design plan detailed in Section 8 of this report.

3.3 Water

TasWater has been consulted to ascertain any major asset upgrades required to service the development. Their advice is as follows:

> *The approximate 583 lots are all in the Lauderdale water pressure zone (capacity= 9 ML, TWL=97m). As they are all below 5 m AHD the minimum static head is approximately 90 m. The pipes around the proposed areas provided to us indicate that the existing mains in the area are all adequately sized - DN250 in South Arm Rd, DN200 in North Tce, DN200 in Bangalee St, DN100 in Mannata St. In the absence of a water concept plan to show where they will be connected to the existing pipework, initial modelling indicates that there is sufficient capacity in the existing network to supply the proposed approximate 583 lots.*

Therefore, no additional network augmentation has been allowed for to service the development with water.

3.4 Sewer

TasWater has been consulted to ascertain any major asset upgrades required to service the development. Their advice is as follows:

> *Upgrades will be required to service the ~583 additional lots. As a minimum, **emergency storage at TasWater's existing pump stations** would need to be augmented as required. Additional upgrades will be assessed in accordance with **TasWater's Service Extension and Expansion Policy when development applications** are received. Such requirements will depend on multiple variables, including timing of developments throughout the entire Sewage Treatment Plant catchment and subsequent capacity at the time of application.*
>
> ***TasWater's preference is for new developments to be connected to gravity systems** where reasonable. The final method of servicing the areas (either gravity/pressure sewer or both) will be determined at the time of application. Connection to the pressure system will be assessed on a case-by-case basis.*
>
> *It is noted on the concept outline that some of the land to be re-zoned and become road reserve is TasWater owned land.*
>
> *Augmenting the shape of existing TasWater properties will need to be discussed with TasWater and may require land acquisitions to facilitate the proposed roads.*
>
> *Suitable buffers, in line with the DPIWE Planning and Scientific Services Division SEWAGE PUMPING STATION ENVIRONMENTAL GUIDELINES December 1999, should also be placed around existing TasWater sewage pump stations and the lot layouts designed around these buffer zones.*

Given that the land is very flat, serving new lots using a gravity sewerage system is problematic and expensive. An extensive investigation was undertaken by TasWater to determine the most cost effective method of servicing the residential part of Lauderdale. The study concluded that pressure sewer is preferable, and this was subsequently installed in 2012/13.

For this feasibility study it has been assumed that the following number of lots can be serviced by gravity flowing into the existing Sewerage Pumping Stations (SPS). These quantities are based on a gravity sewerage pipe maximum length of 300 m. The remaining Lots would be serviced by pressure sewer.

- 438 South Arm Highway SPS – 20 Lots
- 488 South Arm Highway SPS – 60 Lots
- Main SPS at 36 Mannata Street – 60 Lots

The required emergency storage augmentations are thus assumed as follows (based on 8 hours storage time at Average Dry Weather Flow):

- 438 South Arm Highway SPS – 20 Lots – 4k. No additional storage proposed.
- 488 South Arm Highway SPS – 60 Lots - 11kL.
- 36 Mannata Street SPS – 500 Lots – 91kL.

In addition to the requirements highlighted by TasWater it will be necessary to raise the level of the SPS at 488 South Arm Highway from 2.2 m AHD to the proposed ground level of 3.2 m AHD. The other two existing SPS's have a lid level above 3.2 m and therefore do not require raising.

3.5 Electrical Infrastructure and Lighting

The existing area of Lauderdale is predominantly serviced by overhead electrical infrastructure including street lighting. It is proposed that these services would be relocated underground as part of any new subdivision development as is the current Council requirement.

TasNetworks have been consulted to determine whether additional costs will be incurred for the provision of electrical infrastructure over and above standard development costs. At present TasNetworks policy is for full cost recovery for infrastructure required to service the development. This cost is generally between $5,000 and $7,000 per urban property, including street lighting. Major network upgrades are not included in standard development costs.

TasNetworks are investigating the inclusion of major network upgrade costs in developer charges. TasNetworks have advised that a new feeder would be required from the substation in Rokeby to Lauderdale to service the new proposed development. Costs for this upgrade would be shared by beneficiaries and are estimated at $1,200 per lot. This additional cost has not been included in the financial analysis as it is not yet TasNetworks policy.

3.6 Communications

It is a requirement under the development standards for subdivision in the General Residential zone that where a new road is included in the subdivision, that the subdivision provides for the installation of fibre ready facilities (pit and pipe that can hold optical fibre line).

3.7 Natural Gas

Natural gas is not available at this time. Therefore, there would be no requirement to provide for this infrastructure within the development at this time. Future strategic changes may alter this requirement in the future.

4. Environmental Assessment

4.1 Natural Values Assessment

Welling Consulting (2016) has completed a natural values assessment of the study area.

The survey area is characterized by a narrow diversity of vegetation communities in a highly degraded state. Large areas have been filled over the last 5-10 years raising the ground level. This, coupled with the existing residences and gardens has contributed to the disturbance of natural values. The natural values of the site are mainly restricted to small saltmarsh remains (1.8 ha) and woodland areas. These areas are shown in Figure 4-1.

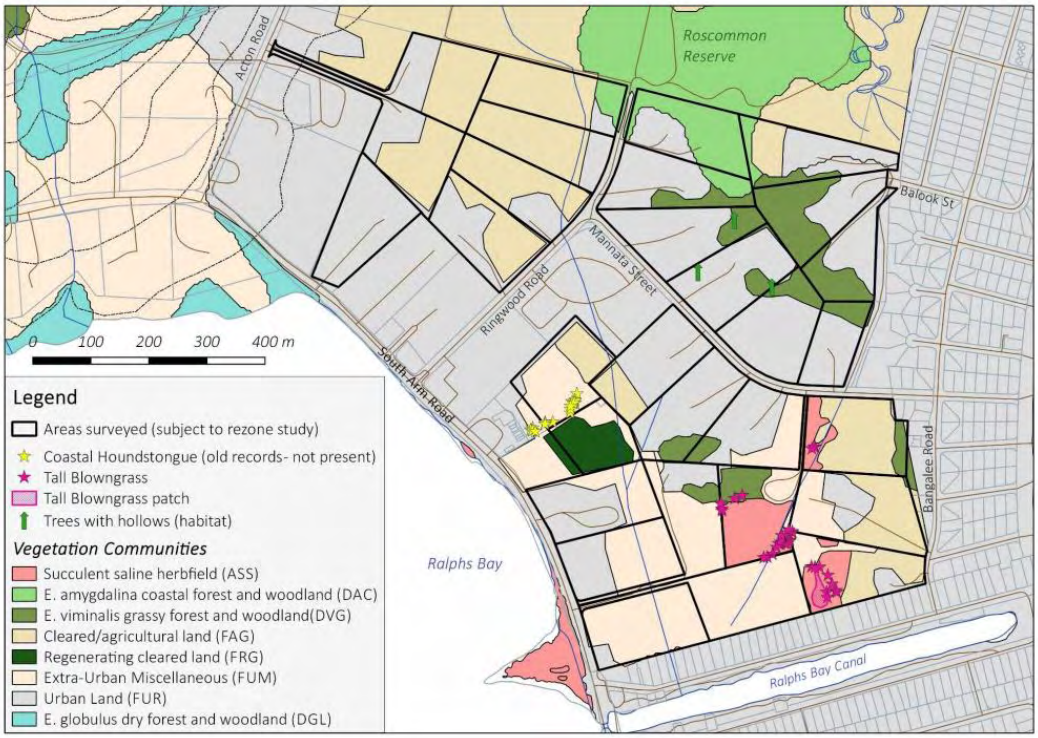

Figure 4-1 - Vegetation communities and threatened flora species recorded onsite

A significant population of threatened flora species, Tall Blowngrass (*Lachnagrostis robusta*), was recorded in the degraded saltmarsh vegetation in the southern end of the site.

Three native vegetation communities were identified in the study area, none of which are listed as threatened under the *Nature Conservation Act 2002*:

- *Eucalyptus amygdalina* coastal forest and woodland (DAC);
- *Eucalyptus viminalis* forest and woodland (DVG); and
- Succulent saline herbland (ASS).

The balance of land is supplemented by agricultural land, regenerating cleared land, extra-urban miscellaneous, and urban areas.

The saltmarsh and surrounding grassland and fringing vegetation provides a potential habitat for three threatened species of moth and one butterfly species, listed under State legislation. However, targeted surveys of moth and butterfly species would be required to determine whether the saltmarsh remnants are significant habitat.

The saltmarsh remnants also provide marginal roosting habitat for the curlew sandpiper and eastern curlew, listed under Commonwealth legislation. The remnants are small and fragmented and therefore not considered critical habitat making the loss of the remnants unlikely to be a significant impact under the EPBC.

The woodland vegetation located at the northern end of the site is contiguous with the Roscommon Reserve, providing potential habitat for bird and mammal species as well as acting as a buffer for Roscommon Reserve (i.e. from invasion by foreign species, maintaining the natural values of the Reserve). The remnant woodland is also part of a landscape scale bushland remnant linking with the Mt Rumney Hills, forming part of the only remaining natural forested area in this low lying area of Lauderdale. The removal of this vegetation may increase the potential for edge effects on vegetation within the Roscommon Reserve but will not directly impact any flora or fauna species of conservation significance.

Rezoning land within the study area will potentially impact the threatened fauna habitat located in the saltmarsh remnants and the rare Tall Blowngrass. Control of declared weeds within the study area needs to be considered as part of rezoning or development applications.

4.2 Acid Sulfate Soils

Acid Sulfate Soils are soils that contain sulfides which are usually in microscopic form. Acid sulfate soils are harmless in an undisturbed and waterlogged state but when exposed to oxygen through drainage or excavation, oxidation can produce large quantities of sulfuric acid. The acid may cause the release of heavy metals and other toxins as it flows through the soil profile which may eventually be introduced to surrounding waterways. The run-off can reduce oxygen levels in water, decreasing water quality, kill marine life and damage sensitive ecosystems. Acid discharge can also damage infrastructure services and structures including pipes, foundations, drains, bridges and flood controls.

The study area is mapped as having medium to high probability of acid sulfate soils on the LIST database (Figure 4-2).

Construction of drains involving excavation require subsurface site investigations including sampling and analysis in accordance with the *Tasmanian Acid Sulfate Soil Management Guidelines* (DPIPWE, 2009) will be required during detailed design.

The cost of these investigations is included in the overall development costs.

Figure 4-2 - Probability of Acid Sulfate Soils in Study Area (from LIST database)

5. Cultural Heritage

5.1 Aboriginal Heritage

An Aboriginal heritage assessment was completed for the site by consultants Anne McConnell and Caleb Pedder of Cultural Heritage Management, Archaeology & Quaternary Geoscience.

A total of eight archaeological sites were located within the study area comprising seven isolated artefacts discoveries and two artefact scatters. One of the archaeological sites (02) is located in introduced fill, two sites may have been introduced (01 and 03) and it is possible, though highly unlikely, that sites 01, 05 and 07 have potentially been introduced through fill.

All land irrespective of its tenure and use has high cultural heritage significance for individual Aboriginal people and for the Aboriginal community collectively. Notwithstanding the above, no specific non-site Aboriginal heritage values, including landscape values, were identified in the study area. This is due largely to the major extent of disturbance of the study area.

The identified relics were found to have low historical significance. They represent historical Holocene occupation and use of the landscape which is of some social value to the Tasmanian Aboriginal community.

Identified sites should be protected to the extent possible by being left in situ and undisturbed. Future development should avoid sites where possible (i.e. by locating property boundaries at least 1.0 m from identified sites and considering building envelope locations), however where disturbance[1] of a site cannot be avoided, then –

1. A permit under the *Aboriginal Relics Act 1975* to disturb or destroy the site will need to be obtained before any ground disturbance occurs.
2. All feasible impact mitigation should be considered, included those types of disturbance with the lesser impact, for example covering an artefact or site rather than excavating it.

The assessment concluded that there are no constraints in relation to subdivision of the study area with respect to the recognition or protection of broader Aboriginal heritage values.

No further investigation is required for the purposes of this study. In the event that a previously unidentified site is located, then –

1. If located though works, those works must stop immediately and Aboriginal Heritage Tasmania must be contacted for advice on how to proceed. Work in the site area should not be resumed until advised by Aboriginal Heritage Tasmania
2. If further disturbance of the site is not avoidable, then assuming the work is essential or permitted and there are no feasible alternatives, a permit under the *Aboriginal Relics Act 1975* to disturb or destroy the site will need to be obtained before any further site disturbance occurs.

5.2 European Heritage

No properties in the study area are listed on the Tasmanian Heritage Register or the Planning Scheme Historic Heritage Code. As such, European heritage will not affect the subdivision potential of the study area.

[1] Under the *Aboriginal Relics Act 1975* disturbance includes to "destroy, damage, deface, conceal, or otherwise interfere with a relic", and also includes the removal of a relic from the place where it is found or abandoned.

6. Social Services and Facilities

'Social infrastructure' is defined under the *Southern Tasmania Regional Land Use Strategy* as *all services, facilities and structures that are intended to support the well-being and amenity of the community. This includes not only educational and health facilities, but social housing and other community facilities (such as online access centres).* (pg. 46)

The social infrastructure of Lauderdale is dependent on nearby activity centres and networks that form part of the regional landscape. The *Southern Tasmania Regional Land Use Strategy* defines different activity centres based on their size and function.

As previously mentioned in Section 7.1.6, Lauderdale is defined as a 'Minor or Neighbourhood Centre'.

MINOR OR NEIGHBOURHOOD CENTRE		
Role	To serve daily needs of surrounding community and provide a focus for day-to-day life within a community.	To be determined at the local level, (examples include Claremont, Howrah (Shoreline), Lauderdale, Margate, Sandy Bay Shopping Centre, Triabunna)
Employment	Includes a mix of retail, community, and health services (such as GP) and small scale office-based employment servicing the local area.	
Commercial including retail	Should offer at least one supermarket, a range of speciality shops and secondary retailing. Should be mix of convenience and range. May include discount department store. In rural context, often includes tourism related businesses.	
Government Services & Community infrastructure	Local community services, including community health facilities.	
Residential	Some residential may be interspersed, although there is no emphasis on residential amenity.	
Entertainment	May include some night time activities focussed on dining or a local Hotel.	
Access	In an urban context ideally located on a public transport corridor with at good bus services. Should be highly accessible by cycling or walking from surrounding area to enhance local access.	
Catchment	Serves a number of suburbs but may attract people from a wider catchment on an occasional basis.	

6.1 Services and Facilities

This section sets out the services and facilities in Lauderdale, and considers the proximity of these services to the study area. Figure 6-1 provides a visual representation of the services available within Lauderdale and the immediate surrounding area.

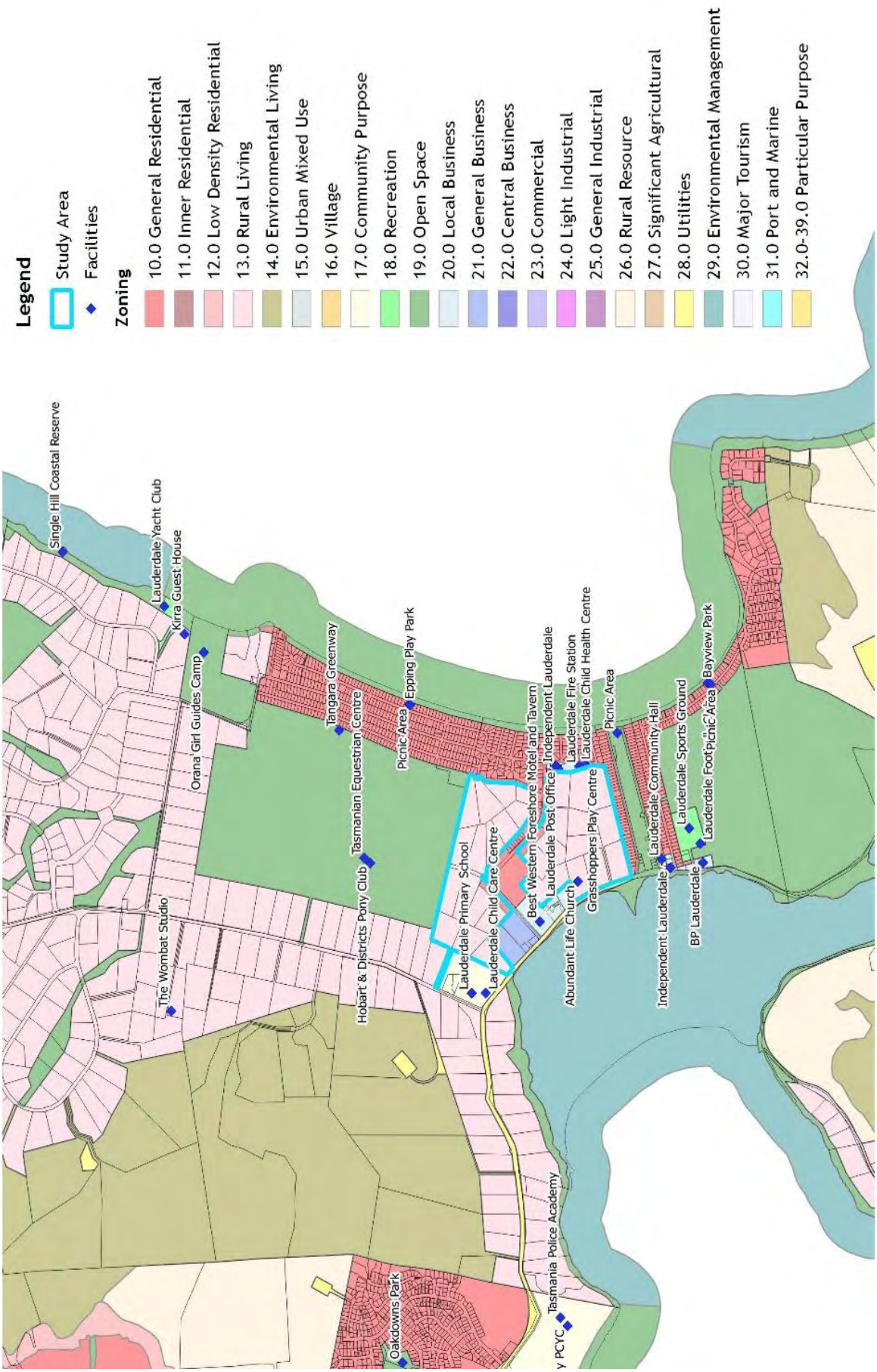

Figure 6-1 - Facilities Supporting Social Infrastructure in Lauderdale

6.1.1 Education

Lauderdale Primary School is located within easy walking distance to the study area. The school is currently at capacity for enrollment. The school population is already expected to increase by about 50 students from the surrounding area in the next three years. The school has applied for an expansion to accommodate this projected increase in enrolment. In addition, the school has the physical capacity to expand further without requiring additional land (pers. comm. S. Jeffery, Lauderdale Primary School, 2016).

The nearest secondary school is Rokeby High School, which is a 22-minute bus ride. It is likely that students would also travel to Rosny Park (20 minutes) and Hobart CBD (35 to 45-minute bus ride) for secondary education.

Further education through TAFE (Clarence Campus is 15 to 20-minute bus ride) or University (1hr bus ride) would require travel by car or bus.

6.1.2 Retail & Commercial

Lauderdale is serviced by various small retailers including grocery stores (Hill Street Grocer, Bangalee Store, IGA X-press Lauderdale, Butcher), formal and informal dining options (The Sand Bar, The Lab, Canal Café & Pizza, Frito Misto, Foreshore Tavern), a florist, pharmacy and real estate agent.

Planning approval was granted in June 2013 for a supermarket, retail shops, car parking, access and landscaping at 438 & 450 South Arm Road. The approved development is a Woolworths shopping village in Lauderdale. The permit has been extended and is currently valid, though works have not yet commenced.

6.1.3 Health

Lauderdale is serviced by a doctor's surgery and skin cancer clinic as well as a pharmacy.

6.1.4 Community

The Foreshore Tavern in Lauderdale provides a place for people to meet and have a meal, as well as providing accommodation and an outdoor play area for children. This venue offers free Wi-Fi access, a function centre and has regular entertainment such as live music.

The Abundant Life Church provides a religious meeting place in Lauderdale for those of the Christian faith.

There is also a Community Hall on the Esplanade within walking distance of much of the site.

6.1.5 Sports and Recreation

Lauderdale is well serviced in terms of both natural and man-made sports and recreation opportunities.

Ralphs Bay and Roches Beach both provide easy access to natural coastal recreation areas that are a key part of the lifestyle characteristic of Lauderdale.

Lauderdale also provides recreation facilities including the Epping Play Park, the Lauderdale Sports Ground and Football Club and the Lauderdale Skate Park.

Clarence City Council planning policy (discussed in section 3) also includes Lauderdale in plans for increasing connectivity through walking and cycling paths throughout the municipality.

6.1.6 Employment

Lauderdale has a small commercial area with a number of retailers and food stores, which would provide a small number of employment opportunities near the study area.

6.1.7 Transport

There are currently six bus routes, including three express services, that travel through Lauderdale along South Arm Highway (see Figure 6-2). Three routes continue through Lauderdale east along South Terrace and north along Bangalee Street.

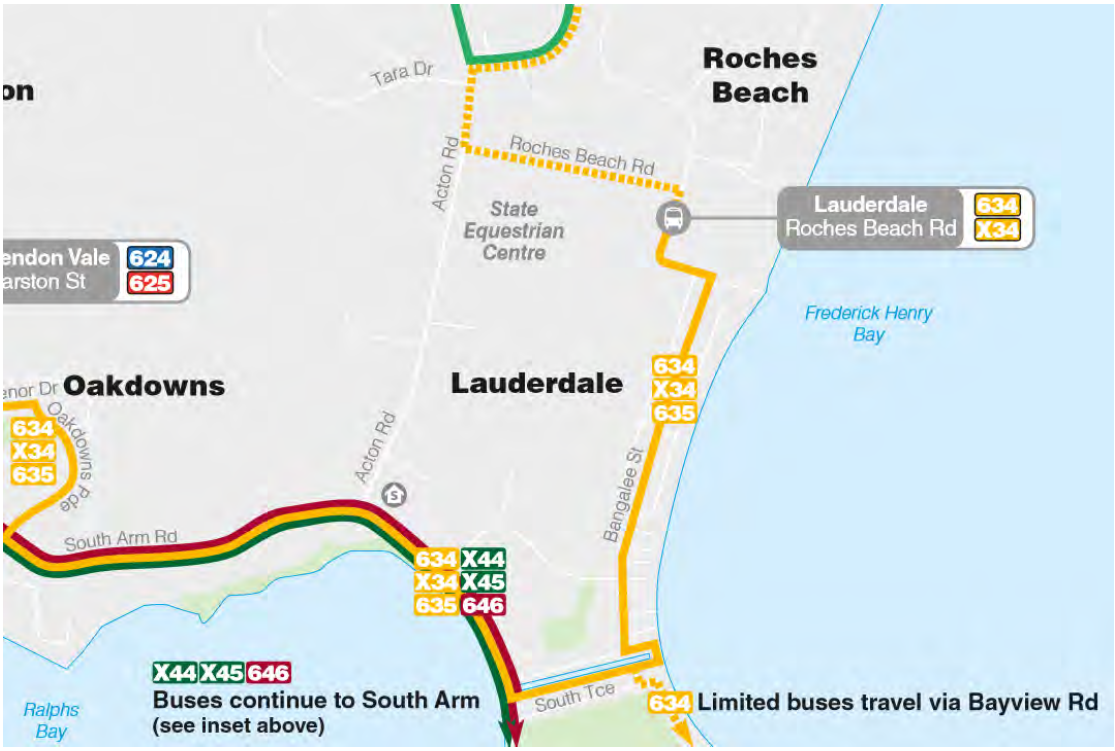

Figure 6-2 - Bus routes through Lauderdale

Based on the above the site has good access to services, but it is likely that some facilities would need to be augmented or created if the development proceeded in full. The need for services is generally determined through a community needs assessment, which audits the capability and user rates or existing facilities, uses population data to predict future trends and tests these aspirations through community consultation. Whilst this is beyond the brief of this study the following conclusions can be reasonably drawn.

It is likely any employment created would be accommodated in existing employment areas. It appears likely that the Lauderdale Primary School would need to expand, but this would not necessarily require land from the subject area. There is unlikely to be any additional requirement for retail facilities, but the increased local population may trigger the development of the approved Woolworths supermarket. It is likely the development would increase the need for local health facilities, but these are allowable uses within the General Residential zone. The development is unlikely to require further community or sporting facilities, but if there were there is opportunities within the public open space areas in the proposal plan. It is unlikely the development would require additional local business areas given the existing areas on South Arm Road. It is likely that the development would detour the 634/X34/635 bus routes into the site to capture the new users to the service.

7. Planning Policy Framework

This section provides a review of the existing strategic planning framework and identifies key policy considerations relevant to this Study. The mapping shown in this Section may be amended as appropriate based on the results of the engineering investigations outlined in Section 7 of this report.

7.1 Southern Tasmania Regional Land Use Strategy 2010-2035

The *Southern Tasmania Regional Land Use Strategy 2010-2035* ('the Strategy') is a regional level policy document providing policies and strategies to guide future land use and development of Southern Tasmania. The document principally is intended to inform the development of interim planning schemes within the region. Any future amendments to local planning schemes will be required to be consistent with the Strategy.

The key strategic considerations under the Strategy with respect to the potential expansion of the Lauderdale settlement are discussed in this section of the report.

7.1.1 The Coast

Part 7.5 (C1) promotes the protection of coastal vegetation and the avoidance of mobile landforms and mudflats. The subject site is inland and is bordered by existing settlement hence is considered acceptable in this respect.

Part 7.5 (C2) requires that use and development in coastal areas is responsive to the effects of climate change. To achieve this, growth is to be directed to areas that avoid exacerbating current risk. A rezoning that allowed for residential expansion within the study area would therefore need to be supported by an engineering solution that demonstrates how drainage and the future impacts of climate change can be managed in the long term. A solution that can also reduce risk to the existing settlement through drainage improvements would also have greater strategic merit.

7.1.2 Managing Risks & Hazards

Part 8.4 (MRH2) seeks to protect life and property from flooding through early consideration in the land use planning process. For this purpose, it would be necessary to ensure an acceptable level of residual risk is achieved for future residents and development.

Part 8.4 (MRH5) seeks to avoid further subdivision or development in areas containing sodic soils unless the potential risk can be mitigated. A significant portion of the study area is mapped as having a high probability of containing sodic soils, with the remaining area mapped as low probability. An engineering design for the site would need to be supported by consideration of acid sulfate soils to demonstrate that further development of the area will not significantly impact water quality, infrastructure of residential amenity.

7.1.3 Social Infrastructure

Part 11.5 (SI 1) requires consideration of social infrastructure needs as part of land releases and the need to protect sites for this purpose. For a rezoning of the scale envisaged, future social infrastructure demands and how they would be met would need to be considered.

Social infrastructure required to service expansion of the Lauderdale settlement is considered in Section 6 of this report.

7.1.4 Physical Infrastructure

Part 12.5 (PI 1) requires a strategic approach to infrastructure be adopted, including efficient use of existing infrastructure and planning new infrastructure with consideration of projected future demand.

Physical infrastructure required to service expansion of the Lauderdale settlement is considered in Section 7 of this report.

7.1.5 Land Use and Transport Integration

Part 13.5 (LUTI 1) requires consideration be given to the integration of transport infrastructure with land use. The strategy is somewhat ambiguous in that it seeks to "*give preference to*" urban expansion around higher order Activity Centres rather than Urban Satellites or dormitory suburbs, yet also acknowledges that residential development outside of Greater Hobart will occur but should be consolidated into key settlements where the daily/weekly needs of residents can be met.

Rezoning the study area would constitute urban expansion around a defined Urban Satellite suburb. It would also however have the benefit of consolidating an existing settlement and supporting the viability and diversity of local business and social infrastructure, thereby reducing the need to travel to larger centres.

7.1.6 Activity Centres

Part 18.6 (AC 1) aims to protect and enhance the role and function of the Activity Centre network. Lauderdale is classified as a 'Minor or Neighbourhood Centre', meaning it functions primarily to serve the daily needs of the local community with a mix of retail, community and health services.

Rezoning the study area would support the viability of the Lauderdale Neighbourhood Centre and potentially stimulate additional local businesses and the construction of an approved supermarket development.

7.1.7 Settlement and Residential Development

Part 19 outlines a range of policies aimed at regulating the physical growth of settlements and establishes the 'Greater Hobart Residential Strategy'. Lauderdale is designated as a Minor Satellite of Greater Hobart and the Urban Growth Boundary does not currently allow for urban expansion in this area (Figure 7-1).

Figure 7-1 - Extract from Map 10 of the Strategy

For a rezoning of the study area to be acceptable under Part 19 (SRD 1.1), it would be necessary first to amend the Urban Growth Boundary of the Strategy. Clause 34(2)(e) of LUPAA requires that a Local Provisions Schedule be consistent with the Regional Land Use Strategy. Justification for an amendment to the Urban Growth Boundary would require examining the assumptions underpinning it in the context of current population trends.

Greater Hobart

The Urban Growth Boundary was established by the Greater Hobart[2] Residential Settlement Strategy and sets a 20-year supply limit from 2015 to 2035. The Greater Hobart Residential Settlement Strategy was based on a forecast demand of 26,500[3] additional dwellings aspiring to 50% Greenfield development greatly reducing the existing rate of 85% Greenfield development[4]. *Background Report No. 2 The Regional Profile* ('Background Report No. 2') utilised information and analysis on population trends from the Demographic Change Advisory Council (DCAC) projections using the 'medium growth scenario'. *Background Report No. 14, Providing for Housing Needs* ('Background Report No. 14') sets out the basis for the dwelling forecast utilising population and household projections prepared by the ABS using the 'medium growth scenario', and the dwelling approval trends outlined in Background Report No. 2 (also based on ABS data). However, the dwelling demand was only forecast to 2032.

Background Report No. 2 (pg. 81) states that population growth was not the predominant driver of dwelling growth for the period 2000-2008 (with the exception of Brighton, Derwent Valley and Southern Midlands). It is indicated that demographic change was a key driver of dwelling growth.

The Greater Hobart Residential Settlement Strategy states that to meet the projected demand approximately 710 ha of further residential land would be required (using net density). This land was allocated to Greenfield Development Precincts in the Strategy and is generally zoned either 'General Residential' or 'Particular Purpose-Urban Growth' under the Interim Planning Schemes.

Section 3 of the Strategy states that Greater Hobart accounts for nearly 86% of the Southern Tasmanian population. Section 19.1 of the Strategy, however states that Greater Hobart is home to just over 82% of the region's population (268,169.52). The forecast population for Southern Tasmania to 2035 was stated in Section 3 as being 327,036. It can therefore be deduced that Greater Hobart has a forecast population of 281,250.96 (86% of 327,036).

The Department of Treasury and Finance ('DTF') released updated population projections for Tasmania in 2014. Under the DTF projections the population of Greater Hobart in 2035 under the 'Medium Growth' series is 254,366[5]. If the forecast population used for the Greater Hobart Settlment Strategy was 86% of 327,036, then the current population projection is nearly 27,000 people (approximately 10%) below the population estimate used in the Greater Hobart Settlement Strategy. This means that there is likely to be an oversupply of residential land of about 71 hectares in the Strategy, which is more than the area proposed for rezoning in Lauderdale (56 ha).

Clarence

The population of Clarence is estimated to have grown from 52,396 in 2010 to 54,040 in 2014[6] (Figure 7-2). The DTF projections set the population of Clarence for 2014 at 54,015 people. This suggests that the DTF projections are a fairly accurate representation of the projected population growth in Clarence. The DTF forecast for Clarence is well above what was forecast under DCAC (Figure 7-2).

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[2] Defined in the Strategy as the land contained within the Statistical Local Areas (ABS statistical data unit) of Brighton, Clarence, Glenorchy, Hobart Inner, Hobart Outer, Kingborough Part A and Sorell Part A. It includes the metropolitan area and dormitory suburbs.

[3] NB: This forecast was actually to 2032 as outlined in Background Report No. 14.

[4] *Background Report No.14 Providing for Housing Needs* (pg. 15)

[5] Total projected population to 2035 for Brighton, Clarence, Glenorchy, Hobart, Kingborough, and Sorell municipalities using the medium growth scenario (DTF, 2014).

[6] ABS (2016) Regional Statistics by LGA, 2010-2014, Annual – Clarence C 61410

The DTF predicts that the population of Clarence will grow to 61,886 in 2035 if growth continues at the medium rate of 0.7%. If growth is high (1.1%) the predicted population for Clarence is 68,421, and 56,344 if growth is low (0.2%). Given these projections, Clarence can be expected to grow by 4,492-16,569 people from 2011 to 2035, depending on growth rate.

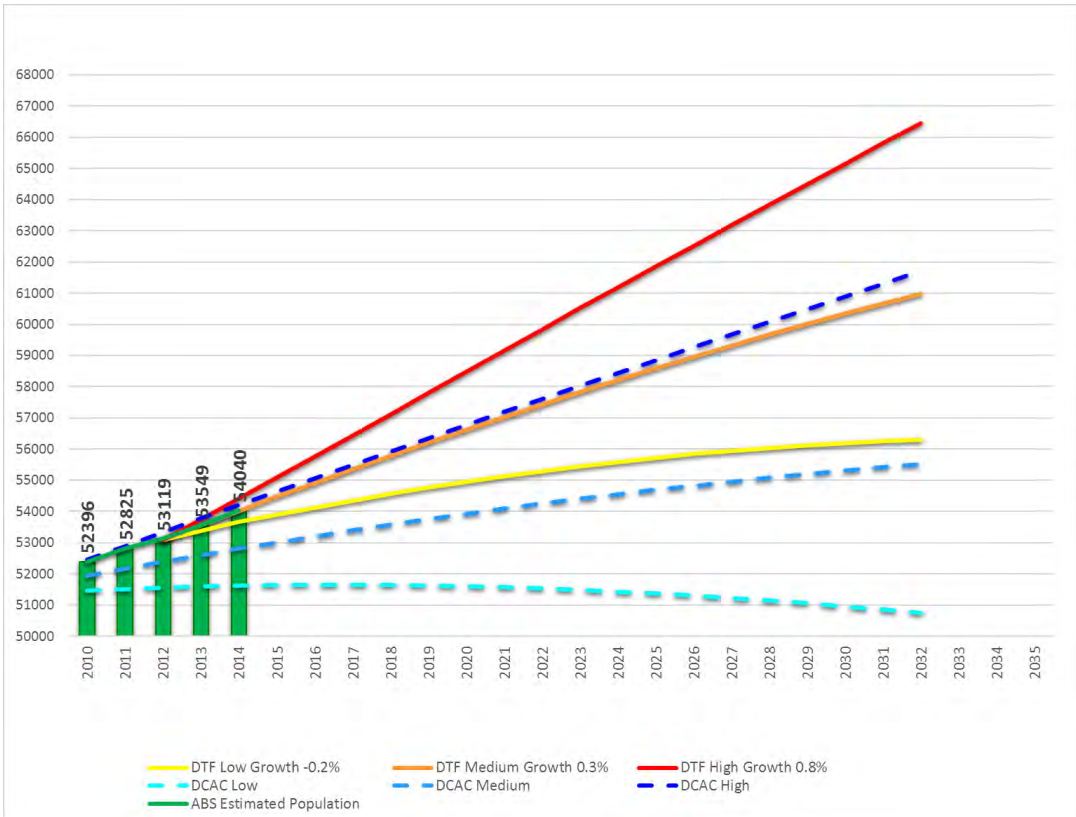

Figure 7-2 - Clarence Population Estimate and Projections

Building Approvals

It is also relevant to note that the number of building approvals in Greater Hobart from 2010 to 2015 was 6,677[7], or approximately 25% of the forecast additional dwellings (26,500) for Greater Hobart to 2035.

Greenfield Precincts

The actual area of land zoned Particular Purpose-Urban Growth or General Residential located within the Greenfield Precincts is approximately 883 ha[8]. Of this land, approximately 273 ha (approximately 30%) has development approval for subdivision, leaving 610 ha for future subdivision. The total number of lots approved within these greenfield sites is approximately 1,345[9]. During the minor review of the Strategy in 2013, the Greenfield Precincts located in Brighton and Rokeby (Pass Road) were remapped as 'Urban Zoning' and have now been rezoned. At this point it is noted that SRD 2.5 was to:

SRD 2.5 Implement a Residential Land Release Program that follows a land release hierarchy planning processes as follows:

1. Strategy (greenfield targets within urban growth boundary);

[7] ABS Building Approvals by Statistical Local Area (2011-2016)

[8] Calculated using zoning maps on LISTmap.

[9] Based on Planning Approvals to date.

2. Conceptual Sequencing Plan;
3. Precinct Structure Plans (for each Greenfield Development Precinct);
4. Subdivision Permit; and
5. Use and Development Permit

A Conceptual Sequencing Plan has not yet been established. The Sequencing Plan is to be based upon multi-criteria analysis of components such as capacity of infrastructure, cost of infrastructure upgrades, cost of land release and alignment with release of employment lands. Stage 4 of the Residential Land Release Program stipulates that subdivision applications are not to be submitted as combined rezoning and permit application under S43A of the *Land Use and Planning Approvals Act 1993* ('LUPAA') unless the applicant is willing to prepare a Structure Plan that the Planning Authority or Regional Planning entity is satisfied with.

However, several areas of land within the Greenfield Precincts were already the subject of Section 43A (combined permit and planning scheme amendment) applications under LUPAA prior to the gazettal of the Strategy.

Market Sectors

Background Report No.13 - Dwelling Yield Analysis of the Strategy found that the greatest potential for growth is land located in the middle lower market segment within the urban and urban fringe. The market segments are determined by the median price for the suburb relative to the sale price of other suburbs in the study area. Lauderdale was defined as being in 'middle top' band with a median sale value[10] of $349,000 in 2009.

The location of Greenfield Precincts by market sector (based on median house price in September 2009) are as follows:

- Lower (Min $155K Max $205K) – Bridgewater North, Droughty Point Corridor (EAST), Risdon Vale, Gagebrook.
- Middle Lower (Min $240 Max $300K) – Spring Farm (Kingston), Granton, Old Beach, Granton (Upper Hilton Rd to and including Black Snake Village), Sorell Township East.
- Middle Top (Min $305 Max $391K) – Geilston Bay, Huntingfield South.
- Top (Min $400 Max $635K) – Blackmans Bay, Droughty Point Corridor (WEST).

The current median price for a home in 'middle-top' suburbs that are also defined in the *Southern Tasmania Regional Land Use Strategy* as 'Minor or Neighbourhood Activity Centre' are:

Suburb	realestate.com.au	domain.com.au (3-bedroom)	reit.com.au
Lauderdale	$368,000	$353,000	$366,250
Howrah	$370,000	$354,000	$368,500
Margate	$385,000	$365,000	$387,000

Southern Tasmania Regional Land Use Strategy Review

The Strategy was declared under clause 30C of the *Land Use Planning and Approvals Act 1993* ('LUPAA'). Sub-clause (4) requires that the Minister keep all regional land use strategies under "*regular and periodic review*". For the pending Tasmanian Planning Scheme, clause 34 of LUPAA requires the Local Provisions Schedules be consistent with the regional land use strategy, if any, for the regional area in which the land is situated.

[10] It is not specified whether median sale price is for land, house and land or a combination. Result from Australian Property Monitors.

The Strategy was reviewed to address 'house-keeping' and update data in Background Report No.2 following the release of 2011 Census data. A minor review was completed in 2013 at which point the current version of the Strategy was adopted. Further reviews are to take place at least every five years unless an earlier review is triggered through monitoring indicators[11]. Therefore, the next review is due in approximately 2018.

Summary

The Greater Hobart Residential Strategy provides a dwelling demand forecast for the Hobart area to 2035. The population basis for this estimate is somewhat unclear, with the dwelling demand forecast based on ABS projections for populations, whilst the Regional Profile utilises DCAC projections. Depending on the actual population utilised, the area of land allocated for further residential development may be in excess rather than suggesting further General Residential land is required.

The Land Release Program for Greenfield Precincts is yet to be established, and the monitoring indicators for the Strategy are undefined. Greenfield Precincts within the same market sector as Lauderdale are yet to be rezoned and remain undeveloped (Geilston Bay and Huntingfield South).

Building approvals for Greater Hobart since the Strategy was gazetted account for 25% of the forecast dwelling demand, despite the lack of additional greenfield land release. Therefore, there are no local anomalies around the release of land suggesting a need to amend the Urban Growth Boundary.

The population of Clarence as estimated by the ABS is currently tracking the DTF Medium Growth Scenario.

Based on the above it can be concluded that Southern Tasmania is not constrained by a lack of developable residential land at the present time. Not only is there sufficient land available for the forecast additional dwelling demand, there is likely to be an excess of appropriate land. Therefore, an additional residential land release in Lauderdale, without a rationalisation of Residential land supply in the Southern Tasmania Regional Land Use Strategy as a whole, could not be justified based on the current data.

7.2 Clarence Interim Planning Scheme 2015

The *Clarence Interim Planning Scheme 2015* is the relevant planning instrument at present. It is anticipated that it will be superseded by the *Tasmanian Planning Scheme* within the next 12-24 months.

The study area is currently zoned Rural Living (see Figure 2-2) and is subject to a number of Codes including:

- E1.0 Bushfire Prone Areas Code;
- E5.0 Road and Railway Assets Code;
- E7.0 Stormwater Management Code;
- E6.0 Parking and Access Code;
- E7.0 Stormwater Management Code;
- E10.0 Biodiversity Code;
- E11.0 Waterway and Coastal Protection Code;
- E15.0 Inundation Prone Areas Code;
- E16.0 Coastal Erosion Hazard Code;
- E17.0 Signs Code;
- E20.0 Acid Sulfate Soils Code;
- E27.0 Natural Assets Code.

[11] It is noted that the monitoring indicators have not been defined under the Strategy or its supporting documentation. An example of the indicators is provided in *The Process Forward: Implementing and Monitoring the Regional Land Use Strategy for Southern Tasmania (FINAL DRAFT)* (Southern Tasmania Councils Authority, October 2011).

7.2.1 Zoning

The purpose of the existing zoning (Rural Living) is primarily to provide for limited residential use and development on large lots (2ha minimum) in a rural setting where services are limited. The existing subdivision pattern offers very little opportunity for further subdivision. No Local Area Objectives or Desired Future Character Statements are provided for Lauderdale.

Urban expansion within the study area would require amendment of the Planning Scheme to rezone the land to General Residential and adjust the urban growth boundary to form an extension of the adjoining existing zoned area.

The General Residential Zone is intended to accommodate a range of dwelling types at suburban densities (no less than 15 dwellings per hectare) where full infrastructure services can be provided. The zone requirements for subdivision are summarised in Table 7 as relevant to the production of a concept urban design solution for the study area.

Table 7 - Summary of General Residential Zone Subdivision Requirements

10.6.1 Lot Design	Permitted lot size Ordinary lots - 450sqm to 1000sqm. Corner and internal lots - 550sqm to 1000sqm. Lots adjoining/opposite POS or on public transport corridor or within 200m of a business zone, local shop or school - 400sqm - 600sqm (unless designated for multiple dwellings or retirement village in which case the lot may be fit for purpose). Permitted frontage All lots (unless otherwise specified) - 15m minimum. Corner lots - 15m minimum to primary frontage. Lots adjoining/opposite POS or on public transport corridor or within 200m of a business zone, local shop or school - 12m - 15m. Internal lots Internal lots will only be approved if the lot gains access from an existing road, unless site constraints make internal lot configuration the only reasonable option to efficiently utilise land and if no unreasonable impact on amenity results. Arrangement Subdivision must have regard to providing a higher net density of dwellings along public transport corridors, adjoining/opposite POS (subject to bushfire requirements) and within 200m of business zones and local shops. Subdivision design must optimise the opportunity for passive surveillance of public spaces. Subdivision design must enable future development to achieve maximum solar access.
10.6.2 Roads	Design Road network design must maximise permeability, legibility, connectivity, user safety and the efficiency of future stages of subdivision. Cul-de-sac and dead-end roads must be kept to a minimum. Cycle infrastructure New arterial and collector roads must include provision for bicycle infrastructure.
10.6.3 Ways and Public Open Space	Connections

	New public ways and open space must ensure suitable connections to the neighbourhood road network and suitable convenient access to local shops, community facilities are provided. Crime prevention through design New public spaces must be designed to minimise the potential for entrapment or other criminal behavior through consideration of width/length of ways, landscaping, lighting, sightlines and passive surveillance.
10.6.4 Services	All lots must be serviced with reticulated water, sewer and gravity storm water system.

7.2.2 Bushfire-Prone Areas Code

Land within 100m of the Roscommon Reserve is mapped as 'bushfire-prone' and can be expected to remain so for the foreseeable future. A compliant subdivision design will need to provide for a minimum setback of 23m for habitable buildings from the Roscommon to ensure a maximum construction rating of BAL-19 for future habitable buildings (Figure 7-3).

Figure 7-3 - Bushfire-Prone Areas Overlay and Setback

The interface with the Roscommon Reserve should include perimeter access to facilitate firefighter access to vegetation and for property defense. This could be in the form of a perimeter road or a perimeter fire trail (minimum carriageway width of 4.0m wide with minimum 2.0m horizontal clearance either side). The most practicable location for a fire trail would be on the Roscommon Reserve consistent with a multi-use path recommended in the Roscommon Master Plan (refer to section 7.4 of this report).

Approximately three hectares of remnant vegetation within the site that adjoins the reserve is not mapped as bushfire-prone vegetation however is highly likely to be bushfire-prone (subject to inspection). This vegetation would be incrementally removed/managed as part of urban expansion within the study area. This may necessitate temporary hazard management areas be considered as part of the staging of a future subdivision.

Engineering design for the subdivision will need to provide for fire hydrants throughout the public road network that can meet TasWater flow rate requirements.

7.2.3 Road & Railway Assets Code

A subdivision proposal will need to be supported by a traffic impact assessment that can demonstrate that traffic impacts on the surrounding road network will be acceptable.

As is examined further in this report, it is possible to manage traffic impacts associated with subdivision of the site through appropriate engineering design.

A Traffic Impact Assessment in included in Appendix B.

7.2.4 Stormwater Management Code

The Stormwater Management Code regulates stormwater quality and quantity from developments.

A subdivision proposal will need to be supported by stormwater analysis that demonstrates how the proposed stormwater system will achieve water quality and quantity standards in accordance with the *State Stormwater Strategy 2010.* Consideration must be given to water sensitive urban design principles, which may include measures such as onsite detention basins/wetlands and bioretention swales as necessary to achieve the relevant targets.

The Code requires that:

- A 'major stormwater system'[12] be designed to accommodate a storm with an ARI of 100 years; and
- A 'minor stormwater system'[13] be designed to accommodate a storm with an ARI of 20 years.

As is examined further in this report, a suitable stormwater solution can be engineered for urban expansion within the study area.

7.2.5 Waterway & Coastal Protection Code

The Waterway and Coastal Protection Code regulates vegetation and soil disturbance to control impacts on water quality, natural values and natural processes.

The purpose of the Code is

> *… to manage vegetation and soil disturbance in the vicinity of wetlands, watercourses and the coastline in order to:*
>
> *(a) minimise impact on water quality, natural values including native riparian vegetation, river condition and the natural ecological function of watercourses, wetlands and lakes;*
>
> *(b) minimise impact on coastal and foreshore values, native littoral vegetation, natural coastal processes and the natural ecological function of the coast;*
>
> *(c) protect vulnerable coastal areas to enable natural processes to continue to occur, including the landward transgression of sand dunes, wetlands, saltmarshes and other sensitive coastal habitats due to sea-level rise.*
>
> *(d) minimise impact on water quality in potable water supply catchment areas.*

The Code applies to development within

a) Waterway and Coastal Protection Areas;
b) Future Coastal Refugia Areas; and
c) Potable Water Supply Areas.

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[12] means the combination of overland flow paths (including roads and watercourses) and the underground reticulation system designed to provide safe conveyance of stormwater runoff and a specific level of flood mitigation.

[13] means the stormwater reticulation infrastructure designed to accommodate more frequent rainfall events (in comparison to major stormwater drainage systems) having regard to convenience, safety and cost.

Parts of the site are mapped as Waterway and Coastal Protection Area, as shown in Figure 7-4. The mapped areas include natural drainage paths but also an area of low-lying, degraded saltmarsh at the southern end of the site. The study area is not within a Potable Water Supply Area. The Future Coastal Refugia Areas mapping is not complete for the area, however there may be Coastal Refugia areas in the study area. The impacts of fill in the study area are likely to threaten the values provided by Refugia areas in the subject area. Without mapping of these areas, it is unclear whether the development would have a negative impact on values provided by Future Coastal Refugia.

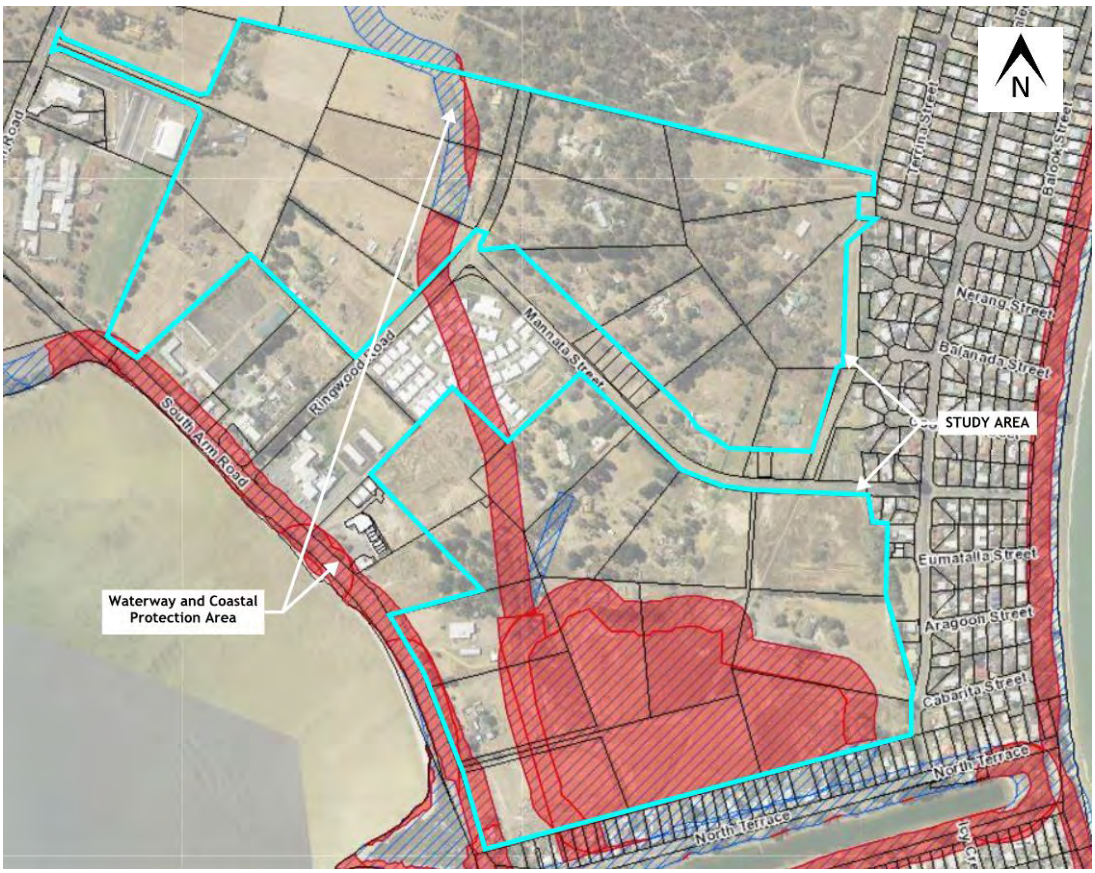

Figure 7-4 - Waterway and Coastal Protection Area Overlay

A subdivision proposal would need to demonstrate compliance with Clause E11.8.1(P1), which requires that the development minimise impacts on natural values, which would include a threatened flora species and potential habitat for threatened fauna that has been identified by Welling Consulting (refer to Section 4.1 of this report for discussion).

The extent of this overlay would need to be amended – most likely via a s.43A application - based on the implementation of the engineering results.

7.2.6 Inundation Prone Areas Code

The majority of the study area is mapped as subject to coastal inundation including land classed as 'Low Risk', 'Medium Risk' and a smaller areas mapped as 'High Risk' and 'Riverine Inundation'. The spatial extent of these areas within the study area are shown in Figure 7-5.

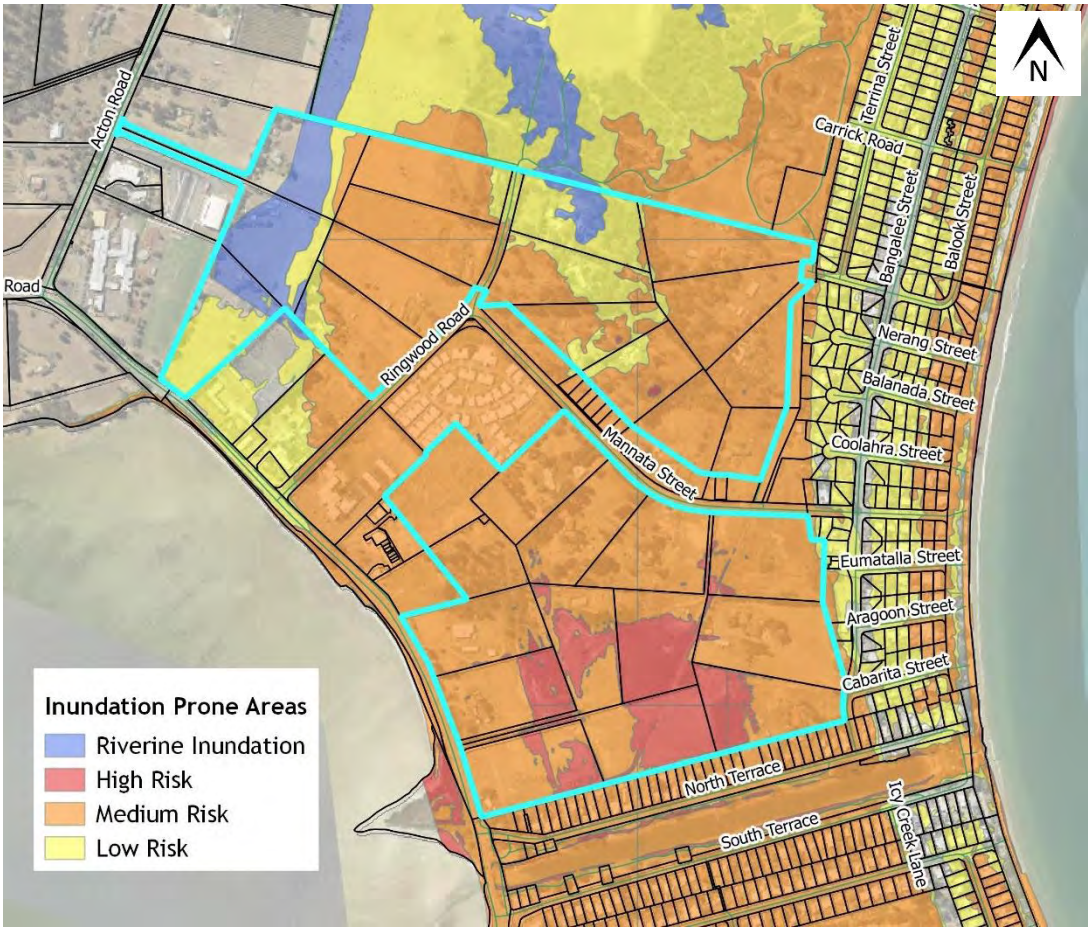

Figure 7-5 - Inundation Prone Areas

For High Hazard Areas, E15.7.1 A1/P1 prohibits habitable buildings, unless the development is dependent on a coastal location. It would accordingly be necessary to amend the overlay controls based on an engineering solution for the area in order to facilitate urban expansion.

For Medium and Low Hazard Areas, E15.7.2 A1/P1 requires that habitable building floor level is no lower than:

- Lauderdale – Roches Beach-Mays Beach – 3.0 m AHD;
- Lauderdale – Ralphs Bay – 3.2 m AHD.

For Riverine Inundation Hazard Areas, E15.7.4 requires that a habitable building floor level is no lower than the 1% AEP (100 year ARI) storm event plus 300mm (which is also a requirement of the National Construction Code applicable to residential dwellings).

To satisfy the requirements of E15.8 a subdivision application would need to be supported by engineering analysis detailing how the site's hydrology will be managed to protect future development and occupants of the site and surrounding property from flood flow. This will mean demonstrating that the minimum habitable floor levels can be achieved. As discussed further in this report, it is possible to engineer a solution for the site that will not adversely affect flood flow or be detrimental to future development within the site or any other property.

The mapping of this Overlay would need to be amended based on the implementation of the engineering results.

7.2.7 Coastal Erosion Hazard Code

A relatively minor portion of the study area is mapped as low risk Coastal Erosion area, as shown in Figure 7-6. The overlay is limited to the edges of 424, 490, 506, 514, 526 South Arm Highway and 2 Bangalee Street.

Development of land within the overlay will require justification that works will not increase risk to life, property or infrastructure. This is not anticipated to have any major implications with respect to the subdivision potential of the study area.

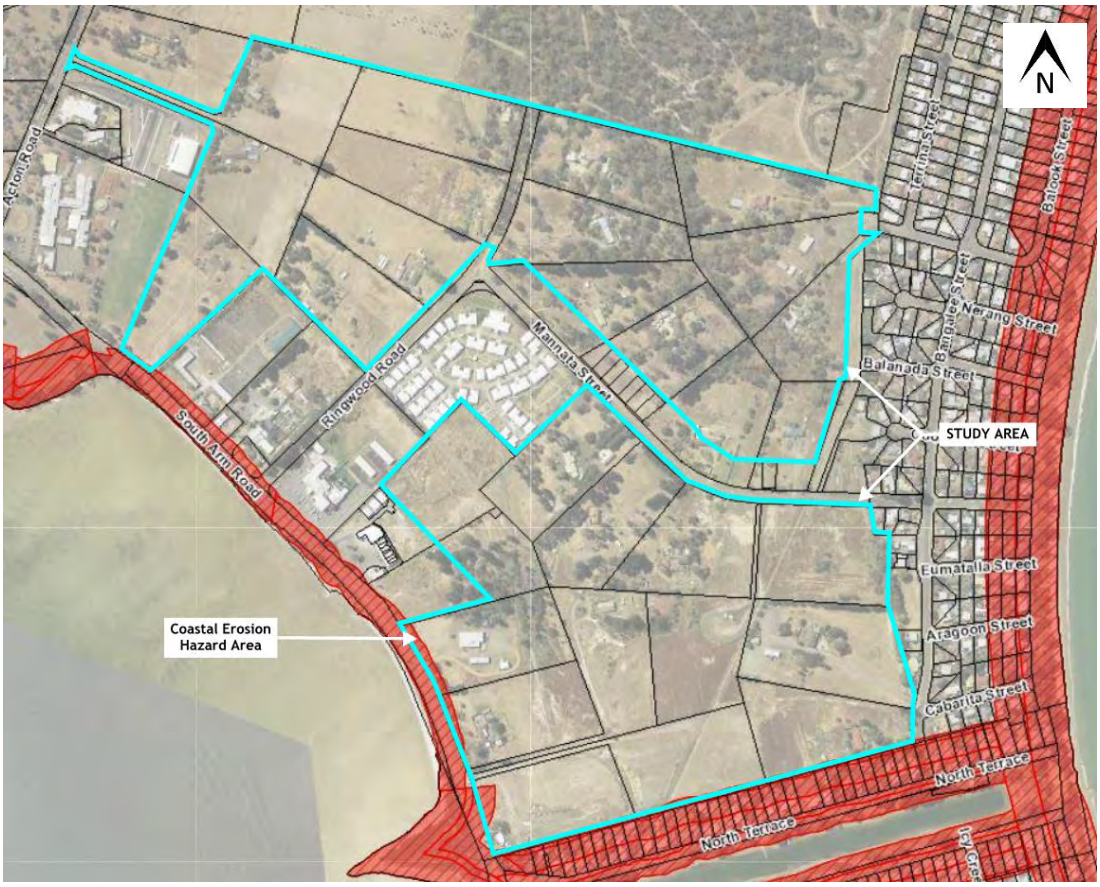

Figure 7-6 - Coastal Erosion Hazard Overlay

7.2.8 Natural Assets Code

Parts of the southern section of the study area are mapped within the Biodiversity Protection Area (High Risk), as shown in Figure 7-7. A subdivision proposal would therefore trigger Section E27.0 of the Planning Scheme.

At the southern end of the study area this includes the degraded saltmarsh area. At the northern end of the site it includes areas of remnant *Eucalyptus amygdalina* coastal forest and woodland. As discussed in Section 4.1 of this report, a recent Natural Values Report has been completed by Welling Consulting (March 2016) that found:

- The saltmarsh remnants within part of the Biodiversity Protection Area provides potential habitat (although marginal) for one threatened fauna species and contains one threatened grass species (Tall Blowngrass);
- The loss of woodland at the northern end of the site will not significantly impact on any threatened fauna habitat, flora species or vegetation community.

The *Eucalyptus amygdalina* coastal forest and woodland vegetation community and small areas of succulent saline herbland are located within a Biodiversity Protection Area – High Risk overlay under the Planning Scheme due to threats from fragmentation, exotic species, inundation and sea level rise. The saltmarsh is also subject to the Waterway and Coastal

Protection Area overlay. It is noted that the mapping no longer reflects the extent of the saltmarsh, which has been reduced in area

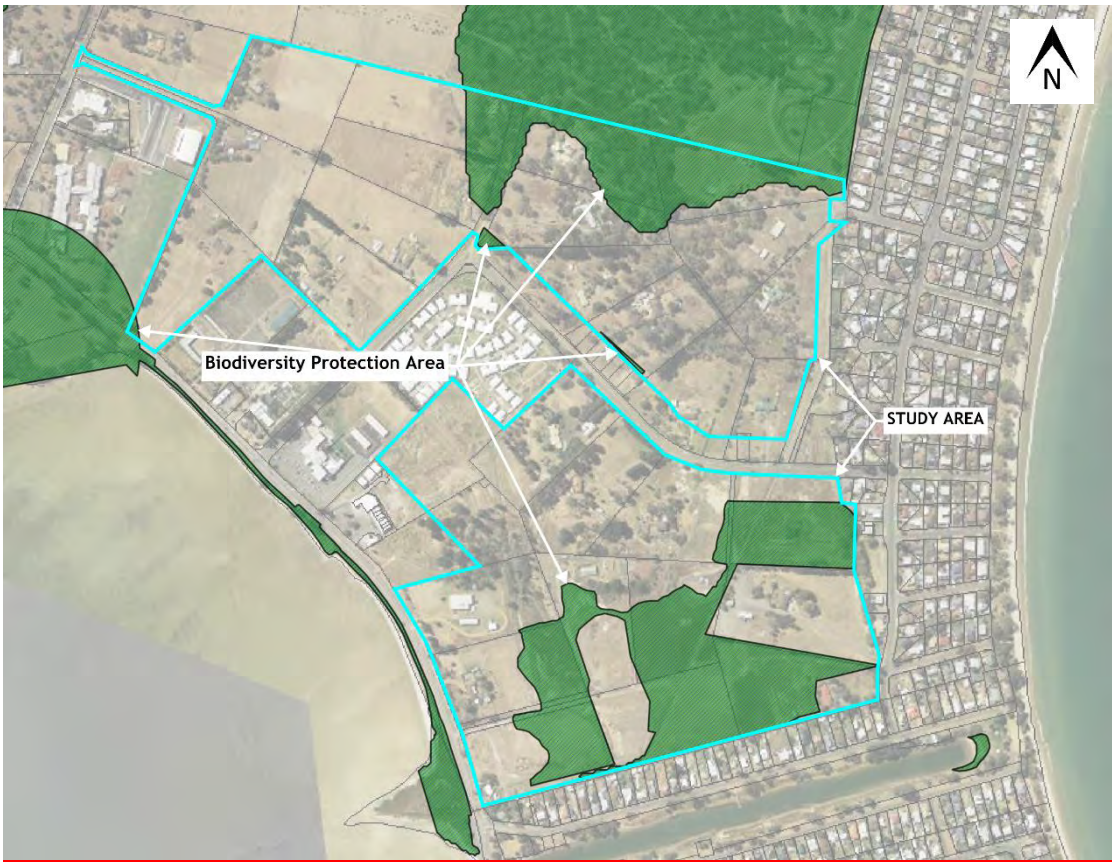

Figure 7-7 - Biodiversity Protection Area Overlay

Subdivision and filling of the southern part of the site for urban development would be classed as a 'Major' impact under clause E27.6 as it would cause significant disturbance of 'priority vegetation'.

Subdivision of the northern end of the site would be classed as a 'Negligible' impact.

A future s.43A application would likely require amendments to the overlay area to take account of the expanded urban area and the loss of priority vegetation. This would need to be supported by suitable justification for the impact to the priority vegetation. This may need to be supported by further field studies of Tall blowngrass in the local area to ascertain the significance of the local impact. Advice from Welling Consulting is that even with active management it could not be guaranteed that the species will survive, largely due to edge effects of surrounding development.

7.3 Lauderdale Structure Plan 2011

The *Lauderdale Structure Plan 2011* ('the Structure Plan') was prepared to provide broad guidance for land use and development in Lauderdale. The Structure Plan has been formally adopted by Council.

Drawing on the findings of the *Clarence Residential Strategy 2008* (now superseded by the Southern Tasmania Regional Land Use Strategy), the Structure Plan recognised that there was no more unsubdivided land within urban zonings at Lauderdale and that there was some demand for further growth, reflecting sea-change and other lifestyle phenomena.

With respect to spatial patterns of land use the Structure Plan recommended:

- Ringwood and Mannata Roads were identified as having some potential for residential development (a rezoning was subsequently approved that provided some additional General Residential land along these roads);
- The key limiting factor for growth in Lauderdale was acknowledged as inundation and drainage, hence the study area was designated as Rural Residential and outside of the urban growth boundary. The Structure Plan acknowledges however that the existing constraints could potentially be overcome through engineering design;
- Provision for an expanded commercial precinct on South Arm Road to provide the level of services demanded by the surrounding locality. The recommended commercial precinct is reflected in the current Commercial/Local Business zoning on South Arm Road.

7.4 Roscommon Master Plan 2014-2024

The Roscommon Master Plan provides direction for the use and development of the adjoining Roscommon Reserve.

Whilst generally limited to the reserve itself, the Master Plan does recommend that Council consult with private landowners with respect to the potential development of new linkages between the Lauderdale Primary and the Roscommon Reserve (refer to Figure 7-8). This link could be provided as part of a subdivision of the study area.

Furthermore, the Roscommon Master Plan includes a new track that would run parallel to the northern boundary of the study area. This track if designed appropriately could serve a dual purpose as a perimeter fire trail for urban development within the study area.

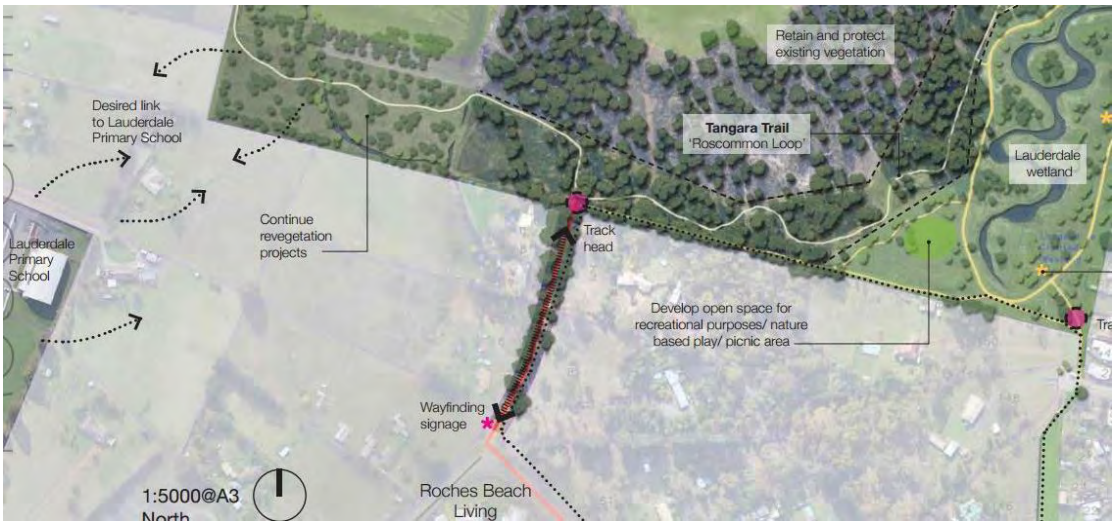

Figure 7-8 - Extract from Roscommon Master Plan

7.5 Clarence Tracks & Trails Action Plan 2015-2020

The Clarence City Council Tracks & Trails Action Plan guides the development of tracks and trails in the Clarence municipality. The goal is to develop an integrated network of tracks and trails through bushland and coastal areas, incorporating existing trails and prioritising missing links to future trail alignments.

The Action Plan identifies a network of public tracks and trails that include adjoining road reserves, through the Roscommon Reserve and along the coastal reserve. No new tracks through the study area are proposed in the Action Plan. Future subdivision of the site will however increase opportunities for linkages in the local area and connection with existing tracks and trails (refer to Figure 7-9).

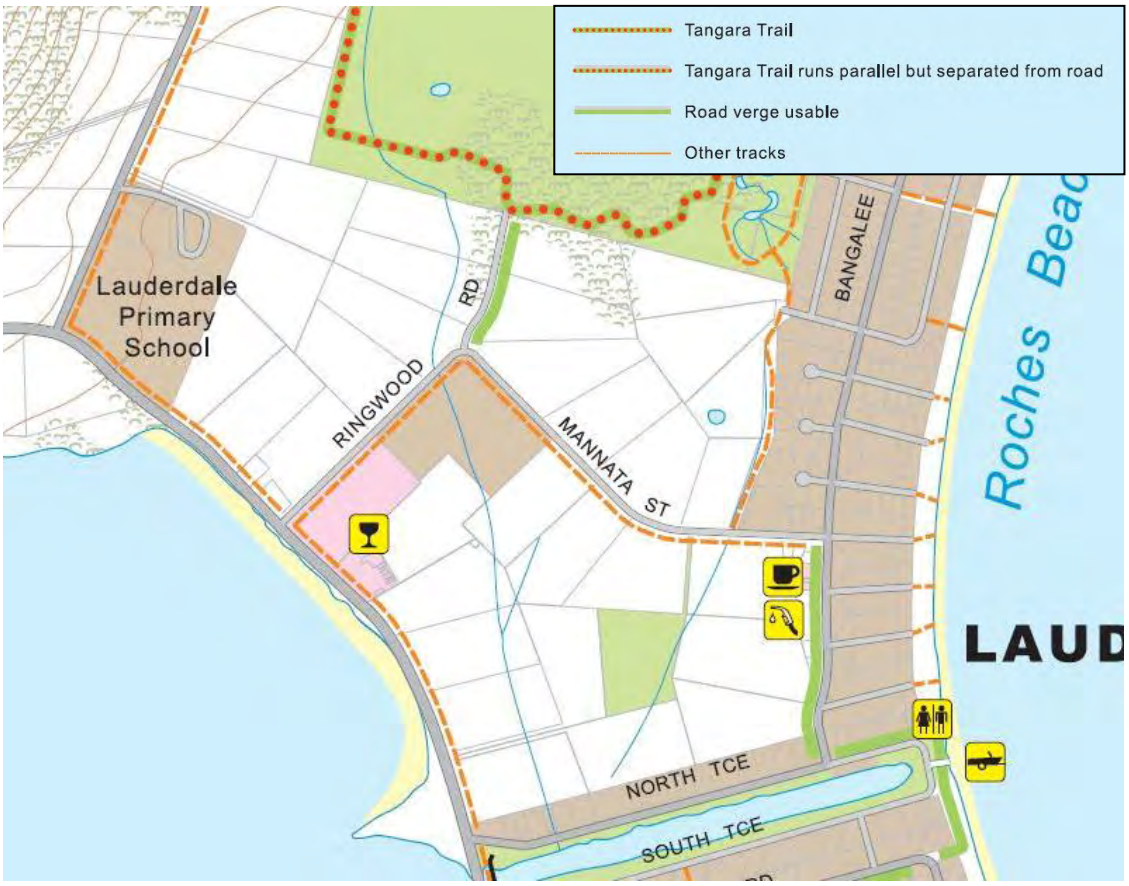

Figure 7-9 - Existing tracks and trails in locality of study area

7.6 Clarence Bicycle Strategy & Action Plan 2013-2017

The Clarence Bicycle Strategy & Action Plan recognises the needs and requirements of cyclists and identifies works required to develop an integrated bicycle network for Clarence.

The Action Plan recommends that new subdivisions include cycling infrastructure on all collector roads and provide for direct links to the arterial cycling network and local schools where possible. Cycling infrastructure should be designed in accordance with Austroads Guidelines, which provide various design options.

A bicycle path linking Lauderdale and Rokeby was identified as an incomplete key project.

To further the Bike Strategy, subdivision design within the study area should make provision for a cycle/pedestrian link through the site to the Lauderdale Primary School, which adjoins the study area to the west. Provision for a link to Ringwood Road/Mannata Street would also assist in providing cyclist access to the South Arm Highway.

8. Urban Design Analysis

8.1 Context

Lauderdale is set in an attractive coastal and riparian environment with frontages to both the River Derwent and Frederick Henry Bay. It is conveniently located approximately 15 kilometres from both Clarence (to the west) and Hobart International Airport (to the north).

The settlement pattern is well-established, with typical suburban housing densities situated along the northern and southern sides of Ralphs Bay Canal and adjacent to Roaches Beach. There is a small commercial precinct fronting South Arm Road, that is connected to the existing residential area via Ringwood Road and Mannata Street. A secondary local shopping strip is located on Bangalee Street, just to the north of North Terrace. Lauderdale Primary School is located to the north-west, at the corner of South Arm and Acton Roads.

Lauderdale is a sought-after location due to its high amenity, convenience and water frontages. The current population of 2,300 is set to increase, due to the expansion of residentially-zoned land resulting from a planning scheme amendment in 2013. The amendment was designed to allow for development of a residential link along Ringwood Road and Mannata Street, closing the division between the already existing residential and commercial areas. The Roches Beach Retirement Living development has recently been constructed within this rezoned area.

8.2 Key Features

The study area comprises 56 ha of Rural Living zoned land (refer to Figure 2-1 and Figure 2-2, on pages 10 and 11). It is abutted by existing General Residential Zone areas to the east, along Roches Bay, to the south along Ralphs Canal and centrally between the two halves of the study areas. Within the established General Residential Zone area, the layout is in a typical grid like formation with a small number of cul-de-sacs and larger corner lots.

There are a range of existing lot sizes that characterise the area surrounding the site. The site is surrounded by existing development to differing densities. Outside the site but centrally located is a retirement village located on the corner of Ringwood Road and Mannata Street. The site abuts the rear of surrounding residential properties to the west and east, commercial properties to the south and a wetland to the north.

Along the study area boundaries to the east and more prominently to the west along South Arm Road and Ralphs Bay, are Local Business, General Business and Community Purpose zones. Located within these zones are a primary school, doctor's surgery, motel, florist, pharmacy, church, post office and cafes.

8.3 Site Analysis

The site analysis of the study area and its surrounds demonstrates that the area exhibits a variety of physical and environmental opportunities and constraints. These are shown in Figure 8-1 (page 55).

The existing subdivision layout or 'rural living' properties are sparsely developed with a mixture of one and two storey homes, which appear to have been constructed primarily in the 1970s or 80s. Properties to the centre and north-east of the study area, particularly adjacent to Ringwood Road, are well vegetated. Those to the north-east and south are less well vegetated.

Of significance is the locality's close proximity to wetlands, a beach, a bay and a canal. There are also existing stormwater drainage lines that run through the site and a biodiversity protection area within the wetlands to the north. Vegetated areas of the site and surrounding area are subject to bushfire risk.

The low-lying nature of the precinct opens up sightlines to viewpoints such as; Richardson's Hill, Single Hill, Mt Rumney, Mt Nelson and Mt Wellington.

Other site features that are needed to inform the design layout are the:

- Existing vegetation (both within and surrounding the wetlands).
- Land ownership patterns.
- Existing lot boundaries.
- Existing roads.
- Proximity to coastlines.
- Surrounding residential lot sizes.
- Existing shared paths and walking trails.

Lauderdale has low lying terrain and as a result there is poor drainage across the study area.

The entire precinct has a medium inundation rating, while a substantial area towards Ralphs Bay Canal has a high level of flood risk. Although there are existing wetlands and stormwater pump stations (shown in Figure 8-1), high tides and storm surges affect the ability of the area to efficiently and effectively drain excess stormwater into the sea.

Design considerations due to the site's inundation:

- The future development layout must respond to existing drainage lines and drainage issues to plan effectively for flood events.
- Ensure acceptable buffers are allowed around open drainage lines to satisfy drainage, flooding and safety requirements.
- Exclude the stormwater pump stations from the developable area.
- Allows for existing sewer pump stations in the developable area.

8.4 Urban Design Principles

The following urban design principles identify those features within the site and its context that can be used to generate appropriate design concepts that are site responsive. In addition, they outline those principles that represent best practice urban design that informs the features of the design concepts.

Figure 8-2 (page 56) shows the features of the site and the surrounding opportunities and constraints of the site.

Due to the site's location between existing residential and business precincts, it is essential that the future development design promotes a connected and seamless layout. In particular, there is an opportunity to increase the permeability of the site for both existing and future residents.

The opportunities within the site are to:

- Utilise the existing drainage lines as possible active and green corridors to link into the existing wetlands and surrounding green spaces.
- Allow for ease of movement into the study area and from the study area to the surrounds.
- Reflect the surrounding layout where possible, so as not to detract from the existing character of the area.
- Use existing/surrounding road networks as possible entry/exit connections into the study area subdivision layout.
- Provide enhanced access to established bike trials and walking paths.
- Harness views through the placement of open space and pocket parks.
- Face lot frontages onto green corridors, pocket parks and streets.

Figure 8-1 - Analysis Map

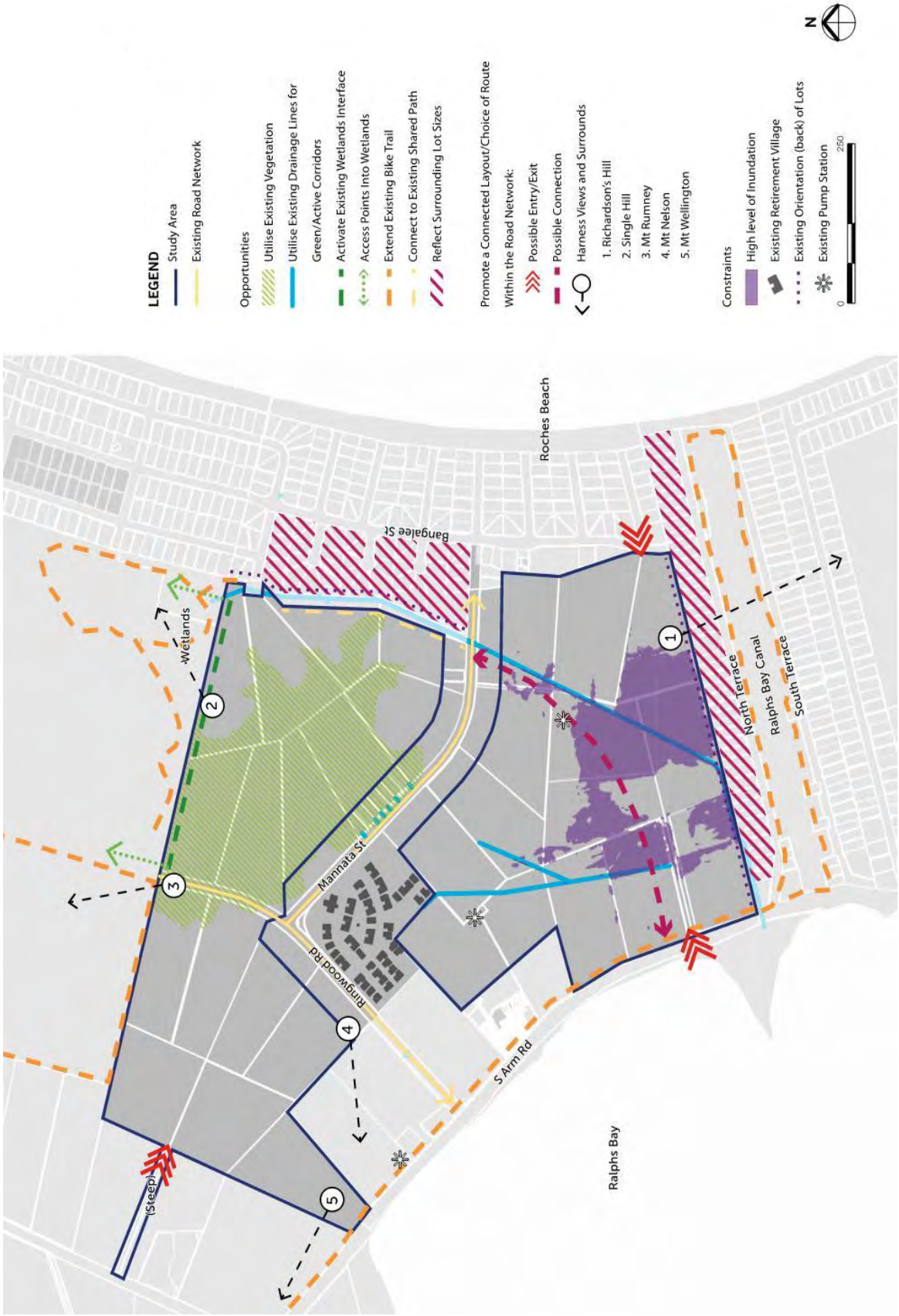

Figure 8-2 - Urban Design Principles Map

8.5 Concept Lot Layouts

The Concept Layout Design Options discussed below are shown with greater detail in Appendix C.

8.5.1 Concept 1 - Water Sensitive Urban Design

This is the first of three design concepts developed for the site.

The Water Sensitive Urban Design (WSUD) Development Concept shown in Figure 8-3, establishes a road network around the existing drainage lines and uses these to create linear corridors that run North to South through the site area, allowing residents physical access into the existing wetlands and canal areas and also connecting the site to them visually.

WSUD Key Design Principles:

- Combination of open drainage and culvert drainage across the site.
- 10m buffer of open space applied to open drainage, with breakout spaces of unencumbered open space linking residents to surrounding areas.
- The street network is connected with minimal culs-de-sac within the development design, allowing continual flow and ease of route for residents.
- Multiple access points into the development area, connecting into Ringwood Road and Mannata St.
- A high yield of 501 lots, with an ordinary lot size ranging from 650-1,000m^2.
- Views of existing vegetation and wetlands from within the development area.

Figure 8-3 - Water Sensitive Urban Design Concept

8.5.2 Concept 2 - Cul-de-sac Design

The second concept shown in Figure 8-4 is designed around interlocking and interweaving culs-de-sac and a combination of lot sizes in the layout.

Although the adoption of culs-de-sac does not allow for a road network with a continual flow, it would allow residents multiple access points into existing connector roads.

This concept has been generated with regard for the following design principles:

- Variation of lot sizes throughout the development while still adhering to ordinary lot sizes of 650-1,000 m^2, where possible. Lot yield of 469.
- Combination of open drainage and culvert drainage across the site.
- 10 m buffer of open space applied to open drainage, with breakout spaces of unencumbered open space linking residents to surrounding areas.
- Views of existing vegetation and wetlands from within the development area.
- Views of Ralphs Bay from Open Space located along the west boundary of the development layout.

Figure 8-4 - Cul-de-sac Concept

8.5.3 Concept 3 - ***'Big Loop'***

The third concept or 'Big Loop' concept is the preferred subdivision layout as it the most efficient use of the land and promotes a choice of route both internally and externally with minimal culs-de-sacs Figure 8-6. This option realigns and covers the existing drainage lines to ensure an efficient road network.

This concept has been generated with regard for the following design principles:

- Use of culvert drainage through the site allows for a far more effective and efficient road network and lot layout.
- Culvert drainage lines placed along boundary lines where possible to ensure maximum yield and developable space.
- Maximum yield of 583 lots, ensuring ordinary lot sizes in the ranges of 450-549m^2 and 550-649m^2, with minimum lots at 650-749m and greater than 750m^2.
- Access to and views of Ralphs Bay from open space located along the west boundary of the development layout.
- Access to and views of Ralphs Canal from Open Space located along the southern boundary of the development layout.
- Provision of centrally located open space in each area of the development layout.
- Multiple access points into the development area, connecting into Ringwood Road and Mannata Street.

Figure 8-5 - 'Big Loop' Concept

8.5.4 Final Concept

The final layout selected is a refined version of the 'Big Loop' concept, which has incorporated refinements from the civil engineers, traffic engineer and urban designers. This design has increased the available lot yield from the 'Big Loop' concept plan from 525 residential lots to 583 residential lots. This is not to suggest that additional lots could not be created through a more detailed lot design, but that the quantum of any additions is likely to be small in number and thus unlikely to distort the feasibility of the project. Equally there may be factors that decrease the available lot yield, but again the number would be small and thus unlikely to distort the feasibility assessment.

Figure 8-6 - Final Concept

9. Traffic Engineering

A Traffic Impact Assessment has been undertaken by Traffic Engineer Milan Prodanovic and is included as Appendix B.

The assessment considers the proposed subdivision layout and addresses the expected traffic implications and outcomes from the development.

The existing road layout is shown in Figure 9-1, below.

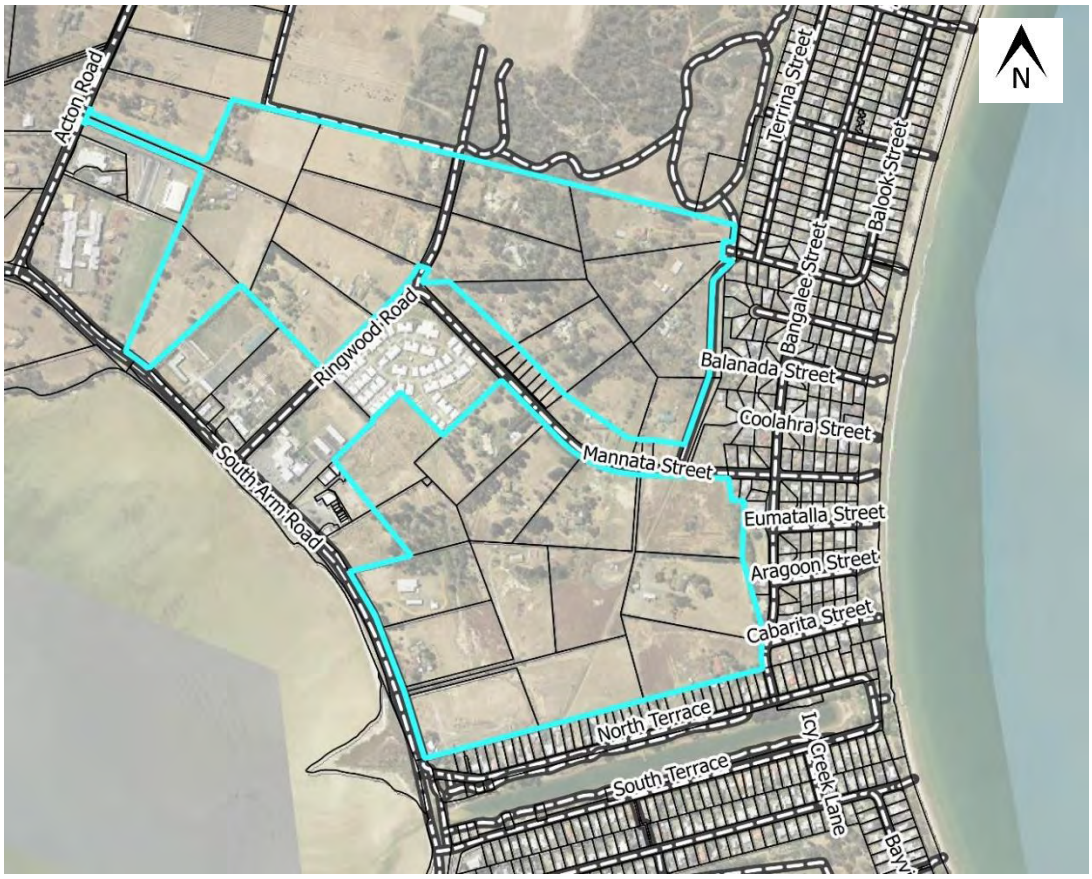

Figure 9-1 - Road Layout

The existing roads that will be affected by the subdivision include South Arm Secondary Road, Acton Road, Ringwood Road to Mannata Street. There will be redistribution impacts on Balook Street and Bangalee Street.

The development is expected to generate approximately 4,875 vehicles/day, with 10% occurring in morning and afternoon peak hour.

A roundabout control with auxiliary approach lanes will be required at the junction of Acton Road and South Arm Secondary Road to service expected future traffic activity from the subdivision.

A further roundabout will be required at the Ringwood Road and South Arm Secondary Road junction. This will provide necessary operational and safety improvements that cannot be achieved with auxiliary lanes.

A capacity analysis of other affected or new intersections within the subdivision was not considered necessary as the level of traffic conflict will not be high enough to be of concern.

There are no concerns with the proposed road layout within the subdivision. Good sight lines will be achieved along the continuing road at all junctions for the expected speed environment.

It is recommended that the Department of State Growth widen South Arm Secondary Road in coming years to the north of the garden nursery to install median treatment where there are frontage accesses to reduce the risk of crashes.

The new subdivision access road junction on Acton Road will be too close to the access driveway to the Lauderdale Primary School main car park area. To ensure the safe movement of vehicles to and from both access roads, it is recommended that the design of the subdivision road provide for the school car park to be accessed off the subdivision road around 100m from Acton Road. There will be a need for the installation of a CHR treatment on Acton road at the subdivision road junction.

Clarence City Council will need to ensure that the required road reservation is preserved to allow the future road connection to Mannata Street with the proposed roundabout control will be realized.

Increase the width of the narrower western end of Balook Street to the west of Terrina Street from around 7.7m to 8.3m to be consistent with the adjacent road standards.

The location of the new junction at the south-eastern corner of the subdivision onto Bangalee Street should be offset from Cabarita Street so as not to create a four leg intersection. The access could also be created simply as a convenient pedestrian access.

Ringwood Road will need to be upgraded with kerb and gutter as well as footpaths both sides of the road and a width between kerb faces of 11.0m.

The report also recommends a review of bus services to provide a service along Ringwood Road-Mannata Street.

10. Financial Modelling

The financial modelling is based on the final concept plan which has a yield of 583 residential lots. The basic variables of the modelling are the acquisition price of existing land, the construction cost and the sale price of the created lots. These are discussed in more detail below. The Net Present Value Analysis stages the acquisition and construction costs and the lot sales price and calculates a Net Present Value Rate which is a measure of project feasibility. A small 10% contingency has been applied to the development costs but this would not account for a number of costs that have been excluded (including road/intersection land acquisition or services relocation, decontamination, legal conveyancing, marketing, real-estate and finance costs).

10.1 Acquisition Price

Table 8 provides current market value estimates for lots within the study area, together with the accuracy of those estimates and the last sold price/date[14]. All lots included are just over 2 ha with the average price estimate being $514,702. This information is limited and actual property valuation would be required were the properties in the study to be acquired. This data provides a general estimate for the financial modelling in the following sections.

Table 8 - Property Valuation Estimates from 'onthehouse.com.au[15]'

Address	Last Sold	Estimated Value ($)	Estimate Accuracy	Estimate Range	
				Low	High
25 Acton Road (6-bedroom house) - 2.19 ha	29/4/2013 for $440000	528117	High	475	580
424 South Arm Road (4-bedroom house) 2.023 ha	10/08/2015 for $430000	521378	High	469	573
8 Ringwood Road (3-bedroom house) 2.065 ha	10/01/1997 for $175000	563896	Low	451	676
2 Ringwood Road (4-bedroom house) 2.088 ha	04/04/1998 for $177500	554846	Low	443	665
5 Ringwood Road (5-bedroom house) 2.019 ha	22/11/2005 for $435000	571106	Medium	485	656
148 Balook Street (4-bedroom house) 2.043 ha	25/02/2010 for $475000	491887	High	442	541
512 South Arm Road (3-bedroom house) 2.074 ha	03/02/2000 for $125000	408181	Medium	346	469
37 Mannata Street (4-bedroom house) 2.084 ha	30/05/2003 for $250000	478203	Medium	406	549
Average Area = 2.073	Average Price Estimate = $514702	Lowest Estimate= $439625		Highest Estimate= $588625	

[14] Multiple property websites ('Domain', 'All Homes' and 'Real Estate.com') were consulted for sales prices. However, there is a distinct lack of sales data for the area published online. The LIST was also consulted, however obtaining valuation reports for each site was beyond the scope of this study.

[15] onthehouse.com.au estimates are calculated based on publicly available property data and past sales histories sourced from state governments, property owners, real estate agents and other third party sources. Estimates and Estimates Range can vary depending on data available.

10.2 Estimated Sales Price

Establishing an estimated sales price for future lots in the study area is essential to calculating the feasibility of the project. There are many variables that influence sales prices, and sales prices are not necessarily an accurate reflection of the value of the land.

Data on sales in Lauderdale are limited and it was therefore considered that the average sales price of that data would not be meaningful. For the purposes of this study sales data[16] from Lauderdale and the surrounding area was collected and the average price per square metre of land was calculated. The suburbs included in the analysis are Oakdowns, Rokeby, Tranmere, Clarendon Vale, Howrah and Lauderdale. All sales included occurred between 2009 to 2016.

As future lots would be zoned General Residential, sales prices from properties in other zones were excluded.

Waterfront lots were excluded as they are not considered to be of comparable value.

The date of sale, views and the closest school were also noted.

Sales from surrounding suburbs represent a number of market segments. STRLUS Background Report No. 13 establishes the market segments for suburbs in Southern Tasmania based on the median sales price in 2009. The surrounding suburbs fall into the following segments:

- Lower Market Sector: Rokeby, Clarendon Vale
- Middle Top Market Sector: Howrah, Oakdowns, Lauderdale
- Top Market Sector: Tranmere

Clarendon Vale and Rokeby are in the Lower market segment, therefore using an average sales price of properties in those areas as a basis for this study would likely underestimate the value of future lots. Similarly, though Oakdowns is defined as being in the same market segment as Lauderdale, it's median sales price is lower than that of the other middle top suburbs considered, both in recent sales and in STRLUS Background Report No. 13. Finally, prices from property sales in Top market segment Tranmere are likely to be higher than the value of future lots. Therefore, the average sales prices of these areas have not been used in the estimated values of lots in the study area.

Given that Lauderdale is in the Middle Top market segment it was assumed that sales of properties within the same market segment would provide the most comparable value. These prices were then separated based on lot size to provide an overall average, an average for lots under 650 m^2 and an average for lots over 650 m^2. Lots greater than 650 m^2 were considered to have the potential for multiple dwelling development[17] and would therefore likely have a different value to a lot restricted to single dwelling development. Whilst included, lots greater than 1,000 m^2 are considered to have the potential to be subdivided[18]. A general trend of the data shows that as the lot size increases, the price per square metre decreases.

The majority of existing houses in Lauderdale are within easy walking distance to the beach, generally less than 400 m. Though qualitative, it is assumed that this proximity to the beach contributes to the value of properties in Lauderdale. The lots that would be created in the study area are unlikely to have substantial views and only the easternmost

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[16] Sale prices for undeveloped lots were obtained from property website 'www.realestate.com.au'.

[17] Permitted multiple dwelling development in the General Residential zone requires a site area of 325 m^2 per dwelling.

[18] Subdivision of land in the General Residential zone requires that a lot have a site area per dwelling generally 450-1000 m^2. Site area per dwelling is defined as the area of the site (excluding any access strip) divided by the number of dwellings. Given the variable dimensions of lots from past subdivision at lower density, it is likely that lots with potential for subdivision in this area would create internal lots, therefore requiring more land to accommodate suitable access strips.

lots will be within a similar distance to Roches Beach. Whilst here is likely to be a range of values for lots in the study area, dependent on lot size and location, the lots in the study are likely to be less valuable as the properties in easy walking distance to the beach.

The final estimates for lot values in the study area are based on the average sales price of properties in the Middle Top market sector excluding Oakdowns. The minimum estimate uses the average price per square metre for lots over 650 m^2 and the maximum estimate uses the average price per square metre for lots under 650 m^2, based on a lot size of 650 m^2.

The results of the analysis are included in Appendix D and summarised in Table 9 and Table 10 below.

Table 9 - Sales Prices of undeveloped land in Lauderdale, Howrah, Rokeby, Clarendon Vale, Tranmere, and Oakdowns

Market Sector	Price per m^2 ($)					
	Minimum	Maximum	Median	Average	Average (no views)	Average (views)
Lower	42.318	196.91	77.83	107.84	88.64	127.03
Middle Top	82.123	393.89	201.73	204.86	198.11	211.6
Top	143.13	423.53	206.9	218.68	N/A	218.68

Table 10 - Estimated of undeveloped General Residential Land in Lauderdale

Lauderdale Estimate	Average price per m^2 ($)	Calculation	Sales Price for 650m^2 Lot	Average +10% (accounting for inflated sales price)
Maximum	286.92	=286.92 x 650	$186,498.00	$205,147.80
Minimum	209.3	=209.30 x 650	$136,045.00	$149,649.50
Average	248.11	=248.11x 650	$161,271.50	$177,398.70

10.2.1 Valuation Reports

Valuation reports for developed General Residential lots between the two portions of the study area were also obtained to provide greater insight into the potential land value of the future subdivision. The lot values (included in Appendix D) estimated by the Valuer General are as follows:

- 47 Mannata Street (668 m^2) valued at $150,000, last sold for $165,000; contract date 01/10/2013.
- 51 Mannata Street (548 m^2) valued at $150,000, last sold for $150,000; contract date 24/04/2014.
- 55 Mannata Street (549 m^2) valued at $150,000, last sold for $147,000; contract date 30/05/2014.
- 59 Mannata Street (674 m^2) valued at $150,000, last sold for $170,000; contract date 22/11/2013.

All lots had a settlement date of 21 July 2014 and have since been developed with dwellings.

From the above valuations we can see that the estimated value of the land does not necessarily predict the sale price of the land. All lots are valued at $150,000.00, yet the

sales prices range from $147,000.00 to $170,000.00. The price settled on decreased the longer the lot was on the market.

10.3 Property Value Estimates for Financial Model

Obtaining an estimated value for the proposed lots is a keystone to projecting the feasibility of urban expansion in Lauderdale. Recent sales figures of undeveloped lots in the surrounding area and Middle Top market sector provide an outline within which to focus the analysis. Valuations of lots adjacent to the study area from the Valuer-General also provides support for the final estimates utilised in the overall financial modeling of the project. No estimate can fully predict the real sales price of the future lots.

Given the valuations in section 10.2.1, the lack of views and distance from the beach, it is considered prudent to take a conservative estimate for modeling the financial feasibility of the project. Further to this, the preferred concept plan includes larger lots and the maximum price of recent land sales in the immediate area was $170,000.00. It is therefore considered reasonable to use the minimum value from the lot price analysis, the Valuation as an average and the maximum of recent sales in Mannata Street as values for calculating the feasibility of the project. The final assumptions to be used in the Net Present Value Analysis in section 10.6 below are summarised in Table 11.

Table 11 - Property Value Estimates for Net Present Value Analysis

	Average	Low	High
Acquisition Price	525,000.00	400,000.00	650,000.00
Sales Price	150,000.00	135,000.00	170,000.00

10.4 Construction Cost Estimate

A construction cost estimate has been established based on the preferred lot layout and is included in Appendix E and summarised in Table 12 below. The development cost summary assumes the median costs of $20/m^3 for fill and acquired property price of $525,000.

Table 12 - Development Cost Summary

DEVELOPMENT COST SUMMARY		COST
1.0	SITE ESTABLISHMENT / EARTHWORKS SUB TOTAL	$21,009,600
2.0	STORMWATER SUB TOTAL	$7,613,700
3.0	SEWER SUB TOTAL	$7,207,600
4.0	WATER SUB TOTAL	$1,039,000
5.0	ROADWORKS SUB TOTAL	$10,745,350
6.0	MISCELLANEOUS SUB TOTAL	$22,378,850
7.0	AUTHORITY CHARGES	$2,020,762
8.0	10% CONTINGENCY	$7,201,486
9.0	GST	$7,921,635
TOTAL ESTIMATED DEVELOPMENT COST (INCLUDING GST):		$87,137,982

Unit rates have been assumed based on JMG's database of previous civil construction projects and the Australian Construction Handbook[19].

A major unknown that makes a significant difference to overall costs is associated with filling of the land. It is estimated that 635,000 m^3 of fill will be required to bring ground levels up to 3 m AHD. Laying and compaction rates for the fill are relatively easy to estimate but supply rates can vary significantly. Commercial supply rates are in the order of $20/$m^3$ but it is assumed that fill material used to date has been sourced for free. It should be noted, however, that the current fill is uncontrolled both for its quality and compaction and may need to be removed (or treated) if inadequate, at a significant cost (refer to section 3.1). A sensitivity analysis has been done as part of the Net Present Value analysis.

Similarly, the value of acquiring the existing properties is factored into the financial analysis, but is difficult to establish and has a significant impact on overall price. The current median house price for similar rural residential properties in Lauderdale and surrounds is estimated at $525,000 but this will obviously vary if the land is rezoned to urban residential. Considering that for some properties, dwellings will have to be demolished to facilitate development their value is limited. A sensitivity analysis has been done with existing property prices varying between $400,000 and $650,000.

The cost for provision of standard infrastructure (excluding fill/compaction, intersections/external road widenings, raising sewerage pump stations, stormwater culverts and land acquisition) for an urban residential development such as roads, sewer, stormwater, water, power, telecommunications and landscaping has been estimated at approximately $48,000 per lot. This is consistent with other similar developments where these costs generally range between $40,000 - $50,000 per lot, but are pushed to the higher end by the pressure sewerage system in this instance.

10.5 Staging

It has been assumed that the entire area will be developed over 17 stages comprising approximately 35 lots per stage. Each stage is assumed to take a year and therefore the entire area is assumed to be developed over a 17-year period.

The area south of Mannata Street will have to be developed first to ensure that drainage is adequate for future stages. Significant upfront costs will be required in year one, including:

- Purchase land and remove all buildings
- Raise Sewerage Pumping Station (SPS) at 488 South Arm Highway
- Fill entire southern area
- Providing drainage upgrades to southern area

Intersection upgrades will be required based on the number and location of developed lots and are assumed as follows:

- Year 1 – Bangalee Street opposite Cabarita Street
- Year 3 – Mannata Street roundabout
- Year 3 – Ringwood Road / South Arm Highway intersection
- Year 3 – Ringwood / Mannata Road Widening
- Year 5 – Ringwood Road at 464 South Arm Highway
- Year 9 - Upgrade new intersection onto Acton Rd (including passing layby)
- Year 11 – Acton Road / South Arm Highway roundabout
- Year 15 - Balook St widening 50m section from 7.7m to 8.3m

Additional emergency storage at SPS sites will also be required depending on the number and location of developed lots and is assumed as follows:

[19] Rawlinsons (2006)

- Year 3 - 91kL at 36 Mannata Street SPS
- Year 4 - 11kL at 488 South Arm Highway SPS

The northern area will be developed after the southern area with the following major works required in the first year of this part of the development (year 8):

- Purchase land and remove all buildings
- Fill entire northern area
- Provide drainage upgrades

It should be noted that it may be possible to undertake the development on a piecemeal approach by each property owner in a similar fashion to the strip either side of Mannata Street. However, this would significantly add to the cost and brings in issues associated with infrastructure upgrades such as drainage culverts and road works. This infrastructure could be constructed by Council and funds recouped via a headworks charge. However, it is anticipated that the headworks charge would be cost prohibitive. The above staging assumptions provide the best case to undertake financial modelling from.

10.6 Net Present Value Analysis

In order to ascertain financial viability a Net Present Value (NPV) analysis has been done (Appendix F). Costs and revenues over the life of the project are compared and the difference brought back to the present value. Projects with a positive NPV are deemed economically viable.

The Hurdle Rate (or Discount Rate) used in NPV analysis can sometimes make a significant difference to the outcome and can change over the life of the project. According to the Reserve Bank of Australia (RBA) around half of businesses in Australia use a Hurdle rate exceeding 13% and this does not change dramatically over time. For this project a Hurdle Rate of 10% has been assumed.

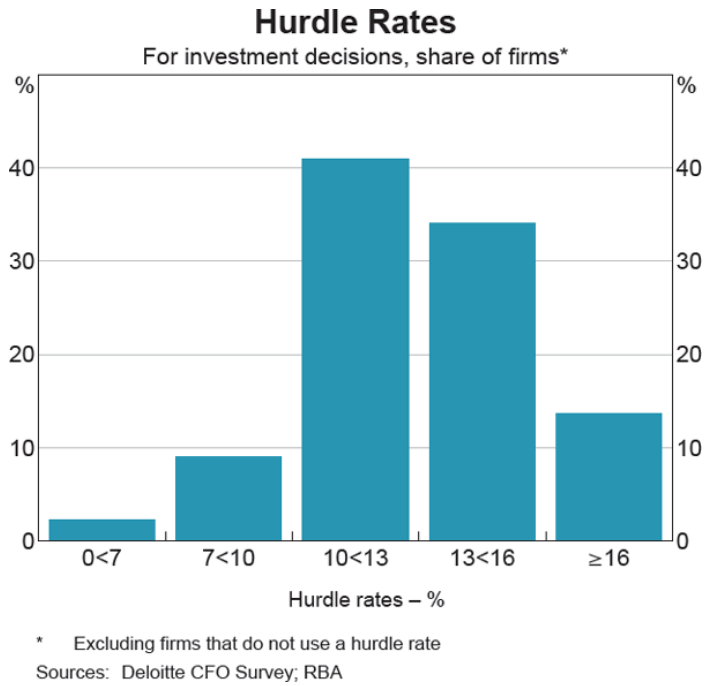

Figure 10-1 - Hurdle (Discount) Rates used by Australian businesses. Source RBA.

The three significant variables are the cost of fill, property acquisition prices and the sales prices. To understand the impact of these costs a sensitivity analysis has been done around each variable. Fill supply rates have been varied between $0 and $20 per cubic metre, existing property acquisition prices have been varied between $400,000 and $650,000 and lot sales prices have been varied between $135,000 and $170,000.

Table 13 - NPV analysis results for various discount rates.
(Based on $20/m^3 for fill and acquired property price of $525,000)

	Hurdle Rate			
Sales Price	10%	7%	5%	3%
$135,000	-$11,840,479	-$9,327,539	-$6,885,517	-$3,551,154
$150,000	-$8,085,282	-$4,643,488	-$1,385,936	$2,980,710
$170,000	-$3,078,352	$1,601,913	$5,946,837	$11,689,861

As can be seen, on a 20m^3 fill price the project is not viable at a 10% Hurdle rate assuming the upper sales price of $170,000. It is considered the 10% Hurdle Rate, $150,000 sales figure at the median acquired property price of $525,000 is the most accurate scenario. The property yield has very little impact on project viability for variations of 5% either way.

The best scenario is if the fill price is low (nil), the sales price is high ($170,000 per lot) and the acquisition price is low ($400,000).

Table 14 - NPV analysis results for various discount rates.
(Based on free fill and acquired property price of $400,000)

	Hurdle Rate			
Sales Price	10%	7%	5%	3%
$135,000	$2,127,402	$6,068,518	$9,671,818	$14,379,057
$150,000	$5,882,599	$10,752,569	$15,171,398	$20,910,920
$170,000	$10,889,528	$16,997,970	$22,504,172	$29,620,072

As can be seen under these circumstances the project is has a positive NPV at all sales prices and all Hurdle Rates.

The worst scenario is a fill price of 20m^3, an acquisition price of $650,000 per lot and a sales price of $135,000 per lot.

Table 15 - NPV analysis results for various discount rates.
(Based on $20/m^3 for fill and acquired property price of $650,000 per lot)

	Hurdle Rate			
Sales Price	10%	7%	5%	3%
$135,000	-$14,327,144	-$12,104,800	-$9,900,652	-$6,848,898
$150,000	-$10,571,947	-$7,420,749	-$4,401,072	-$317,034
$170,000	-$5,565,018	-$1,175,348	$2,931,701	$8,392,117

As can be seen, project has large negative NPV Rates at the 10% Hurdle Rate in this scenario. Full modelling of these scenarios is attached in Appendix F.

10.6.1 Exclusions

It is worth noting that the modelled figures include a number of exclusions which could significantly impact on the financial modelling above.

The quantity and quality of the existing fill on the site is unknown and for the purpose of the above assessment it is assumed that it is not present on the site. It is known there are already issues with contamination regarding fill on the subject site, but these also have not been considered. The cost to excavate, transport and dispose of contaminated fill is likely to be $150 per tonne.

Preliminary advice is that there are no TasWater downstream works required for this area. If this were to alter once TasWater assessed a development application these works may have a substantial cost.

Likewise, TasNetworks system upgrades have not been included in the modelling figures. The base per lot cost is that expected for large subdivisions in JMG's experience and includes a local substation, but not upgrades beyond the site. Costs for this upgrade would be shared by beneficiaries and are estimated at $1,200 per lot. This additional cost has not been included in the financial analysis as it is not yet TasNetworks policy.

It has been assumed that the South Arm Highway/ Acton Road and Ringwood/South Arm Highway intersection upgrades would not be fully bourn by the developer as there is already some demand for these upgrades by existing development. A half price discount has been applied for the purposes of the costing for these two intersections.

No land acquisition costs have been included for the road widening or intersections. There is not sufficient detail to provide any accuracy for these costings at this stage, but they will be required. Likewise, no costs have been included to re-locate existing services resulting from new intersections or road widenings, but it is known this will be required.

There is no consideration of legal conveyancing, marketing, real estate sales or finance costs in this assessment, as again these are variable and likely to be negotiated on a bulk rate.

The staging of the project is assumed to be continuous and for the two development areas to be wholly filled two separate stages. An incremental staged approach to filling the north and south development areas would create significant issues with managing the fill and staging services, thus significantly increasing the costs of the project.

The above factors should be included in a contingency, sized depending on the developer's approach. The 10% contingency provided in the costing is not meant to cover these matters, but is to cover unknowns such as weather, price increases in materials, subsurface conditions etc.

It is also noted that potentially the project developers may already own some land in the site. For the purposes of this analysis it has been assumed that a developer would need to acquire all the land in the subject area anew.

10.7 Conclusion

The project based on a 10% Hurdle Rate, a median sales price of $150,000 per lot, a median acquisition price of $525,000 and a fill supply cost of $20 per cubic metre returns a negative NPV value of -$8,085,282 and thus is not feasible. The NPV value can be brought positive by altering these variables within a reasonable range, but given they are largely outside the control of the developer and there are number of exclusions likely to drive up the project cost, to do so would result in high risk project. There is scope to refine the lot layout to increase the yield by 5% but this would not substantially improve the feasibility. The cost for provision of standard infrastructure for an urban residential development has been estimated at approximately $48,000 per lot. This is consistent with other similar developments where these costs generally range between $40,000 - $50,000 per lot. The cost of the pressure sewerage system (approximately $9k per lot) is the reason this cost is at the high end.

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Legislation

Aboriginal Relics Act 1975 (Tasmania)

Clarence Interim Planning Scheme 2015

Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

Environment Protection (Impact of Proposals) Act 1974 (Commonwealth)

Forest Practices Act 1995 (Tasmania)

Historic Cultural Heritage Act 1995 (Tasmania)

Land Use and Planning Approvals Act 1999 (Tasmania)

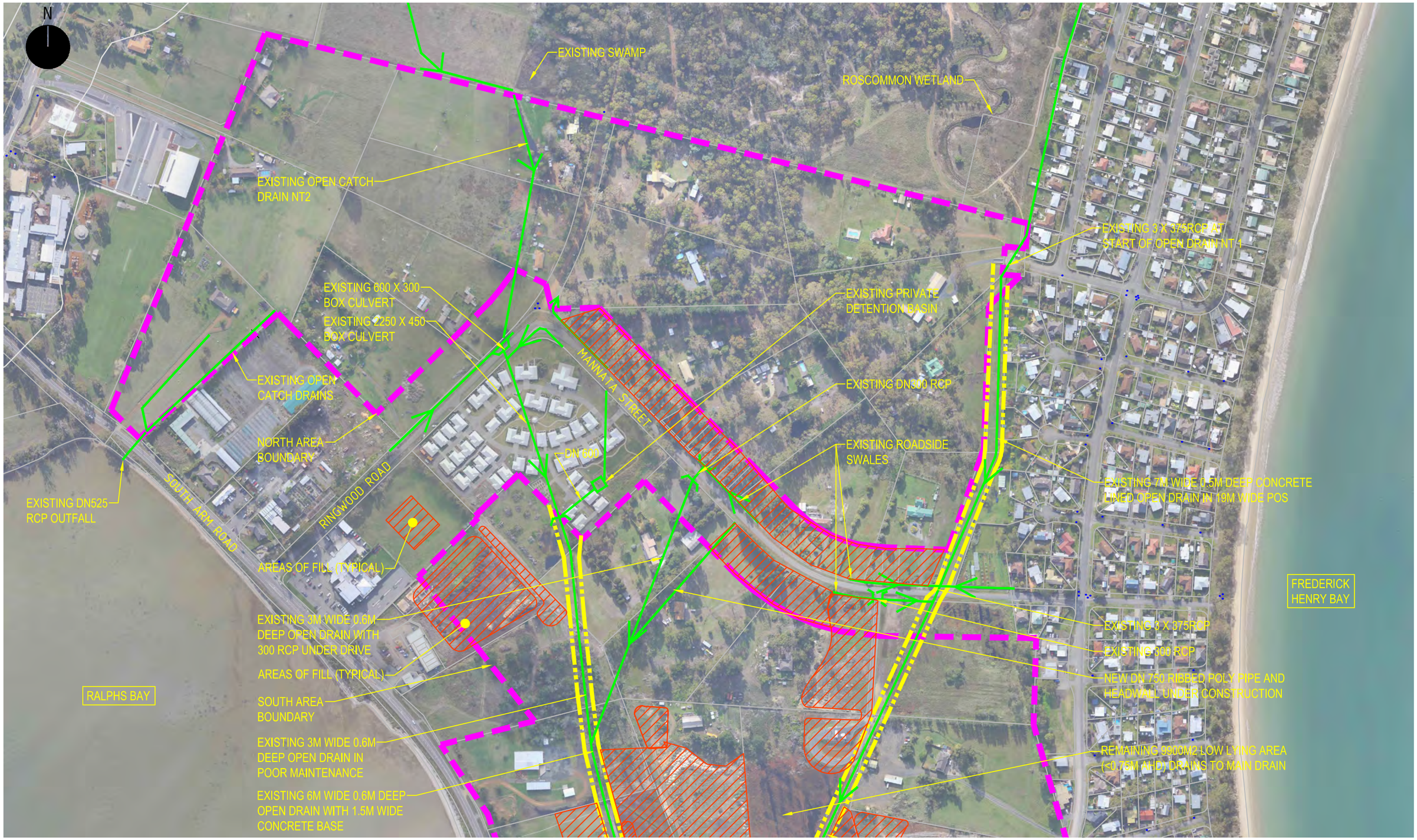
Nature Conservation Act 2002 (Tasmania)

Threatened Species Protection Act 1995 (Commonwealth)

Weed Management Act 1999 (Tasmania)

APPENDIX A

Drainage Analysis Results and Figures



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Approved Grant Atherton (Group Manager)	Date	

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PROJECT
LAUDERDALE STORMWATER DRAINAGE ASSESSMENT

TITLE
STUDY AREA PLAN AND EXISTING DRAINAGE
SHEET 1 OF 2

PROJECT NO. J153075PH
DWG NO. SK01
REVISION P1
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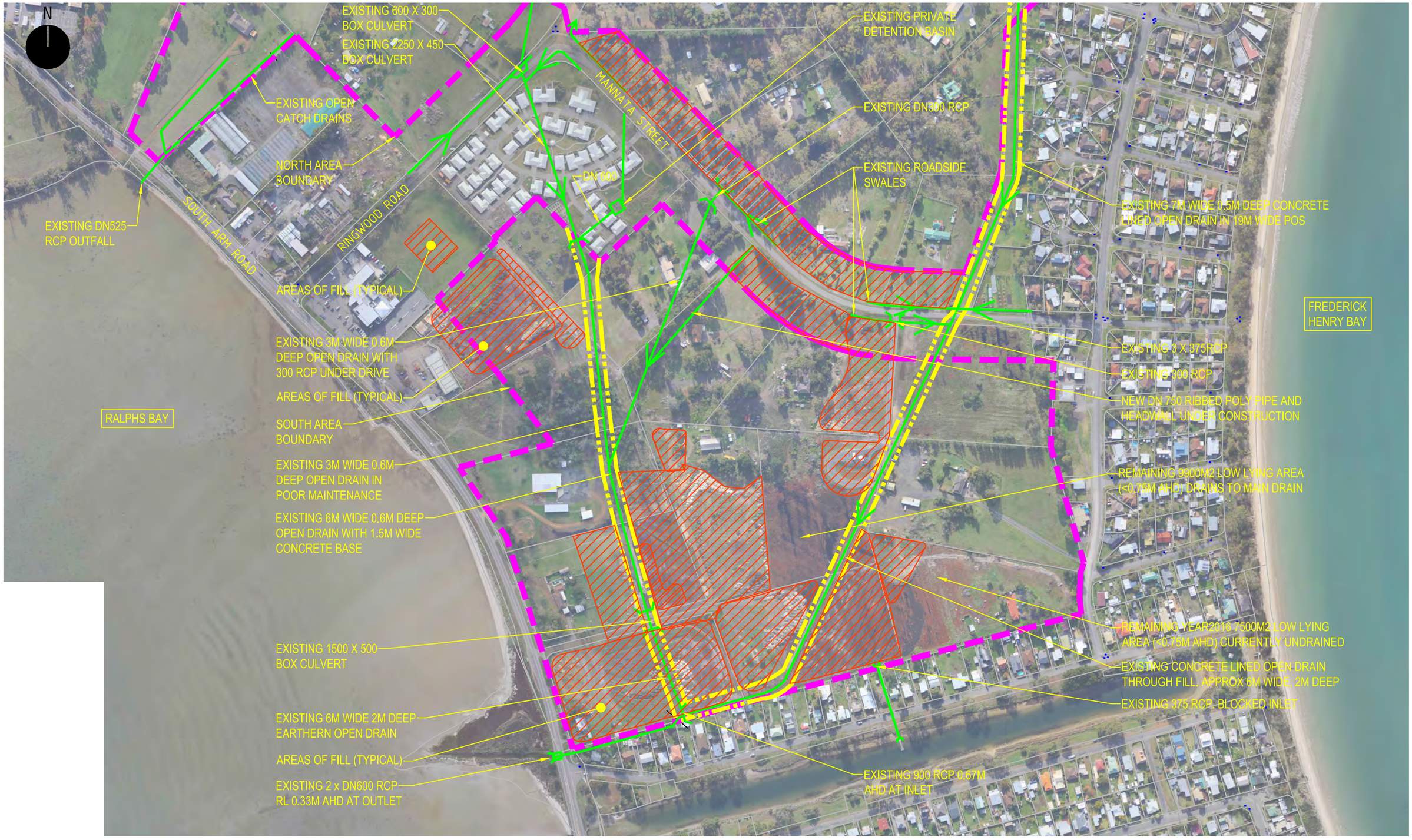

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PROJECT
LAUDERDALE STORMWATER DRAINAGE ASSESSMENT

TITLE
STUDY AREA PLAN AND EXISTING DRAINAGE SHEET 2 OF 2

PROJECT NO. J153075PH
DWG NO. SK02
REVISION P1
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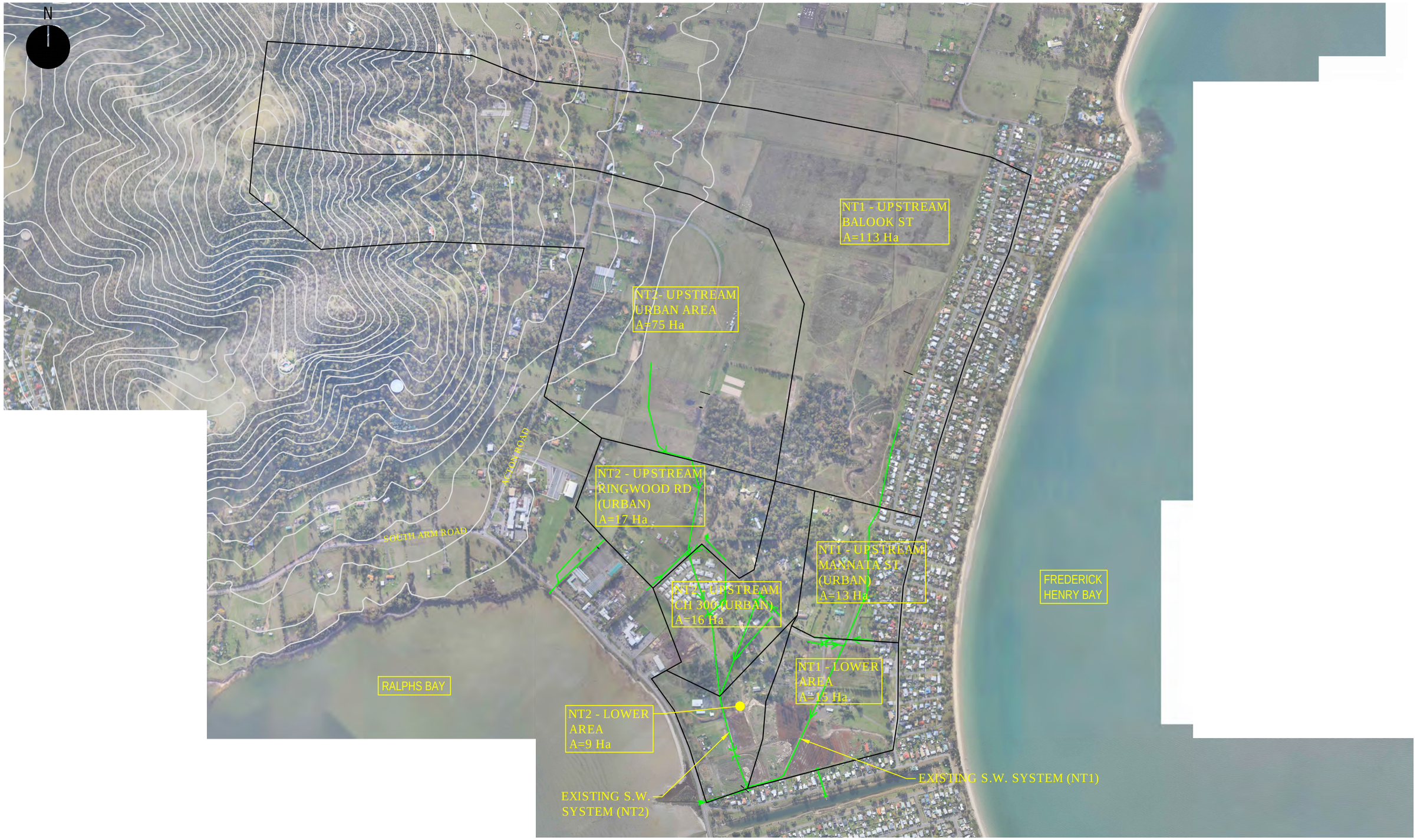

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PROJECT
LAUDERDALE STORMWATER DRAINAGE ASSESSMENT

TITLE
CATCHMENT PLAN

PROJECT NO. J153075PH

DWG NO. SK03

REVISION P1

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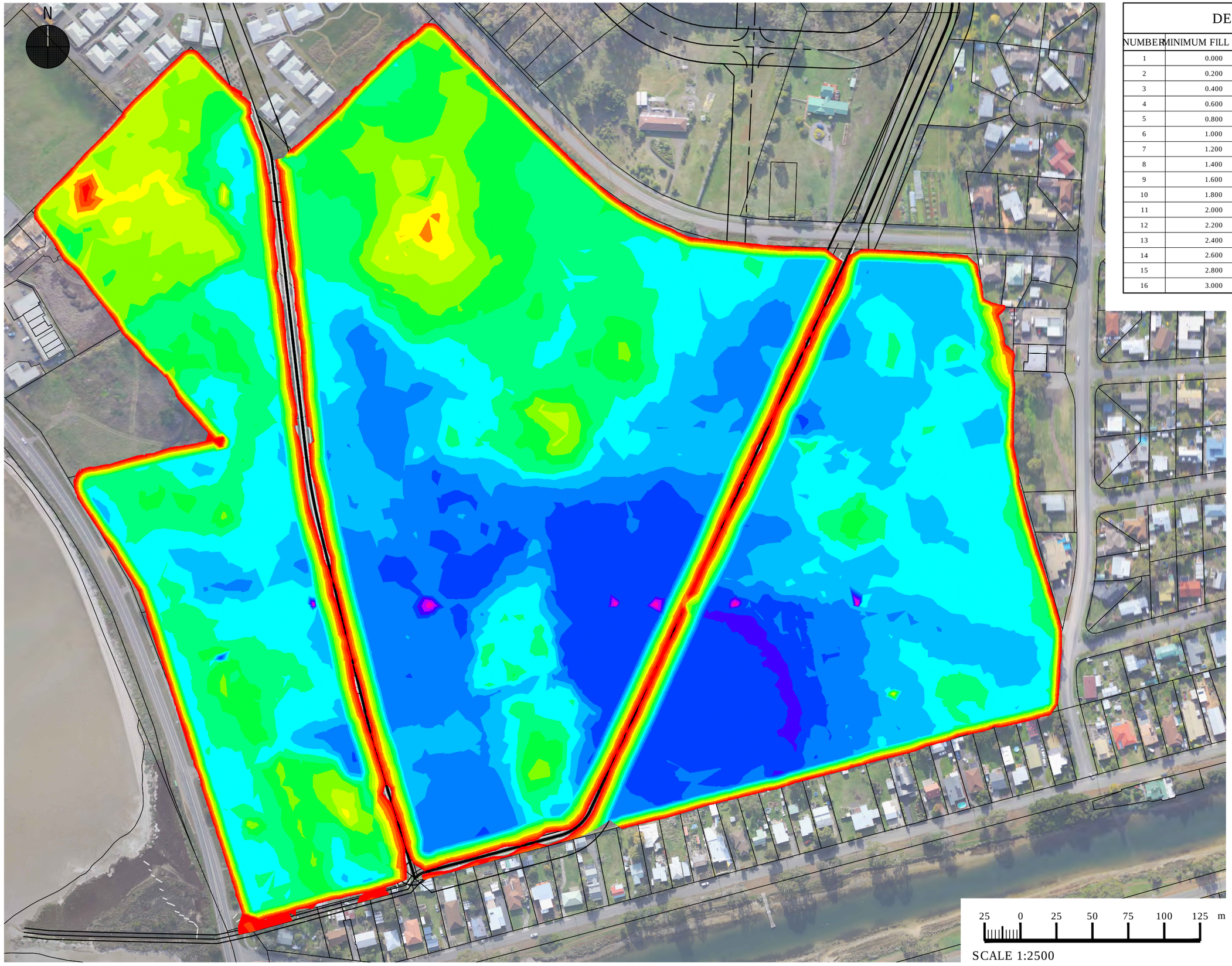

DEPTH OF FILL

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4	0.600	0.800	
5	0.800	1.000	
6	1.000	1.200	
7	1.200	1.400	
8	1.400	1.600	
9	1.600	1.800	
10	1.800	2.000	
11	2.000	2.200	
12	2.200	2.400	
13	2.400	2.600	
14	2.600	2.800	
15	2.800	3.000	
16	3.000	3.200	

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PROJECT
LAUDERDALE URBAN EXPANSION FEASABILITY STUDY

TITLE
DEPTH OF FILL
TO 3.00 AHD
AREA 1

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Approved Justin Boocock (Group Manager)	Date

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PLOT DETAILS CIVIL3D BASE - FLOOD MODELLING.DWG

PROJECT NO. J153075PH

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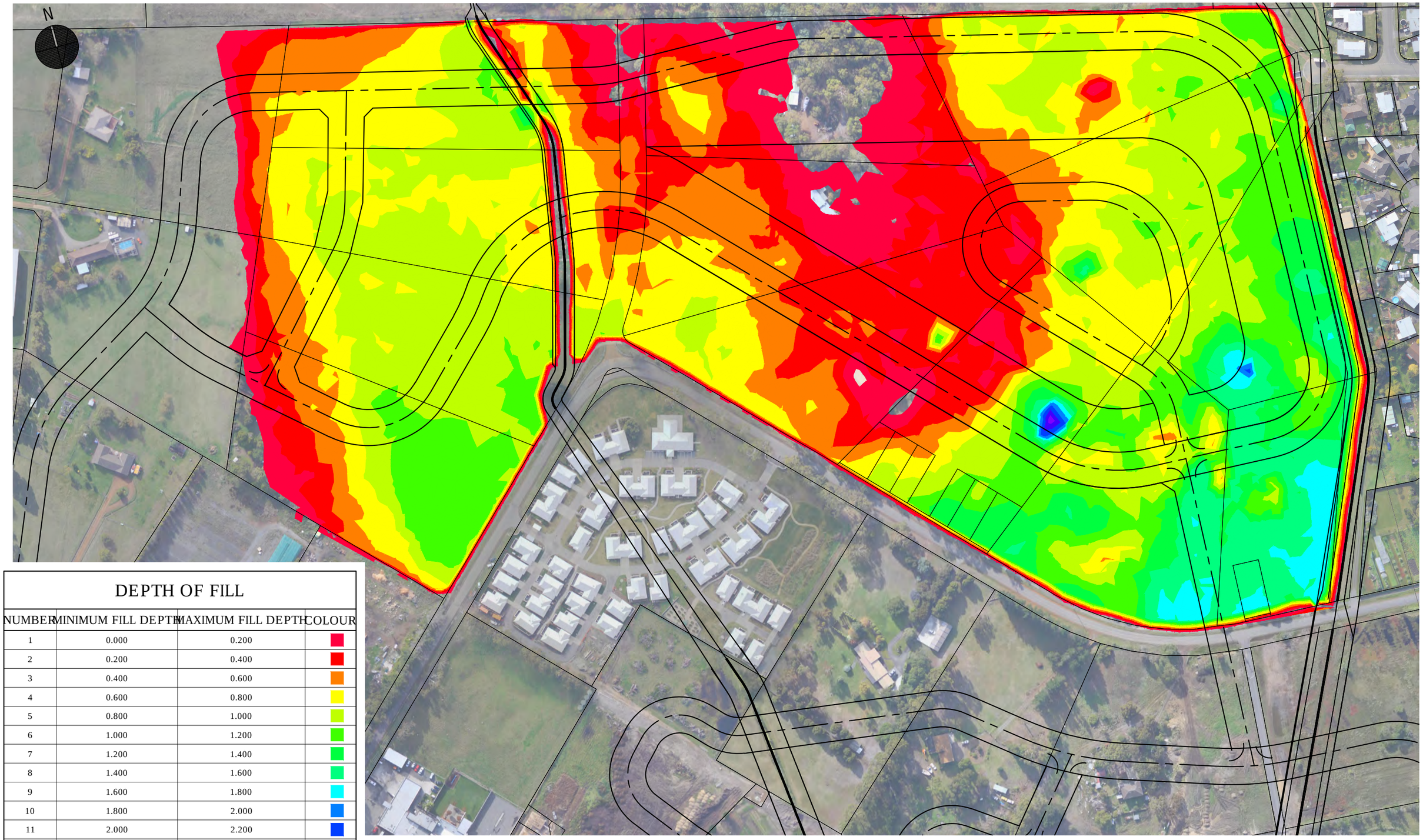

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11	2.000	2.200	
12	2.200	2.400	
13	2.400	2.600	

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PROJECT
LAUDERDALE URBAN EXPANSION FEASABILITY STUDY

TITLE
DEPTH OF FILL TO 3.00 AHD AREA 2

PROJECT NO. J153075PH

DWG NO. SK05

REVISION P1

PLOT DETAILS CIVIL3D BASE - FLOOD MODELLING.DWG

J153075PH - Lauderdale feasibility study
Entire catchment to DN900 drain at 12 North Tce.
Using varying catchment characteristics

	Area	
Upstream	2.68000	(km2)
	2680000	m2

Time of Concentration - Upstream Catchment

A=	2.68000	Km^2
S_e=	1.3	m/Km
L=	2.6	Km
t_c=	114.00	mins (Refer hand calcs for differing catchment)

IFD Table for tc = 114.00 mins (From Bom Website)

DURATION	1 Year	2 years	5 years	10 years	20 years	50 years	100 years
5Mins	32.6	44.5	65.2	80.2	99.7	128	153
6Mins	30.5	41.7	61	74.8	92.8	120	142
10Mins	25.4	34.3	49	59.1	72.4	92	108
20Mins	19.2	25.3	34.3	40.2	48.1	59.3	68.4
30Mins	15.8	20.7	27.2	31.5	37.2	45.1	51.5
1Hr	11	14.2	18.1	20.5	23.8	28.4	32
2Hrs	7.4	9.5	12	13.5	15.5	18.4	20.6
3Hrs	5.82	7.48	9.41	10.6	12.2	14.5	16.2
6Hrs	3.84	4.95	6.26	7.07	8.19	9.71	10.9
12Hrs	2.5	3.24	4.12	4.67	5.44	6.47	7.3
24Hrs	1.59	2.05	2.63	2.99	3.49	4.17	4.71
48Hrs	0.959	1.24	1.6	1.83	2.14	2.57	2.92
72Hrs	0.691	0.9	1.17	1.35	1.59	1.92	2.19

Frequency Conversion Factors

ARI (years)	1	2	5	10	20	40	60	80	100	50
Conversion Factor, F_y	0.8	0.85	0.95	1	1.05	1.2	1.17	1.19	1.2	1.15

Fraction impervious 14% Future developed
C1,10 0.1 Refer ARR Book VIII

Peak Flows For Catchment For Given ARI **C10= 0.2096**

ARI (years)	$I_{tc,Y}$ (mm/h)	Upstream Catchment Flow (m3/s)	Upstream Catchment Flow (L/s)	Upstream Catchment Flow including 20% extra for climate change
1	7.62	0.952	952	1143
2	9.79	1.300	1300	1560
5	12.32	1.828	1828	2194
10	13.87	2.167	2167	2600
20	16.02	2.627	2627	3152
50	18.96	3.406	3406	4087
100	21.29	3.989	3989	4787

IFD Data

IFD Table for tc = 114.00 mins

ARI in years	Coefficients A	B	C	D	E	F	G	loge(I)	I Area A(mm/hr)
1	2.397865	-5.54E-01	-3.37E-02	1.06E-02	-2.20E-04	-7.40E-04	8.46E-05	2.031166144	7.62
2	2.652883	-5.67E-01	-2.37E-02	1.02E-02	-1.14E-03	-6.26E-04	9.46E-05	2.281832136	9.79
5	2.894399	-5.98E-01	-2.49E-03	8.00E-03	-2.53E-03	-1.98E-04	6.04E-05	2.511374481	12.32
10	3.020462	-6.17E-01	9.67E-03	7.78E-03	-3.50E-03	-8.58E-05	7.00E-05	2.630067763	13.87
20	**3.17**	**-6.33E-01**	**2.01E-02**	**7.68E-03**	**-4.33E-03**	**2.25E-06**	**7.84E-05**	**2.7738548**	**16.02**
50	3.345843	-6.50E-01	3.15E-02	6.02E-03	-4.99E-03	2.93E-04	4.68E-05	2.94255363	18.96
100	3.466306	-6.63E-01	3.97E-02	5.89E-03	-5.61E-03	3.67E-04	5.15E-05	3.058046384	21.29

e= 2.72
tc (mins)= 114.00
tc (hrs) = 1.90

10 year ARI, 1 hour rainfall Intensity 25 mm/hr

J153075PH - Lauderdale feasibility study
Only urban catchment to DN900 drain at 12 North Tce.

	Area	
Upstream	0.71200	(km2)
	712000	m2

Time of Concentration - Upstream Catchment

A=	0.71200	Km^2
S_e=	1.3	m/Km
L=	1.1	Km
t_c=	62.63	mins

IFD Table for tc = 62.63 mins (From Bom Website)

DURATION	1 Year	2 years	5 years	10 years	20 years	50 years	100 years
5Mins	32.6	44.5	65.2	80.2	99.7	128	153
6Mins	30.5	41.7	61	74.8	92.8	120	142
10Mins	25.4	34.3	49	59.1	72.4	92	108
20Mins	19.2	25.3	34.3	40.2	48.1	59.3	68.4
30Mins	15.8	20.7	27.2	31.5	37.2	45.1	51.5
1Hr	11	14.2	18.1	20.5	23.8	28.4	32
2Hrs	7.4	9.5	12	13.5	15.5	18.4	20.6
3Hrs	5.82	7.48	9.41	10.6	12.2	14.5	16.2
6Hrs	3.84	4.95	6.26	7.07	8.19	9.71	10.9
12Hrs	2.5	3.24	4.12	4.67	5.44	6.47	7.3
24Hrs	1.59	2.05	2.63	2.99	3.49	4.17	4.71
48Hrs	0.959	1.24	1.6	1.83	2.14	2.57	2.92
72Hrs	0.691	0.9	1.17	1.35	1.59	1.92	2.19

Frequency Conversion Factors

ARI (years)	1	2	5	10	20	40	60	80	100	50
Conversion Factor, F_y	0.8	0.85	0.95	1	1.05	1.2	1.17	1.19	1.2	1.15

Fraction impervious 50% Future developed
C1,10 0.1 Refer ARR Book VIII

Peak Flows For Catchment For Given ARI **C10= 0.5**

ARI (years)	$I_{tc,Y}$ (mm/h)	Upstream Catchment Flow (m3/s)	Upstream Catchment Flow (L/s)	Upstream Catchment Flow including 20% extra for climate change
1	10.74	0.850	850	1020
2	13.85	1.165	1165	1398
5	17.61	1.656	1656	1987
10	19.97	1.976	1976	2371
20	23.18	2.409	2409	2891
50	27.61	3.142	3142	3770
100	31.12	3.696	3696	4435

IFD Data

IFD Table for tc = 62.63 mins

ARI in years	Coefficients A	B	C	D	E	F	G	loge(I)	I Area A(mm/hr)
1	2.397865	-5.54E-01	-3.37E-02	1.06E-02	-2.20E-04	-7.40E-04	8.46E-05	2.374039424	10.74
2	2.652883	-5.67E-01	-2.37E-02	1.02E-02	-1.14E-03	-6.26E-04	9.46E-05	2.628528463	13.85
5	2.894399	-5.98E-01	-2.49E-03	8.00E-03	-2.53E-03	-1.98E-04	6.04E-05	2.868749733	17.61
10	3.020462	-6.17E-01	9.67E-03	7.78E-03	-3.50E-03	-8.58E-05	7.00E-05	2.994021047	19.97
20	**3.17**	**-6.33E-01**	**2.01E-02**	**7.68E-03**	**-4.33E-03**	**2.25E-06**	**7.84E-05**	**3.1433669**	**23.18**
50	3.345843	-6.50E-01	3.15E-02	6.02E-03	-4.99E-03	2.93E-04	4.68E-05	3.318023883	27.61
100	3.466306	-6.63E-01	3.97E-02	5.89E-03	-5.61E-03	3.67E-04	5.15E-05	3.437953684	31.12

e=	2.72
tc (mins)=	62.63
tc (hrs) =	1.04

10 year ARI, 1 hour rainfall Intensity 25 mm/hr

J153075PH - Lauderdale feasibility study
NT1 north of Balook St. (wetlands)

	Area	
Upstream	1.13448	(km2)
	1134480	m2

Time of Concentration - Upstream Catchment

A=	1.13448	Km^2
S_e=	94	m/Km
L=	2.6	Km
t_c=	59.99	mins

IFD Table for tc = 59.99 mins (From Bom Website)

DURATION	1 Year	2 years	5 years	10 years	20 years	50 years	100 years
5Mins	32.6	44.5	65.2	80.2	99.7	128	153
6Mins	30.5	41.7	61	74.8	92.8	120	142
10Mins	25.4	34.3	49	59.1	72.4	92	108
20Mins	19.2	25.3	34.3	40.2	48.1	59.3	68.4
30Mins	15.8	20.7	27.2	31.5	37.2	45.1	51.5
1Hr	11	14.2	18.1	20.5	23.8	28.4	32
2Hrs	7.4	9.5	12	13.5	15.5	18.4	20.6
3Hrs	5.82	7.48	9.41	10.6	12.2	14.5	16.2
6Hrs	3.84	4.95	6.26	7.07	8.19	9.71	10.9
12Hrs	2.5	3.24	4.12	4.67	5.44	6.47	7.3
24Hrs	1.59	2.05	2.63	2.99	3.49	4.17	4.71
48Hrs	0.959	1.24	1.6	1.83	2.14	2.57	2.92
72Hrs	0.691	0.9	1.17	1.35	1.59	1.92	2.19

Frequency Conversion Factors

ARI (years)	1	2	5	10	20	40	60	80	100	50
Conversion Factor, F_y	0.8	0.85	0.95	1	1.05	1.2	1.17	1.19	1.2	1.15

Fraction impervious 5.00% Current
C1,10 0.1 Refer ARR Book VIII

Peak Flows For Catchment For Given ARI **C10= 0.14**

ARI (years)	$I_{tc,Y}$ (mm/h)	Upstream Catchment Flow (m3/s)	Upstream Catchment Flow (L/s)	Upstream Catchment Flow including 20% extra for climate change
1	11.00	0.389	389	466
2	14.20	0.533	533	639
5	18.07	0.758	758	910
10	20.50	0.905	905	1086
20	23.82	1.104	1104	1325
50	28.39	1.441	1441	1730
100	32.02	1.697	1697	2036

IFD Data

IFD Table for tc = 59.99 mins

ARI in years	Coefficients A	B	C	D	E	F	G	loge(I)	I Area A(mm/hr)
1	2.397865	-5.54E-01	-3.37E-02	1.06E-02	-2.20E-04	-7.40E-04	8.46E-05	2.397952203	11.00
2	2.652883	-5.67E-01	-2.37E-02	1.02E-02	-1.14E-03	-6.26E-04	9.46E-05	2.652971961	14.20
5	2.894399	-5.98E-01	-2.49E-03	8.00E-03	-2.53E-03	-1.98E-04	6.04E-05	2.894492952	18.07
10	3.020462	-6.17E-01	9.67E-03	7.78E-03	-3.50E-03	-8.58E-05	7.00E-05	3.020558321	20.50
20	**3.17**	**-6.33E-01**	**2.01E-02**	**7.68E-03**	**-4.33E-03**	**2.25E-06**	**7.84E-05**	**3.1705805**	**23.82**
50	3.345843	-6.50E-01	3.15E-02	6.02E-03	-4.99E-03	2.93E-04	4.68E-05	3.345945266	28.39
100	3.466306	-6.63E-01	3.97E-02	5.89E-03	-5.61E-03	3.67E-04	5.15E-05	3.466410405	32.02

e=	2.72
tc (mins)=	59.99
tc (hrs) =	1.00

10 year ARI, 1 hour rainfall Intensity 25 mm/hr

J153075PH - Lauderdale feasibility study
NT1 Upstream Manatta St (urban only)

	Area	
Upstream	0.13000	(km2)
	130000	m2

Time of Concentration - Upstream Catchment

A=	0.13000	Km^2
S_e=	1.9	m/Km
L=	0.42	Km
t_c=	26.27	mins

IFD Table for tc = 26.27 mins (From Bom Website)

DURATION	1 Year	2 years	5 years	10 years	20 years	50 years	100 years
5Mins	32.6	44.5	65.2	80.2	99.7	128	153
6Mins	30.5	41.7	61	74.8	92.8	120	142
10Mins	25.4	34.3	49	59.1	72.4	92	108
20Mins	19.2	25.3	34.3	40.2	48.1	59.3	68.4
30Mins	15.8	20.7	27.2	31.5	37.2	45.1	51.5
1Hr	11	14.2	18.1	20.5	23.8	28.4	32
2Hrs	7.4	9.5	12	13.5	15.5	18.4	20.6
3Hrs	5.82	7.48	9.41	10.6	12.2	14.5	16.2
6Hrs	3.84	4.95	6.26	7.07	8.19	9.71	10.9
12Hrs	2.5	3.24	4.12	4.67	5.44	6.47	7.3
24Hrs	1.59	2.05	2.63	2.99	3.49	4.17	4.71
48Hrs	0.959	1.24	1.6	1.83	2.14	2.57	2.92
72Hrs	0.691	0.9	1.17	1.35	1.59	1.92	2.19

Frequency Conversion Factors

ARI (years)	1	2	5	10	20	40	60	80	100	50
Conversion Factor, F_y	0.8	0.85	0.95	1	1.05	1.2	1.17	1.19	1.2	1.15

Fraction impervious 50% Proposed developed
C1,10 0.1 Refer ARR Book VIII

Peak Flows For Catchment For Given ARI **C10= 0.5**

ARI (years)	$I_{tc,Y}$ (mm/h)	Upstream Catchment Flow (m3/s)	Upstream Catchment Flow (L/s)	Upstream Catchment Flow including 20% extra for climate change
1	16.89	0.244	244	293
2	22.17	0.340	340	409
5	29.39	0.505	505	605
10	34.14	0.617	617	740
20	40.47	0.768	768	921
50	49.31	1.025	1025	1230
100	56.51	1.225	1225	1470

IFD Data

IFD Table for tc = 26.27 mins

ARI in years	Coefficients A	B	C	D	E	F	G	loge(I)	I Area A(mm/hr)
1	2.397865	-5.54E-01	-3.37E-02	1.06E-02	-2.20E-04	-7.40E-04	8.46E-05	2.826520243	16.89
2	2.652883	-5.67E-01	-2.37E-02	1.02E-02	-1.14E-03	-6.26E-04	9.46E-05	3.098613817	22.17
5	2.894399	-5.98E-01	-2.49E-03	8.00E-03	-2.53E-03	-1.98E-04	6.04E-05	3.380703335	29.39
10	3.020462	-6.17E-01	9.67E-03	7.78E-03	-3.50E-03	-8.58E-05	7.00E-05	3.530347663	34.14
20	**3.17**	**-6.33E-01**	**2.01E-02**	**7.68E-03**	**-4.33E-03**	**2.25E-06**	**7.84E-05**	**3.7004455**	**40.47**
50	3.345843	-6.50E-01	3.15E-02	6.02E-03	-4.99E-03	2.93E-04	4.68E-05	3.898100133	49.31
100	3.466306	-6.63E-01	3.97E-02	5.89E-03	-5.61E-03	3.67E-04	5.15E-05	4.034442028	56.51

e=	2.72
tc (mins)=	26.27
tc (hrs) =	0.44

10 year ARI, 1 hour rainfall Intensity 25 mm/hr

J153075PH - Lauderdale feasibility study
NT1 upstream of Manatta St (whole catchment using varying catchment characteristics)

	Area	
Upstream	1.26448	(km2)
	1264480	m2

Time of Concentration - Upstream Catchment

A=	1.26448	Km^2
S_e=	1.9	m/Km
L=	0.42	Km
t_c=	85.00	mins (Refer hand calcs for mixed catchment)

IFD Table for tc = 85.00 mins (From Bom Website)

DURATION	1 Year	2 years	5 years	10 years	20 years	50 years	100 years
5Mins	32.6	44.5	65.2	80.2	99.7	128	153
6Mins	30.5	41.7	61	74.8	92.8	120	142
10Mins	25.4	34.3	49	59.1	72.4	92	108
20Mins	19.2	25.3	34.3	40.2	48.1	59.3	68.4
30Mins	15.8	20.7	27.2	31.5	37.2	45.1	51.5
1Hr	11	14.2	18.1	20.5	23.8	28.4	32
2Hrs	7.4	9.5	12	13.5	15.5	18.4	20.6
3Hrs	5.82	7.48	9.41	10.6	12.2	14.5	16.2
6Hrs	3.84	4.95	6.26	7.07	8.19	9.71	10.9
12Hrs	2.5	3.24	4.12	4.67	5.44	6.47	7.3
24Hrs	1.59	2.05	2.63	2.99	3.49	4.17	4.71
48Hrs	0.959	1.24	1.6	1.83	2.14	2.57	2.92
72Hrs	0.691	0.9	1.17	1.35	1.59	1.92	2.19

Frequency Conversion Factors

ARI (years)	1	2	5	10	20	40	60	80	100	50
Conversion Factor, F_y	0.8	0.85	0.95	1	1.05	1.2	1.17	1.19	1.2	1.15

Fraction impervious 8.6% Proposed developed
C1,10 0.1 Refer ARR Book VIII

Peak Flows For Catchment For Given ARI **C10= 0.1688**

ARI (years)	$I_{tc,Y}$ (mm/h)	Upstream Catchment Flow (m3/s)	Upstream Catchment Flow (L/s)	Upstream Catchment Flow including 20% extra for climate change
1	9.04	0.429	429	515
2	11.62	0.586	586	704
5	14.68	0.827	827	993
10	16.56	0.983	983	1179
20	19.16	1.194	1194	1432
50	22.73	1.551	1551	1861
100	25.55	1.819	1819	2183

IFD Data

IFD Table for tc = 85.00 mins

ARI in years	Coefficients A	B	C	D	E	F	G	loge(I)	I Area A(mm/hr)
1	2.397865	-5.54E-01	-3.37E-02	1.06E-02	-2.20E-04	-7.40E-04	8.46E-05	2.201292518	9.04
2	2.652883	-5.67E-01	-2.37E-02	1.02E-02	-1.14E-03	-6.26E-04	9.46E-05	2.453042874	11.62
5	2.894399	-5.98E-01	-2.49E-03	8.00E-03	-2.53E-03	-1.98E-04	6.04E-05	2.686197113	14.68
10	3.020462	-6.17E-01	9.67E-03	7.78E-03	-3.50E-03	-8.58E-05	7.00E-05	2.807108191	16.56
20	**3.17**	**-6.33E-01**	**2.01E-02**	**7.68E-03**	**-4.33E-03**	**2.25E-06**	**7.84E-05**	**2.9527497**	**19.16**
50	3.345843	-6.50E-01	3.15E-02	6.02E-03	-4.99E-03	2.93E-04	4.68E-05	3.123529009	22.73
100	3.466306	-6.63E-01	3.97E-02	5.89E-03	-5.61E-03	3.67E-04	5.15E-05	3.240516989	25.55

e=	2.72
tc (mins)=	85.00
tc (hrs) =	1.42

10 year ARI, 1 hour rainfall Intensity 25 mm/hr

J153075PH - Lauderdale feasibility study
NT2 Upstream new urban area north of Ringwood

	Area	
Upstream	0.75000	(km2)
	750000	m2

Time of Concentration - Upstream Catchment

A=	0.75000	Km^2
S_e=	164	m/Km
L=	1.2	Km
t_c=	25.83	mins

IFD Table for tc = 25.83 mins (From Bom Website)

DURATION	1 Year	2 years	5 years	10 years	20 years	50 years	100 years
5Mins	32.6	44.5	65.2	80.2	99.7	128	153
6Mins	30.5	41.7	61	74.8	92.8	120	142
10Mins	25.4	34.3	49	59.1	72.4	92	108
20Mins	19.2	25.3	34.3	40.2	48.1	59.3	68.4
30Mins	15.8	20.7	27.2	31.5	37.2	45.1	51.5
1Hr	11	14.2	18.1	20.5	23.8	28.4	32
2Hrs	7.4	9.5	12	13.5	15.5	18.4	20.6
3Hrs	5.82	7.48	9.41	10.6	12.2	14.5	16.2
6Hrs	3.84	4.95	6.26	7.07	8.19	9.71	10.9
12Hrs	2.5	3.24	4.12	4.67	5.44	6.47	7.3
24Hrs	1.59	2.05	2.63	2.99	3.49	4.17	4.71
48Hrs	0.959	1.24	1.6	1.83	2.14	2.57	2.92
72Hrs	0.691	0.9	1.17	1.35	1.59	1.92	2.19

Frequency Conversion Factors

ARI (years)	1	2	5	10	20	40	60	80	100	50
Conversion Factor, F_y	0.8	0.85	0.95	1	1.05	1.2	1.17	1.19	1.2	1.15

Fraction impervious 1.0% Current
C1,10 0.1 Refer ARR Book VIII

Peak Flows For Catchment For Given ARI **C10= 0.108**

ARI (years)	$I_{tc,y}$ (mm/h)	Upstream Catchment Flow (m3/s)	Upstream Catchment Flow (L/s)	Upstream Catchment Flow including 20% extra for climate change (L/s)
1	17.03	0.307	307	368
2	22.36	0.428	428	514
5	29.68	0.635	635	762
10	34.50	0.777	777	932
20	40.91	0.967	967	1161
50	49.89	1.292	1292	1550
100	57.20	1.546	1546	1855

IFD Data

IFD Table for tc = 25.83 mins

ARI in years	Coefficients A	B	C	D	E	F	G	loge(I)	I Area A(mm/hr)
1	2.397865	-5.54E-01	-3.37E-02	1.06E-02	-2.20E-04	-7.40E-04	8.46E-05	2.834742465	17.03
2	2.652883	-5.67E-01	-2.37E-02	1.02E-02	-1.14E-03	-6.26E-04	9.46E-05	3.107315953	22.36
5	2.894399	-5.98E-01	-2.49E-03	8.00E-03	-2.53E-03	-1.98E-04	6.04E-05	3.390556669	29.68
10	3.020462	-6.17E-01	9.67E-03	7.78E-03	-3.50E-03	-8.58E-05	7.00E-05	3.540842406	34.50
20	**3.17**	**-6.33E-01**	**2.01E-02**	**7.68E-03**	**-4.33E-03**	**2.25E-06**	**7.84E-05**	**3.7114853**	**40.91**
50	3.345843	-6.50E-01	3.15E-02	6.02E-03	-4.99E-03	2.93E-04	4.68E-05	3.909781012	49.89
100	3.466306	-6.63E-01	3.97E-02	5.89E-03	-5.61E-03	3.67E-04	5.15E-05	4.046554913	57.20

e=	2.72
tc (mins)=	25.83
tc (hrs) =	0.43

10 year ARI, 1 hour rainfall Intensity 25 mm/hr

J153075PH - Lauderdale feasibility study
NT2 Upstream Ringwood Rd (Urban only)

	Area	
Upstream	0.17000	(km2)
	170000	m2

Time of Concentration - Upstream Catchment

A=	0.17000	Km^2
S_e=	5	m/Km
L=	0.4	Km
t_c=	20.07	mins

IFD Table for tc = 20.07 mins (From Bom Website)

DURATION	1 Year	2 years	5 years	10 years	20 years	50 years	100 years
5Mins	32.6	44.5	65.2	80.2	99.7	128	153
6Mins	30.5	41.7	61	74.8	92.8	120	142
10Mins	25.4	34.3	49	59.1	72.4	92	108
20Mins	19.2	25.3	34.3	40.2	48.1	59.3	68.4
30Mins	15.8	20.7	27.2	31.5	37.2	45.1	51.5
1Hr	11	14.2	18.1	20.5	23.8	28.4	32
2Hrs	7.4	9.5	12	13.5	15.5	18.4	20.6
3Hrs	5.82	7.48	9.41	10.6	12.2	14.5	16.2
6Hrs	3.84	4.95	6.26	7.07	8.19	9.71	10.9
12Hrs	2.5	3.24	4.12	4.67	5.44	6.47	7.3
24Hrs	1.59	2.05	2.63	2.99	3.49	4.17	4.71
48Hrs	0.959	1.24	1.6	1.83	2.14	2.57	2.92
72Hrs	0.691	0.9	1.17	1.35	1.59	1.92	2.19

Frequency Conversion Factors

ARI (years)	1	2	5	10	20	40	60	80	100	50
Conversion Factor, F_y	0.8	0.85	0.95	1	1.05	1.2	1.17	1.19	1.2	1.15

IFD Data

IFD Table for tc = 20.07 mins

Coefficients

ARI in years	A	B	C	D	E	F	G	loge(I)	I Area A(mm/hr)
1	2.397865	-5.54E-01	-3.37E-02	1.06E-02	-2.20E-04	-7.40E-04	8.46E-05	2.951006049	19.13
2	2.652883	-5.67E-01	-2.37E-02	1.02E-02	-1.14E-03	-6.26E-04	9.46E-05	3.230974579	25.30
5	2.894399	-5.98E-01	-2.49E-03	8.00E-03	-2.53E-03	-1.98E-04	6.04E-05	3.532153663	34.20
10	3.020462	-6.17E-01	9.67E-03	7.78E-03	-3.50E-03	-8.58E-05	7.00E-05	3.692288393	40.14
20	**3.17**	**-6.33E-01**	**2.01E-02**	**7.68E-03**	**-4.33E-03**	**2.25E-06**	**7.84E-05**	**3.8712911**	**48.00**
50	3.345843	-6.50E-01	3.15E-02	6.02E-03	-4.99E-03	2.93E-04	4.68E-05	4.079635391	59.12
100	3.466306	-6.63E-01	3.97E-02	5.89E-03	-5.61E-03	3.67E-04	5.15E-05	4.223047536	68.24

e=	2.72
tc (mins)=	20.07
tc (hrs) =	0.33

10 year ARI, 1 hour rainfall Intensity 25 mm/hr

Fraction impervious	50.0%	Future developed
C1,10	0.1	Refer ARR Book VIII

Peak Flows For Catchment For Given ARI **C10= 0.5**

ARI (years)	$I_{tc,y}$ (mm/h)	Upstream Catchment Flow (m3/s)	Upstream Catchment Flow (L/s)	Upstream Catchment Flow including 20% extra for climate change (L/s)
1	19.13	0.362	362	434
2	25.30	0.508	508	610
5	34.20	0.768	768	921
10	40.14	0.948	948	1138
20	48.00	1.191	1191	1429
50	59.12	1.607	1607	1928
100	68.24	1.935	1935	2322

J153075PH - Lauderdale feasibility study
NT2 Upstream Ringwood Rd (whole catchment)
Based on varying catchment characteritics

	Area	
Upstream	0.92000	(km2)
	920000	m2

Time of Concentration - Upstream Catchment

A=	0.92000	Km^2	
S_e=	5	m/Km	
L=	1.2	Km	
t_c=	43.00	mins	(refer hand calcs)

IFD Table for tc = 43.00 mins (From Bom Website)

DURATION	1 Year	2 years	5 years	10 years	20 years	50 years	100 years
5Mins	32.6	44.5	65.2	80.2	99.7	128	153
6Mins	30.5	41.7	61	74.8	92.8	120	142
10Mins	25.4	34.3	49	59.1	72.4	92	108
20Mins	19.2	25.3	34.3	40.2	48.1	59.3	68.4
30Mins	15.8	20.7	27.2	31.5	37.2	45.1	51.5
1Hr	11	14.2	18.1	20.5	23.8	28.4	32
2Hrs	7.4	9.5	12	13.5	15.5	18.4	20.6
3Hrs	5.82	7.48	9.41	10.6	12.2	14.5	16.2
6Hrs	3.84	4.95	6.26	7.07	8.19	9.71	10.9
12Hrs	2.5	3.24	4.12	4.67	5.44	6.47	7.3
24Hrs	1.59	2.05	2.63	2.99	3.49	4.17	4.71
48Hrs	0.959	1.24	1.6	1.83	2.14	2.57	2.92
72Hrs	0.691	0.9	1.17	1.35	1.59	1.92	2.19

Frequency Conversion Factors

ARI (years)	1	2	5	10	20	40	60	80	100	50
Conversion Factor, F_y	0.8	0.85	0.95	1	1.05	1.2	1.17	1.19	1.2	1.15

IFD Data

IFD Table for tc = 43.00 mins

ARI in years	Coefficients A	B	C	D	E	F	G	loge(I)	I Area A(mm/hr)
1	2.397865	-5.54E-01	-3.37E-02	1.06E-02	-2.20E-04	-7.40E-04	8.46E-05	2.578268278	13.17
2	2.652883	-5.67E-01	-2.37E-02	1.02E-02	-1.14E-03	-6.26E-04	9.46E-05	2.838639573	17.09
5	2.894399	-5.98E-01	-2.49E-03	8.00E-03	-2.53E-03	-1.98E-04	6.04E-05	3.092932482	22.04
10	3.020462	-6.17E-01	9.67E-03	7.78E-03	-3.50E-03	-8.58E-05	7.00E-05	3.226656926	25.20
20	**3.17**	**-6.33E-01**	**2.01E-02**	**7.68E-03**	**-4.33E-03**	**2.25E-06**	**7.84E-05**	**3.3832067**	**29.47**
50	3.345843	-6.50E-01	3.15E-02	6.02E-03	-4.99E-03	2.93E-04	4.68E-05	3.565530116	35.36
100	3.466306	-6.63E-01	3.97E-02	5.89E-03	-5.61E-03	3.67E-04	5.15E-05	3.691154442	40.09

e=	2.72
tc (mins)=	43.00
tc (hrs) =	0.72

10 year ARI, 1 hour rainfall Intensity 25 mm/hr

Fraction impervious	8.0%	Future developed
C1,10	0.1	Refer ARR Book VIII

Peak Flows For Catchment For Given ARI **C10= 0.164**

ARI (years)	**$I_{tc,y}$ (mm/h)**	**Upstream Catchment Flow (m3/s)**	**Upstream Catchment Flow (L/s)**	**Upstream Catchment Flow including 20% extra for climate change (L/s)**
1	13.17	0.442	442	530
2	17.09	0.609	609	731
5	22.04	0.878	878	1054
10	25.20	1.057	1057	1268
20	29.47	1.298	1298	1557
50	35.36	1.706	1706	2047
100	40.09	2.018	2018	2422

J153075PH - Lauderdale feasibility study
NT2 Upstream CH.300 (Urban only)

	Area	
Upstream	0.33100	(km2)
	331000	m2

Time of Concentration - Upstream Catchment

A=	0.33100	Km^2
S_e=	4	m/Km
L=	0.9	Km
t_c=	44.19	mins

IFD Table for tc = 44.19 mins (From Bom Website)

DURATION	1 Year	2 years	5 years	10 years	20 years	50 years	100 years
5Mins	32.6	44.5	65.2	80.2	99.7	128	153
6Mins	30.5	41.7	61	74.8	92.8	120	142
10Mins	25.4	34.3	49	59.1	72.4	92	108
20Mins	19.2	25.3	34.3	40.2	48.1	59.3	68.4
30Mins	15.8	20.7	27.2	31.5	37.2	45.1	51.5
1Hr	11	14.2	18.1	20.5	23.8	28.4	32
2Hrs	7.4	9.5	12	13.5	15.5	18.4	20.6
3Hrs	5.82	7.48	9.41	10.6	12.2	14.5	16.2
6Hrs	3.84	4.95	6.26	7.07	8.19	9.71	10.9
12Hrs	2.5	3.24	4.12	4.67	5.44	6.47	7.3
24Hrs	1.59	2.05	2.63	2.99	3.49	4.17	4.71
48Hrs	0.959	1.24	1.6	1.83	2.14	2.57	2.92
72Hrs	0.691	0.9	1.17	1.35	1.59	1.92	2.19

Frequency Conversion Factors

ARI (years)	1	2	5	10	20	40	60	80	100	50
Conversion Factor, F_y	0.8	0.85	0.95	1	1.05	1.2	1.17	1.19	1.2	1.15

Fraction impervious 50.0% Future developed
C1,10 0.1 Refer ARR Book VIII

Peak Flows For Catchment For Given ARI **C10= 0.5**

ARI (years)	$I_{tc,y}$ (mm/h)	Upstream Catchment Flow (m3/s)	Upstream Catchment Flow (L/s)	Upstream Catchment Flow including 20% extra for climate change (L/s)
1	12.99	0.478	478	574
2	16.84	0.659	659	790
5	21.69	0.948	948	1138
10	24.77	1.140	1140	1368
20	28.95	1.399	1399	1679
50	34.72	1.837	1837	2205
100	39.35	2.173	2173	2607

IFD Data

IFD Table for tc = 44.19 mins

Coefficients

ARI in years	A	B	C	D	E	F	G	loge(I)	I Area A(mm/hr)
1	2.397865	-5.54E-01	-3.37E-02	1.06E-02	-2.20E-04	-7.40E-04	8.46E-05	2.563882305	12.99
2	2.652883	-5.67E-01	-2.37E-02	1.02E-02	-1.14E-03	-6.26E-04	9.46E-05	2.823734249	16.84
5	2.894399	-5.98E-01	-2.49E-03	8.00E-03	-2.53E-03	-1.98E-04	6.04E-05	3.076800097	21.69
10	3.020462	-6.17E-01	9.67E-03	7.78E-03	-3.50E-03	-8.58E-05	7.00E-05	3.209799507	24.77
20	**3.17**	**-6.33E-01**	**2.01E-02**	**7.68E-03**	**-4.33E-03**	**2.25E-06**	**7.84E-05**	**3.3657314**	**28.95**
50	3.345843	-6.50E-01	3.15E-02	6.02E-03	-4.99E-03	2.93E-04	4.68E-05	3.547384624	34.72
100	3.466306	-6.63E-01	3.97E-02	5.89E-03	-5.61E-03	3.67E-04	5.15E-05	3.672520801	39.35

e=	2.72
tc (mins)=	44.19
tc (hrs) =	0.74

10 year ARI, 1 hour rainfall Intensity 25 mm/hr

J153075PH - Lauderdale feasibility study
NT2 Upstream CH.300 (whole catchment)
Based on varying catchment characteritics

	Area	
Upstream	1.08100	(km2)
	1081000	m2

Time of Concentration - Upstream Catchment

A=	1.08100	Km^2	
S_e=	4	m/Km	
L=	1.2	Km	
t_c=	66.00	mins	(refer hand calcs)

IFD Table for tc = 66.00 mins (From Bom Website)

DURATION	1 Year	2 years	5 years	10 years	20 years	50 years	100 years
5Mins	32.6	44.5	65.2	80.2	99.7	128	153
6Mins	30.5	41.7	61	74.8	92.8	120	142
10Mins	25.4	34.3	49	59.1	72.4	92	108
20Mins	19.2	25.3	34.3	40.2	48.1	59.3	68.4
30Mins	15.8	20.7	27.2	31.5	37.2	45.1	51.5
1Hr	11	14.2	18.1	20.5	23.8	28.4	32
2Hrs	7.4	9.5	12	13.5	15.5	18.4	20.6
3Hrs	5.82	7.48	9.41	10.6	12.2	14.5	16.2
6Hrs	3.84	4.95	6.26	7.07	8.19	9.71	10.9
12Hrs	2.5	3.24	4.12	4.67	5.44	6.47	7.3
24Hrs	1.59	2.05	2.63	2.99	3.49	4.17	4.71
48Hrs	0.959	1.24	1.6	1.83	2.14	2.57	2.92
72Hrs	0.691	0.9	1.17	1.35	1.59	1.92	2.19

Frequency Conversion Factors

ARI (years)	1	2	5	10	20	40	60	80	100	50
Conversion Factor, F_y	0.8	0.85	0.95	1	1.05	1.2	1.17	1.19	1.2	1.15

IFD Data

IFD Table for tc = 66.00 mins

Coefficients

ARI in years	A	B	C	D	E	F	G	loge(I)	I Area A(mm/hr)
1	2.397865	-5.54E-01	-3.37E-02	1.06E-02	-2.20E-04	-7.40E-04	8.46E-05	2.344775265	10.43
2	2.652883	-5.67E-01	-2.37E-02	1.02E-02	-1.14E-03	-6.26E-04	9.46E-05	2.598667695	13.45
5	2.894399	-5.98E-01	-2.49E-03	8.00E-03	-2.53E-03	-1.98E-04	6.04E-05	2.837411808	17.07
10	3.020462	-6.17E-01	9.67E-03	7.78E-03	-3.50E-03	-8.58E-05	7.00E-05	2.961777346	19.33
20	**3.17**	**-6.33E-01**	**2.01E-02**	**7.68E-03**	**-4.33E-03**	**2.25E-06**	**7.84E-05**	**3.110352**	**22.43**
50	3.345843	-6.50E-01	3.15E-02	6.02E-03	-4.99E-03	2.93E-04	4.68E-05	3.284203764	26.69
100	3.466306	-6.63E-01	3.97E-02	5.89E-03	-5.61E-03	3.67E-04	5.15E-05	3.403522759	30.07

e=	2.72
tc (mins)=	66.00
tc (hrs) =	1.10

10 year ARI, 1 hour rainfall Intensity 25 mm/hr

Fraction impervious 13.0% Future developed
C1,10 0.1 Refer ARR Book VIII

Peak Flows For Catchment For Given ARI **C10= 0.204**

ARI (years)	**$I_{tc,y}$ (mm/h)**	**Upstream Catchment Flow (m3/s)**	**Upstream Catchment Flow (L/s)**	**Upstream Catchment Flow including 20% extra for climate change (L/s)**
1	10.43	0.512	512	614
2	13.45	0.701	701	841
5	17.07	0.994	994	1193
10	19.33	1.185	1185	1422
20	22.43	1.444	1444	1733
50	26.69	1.882	1882	2258
100	30.07	2.212	2212	2655

J153075PH - Lauderdale feasibility study
Critical Flow Summary

Location			Flows at various ARI's (L/s)						
			ARI (years)						
River	**Chainage**	**Description**	**1**	**2**	**5**	**10**	**20**	**50**	**100**
NT2	1245	Upper end of NT2 drain	368	514	762	932	1161	1550	1855
	760	Ringwood Road	530	731	1054	1268	1557	2047	2422
	300	New drain from Manata Rd	614	841	1193	1422	1733	2258	2655
NT1 and 2	280	Confluence of NT1 and NT2	1143	1560	2194	2600	3152	4087	4787
NT1	1664	Upper end of NT1 drain	466	639	910	1086	1325	1730	2036
	600	Manatta Rd	515	704	993	1179	1432	1861	2183

Sea Level Rise backwater levels					
SLR (m)	MSL	MHHW	MLLW	"100yr ARI Tide Gauge"	"100yr ARI Still Water including setup"
0	-0.16	0.2	-0.7	1.44	2
0.9	0.74	1.1	0.2	2.34	2.9

J153075PH - Lauderdale feasibility study
Box culvert capacity and cost analysis

Inlet Control check
If Q/(A(D)^0.5) > 2.2 then inlet control governs

$$\frac{HW}{D} = c\left[\frac{K_1 Q}{AD^{0.5}}\right]^2 + Y + K_s S$$

Inlet Control

HW	depth above inlet invert		m
D	depth of pipe		m
Q	Flow rate		m3/s
B	breadth of box culvert		m
A	CSA		m3
S	slope		m/m
K1	SI constant	1.811	
Ks	inlet constant	0.5	
Y			
c			

Outlet control governs due to long pipes and shallow grade

			NT2				NT1		
			Upstream Ringwood		Downstream RBL		Downstream Manatta		RBL culvert
Outlet Control			Q20	Q100	Q20	Q100	Q20	Q100	
hL	Head loss	m	0.600	0.831	0.467	0.457	0.462	0.481	0.374
Ku	SI unit constant		19.63	19.63	19.63	19.63	19.63	19.63	19.63
n	Mannings n		0.013	0.013	0.013	0.013	0.013	0.013	0.013
L	Culvert length	m	270	270	400	400	470	470	190
D	Culvert depth	m	0.6	0.6	0.6	0.6	0.6	0.6	0.45
B	Culvert breadth	m	2.1	2.7	3	4.5	2.7	3.9	2.25
A	CSA (BxD)	m2	1.26	1.62	1.8	2.7	1.62	2.34	1.0125
P	wetted perimeter	m	5.4	6.6	7.2	10.2	6.6	9	5.4
R	Hydraulic Radius (A/P)	m	0.233	0.245	0.250	0.265	0.245	0.260	0.188
Ke	Entrance loss coefficient		0.5	0.5	0.5	0.5	0.5	0.5	0.5
Q	Flow rate	m3/s	1.557	2.422	1.733	2.655	1.432	2.183	2.420
V	velocity (Q/A)	m/s	1.236	1.495	0.963	0.983	0.884	0.933	1.000

$$h_L = \left[\frac{K_u n^2 L}{R^{1.33}} + 1 + Ke\right]\frac{V^2}{2g}$$

Invert at top (m, AHD)	2.1	2.1	0.9	0.9	0.9	0.9	1.2
Invert at bottom (m, AHD)	1.1	1.1	0.4	0.4	0.4	0.4	0.8
Available head loss (m)	**1**	**1**	**0.5**	**0.5**	**0.5**	**0.5**	**0.4**

Available HL must be more than calculated otherwise upsize culvert

Summary - Required box culverts	**Q20**		**Supply and install**	**Q20 Cost**	**Q100**		**Supply and install rate ($/m)**	**Q100 Cost**
Western drain (through RBL)	**Breadth (m)**	**Depth (m)**			**Breadth (m)**	**Depth (m)**		
Upstream Ringwood Road	2.1	0.6	1880	$ 507,600	2.7	0.6	2510	$ 677,700
Downstream RBL	3	0.6	2680	$ 1,072,000	4.5	0.6	3930	$ 1,572,000
Eastern Drain (Manatta Road)								
Downstream Manata Road	2.7	0.6	2510	$ 1,179,700	3.9	0.6	3760	$ 1,767,200
Procure easement through 52 North Tce				$ 40,000				$ 50,000
Extra over for road crossing and outfall				$ 50,000				$ 60,000
TOTAL				**$ 2,849,300**				**$ 4,126,900**

Prices based on Hudson Civil quote for delivery and following excavation and lay costs

Box width	Excavation rate ($/m)	Lay rate ($/m	Supply rate	Total rate ($/m)
2.1	130	100	1650	1880
2.4	150	100	1800	2050
2.7	160	100	2250	2510
3	180	100	2400	2680

Open drain costs	**Quantity**	**Rate ($)**	**Q20 cost**	**Q100 cost**
Concrete base	500	100	$ 50,000	$ 50,000
Excavation and forming drain	500	200	$ 100,000	$ 100,000
Balook Street culvert upgrade to 5m x 450mm	1	125000	$ 125,000	
Balook Street culvert upgrade to 6m x 450mm	1	150000		$ 150,000
Additional 2.25m x 450mm culvert under RBL	1	347800	$ 347,800	
Additional 3.6m x 600mm culvert under RBL	1	555000		$ 555,000
20m long under new road culverts 3m x 0.6m	6	50000	$ 300,000	
20m long under new road culverts 4.2m x 0.6m	6	70000		$ 420,000
Additional 3m x 600mm culvert from 12 North Tce to Ralphs Bay	1	420000	$ 420,000	
Additional 4m x 600mm culvert from 12 North	1	560000		$ 560,000
TOTAL			**$ 1,342,800**	**$ 1,835,000**

	Q20	**Q100**
Cost difference	$ 1,506,500	$ 2,291,900
Additional lots	50	50
Cost per lot	$ 30,130	$ 45,838
Development cost per lot	$ 50,000	$ 50,000
Total development cost per lot (less filling/design/land purchase)	$ 80,130	$ 95,838
Sale price	$ 140,000	$ 140,000
Approx profit	$ 59,870	$ 44,162

Clarence City Council - Box Culvert Budget Estimate

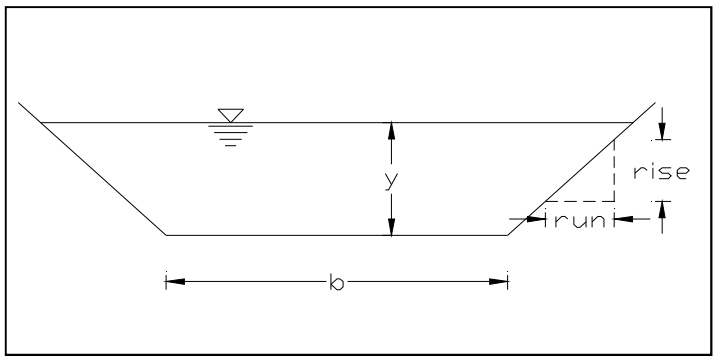
Item	Price	Quantity	Extension	Mass (T)	Ext (T)
2400 x 600 total length = 270.84m					
2400 x 600 x 2440 RCBC	$ 2,654.36	111	$ 294,634.48	4.80	532.80
2760 x 2440 x 300 base slab	$ 1,700.36	111	$ 188,740.42	5.10	566.10
3000 x 600 total length = 400.16m					
3000 x 600 x 1220 RCBC	$ 1,751.00	328	$ 574,329.43	3.60	1180.80
3420 x 2440 x 300 base slab	$ 2,277.86	164	$ 373,568.95	6.30	1033.20
2700 x 600 total length = 470.92m					
2700 x 600 x 1220 RCBC	$ 1,693.33	386	$ 653,624.90	3.40	1312.40
3120 x 2440 x 300 base slab	$ 2,066.59	193	$ 398,852.41	5.80	1119.40
2100 x 600 total length = 470.92m					
2100 x 600 x 2440 RCBC	$ 2,482.50	193	$ 479,122.30	3.65	704.45
2760 x 2440 x 300 base slab	$ 1,540.62	193	$ 297,340.32	4.60	887.80
		Total	$ 3,260,213.21 Exc GST	Total	7336.95
			$ 3,586,234.54 Inc GST		

Notes:
Budget Estimate Only
Delivered to the Clarence Council Area - Customer to unload, max 1 hour on site

Hobart Airport Rainfall Intensity

Duration	Average Recurrence Interval						
	1 year (mm/hr)	2 year (mm/hr)	5 year (mm/hr)	10 year (mm/hr)	20 year (mm/hr)	50 year (mm/hr)	100 year (mm/hr)
5m	32.63	44.52	65.40	80.29	99.88	128.58	152.99
5.5m	31.52	43.01	63.15	77.49	96.41	124.07	147.56
6m	30.56	41.67	61.09	74.88	93.11	119.69	142.25
6.5m	29.70	40.47	59.18	72.44	89.98	115.51	137.13
7m	28.93	39.38	57.42	70.16	87.02	111.54	132.26
7.5m	28.23	38.38	55.78	68.03	84.25	107.79	127.65
8m	27.58	37.45	54.25	66.04	81.64	104.26	123.31
8.5m	26.98	36.59	52.82	64.17	79.20	100.94	119.22
9m	26.43	35.79	51.47	62.42	76.90	97.82	115.38
9.5m	25.91	35.04	50.21	60.77	74.74	94.88	111.77
10m	25.42	34.33	49.03	59.22	72.70	92.13	108.38
11m	24.52	33.03	46.85	56.38	68.98	87.08	102.18
12m	23.71	31.86	44.90	53.84	65.65	82.60	96.68
13m	22.97	30.80	43.14	51.55	62.68	78.59	91.78
14m	22.30	29.83	41.54	49.49	59.99	74.99	87.39
15m	21.68	28.93	40.08	47.61	57.56	71.74	83.44
16m	21.10	28.11	38.74	45.89	55.35	68.80	79.86
17m	20.56	27.35	37.51	44.32	53.33	66.12	76.62
18m	20.06	26.63	36.37	42.88	51.48	63.67	73.66
19m	19.59	25.97	35.32	41.54	49.78	61.43	70.96
20m	19.15	25.34	34.34	40.30	48.20	59.36	68.47
21m	18.74	24.76	33.42	39.15	46.75	57.45	66.18
22m	18.35	24.21	32.57	38.08	45.39	55.69	64.07
23m	17.97	23.68	31.77	37.08	44.13	54.04	62.10
24m	17.62	23.19	31.01	36.15	42.95	52.52	60.28
25m	17.29	22.73	30.30	35.26	41.85	51.09	58.58
26m	16.97	22.28	29.64	34.44	40.82	49.75	56.99
27m	16.66	21.86	29.00	33.66	39.84	48.50	55.51
28m	16.37	21.46	28.40	32.92	38.93	47.32	54.11
29m	16.09	21.08	27.83	32.22	38.06	46.22	52.80
30m	15.83	20.71	27.29	31.56	37.24	45.17	51.56
32m	15.33	20.03	26.29	30.34	35.73	43.25	49.30
34m	14.87	19.40	25.38	29.23	34.37	41.52	47.26
36m	14.44	18.82	24.54	28.22	33.13	39.95	45.43
38m	14.05	18.28	23.77	27.29	32.00	38.53	43.76
40m	13.68	17.78	23.06	26.44	30.97	37.23	42.25
45m	12.85	16.68	21.51	24.59	28.73	34.43	38.99
50m	12.15	15.73	20.21	23.04	26.87	32.13	36.32
55m	11.53	14.92	19.09	21.73	25.30	30.19	34.08
60m	10.99	14.20	18.13	20.60	23.95	28.54	32.18
75m	9.70	12.51	15.87	17.98	20.85	24.76	27.87
90m	8.74	11.26	14.24	16.10	18.65	22.11	24.85
105	7.99	10.29	13.00	14.68	16.99	20.13	22.61
120m	7.39	9.52	12.01	13.57	15.69	18.58	20.86
135m	6.90	8.88	11.21	12.65	14.64	17.33	19.46
150m	6.48	8.35	10.53	11.90	13.76	16.30	18.30
165m	6.13	7.89	9.96	11.25	13.02	15.42	17.32
180m	5.82	7.50	9.47	10.70	12.38	14.67	16.47
195m	5.55	7.15	9.04	10.21	11.82	14.01	15.74
210m	5.31	6.84	8.66	9.78	11.33	13.43	15.10
225m	5.09	6.57	8.32	9.40	10.89	12.92	14.52
240m	4.90	6.32	8.01	9.06	10.50	12.46	14.01
270m	4.57	5.89	7.48	8.47	9.81	11.66	13.12
300m	4.29	5.54	7.04	7.97	9.24	10.99	12.37
6h	3.84	4.96	6.33	7.17	8.33	9.92	11.18
7h	3.50	4.52	5.78	6.56	7.63	9.09	10.26
8h	3.22	4.17	5.34	6.07	7.07	8.43	9.52
9h	3.00	3.88	4.98	5.66	6.60	7.88	8.91
10h	2.81	3.64	4.67	5.32	6.20	7.42	8.39
11h	2.65	3.43	4.41	5.02	5.87	7.02	7.94
12h	2.51	3.25	4.18	4.77	5.57	6.67	7.55
14h	2.27	2.94	3.80	4.34	5.07	6.08	6.89
16h	2.08	2.70	3.50	3.99	4.68	5.61	6.36
18h	1.93	2.50	3.24	3.70	4.34	5.21	5.91
20h	1.80	2.33	3.03	3.46	4.06	4.88	5.54
22h	1.69	2.19	2.84	3.25	3.82	4.59	5.22
24h	1.59	2.06	2.68	3.07	3.61	4.34	4.93
30h	1.36	1.76	2.30	2.64	3.11	3.75	4.26
36h	1.19	1.55	2.03	2.33	2.75	3.32	3.78
42h	1.06	1.38	1.81	2.09	2.47	2.98	3.40
48h	0.96	1.25	1.64	1.90	2.25	2.72	3.10
54h	0.87	1.14	1.51	1.74	2.06	2.50	2.86
60h	0.80	1.05	1.39	1.61	1.91	2.33	2.66
66h	0.74	0.98	1.30	1.50	1.79	2.18	2.49
72h	0.69	0.91	1.21	1.41	1.68	2.05	2.35

OPEN CHANNEL FLOW ANALYSIS:



CONSTANTS:

Mannings Coefficient, n:	0.025	
Side inv. Slope (run/rise):	7	
Channel Width, b:	1	m
Channel Slope, S_0:	0.0002	

Depth (y) (m)	A (m^2)	P (m)	R (m)	Q (m^3/s)	v (m/s)
0.8	5.280	12.314	0.429	1.698	0.322

Froude Number, Fr 0.115 Critical Slope Occurs where Fr =1

A = Area of cross-section occupied by water (m^2)
P = Wetted Perimeter (m)
R = A/P = Hydraulic Radius (m)
Q = Flow Rate (m^3/s)
v = Q/A = Flow Velocity (m/s)

Mannings Coefficients:

Concrete Pipe	0.013
Asphalt	0.016
Gravel	0.029
PVC Pipe	0.010
Short Grass	0.025

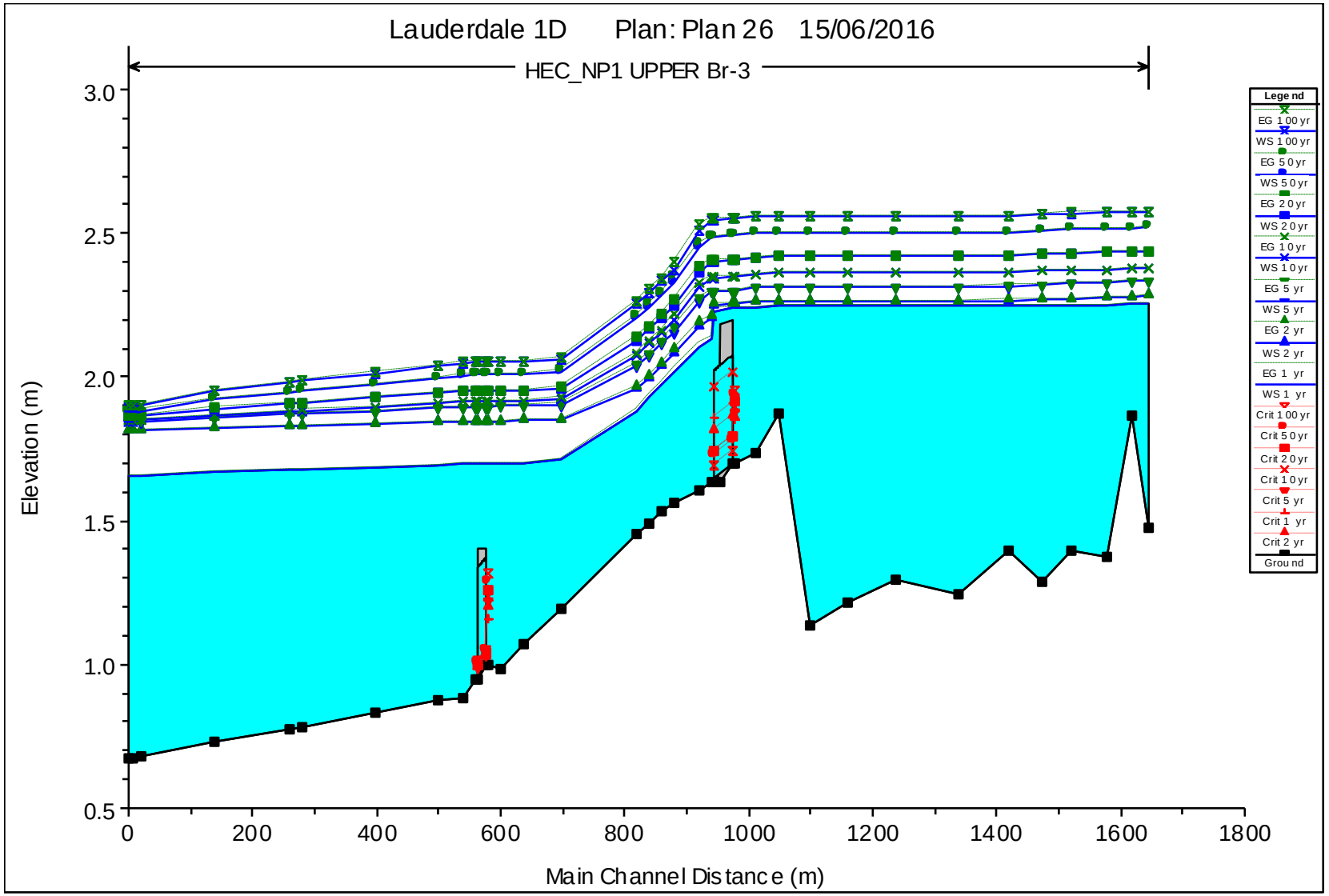


Figure A - Water profile plot for various ARI rainfall events for catchment NT1. The culvert at Balook Street (CH. 990) is overtopped in an event less than 1 in 100 year ARI and water levels reach 2.55m in Roscommon Wetlands. Mannata Street is overtopped in all rainfall events as a result of backing up from the DN900 culvert at outlet.

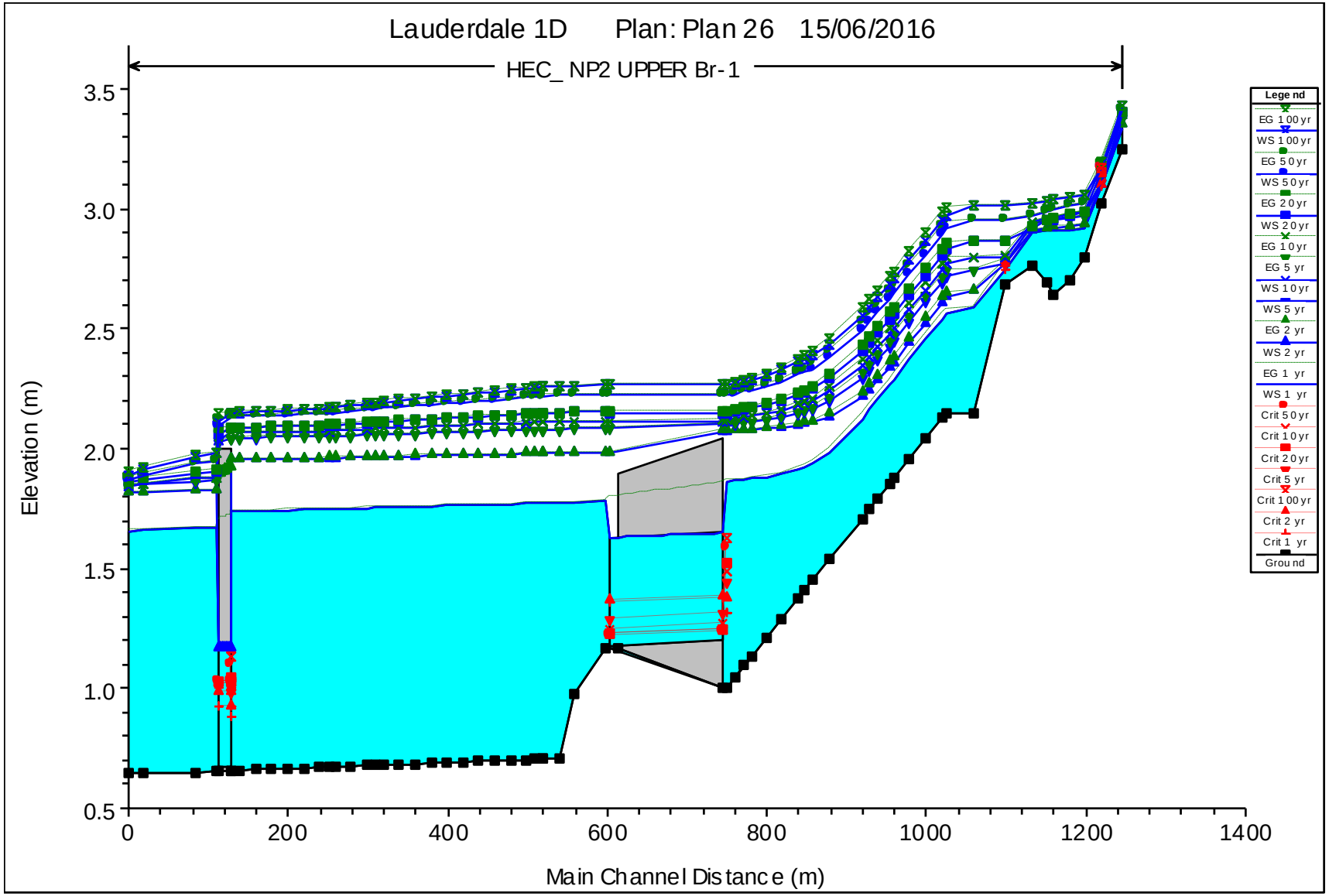


Figure B - Water profile plot for various ARI rainfall events for catchment NT2. The culvert at RBL (CH. 700) is overtopped due to the backwater effect from the undersized culvert on the access road at CH. 130 and levels reach over 2.25m.

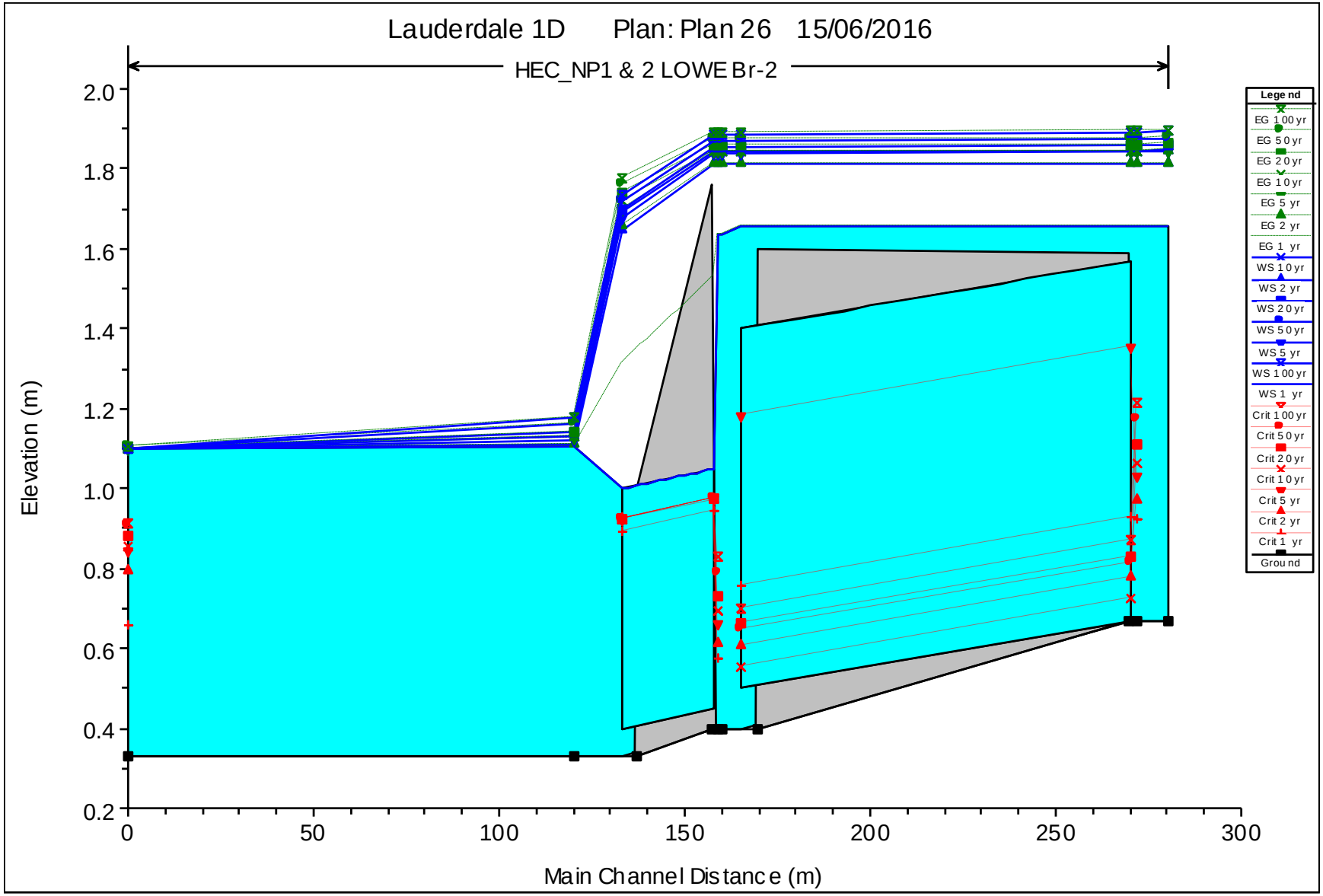


Figure C - Water profile plot for various ARI rainfall events for the combined drain to Ralphs Bay. The DN900 culvert is overtopped in events less than 1 in 1 year ARI and the twin DN600 pipes under South Arm Highway are overtopped in a 1 in 2 year event or greater. Levels reach about 1.9m over South Arm Highway (300mm over road) in a 1 in 100 year event.

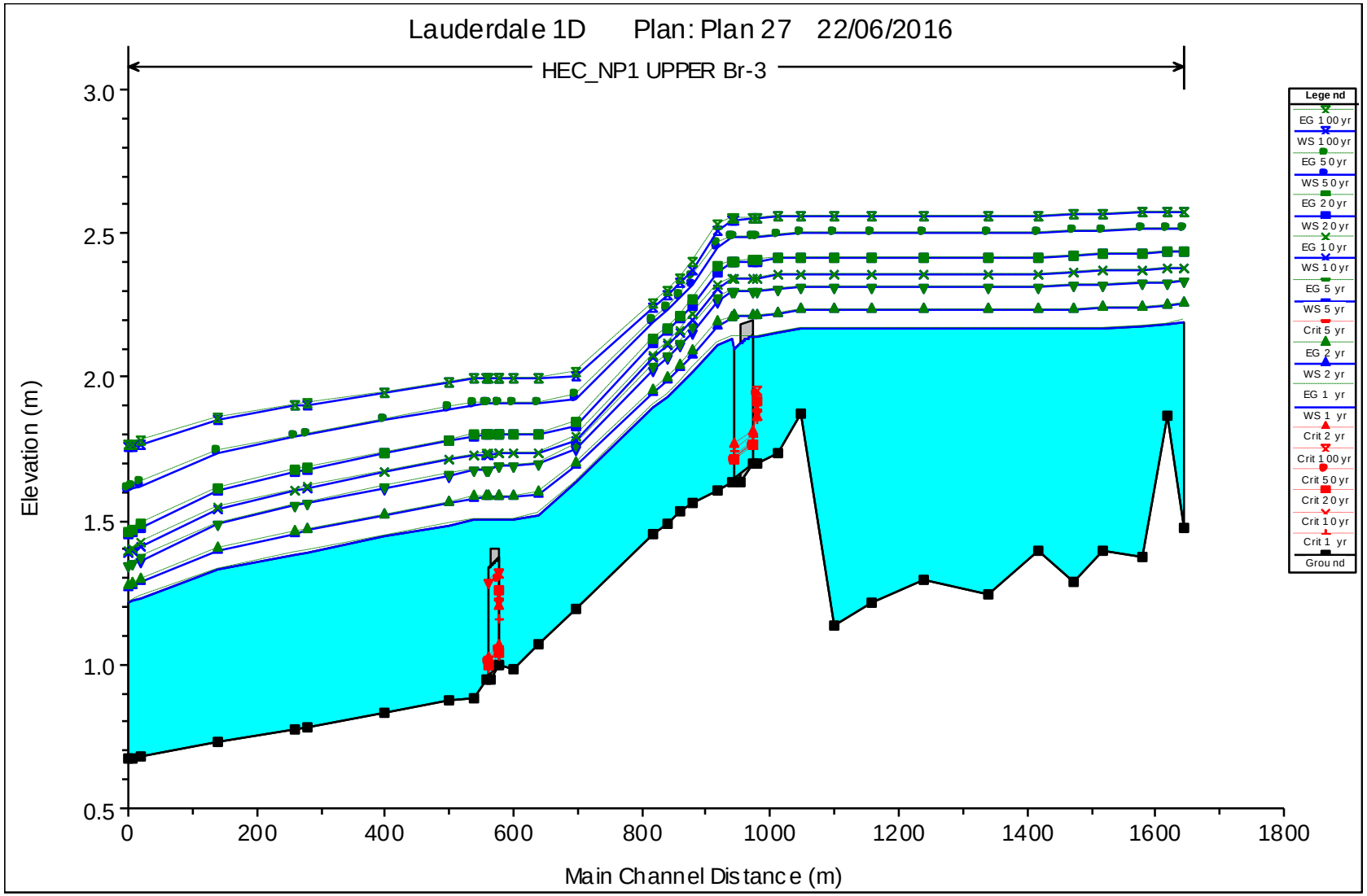


Figure D - Water profile plot for various ARI rainfall events for catchment NT1 with increased culvert sizes. The culvert at Balook Street (CH. 990) is now only overtopped in an event greater than 1 in 2 year and water levels reach 2.55m in Roscommon Wetlands. Mannata Street is still overtopped in all rainfall events even with the upsized culvert. As this makes no difference it is proposed to retain the 3 x DN375mm culverts at Mannata Street.

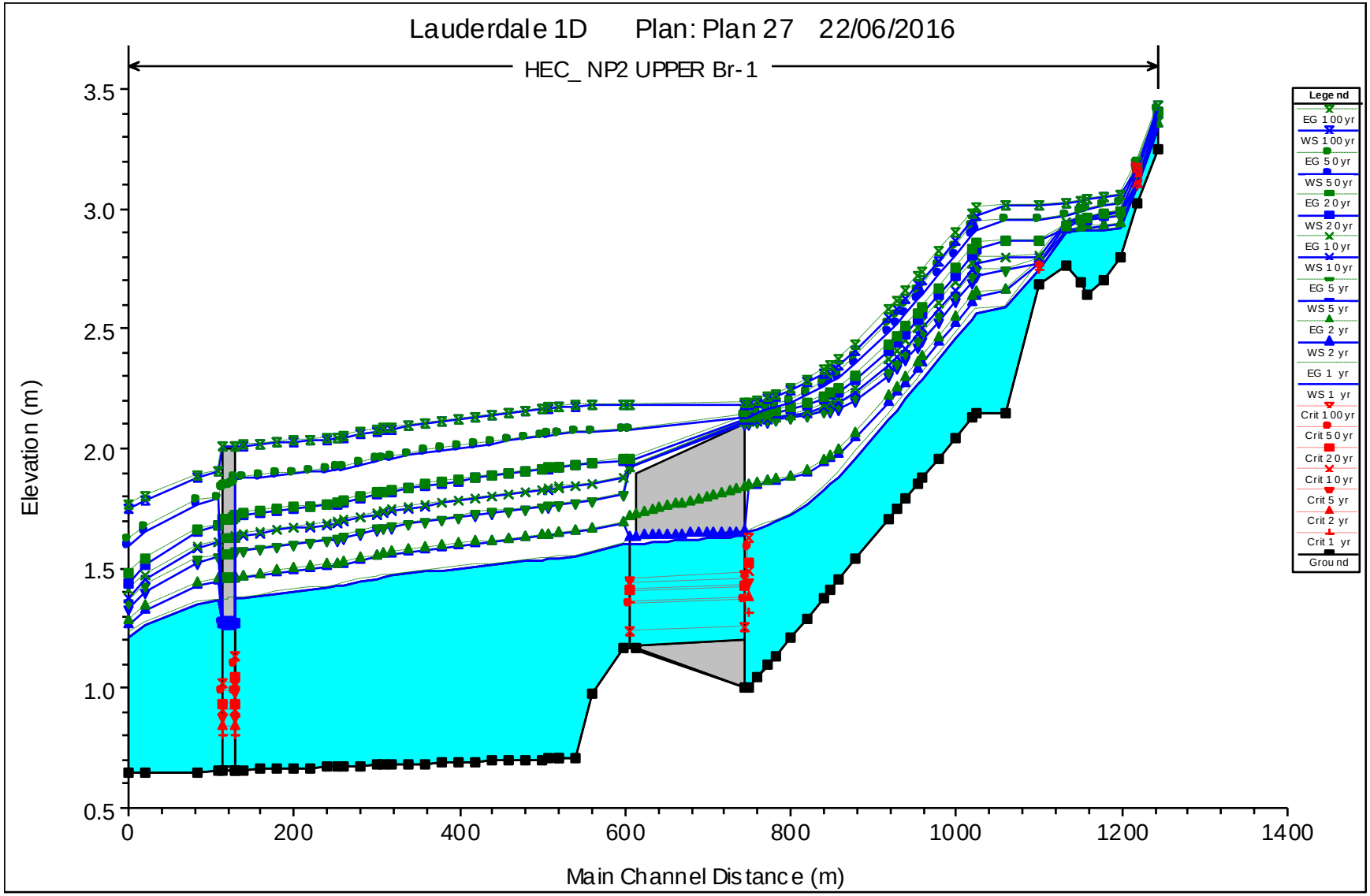


Figure E - Water profile plot for various ARI rainfall events for catchment NT2 with increased culvert sizes. The culvert at RBL (CH. 700) is now only overtopped in events greater than 1 in 5 years as a result of increasing the culvert capacity at CH. 130. Levels reach 2.18m at Ringwood Road, which is about 180mm over the road. Water will run down Mannata Street to join NT1 as the road is less than 2.1m AHD between the two catchments.

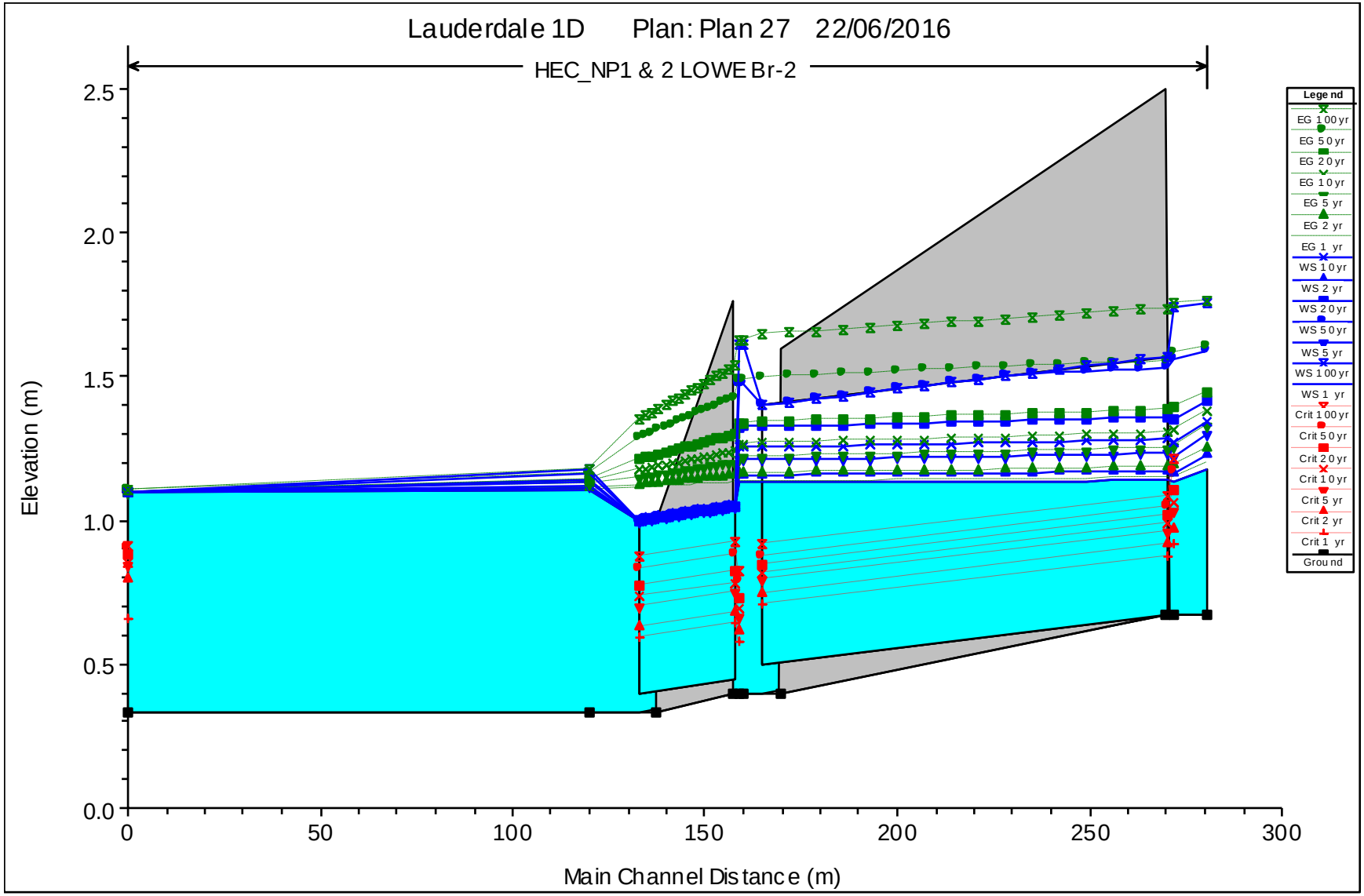


Figure F - Water profile plot for various ARI rainfall events for the combined drain to Ralphs Bay with increased culvert capacity. South Arm Highway is now not overtopped with the additional box culverts but water levels reach 1.75m on the upstream end of the culvert.

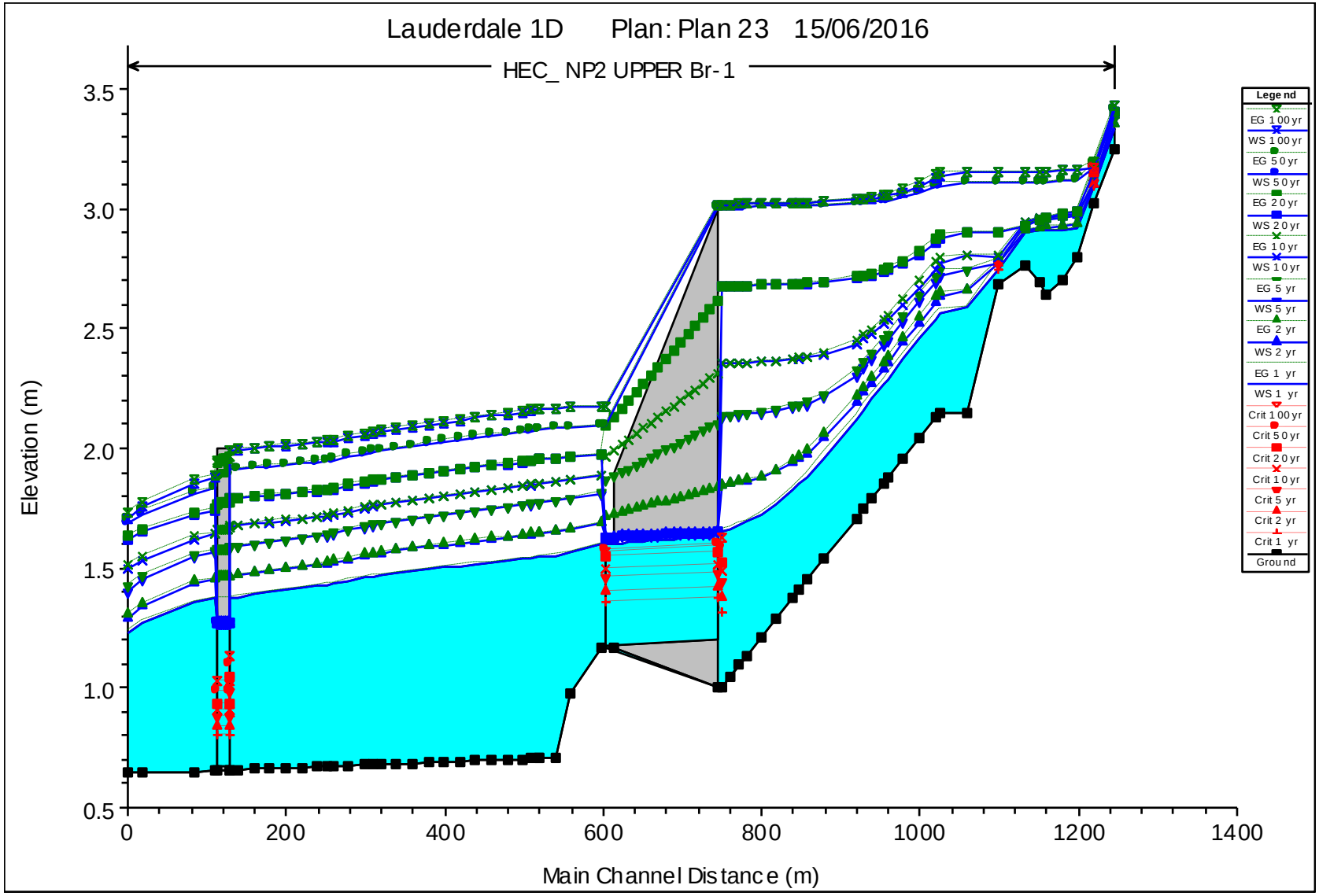


Figure G - Water profile plot for various ARI rainfall events for catchment NT2 with increased culvert size at CH.130 and raised Ringwood and Mannata Street to 3m AHD. Ringwood Road is now only overtopped in events greater than 1 in 20 year ARI and water can be confined to the existing drain under RBL (for these events).

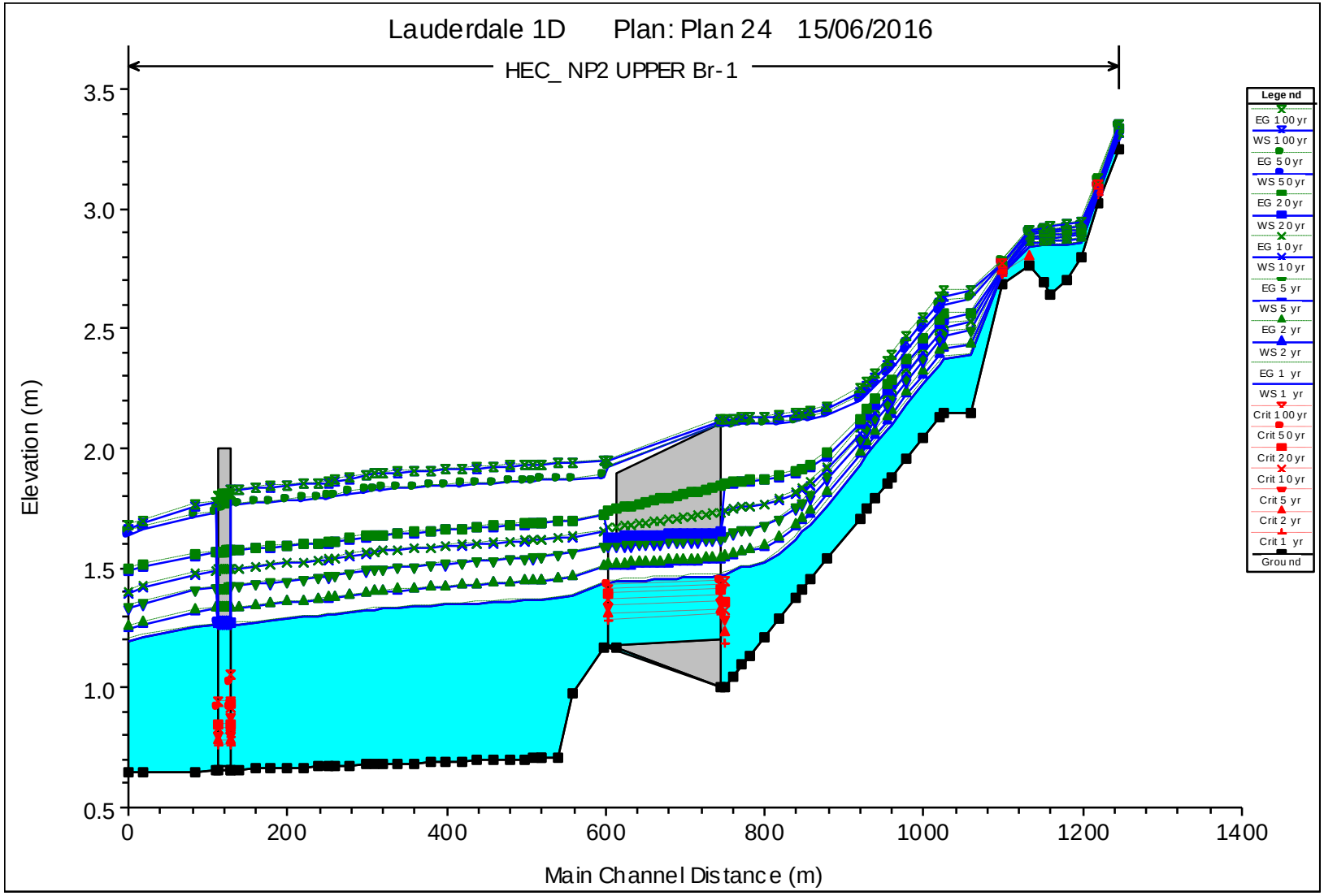


Figure H - Water profile plot for various ARI rainfall events for catchment NT2 with increased culvert size at CH.130 and reduced flow rates as a result of a catch drain to divert flows from above 3.6m AHD through 424 South Arm Highway. The existing culvert under RBL is still undersized for 1 in 50 year events and the road is inundated by approximately 100mm (2.1m AHD).

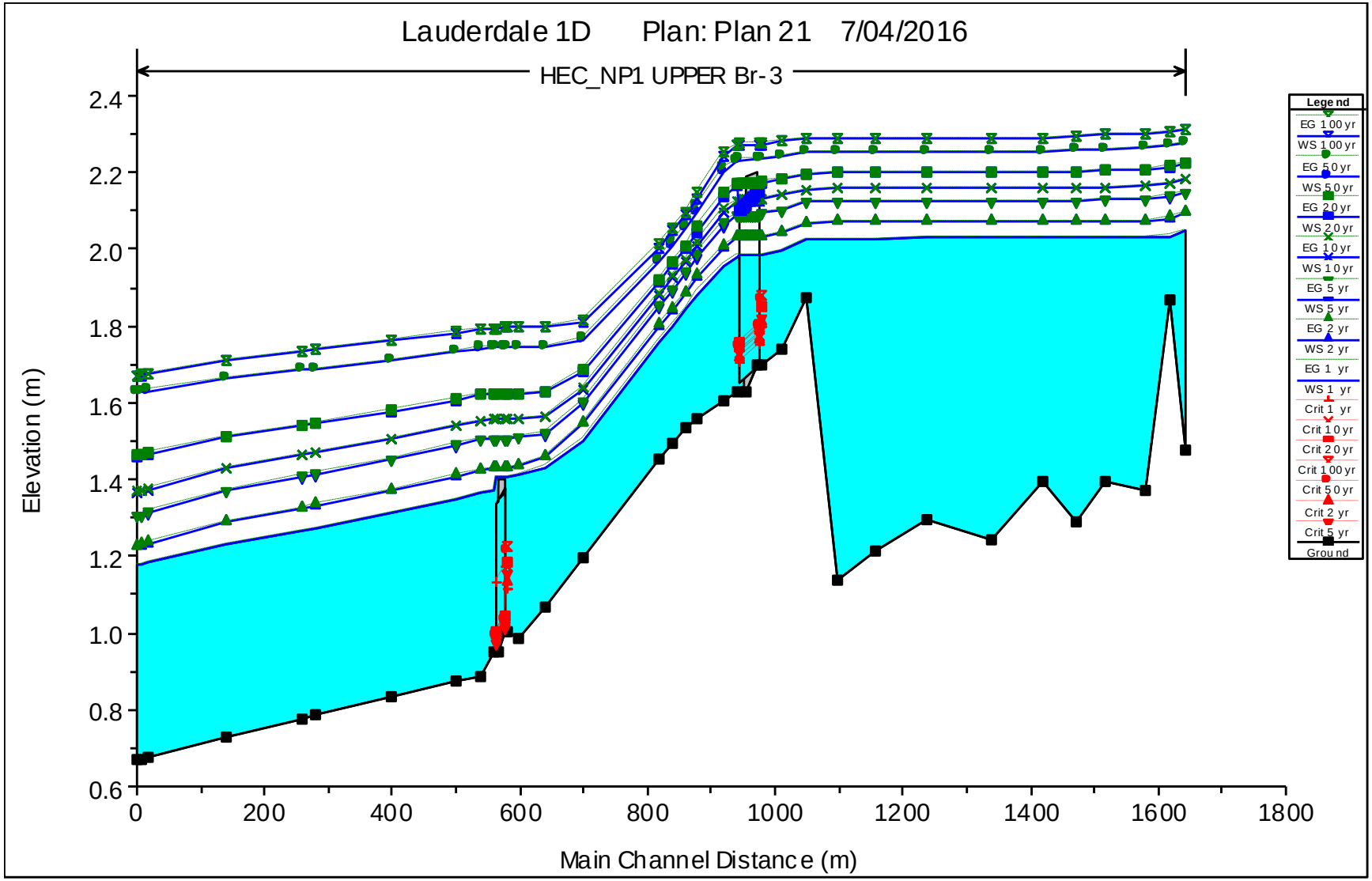


Figure I - Water profile plot for various ARI rainfall events for catchment NT1 with increased culvert size at CH.990 and reduced flow rates as a result of a catch drain to divert flows from above 3.6m AHD through 424 South Arm Highway. The upsized culvert at CH.990 (Balook Street) is capable of taking 1 in 10 year ARI flows and Roscommon wetland water levels reduce to 2.35m AHD. Water levels over Mannata Street reduce to 1.8m AHD if flows from NT2 can be stopped from running through RBL to Mannata Street.

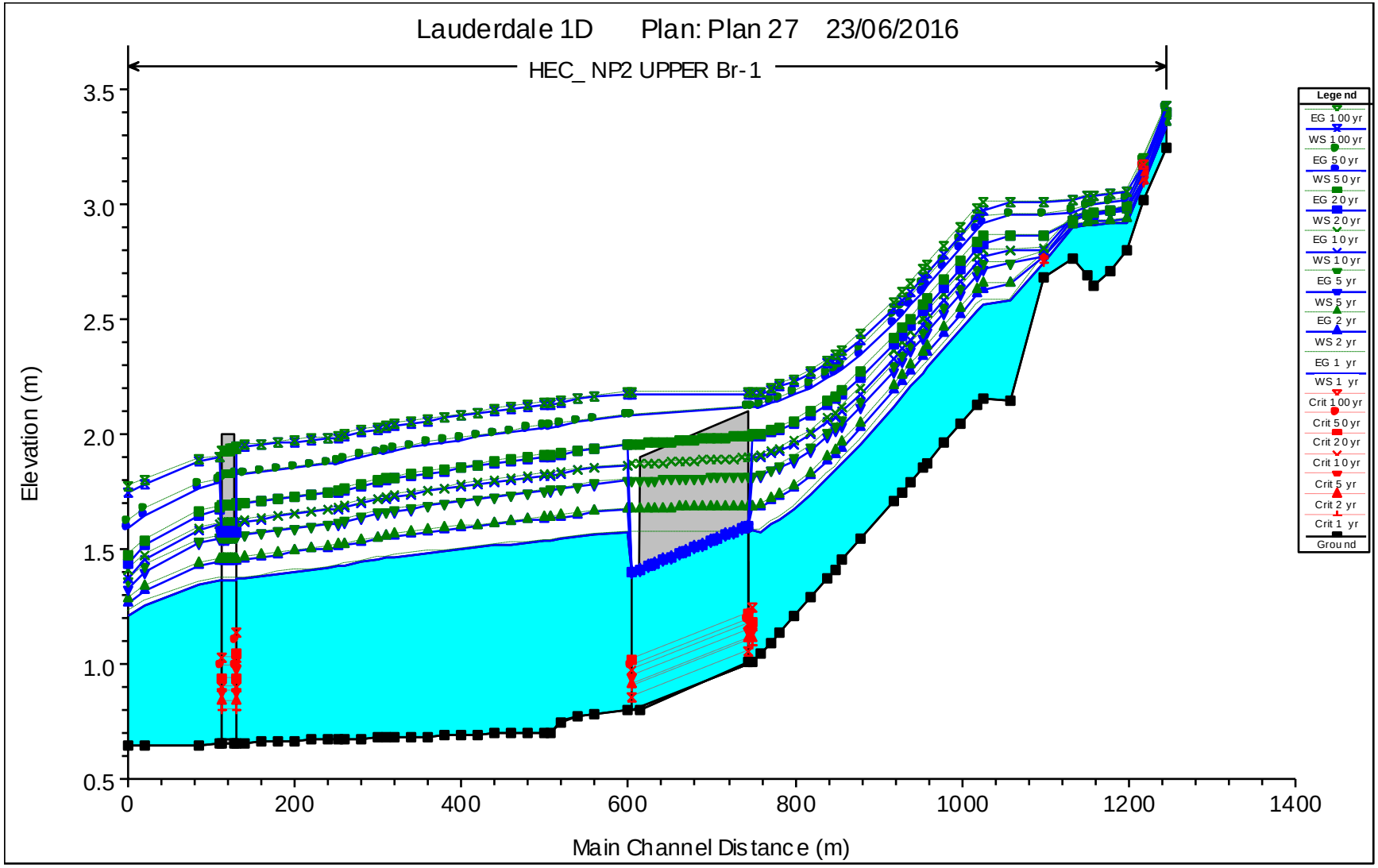


Figure J - Water profile plot for various ARI rainfall events for catchment NT2 with increased culvert size at CH.130 and under RBL. Ringwood Road is still overtopped in events greater than 1 in 50 ARI and water levels reach 2.16m AHD (160mm over the road).

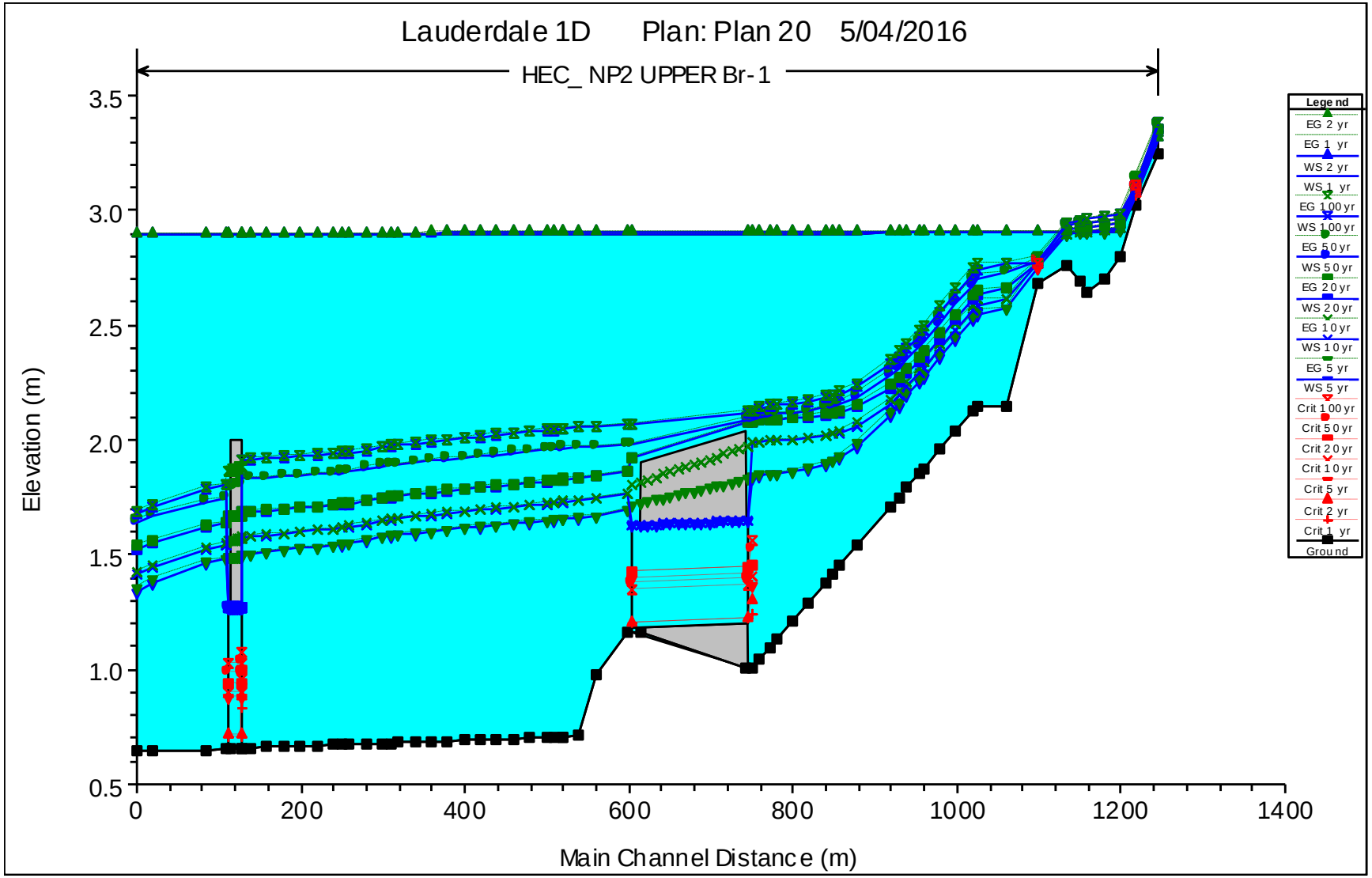


Figure K - Water profile plot for Scenario 2. The top line is the 1 in 1 year ARI rainfall event with a back water of 2.9m AHD.

APPENDIX B

Traffic Impact Assessment

MILAN PRODANOVIC B.E. PEng
TRAFFIC ENGINEERING & ROAD SAFETY

TRAFFIC IMPACT ASSESSMENT

PROPOSED RESIDENTIAL

SUBDIVISION DEVELOPMENT

LAUDERDALE

AUGUST 2016

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TRAFFIC ENGINEERING & ROAD SAFETY

TRAFFIC IMPACT ASSESSMENT

PROPOSED RESIDENTIAL

SUBDIVISION DEVELOPMENT

LAUDERDALE

AUGUST 2016

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CONTENTS

REFERENCES:

1. AUSTROADS – Guide to Road Design Part 3: Geometric Design (2009)

2. AUSTROADS – Guide to Road Design Part 4A: Unsignalised and Signalised Intersections (2009)

3. AUSTROADS – Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings (2009)

4. AUSTROADS – Guide to Road Safety Part 6: Road Safety Audit (2009)

5. Road Traffic Authority NSW – Guide to Traffic Generating Developments, 2002

6. Road and Maritime Services (Transport) - Guide to Traffic Generating Developments; Updated traffic surveys (August 2013)

1. INTRODUCTION

The Clarence City Council has commissioned a Feasibility Report on the sustainable further development of a large area of land at Lauderdale.

While there are major constraints to the growth area which include the physical boundaries created by Ralphs Bay, Roches Beach as well as the South Arm Secondary Road, the Council is considering the potential for Lauderdale to expand subject to the sustainability of further growth.

The Council has identified various matters that the Feasibility Report will need to deal with to determine the possible nature and extent of growth boundaries for Lauderdale.

One of these matters is traffic engineering advice and the need for a Traffic Impact Assessment (TIA) demonstrating the capacity to introduce additional traffic activity into the road network.

A proposed subdivision layout with an integrated road network has been defined for the study area by the consultancy team.

This TIA report has been prepared to address the expected traffic implications and outcomes from the proposed subdivision development. The report outlines the existing road and traffic conditions along South Arm Secondary Road, Acton Road and Ringwood Road – Mannata Street. It determines the vehicle traffic that the proposed subdivision development is expected to generate and assesses the effect that this traffic will have on these roads and their intersections.

Consideration is also given to the proposed internal subdivisional road layout and recommendations have been made on desirable geometric road design parameters and traffic management measures for the subdivisional streets and their connections to the existing roads to ensure a safe and efficient flow of traffic into the future with the full completion of the development.

The report is based on the Department of State Growth (DSG) Traffic Impact Assessment Guidelines. The techniques used in the investigation and assessment incorporate best practice road safety and traffic management principles.

2. STUDY AREA

The study area contains around 56ha of land currently zoned rural living. It is bounded by the South Arm Secondary Road and Acton Road to the west and abutting general residential and local business development along the other boundaries including the Roches Beach residential development to the east.

The study area is shown on the arterial photograph which is an extract from the Council's 'Expressions of Interest' document and is seen in Figure 2.1.

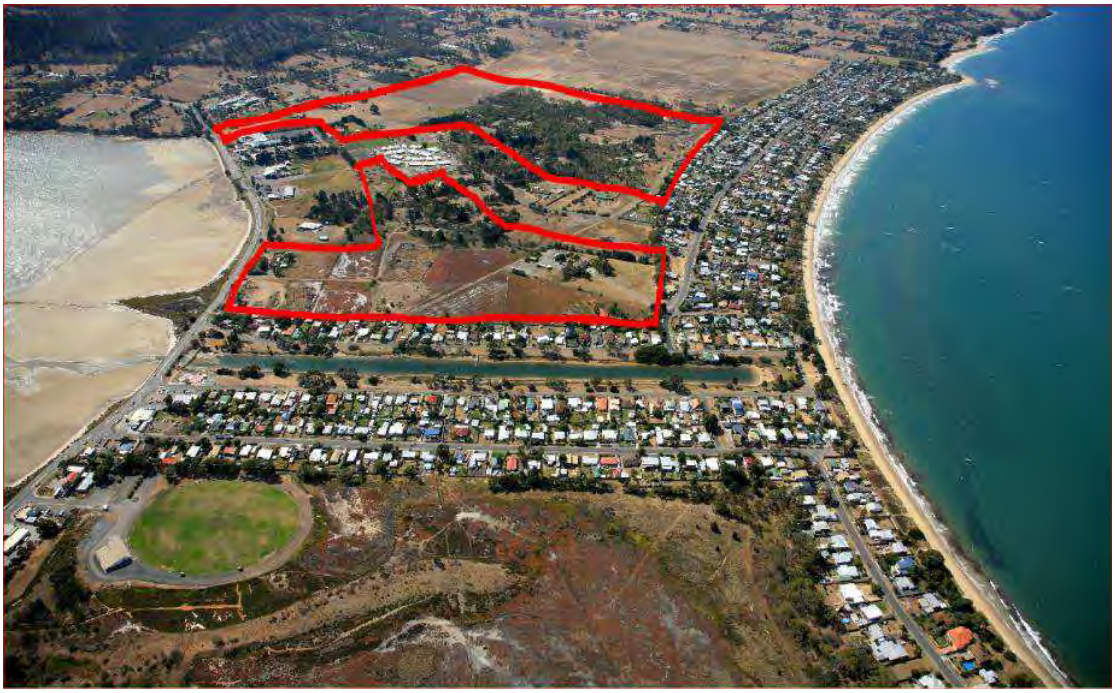

Figure 2.1: Lauderdale study area

3. DEVELOPMENT PROPOSAL

The consultancy team has prepared a Development Layout Plan for the study area.

While the study area has a total area of around 50.5ha, an area of around 37.3ha has been determined as suitable to be developed.

The plan details an overall subdivision layout which will have around 583 residential lots. The proposed area of the lots would range from:

- 450 m^2 to 550m^2 for lots nearer a business or local shop; and
- 550m^2 to around 1,000m^2 for other lots.

The study area will effectively have two proposed subdivision areas separated by the Ringwood Road -Mannata Street corridor, as can be appreciated from Figure 2.1.

The development layout plan proposes the southern subdivision area to have some 284 lots. A number of local streets would provide access to each of the lots in this area.

It is proposed this area be connected to the existing road network with:

- a road from the western part of the subdivision to junction with Ringwood Road midway along its length (around 200m from the South Arm Secondary Road);
- a road from the eastern part of the subdivision to intersect with Mannata Street some 230m to the west of Bangalee Street; and
- a local street connection between the south-eastern part of the subdivision to Bangalee Street at a point some 100m to the north of North Terrace.

The northern subdivision area would have some 299 lots. Access to the lots would also be serviced by number of local streets and the area would have four road connections to the existing road network.

These would include:

- an east – west road through the subdivision to connect at its eastern end with Balook Street and its western end with Acton Road;
- a road from the middle part of the subdivision to form a T-junction with Ringwood Road/Mannata Street and effectively become the northward extension Ringwood Road; and
- a north – south road along the eastern part of the subdivision to form an intersection with Mannata Street and the subdivisional road from the southern subdivision.

The Development Layout Plan is included with this report as Attachment A.

Accepting that the development of these areas will occur in the future, it is not possible to specify the time frame for the full completion of the whole subdivision development as this will be dependant on market demand and economic factors. The development of the whole subdivision area will occur in stages and expected to take 17 years.

4. EXISTING ROAD AND TRAFFIC ENVIRONMENT

4.1 Road Characteristics

The existing roads that will be affected by this proposed subdivision development include the South Arm Secondary Road, Acton Road and Ringwood Road – Mannata Street. There will also be some traffic redistribution impacts on Balook Street and Bangalee Street.

South Arm Secondary Road

The South Arm Secondary Road is a Category 4 - *Feeder Road* from Rokeby to Lauderdale and a Category 5 – *Other Road* to the south of Lauderdale.

Through Lauderdale, the South Arm Secondary Road has one traffic lane in each direction with a CHR type right turn lane for each of the side roads including Ringwood Road and Acton Road as well as the main commercial accesses.

The Ringwood Road/South Arm Secondary Road junction is a sign controlled junction. Ringwood Road at the junction of South Arm Secondary Road is around 8.0m wide between kerb faces with the kerb and gutter ending some 25m from the junction.

The Acton Road/South Arm Secondary Road junction also is a sign controlled junction. There is kerb and gutter along the eastern side of Acton Road adjacent to the Lauderdale Primary School. The Acton Road approach to the junction has separate left and right turn lanes.

There is a shared footpath along the eastern side of South Arm Secondary Road from Acton Road to south of Ralphs Bay Canal as well as a pedestrian refuge on South Arm Secondary Road near Ringwood Road to facilitate pedestrian movements across the road to and from bus stops on both sides of the road.

The speed limit along South Arm Secondary Road through Lauderdale is 70km/h.

Views along South Arm Secondary Road at the junction of Acton Road and Ringwood Road and at the Acton Road and Ringwood Road approaches to South Arm Secondary Road are seen in Photographs 4.1 to 4.4.

Photograph 4.1: View to north along South Arm Secondary Road at Ringwood Road junction

Photograph 4.2: View of Ringwood Road approach to South Arm Secondary Road

Photograph 4.3: View to northwest along South Arm Secondary Road at Acton Road junction

Photograph 4.4: View of Acton Road approach to South Arm Secondary Road

Acton Road

Acton Road has a collector road function linking South Arm Secondary Road with the Tasman Highway and providing access to the large residential area of Acton Park.

Acton Road has a sealed width of around 6.5m and is marked with a centreline as well as edge lines. The traffic lanes have a width of around 3.0m and the sealed shoulders are around 0.2-0.3m wide.

Along the frontage of the Lauderdale Primary School the road has been widened to provide a 2.1m wide right turn median treatment with the through traffic lanes having a width of 3.0m clear of the gutter along the school side of the road.

The speed limit along Acton Road is 70km/h with a 40km/h speed limit applying along the school frontage before and after school.

Views along Acton Road in the area of the school and the future new subdivision road junction are seen in Photographs 4.5 and 4.6.

Photograph 4.5: View to north along Acton Road past Lauderdale Primary School on right

Photograph 4.6: View to south along Acton Road with proposed new subdivision road junction at start of median

Ringwood Road – Mannata Street

Ringwood Road and Mannata Street form a continuing road on a right angled bend which currently would have a collector road function in connecting the Roches Beach area via Bangalee Street with South Arm Secondary Road.

There is some intermittent residential development along the length of the two roads. However, the hotel at the junction of Ringwood Road/South Arm Secondary Road and a retirement village on the bend where the two roads join are currently the two main traffic generating developments with access to these roads.

Apart from the short sections of kerb and gutter at the western end of Ringwood Road (around 25m in length) and eastern end of Mannata Street before it intersects with Bangalee Street (around 75m in length) both roads have no kerb and gutter.

The sealed width of the roads is around 5.7m to 5.4m with the width of the eastern section of Mannata Street being 8.3m between kerb faces. There is a footpath on the northern side of the road along the full length of both roads.

The speed limit along Ringwood Road and Mannata Street is 60km/h, reducing to 50km/h at the western Mannata Street approach to Bangalee Street.

Views along these roads are seen in Photographs 4.7 to 4.10.

Photograph 4.7: View to east along Ringwood Road towards bend linking with Mannata Street

Photograph 4.8: View to west along Mannata Street towards bend linking with Ringwood Road

Photograph 4.9: View to east along Mannata Street just east of Ringwood Road

Photograph 4.10: View to east along Mannata Street approach to Bangalee Street

Bangalee Street

Bangalee Street is the main local street for Roches Beach area with a length of around 2km extending over the full length of the residential development in this area. It has a width between kerb faces of around 8.3m and a footpath both sides of the road.

The speed limit along the residential streets in Roches Beach is 50km/h.

The only four leg intersection in Roches Beach apart from the Mannata Street intersection is the Balook Street intersection with Bangalee Street. This intersection has a roundabout control whereas the Mannata Street intersection has 'give way' sign control.

A view along Bangalee Street is seen in Photograph 4.11

Photograph 4.11: View to south along Bangalee Street with Mannata Street intersection ahead near large tree

Balook Street

One of the subdivisional roads in the proposed northern subdivision area will form a westward extension of Balook Street. Currently the western end of Balook Street is a cul-de-sac as seen in Photograph 4.12.

The width of Balook Street between kerb faces reduces from around 8.3m between Bangalee Street and Terrina Street to around 7.7m to the west of Terrina Street.

A view of the western Balook Street approach to Bangalee Street is seen in Photograph 4.13.

Photograph 4.12: View to west along Balook Street from near Terrina Street

Photograph 4.13: View to east along Balook Street from near Terrina Street towards Bangalee Street intersection

4.2. Traffic Activity

South Arm Secondary Road

Enquiries about available traffic data for the South Arm Secondary Road found that DSG has record of an automatic counter survey undertaken on the road at a point 100m to the east of Horsham Road at Oakdowns Estate.

DSG has determined the section of South Arm Secondary Road between Droughty Point Road in Rokeby and Bayview Road in Lauderdale is a uniform traffic section.

The most recent survey was undertaken in September 2012 and the following traffic volumes were recorded:

Average weekday traffic	- 11,600 vehicles/day;
Morning weekday peak hour traffic (8-9am)	- 303 vehicles/hour to east; - 870 vehicles/hour to west;
Afternoon weekday peak hour traffic (5-6pm)	- 820 vehicles/hour to east; - 278 vehicles/hour to west;

The hourly distribution of traffic volumes over the average weekday in September 2012 at the survey site has been presented graphically in Figure 4.1.

The graphs display typical morning and afternoon commuter peak hour traffic distributions for an arterial road.

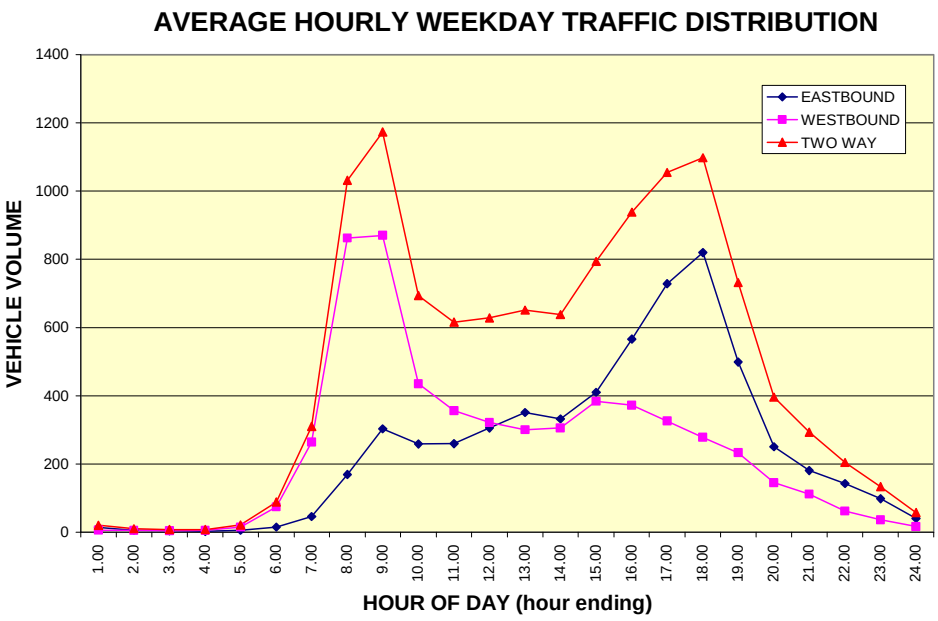

Figure 4.1: Hourly weekday traffic volumes on South Arm Secondary Road east of Horsham Road

The traffic volume along the South Arm Secondary Road on a Saturday and Sunday was around 88% and 79% respectively that of the average weekday traffic.

The hourly distribution of traffic volumes at the survey site over a Saturday and Sunday in September 2012 has been presented graphically in Figures 4.2 and 4.3.

The AADT traffic at the survey site within this segment in 2012 was 11,172 vehicles/day with 5.4% commercial vehicles.

The seasonal traffic variation for this section of South Arm Secondary Road falls within Seasonal Group G02 which is presented graphically in Figure 4.4.

DSG has advised the compound annual traffic growth for the site has been 1.3% p.a. over the last 20 years.

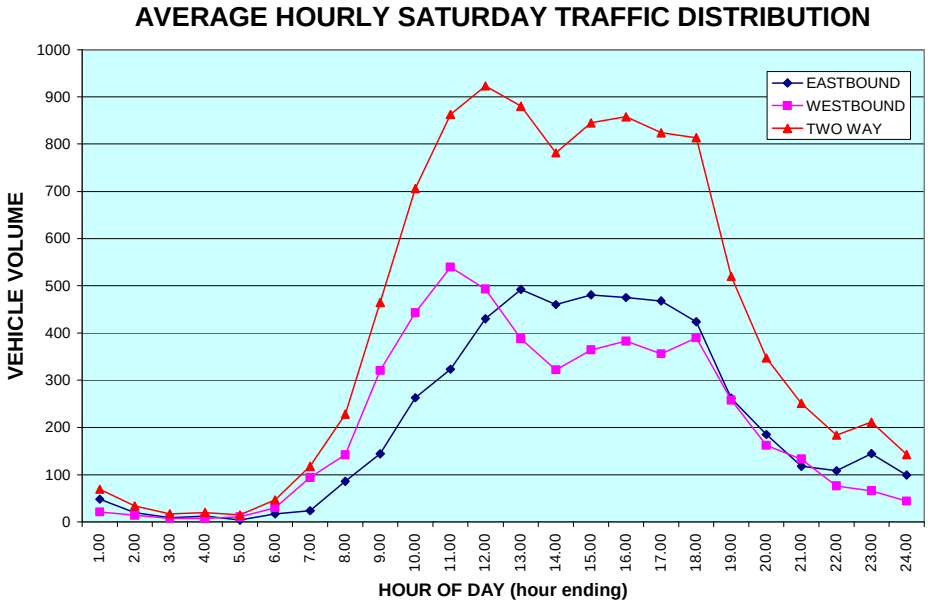

Figure 4.2: Hourly Saturday traffic volumes on South Arm Secondary Road east of Horsham Road

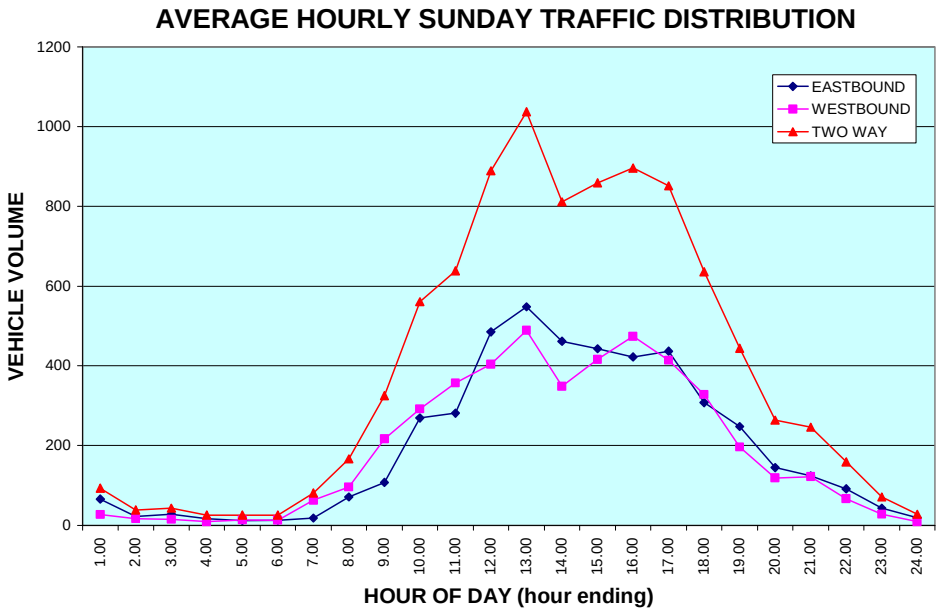

Figure 4.3: Hourly Sunday traffic volumes on South Arm Secondary Road east of Horsham Road

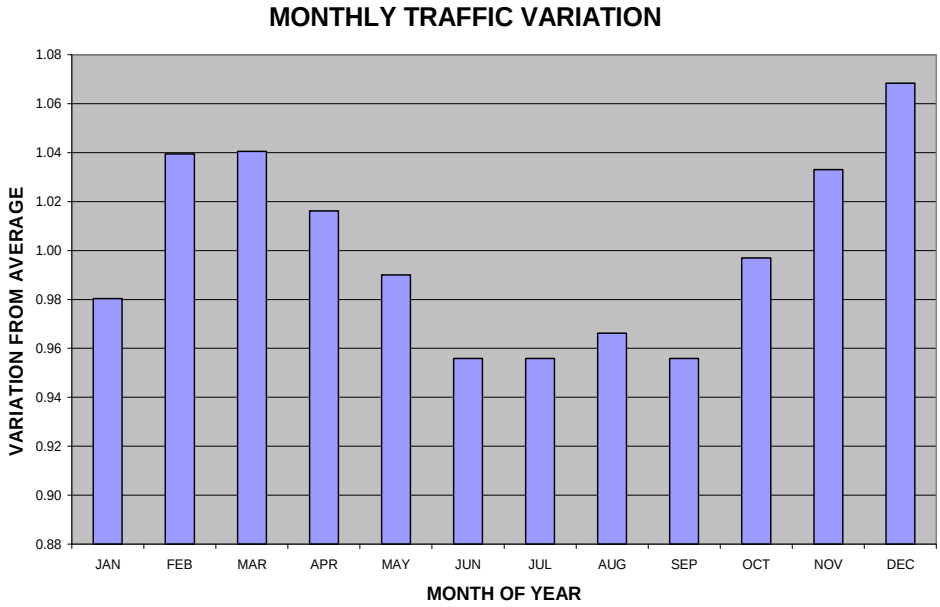

Figure 4.4: Monthly traffic variation on South Arm Secondary Road east of Horsham Road

Enquiries with the Clarence City Council did not result in any recent traffic data being obtained for the busier council roads of interest in the Lauderdale area.

Therefore, in order to have some measure of the traffic volume using Acton Road and Ringwood Road – Mannata Street, peak hour turning movement

surveys were undertaken at the South Arm Secondary Road/Acton Road and South Arm Secondary Road/Ringwood Road intersections. The surveys were undertaken between Tuesday 15 December 2015 and Thursday 17 December 2015 during the 8:00am - 9:00am and 4:45 - 5:45pm periods.

The results from these surveys have been summarised in Figures 4.5 to 4.8.

The turning movement survey results indicate the current daily traffic volume on Ringwood Road would be around 2,500 vehicles/day which is at the low end for a minor collector road.

The turning movement surveys also suggest that the daily traffic volume on Acton Road just north of the South Arm Secondary Road is around 5,300 vehicles/day with the Lauderdale Primary School generating a significant traffic movement. It is estimated that to the north of the school the daily traffic volume on Acton Road would be around 4,000 vehicles/day.

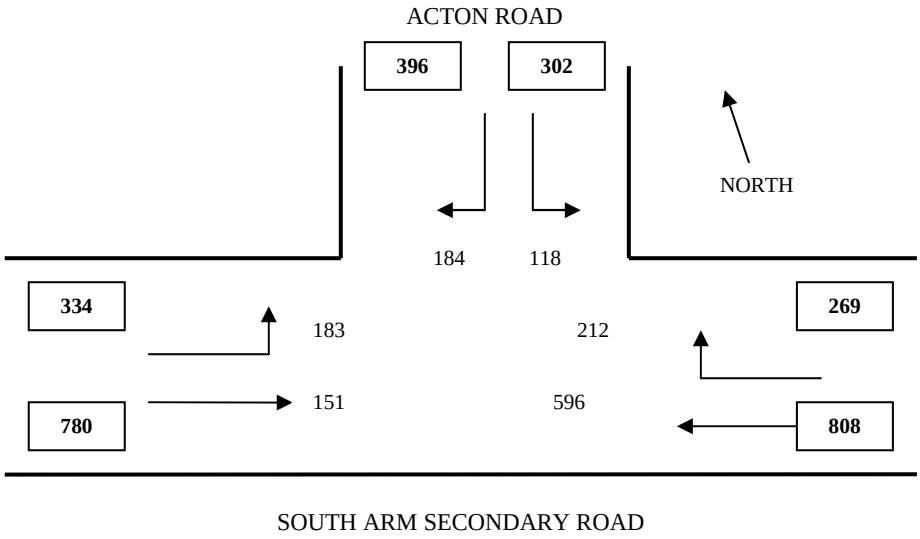

Figure 4.5: Turning traffic volumes at junction of South Arm Secondary Road/Acton Road – 8:00am to 9:00am

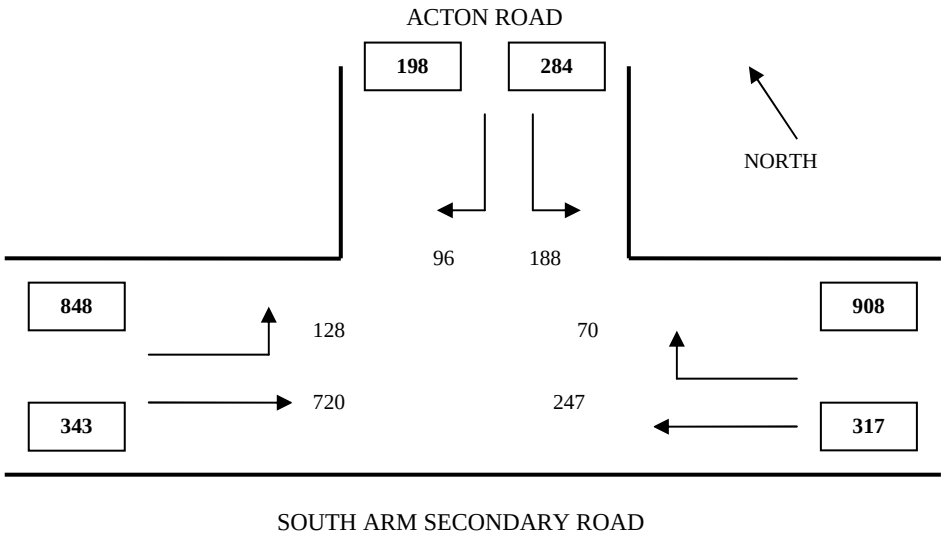

Figure 4.6: Turning traffic volumes at junction of South Arm Secondary Road/Acton Road – 4:45pm to 5:45pm

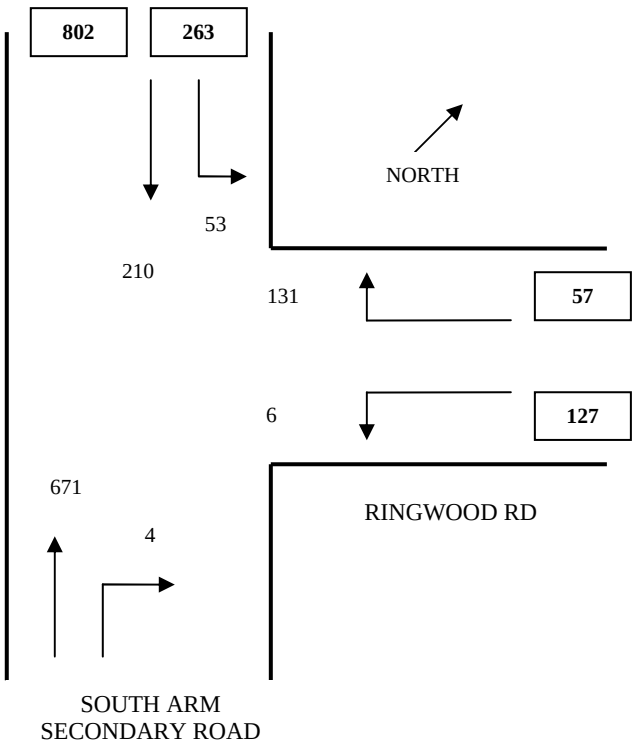

Figure 4.7: Turning traffic volumes at junction of South Arm Secondary Road/Ringwood Road – 8:00am to 9:00am

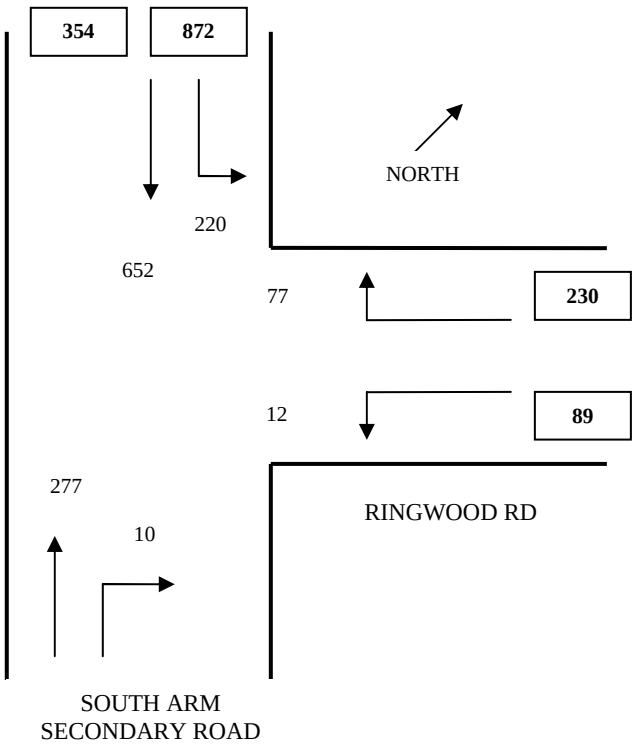

Figure 4.8: Turning traffic volumes at junction of South Arm Secondary Road/Ringwood Road – 4:40pm to 5:40pm

4.3. Crash Record

All crashes that result in personal injury are required to be reported to Tasmania Police. Tasmania Police record all crashes that they attend. Any crashes that result in property damage only, which are reported to Tasmania Police, are also recorded even though they may not visit the site.

Details of reported crashes are collated and recorded on a computerised database that is maintained by DSG.

Information was requested from DSG about any reported crashes along the South Arm Secondary Road between Acton Road and North Terrace, Acton Road, Ringwood Road - Mannata Street as well as along Bangalee Street and Balook Street over the five year period since January 2011.

South Arm Secondary Road

The DSG database has record of 11 crashes along the above section of South Arm Secondary Road. Three of these crashes occurred at the South Arm Secondary Road/Ringwood Road junction and one at the South Arm Secondary Road/Acton Road junction.

The three crashes at the Ringwood junction were angle collisions with one crash requiring first aid attention.

The crash at the Acton Road junction appears to have been a minor vehicle roll back incident.

Six of the other seven crashes occurred between Acton Road and Ringwood Road. One involved a cyclist just south of Acton Road while the other six crashes occurred between 80m and 170m to the north of Ringwood Road. These crashes were all due to frontage development vehicles including rear end collisions, front-on collisions or reversing vehicles. The crash involving the bicycle and one of the front-on collisions resulted in injury.

Acton Road

There have been only three crashes along Acton Road between South Arm Secondary Road and Equestrian Drive, a distance of around one kilometre. The crashes were all different type of incidents including a collision with a native animal, a loss of control and a rear end collision with a left turning vehicle. The loss of control crash resulted in injury.

Ringwood Road

Of the three reported crashes along Ringwood Road, two involved vehicle emerging from a driveway including one on the gravel section of Ringwood Road. These two collisions both resulted in injury. The other crash involved a collision between an oncoming vehicle and a right turning vehicle into a property and resulted in property damage only.

Mannata Street

The two crashes along Mannata Street occurred along the curved section of the street around midway between Ringwood Road and Bangalee Street. Both were single vehicle loss of control crashes with one requiring first aid attention.

There have been two reported crash at the Mannata Street/Bangalee Street intersection. One crash involved a head-on collision and possibly unrelated to the junction, the other was a loss of control incident. Both crashes resulted in property damage only.

Bangalee Street

The crash database has record of two reported crashes along this street other than at the Mannata Street intersection.

One of these crashes occurred at the Balook Street intersection which is controlled by a roundabout. The incident was a rear end collision which required first aid attention.

The other occurred further to the north and involved a vehicle emerging from a driveway. It resulted in property damage only.

Balook Street

Apart from the above crash at the Bangalee Street intersection there has been one other reported crash along this street. It occurred some 350m to the north of Bangalee Street and involved a minor property damage incident with a parked car.

5. TRAFFIC GENERATION BY THE PROPOSED SUBDIVISION DEVELOPMENT

As outlined in Section 3 of this report the proposed development will consist of the construction of a residential subdivision in two areas of Lauderdale separated by Ringwood Road – Mannata Street corridor.

The total subdivision development will eventually have some 583 residential lots.

Around 299 residential lots are proposed in the slightly larger subdivision area to the north of Ringwood Road – Mannata Street and around 284 lots to the south of this road corridor.

In considering the traffic activity that each dwelling on the lots will generate when occupied, guidance is often sought from the New South Wales, Road Traffic Authority document – Guide to Traffic Generating Developments. The RTA guide is a nationally well accepted document that provides advice on trip generation rates and vehicle parking requirements for new developments. This document advises that daily vehicle trips for residences are around 9 per household.

The updated 'Technical Direction' to the Guide dated August 2013 advises that the trip generation for residential dwellings in regional areas of New South Wales is 7.4 trips/dwelling/day.

This latter figure is more consistent with findings by this consultant for dwellings in Tasmania. Surveys in the built up areas of Tasmania over a number of years have found that typically the trip generation rate for residential dwellings is 8.0 trips/dwelling/day with smaller residential units generating around 4 trips/unit/day and larger units generating around 6 trip/unit/day.

While the above 7.4 vehicles/dwelling/day could be applicable because Tasmania is regarded as a regional area, it is most appropriate that current local traffic generation data is used whenever possible as it will reflect the actual traffic activity that will occur. Therefore, the total traffic generation will be based on a trip generation rate of 8 trips/lot/day for single dwelling lots and a traffic generation rate of 4.5 trips/unit/day for multiple residential unit lots.

It is possible that up to 25% of the lots could be developed with multiple residential units, 90 % of these lots with two units per lot and 10% with three units per lot, giving an average trip generation rate of 8.3625 trips/lot/day. This proportion of unit development on lots is based on advice from various developers and experience gained over recent years with dealing with larger residential subdivision developments.

The approximately 583 residential lots in the total development are expected to generate some 4,875 vehicles/day. If a traffic generation rate of 7.4 trips/lot/day for single dwelling lots and a traffic generation rate of 4.0

trips/unit/day for multiple residential unit lots had been used, the total traffic generation would be less by around 415 vehicles/day.

The northern subdivision area with some 299 lots will generate around 2,500 vehicles/day while the southern subdivision area with some 284 lots will generate around 2,375 vehicles/day.

Around 10% of this traffic volume or 488 vehicles/hour in total will occur in the morning and also afternoon peak hour.

The total peak hour traffic activity from the future full development of the subdivision areas has been assigned to the existing and proposed road network to give an indication of the expected level of the morning and afternoon peak hour traffic activity at key intersections. The resultant traffic volumes have been shown in Figures 5.1 and 5.2.

The traffic volumes along the South Arm Secondary Road, Acton Road and Ringwood Road – Mannata Street in Figures 5.1 and 5.2, include the recorded traffic volumes from the turning movement surveys (Figures 4.5 to 4.8), which have been increased by 1.3% p.a. for the South Arm Secondary Road and 1% p.a. for the other roads to allow the expected traffic growth over the next 20 year period. No seasonal correction is required as the traffic volumes are from surveys in December which is the highest trafficked month of the year as seen from Figure 4.4.

While the staged subdivision development of the whole site is expected to take 17 years, it was decided the traffic assessment of future traffic conflicts be undertaken for Year 2036 or 20 years time.

It is normal to consider the impact of developments some 10 years after completion. However, there are also some limits to the accuracy of predicting traffic activity beyond a 10 year period. Therefore, it was decided that allowing for a 20 year period may reasonably for expected traffic outcomes to be defined at the time of or soon after the completion of the whole subdivision development.

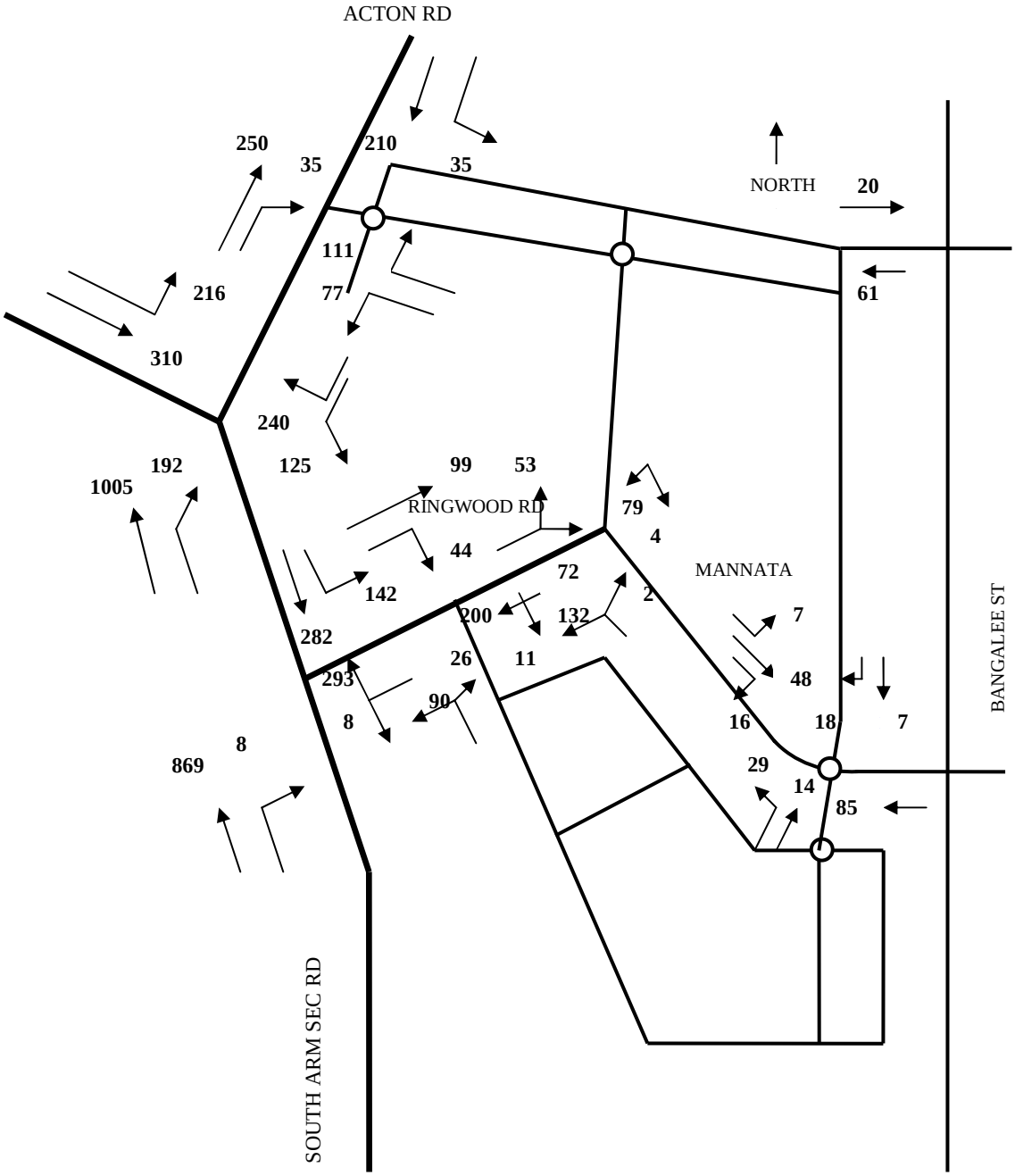

Figure 5.1: Expected AM peak hour turning traffic volumes at key intersections in Lauderdale in 2036

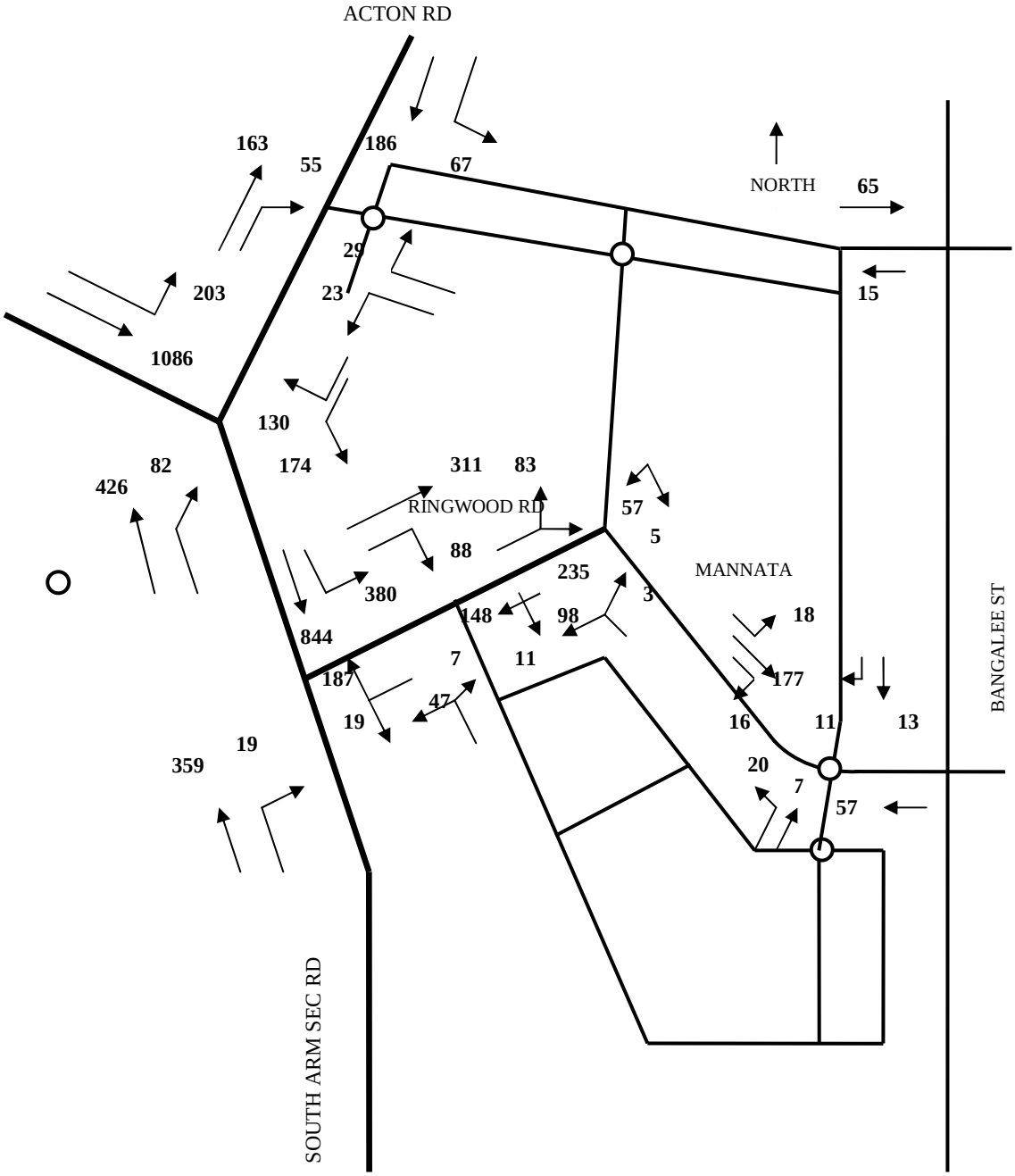

Figure 5.2: Expected PM peak hour turning traffic volumes at key intersections in Lauderdale in 2036

6. TRAFFIC ASSESSMENT AND IMPACT

This section of the report considers the impact of the traffic which the subdivision development will generate on the adjacent road network. Consideration is also given to the appropriateness of the proposed subdivision road layout with advice provided on required road design standards, intersection controls and traffic management measures.

6.1 Road Hierarchy

There is a strong case to provide for collector roads at an early stage of a residential precinct's development; ideally the road hierarchy should be developed at the planning stage which has been the case with this development.

The Development Layout Plan (Attachment A) identifies a street layout for the subdivision areas which is integrated with the existing road network to provide the whole area with an overall hierarchical road network. There are some existing constraints to preparation of an ideal road hierarchy for the area which include the shape of the areas that are being considered for subdivision and the existing location and alignment of Ringwood Road – Mannata Street passing between the two subdivision areas.

The objectives that were applied in the development of the road network for the subdivision areas were:

- Provision of at least two access roads to service each subdivisional area;
- Creation of a logical hierarchy of roads within the subdivision areas with internal collector roads connecting to the existing collector and the arterial roads;
- Not to create any new junctions unless absolutely necessary onto the main arterial roads, particularly the South Arm Secondary Road; and
- Installation of a roundabout control at any four leg intersection being essential for safety.

It is considered this has been achieved with the Development Layout Plan with two minor collector roads from the northern and southern subdivision areas linking with Ringwood Road and Mannata Street as well as an internal interconnecting road through the northern subdivision area between Acton Road and Roches Beach.

6.2 Operational Impact of Increased Traffic Activity

As determined in Section 5.1 of the report, the full development and occupancy of the proposed subdivision will generate a two way traffic

movement of around 4,875 vehicles/day and around 488 vehicles/hour during peak traffic periods external to the local road network within the subdivision.

As indicated earlier in this report, at this stage the development of the subdivision is expected to occur over the next 17 years. For reasons outlined in Section 5 of this report, the traffic assignments have targeted Year 2036.

The Acton Road and Ringwood Road junctions with South Arm Secondary Road are the most critical for the whole subdivision development as these will be the highest trafficked intersections. The next most trafficked junction will be the proposed new junction on Acton Road just to the north of the Lauderdale Primary School.

A SIDRA analysis was undertaken of the current performance of Acton Road/South Arm Secondary Road junction and Ringwood Road/South Arm Secondary Road junction using the traffic volumes in Figures 4.5 to 4.8.

The main outputs from this analysis have been summarised in Tables 6.1 and 6.2. The outputs indicate that while the Ringwood Road/South Arm Secondary Road junction is currently operating satisfactorily with maximum Level of Service D on the Ringwood Road approach during both peak hour periods, the Acton Road/South Arm Secondary Road junction is operating unsatisfactorily during both peak periods with Level of Service F and E on the Acton Road approach.

The addition of an auxiliary left turn lane on the western South Arm Secondary Road approach to the Acton Road junction will not provide any improvement to the situation.

TIME OF DAY/ SITUATION	APPROACH	WORST LEVEL OF SERVICE	DEGREE OF SAT	LONGEST QUEUE LENGTH (m)	HIGHEST APPROACH DELAY (sec)
8:00-9:00AM PEAK HOUR TRAFFIC 2016	Acton Road	F	0.87	48	56.8
	South Arm SR- east	A	0.34	6	7.7
	South Arm SR- west	A	0.19	0	6.4
4:45-5:45PM PEAK HOUR TRAFFIC 2016	Acton Road	E	0.57	17	38.8
	South Arm SR- east	B	0.14	3	12.2
	South Arm SR- west	A	0.47	0	6.5

Table 6.1: Outputs from SIDRA analysis for junction of South Arm Secondary Road and Acton Road in 2016 – current layout

TIME OF DAY/ SITUATION	APPROACH	WORST LEVEL OF SERVICE	DEGREE OF SAT	LONGEST QUEUE LENGTH (m)	HIGHEST APPROACH DELAY (sec)
8:00-9:00AM PEAK HOUR TRAFFIC 2016	Ringwood Road	D	0.52	17	26.1
	South Arm SR- south	A	0.38	0	7.0
	South Arm SR- north	A	0.15	0	6.4
4:45-5:45PM PEAK HOUR TRAFFIC 2016	Ringwood Road	D	0.43	12	30.4
	South Arm SR- south	B	0.16	0	11.9
	South Arm SR- north	A	0.49	0	6.5

Table 6.2: Outputs from SIDRA analysis for junction of South Arm Secondary Road and Ringwood Road in 2016 – current layout

The next realistic improvement to the South Arm Secondary Road/Acton Road junction management would be the addition of a roundabout control.

A roundabout with one traffic lane on each approach would provide the necessary improvements to the operation and delays with resultant Level of Service outputs of A and B for all the approaches.

The roundabout control will need to accommodate expected traffic movements well into the future. Therefore, the turning movement volumes from Figures 5.1 and 5.2, that were determined to pass through this junction in Year 2036 with the completion of the proposed subdivision development and allowing for other annual traffic growth in the region, were applied to the SIDRA model.

This analysis found that for a satisfactory outcome there will be a need to provide auxiliary approach lanes for the right turn movement from the eastern South Arm Secondary Road approach and left turn movement from Acton Road.

The SIDRA output for this roundabout arrangement are presented in Table 6.3.

There would be a further significant benefit if there also was an auxiliary left turn lane on the western South Arm Secondary Road approach to the junction with the roundabout installation.

Examination of the geometric characteristic of the current junction layout has indicated the roundabout at this junction would have an inscribed circle radius of up to 20m radius. There would be a need for some property acquisition and services relocation.

Discussions with DSG about the possible need for traffic management measures in the Lauderdale area as a result of the subdivision development

under consideration included some comparison of the costs of more recent roundabout installations at intersections on state roads.

Based on those discussions, it is considered the cost of reconstructing this junction with a roundabout control and auxiliary lanes is estimated to be at least $1.5m. This is the best estimate in the absence of any detailed design.

TIME OF DAY/ SITUATION	APPROACH	WORST LEVEL OF SERVICE	DEGREE OF SAT	LONGEST QUEUE LENGTH (m)	HIGHEST APPROACH DELAY (sec)
8:00-9:00AM PEAK HOUR TRAFFIC 2036	Acton Road	B	0.2	10	14.4
	South Arm SR- east	B	0.78	87	15.1
	South Arm SR- west	B	0.47	29	14.6
4:45-5:45PM PEAK HOUR TRAFFIC 2036	Acton Road	C	0.50	32	34.6
	South Arm SR- east	B	0.30	19	14.0
	South Arm SR- west	B	0.93	199	15.4

Table 6.3: Outputs from SIDRA analysis for junction of South Arm Secondary Road and Acton Road in 2036 - roundabout control, two lanes on east and north approach

In modelling the performance of the Ringwood Road/South Arm Secondary Road junction with the expected Year 2036 traffic (Figures 5.1 and 5.2), it was found there will be a need to also provide a roundabout control at this junction. The provision of auxiliary lanes on one or more of the approaches to a give way sign controlled junction will not provide the necessary operational and safety improvements.

The operational outputs from the SIDRA analysis with one lane approaches have been summarised in Table 6.4.

The geometric characteristics of the current junction layout indicate the roundabout at this junction would have an inscribed circle radius of up to around 15m radius. There may be a need for some minimal property acquisition and some relocation of services.

Again based on DSG discussions, it is considered the cost of installing a roundabout control at this junction is estimated to be around $0.9m. This is again the best estimate in the absence of any detailed design.

TIME OF DAY/ SITUATION	APPROACH	WORST LEVEL OF SERVICE	DEGREE OF SAT	LONGEST QUEUE LENGTH (m)	HIGHEST APPROACH DELAY (sec)
8:00-9:00AM PEAK HOUR TRAFFIC 2036	Ringwood Road	B	0.29	13	14.9
	South Arm SR- south	C	0.86	132	23.4
	South Arm SR- north	A	0.27	17	13.0
4:45-5:45PM PEAK HOUR TRAFFIC 2036	Ringwood Road	C	0.35	18	20.4
	South Arm SR- south	B	0.35	20	14.3
	South Arm SR- north	B	0.78	117	13.3

Table 6.4: Outputs from SIDRA analysis for junction of South Arm Secondary Road and Ringwood Road in 2036 - roundabout control, one lane approaches

The traffic volume passing through the junction of the new subdivisional road with Acton Road will be reasonably high with traffic conflict volumes up to 600 vehicles/hour while traffic conflicts at the Mannata Street junction with Ringwood Road will be up to 400 vehicles/hour in Year 2036.

A capacity analysis of these and other affected or new intersections within the subdivision development was considered not necessary as the level of traffic conflict will not be high enough to be of concern.

Traffic volumes of up to 1,500 vehicles/hour can generally be accommodated at intersections between conflicting traffic streams before operational issues begin to occur. The expected future conflicting traffic volumes at any of these subdivisional road intersections internally or with existing roads during peak traffic periods will be less than half of this traffic volume.

As outlined in Section 5 of this report, there are limits to the accuracy that future traffic growth can be predicted, particularly beyond 10 years. The need with this subdivision development is to predict the peak hour traffic volumes some 20 years or more from now.

In regard to the accuracy of the predictions of future traffic volumes, Austroads Guide to Traffic Management Part 12 states that when staging of a development exceeds five years, it is preferable to reassess the traffic impact closer to the time of implementation where other influences can be considered with greater certainty.

It would be appropriate for the Clarence City Council to request a future review of the traffic situation at the South Arm Secondary Road junctions in say 10 years time if progress with the development is slower than expected or if other major changes to the traffic circumstances have occurred in the meantime.

However, in view of the findings from the SIDRA analysis, no operational traffic issues will arise at any of the main intersections well beyond the expected completion of the whole subdivision if there is a commitment to the timely installation of the traffic controls on South Arm Secondary Road at Acton Road and Ringwood Road.

Impact of Woolworths Supermarket Development

It is understood planning approval exists for a Woolworths supermarket, bottle shop and specialty shops on the northeast corner of the South Arm Secondary Road/Ringwood Road junction. Access driveways to the site are proposed off South Arm Secondary Road and Ringwood Road.

GHD prepared a TIA report on this proposed development in 2012.

The GHD report did not provide discussion on any morning peak hour traffic impacts. This would be due to such developments normally having the highest traffic generation during the afternoon peak hour and minimal traffic activity during the morning peak hour. As a result, the development will have a negligible affect on the above findings in regard to the traffic operation at the South Arm Secondary Road junctions.

The TIA report determined it would generate 444 vehicles/hour during the afternoon peak hour. The report also defined the expected directional traffic distribution to and from the development site and the adjacent roads.

Assignment of the traffic to the adjacent roads has shown that much of the generated traffic in the afternoon peak hour will by-pass the South Arm Secondary Road/Ringwood Road junction when visiting the development site, travelling from South Arm Secondary Road (northern approach) to Ringwood Road or will be existing traffic along South Arm Secondary Road passing through this location that will visit the site. The assignment indicates that there will be around an additional 50 vehicles/hour through the junction on three different directional movements.

With the proposed roundabout traffic control at the junction, this additional traffic will have a minimal affect on the traffic operation of the junction. Average vehicle delays will increase by a fraction of a second and the 95th percentile queue on South Arm Secondary Road approaches will increase by 2-4m.

The supermarket development will therefore also be a negligible impact on the traffic operation at the South Arm Road/Acton Road junction.

6.3 Other Intersection and Road Improvements

South Arm Secondary Road

The above analysis has determined the required future improvements to the Acton Road and Ringwood Road junctions with South Arm Secondary Road.

The crash record along South Arm Secondary Road between the Acton Road and Ringwood Road junctions indicates that with increased traffic flow along the road, the potential for more rear end collisions will increase where there is no protected turning bay on South Arm Secondary Road at the frontage accesses.

It has been determined from DSG discussions that there are no current plans for any significant traffic management or safety improvements along the South Arm Secondary Road through Lauderdale. DSG does undertake ongoing monitoring of the safety performance of state roads.

If the safety record in this area becomes unacceptable, it would determine if there was a need and a priority for improvements such as widening the road to the north of the garden nursery to install median treatment where there are frontage accesses.

New Junction on Acton Road

The proposed new subdivisional access road junction on Acton Road will be located some 25m to the north of the access driveway to the Lauderdale Primary School main car park area.

The current volume of turning traffic activity at the school access junction before and after school is very high and the new junction will also have a reasonably high level of turning traffic.

The two junctions will be too close to ensure the safe movement of vehicles to and from both access roads without giving rise to adverse conflicts. It is therefore recommended that the design of the subdivisional road provide for the school car park to be accessed off the subdivisional road around 100m from Acton Road.

The conflict between right turning traffic and oncoming as well as passing vehicles on Acton road will be at a level requiring the installation of a CHR treatment on Acton road at the subdivisional road junction.

The cost of constructing this junction is estimated to be around $70,000.

Ringwood Road/Mannata Street junction

The future (Year 2036) traffic conflict at this junction is expected to be no more than 500 vehicles/hour during each peak hour.

As indicated earlier in this report, traffic volumes of up to 1,500 vehicles/hour can generally be accommodated at intersections between conflicting traffic streams. With the expected junction traffic conflict being no more than around one third of this volume, the junction will not experience any operational issues as a conventional T-junction.

It is proposed the future upgrade of this junction results in Ringwood Road being the continuing road into the subdivision development and Mannata Street forming a T-junction as the terminating road.

Mannata Street Roundabout

During site investigations it was noted there are currently a number of lots for sale and house construction is being undertaken on other lots along the northern side of Mannata Street in the area where the new intersection with a roundabout control is proposed.

Clarence City Council will need to ensure the required road reservation is preserved to allow the future road connection to be realised.

The cost of constructing this roundabout controlled intersection is estimated to be around $250,000.

Balook Street

As outlined in Section 4.2 of the report, Balook Street reduces in width from around 8.3m between Bangalee Street and Terrina Street to around 7.7m to the west of Terrina Street.

As this road will become the link road into the northern part of the proposed subdivision development the narrow section will need to be widened to 8.3m between kerb faces, consistent with the adjacent road standards.

The cost of the widening is estimated to be around $20,000.

New Junction on Bangalee Street

The road link to Bangalee Street at the south-eastern corner of the subdivision development is seen as a minor local street access which will provide access to the foreshore area. It should not provide any through road function.

The location of the new junction should be offset from Cabarita Street so as not to create a four leg intersection. The access could also be created simply as a convenient pedestrian access.

The cost of constructing this new junction is estimated to be around $50,000.

Construction Standard of Ringwood Road and Mannata Street

Ringwood Road currently has a width of around 5.7m with no kerb and gutter. With the completion of the subdivision development, it will carry at least 3,000 vehicles/day at the eastern end and over 4,500 vehicles/day at the western end.

With this traffic volume there will be a need to upgrade the road with kerb and gutter as well as footpaths both sides of the road and a width between kerb faces of 11.0m.

Mannata Street will also require upgrading but this is expected to occur with subdivision development of frontage properties.

It is proposed this road be also upgraded to a width of 11.0m between kerb faces.

With the upgrading of these roads, it would also be appropriate to install give way sign and supplementary pavement marking control at the junctions along Ringwood Road.

The cost of the upgrading of these two roads has been estimated at $1.2m.

6.4 Adequacy of Sight Distances at Intersections on Existing Roads

South Arm Secondary Road

No new intersections are proposed along South Arm Secondary Road. The Acton Road and Ringwood Road junctions with South Arm Secondary Road will require upgrading at some stage in the future and the design of the new junctions should address sight line safety considerations for the proposed treatments.

Acton Road

The new subdivisional road junction on Acton Road will be located on a straight section of Acton Road.

As can be appreciated from the views in Photographs 6.1 and 6.2, the available sight distances along Acton road will be at least 250m in each direction which is well over the required safe intersection sight distance of 150m for a speed environment of 70km/h based on Austroads guidelines.

Ringwood Road

The proposed new subdivisional road junction on Ringwood Road will be located around 200m from both the Ringwood Road/South Arm Secondary Road junction and the Ringwood Road/Mannata Street junction.

For the current 60km/h speed environment the required safe intersection sight distance is 123m, based on Austroads guidelines. Therefore, the available sight distances will be more than required.

Views along Ringwood Road from the proposed location for the junction are seen in Photographs 6.3 and 6.4.

Photograph 6.1: View to north along Acton Road from location of proposed new subdivisional road junction

Photograph 6.2: View to south along Acton Road from location of proposed new subdivisional road junction

Photograph 6.3: View to west along Ringwood Road from location of proposed new subdivisional road junction

Photograph 6.4: View to east along Ringwood Road from location of proposed new subdivisional road junction

Mannata Street

The proposed new subdivisional road junction on Mannata Street will be located around 230m to the west of the Mannata Street /Bangalee Street intersection. Mannata Street has a straight alignment to the east of the proposed intersection location but the road follows a curved horizontal alignment on a flat grade to the west of this location.

Views along Mannata Street from the proposed location for the intersection are seen in Photographs 6.5 and 6.6.

For the current 60km/h speed environment the required safe intersection sight distance is 123m based on Austroads guidelines. Therefore, the available sight distance to the east will be more than required.

It is estimated that to the west the sight distance will be around 110m which for a curved road approach to a signed roundabout control at the intersection will be quite sufficient provided there are no sight line obstructions within the road reservation.

Ringwood Road/Mannata Street junction

It is proposed the future upgrade of this junction with a continuing road into the subdivision development should result in Ringwood Road being the continuing road and Mannata Street forming the T-junction terminating road.

Views in Photographs 4.7 and 4.8 show the straight alignment of the roads on the existing approaches are over several hundred metres to the junction, such that sight distances will not be an issue.

Bangalee Street

A new minor local street junction is proposed off Bangalee Street opposite Cabarita Street.

The available sight lines along Bangalee Street at this location can be appreciated from the views in Photographs 6.7 and 6.8.

The available sight distances have determined to be around 100m to the north and around 90m to the south to the Bangalee Street/North Terrace junction.

These sight distances are sufficient for a 50km/h speed environment where required sight distances are 97m based on Austroads guidelines.

Photograph 6.5: View to east along Mannata Street from location of proposed new subdivisional road intersection

Photograph 6.6: View to west along Mannata Street from location of proposed new subdivisional road intersection

Photograph 6.7: View to north along Bangalee Street from location of new subdivisional road junction near Cabarita Street

Photograph 6.8: View to south along Bangalee Street from location of new subdivisional road junction near Cabarita Street

6.5 Internal Subdivisional Road Design and Traffic Environment

Consideration has been given to the proposed subdivisional road layout, the interconnection of the streets and the creation of a traffic environment that complements the expected amenity of the area, particularly along local residential streets and collector roads.

6.5.1 Subdivisional Road Layout

There are no concerns with the proposed subdivision road layout as detailed in the Development Layout Plan attached to this report.

The proposed internal road network will have a defined road hierarchy with a road connection between Acton Road and Roches Beach as well as north – south road connections to Ringwood Road – Mannata Street.

By 2036, the collector road through the northern subdivision to Acton Road is expected to be carrying up to around 2,300 vehicles/day, with full development and occupancy of all the lots in this area. The western end of Ringwood Road is expected to be carrying over 4,500 vehicles/day while the western end of Mannata Street is expected to be carrying around 2,500 vehicles/day.

No other street within the subdivision will carry over 2,000 vehicles/day.

A good aspect of the road network management is that all four leg intersections within the subdivision development site will have a roundabout. The layout of the streets will otherwise provide for fairly square T–junctions that will ensure vehicle priorities will be clear to road users.

While curved alignments are somewhat limited within the subdivision due to the area layout, the shorter length of the subdivisional streets will assist in providing for a more calmed speed environment throughout the subdivision development site.

Consideration has also been given to the configuration of the intersections along the subdivisional streets with respect to the adequacy of intersection sight distances.

This has established good junction sight lines will be available along the continuing street through the junctions for the expected speed environment; there will not be any intersection sight distance issues with the road network as proposed.

6.5.2 Geometric Road Design Standards

It is expected all new streets within the area of the subdivision development will be constructed to IPWEA geometric street design standards applicable at the time of development application.

6.6 Pedestrian and Bicycle Traffic Needs

The proposed street network within the subdivision development will provide for the safe movement of pedestrians and cyclists with footpaths along one or both sides of the subdivisional roads in accordance with Council Planning Scheme requirements and IPWEA standards.

It is not envisaged that pedestrian and vehicle numbers will be high enough to create a sufficient conflict which would justify the provision of any pedestrian refuge on other pedestrian crossing facilities along any of the subdivisional roads or adjacent existing roads.

There is a pedestrian and bicycle footpath along the eastern side of South Arm Secondary Road. There would be merit in extending this shared footpath along one side for the length of Ringwood Road – Mannata Street with a wider than normal footpath.

6.7 Public Transport Access Considerations

There are currently Metro Tasmania bus route services into Lauderdale and Roches Beach.

Route bus services run along the South Arm Secondary Road and enter into Lauderdale via South Terrace, Bangalee Street and Roches Beach Road and continue on via Acton Road to Seven Mile Beach, as detailed on the Metro route map and timetable included as Attachment B to this report.

For any new development the desirable maximum walking distance between any residential development and a bus route service is usually 400m.

In consulting Metro Tasmania about future bus route services into Lauderdale with the subdivision development under consideration, advice has been received that Metro Tasmania considers the existing route would, for the foreseeable future, provide appropriate coverage within a 500m walk distance to the subdivision and without undue effect on the access to services for existing housing areas.

This is premised on the expectation that there will be pedestrian access through the defined open space areas along the western side of the subdivision to access existing bus stops along South Arm Secondary Road.

Reviews of services would of course be considered over the extended time frame of the subdivision development.

The proposed subdivision development will be centrally located along the Ringwood Road - Mannata Street route and all new dwellings will be around 400m from this route.

The proposed upgrading of these roads will provide a road design standard suitable for a regular route bus service, should Metro Tasmania determine at some time into the future that bus services should include this route.

7. SUMMARY AND RECOMMENDATIONS

This Traffic Impact Assessment of the proposed residential subdivision development in Lauderdale has considered the current and future road and traffic environment in the area of the development site.

Average weekday traffic in September 2012 along the South Arm Secondary Road was 11,600 vehicles/day. It has further been estimated from recent peak hour surveys that the volume on Acton Road just north of the South Arm Secondary Road is around 5,300 vehicles/day and north of the Lauderdale Primary School would be around 4,000 vehicles/day while on Ringwood Road it would be around 2,500 vehicles/day.

A review of the crash history in the area has not found any locations of concern as a result of the historic crash record.

The objectives that were applied in the development of the road network for the subdivision areas were:

- Provision of at least two access roads to service each subdivisional area;

- Creation of a logical hierarchy of roads within the subdivision areas with internal collector roads connecting to the existing collector and the arterial roads;

- Not to create any new junctions unless absolutely necessary onto the main arterial roads, particularly the South Arm Secondary Road; and

- Installation of a roundabout control at any four leg intersection as being essential for safety.

The proposed subdivision development will create approximately 583 residential lots in the total development.

This development is expected to generate some 4,875 vehicles/day.

The subdivision area to the north of Ringwood Road – Mannata Street with some 299 lots will generate around 2,500 vehicles/day while the southern subdivision area with some 284 lots will generate around 2,375 vehicles/day.

Around 10% of this traffic volume or 488 vehicles/hour in total will occur in the morning and also afternoon peak hour.

A SIDRA analysis has been undertaken of the performance of Acton Road/South Arm Secondary Road junction and Ringwood Road/South Arm Secondary Road junction with the expected future traffic activity from the proposed subdivision development and allowing for annual growth for the surrounding area (Year 2036 traffic).

This analysis has found there will be a need to provide a roundabout control at this junction. For a satisfactory outcome there will be a need to provide

auxiliary approach lanes for the right turn movement from the eastern South Arm Secondary Road approach and left turn movement from Acton Road. There would be a further significant benefit if an auxiliary left turn lane was also provided on the western South Arm Secondary Road approach to the junction.

In modelling the performance of the Ringwood Road/South Arm Secondary Road junction with the expected Year 2036 traffic, it was found there will be a need to also provide a roundabout control at this junction. The provision of auxiliary lanes on one or more of the approaches to a give way sign controlled junction will not provide the necessary operational and safety improvements.

A capacity analysis of other affected or new intersections within the subdivision development was considered not necessary as the level of traffic conflict will not be high enough to be of concern.

Traffic volumes of up to 1,500 vehicles/hour can generally be accommodated at intersections between conflicting traffic streams. The expected future conflicting traffic volumes at any of these subdivisional road intersections internally or with existing roads during peak traffic periods will be less than half of this traffic volume.

Other recommended intersection and road improvements or actions are:

- Ongoing monitoring by DSG of the safety record along South Arm Secondary Road to the north of Ringwood Road with respect to the need for widening of the road to extend the median treatment northwards;

- The new subdivisional access road junction on Acton Road will be too close to the access driveway to the Lauderdale Primary School main car park area. To ensure the safe movement of vehicles to and from both access roads, it is recommended that the design of the subdivisional road provide for the school car park to be accessed off the subdivisional road around 100m from Acton Road. There will be a need for the installation of a CHR treatment on Acton road at the subdivisional road junction;

- Clarence City Council will need to ensure that the required road reservation is preserved to allow the future road connection to Mannata Street with the proposed roundabout control will be realised;

- Increase the width of the narrower western end of Balook Street to the west of Terrina Street from around 7.7m to 8.3m; consistent with the adjacent road standards;

- The location of the new junction at the south-eastern corner of the subdivision onto Bangalee Street should be offset from Cabarita Street so as not to create a four leg intersection. The access could also be created simply as a convenient pedestrian access;

- The future upgrade of the Ringwood Road/Mannata Street junction results in Ringwood Road being the continuing road into the subdivision

development and Mannata Street forming a T-junction as the terminating road;

- Ringwood Road will need to be upgraded with kerb and gutter as well as footpaths both sides of the road and a width between kerb faces of 11.0m;

- Mannata Street will also require upgrading to a width of 11.0m between kerb faces; this is expected to occur with subdivision development of frontage properties.

There are no concerns with the proposed subdivision road layout. The layout of the streets will provide for fairly square T–junctions that will ensure vehicle priorities are clear. Furthermore, all four leg intersections will be controlled with proposed roundabout installations.

Good junction sight lines will be available along the continuing road at all junctions for the expected speed environment.

It is expected all new street within the area of the subdivision development will be constructed to IPWEA geometric street design standards applicable at the time of development application.

Pedestrian and vehicle numbers will not be sufficiently high to create conflicts which would justify the provision of any pedestrian refuge on other pedestrian crossing facilities on any of the subdivisional roads or adjacent existing roads, other than where major intersection controls have been proposed.

There is a pedestrian and bicycle footpath along the eastern side of South Arm Secondary Road. There would be merit in extending this shared footpath along one side for the length of Ringwood Road – Mannata Street with a wider than normal footpath.

Metro Tasmania considers the existing route through Lauderdale would, for the foreseeable future, provide appropriate coverage within a 500m walk distance to the subdivision and without undue effect on the access to services for existing housing areas.

This is on the basis that there will be pedestrian access through the defined open space areas along the western side of the subdivision to access existing bus stops along South Arm Secondary Road.

Reviews of services would of course be considered over the extended time frame of the subdivision development.

The proposed subdivision development will be centrally located along the Ringwood Road - Mannata Street route and all dwellings will be around 400m from this route. The proposed upgrading of these roads will provide a road design standard suitable for a regular bus service should this be found to be necessary by Metro Tasmania into the future as the density of residential development increases.

Provided the above recommended improvements are addressed, due attention is given to the road network needs as outlined in the report and the proposed geometric standards for the subdivisional streets are agreed to, the subdivision development should be supported on traffic grounds.

ATTACHMENT A

Development Layout Plan

Big Loop Development Layout

LEGEND

- Study Area - 504,572m²
- Existing Property Boundaries
- Existing Retirement Viallage
- Existing Pump Station
- Open Drainage
- Culvert Drainage - Underground Box (600 x 2250)
- Existing Drainage Pipe (600 Diameter)
- Existing Pressure Sewer
- Existing Gravity Sewer
- Existing Shared Paths
- Tangara Trail
- Existing Public Open Space (POS)

Proposed Subdivision:

- Developable Area -364,046 m²
- YIELD - 583 lots
- Proposed Public Open Space (POS) - 14,640m²
- Open Space (Drainage/Encumbered) - 6,361m² (1.68%)
- Open Space (Unencumbered) - 8,279m² (2.19%)
- Area for Roads - 125,886m² (24.95%)
- Typical Road Width - 20m
- Road Width with Culvert - 25m
- Proposed Roundabout

Lot Sizes:

- 450-549m² - 134 lots
- 550-649m² - 286 lots
- 650-749m² - 109 lots
- 750m² + - 54 lots

0 250

N

ATTACHMENT B

Map and timetable of current route bus services in Lauderdale

Metro

Lauderdale - Oakdowns
Revised **3 February 2016**

634 Roches Beach to Hobart City

X34 Roches Beach to Hobart City EXPRESS

635 Seven Mile Beach to Hobart City

Also shows Routes **X44**, **X45** & **646**

Routes

634 **Roches Beach to Hobart City** via Lauderdale, Oakdowns, Shoreline Central & Rosny Park

X34 **Roches Beach to Hobart City EXPRESS** via Lauderdale, Oakdowns & Shoreline Central

635 **Seven Mile Beach to Hobart City** via Roches Beach, Lauderdale, Oakdowns, Shoreline Central & Rosny Park

Also shows Routes X44, X45 & 646 between Lauderdale & Hobart City. For full details, refer to separate timetable

Turn up and GO
Shoreline Central to Hobart City

Routes 634 & 635 combine with other services to operate approximately every **10 MINS** MONDAY TO FRIDAY between 7am and 7pm

Metro

For more information including timetables maps and fares

www.metrotas.com.au

13 22 01

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@metro_tasmania

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Be at your stop five minutes before your bus is due

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Hobart City Interchange
22 Elizabeth St, Hobart

8am to 6pm Monday to Friday
During daylight savings also open 9.30am to 2pm on Saturdays

13 22 01 between 7am and 7pm Monday to Friday

During daylight savings also available 9.30am to 2pm on Saturdays

634, X34, 635 from Seven Mile Beach & Roches Beach towards Hobart City

map ref	Monday to Friday Route number	634	634	X45	X34	646	635	X45	X44	X34	634	634	646	634	634	634
		am	am	am	am	am	am	am	am	am	am	am	am	am	am	pm
A	**Seven Mile Beach,** Surf Rd	-	-	-	-	-	7:15	-	-	-	-	-	-	-	-	-
B	**Lauderdale,** Roches Beach Rd	6:28	7:00	-	7:14	-	7:27	-	-	7:56	8:15	9:47	-	10:47	11:47	12:47
C	**Lauderdale,** Bayview Rd	-	-	-	-	-	-	-	-	-	8:21	-	-	-	-	-
D	**Lauderdale,** South Arm Rd Stop 79	6:34	7:06	7:13	7:20	7:25	7:33	7:48	7:49	8:02	p8:25	9:53	10:47	10:53	11:53	12:53
E	**Oakdowns,** Oakdowns Pde	6:38	7:11	-	7:26	-	7:40	-	-	8:09	8:30	9:57	-	10:57	11:57	12:57
F	South Arm Rd/Horsham Rd	6:40	7:13	7:17	7:28	7:29	7:42	7:53	7:54	8:11	8:32	9:59	10:51	10:59	11:59	12:59
G	**Shoreline Central**	6:50	7:24	7:23	7:40	7:38	7:54	s8:01	c8:01	8:23	8:43	10:09	10:59	11:09	12:09	1:09
H	Clarence St/Wentworth St	6:53	7:28	-	-	7:42	7:58	-	c	-	8:47	10:13	11:03	11:13	12:13	1:13
I	**Rosny Park Interchange** Stop E	6:59	7:35	-	-	7:49	8:06	-	-	-	8:55	10:20	11:10	11:20	12:20	1:20
J	**Hobart City,** Collins St	7:11	7:49	7:39	7:56	8:03	8:22	d8:19	8:17	8:38	9:08	10:31	-	11:31	12:31	1:31

map ref	Monday to Friday (cont...) Route number	634	646	634	634	634	646	634	634	634	634	634
		pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm
A	**Seven Mile Beach,** Surf Rd	-	-	-	-	-	-	-	-	-	-	-
B	**Lauderdale,** Roches Beach Rd	1:47	-	2:45	3:49	5:03	-	5:57	6:51	7:27	8:12	10:12
C	**Lauderdale,** Bayview Rd	-	-	-	-	-	-	-	-	-	-	-
D	**Lauderdale,** South Arm Rd Stop 79	1:53	2:47	2:51	3:55	5:09	5:23	6:03	6:57	7:32	8:17	10:17
E	**Oakdowns,** Oakdowns Pde	1:57	-	2:55	4:00	5:14	-	6:07	7:01	7:36	8:21	10:21
F	South Arm Rd/Horsham Rd	1:59	2:51	2:57	4:02	5:16	5:27	6:09	7:03	7:38	8:23	10:23
G	**Shoreline Central**	2:09	2:59	3:07	4:13	5:27	5:35	6:19	7:13	7:48	8:32	10:32
H	Clarence St/Wentworth St	2:13	3:03	3:11	4:17	5:31	5:39	6:22	7:16	7:51	8:35	10:35
I	**Rosny Park Interchange** Stop E	2:20	3:10	3:18	4:24	5:38	5:46	6:29	7:22	7:57	8:41	10:41
J	**Hobart City,** Collins St	2:31	-	3:31	4:37	5:51	-	6:40	7:32	8:07	8:51	10:51

map ref	Saturday Route number	635	634	635	646	634	635	634	635	634	635	634	635	634	646	635
		am	am	am	am	am	am	pm	pm	pm	pm	pm	pm	pm	pm	pm
A	**Seven Mile Beach,** Surf Rd	6:52	-	8:52	-	-	10:52	-	12:52	-	2:52	-	4:52	-	-	6:52
B	**Lauderdale,** Roches Beach Rd	7:03	8:03	9:03	-	10:03	11:03	12:03	1:03	2:03	3:03	4:03	5:03	6:03	-	7:03
D	**Lauderdale,** South Arm Rd Stop 79	7:10	8:10	9:10	10:06	10:10	11:10	12:10	1:10	2:10	3:10	4:10	5:10	6:10	6:37	7:10
E	**Oakdowns,** Oakdowns Pde	7:16	8:16	9:16	-	10:16	11:16	12:16	1:16	2:16	3:16	4:16	5:16	6:16	-	7:16
F	South Arm Rd/Horsham Rd	7:18	8:18	9:18	10:11	10:18	11:18	12:18	1:18	2:18	3:18	4:18	5:18	6:18	6:41	7:18
G	**Shoreline Central**	7:25	8:25	9:25	10:20	10:25	11:25	12:25	1:25	2:25	3:25	4:25	5:25	6:25	6:50	7:25
H	Clarence St/Wentworth St	7:28	8:28	9:28	10:23	10:28	11:28	12:28	1:28	2:28	3:28	4:28	5:28	6:28	6:53	7:28
I	**Rosny Park Interchange** Stop E	7:35	8:35	9:35	10:30	10:35	11:35	12:35	1:35	2:35	3:35	4:35	5:35	6:35	7:00	7:35
J	**Hobart City,** Collins St	7:45	8:45	9:45	-	10:45	11:45	12:45	1:45	2:45	3:45	4:45	5:45	6:45	-	7:45

map ref	Saturday (cont...) Route number	634	634
		pm	pm
A	**Seven Mile Beach,** Surf Rd	-	-
B	**Lauderdale,** Roches Beach Rd	8:25	10:12
D	**Lauderdale,** South Arm Rd Stop 79	8:31	10:18
E	**Oakdowns,** Oakdowns Pde	8:37	10:24
F	South Arm Rd/Horsham Rd	8:39	10:26
G	**Shoreline Central**	8:46	10:33
H	Clarence St/Wentworth St	8:49	10:36
I	**Rosny Park Interchange** Stop E	8:56	10:43
J	**Hobart City,** Collins St	-	10:53

map ref	Sunday & Public Holidays Route number	635	635	635	635	635	635
		am	am	pm	pm	pm	pm
A	**Seven Mile Beach,** Surf Rd	8:31	10:31	12:31	2:31	4:31	6:31
B	**Lauderdale,** Roches Beach Rd	8:43	10:43	12:43	2:43	4:43	6:43
D	**Lauderdale,** South Arm Rd Stop 79	8:50	10:50	12:50	2:50	4:50	6:50
E	**Oakdowns,** Oakdowns Pde	8:56	10:56	12:56	2:56	4:56	6:56
F	South Arm Rd/Horsham Rd	8:58	10:58	12:58	2:58	4:58	6:58
G	**Shoreline Central**	9:05	11:05	1:05	3:05	5:05	7:05
H	Clarence St/Wentworth St	9:08	11:08	1:08	3:08	5:08	7:08
I	**Rosny Park Interchange** Stop E	9:15	11:15	1:15	3:15	5:15	7:15
J	**Hobart City,** Collins St	-	-	-	-	-	-

Explanations

- Wheelchair accessible bus
- **c** On school days travels via Clarence St (refer route map, Express Bus Stops)
- **d** During school vacation, service arrives 2 minutes earlier
- **p** Service travels via Lauderdale Primary School on school days only
- **s** Service travels via MacKillop College on school days only

634, X34, 635 from Hobart City towards Roches Beach & Seven Mile Beach

map ref	Monday to Friday Route number	634	646	634	634	634	634	646	634	634	634	646	634	X45	X44	X34
		am	am	am	am	am	am	pm	pm	pm	pm	pm	pm	pm	pm	pm
J	**Hobart City Interchange** Stop B	-	-	-	-	-	-	-	-	-	-	-	-	4:15	4:30	4:36
J	**Hobart City Interchange** Stop A	7:26	-	8:57	9:57	10:57	11:57	-	12:57	1:57	2:57	3:28	4:01	-	-	-
I	**Rosny Park Interchange** Stop A	7:37	9:00	9:07	10:07	11:07	12:07	1:00	1:07	2:07	3:07	3:38	4:13	-	-	-
H	Clarence St/Wentworth St	7:42	9:05	9:12	10:12	11:12	12:12	1:05	1:12	2:12	3:13	3:44	4:19	-	-	-
G	**Shoreline Central**	7:46	9:09	9:16	10:16	11:16	12:16	1:09	1:16	2:16	3:18	3:49	4:24	4:32	4:47	4:53
F	South Arm Rd/Horsham Rd	7:54	9:16	9:25	10:25	11:25	12:25	1:16	1:25	2:25	3:30	3:56	4:34	4:38	4:53	5:01
E	**Oakdowns,**Oakdowns Pde	7:56	-	9:27	10:27	11:27	12:27	-	1:27	2:27	3:32	-	4:36	-	-	5:03
D	**Lauderdale,** South Arm Rd Stop 79	8:01	9:20	9:32	10:32	11:32	12:32	1:20	1:32	2:32	3:37	4:01	4:41	4:42	4:57	5:10
B	**Lauderdale,** Roches Beach Rd	8:08	-	9:39	10:39	11:39	12:39	-	1:39	2:39	3:45	-	4:48	-	-	5:17
	Journey continues to	-	Obay	-	-	-	-	Obay	-	-	-	Obay	-	ClBch	Obay	-

map ref	Monday to Friday (cont...) Route number	634	X45	X34	X44	634	634	646	634	634	634
		pm	pm	pm	pm	pm	pm	pm	pm	pm	pm
J	**Hobart City Interchange** Stop B	-	5:15	5:27	5:30	-	-	-	-	-	-
J	**Hobart City Interchange** Stop A	5:01	-	-	-	6:00	6:38	-	7:30	9:30	f11:30
I	**Rosny Park Interchange** Stop A	5:13	-	-	-	6:10	6:48	6:50	7:40	9:40	f11:40
H	Clarence St/Wentworth St	5:19	-	-	-	6:16	6:53	6:55	7:44	9:44	f11:44
G	**Shoreline Central**	5:24	5:32	5:44	5:47	6:21	6:57	6:59	7:48	9:48	f11:48
F	South Arm Rd/Horsham Rd	5:34	5:38	5:52	5:53	6:30	7:06	7:06	7:56	9:56	f11:56
E	**Oakdowns,**Oakdowns Pde	5:36	-	5:54	-	6:32	7:08	-	7:58	9:58	f11:58
D	**Lauderdale,** South Arm Rd Stop 79	5:41	5:42	6:01	5:57	6:37	7:13	7:10	8:03	10:03	f12:03
B	**Lauderdale,** Roches Beach Rd	5:48	-	6:07	-	6:44	7:19	-	8:09	10:09	f12:09
	Journey continues to	-	ClBch	-	Obay	-	-	Obay	-	-	-

map ref	Saturday Route number	646	634	635	634	635	634	635	634	635	646	634	635	634	634	634
		am	am	am	am	am	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm
J	**Hobart City Interchange** Stop B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
J	**Hobart City Interchange** Stop A	-	8:55	9:55	10:55	11:55	12:55	1:55	2:55	3:55	-	4:55	5:55	-	9:30	11:30
I	**Rosny Park Interchange** Stop A	8:25	9:05	10:05	11:05	12:05	1:05	2:05	3:05	4:05	4:48	5:05	6:05	7:43	9:40	11:40
H	Clarence St/Wentworth St	8:30	9:10	10:10	11:10	12:10	1:10	2:10	3:10	4:10	4:53	5:10	6:10	7:48	9:44	11:44
G	**Shoreline Central**	8:34	9:14	10:14	11:14	12:14	1:14	2:14	3:14	4:14	4:57	5:14	6:14	7:52	9:48	11:48
F	South Arm Rd/Horsham Rd	8:42	9:22	10:22	11:22	12:22	1:22	2:22	3:22	4:22	5:05	5:22	6:22	7:59	9:56	11:56
E	**Oakdowns,**Oakdowns Pde	-	9:24	10:24	11:24	12:24	1:24	2:24	3:24	4:24	-	5:24	6:24	8:01	9:58	11:58
D	**Lauderdale,** South Arm Rd Stop 79	8:48	9:31	10:31	11:31	12:31	1:31	2:31	3:31	4:31	5:11	5:31	6:31	8:07	10:03	12:03
B	**Lauderdale,** Roches Beach Rd	-	9:38	10:38	11:38	12:38	1:38	2:38	3:38	4:38	-	5:38	6:38	8:13	10:09	12:09
A	**Seven Mile Beach,** Surf Rd	-	-	10:49	-	12:49	-	2:49	-	4:49	-	-	6:49	-	-	-
	Journey continues to	Obay	-	-	-	-	-	-	-	-	Obay	-	-	-	-	-

map ref	Sunday & Public Holidays Route number	635	635	635	635	635
		am	am	pm	pm	pm
J	**Hobart City Interchange** Stop B	-	-	-	-	-
J	**Hobart City Interchange** Stop A	-	-	-	-	-
I	**Rosny Park Interchange** Stop A	9:31	11:31	1:31	3:31	5:31
H	Clarence St/Wentworth St	9:36	11:36	1:36	3:36	5:36
G	**Shoreline Central**	9:40	11:40	1:40	3:40	5:40
F	South Arm Rd/Horsham Rd	9:48	11:48	1:48	3:48	5:48
E	**Oakdowns,**Oakdowns Pde	9:50	11:50	1:50	3:50	5:50
D	**Lauderdale,** South Arm Rd Stop 79	9:57	11:57	1:57	3:57	5:57
B	**Lauderdale,** Roches Beach Rd	10:04	12:04	2:04	4:04	6:04
A	**Seven Mile Beach,** Surf Rd	10:15	12:15	2:15	4:15	6:15
	Journey continues to	-	-	-	-	-

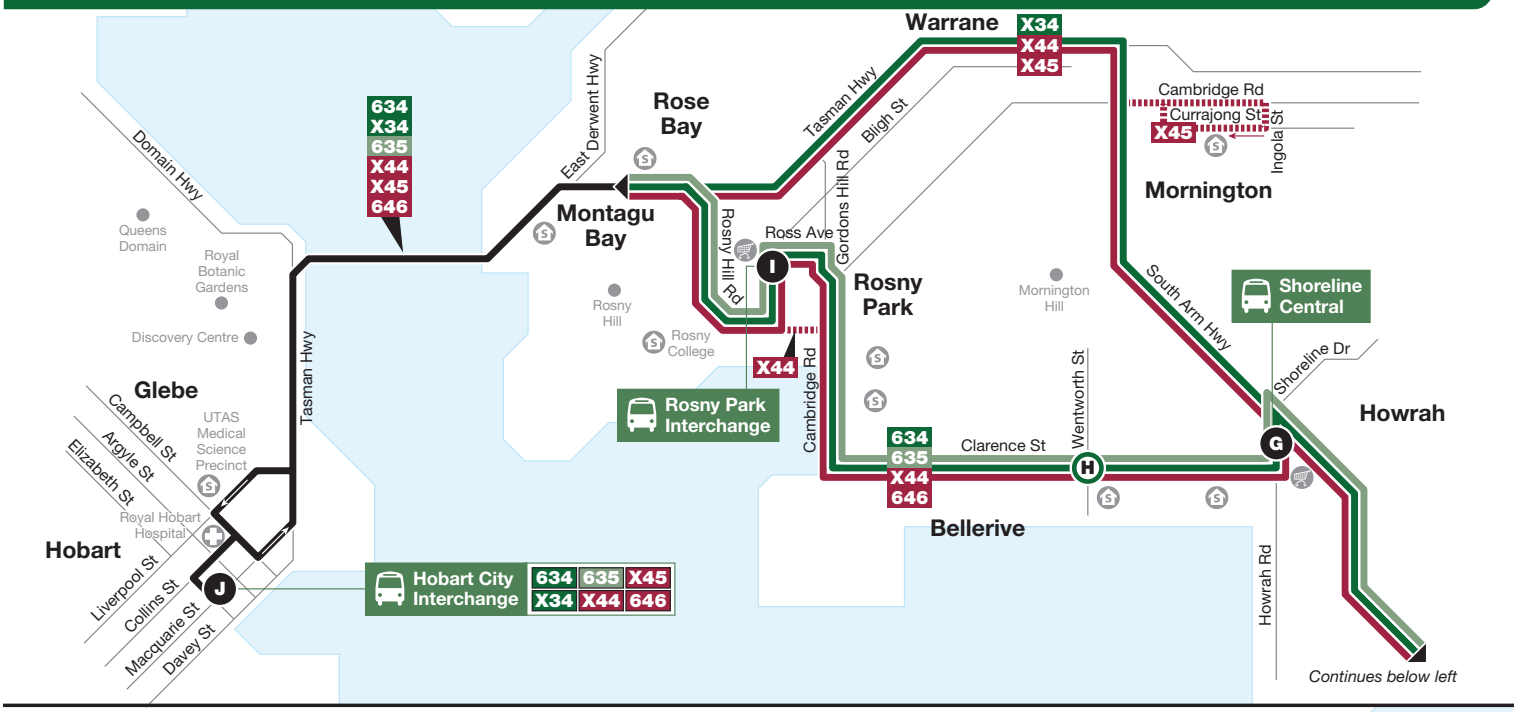
Explanations

Wheelchair accessible bus
f Service operates on Friday nights only

Journey continues to

ClBch Clifton Beach (for more details, see South Arm timetable)
Obay Opossum Bay (for more details, see South Arm timetable)

Route Map 634, X34, 635



Legend

- Routes 634, X34
- Route 635
- Routes X44, X45, 646
- Variant of route
- Timing point
- Interchange
- Hospital
- Educational institution
- Shopping centre
- Point of interest

N

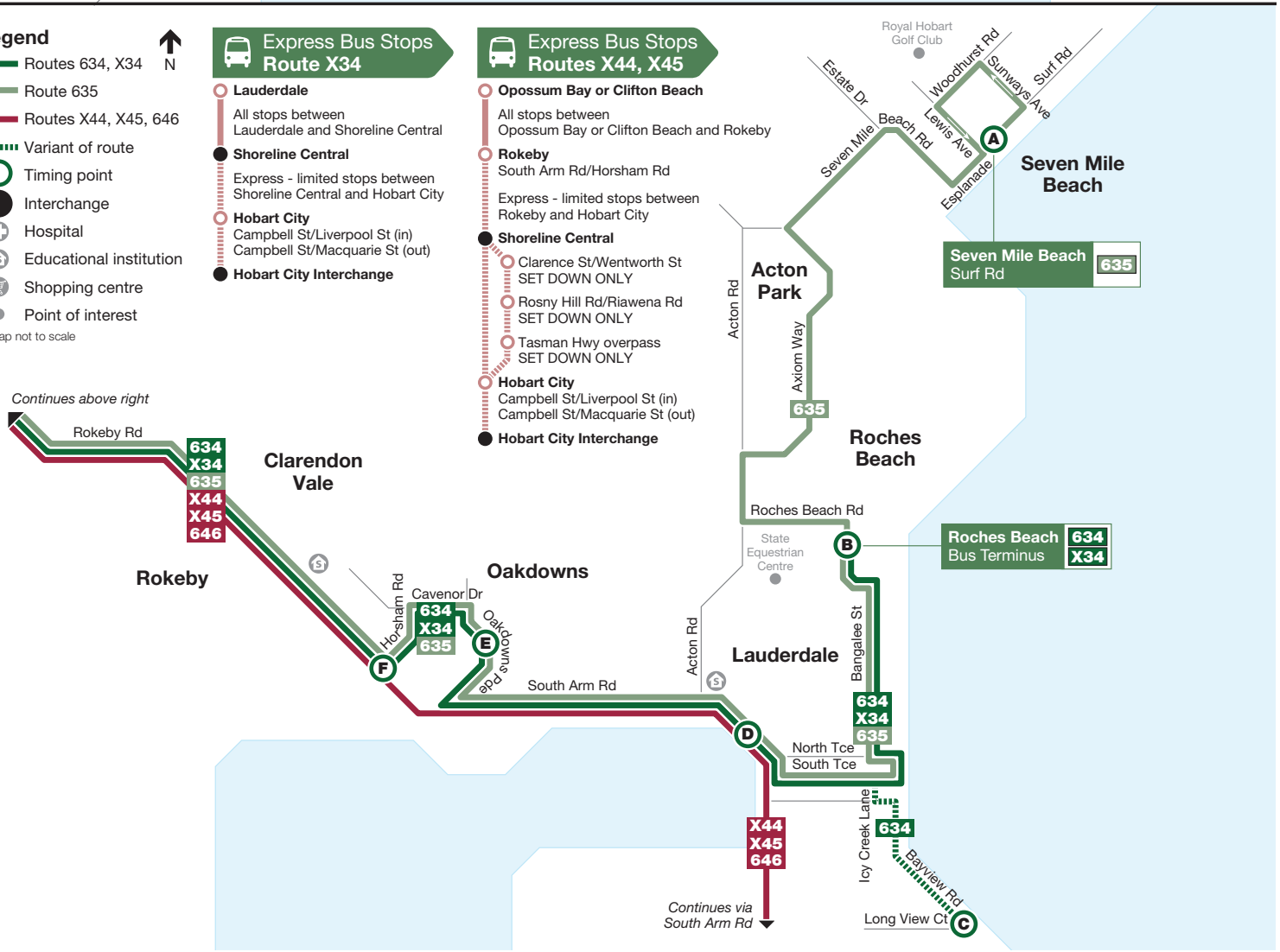
Map not to scale

Express Bus Stops Route X34

- **Lauderdale**
  All stops between Lauderdale and Shoreline Central
- **Shoreline Central**
  Express - limited stops between Shoreline Central and Hobart City
- **Hobart City**
  Campbell St/Liverpool St (in)
  Campbell St/Macquarie St (out)
- **Hobart City Interchange**

Express Bus Stops Routes X44, X45

- **Opossum Bay or Clifton Beach**
  All stops between Opossum Bay or Clifton Beach and Rokeby
- **Rokeby**
  South Arm Rd/Horsham Rd
  Express - limited stops between Rokeby and Hobart City
- **Shoreline Central**
  - Clarence St/Wentworth St SET DOWN ONLY
  - Rosny Hill Rd/Riawena Rd SET DOWN ONLY
  - Tasman Hwy overpass SET DOWN ONLY
- **Hobart City**
  Campbell St/Liverpool St (in)
  Campbell St/Macquarie St (out)
- **Hobart City Interchange**



APPENDIX C

Concept Lot Layout

WSUD Development Layout

LEGEND

- Study Area - 504,572m²
- Existing Property Boundaries
- Existing Retirement Viallage
- Existing Pump Station (constraint)
- Open Drainage
- Culvert Drainage Underground Box (600 x 2250)
- Existing Drainage Pipe (600 Diameter)
- Existing Pressure Sewer - possible to realign but at $400/m
- Existing Gravity Sewer - possible to realign but at $500/m
- Existing Shared Paths
- Tangara Trail
- Existing Public Open Space (POS)

Proposed Subdivision:

- Developable Area -376,006m²
- YIELD - 500
- Proposed Public Open Space (POS) - 17,799m²
- Open Space (Drainage/Encumbered) - 13,271m²/3.53%
- Open Space (Unencumbered) - 4,528m²/1.2%
- Area for Roads - 110,767m²
- Typical Road Width - 20m
- Road Width with Culvert - 25m

Lot Sizes:

Ordinary Lot sizes range from 650 - 1,000m²

Corner Lots range from 550 - 1,000m²

Lots adjoining/opposite POS or within 200m² of a business zone or local shop range from 400 - 600m²

0 250

N

Cul-de-sac Development Layout

LEGEND

- Study Area - 504,572m²
- Existing Property Boundaries
- Existing Retirement Viallage
- Existing Pump Station (constraint)
- Open Drainage
- Culvert Drainage Underground Box (600 x 2250)
- Existing Drainage Pipe (600 Diameter)
- Existing Pressure Sewer - possible to realign but at $400/m
- Existing Gravity Sewer - possible to realign but at $500/m
- Existing Shared Paths
- Tangara Trail
- Existing Public Open Space (POS)

Proposed Subdivision:

- Developable Area -387,728 m²
- YIELD - 469
- Proposed Public Open Space (POS) - 14,869m²
- Open Space (Drainage/Encumbered) - 8,646m²/2.23%
- Open Space (Unencumbered) - 6,223m²/1.6%
- Area for Roads - 101,975m²
- Typical Road Width - 20m
- Road Width with Culvert - 25m

Lot Sizes:

Ordinary Lot sizes range from 650 - 1,000m²

Corner Lots range from 550 - 1,000m²

Lots adjoining/opposite POS or within 200m² of a business zone or local shop range from 400 - 600m²

N

0 250

Big Loop Development Layout

LEGEND

- Study Area - 504,572m²
- Existing Property Boundaries
- Existing Retirement Viallage
- Existing Pump Station
- Open Drainage
- Culvert Drainage - Underground Box (600 x 2250)
- Existing Drainage Pipe (600 Diameter)
- Existing Pressure Sewer
- Existing Gravity Sewer
- Existing Shared Paths
- Tangara Trail
- Existing Public Open Space (POS)

Proposed Subdivision:

- Developable Area -364,046 m²
- YIELD - 583 lots
- Proposed Public Open Space (POS) - 14,640m²
- Open Space (Drainage/Encumbered) - 6,361m² (1.68%)
- Open Space (Unencumbered) - 8,279m² (2.19%)
- Area for Roads - 125,886m² (24.95%)
- Typical Road Width - 20m
- Road Width with Culvert - 25m
- Proposed Roundabout

Lot Sizes:

- 450-549m² - 134 lots
- 550-649m² - 286 lots
- 650-749m² - 109 lots
- 750m² + - 54 lots

0 250

N

APPENDIX D

Lot Price Analysis

Address	Suburb	Market Segment	View	Size	Sold price	Date of sale	Year of Sale	Value psm
12 Saladin Circle Clarendon Vale	Clarendon Vale	Lower	N	667	30600	17-11-2015	2015	45.87706147
1 Eve Court Clarendon Vale	Clarendon Vale	Lower	N	680	37500	6-05-2016	2016	55.14705882
7 Launde Avenue Clarendon Vale	Clarendon Vale	Lower	N	768	32500	27-01-2012	2012	42.31770833
5 Carslake Street Clarendon Vale	Clarendon Vale	Lower	N	826	50000	23-09-2010	2010	60.53268765
142 Rockingham Drive Clarendon Val	Clarendon Vale	Lower	N	1032	67800	3-11-2010	2010	65.69767442
152a Tranmere Road Howrah	Howrah	Middle Top	N	500	115000	22-08-2012	2012	230
17 Hance Road Howrah	Howrah	Middle Top	N	521	128000	26-09-2014	2014	245.681382
10 Betsy Mack Place Howrah	Howrah	Middle Top	N	601	110000	3-11-2011	2011	183.0282862
72 Hance Rd Howrah	Howrah	Middle Top	N	694	140000	13-08-2015	2015	201.7291066
12 Highclere Court Howrah	Howrah	Middle Top	N	696	120000	15-06-2011	2011	172.4137931
4 Chaplains Court Howrah	Howrah	Middle Top	N	842	137000	18-08-2014	2014	162.7078385
126 Balook Lauderdale	Lauderdale	Middle Top	N	622	245,000	4-04-2016	2016	393.8906752
28 Cavenor Drive Oakdowns	Oakdowns	Middle Top	N	490	110000	7-01-2011	2011	224.4897959
14a Vasili Court Oakdowns	Oakdowns	Middle Top	N	550	100000	29-01-2015	2015	181.8181818
21 Cavenor Drive Oakdowns	Oakdowns	Middle Top	N	698	115000	19-06-2012	2012	164.756447
23 Horsham Road Oakdowns	Oakdowns	Middle Top	N	705	126500	15-07-2011	2011	179.4326241
27 Ivy Close Oakdowns	Oakdowns	Middle Top	N	780	125000	27-05-2015	2015	160.2564103
30 Cavenor Drive Oakdowns	Oakdowns	Middle Top	N	810	165000	1-11-2011	2011	203.7037037
4 Kernot Close Oakdowns	Oakdowns	Middle Top	N	897	115000	31-05-2010	2010	128.2051282
49 Mariah Crescent Oakdowns	Oakdowns	Middle Top	N	948	130000	16-02-2012	2012	137.1308017
Lot 6 Knopwood Estate Rokeby (aka	Rokeby	Lower	N	518	102000	22-12-2015	2015	196.9111969
11 Hookey Place Rokeby	Rokeby	Lower	N	656	42000	20-10-2012	2012	64.02439024
12 Grange Road West Rokeby	Rokeby	Lower	N	660	66900	3-05-2010	2010	101.3636364
14 Parsonage Place Rokeby	Rokeby	Lower	N	705	80000	8-01-2013	2013	113.4751773
10 Emmaline Court Rokeby	Rokeby	Lower	N	715	86000	6-03-2015	2015	120.2797203
2 Benboyd Circle Rokeby	Rokeby	Lower	N	761	42000	16-04-2013	2013	55.19053876
55 Cavenor Drive Rokeby	Rokeby	Lower	N	972	115000	12-08-2013	2013	118.3127572
57 Cavenor Drive Rokeby	Rokeby	Lower	N	1016	115000	8-08-2013	2013	113.1889764
60a Tranmere Rd Howrah	Howrah	Middle Top	Y	426	160000	3-02-2015	2015	375.5868545
242 Carella St Howrah	Howrah	Middle Top	Y	627	161600	26-08-2015	2015	257.7352472

Address	Suburb	Market Segment	View	Size	Sold price	Date of sale	Year of Sale	Value psm
15 Fairisle Terrace Howrah	Howrah	Middle Top	Y	641	187500	21-02-2014	2014	292.5117005
256 Carella Street Howrah	Howrah	Middle Top	Y	670	165000	8-09-2014	2014	246.2686567
6 Beebo Place Howrah	Howrah	Middle Top	Y	818	175000	19-08-2011	2011	213.9364303
625 Oceana Drive Howrah	Howrah	Middle Top	Y	900	165000	13-05-2013	2013	183.3333333
589 Oceana Dr Howrah	Howrah	Middle Top	Y	938	215000	22-12-2015	2015	229.2110874
18 Skyline Drive Howrah	Howrah	Middle Top	Y	989	265000	15-07-2014	2014	267.9474216
608 Oceana Drive Howrah	Howrah	Middle Top	Y	998	245000	11-08-2014	2014	245.490982
6 Skyline Drive Howrah	Howrah	Middle Top	Y	1094	120000	30-05-2014	2014	109.6892139
172 Bayview St Lauderdale	Lauderdale	Middle Top	Y	568	180000	19-02-2016	2016	316.9014085
47 Bayview St Lauderdale	Lauderdale	Middle Top	Y	1428	385000	26-11-2015	2015	269.6078431
Lot 82 Millview Drive Oakdowns (5 B	Oakdowns	Middle Top	Y	472	105000	13-03-2015	2015	222.4576271
Lot 134 Millview Drive Oakdowns	Oakdowns	Middle Top	Y	540	110000	6-10-2014	2014	203.7037037
Lot 133 Millview Drive Oakdowns	Oakdowns	Middle Top	Y	540	110000	13-02-2015	2015	203.7037037
Lot 118 (now 23) Vasili Court Oakdo	Oakdowns	Middle Top	Y	652	110000	18-08-2014	2014	168.7116564
46 Millview Drive Oakdowns	Oakdowns	Middle Top	Y	775	142000	15-02-2015	2015	183.2258065
Lot 75 Millview Drive Oakdowns	Oakdowns	Middle Top	Y	818	135000	13-04-2015	2015	165.0366748
9 Emmaline Court Oakdowns	Oakdowns	Middle Top	Y	1020	92000	1-09-2014	2014	90.19607843
Lot 76 Millview Drive Oakdowns (14 I	Oakdowns	Middle Top	Y	1161	135000	13-03-2015	2015	116.2790698
Lot 68 Millview Drive Oakdowns	Oakdowns	Middle Top	Y	1583	130000	17-12-2015	2015	82.12255212
33 Emmaline Court Rokeby	Rokeby	Lower	Y	505	90000	27-04-2015	2015	178.2178218
215 Tollard Drive Rokeby	Rokeby	Lower	Y	596	112000	10-09-2015	2015	187.9194631
21 Emmaline Court Rokeby	Rokeby	Lower	Y	848	66000	2-07-2014	2014	77.83018868
2 Annabelle Street Rokeby	Rokeby	Lower	Y	1247	80000	12-12-2014	2014	64.15396953
17 Pindos Drive Tranmere	Tranmere	Top	Y	425	180000	20-01-2015	2015	423.5294118
633A Oceana Drive Tranmere	Tranmere	Top	Y	464	160000	18-06-2014	2014	344.8275862
635 Oceana Drive Tranmere	Tranmere	Top	Y	492	155000	21-10-2013	2013	315.0406504
35 Emmaline Court Tranmere	Tranmere	Top	Y	504	75500	21-03-2014	2014	149.8015873
25 Vaughn Court Tranmere	Tranmere	Top	Y	695	187000	13-08-2013	2013	269.0647482
275 Carella Street Tranmere	Tranmere	Top	Y	756	145000	4-11-2010	2010	191.7989418
643 Oceana Drive Tranmere	Tranmere	Top	Y	899	185000	16-12-2014	2014	205.7842047

Address	Suburb	Market Segment	View	Size	Sold price	Date of sale	Year of Sale	Value psm
671 Oceana Drive Tranmere	Tranmere	Top	Y	900	200000	9-06-2014	2014	222.2222222
3 Intrigue Court Tranmere	Tranmere	Top	Y	903	195000	30-09-2015	2015	215.9468439
686 Oceana Drive Tranmere	Tranmere	Top	Y	920	225000	23-10-2014	2014	244.5652174
21 Regatta Place Tranmere	Tranmere	Top	Y	922	242000	17-05-2016	2016	262.472885
36 Spinnaker Crescent Tranmere	Tranmere	Top	Y	925	192000	17-07-2009	2009	207.5675676
564 Oceana Drive Tranmere	Tranmere	Top	Y	996	210000	29-04-2014	2014	210.8433735
566 Oceana Drive Tranmere	Tranmere	Top	Y	1001	190000	17-12-2012	2012	189.8101898
41 Spinnaker Crescent Tranmere	Tranmere	Top	Y	1048	150000	30-04-2015	2015	143.129771
1 Reliance Court Tranmere	Tranmere	Top	Y	1139	196000	28-01-2016	2016	172.0807726
19 Vitesse Court Trasnmere	Tranmere	Top	Y	1188	245000	26-03-2016	2016	206.2289562
8 Anchorage Cout Tranmere	Tranmere	Top	Y	1200	210000	15-05-2015	2015	175
7 Anchorage Court Tranmere	Tranmere	Top	Y	1209	185000	10-07-2013	2013	153.019024
6 Intrigue Court Tranmere	Tranmere	Top	Y	1299	190000	26-03-2015	2015	146.2663587
738 Oceana Drive Tranmere	Tranmere	Top	Y	1550	238000	8-11-2014	2014	153.5483871
955 Oceana Drive Tranmere	Tranmere	Top		1080	225000	2-12-2015	2015	208.3333333

ANALYSIS

	Price per square metre			
Middle Top (no views)	197.884711			
Middle Top (views)	211.602717			
All Middle Top	204.743714			
Range	82.1225521	393.890675	Median	202.7164
Oakdowns (no views)	172.474137			
Oakdowns (views)	159.492986			
Oakdowns (all)	165.983561			
Range	82.1225521	224.489796	Median	174.0721
Lower (no views)	88.6398911			
Lower (views)	127.030361	only four)		
Lower (all)	107.835126			
Range	42.3177083	196.911197	Median	77.83019
Top (no views)	N/A			
Top (views)	218.676456			
Top (all)	218.676456			
Range	143.129771	423.529412	Median	206.8983

MIDDLE TOP EXCLUDING OAKDOWNS

Lots under 650	286.916944	8 results from 2011-2016	172150.2
Lots over 650	209.303246	11 results from 2011-2015	140233.2
Overall	248.110095		161271.6

Market Segment Price per m2

	Minimum	Maximum	Median	Average	Average (no views	Average (views)
Lower	42.318	196.91	77.83	107.84	88.64	127.03
Middle Top	82.123	393.89	201.73	204.86	198.11	211.6
Top	143.13	423.53	206.9	218.68	N/A	218.68

Middle Top (excluding Oakdowns)

Lot Size	Price per square	Notes
Lots under 650	286.9169442	8 results from 2011-2016
Lots over 650	209.3032461	11 results from 2011-2015
Overall	248.1100952	

Lauderdale Estimated Lot Value

Lot Size	Average	Minimum	Maximum	650 lot	Average +10%
Lots under 650	286.92	129114	186211.08	186498	205147.8
Lots over 650	209.3	136045	209300	136045	149649.5
Overall	248.11	111649.5	248110	161271.5	177398.65

APPENDIX E

Construction Cost Estimate

Johnstone McGee & Gandy
incorporating Dale P Luck & Associates

117 Harrington Street, Hobart. 7000
Phone (03)6231 2555 Fax (03) 6231 1535
Email : infohbt@jmg.net.au

Offices also in Launceston

Engineers & Planners

CIVIL WORKS SCHEDULE

Project: Lauderdale Urban Expansion Feasibility
Subject: Preliminary Construction Schedule
Date: 04-10-16
Contract No. J153075PH
Revision: 3
Basis of Schedule: Big Loop Concept (revised)
Sheet No. 5
Estimator: Mat Clark
Reviewer: Chris Males

Item No.	Description	Quantity	Unit	Rate	Amount
1.0	SITE ESTABLISHMENT / EARTHWORKS				
1.01	Site Establishment.	583	No.	$500	$291,500
1.02	Location of all underground services	583	No.	$100	$58,300
1.03	Costs associated with compliance with all other Council and Authority conditions including inspections and testing	583	No.	$1,000	$583,000
1.04	Remove existing buildings and make good site	17	No.	$40,000	$680,000
1.05	Supply fill to 3m AHD (North)	185000	m3	$20	$3,700,000
1.06	Lay and compact fill to 3m AHD (North)	185000	m3	$10	$1,850,000
1.07	Supply fill to 3m AHD (South)	450000	m3	$20	$9,000,000
1.08	Lay and compact fill to 3m AHD (South)	450000	m3	$10	$4,500,000
1.09	Trim and shape fill to road subgrade level	69360	m2	$5	$346,800
	SITE ESTABLISHMENT / EARTHWORKS SUB TOTAL :				$21,009,600
2.0	STORMWATER				
2.01	Excavate in all materials, supply, bed and lay DN225 upvc SN8	900	m	$115	$103,500
2.02	Excavate in all materials, supply, bed and lay DN300 stormPRO.	2750	m	$125	$343,750
2.03	Excavate in all materials, supply, bed and lay DN375 stormPRO.	700	m	$150	$105,000
2.04	Excavate in all materials, supply, bed and lay DN450 stormPRO.	375	m	$200	$75,000
2.05	Excavate in all materials, supply, bed and lay DN525 stormPRO.	275	m	$300	$82,500
2.06	Excavate in all materials, supply, bed and lay DN600 stormPRO.	150	m	$400	$60,000
2.07	Supply and install Grated Side Entry Pit in accordance with IPWEA Std Drg's		No.	$3,000	
2.08	Supply and install grated pit at end swales in accordance with IPWEA Std Drg's	110	No.	$3,000	$330,000

Item No.	Description	Quantity	Unit	Rate	Amount
2.09	Supply and install DN1050 manhole in accordance with IPWEA Std Drg TSD-SW02-v1 with Class B Gatic cover and surround	85	No.	$2,500	$212,500
2.1	Supply and install DN100 x 3m long Sub-soil drain starters to uphill side of pits, manholes and headwalls	210	No.	$60	$12,600
2.11	Supply and install Sub-soil drains to IPWEA Std Drg TSD-R12-v1 to rear of kerb	13870	m	$35	$485,450
2.12	Supply and install DN100 uPVC Lot Connection (5m long) including 450 x 450 RCP bubble pit in driveway	299	No.	$500	$149,500
2.13	Supply and install DN100 uPVC Lot Connection (1m long) in back yard	284	No.	$200	$56,800
2.14	Supply and install 2.7m x 0.6m box culvert from reserve to Ringwood Road	290	m	$2,510	$727,900
2.15	Supply and install 3.0m x 0.6m box culvert from Ringwood Road under RBL	190	m	$2,680	$509,200
2.16	Supply and install 4.5m x 0.6m box culvert from RBL to Ralphs Bay	400	m	$3,930	$1,572,000
2.17	Supply and install 3.9m x 0.6m box culvert from Mannata Street to outfall in Canal	500	m	$3,760	$1,880,000
2.18	Procure easement through 52 North Terrace	1	Item	$50,000	$50,000
2.19	Extra over for box culvert under South Arm Highway and North Terrace	2	No.	$20,000	$40,000
2.2	New outfall from box culverts	2	No.	$10,000	$20,000
2.21	Construct 6m wide grass swales	6650	m	$120	$798,000
				STORMWATER SUB TOTAL :	$7,613,700
3.0	SEWER				
3.01	Excavate in all materials, supply, bed and lay DN150 uPVC SN8 up to 3m deep	2600	m	$115	$299,000
3.02	Supply and install DN1050 manhole in accordance with WSAA Std Drg SEW-1300-V Type P2 with Class B Gatic Cover and Surround	40	No.	$3,000	$120,000
3.03	Supply and install DN1050 manhole in accordance with WSAA Std Drg SEW-1300-V Type P2 with Class D Gatic Cover and Surround	15	No.	$3,200	$48,000
3.04	Supply and install DN150 uPVC Property Connection in accordance with WSAA Std Drg SEW-1106	155	No.	$200	$31,000
3.05	Excavate in all materials, supply, bed and lay DN63 to 160 poly pressure sewer lines including valves	7000	m	$120	$840,000
3.06	Excavate in all materials, supply, bed and lay DN40 pressure sewer property branches average 10m long. Includes PS boundary kit	428	No.	$1,200	$513,600
3.07	Supply and install complete pressure sewer unit including control panel	428	No.	$12,000	$5,136,000
3.08	Additional 11kL emergency storage at 488 South Arm Road SPS including wash down etc.	1	Item	$40,000	$40,000
3.09	Additional 91kL emergency storage at 36 Mannata Street SPS including wash down etc.	1	Item	$120,000	$120,000
3.1	Raise SPS at 488 South Arm Road from 2.2m to 3.3m AHD	1	Item	$60,000	$60,000
				SEWER SUB TOTAL :	$7,207,600

Item No.	Description	Quantity	Unit	Rate	Amount
4.0	WATER				
4.01	Excavate in all materials, supply, bed and lay DN100 PVC.	4000	m	$65	$260,000
4.02	Excavate in all materials, supply, bed and lay DN150 PVC.	2000	m	$85	$170,000
4.03	Excavate in all materials, supply, bed and lay DN63 Poly loops.	4000	m	$50	$200,000
4.04	Supply and install DN100 stop valves including risers, valve box's and markers.	30	No.	$500	$15,000
4.05	Supply and install DN50 stop valves including risers, valve box's and markers.	50	No.	$400	$20,000
4.06	Supply and install Fire Plug in accordance with WSA Std Drg's MRWA-W-301, 302 7 303	75	No.	$1,000	$75,000
4.07	Supply and install DN20 water connection in PVC valve box to TW standard	583	m	$500	$291,500
4.08	Connection of new main to existing (By TasWater at developers cost)	3	No.	$2,500	$7,500
4.09					
				WATER SUB TOTAL :	$1,039,000
5.0	ROADWORKS				
5.01	Prime & 40mm thick asphalt surfacing	55480	m^2	$30	$1,664,400
5.02	Supply spread and compact 100mm thick Base Course	55480	m^2	$13	$721,240
5.03	Supply spread and compact 200mm thick Sub Base	69360	m^2	$20	$1,387,200
5.04	Concrete kerb and channel pedestrian access ramp in accordance with IPWEA Std Drg TSD-R18-V1	64	No.	$500	$32,000
5.05	Supply and place vehicle crossing in accordance with IPWEA Std Drg TSD-R14-v2 (Type KC)	10202	m^2	$130	$1,326,260
5.06	Supply and place Kerb & Channel in accordance with IPWEA Std Drg TSD-R14-v2 (Type KC)	13870	m	$75	$1,040,250
5.07	Reinforced concrete footpath (1.5m wide) on 100mm thick sub-base material	20800	m^2	$80	$1,664,000
5.08	Construct new intersection on Manata Road (Roundabout)	1	Item	$250,000	$250,000
5.09	Upgrade Mannata Street / Ringwood Road intersection	1	Item	$60,000	$60,000
5.1	Construct new intersection on Bangalee Street opposite Cabarita Street	1	Item	$50,000	$50,000
5.11	Construct new intersection on Ringwood Road (excludes property acquisition at 464 South Arm Highway)	1	Item	$60,000	$60,000
5.12	Upgrade South Arm Highway/ Acton Road intersection (Roundabout)	0.5	Item	$1,500,000	$750,000
5.13	Upgrade Ringwood/South Arm Highway intersection (Roundabout)	0.5	Item	$900,000	$450,000
5.14	Upgrade new intersection onto Acton Rd (incl passing layby)	1	Item	$70,000	$70,000
5.15	Balook St widening 50m section from 7.7m to 8.3m	1	Item	$20,000	$20,000
5.16	Ringwood Road widening from 5.7m to 11m (excluding relocation of services)	1	Item	$1,200,000	$1,200,000

Item No.	Description	Quantity	Unit	Rate	Amount
				ROADWORKS SUB TOTAL :	$10,745,350

Item No.	Description	Quantity	Unit	Rate	Amount
6.0	MISCELLANEOUS				
6.01	Detailed Design and Approvals management	583	No.	$2,000	$1,166,000
6.02	Project/Contract Management	583	No.	$1,000	$583,000
6.03	TasNetworks design and construct costs	583	No.	$6,000	$3,498,000
6.04	NBN design and construct Costs	583	No.	$1,000	$583,000
6.05	Landscaping (excluding swales)	583	No.	$500	$291,500
6.06	Trenching for TasNetworks and NBN services in individual trench including liaison with service authorities and placement of backfill	7000	m	$35	$245,000
6.07	Supply, placement and backfill of DN125 TasNetworks road crossing conduits	2915	m	$50	$145,750
6.08	CCTV inspection of installed TasWater and Council pipework at Completion of Works	583	No.	$100	$58,300
6.09	Land purchase (30 existing properties)	30	No.	$525,000	$15,750,000
6.10	As Constructed Drawings	583	No.	$100	$58,300
	MISCELLANEOUS SUB TOTAL :				$22,378,850

DEVELOPMENT COST SUMMARY

1.0	SITE ESTABLISHMENT / EARTHWORKS SUB TOTAL :	$21,009,600
2.0	STORMWATER SUB TOTAL :	$7,613,700
3.0	SEWER SUB TOTAL :	$7,207,600
4.0	WATER SUB TOTAL :	$1,039,000
5.0	ROADWORKS SUB TOTAL :	$10,745,350
6.0	MISCELLANEOUS SUB TOTAL :	$22,378,850
	TOTAL ESTIMATED DEVELOPMENT COST (EXCLUDING GST):	$69,994,100

Item No.	Description	Quantity	Unit	Rate	Amount
7.0	AUTHORITY CHARGES				
8.01	Council Approval Fee's (Nom. 1.5% of construction costs)	1	Item	$1,049,912	$1,049,912
8.02	TasWater DA Fee's	1	No.	$1,500	$1,500
8.03	TasWater Engineering design approval fees	17	No.	$400	$6,800
8.04	TasWater Engineering Asset Creating Fee	17	No.	$1,500	$25,500
8.05	TasWater Final Plan Sealing & Off Maintenance Fee	17	No.	$250	$4,250
8.06	Surveyors & Land Titles Office Fee	583	No.	$1,000	$583,000
8.07	NBN Developer Charge	583	No.	$600	$349,800
				AUTHORITY CHARGES SUB TOTAL :	$2,020,762
				DEVELOPMENT COST :	$72,014,862
				10% CONTINGENCY:	$7,201,486
				GST	$7,921,635
				TOTAL DEVELOPMENT COST:	$87,137,982

Please note that this schedule has been prepared for the feasibility study on the basis of our understanding of the project requirements and current market conditions. JMG are not quantity surveyors. The quantities shown in the schedule have been calculated from the Urban Design concept plans only and adjustments to these quantities are highly likely following detailed design. Therefore, any developer should ensure a suitable contingency on the rates provided should be allowed for to cater for these adjustments.

APPENDIX F

Net Present Value Analysis

J153075PH - Lauderdale Urban Expansion Feasibility Study
Net Present Value Analysis Lot Sale Price $135,000 per lot

140

	Cost	South (284 lots)								North (299 lots)									
Stage		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	
Number of Lots		**35**	**35**	**35**	**35**	**35**	**35**	**35**	**39**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**35**	583
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**0**
Fixed costs up front																			
Fill southern area	$ 13,500,000	$ 13,500,000																	
Fill northern area	$ 7,400,000									$ 7,400,000									
Provide major drainage system																			
Supply and install 2.7m x 0.6m box culvert from reserve to Ringwood Road	$ 727,900									$ 727,900									
Supply and install 3.0m x 0.6m box culvert from Ringwood Road under RBL	$ 509,200	$ 509,200																	
Supply and install 4.5m x 0.6m box culvert from RBL to Ralphs Bay	$ 1,572,000	$ 1,572,000																	
Supply and install 3.9m x 0.6m box culvert from Mannata Street to outfall in Canal	$ 1,880,000	$ 1,880,000																	
Procure easement through 52 North Terrace	$ 50,000	$ 50,000																	
Extra over for box culvert under South Arm Highway and North Terrace	$ 40,000	$ 40,000																	
New outfall from box culverts	$ 20,000	$ 20,000																	
Remove existing buildings and make good site	$ 680,000	$ 400,000								$ 280,000									
Raise SPS at 488 South Arm Road from 2.2m to 3.3m AHD	$ 60,000	$ 60,000																	
Additional 11kL emergency storage at 488 South Arm Road SPS including wa	$ 40,000				$ 40,000														
Additional 91kL emergency storage at 36 Mannata Street SPS including wast	$ 120,000			$ 120,000															
Construct new intersection on Manata Road (Roundabout)	$ 250,000			$ 250,000															
Upgrade Mannata Street / Ringwood Road intersection	$ 60,000									$ 60,000									
Construct new intersection on Bangalee Street opposite Cabarita Street	$ 50,000	$ 50,000																	
Construct new intersection on Ringwood Road (excludes property acquisition at 464 South Arm Highway)	$ 60,000					$ 60,000													
Upgrade South Arm Highway/ Acton Road intersection (Roundabout)	$ 750,000												$ 750,000						
Upgrade Ringwood/South Arm Highway intersection (Roundabout)	$ 450,000			$ 450,000															
Upgrade new intersection onto Acton Rd (incl passing layby)	$ 70,000									$ 70,000									
Balook St widening 50m section from 7.7m to 8.3m	$ 20,000															$ 20,000			
Ringwood Road widening from 5.7m to 11m (excluding relocation of services)	$ 1,200,000			$ 1,200,000															
Land Purchase south	$ 7,350,000	$ 7,350,000																	
Land Purchase north	$ 8,400,000									$ 8,400,000									
Variable costs per Lot created																			
Site establishment	$ 1,600	$ 56,000	$ 56,000	$ 56,000	$ 56,000	$ 56,000	$ 56,000	$ 56,000	$ 62,400	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 56,000	
Stormwater	$ 4,828	$ 168,973	$ 168,973	$ 168,973	$ 168,973	$ 168,973	$ 168,973	$ 168,973	$ 188,284	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 168,973	
Gravity sewer connections south (130 lots)	$ 3,213		$ 89,961.29	$ 102,812.90	$ 112,451.61	$ 112,451.61													$ 130	12
Gravity sewer connections north (25 lots)	$ 3,213										$ 80,322.58								$ 25	5
Pressure sewer connections (428 lots)	$ 15,163	$ 530,691.59	$ 106,138.32	$ 45,488	$ -	$ -	$ 530,692	$ 530,692	$ 591,342	$ 500,366	$ 121,301	$ 500,366	$ 500,366	$ 500,366	$ 500,366	$ 500,366	$ 500,366	$ 530,692	$ 428	-11
Water	$ 1,782	$ 62,376	$ 62,376	$ 62,376	$ 62,376	$ 62,376	$ 62,376	$ 62,376	$ 69,504	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 62,376		
Roadworks	$ 13,440	$ 470,390	$ 470,390	$ 470,390	$ 470,390	$ 470,390	$ 470,390	$ 470,390	$ 524,149	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 470,390		
Miscellaneous	$ 11,370	$ 397,958	$ 397,958	$ 397,958	$ 397,958	$ 397,958	$ 397,958	$ 397,958	$ 443,439	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 397,958		
Authority Charges	$ 3,466	$ 121,315	$ 121,315	$ 121,315	$ 121,315	$ 121,315	$ 121,315	$ 121,315	$ 135,180	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 121,315		
Contingency	*$ 12,352*	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 481,746.07	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 432,336.22		
Total costs		$ 27,671,239	$ 1,473,111	$ 3,445,312	$ 1,429,463	$ 1,449,463	$ 1,807,703	$ 1,807,703	$ 2,014,298	$ 18,642,306	$ 1,405,663	$ 1,704,406	$ 2,454,406	$ 1,704,406	$ 1,704,406	$ 1,724,406	$ 1,704,406	$ 1,807,703	$ 583	
Revenue																			
Lot Sales		$ -	$ 4,725,000	$ 4,725,000	$ 4,725,000	$ 4,725,000	$ 4,725,000	$ 4,725,000	$ 4,725,000	$ 4,725,000	$ 4,455,000	$ 4,455,000	$ 4,455,000	$ 4,455,000	$ 4,455,000	$ 4,455,000	$ 4,455,000	$ 4,455,000	$ 4,455,000	
Revenue less cost		**-$ 27,671,239**	**$ 3,251,889**	**$ 1,279,688**	**$ 3,295,537**	**$ 3,275,537**	**$ 2,917,297**	**$ 2,917,297**	**$ 2,710,702**	**-$ 13,917,306**	**$ 3,049,337**	**$ 2,750,594**	**$ 2,000,594**	**$ 2,750,594**	**$ 2,750,594**	**$ 2,730,594**	**$ 2,750,594**	**$ 2,647,297**	**$ 4,454,417**	
Cummulative Profit			-$ 24,419,350	-$ 23,139,662	-$ 19,844,125	-$ 16,568,588	-$ 13,651,291	-$ 10,733,994	-$ 8,023,292	-$ 21,940,598	-$ 18,891,261	-$ 16,140,666	-$ 14,140,072	-$ 11,389,478	-$ 8,638,883	-$ 5,908,289	-$ 3,157,695	-$ 510,398	$ 3,944,019	
Lot sales value	$ 135,000																		

	Hurdle Rate			
	10%	**7%**	**5%**	**3%**
NPV	**-$11,840,479**	**-$9,327,539**	**-$6,885,517**	**-$3,551,154**

Property acquisition price	Cost of supply of fill ($/m3)				
	0	**5**	**10**	**15**	**20**
$400,000	**$2,127,402**	**-$742,902**	**-$3,613,206**	**-$6,483,509**	**-$9,353,813**
$525,000	**-$359,264**	**-$3,229,568**	**-$6,099,871**	**-$8,970,175**	**-$11,840,479**
$650,000	**-$2,845,930**	**-$5,716,233**	**-$8,586,537**	**-$11,456,841**	**-$14,327,144**

J153075PH - Lauderdale Urban Expansion Feasibility Study
Net Present Value Analysis Lot Sale Price $150,000 per lot

140

		Stage																		
		South (284 lots)								North (299 lots)										
Stage	**Cost**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**		
Number of Lots		**35**	**35**	**35**	**35**	**35**	**35**	**35**	**39**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**35**	583	
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**0**	
Fixed costs up front																				
Fill southern area	$ 13,500,000	$ 13,500,000																		
Fill northern area	$ 7,400,000									$ 7,400,000										
Provide major drainage system																				
Supply and install 2.7m x 0.6m box culvert from reserve to Ringwood Road	$ 727,900									$ 727,900										
Supply and install 3.0m x 0.6m box culvert from Ringwood Road under RBL	$ 509,200	$ 509,200																		
Supply and install 4.5m x 0.6m box culvert from RBL to Ralphs Bay	$ 1,572,000	$ 1,572,000																		
Supply and install 3.9m x 0.6m box culvert from Mannata Street to outfall in Canal	$ 1,880,000	$ 1,880,000																		
Procure easement through 52 North Terrace	$ 50,000	$ 50,000																		
Extra over for box culvert under South Arm Highway and North Terrace	$ 40,000	$ 40,000																		
New outfall from box culverts	$ 20,000	$ 20,000																		
Remove existing buildings and make good site	$ 680,000	$ 400,000								$ 280,000										
Raise SPS at 488 South Arm Road from 2.2m to 3.3m AHD	$ 60,000	$ 60,000																		
Additional 11kL emergency storage at 488 South Arm Road SPS including wa	$ 40,000				$ 40,000															
Additional 91kL emergency storage at 36 Mannata Street SPS including wast	$ 120,000			$ 120,000																
Construct new intersection on Manata Road (Roundabout)	$ 250,000			$ 250,000																
Upgrade Mannata Street / Ringwood Road intersection	$ 60,000									$ 60,000										
Construct new intersection on Bangalee Street opposite Cabarita Street	$ 50,000	$ 50,000																		
Construct new intersection on Ringwood Road (excludes property acquisition at 464 South Arm Highway)	$ 60,000					$ 60,000														
Upgrade South Arm Highway/ Acton Road intersection (Roundabout)	$ 750,000												$ 750,000							
Upgrade Ringwood/South Arm Highway intersection (Roundabout)	$ 450,000			$ 450,000																
Upgrade new intersection onto Acton Rd (incl passing layby)	$ 70,000									$ 70,000										
Balook St widening 50m section from 7.7m to 8.3m	$ 20,000															$ 20,000				
Ringwood Road widening from 5.7m to 11m (excluding relocation of services)	$ 1,200,000			$ 1,200,000																
Land Purchase south	$ 7,350,000	$ 7,350,000																		
Land Purchase north	$ 8,400,000									$ 8,400,000										
Variable costs per Lot created																				
Site establishment	$ 1,600	$ 56,000	$ 56,000	$ 56,000	$ 56,000	$ 56,000	$ 56,000	$ 56,000	$ 62,400	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 56,000		
Stormwater	$ 4,828	$ 168,973	$ 168,973	$ 168,973	$ 168,973	$ 168,973	$ 168,973	$ 168,973	$ 188,284	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 168,973		
Gravity sewer connections south (130 lots)	$ 3,213		$ 89,961.29	$ 102,812.90	$ 112,451.61	$ 112,451.61													$ 130	12
Gravity sewer connections north (25 lots)	$ 3,213										$ 80,322.58								$ 25	5
Pressure sewer connections (428 lots)	$ 15,163	$ 530,691.59	$ 106,138.32	$ 45,488	$ -	$ -	$ 530,692	$ 530,692	$ 591,342	$ 500,366	$ 121,301	$ 500,366	$ 500,366	$ 500,366	$ 500,366	$ 500,366	$ 500,366	$ 530,692	$ 428	-11
Water	$ 1,782	$ 62,376	$ 62,376	$ 62,376	$ 62,376	$ 62,376	$ 62,376	$ 62,376	$ 69,504	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 62,376		
Roadworks	$ 13,440	$ 470,390	$ 470,390	$ 470,390	$ 470,390	$ 470,390	$ 470,390	$ 470,390	$ 524,149	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 470,390		
Miscellaneous	$ 11,370	$ 397,958	$ 397,958	$ 397,958	$ 397,958	$ 397,958	$ 397,958	$ 397,958	$ 443,439	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 397,958		
Authority Charges	$ 3,466	$ 121,315	$ 121,315	$ 121,315	$ 121,315	$ 121,315	$ 121,315	$ 121,315	$ 135,180	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 121,315		
Contingency	*$ 12,352*	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 481,746.07	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 432,336.22		
Total costs		$ 27,671,239	$ 1,473,111	$ 3,445,312	$ 1,429,463	$ 1,449,463	$ 1,807,703	$ 1,807,703	$ 2,014,298	$ 18,642,306	$ 1,405,663	$ 1,704,406	$ 2,454,406	$ 1,704,406	$ 1,704,406	$ 1,724,406	$ 1,704,406	$ 1,807,703	$ 583	
Revenue																				
Lot Sales		$ -	$ 5,250,000	$ 5,250,000	$ 5,250,000	$ 5,250,000	$ 5,250,000	$ 5,250,000	$ 5,250,000	$ 5,250,000	$ 4,950,000	$ 4,950,000	$ 4,950,000	$ 4,950,000	$ 4,950,000	$ 4,950,000	$ 4,950,000	$ 4,950,000	$ 4,950,000	
Revenue less cost		**-$ 27,671,239**	**$ 3,776,889**	**$ 1,804,688**	**$ 3,820,537**	**$ 3,800,537**	**$ 3,442,297**	**$ 3,442,297**	**$ 3,235,702**	**-$ 13,392,306**	**$ 3,544,337**	**$ 3,245,594**	**$ 2,495,594**	**$ 3,245,594**	**$ 3,245,594**	**$ 3,225,594**	**$ 3,245,594**	**$ 3,142,297**	**$ 4,949,417**	
Cummulative Profit			-$ 23,894,350	-$ 22,089,662	-$ 18,269,125	-$ 14,468,588	-$ 11,026,291	-$ 7,583,994	-$ 4,348,292	-$ 17,740,598	-$ 14,196,261	-$ 10,950,666	-$ 8,455,072	-$ 5,209,478	-$ 1,963,883	$ 1,261,711	$ 4,507,305	$ 7,649,602	$ 12,599,019	
Lot value	$ 150,000																			

	Hurdle Rate			
	10%	**7%**	**5%**	**3%**
NPV	**-$8,085,282**	**-$4,643,488**	**-$1,385,936**	**$2,980,710**

Property acquisition price	Cost of supply of fill ($/m3)				
	0	**5**	**10**	**15**	**20**
$400,000	**$5,882,599**	**$3,012,295**	**$141,991**	**-$2,728,312**	**-$5,598,616**
$525,000	**$3,395,933**	**$525,629**	**-$2,344,674**	**-$5,214,978**	**-$8,085,282**
$650,000	**$909,267**	**-$1,961,036**	**-$4,831,340**	**-$7,701,644**	**-$10,571,947**

J153075PH - Lauderdale Urban Expansion Feasibility Study
Net Present Value Analysis (Lot Sale Price $170,000 per lot)

140

		Stage																			
		South (284 lots)								North (299 lots)										
Stage	**Cost**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	
Number of Lots		**35**	**35**	**35**	**35**	**35**	**35**	**35**	**39**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**35**	583
Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**0**
Fixed costs up front																				
Fill southern area	$ 13,500,000	$ 13,500,000																		
Fill northern area	$ 7,400,000									$ 7,400,000										
Provide major drainage system																				
Supply and install 2.7m x 0.6m box culvert from reserve to Ringwood Road	$ 727,900									$ 727,900										
Supply and install 3.0m x 0.6m box culvert from Ringwood Road under RBL	$ 509,200	$ 509,200																		
Supply and install 4.5m x 0.6m box culvert from RBL to Ralphs Bay	$ 1,572,000	$ 1,572,000																		
Supply and install 3.9m x 0.6m box culvert from Mannata Street to outfall in Canal	$ 1,880,000	$ 1,880,000																		
Procure easement through 52 North Terrace	$ 50,000	$ 50,000																		
Extra over for box culvert under South Arm Highway and North Terrace	$ 40,000	$ 40,000																		
New outfall from box culverts	$ 20,000	$ 20,000																		
Remove existing buildings and make good site	$ 680,000	$ 400,000								$ 280,000										
Raise SPS at 488 South Arm Road from 2.2m to 3.3m AHD	$ 60,000	$ 60,000																		
Additional 11kL emergency storage at 488 South Arm Road SPS including wa	$ 40,000				$ 40,000															
Additional 91kL emergency storage at 36 Mannata Street SPS including wast	$ 120,000			$ 120,000																
Construct new intersection on Manata Road (Roundabout)	$ 250,000			$ 250,000																
Upgrade Mannata Street / Ringwood Road intersection	$ 60,000									$ 60,000										
Construct new intersection on Bangalee Street opposite Cabarita Street	$ 50,000	$ 50,000																		
Construct new intersection on Ringwood Road (excludes property acquisition at 464 South Arm Highway)	$ 60,000					$ 60,000														
Upgrade South Arm Highway/ Acton Road intersection (Roundabout)	$ 750,000												$ 750,000							
Upgrade Ringwood/South Arm Highway intersection (Roundabout)	$ 450,000			$ 450,000																
Upgrade new intersection onto Acton Rd (incl passing layby)	$ 70,000									$ 70,000										
Balook St widening 50m section from 7.7m to 8.3m	$ 20,000															$ 20,000				
Ringwood Road widening from 5.7m to 11m (excluding relocation of services)	$ 1,200,000			$ 1,200,000																
Land Purchase south	$ 7,350,000	$ 7,350,000																		
Land Purchase north	$ 8,400,000									$ 8,400,000										
Variable costs per Lot created																				
Site establishment	$ 1,600	$ 56,000	$ 56,000	$ 56,000	$ 56,000	$ 56,000	$ 56,000	$ 56,000	$ 62,400	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 52,800	$ 56,000		
Stormwater	$ 4,828	$ 168,973	$ 168,973	$ 168,973	$ 168,973	$ 168,973	$ 168,973	$ 168,973	$ 188,284	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 159,317	$ 168,973		
Gravity sewer connections south (130 lots)	$ 3,213		$ 89,961.29	$ 102,812.90	$ 112,451.61	$ 112,451.61													$ 130	12
Gravity sewer connections north (25 lots)	$ 3,213										$ 80,322.58								$ 25	5
Pressure sewer connections (428 lots)	$ 15,163	$ 530,691.59	$ 106,138.32	$ 45,488	$ -	$ -	$ 530,692	$ 530,692	$ 591,342	$ 500,366	$ 121,301	$ 500,366	$ 500,366	$ 500,366	$ 500,366	$ 500,366	$ 500,366	$ 530,692	$ 428	-11
Water	$ 1,782	$ 62,376	$ 62,376	$ 62,376	$ 62,376	$ 62,376	$ 62,376	$ 62,376	$ 69,504	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 58,811	$ 62,376		
Roadworks	$ 13,440	$ 470,390	$ 470,390	$ 470,390	$ 470,390	$ 470,390	$ 470,390	$ 470,390	$ 524,149	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 443,510	$ 470,390		
Miscellaneous	$ 11,370	$ 397,958	$ 397,958	$ 397,958	$ 397,958	$ 397,958	$ 397,958	$ 397,958	$ 443,439	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 375,218	$ 397,958		
Authority Charges	$ 3,466	$ 121,315	$ 121,315	$ 121,315	$ 121,315	$ 121,315	$ 121,315	$ 121,315	$ 135,180	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 114,383	$ 121,315		
Contingency	*$ 12,352*	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 432,336.22	$ 481,746.07	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 407,631.29	$ 432,336.22		
Total costs		$ 27,671,239	$ 1,473,111	$ 3,445,312	$ 1,429,463	$ 1,449,463	$ 1,807,703	$ 1,807,703	$ 2,014,298	$ 18,642,306	$ 1,405,663	$ 1,704,406	$ 2,454,406	$ 1,704,406	$ 1,704,406	$ 1,724,406	$ 1,704,406	$ 1,807,703	$ 583	
Revenue																				
Lot Sales		$ -	$ 5,950,000	$ 5,950,000	$ 5,950,000	$ 5,950,000	$ 5,950,000	$ 5,950,000	$ 5,950,000	$ 5,950,000	$ 5,610,000	$ 5,610,000	$ 5,610,000	$ 5,610,000	$ 5,610,000	$ 5,610,000	$ 5,610,000	$ 5,610,000	$ 5,610,000	
Revenue less cost		**-$ 27,671,239**	**$ 4,476,889**	**$ 2,504,688**	**$ 4,520,537**	**$ 4,500,537**	**$ 4,142,297**	**$ 4,142,297**	**$ 3,935,702**	**-$ 12,692,306**	**$ 4,204,337**	**$ 3,905,594**	**$ 3,155,594**	**$ 3,905,594**	**$ 3,905,594**	**$ 3,885,594**	**$ 3,905,594**	**$ 3,802,297**	**$ 5,609,417**	
Cummulative Profit			-$ 23,194,350	-$ 20,689,662	-$ 16,169,125	-$ 11,668,588	-$ 7,526,291	-$ 3,383,994	$ 551,708	-$ 12,140,598	-$ 7,936,261	-$ 4,030,666	-$ 875,072	$ 3,030,522	$ 6,936,117	$ 10,821,711	$ 14,727,305	$ 18,529,602	$ 24,139,019	
Lot value	$ 170,000																			

	Hurdle Rate			
	10%	**7%**	**5%**	**3%**
NPV	**-$3,078,352**	**$1,601,913**	**$5,946,837**	**$11,689,861**

Property acquisition price	**Cost of supply of fill ($/m3)**				
	0	**5**	**10**	**15**	**20**
$400,000	**$10,889,528**	**$8,019,224**	**$5,148,921**	**$2,278,617**	**-$591,687**
$575,000	**$8,402,862**	**$5,532,559**	**$2,662,255**	**-$208,049**	**-$3,078,352**
$650,000	**$5,916,197**	**$3,045,893**	**$175,589**	**-$2,694,714**	**-$5,565,018**

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