BROOME NORTH DEVELOPMENT

Engineering Report – Final

LandCorp

- Rev 5
- 27 Jan 2010

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Sinclair Knight Merz
ABN 37 001 024 095
11th Floor, Durack Centre
263 Adelaide Terrace
PO Box H615
Perth WA 6001 Australia
Tel: +61 8 9469 4400
Fax: +61 8 9469 4488
Web: www.skmconsulting.com

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1. Executive Summary

1.1. Description of Development

The proposed development site is approximately 700Ha in area and is located on the Broome Peninsula, north of Gubinge Road and west of Broome Road. The site is generally bounded by Broome Highway to the east, Gubinge Road to the south, Fairway Road and Lullfitz Roads to the west and the Broome Shire refuse area to the north, as shown on the Contour and Land Ownership Plan in **Appendix A**. The site is divided by Fairway Drive. The "Blue Haze" light industrial is located in the south-east corner and the Lullfitz Drive special rural area is located on the north-east boundary.

1.2. Site Characteristics

The topography of the site is generally flat, with a large percentage of the site between zero and 1% grade with a few pockets up to 2% grade. An area of the site in the north-west corner has a greater slope than the rest of the site and varies between 1% and 4% grades. A ridge line traverses the site in a south-west to north-east direction, with the western side grading to the base of the dunes and the eastern side grading to Dampier Creek. There are two main high points on the site which are at the approximate levels of RL 20.7 (south) and RL 19.1 (north). The lowest point in the site is in the north-west corner at RL 5.0.

Soil Characteristics

A detailed Geotechnical investigation and desktop Hydro-geological study has been undertaken by Coffey Geotechnics which should be read in conjunction with this report. The investigation covered the total site and some 27 backhoe pits were investigated as well as a number of following head permeability tests. The results from the field investigation and laboratory testing, the soil over the site can be summarised as:

- The soil is typical Pindan Sand and is classified as a Silty Clayey Sand, fine to medium coarse, dense, and red to brown and weakly cemented. The materials were consistent to the full depth of the excavation of 2.5m.
- The soil contains 16% to 26% of fines most likely silt or clay material less than 75 microns. The fines are generally of low plasticity.
- Soil permeability varies over the site, however the Coffey report recommends a design value of K = 10^{-06} m/sec which is approximately 0.1m/day.
- The plastic index of the Pindan soil varies from 4.5 to 13.9.
- The CBR readings vary from 4 to 30 and the Coffey report recommends a Soaked CBR of 4 for the sub grade.
- The site has been given a Class "S" classification in the Coffey report under AS2870-1996 Residential Slabs and Footings Code. The definition of a Class "S" site is a "slightly reactive clay site with only slight ground movement from moisture changes".
- The area is considered to have a low to medium risk of Acid Sulphate Soils (ASS) as outlined in the GHD Acid Sulphate Soil Desktop Investigation April 2009.

Geo-environmental testing of the soil from the project area was carried out by Coffey Geotechnics in accordance with Australian Standards AS 4482.1-2005 Guide to the Sampling and Investigation of Potentially Contaminated Soil (Standard Australia 2005). Part of the testing was carried out on a potentially contaminated site which is covered in the environmental report. Three (3) soil samples were taken in Lots 304 and 3150 and tested for total Nitrogen and total Phosphorus resulting in concentrations of Total Nitrogen at 130-230 mg N/kg and Total Phosphorus at 13-27 mg/kg.

Climate and Flooding

The climate in Broome is characterised by a wet summer season (December to March) and dry winter seasons (April to November). The major rainfall occurs during the summer season, with occasional storms during the summer. Tropical cyclones can be experienced during the months from November to April, but are most common in January and February (Bureau of Meteorology, 2009).

The median rainfall is 602.4mm on an average of 35 days per year; however this varies considerably from year to year. Over 75% of the average rainfall from January to March is associated with thunderstorms, tropical lows and cyclones. These systems can produce high intensity rain events over very short periods and a high proportion of the rainfall can occur in a few days. The evaporation rate is high and in November, the average rate is 9.5mm/ day.

There is no information in regard to flood levels for the site; however, there is evidence (Shire photo) of areas to the north-west of the site in the Waterfall and Lullfitz Drive special rural area, as being flood prone.

The eastern boundary of the site borders Broome Highway, which is affected by tidal levels. Tidal levels also affect the existing "Lake Broome" drainage basin at the intersection of Broome Highway and Gubinge Road. Broome is subject to significant tide changes, with the highest recorded tide being 10.76m above Chart Datum (post 1/1/09) or RL 5.24m AHD.

Groundwater

Broome is reliant on groundwater for its water supply which is sourced from the 'Broome Sandstone' superficial aquifer which is the most significant aquifer in the Broome region. The Broome Groundwater area is divided into a number of sub areas including the Broome Townsite and Cable Beach sub areas. The Broome North development area is located over the Cable Beach sub area.

Coffey Geotechnics undertook a desktop assessment of the groundwater levels in the development area and assessed the Average Annual Maximum Groundwater Level (AAMGL) to be approximately RL 2.5m AHD with a maximum recurrence interval of 2 years. The groundwater level peaked at approximately 1.5m above "normal" levels at the end of the wet season peak in 1997 following the major cyclone event in September of the same year. On this basis the Maximum Probable Groundwater Level (MPGL) is estimated to be 2.0m higher at RL 4.5m AHD.

1.3. Stormwater Drainage

An indicative "Drainage Catchment Plan" has been prepared for the Development Plan area and is shown in Figure 3.10. The site is divided by a south-west to north-east ridge line along the western third of the site. In general, the western side of the ridge line grades out to Cable Beach and the North-West corner of the development area and the eastern side of the ridge line grades to Gubinge Road and Broome Highway. The site has been divided into five broad catchment areas.

A swale open drain and dry/ephemeral detention basin drainage system will be used for the Broome North project and the storm water design will be based on the following principles:

1) Development of the Broome North project will require detention storage to a level so that the peak runoff outflows for a Q5, Q10, Q50 and Q100 year Average Recurrence Interval (ARI) events are no greater than that which would occur under pre-development conditions.
2) Finished floor levels (FFL) for the buildings on all lots are to be at least 0.5m above the crown of the road.
3) A minimum of 0.3m freeboard is required between the flood level of a major design event and the finished floor level of all buildings on the site.
4) The Q50 and Q100 ARI events are to be contained within the road reserve and the Q10 ARI event is to be within the road.
5) Roads are used as drains and carry the majority of the flows for all events. Gullies and pipes are only used to manage flows where they cannot be carried in the road between the kerbs and for low flow drains from detention basins.
6) Drainage design is to use the following coefficients:
   - Road Reserve 0.9
   - Residential Sites 0.7
   - Vegetation and Bush 0.4 (pre development)

Allotment Drainage

As part of the review of the environmental sustainability for the project consideration has been given to the use of allotment drainage. Allotment drainage makes provision for those lots which do not naturally grade to the road reserve to be provided with drainage at the rear of the lot. The drainage system at the rear of the lots conveys the stormwater to the road or swale system and generally is required to be designed to contain a Q10 ARI event.

Water Quality

The water quality of stormwater originating from the catchment will be managed by the following methods:

- Reduction of stormwater flow velocities to aid sedimentation, reduce erosion and reduce the carriage of seeds into the natural landscape;
- Construction of vegetated swales drains and dry/ephemeral detention basins using weirs and low flow drain system to reduce the water velocity to allow settling out of the silt load and the removal of gross pollutants.
- Design the swales to provide a more natural waterway and meandering creek system rather than a linear conveyance drainage system with no detention or attenuation of flows;
- Link grassed POS area and multi-use parks into the swale/detention systems to improve the water quality through the take up of nutrients. The POS areas will be constructed as detention systems, with low flow drains, to detain a Q5 event;
- All detention basins to have sedimentation traps to maximize the deposition of silt within the basin;
- Provide for natural vegetation re-growth by using topsoil generated from the site on the sides of the swales and the bases of the detention basins. Additional planting of low-lying native plants, in particular grasses, along the sides of the swales and basins, for filtering of sediments and nutrient removal;
- Where possible, restoration of natural drainage pathways to utilize natural nutrient stripping properties of existing vegetation;
- Promote and help implement a maintenance and education program for optimal performance of stormwater system;
- Potential reuse of the existing sand mining area at the north-western corner of the catchment as an infiltration basin for the outlet of the north-west catchment.
- Promote and encourage the use of slow-release organic fertiliser.

An industry- standard water quality stormwater modeling software tool “MUSIC” or similar will be used to assess the efficiency of the water quality treatment system. “MUSIC” estimates the quantities of flow, Total Suspended Solids, Total Phosphorus, Total Nitrogen and Gross Pollutants from catchments. When the mean annual loads produced from the existing and mitigated catchments are compared the effect of the development can be assessed.

The water quality targets for the drainage system are to be;

- At least 60 per cent reduction of total phosphorus;
- At least 80 per cent reduction of total suspended solids;
- At least 45 per cent reduction of total nitrogen; and
- At least 70 per cent reduction of gross pollutants.

1.4. Water and Sewerage

Water

The Broome North development site currently has a traditional water supply system to existing lots within the development, such as the Blue Haze Industrial Area. The area contains a 3.4 Ha Water Corporation tank site on the western edge of the site off Fairway Drive.

Additional water for the Broome North development is calculated to be 3.3 GL per annum. Water Corporation has identified that sustainable yield of the existing town water source is 10.6 GL/annum. DOW (2008) indicates that the long term demand for Broome in 2030 is 9.4 GL/a, including system losses and tourist population.

The estimated total water demand for the town of Broome including the future Broome North development is 8.0 GL/annum. This total incorporates the 2009 production of 4.7 GL/annum and the future estimated water demand from the proposed development of around 3.3 GL/annum.

The existing water source is expected to be sufficient.

Sewerage

The Broome North development site currently has three existing wastewater pumping stations that discharge to the south with treatment at the existing Broome South, Waste Water Treatment Plant (WWTP). Ultimately these flows will be pumped via the upgraded Broome North PS 6, Ocean Drive north to the proposed Broome North WWTP, at Crab Creek, scheduled for commissioning in approximately 2010. The future development of Broome North will initially also discharge to Broome North PS 6.

Water Corporation has already completed detailed sewer planning for the area in the southern part of the development area. Detailed planning will be required for the total development plan area in addition to that already completed.

In summary;

- No additional water source is required
- An additional site (adjacent Buckley's Road) for water reservoir (or recycled water reservoir) will be required
- Up to three additional sewerage pump stations will be required for the Broome North project
- The new (WWTP) at Crab Creek will have sufficient capacity to handle the Broome North project.

1.5. Effluent Reuse

Sinclair Knight Merz (SKM) has prepared a discussion paper on recycled wastewater as part of the investigations for the Broome North project. Recycled water has many applications that can be considered for the proposed development which are outlined in the paper. Key points are;

- Non-drinking uses (toilet flushing and garden watering) would require advanced treatment (e.g. MBR and disinfection) and duplication of the reticulation system.
- A dual reticulation scheme in Broome North would reduce the water demand and delay the expansion of the groundwater borefield.
- Costing and operational responsibilities for the scheme need to be established

1.6. Power

Horizon Power have advanced planning for the new 'Bilingurr' Zone Substation to a point where a formal project has been set-up, a Project Manager has been appointed, a preferred substation site has been identified, land purchase is anticipated to occur soon, a preferred express 33kV cable route has been indentified under the airport runway, conduits have already been installed under the runway in readiness for the express cables and procurement of the 33kV cables is expected to take place soon. Horizon Power has indicated that they are still on-schedule to meet an in-service date in December 2010.

A Master Plan of the HV distribution within Broome North based on the new 'Bilingurr' substation site has been prepared by SKM and included in this report providing an indication of switchgear locations, service corridors and likely land usage.

Various sustainability options are available that could be incorporated in the proposed development to provide environmental, social and economic benefits to the Broome community and stakeholders. Small scale grid connected Solar Photo Voltaic (PV) cells, solar hot water systems, building design and construction materials, and demand side management measures are understood to provide the best opportunities for residents of Broome to reduce green house gas emissions and use electricity in a more sustainable way.

1.7. Transport Planning

Sinclair Knight Merz has prepared a Transport Assessment on behalf of LandCorp for the proposed Broome North development. Due to the scale of the site (735Ha) and long development timeline, the assessment has considered two scenarios:

- **Interim:** year 2031 with 2,000 residential lots, one primary school, one high school, extension to the Blue Haze industrial estate and partial development of one retail centre. This development area is expected to be bounded by Fairway Drive, Broome Highway and Gubinge Road.
- **Ultimate**: notionally year 2051 with full development extending northward to the existing waste transfer station. Full development will comprise 4,800 residential lots, two public primary schools, one public high school, an Anglican school, Blue Haze Light Industrial Estate and two town centres.

The development is planned to be self-contained in relation to education and local shopping needs in the medium to long term. The site's planning has been underpinned by a series of transport objectives agreed with a number of community groups and government agencies at a four-day Planning Design Forum.

Traffic generation forecasts for a typical weekday for the interim and ultimate development scenarios are as follows:

- Interim: 4,626 internal, 12,468 external vehicle trips per day
- Ultimate: 16,249 internal, 20,667 external vehicle trips per day.

The site will be accessed in the interim via the following intersections:

- Broome Road/ Fairway Drive – priority controlled
- Broome Road/ Tanami Drive - priority controlled
- Gubinge Road/ Blue Haze access: priority controlled (right turn-in banned)
- Broome Road/ Magabala Road: priority controlled

The site will also be accessed via an easterly extension of Sanctuary Road.

Ultimately as the development extends north, a new access will be created on Broome Road approximately 900m north of the Fairway Drive and a separate access off Broome Highway for the waste management facility installed. At a stage between interim and ultimate development stages there will be a requirement for some of the site access points to be upgraded, this is in part due to the duplication of Gubinge Road and Broome Road (north of Gubinge Road). It is envisaged that this duplication (as outlined in the Broome Road Planning Study prepared by Western Infrastructure) will take place at some stage between 2031 and 2051.

Upgrading the intersections of Gubinge Road/ Magabala Road and Gubinge Road/ Fairway Drive/ Jigal Drive to traffic signals is likely to be triggered by the need to provide for safe pedestrian crossing of Gubinge Road, rather than on traffic capacity grounds.

In addition to the site access points, the development of Broome North is projected to notably impact the intersections of Broome Road/ Gubinge Road and Broome Road/ Sandpiper Avenue. It is forecast that the Broome Road/ Gubinge Road intersection can remain a priority controlled intersection well into the future. It is expected that the current configuration will remain suitable until such time as Gubinge Road and Broome Road north of Gubinge Road are duplicated to a four lane divided carriageway.

The intersection of Broome Road/ Sandpiper Avenue is forecast to require upgrading to a single lane roundabout control by interim development. Extending Jigal Drive south of Sandpiper Avenue through the airport would reduce the traffic volume through the Broome Road/ Sandpiper Avenue intersection and in this event further upgrade to this intersection may no longer be warranted.

The relocation of the airport and creation of a new arterial north-south route between Broome Road and Gubinge Road will greatly influence travel patterns. The timing of any such development is not yet known. However, if a new north-south road link through the airport is not created by 2051, it is apparent that Broome Road between Gubinge Road and Sandpiper Avenue will need to be duplicated (four lane divided road).

The intersection of Broome Road/ Frederick Street has been recently upgraded to roundabout control. It is expected that this intersection would be upgraded to a two-lane roundabout if/ when Broome Road (south of Gubinge Road) is duplicated.

In terms of sustainable transport, it is recommended that two bus services operate through Broome North – providing connections to cable Beach and Broome Town Centre.

A network of footpaths and cycling routes are planned throughout the Broome North development and integrating with existing infrastructure outside of the development site. A shared path linking Broome North to the Broome Town Centre, preferably along Brome Road, is recommended to encourage cycling as a travel mode.

1.8. Other Utilities

The site contains existing gas and telecomunications assets that are to be maintained and protected. There are major Telstra fibre optic cables mainly to east side. The towns power is generated by gas which is piped through the centre of the site from north to south.

The site is not likely to be serviced by gas as reticulation to lots is not currently provided in Broome. Telecommunications legislations are currently undergoing changes that will likely see the role out of new policies mandating the provision of Fibre To The Premises (FTTP). Depending on the timing of development there may be a need to implement an interim strategy while legislation finalisation is underway.

2. Site Characteristics

2.1. Location

The proposed development site is approximately 700Ha in area and is located on the Broome Peninsula, north of Gubinge Road and west of Broome Road. The site is generally bounded by Broome Highway to the east, Gubinge Road to the south, Fairway Road and Lulfitz Roads to the west and the Broome Shire refuse area to the north, as shown on the Contour and Land Ownership Plan in **Appendix A**. The site is divided into a north (Panel B27) and south (Panel B27) by Fairway Drive. The "Blue Haze" light industrial is located in the south-east corner and the Lulfitz Drive special rural area is located on the north-east boundary.

Panel B27 is split into two almost equal areas by Buckley's Road and the southern area, Panel B26 is cut in a north-south direction by Magabola Road. The Water Corporation water tank site (Lot 3031) sits within the development area to the west off Fairway Drive.

2.2. Soil Characteristics

A detailed Geotechnical investigation and desktop Hydro-geological study has been undertaken by Coffey Geotechnics which also references a recent study by Groundwater Consulting Services Pty Ltd for the Department of Water (DOW).

The Coffey Geotechnics investigation covered the total site and some 27 backhoe pits were investigated as well as a number of following head permeability tests.

- Based on the results from the field investigation and laboratory testing, the soil over the site can be summarised as:
- The soil is typical Pindan Sand and is classified as a Silty Clayey Sand, fine to medium coarse, dense, and red to brown and weakly cemented.
- The materials were consistent to the full depth of the excavation of 2.5 m.
- The soil contains 16% to 26% of fines most likely silt or clay material less than 75 microns. The fines are generally of low plasticity.
- Soil permeability varies over the site, however the Coffey report recommends a design value of K = 10^{-06} in/see which is approximately 0.1m/day.
- The plastic index of the Pindan soil varies from 4.5 to 13.9.
- The CBR readings vary from 4 to 30 and the Coffey report recommends a Soaked CBR of 10 for the sub grade.
- The site has been given a Class "S" classification in the Coffey report under AS2870-1996 Residential Slabs and Footings Code. The definition of a Class "S" site is a "slightly reactive clay site with only slight ground movement from moisture changes". A Class "S" site has an estimated characteristic ground movement between zero and 20mm (AS 2870-1996).

The Pindan soil in the area does not contain any acid sulphate soil as evidenced by the plan shown in **Figure 2.1** below.

Pindan soil is recognised as a soil with collapse potential (Coffey 2009) and the ground preparation procedures will need to be designed to limit this type of settlement. It is a characteristic of high silt content soils that they can be weakly cemented and has the potential to collapse when inundated with water and subjected to external loads. This has an impact on the road design where water should be kept out of the sub grade. Sub grades subject to water ingress are prone to settling and rutting under wheel loads.

Due to the collapse potential of the Pindan sands, the Coffey report recommends that soakwells should not be used.

2.3. Permeability and Infiltration

As part of the Geotechnical Investigation Coffey Geotechnics undertook a series of falling head permeability tests throughout the site and in the sand mining area at the north-eastern corner of the site. The sand mining lease area M04/209 is shown on the Mining Lease plan in **Appendix B**.

Test for the Pindan Sand varied from 0.76m/day to 3.55m/day indicating significant variability over the project area. This is consistent with the variability of the fines in the soil which vary from 16% to 26%; however there does not appear to be a correlation between the percentage of fine, and the location of the test within the site with the permeability. It would normally be expected to find higher permeability's closer to the back of the dune system; however the lowest result was recorded on the western edge of the development area. Coffey Geotechnics have recommended a design value of permeability of K= 10^{-06} m/s (approximately 0.1m/day) be adopted for the project area. This figure can be compared with the field permeability of between 25m/day to 47 m/day observed in Perth sands (Australian Geomechanics Vol. 38 No 4 December 2003 – D McInnes).

Infiltration testing carried out on the sand mining area at the bottom of the excavations gave the following results;

- 3.2 m/day at 0.5m depth (below existing ground level)
- 0.07 m/day at 1.5m depth (below pit level)

The material within the sand mining area has been described (Coffey 2009) as Sand, medium coarse, grey to white. Clay was found at 1.5m below the ground level which would account for the significant reduction in permeability.

These results indicate that while infiltration may occur in some areas over the development plan area it is very small, not consistent over the site and should not be relied on for the design of the drainage system.

The infiltration rates within the sand mining area indicates that it may be suitable for use as an infiltration basin; however this would be subject to further detailed investigation and the depth to the sand/clay layer.

2.4. Topography

The topography of the site is generally flat, with a large percentage of the site between zero and 1% grade with a few pockets up to 2% grade. An area of the site in the north-west corner has a greater slope than the rest of the site and varies between 1% and 4% grades. A ridge line to the south of Fairway Drive has similar grades. A ridge line traverses the site in a south-west to north-east direction, with the western side grading to the base of the dunes to the

west and the eastern side of the side grading to Dampier Creek. There are two main high points on the site which are at the approximate levels of RL 20.7 (south) and RL 19.1 (north). The lowest point in the site is in the north-west corner at RL 5.0. A detailed slope analysis of the existing site is shown in Existing Grade Plan in **Appendix C**.

2.5. Climate and Flooding

The climate in Broome is characterised by a wet summer season (December to March) and dry winter seasons (April to November). The major rainfall occurs during the summer season, with occasional storms during the summer. Tropical cyclones can be experienced during the months from November to April, but are most common in January and February (Bureau of Meteorology, 2009).

The median rainfall is 602.4mm on an average of 35 days per year; however this varies considerably from year to year. Over 75% of the average rainfall from January to March is associated with thunderstorms, tropical lows and cyclones. These systems can produce high intensity rain events over very short periods and a high proportion of the rainfall can occur in a few days.

The highest daily rainfall of 476.6 mm occurred on January 30th 1997. This event was associated with significant flooding in the Cable Beach area and to the north of the development site in the Waterfall area (personal conversation). Cyclones are common; the most recent in February 2002 (“Cyclone Chris”).

The evaporation rate is high and in November, the average rate is 9.5mm/ day. In general, and depending on the variability of the rainfall, the daily evaporation rate exceeds the rainfall in all but the wettest months.

There is no information in regard to flood levels for the site; however, there is evidence (Shire photo) of areas to the north-west of the site in the Waterfall and Lullfitz Drive special rural area, as being flood prone.

The existing ground level in this area is approximately RL 5.0m AHD and the bottom of the area excavated for sand mining is approximately RL 3.1m AHD however the land is not included in the development area. The levels on the site in the development area range from RL 6.6 AHD along Broome Road to RL 20.7m at the Water Corporation site and RL 19.1m AHD as the highest point on the northern boundary.

2.6. Geo-environmental Testing

Geo-environmental testing of the soil from the project area was carried out by Coffey Geotechnics during the geotechnical investigation. The testing was carried out in accordance with Australian Standards AS 4482.1-2005 Guide to the Sampling and Investigation of Potentially Contaminated Soil (Standard Australia 2005).

Part of the testing was carried out on a potentially contaminated site and the results of this testing are the subject of a separate environmental report. Other testing involved sampling across the site to assess the chemical properties of the soil. Three (3) soil samples were taken in Lots 304 and 3150 and tested for total Nitrogen and total Phosphorus. The results were:

- Total Nitrogen 130-230 mg N/kg.
- Total Phosphorus 13-27 mg/kg.

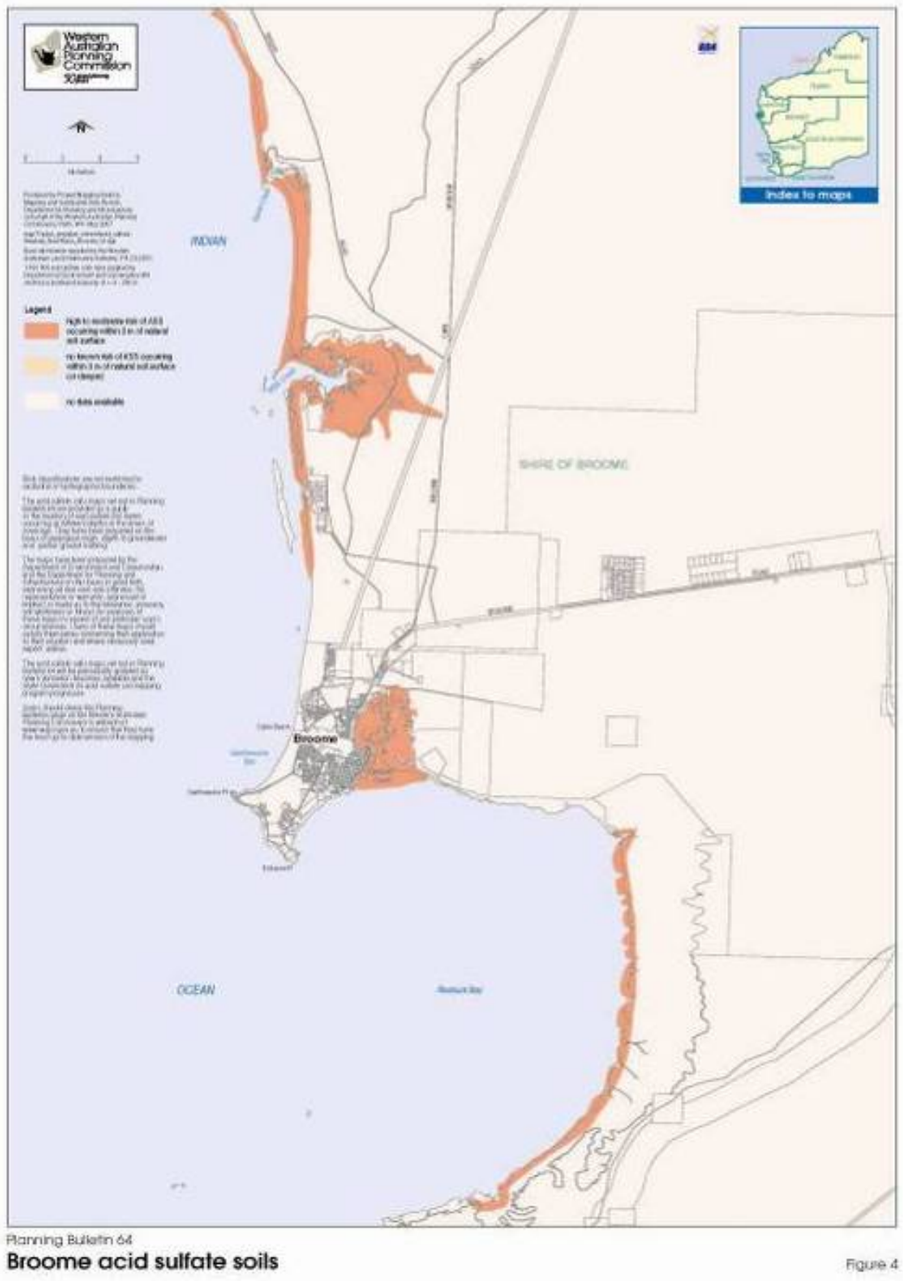

Figure 2.1 Broome Acid Sulphate Soils

2.7. Tides

The eastern boundary of the site borders Broome Highway, which is affected by tidal levels. Tidal levels also affect the existing drainage basin at the intersection of Broome Highway and Gubinge Road, which serves Roebuck Bay Estate, Gubinge Road and part of the future development area.

Broome is subject to significant tide changes, with the highest recorded tide being 10.76m above Chart Datum (post 1/1/09). Details of the tide levels in Chart Datum (CD) and Australian Height Datum (AHD) are shown in **Table 2.1** below. A "Submergence Curve" for Broome is shown in **Figure 2.2**.

Table 2.1 Tide Levels

Tide	Chart Datum(mCD) (Post 1/1/09)	Australian Height Datum (mAHD) (Post 1/1/09)
10yr ARI (SWL*)	+10.56	+5.24
50yr ARI (SWL*)	+10.66	+5.34
100yr ARI (SWL*)	+10.76	+5.44
Highest Recorded	+10.76	+5.44
HAT	+10.47	+5.15
MHWS	+9.39	+4.07
MHWN	+6.42	+1.1
MSL	+5.32	0
MLWN	+4.34	-0.98
MLWS	+0.86	-4.46
LAT	0	-5.32

A study carried out by MP Rogers and Associates in May 2001 for a future boat harbour calculated the extreme water levels shown in **Table 2.2**.

Table 2.2 Extreme Event Levels

Average Recurrence Level	Still Water Level	Australian Height Datum (Post 1/1/09)
10 years	10.56	+5.24
50 years	10.66	+5.34
100 years	10.76	+5.44

Source: MP Rogers and Associates May 2001

2.8. Broome Soils and Groundwater

Broome is reliant on groundwater for its water supply which is sourced from the 'Broome Sandstone' superficial aquifer which is the most significant aquifer in the Broome region. The aquifer comprises fine to coarse grained sandstone with minor beds of pebble conglomerate, grey siltstone and claystone. The Broome Groundwater area is divided into a number of sub areas which are shown in **Figure 2.5**. The Broome Townsite and Cable Beach sub areas cover the majority of the Broome Peninsula and are shown in **Figure 2.3**. The Broome North development area is located over the Cable Beach sub area. Groundwater levels in the vicinity of Broome are highest to the northeast of the well field shown in **Figure 2.4** Broome Proposed Water Reserve.

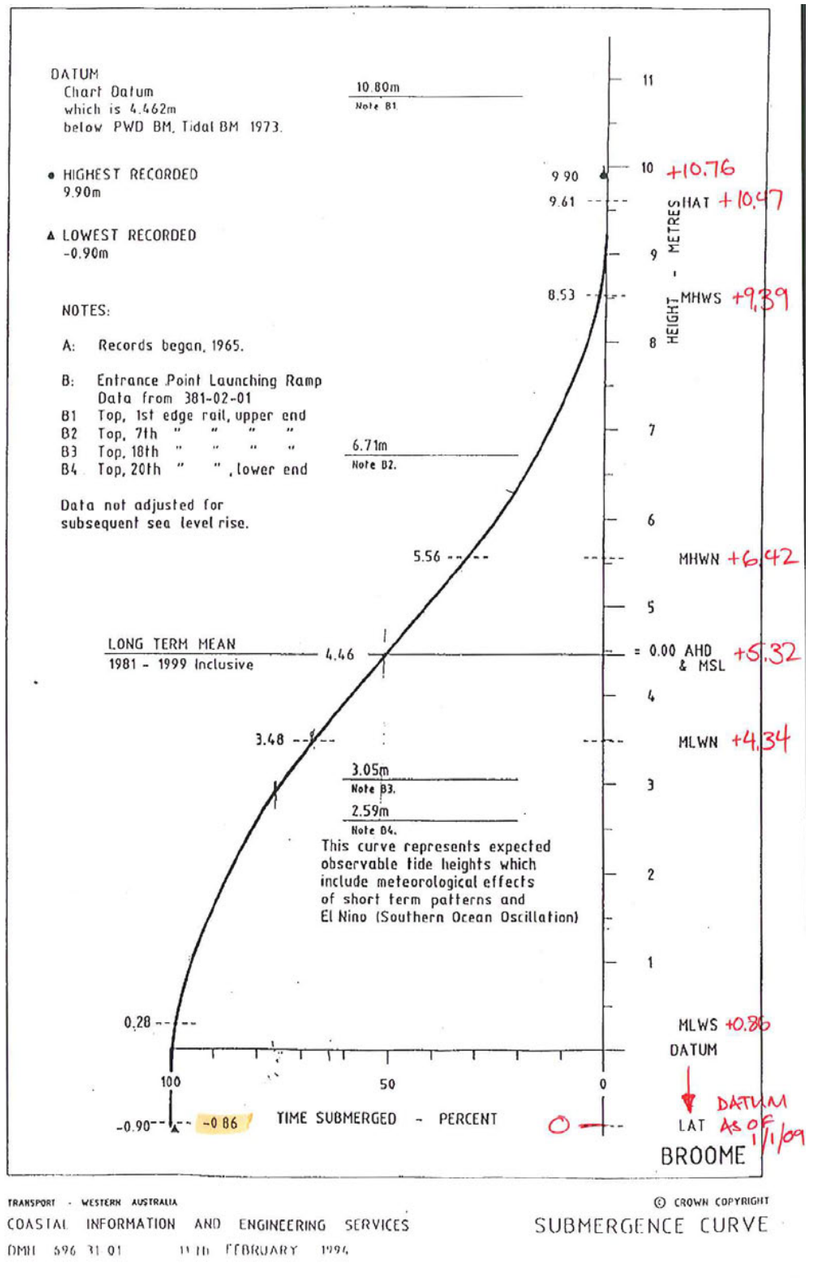

Figure 2.2 Submergence Curve

"Groundwater discharges over a saline interface and management action is required to ensure that the saline interface is not destabilized. Recharge to the system is by direct rainfall infiltration during the monsoonal and cyclonic rainfall events. Recharge is estimated to be about 4 to 5% of the average rainfall" (Broome Water Reserve, Wabu Source Protection Plan WR 41 2001).

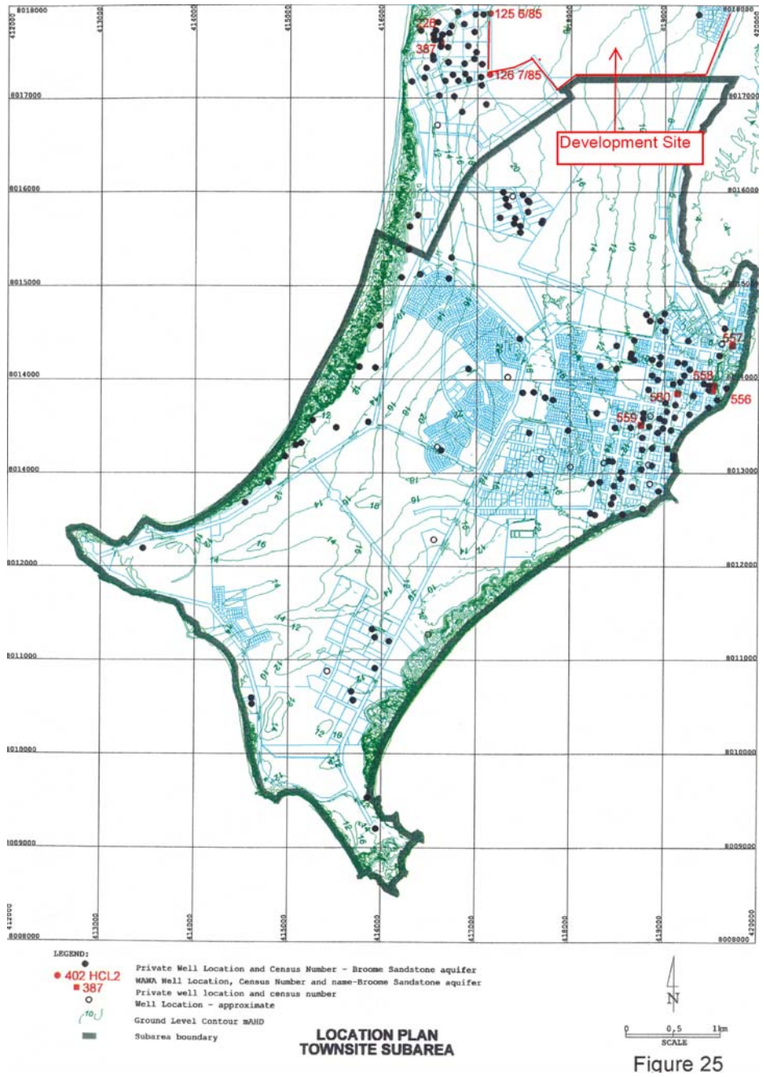

Figure 2.3 Diagrammatic Sketch of Groundwater System
Source: Cable Beach Development Plan 2006

The Cable Beach sub area receives no groundwater through flow and large changes in salinity occur over small distances away from the dune system all recharge to the superficial aquifer is due to rainfall infiltration. Infiltration rates are typically very low (<5%) for Pindan sands and 30% through the coarser sand of the coastal dune system. The majority of the water that does enter the soil is either evaporated from the soil or transpired by the vegetation. Groundwater discharge is to the ocean (Broome Water Reserve, Wabu Source Protection Plan WR 41 2001).

2.9. Groundwater Levels

Coffey Geotechnics undertook a desktop assessment of the groundwater levels in the development area. In addition a recent report reviewing the Groundwater Management Plan for the Department of Water was undertaken by Groundwater Consulting Services in November 2008.

The groundwater levels under the site are influenced by a number of factors including regional groundwater levels, local geology, rainfall and urbanisation. Clearing also has an impact on groundwater levels through the reduction in water take-up from the loss of vegetation and changes to the drainage patterns. Nevertheless Coffey Geotechnics have assessed the Average Annual Maximum Groundwater Level (AAMGL) to be approximately RL 2.5m AHD with a maximum recurrence interval of 2 years.

The groundwater level peaked at approximately 1.5m above "normal" levels at the end of the wet season peak in 1997 following the major cyclone event in September of the same year. On this basis the Maximum Probable Groundwater Level (MPGL) is estimated to be 2.0m higher at RL 4.5m AHD. This MPGL would impact on the exiting levels in "Lake Broome" as the lowest level is RL 4.31m AHD and the invert level for the discharge culvert under Broome Road is RL 4.69.

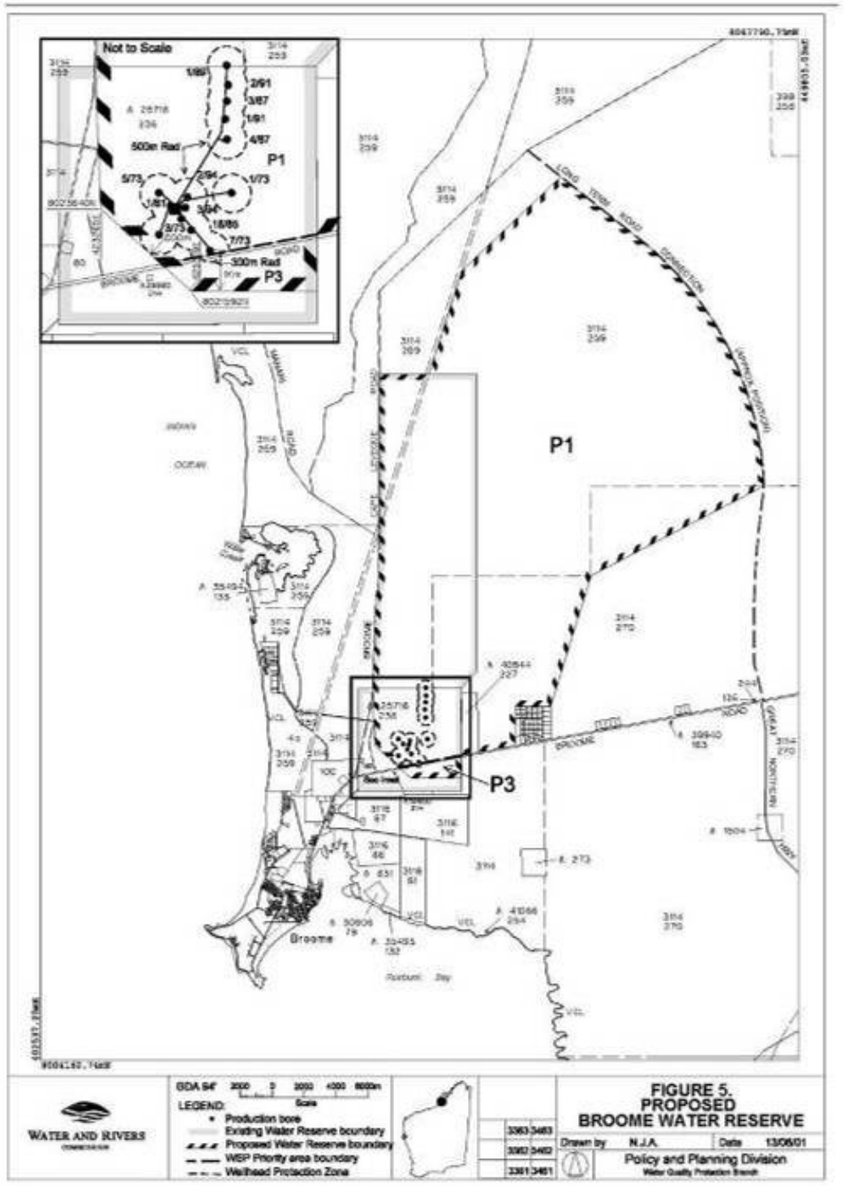

Figure 5. Proposed Broome Water Reserve

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Figure 2.4 Broome Proposed Water Reserve
Source: Waters and Rivers 2001(Ref 6.1)

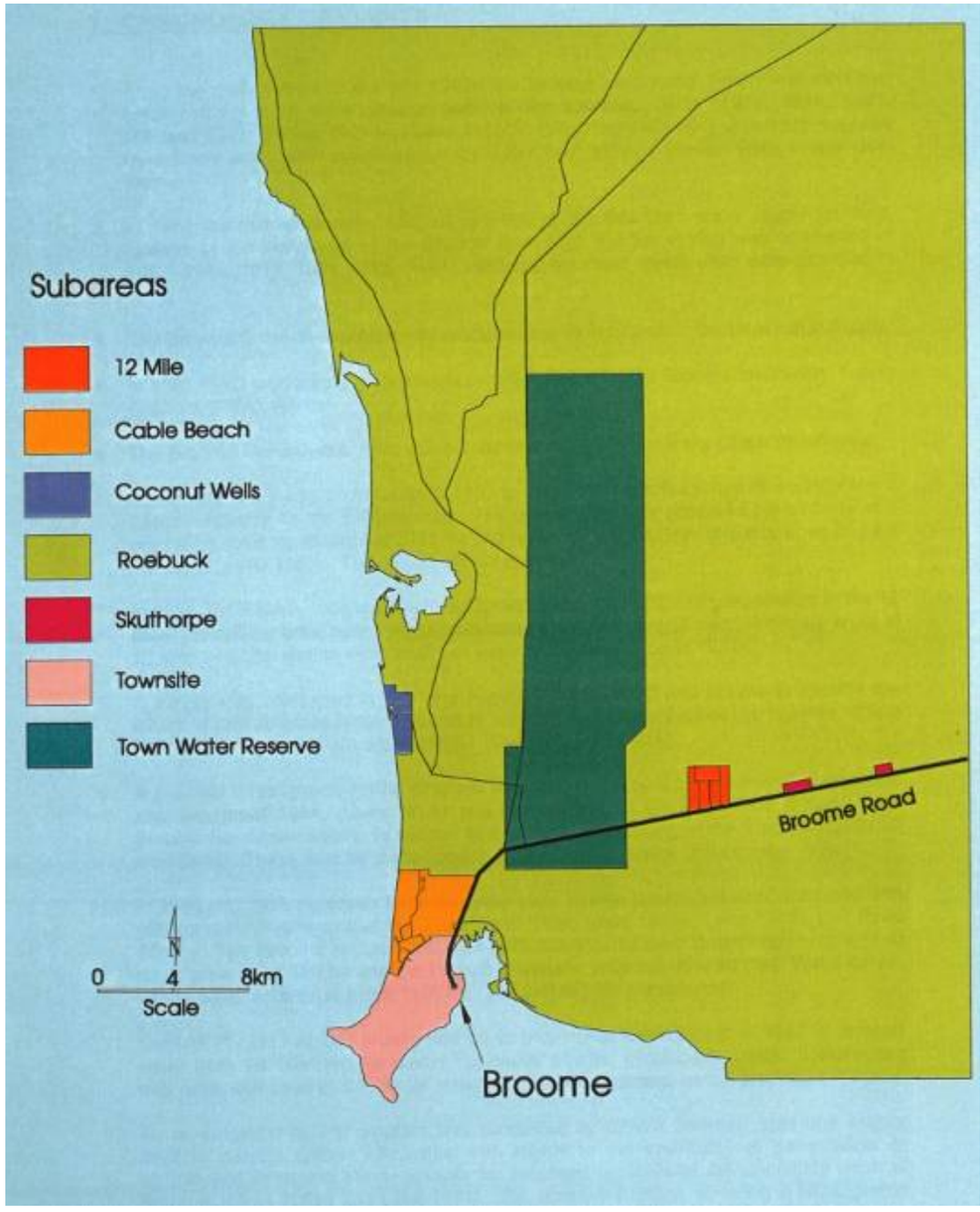


Figure 2.5 Broome Groundwater System Sub-Areas
Source: Waters and Rivers

3. Stormwater Drainage

3.1. Shire of Broome Guidelines

The stormwater system design will be completed in accordance with the following design guidelines;

- The IPWEA local government guidelines for subdivisional development (Edition 2, 2009)
- The Shire of Broome Addendum to the IPWEA (Revision 1 – 16th October 2009)
- The Shire of Broome Addendum drawings
- The Shire of Broome Services Policy 4.4.8 Stormwater Management (previously Policy 7.8 Environmental Initiatives Stormwater Management)

The primary objectives can be broadly stated as:

3.1.1. Stormwater Management Policy

- Protecting water quality and recharging local aquifers
- Protection from flooding and inundation
- Fostering improvements in local habitat values
- The maintenance of ecological processes
- Promotion of natural landscapes

3.1.2. Stormwater Management

The storm water design is to be based on the following principles established by the Shire of Broome:

1) Development of the Broome North project will require detention storage to a level so that the peak runoff outflows for Q5, Q10, Q50 and Q100 year Average Recurrence Interval (ARI) events are no greater than that which would occur under pre-development conditions.
2) Finished floor levels (FFL) for the buildings on all lots are to be at least 0.5m above the crown of the road.
3) A minimum of 0.3m freeboard is required between the flood level of a major design event and the finished floor level of all buildings on the site.
4) The Q100 ARI event is to be contained within the road reserve and the Q10 ARI event is to be within the road between the kerbs.
5) Roads are used as drains and carry the majority of the flows for all events. Gullies and pipes are only used to manage flows where they cannot be carried in the road between the kerbs and for low flow drains from detention basins.
6) Drainage design is to use the following coefficients:
   - Road Reserve 0.9
   - Residential Sites 0.7
   - Vegetation and Bush 0.4 (pre development)

3.2. Previous Drainage Systems

The existing drainage system at Janubaru Stage 4 was designed in accordance with the Shire of Broome's Drainage Design Guidelines and with the application of Water Sensitive Urban Design (WSUD) principles. The total drainage system has been modeled using the XP-SWMM drainage modeling package and can serve as a possible comparison for the Broome North project. The development included adoption of the following practices:

- Protection of the development from extreme flood events;
- Minimize flow velocities to aid sedimentation, reduce erosion and reduce the carriage of seeds into the natural landscape;
- Reduce high velocity flows through the subdivision and into the natural vegetation area during extreme events;
- The application of vegetated swales drains and detention basins using a weir and low flow drain system (within a multiple use corridor) to convey flows. The swale are designed to provide a more natural waterway system rather than a more linear open drain system, with no attenuation of flows;
- Provide for natural vegetation re-growth by using topsoil generated from the site on the sides of the swales and the bases of the detention basins;
- Additional planting of native plants along the sides of the swales and basins;
- Use of detention and sedimentation basins with low-flow drains to maximize the deposition of silt within the basin;
- Where possible, re-establishing natural drainage patterns and flow paths; and
- Infiltration by re-establishing recharge at the base of the dune system in Minyirr Park, and to the recharge area south-east of the racecourse as an alternative to an ocean discharge.

An example of a naturally re-vegetated swale and associated weir and low flow "V" notch drain is shown in **Figure 3.1** below.

Figure 3.1 Typical Vegetated Drainage Swale with "Low Flow" Notch Weir

In the earlier stages of the Janubaru project a multi-use basin was created as shown in **Figure 3.2** below. The basin is grassed and serves a recreation as well as a drainage function. Due to the limited land availability the basin is not as functional as it could be for an adequate recreation facility. Future multi-use basins such as these should be wider and shallower with flatter side slopes to allow a better recreation use.

Figure 3.2 Multi-Use Drainage Basin

The detention basins and low flow drains have proved to be effective in attenuating flows in accordance with the Shire of Broome's drainage guidelines. **Figures 3.2, 3.3** and **3.4** show examples of the detention basins operating under high intensity rainfall conditions.

Figure 3.3 Detention Basin, Weir and Low Flow Notch Outlet

Figure 3.4 Linear Detention Basin and Weir

3.3. Development Plan - Drainage Planning Requirements and Catchment Plan

A preliminary "Drainage Catchment Plan" has been prepared for the Development Plan area, which is shown in **Figure 3.10**. The catchment plan is indicative only and subject to future detailed design and approval. The site is divided by a ridge line which is a south-west to north-east line along the western third of the site. In general, the western side of the ridge line grades out at a slope of between 1% to 2% and the eastern side of the ridge line grades to Gubinge Road and Broome Highway at similar grades.

For the purpose of a preliminary assessment, the site has been divided into five catchment areas, as shown on the catchment plan. The catchment areas are:

- Area 1 (Pink) –51 Ha. This area grades directly to the west, and the Shire of Broome has advised that any discharge from this area cannot be accommodated in the existing Cable Beach drainage system, apart from a DN300 pipe, which can be used as a low flow drain.
- Area 2 (Light Blue) – 69 Ha. This area grades to the west and north, and at present, effectively discharges into the low area to the north of the Lullfitz Drive special rural area. This catchment has the steepest slopes, with some areas in the 2% to 3% range.
- Area 3 (Green) – 214 Ha. This area grades to the east and south towards Magabala and Gubinge Roads.
- Area 4 (Dark Blue) – 112 Ha. This area is to the north of the existing "Blue Haze" industrial area and grades directly east towards Broome Highway. A section of this area will impact on part of the Blue Haze industrial area.
- Area 5 (Yellow) – 248 Ha. This is the largest catchment and generally grades directly east towards Broome Highway, although the northern area grades towards the north-east.

The catchment plan in **Figure 3.10** also indicates the proposed drainage paths through the POS and landscaped green areas. The swale/detention system in the ECC will be contained to the southern boundary and be designed as a meandering creek system. Culverts will be required where the swale drainage system crosses under the roads.

3.3.1. Planning and Drainage

A swale and dry/ephemeral detention basin drainage system, similar to that developed for Stage 4 of the Janubaru project will be used for the Broome North project. Typical swale drains and dry/ephemeral detention basins are shown in **Figures 3.5** and **3.6**. The following improvements are proposed for the Broome North project drainage:

1) Introduce detention basins as high as possible into the catchment. This is to ensure that the road cross section has sufficient capacity and the water quality treatment train is activated as soon as possible. The green spaces shown in the Catchment Plan for the Development area **Figure 3.10** outline the areas to be used for the open swale drains and detention basins.
2) Detention basins are to be shallow and wide with flatter side slopes and be more integrated with the Public Open Space (POS) and ECC areas. Where possible a low flow channel will be introduced into the centre of the basin.
3) Multi-use basins in POS areas would be wide and shallower to allow better use as part of recreation areas. The POS areas will be designed to contain a Q5 storm event using earth bunds and low flow outlets.

Figure 3.5 Typical Vegetated Swale

Figure 3.6 Typical Dry/Ephemeral Detention Basin

To implement the drainage detention system to provide storage for a Q50 ARI pre-development event, between 3% to 5% of the gross land area will be required for detention basins. The area of land required is dependent on the following considerations:

- The average depth achievable for the detention basins.
- The location of the detention basins in the catchment area.
- The ability to connect the detention basins with open swale drains.
- The invert levels at the stormwater outlets and the ability to grade the open drains to the outlets consistent with the natural topography.

The swales and detention basins will be designed to be part of the landscape. Depending on the dispensation granted for drainage use, this area could be part of the overall POS and ECC contribution.

3.3.2. Stormwater Management- Catchment Plan Outlets

A number of preliminary discharge outlets for the drainage system, which are shown in **Figure 3.10** Development Plan - Stormwater Catchment Plan, have been established. Some of the outlets are existing e.g. "Lake Broome", Blue Haze and other catchments such as Area 1, 2 and 5 will require new outlets to be constructed under Broome Highway. The locations of the outlets for the catchment are shown in **Figure 3.10**. The new outlets have been discussed with the Shire of Broome ; however they are subject to detailed design, surface water modelling and future approval by the Shire of Broome and other agencies.

- **Catchment Area 1 (Pink) – 51 Ha**

This area grades directly to the west, and the Shire of Broome has advised that any discharge from this area cannot be accommodated in the existing Cable Beach drainage system. Drainage for this area will require appropriate detention and open swale drains to grade out to the intersection of Sanctuary Road and Fairway Drive. The outlet for this area is the Gubinge Road drainage system and the "Lake Broome" detention basin. The land area to the west of the project boundary also grades to the west and will require its own detention system. The detention basins will be able to use the DN 300 low flow pipe into the Cable Beach Drainage system.

- **Catchment Area 2 (Light Blue) – 69 Ha**

This catchment has the steepest slopes, with some areas in the 2% to 3% range. This area grades to the west and north, and at present, effectively discharges into the low area to the north of the Lullfitz Drive special rural area. The discharge location for this catchment is to a low point of around RL 5.0 in the north-west corner of the development area. This location is currently encumbered by a sand mining lease M04/209 (refer to **Appendix B**). The soil has been tested for infiltration rates which give good results down to around 1.5 m, however below that level the infiltration rate reduces markedly. The area has been mined for clean white sand for construction purposes, and appears to be suitable as an infiltration basin with a level of RL 3.1m AHD. Infiltration rates within the sand mining area indicate that it may be possible to design the area for use as an infiltration basin; however this would be subject to further detailed geotechnical investigation. The sand pits do not appear to be in current use, apart from the area to the east. Use of this area as part of the drainage system is yet to be established and will be subject to further detailed investigation and approval.

Figure 3.7 Sand Mining Areas

- **Catchment Area 3 (Green) -214 Ha**

This area grades to the east and south towards Magabala and Gubinge Roads. The outlet for the southern section of this catchment is along the northern side of Gubinge Road and then east to the existing “Lake Broome” drainage basin at the corner of Gubinge and Broome Roads. The “Lake Broome” basin is under investigation to look at ways to rehabilitate the basin tp provide a detention capability and improve the water quality effectiveness. Rehabilitation work will be undertaken as part of the Stage 1 civil works.

The northern section of the catchment will discharge into a swale/detention system on the southern edge of the Environmental Cultural Corridor (ECC) and then by open swale drain into “lake Broome” which has its outlet into the upper reaches of Dampier Creek via a culvert crossing under Broome Highway.

- **Catchment Area 4 (Dark Blue) -112 Ha**

This area is to the north of the existing “Blue Haze” industrial area and grades directly east towards Broome Highway. The southern section of this area will discharge to the upper reaches of Dampier Creek through the existing outlet under Broome Highway. This system will have to be upgraded to provide detention in the system and upgrade of the existing culvert outlet under Broome Highway. The northern section of this catchment will discharge into a swale/detention system in the new ECC. The outlet for this system will be a new culvert crossing under Broome Highway south of the Rodeo and then to the upper reaches of Dampier Creek.

- **Catchment Area 5 (Yellow) – 278 Ha**

This is the largest catchment and generally grades directly east towards Broome Highway, although the northern area grades towards the northeast. This catchment will require a number of linear green spaces extending in an east-west direction to the upper parts of the catchment to allow for the construction of swale/detention systems. The swales will discharge into a north-south detention basin system along Broome Highway which will outlet to the upper reaches of Dampier Creek via two new culvert crossings under Broome Highway on the northern and southern boundaries of the Speedway.

3.3.3. Stage 1 Development Area Plan

Figure 3.11 shows the preliminary catchment plan for the indicative Stage 1 Development area. This area is subject to future detailed design and approval of the Local Water Management Strategy (LWMS) at subdivision level. The catchment plan shows the proposed drainage paths and outlets for the proposed swale and detention basis system.

The catchment areas shown on the plan are sub areas of the overall catchment plan shown in **Figure 3.10**. At this stage the area for Catchment 3-1 is unknown as the design for the area to the west of the Stage 1 DAP is unknown. The other catchment areas are:

- Catchment Area 3-2 18 Ha
- Catchment Area 3-3 24 Ha
- Catchment Area 3-4 16 Ha
- Catchment Area 4-5 12 Ha
- Catchment Area 4-6 11 Ha

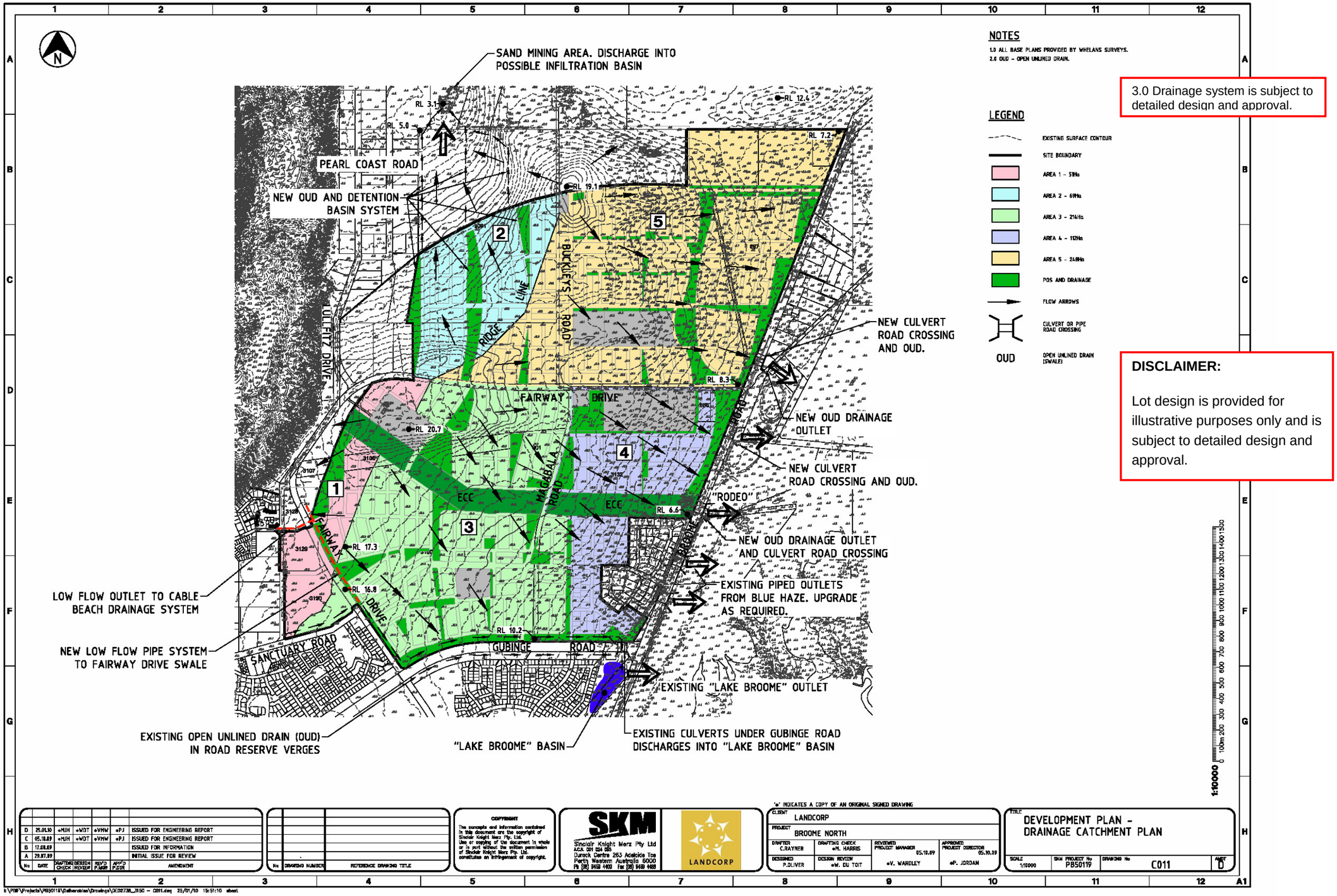
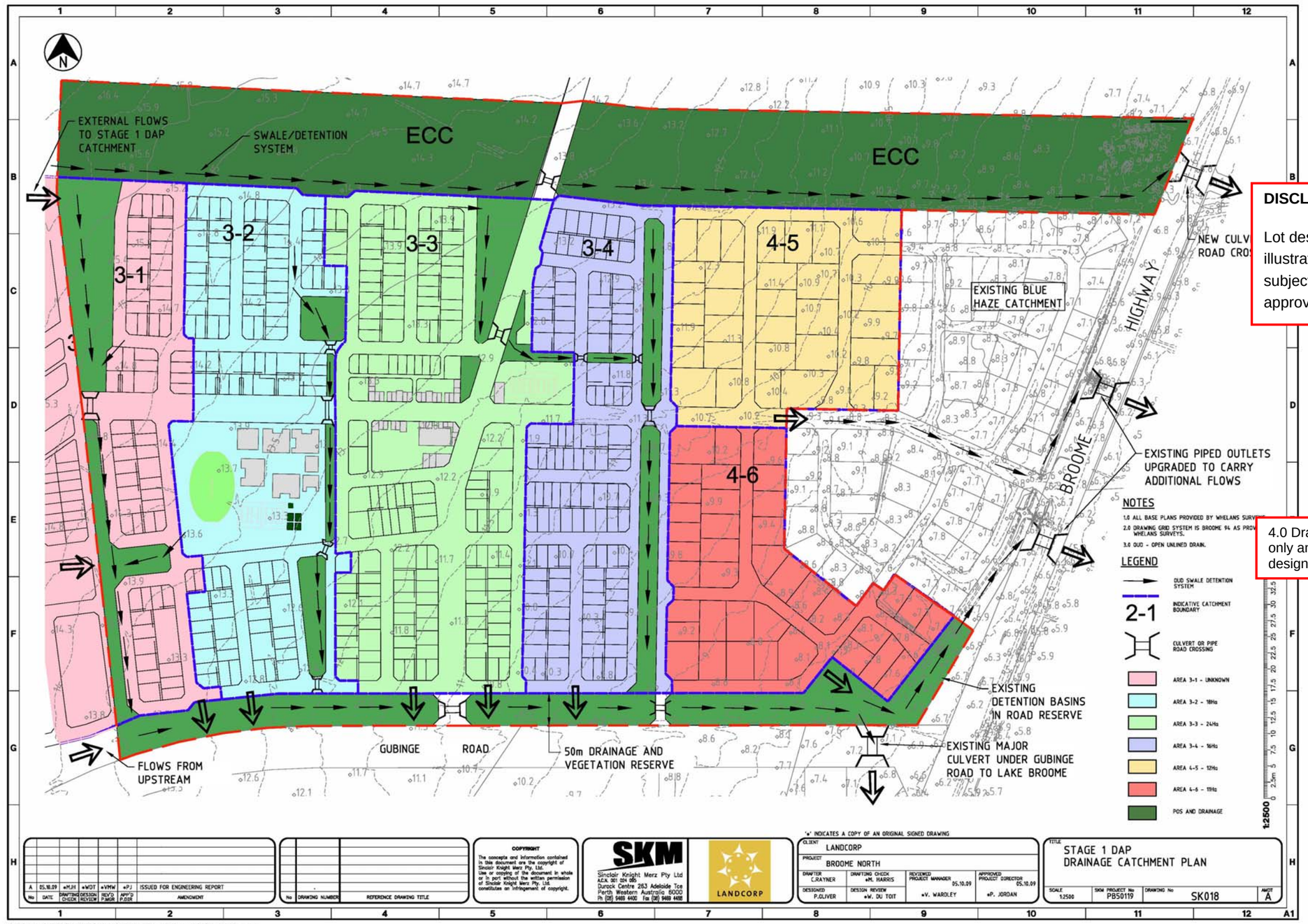


Figure 3.10 Indicative Drainage Catchment Plan – Development Area



DISCLAIMER:

Lot design is provided for illustrative purposes only and is subject to detailed design and approval.

4.0 Drainage design is indicative only and subject to detailed design and approval.

Figure 3.11 Indicative Catchment Plan – Stage 1 DAP

3.3.4. Allotment Drainage and Site Clearing

As part of the review of the environmental sustainability for the project consideration has been given to the use of allotment drainage. Allotment drainage makes provision for those lots which do not naturally grade to the road reserve to be provided with drainage at the rear of the lot. The drainage system at the rear of the lots conveys the stormwater to the road or swale system and generally is required to be designed to contain a Q10 ARI event. The allotment drainage system has the following benefits;

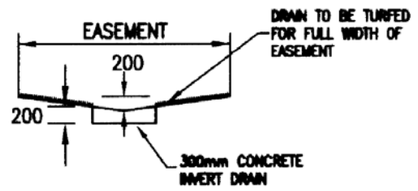
- The potential to reduce the amount of clearing of the vegetation of the lots in the Broome North Development. Natural vegetation is valued by the local community and has other environmental benefits;
- Retention of the vegetation on the lots serves as efficient scour protection reducing Pindan sand being carried in storm runoff into the road system;
- Minimisation of the earthworks required to develop the lots as the rear allotment drain provides the option to grade the lot to the rear, the road verge or both. Grading of the lots must also be consistent with the need to grade out the road system to the open swale drains and detention basins.

A system of allotment drainage was introduced into Stage 4 of the Janubaru project and used a concrete drain at the rear of the lots as shown in Figure 3.8. This system allowed a number of the existing trees to be kept and reduced the earthworks. Design of the system provided for a Q100 ARI event; however only one third of the lot drained to the rear and the balance drained to the road reserve.

Figure 3.8 Janubaru Stage 4 - Allotment Drainage

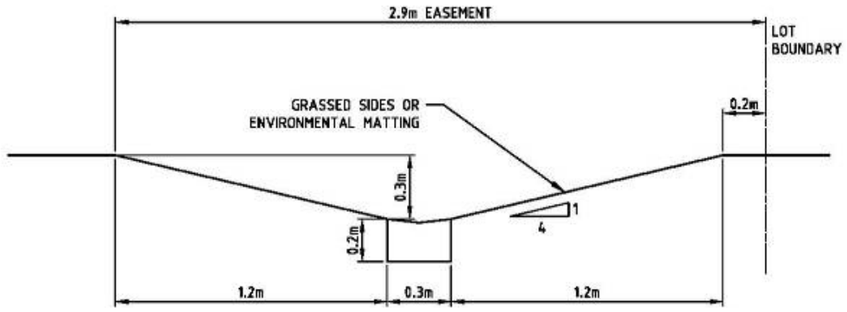
SKM undertook an investigation into allotment drainage elsewhere in Australia. Most of the examples of where allotment drainage has been used occur in Queensland and also the Northern Territory. Examples of the design standards used are;

- **QLD Design Standards:** The FNQROC (Far North Queensland Regional Organisation of Councils) The "Development Manual" provides guidelines for stormwater design that includes above ground allotment drainage. In summary it requires:
  - Above ground drainage (i.e. not piped).
  - Easements are required of minimum 3m or the width of the drain.
  - Design Storm of a Q100 ARI event.
- **Mackay City Council Implementation:** The Mackay City Council regularly uses allotment drainage with the following general principles:
  - Side and back drains are used
  - Turf drains with a 300mm wide concrete base are part of their standard allotment drawings. The concrete base defines the invert level and helps to ensure it is maintained at that level over time.

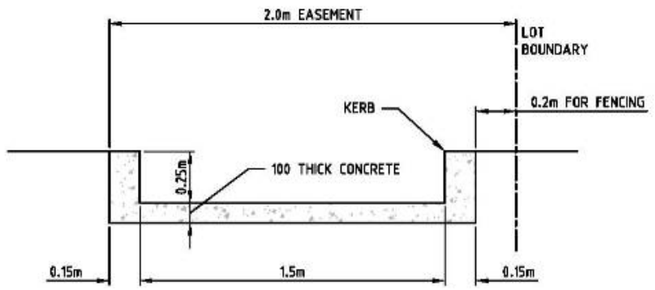


- **Cairns Regional Council Implementation:** The Cairns Regional Council regularly uses allotment drainage with the following general principles:
  - Lot Sizes down to 600m2 have used allotment drainage.
  - Side drains are sometimes used but rear drains are more common
  - Easements are worded such that the maintenance responsibility is on the owner, but allows access by the Shire.
  - Concrete construction is most common but grass or planted swales are sometimes used when slower velocities permit without scour.
  - Community Education is necessary for the unique drainage in this region.

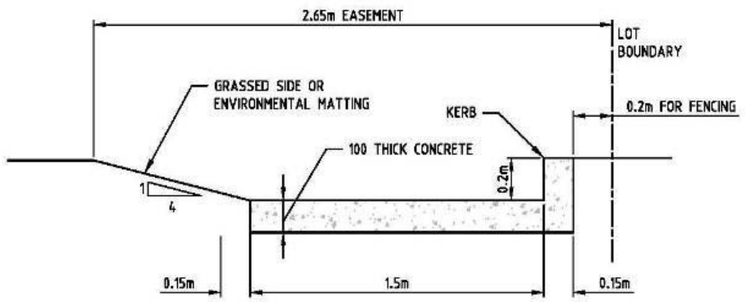
The principles for the use of allotment drainage has been agreed with the Shire of Broome after three alternatives were developed for consideration during the planning phase. The three options are set out below in **Figure 3.9.** The Shire of Broome's preference is Option 3 which will be adopted for detailed design.



Option 1



Option 2



Option 3

Figure 3.9 Allotment Drainage (NTS)

3.4. Stormwater Quality and Best Management Practices

Management of the swales and dry/ephemeral basins will take the form of on-going implementation of structural and non-structural Best Management Practices (BMPs), the maintenance of structural BMPs, public education about the system and water quality monitoring as outlined in the LWMS.

The water quality of stormwater originating from the catchment is proposed to be managed by the following methods:

- Reduce and minimize stormwater flow velocities to aid sedimentation, reduce erosion and reduce the carriage of seeds into the natural landscape;
- Construction of vegetated swale drains and dry/ephemeral detention basins using weirs and low flow drain system to reduce the water velocity to allow settling out of the silt load and the removal of gross pollutants.
- Design the swales to provide a more natural waterway and creek system rather than a more linear conveyance drainage system with no detention of flows;
- Link grassed POS area and multi-use corridors (MUC's) into the swale/detention systems to improve the water quality through the take up of nutrients. The POS areas will be constructed as detention systems with low flow drains ;
- Detention basins with sedimentation traps to maximize the deposition of silt within the basin;
- Provide for natural vegetation re-growth by using topsoil generated from the site on the sides of the swales and the bases of the detention basins. Additional planting of low-lying native plants, in particular grasses, along the sides of the swales and basins, for filtering of sediments and nutrient removal;
- Where possible, restoration of natural drainage pathways to utilize natural nutrient stripping properties of existing vegetation;
- Promotion of a maintenance and education program for optimal performance of stormwater system; and
- Potential for infiltration at the outlet for Catchment Area 2 by the re-use of the existing sand mining area at the north-western comer of the catchment.
- Use of slow-release organic fertiliser.

The effectiveness of the detention basin with a low flow outlet is shown in **Figure 3.12** below, where a significant buildup of rubbish, debris and seeds has accumulated behind the weir wall. The effectiveness of the low flow outlets will be improved as part of the detailed design for the Broome North basins and weirs.

Figure 3.12 Typical Detention Basin Weir with Low Flow Outlet – Upper Catchment

3.4.1. Water Quality Modelling

An industry- standard water quality stormwater modeling software tool “MUSIC” or similar will be used to assess the efficiency of the water quality treatment system. The “MUSIC” model estimates the quantities of flow, Total Suspended Solids, Total Phosphorus, Total Nitrogen and Gross Pollutants from catchments. When the mean annual loads produced from the existing and mitigated catchments are compared the effect of the development can be assessed.

The water quality target for the system is proposed to be;

- At least 60 per cent reduction of total phosphorus;
- At least 80 per cent reduction of total suspended solids;
- At least 45 per cent reduction of total nitrogen; and
- At least 70 per cent reduction of gross pollutants.

Water quality modelling has been carried out on the previous Stage 4 Janubaru swale and detention system. The development was modelled using the water quality software “MUSIC”, comparing the annual pollutant loads from the site in both the existing and developed cases. The efficiency of the ‘as constructed’ system was assessed against current accepted target values and the results of the modelling, shown in **Table 3.1**. This indicates that while the targets for Total Suspended Solids, Gross Pollutants and Total Phosphorus are exceeded, indicating that the swale and detention basin system is appropriately sized, the target for Total Nitrogen was not achieved.

Table 3.1 MUSIC Model Results - Janubaru Stage 4

Pollutant	Reduction Afforded by Treatment	Target Reduction
Total Suspended Solids (%)	88	80
Total Phosphorous (%)	66	60
Total Nitrogen (%)	21	45
Gross Pollutants (%)	100	70

Nitrogen is most efficiently removed through the use of vegetated bio-retention basins. This is not possible in the Broome environment due to the need to limit the standing water to reduce health risks from mosquitoes. The detention treatment is designed to ensure that detained immobile stormwater is fully discharged in a time period not exceeding 72 hours. More work is therefore required to integrate the POS and vegetated areas with the drainage system.

3.5. “Lake Broome”Gubinge Road Drainage Basin.

Gubinge Road surface water runoff discharges into table drains located adjacent to the carriageway shoulders and then into the “Lake Broome” drainage basin. A catchment plan for the Gubinge Road route was developed as part of the Broome Highway Planning Study – Route Definition Report prepared by Western Infrastructure - March 2003 which included areas of the Broome North development site to the north of Gubinge Road. Developed areas discharging into the drainage basin include, Roebuck Estate and Sunset Park residential estate. Future areas to discharge into the basin include the development to the west of Jigal Drive and a section of the Broome North development area.

The Route Definition Study proposed to attenuate the peak runoff from the catchment area using a number of compensating basins for each sub-catchment, however, at this stage there is no attenuation or detention on any of the stormwater flowing into the drainage basin.

Outflow from the existing catchments is conveyed by a major drainage channel located between the highway and the service corridor at the edge of the road reserve and via a major culvert system under Gubinge Road as shown in **Figure 3.13**.The “Lake Broome” drainage basin is a very large excavated area as shown in **Figure 3.14** and was originally a “borrow pit” remaining from excavation of Pindan for the construction of Gubinge Road and other roads in the Broome area (Shire minutes). The outfall from the drainage basin is to Dampier Creek via a culvert structure under Broome Road.

Figure 3.13 Gubinge Road Culvert Crossing

Figure 3.14 “Lake Broome” Drainage Basin

At present, the basin may act as a detention basin, due to the capacity of the culvert under Broome Highway. The survey of the area shows that the basin does not grade out to the outlet and often contains pools of water for a significant time until the water is evaporated.

The Shire of Broome would like to upgrade and rehabilitate the basin to ensure that the basin provides a detention function and improve the water quality of the outflows to Dampier Creek. “Lake Broome” will be rehabilitated as part of the Stage 1 civil works for Broome North. The work will include the design of the drainage system and reconstruction of “Lake Broome” as a detention basin with tidal control.. An indicative rehabilitation strategy is suggested in **Figure 3.17.** The final layout will be subject to detailed design and approval working in conjunction with the Shire of Broome. K**ey elements** could include:

- Re shape the basin to form vegetated islands which will provide a better visual amenity for the area. Construct walking tracks with bridges over basins and weirs. Some examples of possible pedestrian bridges and the detailing of a low flow creek are shown in **Figures 3.15** and **3.16**. The low flow creek is from a Queensland example and whilst it is not typical of Broome it is indicative of how the creek can be constructed.
- Use the islands to construct smaller basins with detention weirs and low flow outlets and provide for all basins to grade to the outlet.
- Upstream reconstruction of the open drains to provide smaller detention basins and attenuation of peak flows.
- Construct a main low flow channel as a meandering creek bed to create a natural waterway. The low flow channel to be designed to deal with the velocities produced in a Q1 short term event with stone scour protection along the waterway.
- Plant native vegetation on the islands, creek banks and the base of the basin.
- The reshaped basin has a significant detention volume depending on the depth of storage which is dictated by the heights of the overflow levels on the weirs; however it may be that the basin cannot meet the required Q50 pre-development flow detention required by the Shire of Broome’s drainage guidelines.

There is no attenuation of any of the flows entering the existing drainage basins. Therefore to ensure the best possible performance it will be necessary to address the existing deficiencies by upgrading the existing drainage systems discharging into the basin. This can be done by retrofitting detention structures systems into the existing open drains and better integrating the drainage with the open spaces. The design of the drainage system will require modelling using industry-standard surface water modelling software package such as XP-SWMM.

Figure 3.15 Pedestrian Walkway Bridge

Figure 3.16 Creek and Bridge

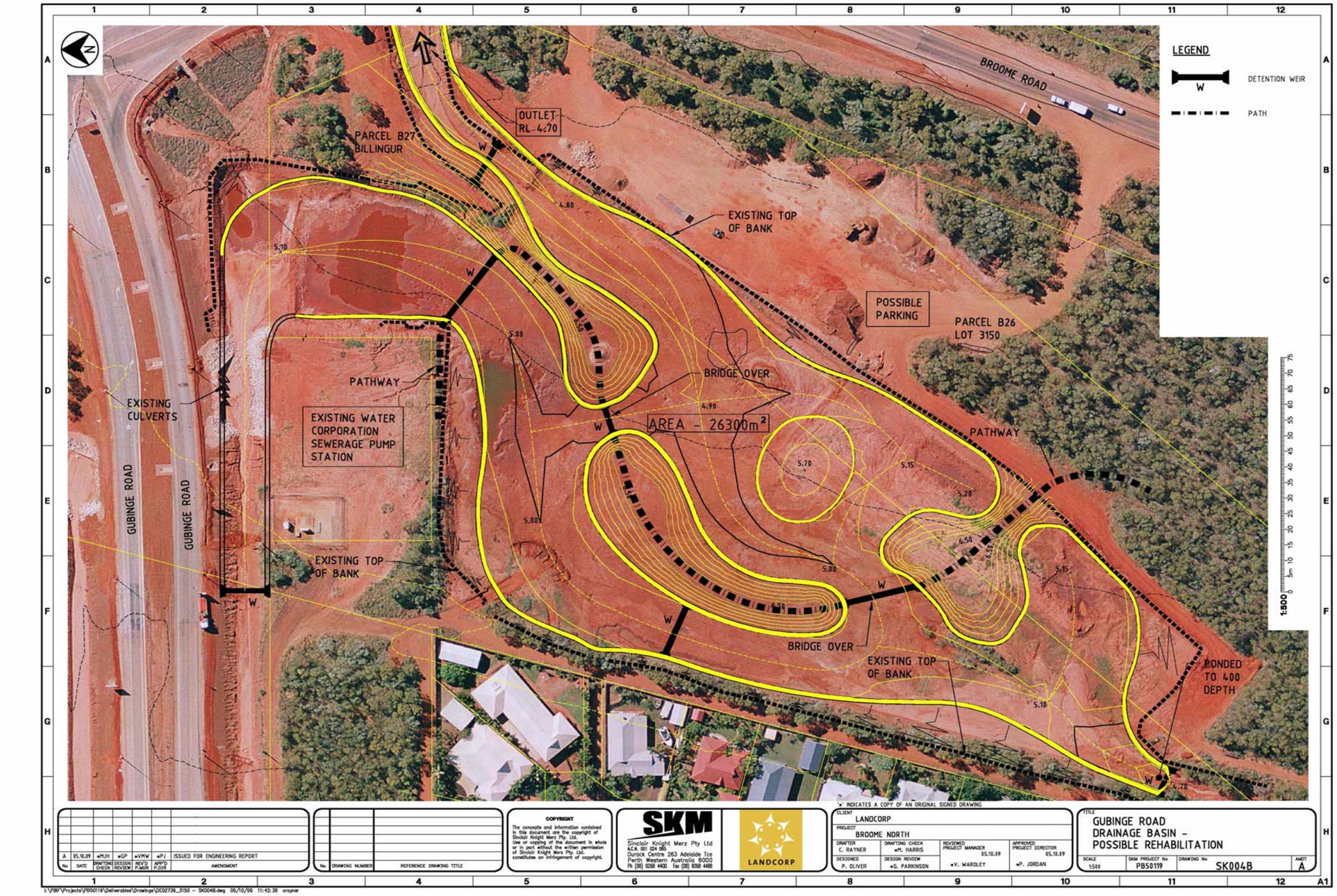


Figure 3.17 "Lake Broome" Rehabilitation Plan

4. Water and Sewerage

4.1. Existing Water Services

The Broome North development site currently has a traditional water supply system to existing lots within the development are, such as Blue Haze Industrial Area. The area contains a 3.4 Ha Water Corporation tank site off Fairway Drive.

The Broome North development site currently has three existing wastewater pumping stations that currently discharge to the south with treatment at the existing Broome South WWTP. Ultimately these flows will be pumped via the upgraded Broome North PS 6, Ocean Drive north to the proposed Broome North WWTP scheduled for commissioning in approximately 2010. The future development of Broome North will initially also discharge to Broome North PS 6.

4.2. Water Demand

Additional water for the Broome North development is calculated to be 3.3 GL per annum. The design inputs used to estimate the water demand are summarised in **Table 4.1** below.

Table 4.1 Water Demand Estimate for Broome North development

Description	Value	Comments
Current Demand in Broome (GL/a)	4.7	2007/08
Residential		
Connections – existing (No)	4146	2007/08
Historic demand (kL/connection/a)	563	Average 2004-2008, WC*
Connections – additional (No.)	4833	Lot yield of development
Percentage increase of connections (%)	116	
Additional residential demand (GL/a)	2.7	
Commercial		
Connections – existing (No.)	1178	2007/08
Historic demand (kL/connection/a)	997	Average 2004-2008, WC*
Connections – additional (No.)	589	Assumed
Percentage increase of connections (%)	50	Assumed
Additional commercial demand (GL/a)	0.6	
Combined		
Total Additional Demand (GL/a)	3.3	Equates to 9 ML/day (average)

Source: Water Corporation of WA, 29/6/09

4.3. Water Source

Water Corporation has identified that sustainable yield of the existing town water source is 10.6 GL/annum. DOW (2008) indicates that the long term demand for Broome in 2030 is 9.4 GL/a, including system losses and tourist population.

The estimated total water demand for Broome including the Broome North development is 8.0 GL/annum. This total incorporates the 2009 production of 4.7 GL/annum and the future estimated water demand from the proposed development of around 3.3 GL/annum.

The existing water source is expected to be sufficient.

Groundwater quality is good with only chlorination and fluoridation treatment. New production bores are likely to include pH correction.

4.4. Water Supply

A 3.4Ha tank site is located at Cable Beach (off Fairway Drive), as shown in the Contour and Land Ownership Plan in **Appendix A**. A 10ML tank currently exists on the site. Water Corporation is undertaking the definition phase for a new 10ML tank on the site, with room to duplicate the tank at the same site in the future. In order to contain infrastructure in a single location, the Water Corporation requires a 3.1Ha expansion of the existing site to the south east. The total of 6.5 Ha will allow the Water Corporation sufficient room to incorporate the long term planning requirements for the Cable Beach area (in addition to the Broome North development) and provide sufficient room future infrastructure which is likely to include 80ML ground level storage, elevated storage, pumping station, overflow sump, concrete skirting, vehicle access and on site drainage. The additional area required by Water Corporation does not include any allowance for a vegetation buffer to provide visual screening of the tanks. However, a vegetation buffer may be provided in the future if the layout of all infrastructure allows sufficient room.

An additional tank site is recommended for the Broome North development area north of Fairway Drive (incorporating B27 parcel). A tank located to the west of Buckley's Road would service this area, as indicated on **Figure 4.1** below. This site may also be used for a future recycled water tank.

Figure 4.1 Proposed additional water tank site

A 30 ML tank on Blackman Road is currently pending funding approval, though this tank does not service the Broome North area.

Water reticulation mains will be required for the development area sized up to DN300 PVC.

4.5. Sewerage

The estimated ultimate wastewater flow contribution is estimated at 7.0 ML/d (average dry weather flow). Design inputs are presented in **Table 4.2**.

Table 4.2 Wastewater flow estimate for Broome North Development

Description	Value	Comments
Residential		
Connections – existing (No.)	4146	2007/08
Connections – additional (No.)	4833	
Population per dwelling (No.)	3.0 - 3.5	Water Corporation, *Wastewater Manual Vol. 1*, Table 4.2
Flow contribution (L/person/day)	230	
Additional residential flow contribution (ML/d)	5.1	At 3.5 persons/ dwelling
Commercial (expansion of existing commercial areas or new areas within development)		
Flow from suburban commercial area (L/Ha/d)	12,075	Water Corporation, *Wastewater Manual Vol. 1*, Table 4.3
Suburban commercial area (Ha)	82	Lot yield of development
Additional commercial flow contribution (ML/d)	1.9	
Combined		
Total Additional Discharge (ML/d)	7.0	Equates to 2.5 GL/a (ave)

Depending on the planning, there will be a requirement for up to three additional sewerage pump stations and associated infrastructure to service the future development comprising:

- 1 x Type 90, 6,000m DN250 PM and Emergency Storage
- 1 x Type 40, 1,000m DN150 PM and Emergency Storage
- 1 x Type 10, 300m DN100 PM and Emergency Storage

The location of the new sewerage pump stations (PS) will be the subject of a future catchment analysis, however, in general, the PS will be located in the lower areas of the catchment. Each PS and pressure main will pump to a gravity system.

Detailed planning will be required for the development plan area in addition to that already completed, shown in **Figure 4.2** Sewer Planning for Lot 3150 (B26 l Parcel).

4.6. Wastewater Treatment

Water Corporation has an existing wastewater treatment plant (WWTP) on Clemenston Drive with capacity of 3.5ML/day. Treatment is via ponds, including the deep anaerobic “smart pond” system.

A second WWTP is being constructed to the north east of the town on 200Ha of land at Crab Creek. Stage 1 capacity is 3.5ML/day with facultative pond treatment plus aeration. Ultimate planned capacity is 10.5ML/day.

Current Water Corporation planning for treated wastewater disposal for Stage 1 is irrigation of Rhodes Grass adjacent to the new WWTP. Water Corporation plans to undertake a review of wastewater management options for the longer term prior to the implementation of Stage 2 of the WWTP (in approximately 2021).

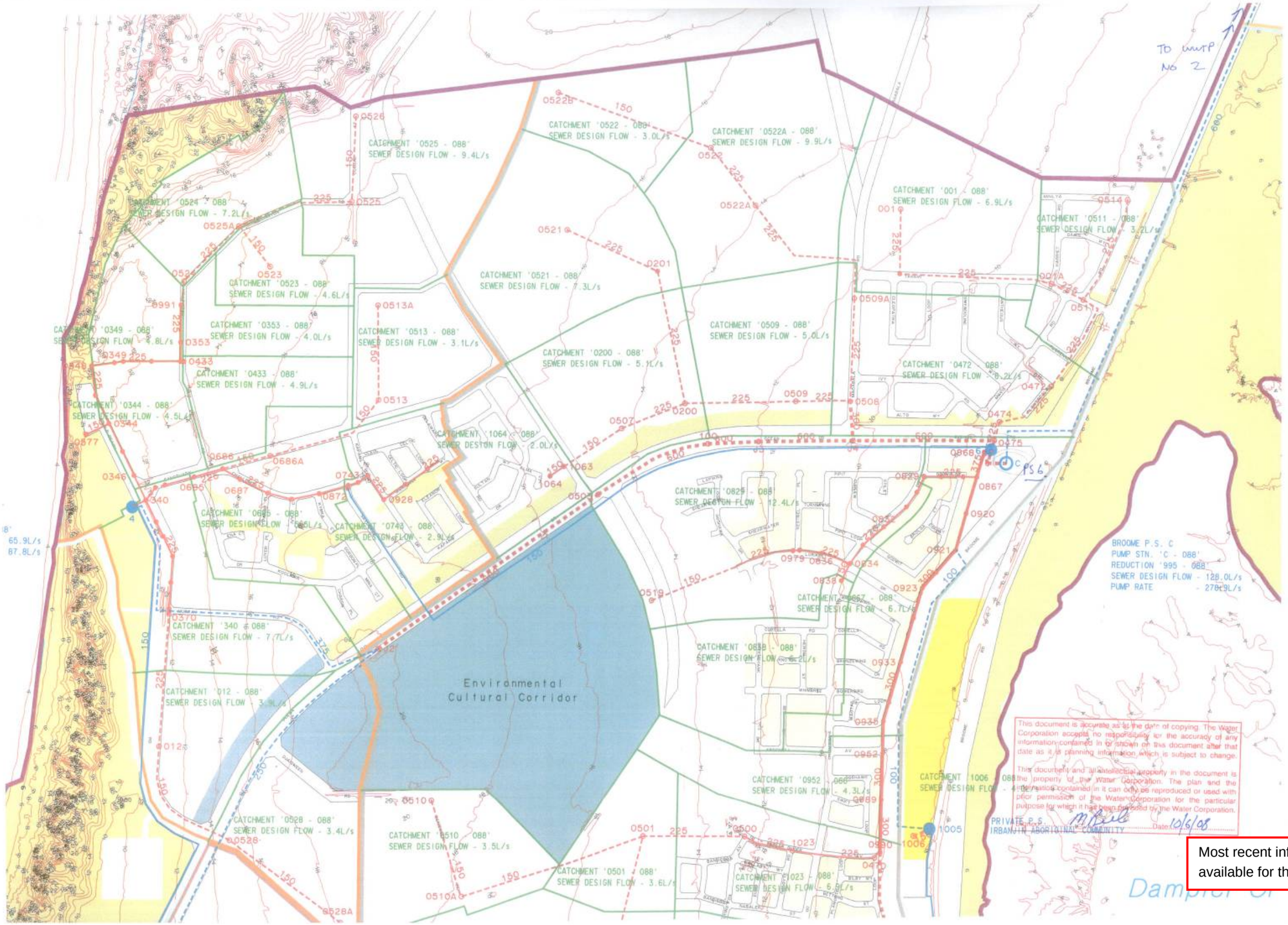


Figure 4.2 Water Corporation Sewer Planning for Lot 3150

5. Effluent Reuse Discussion Paper

5.1. Introduction

Recycled water has many applications that can be considered for the proposed Broome North development including:

1) Industrial reuse – generally used for process make up, washdown applications and fire services, it is not applicable in Broome North as no industry is proposed at this stage in the Development Area. There may be opportunities in the Blue Haze area and the future proposed industrial area zone to the north-east along Broome Road.
2) Public Open Space (POS) sports field/ golf course irrigation – treated wastewater from the existing Broome WWTP is irrigated on the adjacent golf course and ovals around the town.
3) Groundwater Replenishment (GWR)/ aquifer storage and recovery (ASR) – highly treated wastewater is injected into an aquifer to replenish supply, or for storage then recovered for reuse.
4) Dual reticulation – is the installation of second reticulation system for non-drinking water uses (such as toilet flushing, fire fighting and garden watering through trickle irrigation).

This discussion paper considers dual reticulation, with irrigation of local POS, for Broome North as it is a predominantly residential development.

Guidelines that are particularly applicable to Western Australia include *Australian Guidelines for Water Recycling* (2006) and draft *Guidelines for the Use of Recycled Water in Western Australia* (2009). Both of these can be applied to blackwater recycling schemes (which includes water from toilet flushing. The *Code of Practice for the Reuse of Greywater in Western Australia* (2005) is also applicable for greywater schemes (which exclude water from toilet flushing). Broome North is assumed to be a blackwater recycling scheme.

The Water Corporation currently has no formal position on dual reticulation and considers each development on its own merits.

5.2. What happens elsewhere (in Australia)?

There are a number of dual reticulation (recycled water) schemes throughout Australia in particular:

- Rouse Hill in Sydney, NSW;
- Aurora Estate in Melbourne, Victoria; and
- Mawson Lakes in Adelaide, South Australia.

A summary of the main existing scheme features is presented in **Table 5.1**.

Table 5.1 Existing residential recycled water schemes in Australia

Scheme	Rouse Hill, NSW	Aurora Estate, Victoria	Mawson Lakes, SA
Location	35km north-west of Sydney's CBD	20km north of Melbourne's CBD	15km north of Adelaide's CBD
Established (dual reticulation operating)	2001	2009	2005 2010 (full development)
Number of lots	18,000+ 36,000 (ultimate)	8,000	4000
Recycled water source	Municipal wastewater	Municipal wastewater	Municipal wastewater & stormwater
Recycled water use	Flushing toilets Watering gardens Washing cars	Flushing toilets Watering gardens Washing cars	Flushing toilets Watering gardens Washing cars
Drinking water saved	40% (whole scheme)	33% per home	Up to 50% Or ~110kL/house
Usage charge recycled water	$1.496/kL (80% drinking water)	Same as lowest tier	75% drinking water ($0.77/kL in 04/05)
Usage charge drinking water	$1.87/kL	3 tier pricing: $1.25/kL up to 440kL/a $1.47/kL for 441-880kL/a $2.17/kL over 881kl/a	3 tier pricing: $0.71/kL up to 120kL/a $1.38/kL over 120kL/a $1.65/kL over 520kl/a (excluding multiple residential blocks e.g. flats)
Source	www.sydneywater.com.au	www.yvw.com.au	www.sawater.com.au

Dual reticulation is being installed in new homes in the Pimpama Coomera region of the Gold Coast, Queensland, as part of the Pimpama Coomera Master Plan. The scheme has recently commenced operation and is planned to provide 25.5 ML/day recycled water in 2056 to greenfield areas via dual reticulation.

Smaller schemes are also operating, though generally with decentralised treatment. New Haven Estate located about 18km from Adelaide is a small scheme (<100 houses) established in 1995, which was the first to use recycled water for toilet flushing.

Gracetown in south west WA is a proposed development of 140 dwellings that incorporates recycled water for non-drinking water uses. Construction is currently planned to commence in 2010 (Cleary *et al*, 2009)

5.3. What would a Broome North scheme look like?

5.3.1. Recycled water use

The most likely uses for recycled water in a residential dual reticulation scheme are:

a) Toilet flushing;
b) Garden irrigation; and
c) Irrigation of public open space (parks, ovals, verges etc).

This discussion paper assumes all three uses have potential for further development area, and discusses a potential scheme and associated issues on that basis.

5.3.2. Recycled Water Classes

In 2006, Australian Guidelines for Water Recycling were released. These guidelines use a risk management framework, rather than relying on ongoing monitoring to manage schemes. The framework incorporates a proactive approach to identify and manage risks, rather than reacting to issues as they arise. They provide a national approach to developing recycled water schemes whilst allowing enough flexibility to account for state requirements and local issues. The Water Corporation is currently using these guidelines in the context of Water Forever.

Western Australia has draft guidelines for the use of recycled water. Until April 2009, the guidelines utilised a class grading system, summarised in **Table 5.2**. In April 2009, the draft guidelines were revised and reissued and now recommend a risk management framework in accordance with the Australian Guidelines for Recycled Water.

Table 5.2 Recycled Water Classes from Draft *Guidelines for the Use of Recycled Water in Western Australia* (superseded April 2009)

Recycled Water Class	Quality	Range of uses
A+	 Increasing bacteriological, physical and chemical water quality objectives and level of required treatment	Indirect potable reuse and aquifer recharge
A		Toilet flushing and garden watering, irrigation with uncontrolled public access, industrial (open systems)
B		Agricultural (dairy grazing), industrial (washdown water)
C		Urban non-potable irrigation with controlled public access, agricultural food crops (processed/cooked)
D		Agricultural non-food crops (turf, woodlots)

Several Australian states have recycled water guidelines including Queensland, NSW, Victoria and South Australia. These guidelines are similar to the draft Western Australia guidelines, with some variations in approach.

5.3.3. Treatment and balancing storage

An advanced treatment process would be supplied at the end of the existing WWTP to produce a highly treated recycled water stream. Whilst process selection would need to be reviewed during detailed planning and preliminary design phases, a possible process for advanced treatment would comprise:

1) Membrane Bioreactor (MBR) – activated sludge process that would provide biological treatment and consume nutrients (nitrogen and phosphorus). MBRs are available in microfiltration and ultrafiltration sizes with the latter could provide the required level of virus removal. MBRs also provide a disinfection barrier.
2) Disinfection – chlorination would provide effective disinfection and a residual that would protect the recycled water reticulation system.
3) Storage – a balancing storage tank (1ML) would be required to balance the daily fluctuations in demand that the system would experience. A larger storage would be required for storage of recycled water during the wet season when garden watering and irrigation were reduced.
4) Contingency – in the event that the recycled water system failed, a contingency method of managing/disposing treated wastewater is required. It is assumed that the recycled water plant would default to the existing disposal method planned for the WWTP No. 2.

5.3.4. Transfer and Supply System

A transfer pump station would be located at the recycled water plant delivering recycled water through a pressure main (in the order of 10km DN250, depending on pipe route) to a storage reservoir.

The recycled water storage reservoir would be located adjacent to the potable water reservoir. It is assumed that a booster pump station to raise the system pressures would be required, similar to the existing Cable Beach water reservoir. The booster pump station would then supply distribution mains (in the order of DN150 at 15m of main per lot, depending on lot layout and system design).

Each lot would then have a connection and reticulation that supplied toilets in the dwelling and outside taps for garden watering.

All distribution and pressure mains, reticulation, plumbing, fittings and fixtures would be purple (lilac).

5.4. Advantages and Disadvantages of a scheme

Table 5.3 Advantages and Disadvantages of a scheme

Advantages	Disadvantages
Reduced consumption of drinking water by up to 40% (from Rouse Hill)	Storage during low demand periods (wet season)
Substitution of potable water use, delayed implementation of borefield expansion	Over treatment – providing higher quality water than is required for the use
Reduced discharges to the environment (e.g. Roebuck Bay)	Technically more complex treatment. Do operator and maintenance skills match?
First major domestic reuse scheme in WA. Opportunity for a pilot scheme.	Cost and operational responsibilities not known

5.5. Policy issues

Water Corporation policy for third pipe (non-drinking water) is still being defined. Third pipe schemes are currently considered on a case by case basis and assessed on its merits. Contingency operation should be assessed for all schemes in the event the system fails.

The Water Corporation is currently reviewing the Australian Guidelines for Recycled Water (2006) and testing the framework methodology on specific projects. For a significant recycled water (dual reticulation) scheme, such as Broome, it is likely that a risk management approach would be required.

The traditional method of costing a recycled water scheme should be reviewed. A total water cycle cost approach is recommended to incorporate the benefits of delays to water source expansion and the reduction in wastewater disposal through traditional methods.

6. Power

6.1. Introduction and Background

Land Corp is proposing to redevelop lots 3150 and 304 north of the Broome town site. The development could involve up to 6,000 residential lots mixed with some commercial and light industrial use with a population of approximately 12,000 to 15,000 people. This represents a substantial expansion to the existing town site almost doubling the size of Broome. The need for new infrastructure to service this urban growth in a sustainable way is significant.

6.2. Existing Power Infrastructure

Electricity is generated at the Broome Power Station located on McDaniel Road in the southern end of the town site. The Power Station was fully operational from 2008 and is owned-operated by Energy Development Limited (EDL) comprising 25 Gas Engine driven alternators supplied by trucked LNG delivered from a 200tpd LNG plant in Karratha. The LNG is stored in tanks at the Shire's refuse site at the northern end of Buckley's Road. Gas is delivered to the power station in McDaniel Road via a pipeline which is located in the Buckley's Road and Magabola Road reserves.

Horizon Power is responsible for the network management, operation, maintenance and retailing (procurement and sale) of electricity in Broome. Horizon Power is also responsible for the planning of generation and distribution development in the Broome power network. The electricity generated by EDL is supplied to Horizon Power under a Power Purchase Agreement (PPA) for a term of 20 years.

The EDL Power Station generates electricity at 690V that is then transformed to 33kV by step-up power transformers for transmission by three express 33kV Horizon Power overhead line feeders to the Horizon Power 'Frederick Street' 33/11kV Zone Substation. At the 'Frederick Street' substation power is transformer from 33kV to 11kV for distribution around the Broome town site by overhead and underground feeders. 'Frederick Street' substation currently comprises three 27MVA transformers. An interconnection between the new EDL Power Station and the old Diesel Power Station at 33kV also exists, this is only used to provide limited supply in an emergency.

The existing Broome town system Maximum Demand (MD) is 27MW.

6.3. Future Requirements

An ultimate development of some 5,000 residential, commercial and industrial lots including schools, neighbourhood shopping centres, business centres and large shops would equate to an increase in MD of approximately 40MVA requiring additional electricity supply capacity and infrastructure. The final increase in MD could be lowered if the take-up of available renewable practices and renewable energy technologies is encouraged or incentivised further by builders, land developers and Land Corp.

Horizon Power have proposed from Preliminary Planning undertaken in mid-2008 that a new 33/11kV Zone Substation named 'Bilingur' substation would be installed by December 2010 north of Lot 3150 at the corner of Fairway Drive and Buckley's Road. Following Land Corp's Preliminary Design Forum held in Broome during August 2009, the substation location was revised and moved a short distance to the north of Lot 3132 at the corner of Fairway Drive and Magabala Road. A vegetation buffer will be provided for visual screening.

The new substation will require extension to the existing 33kV network involving two new express cable feeders from the existing 'Frederick Street' Zone Substation. Horizon Power's preferred route for these new cables is a direct route that passes through conduits already in place under the airport runway. It is anticipated that the two new express cable feeders will be run on either side of the Magabala Road to achieve 'route diversity' that provides adequate supply security. A plan of the proposed alignment for the new feeder cables is shown on the plan in **Appendix G**. It should be noted that the alignment which affects the development area is along Magabala Road. The 2 feeders would be installed either side of existing roads to provide a level of route diversity.

The ultimate capacity of the new 'Bilingurr' 33/11kV Zone Substation will be two 27MVA transformers. Indoor 33kV and 11kV switchgear will be installed at the new substation. One of the existing three transformers at the 'Frederick Street' may be relocated to the new 'Bilingurr' substation for the initial development. Also, some existing loads in the Bilingur area are likely to be transferred to the new substation. The Horizon Power planning for the new 'Bilingurr' substation has been based largely on the "Report of the Broome Planning Steering Committee – December 2005" and Land Corp's Preliminary Design Forum. A layout of the proposed Bilingurr Zone substation is shown in **Figure 6.1** below.

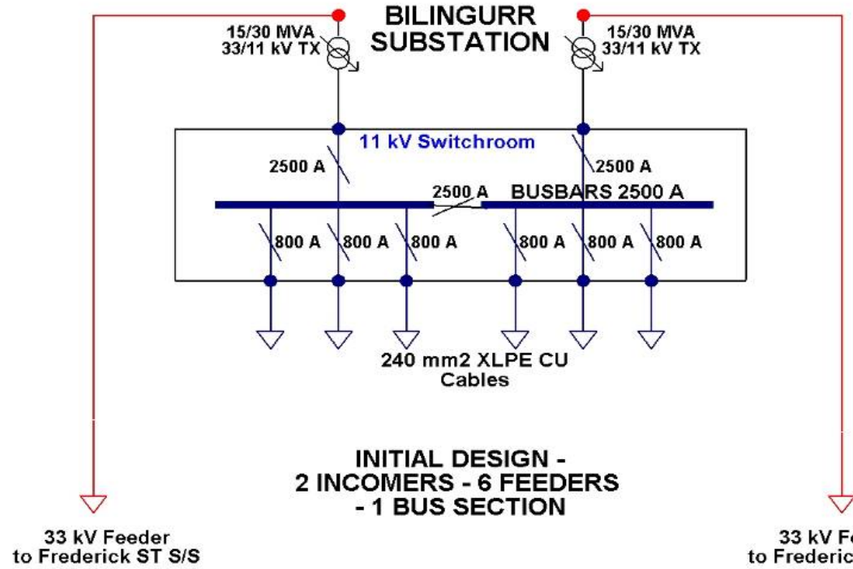


Figure 6.1 Proposed Bilingurr Zone Substation

A 33kV indoor switchboard may be added by Horizon Power to cater for a potential future new substation to the north-east of Broome North development area catering for load beyond the scope of Broome North.

The Horizon Power planned in-service date for the new 'Bilingurr' substation is December 2010 which was based on a land acquisition date in mid-July 2009. The 33kV cable procurement is understood to be Horizon Power's critical path item, and as such, it is essential that the location of the site be finalised as soon as possible. Although the land acquisition has not taken place, Horizon Power is believed to still be on schedule.

A standard lot size of 100m x 100m (1.0Ha) is understood to be required by Horizon Power. The lot will include a substantial buffer zone as the actual utilised area for the substation plant and equipment is expected to be only 30m x 50m. Normally, landscaping in the buffer zone to screen the substation equipment is provided around Zone substations.

A number of new 11kV feeders (ultimately up to 8) originating from the new 'Bilingurr' Zone Substation would be installed in a ring formation to distribute electricity throughout the new Lot 3150 and 304 development area to provide redundant 11kV supplies. Standard pad mount 11kV RMU and 11/0.415kV 630kVA Modular Packaged Switchgear (MPS) transformers together with connecting 11kV and 240/415V buried cables would be installed to provide electricity to the individual lots. Street, park and walkway lighting will also be required and will be supplied from the MPS transformers. Sole-use 11/0.415kV pad mount transformers would normally be required to provide electricity supply to water and sewage pump stations. The 11kV and 415/230V underground distribution system would resemble that found in the Broome area for a new sub-division development. A master plan of the ultimate 11kV distribution design for Broome North has been prepared and included in **Appendix F.**

At present, there appear to be no plans for an interconnection of the Broome power system with neighbouring town Derby or with the potential LNG gas hub development in the Broome area. Any interconnection would require transmission voltages above the current 33kV system.

7. Renewable Energy and Power Demand Reduction

The development of new infrastructure presents the opportunity for the implementation of latest or emerging sustainable programs, practices and renewable energy technology. These programs, practices and technologies include:

7.1. Solar Power

a) Small scale grid connected Solar Photo Voltaic (PV) cells
Horizon Power Renewable Energy Buyback Scheme facilitates the grid connection of residential or commercial sources of renewable generation including PV cells. A new government incentive is now in place where additional Renewable Energy Certificates (RECs) are issued to households that install PV cells. This source of funding replaces the previous Solar Rebate Scheme.

b) Solar hot water systems
Installation of solar hot water systems for residential and commercial buildings will reduce the reliance on traditional gas and electric hot water systems that contribute to the green house gas emissions. Government rebates are available for the installation of solar hot water systems.

7.2. Demand Side Management

a) Smart grid technology
This technology involves improved energy management, greater customer choice, dynamic management of the power system operation, environment benefits and deferment and optimisation of expenditure. Key elements of smart grid technology can include:

- Meter data management systems
- Advanced metering providing in-house consumption, smart tariffs and direct load control by the network operator
- Smart network sensors and distributed automation
- New digital communications and advanced SCADA applications
- Energy aggregation
- Distributed and micro generation

This technology seems to be in an early stage of development with various utilities across the globe running pilot schemes with varying implementation topologies.

b) Distributed Under-Frequency Load Shedding (UFLS) at customer main switchboards
Installation of UFLS relays at customer main switches can interrupt non-essential loads avoiding the need for additional capital expenditure to meet peak system demand periods that may only occur for several days each year.

c) Air-conditioner load control
The remote tripping of non-essential loads such as air-conditioners during system peak conditions can also help avoid the need for additional capital expenditure to meet the rare peak system demand periods. Up to 80% of WA households have installed air-conditioners. Western Power has run a pilot program in the Nedlands-Claremont-Dalkeith area of Perth over the 2007/08 summer period with significant reductions in household peak demand.

d) Energy efficiency (heating, cooling, appliances and lighting)
Government rebates are available for fridges and freezers with a 4 star energy rating and above. Rebates are available for air conditioners with a 5 star energy rating and above for cooling. Rebates for controllers (timers, sensors) are also available. The phasing out of incandescent lighting and replacement with compact fluorescent lighting is another example of government initiative.

7.3. Tidal power generation

The Kimberley coast is subjected to large tidal movements that would provide an ideal resource for power generation in the area. Proponents in the past have investigated tidal power developments without success at Wyndham and Derby where the tidal resources available are higher than at Broome.

7.4. Wind power generation

Wind generation can take the form of grid connected small scale micro-turbines installed at residential and commercial premises much like solar PV cells but unlike PV cells turbine can create noise issues. Alternatively, large scale installations can be connected to the grid. Horizon Power has connected relatively large wind generation to remote power systems at in northern half of WA at Denham and Exmouth. Penetration of large wind generation into small remote power systems has required hybrid power generation with new control schemes of the fossil fuelled generation to cope with the non-dispatchable nature of wind generation. However, Broome is not in an ideal wind resource location.

7.5. Green energy

Horizon Power offers a “Green Select” product allowing customers the option to purchase electricity from a renewable source. Horizon Power purchases electricity from renewable sources on the customers behalf displacing traditional fossil fuel sourced generation and increasing demand for renewable energy development and technology.

7.6. Bio energy (land fill gas and biodiesel)

Potential for land fill gas generation using methane reclamation from rubbish dump could be an option to examine further. Biodiesel fuelled generation also remains an option with sources of fruit and vegetable feed-stock grown locally in the Broome area.

7.7. Construction

- Selection of building and insulation materials

  This involves the use of high thermal mass materials to reduce the loss of heat from buildings and release heat slowly at night time during winter. During summer these materials help keep the building cool during the day and reduce the solar heat gain.

- Building design orientation and landscaping

Key aspects include:

- Shade from verandas and stilt construction for air flow
- Consideration of the prevailing winds and their cooling effect on buildings
- Maximising north facing windows that preferably should be kept clear to the sun in winter
- Location and selection of landscaping and vegetation can be used to provide wind breaks during winter and shade for summer

7.8. Policy Issues

Various Federal and State government policies, bodies, policies and initiatives exist and support the above that include:

- Australian Government Department of the Environment, Water, Heritage and the Arts
- Western Australian Government Sustainable Energy Development Office

Further support and take-up of these initiatives can be made by builders, land developers and Land Corp through incentives for house and land purchasers to adopt sustainable practices and renewable energy technologies.

Other sustainable solutions to reduce the impact of power infrastructure include:

- Low impact, low noise and aesthetically pleasing indoor substation buildings, refer SKM project highlight “Design, Takapuna Zone Substation, Auckland, New Zealand”
- Substation landscaping, buffers set-backs and vegetation screening
- Underground cable systems, located in the road reserves, reduce the need for tree clearing and vegetation pruning

8. Transport Planning

Refer to Appendix J

9. Other Utilities

9.1. Telecommunications

9.1.1. Existing Assets

There are a number of existing major telecommunication assets in the subject site area that are to be maintained and require protection.

An existing major Telstra optic fibre cable is located in the western verge of the Broome Highway road reserve which is continuous for the full length of the eastern boundary of the development area. This optic fibre cable provides a major communication link from the north into Broome Township. There is a similar existing major optic fibre cable located in the western verge of the Broome Highway road reserve.

A major fibre-optic communication cable is located between Cable Beach Road east and Cable Beach Road west. The cable is located along the western boundary of the Gubinge Road reserve. The cable can be accommodated in its existing location; split ducts will be required at road crossings. Additional protection may also be required depending on the cover to the existing cables.

9.1.2. Fibre To The Premises (FTTP)

The Department of Broadband, Communications and the Digital Economy (DBCDE) has announced that legislation addressing the provision of FTTP services to greenfield estates is expected to be enacted from 1 July 2010. The legislation will apply to greenfield estates that are granted planning approvals on or after this date. Stage 1 of the Broome North development is likely to be exempt from this legislation, although later stages are likely to be subject to it depending on their approval dates.

Whilst the details of the legislation is not yet finalised, the Department has issued a consultation paper and has published the submissions made by industry in response to this paper. In general, the submissions (including LandCorp's own submission) broadly agree with the intent of the legislation and the broad technical approach to be taken. Some contention remains in relation to the scale of applicability of the legislation, degree of cooperation between state and federal governments and the competition models that might be introduced for wholesale arrangements. It is likely, however, that the legislative requirements relating to the provision of the fibre itself are likely to be mandated after July 1st 2010 and that these requirements will likely apply to later stages of the Broome North development.

The key technical aspect of the legislation that is likely to be adopted is that developers will be required to provide an FTTP infrastructure capable of supporting at least 100Mbps to each individual residence within all greenfields estates above a certain threshold size. It is likely that wholesale access to this infrastructure will be mandated in the legislation. Therefore the installer and operator of such infrastructure may be a pure wholesaler of bandwidth to other retailers of end user services (voice, video and internet access) or may be a retailer themselves provided they provide access on a fair and equitable basis to other retailers. This meets the stated preferences identified in the consumer research.

9.2. Gas

Gas reticulation to individual lots is not currently provided in Broome. There does not currently appear to be any actions to implement this service in Broome. As the need for heating is minimal in Broome, it is possible that the concept does not financially justify gas reticulation.

The current power station uses gas for generation. As there is not a gas pipeline connection to Broome, the gas is brought in by trucks in cylinders that are stored in the rubbish disposal facility immediately north of the development and piped through the subject site and Broome town to the Horizon Power generation site south of the main town. **Figure 9.1** shows the existing gas route.

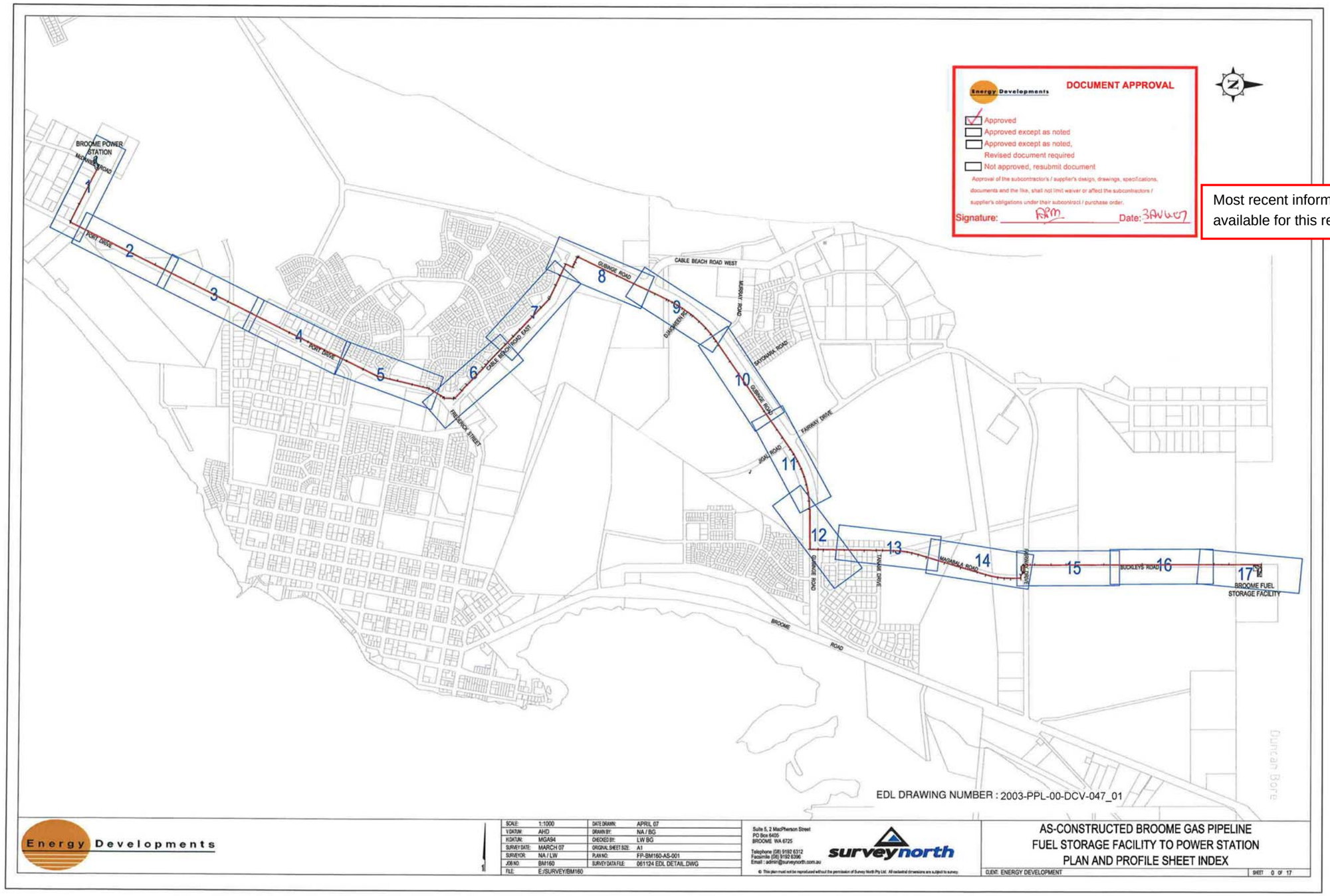


Figure 9.1 Existing Gas

10. References

- *Broome Water Reserve, Water Source Protection Plan* – Waters and Rivers Commission Report WR41 2001.
- The IPWEA Local Government Guidelines for Subdivisional Development (Edition 2, 2009)
- The Shire of Broome Addendum to the IPWEA (Revision 1 – 16th October 2009)
- The Shire of Broome Addendum drawings
- The Shire of Broome Services Policy 4.4.8 Stormwater Management (previously Policy 7.8 Environmental Initiatives Stormwater Management)
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  http://www.horizonpower.com.au/

  http://www.horizonpower.com.au/environment/energySavingWays/index.html

  http://www.horizonpower.com.au/environment/energySavingWays/before_you_build/index.html

  http://www.horizonpower.com.au/environment/energySavingWays/in_your_home/index.html

  http://www.horizonpower.com.au/environment/energySavingWays/photovolatic_rebate.html

  http://www.horizonpower.com.au/residential/about_account/products_services/renewable_energy/residential_renewable.html

  http://www.horizonpower.com.au/downloads/environment/GreenSelect_online_i1.pdf

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- Horizon Power document "Horizon Power transformer" showing the preferred location of the new 'Bilingurr' substation
- Horizon Power document "Cable Route - through runway May08.ppt" showing the preferred express 33kV cable route
- Horizon Power document "Broome Feeders" showing the location of the existing Broome town distribution system
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  http://www1.sedo.energy.wa.gov.au/pages/reepp.asp

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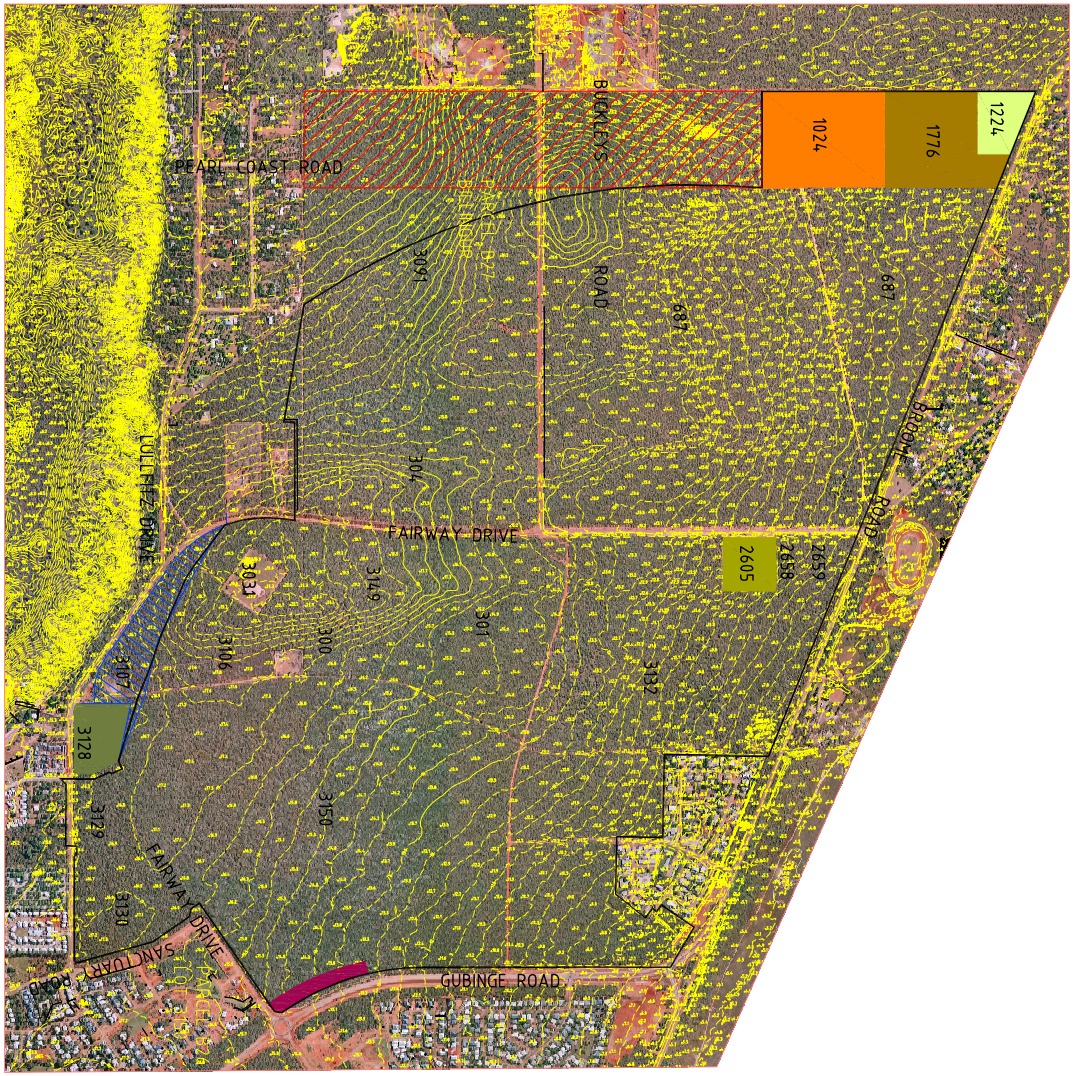
Appendix A Contour and Land Ownership Plan



LEGEND

- Site Boundary
- Ralph Livingstone
- Robert John Knox
- Dean Graham Kemp
- Anglican Schools Commission
- A Class Reserve
- C Class Reserve
- Services Land (Additional)
- Yawuru Development Lease
- Extinguished Area Included by the State in Settlement Negotiations (Area is Indicative Only - 30ha Comprised of Portion Lots 3091, 304 & 687)

SOURCE: WHELAN SURVEYORS

1:10000

0 100m 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500

No	DATE	DRAFTING CHECK	DESIGN REVIEW	REV'D P.MGR	APP'D P.DIR	AMENDMENT
B	05.10.09	*MJH	-	*VMW	*PJ	ISSUED FOR ENGINEERING REPORT
A	28.05.09					ISSUED FOR INFORMATION

No	DRAWING NUMBER	REFERENCE DRAWING TITLE

SKM
Sinclair Knight Merz Pty Ltd
A.C.N. 001 024 095
Durack Centre 263 Adelaide Tce
Perth Western Australia 6000
Ph (08) 9268 4400 Fax (08) 9268 4488

LANDCORP

'*' INDICATES A COPY OF AN ORIGINAL SIGNED DRAWING

CLIENT: LANDCORP
PROJECT: BROOME NORTH

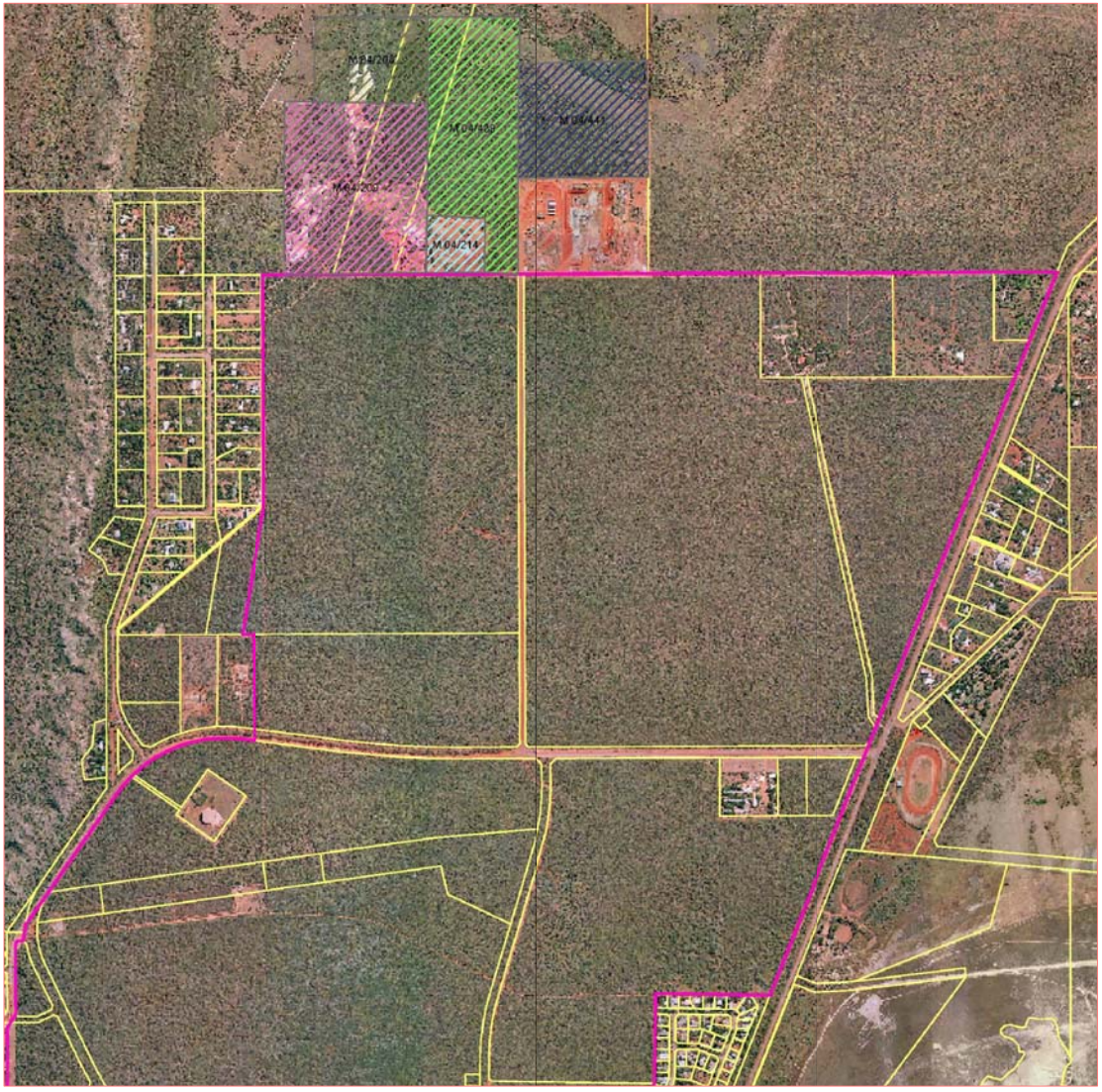
DRAFTER	DRAFTING CHECK	REVIEWED PROJECT MANAGER	APPROVED PROJECT DIRECTOR
S MEWS	*M. HARRIS	05.10.09 *V. WARDLEY	05.10.09 *P. JORDAN
DESIGNED	DESIGN REVIEW		
-	-		

TITLE: CONTOUR AND LAND OWNERSHIP PLAN

SCALE	SKM PROJECT No	DRAWING No	AMDT
1:10000	PB50119	C003	B

A1

Appendix B Mining Lease Plan



Legend

mine_ten mga94

fmt_tenid

- M 04/185
- M 04/191
- M 04/208
- M 04/209
- M 04/214
- M 04/306
- M 04/439
- M 04/441

SOURCE: WHELANS SURVEYORS

No	DATE	DRAFTING CHECK	DESIGN REVIEW	REV'D P.MGR	APP'D P.DIR	AMENDMENT
B	05.10.09	*M.H	-	*V.M.W	*P.J	ISSUED FOR ENGINEERING REPORT
A	25.09.09		-			ISSUED FOR INFORMATION

No	DRAWING NUMBER	REFERENCE DRAWING TITLE

SKM
Sinclair Knight Merz Pty Ltd
A.C.N. 001 024 095
Durack Centre 263 Adelaide Tce
Perth Western Australia 6000
Ph (08) 9268 4400 Fax (08) 9268 4488

LANDCORP

'*' INDICATES A COPY OF AN ORIGINAL SIGNED DRAWING

CLIENT				
LANDCORP				
PROJECT				
BROOME NORTH				
DRAFTER	DRAFTING CHECK	REVIEWED PROJECT MANAGER	APPROVED PROJECT DIRECTOR	
S.MEWS	*M. HARRIS	05.10.09 *V. WARDLEY	05.10.09 *P. JORDAN	
DESIGNED	DESIGN REVIEW			
-	-			

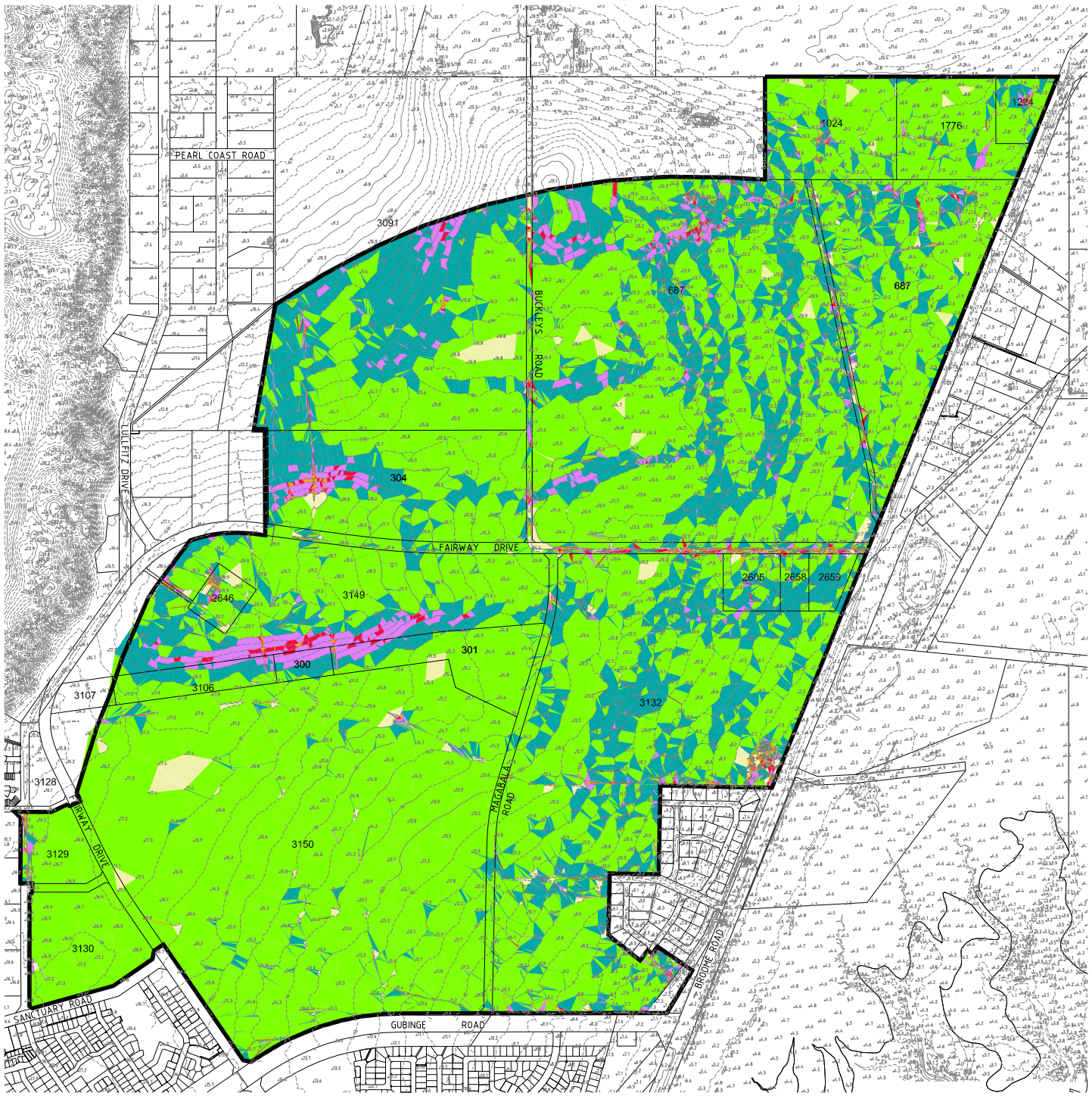
TITLE
MINING LEASE PLAN

SCALE	SKM PROJECT No	DRAWING No	AMDT
DIAGRAMMATIC	PB50119	C007	B

Appendix C Existing Grade Plan

NOTES

1.0 ALL BASE PLANS PROVIDED BY WHELANS SURVEYS



LEGEND

- EXISTING SURFACE CONTOUR
- SITE BOUNDARY
- 0% GRADE
- 0 TO 1% GRADE
- 1% TO 2% GRADE
- 2% TO 3% GRADE
- 3% TO 4% GRADE
- 4% AND STEEPER GRADE

1:5000 0 50m 100 150 200 250 300 350 400 450 500 550 600 650 700 750 mm

'+' INDICATES A COPY OF AN ORIGINAL SIGNED DRAWING

No	DATE	DRAFTING CHECK	DESIGN REVIEW	REV'D PMGR	APP'D PJDir	AMENDMENT
C	15.10.09	aMJH	aWDT	aVHM	aPJ	ISSUED FOR ENGINEERING REPORT
B	17.08.09					ISSUED FOR INFORMATION
A	24.06.09					ISSUED FOR INITIAL REVIEW

SKM
Sinclair Knight Merz Pty Ltd
ACN 071 054 265
Durack Centre 263 Adelaide Tce
Perth Western Australia 6000
Ph (08) 9469 4400 Fax (08) 9469 4488

LANDCORP

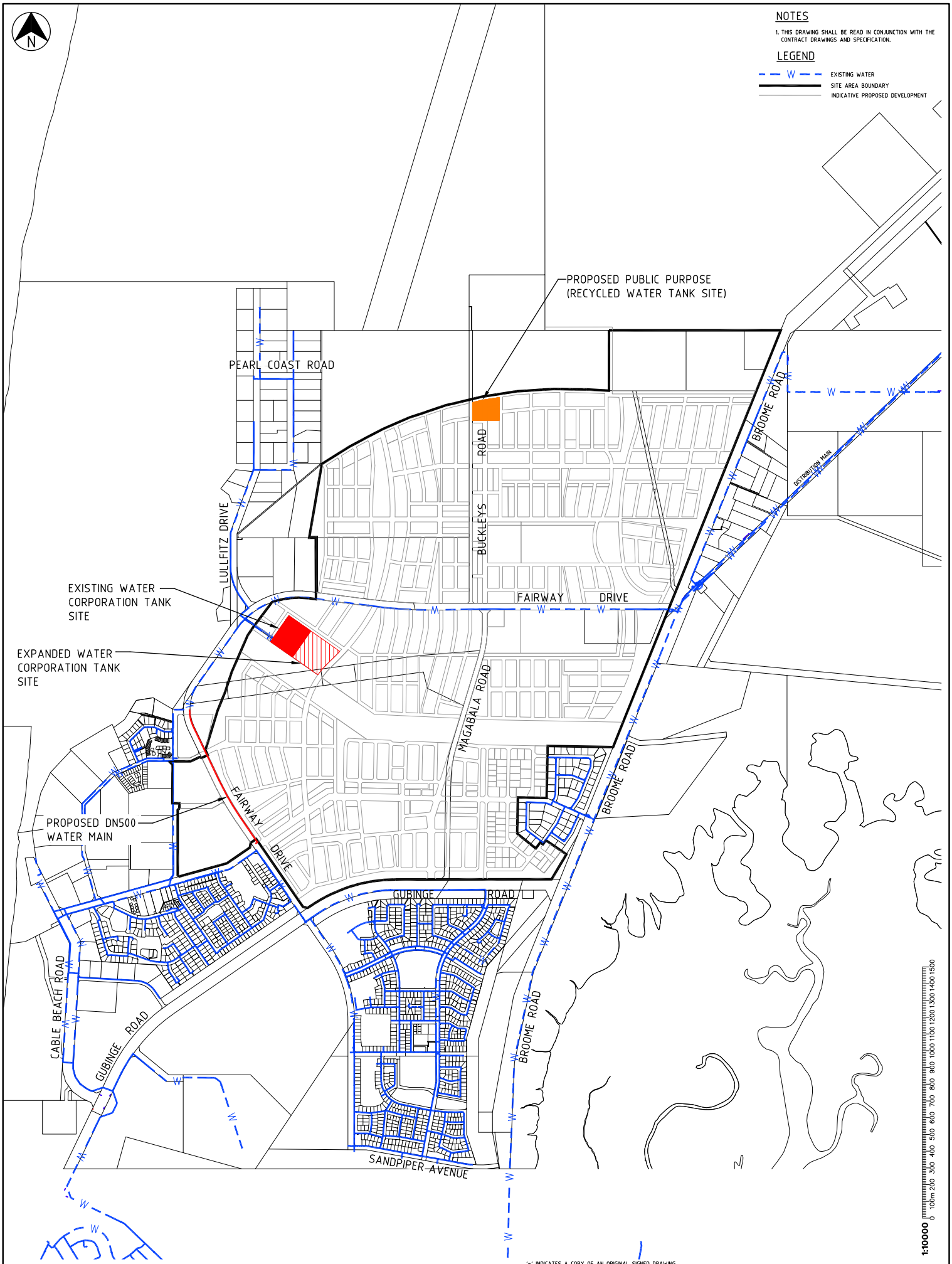
CLIENT LANDCORP
PROJECT BROOME NORTH

DRAFTER	DRAFTING CHECK	REVIEWED PROJECT MANAGER	APPROVED PROJECT DIRECTOR
aM. HARRIS	aM. HARRIS	15.10.09	15.10.09
DESIGNED	DESIGN REVIEW		
P.OLIVER	aW. DU TOIT	aV. WARDLEY	aP. JORDAN

TITLE
EXISTING GRADE PLAN

SCALE	SKM PROJECT No	DRAWING No	AMDT
1:5000	PB50119	C009	C

Appendix D Water Infrastructure Plan



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B	05.10.09	*TJ	*TJ	*VMW	*PJ	ISSUED FOR ENGINEERING REPORT
A	17.08.09					ISSUED FOR INFORMATION

SKM
Sinclair Knight Merz Pty Ltd
A.C.N. 001 024 095
Durack Centre 263 Adelaide Tce
Perth Western Australia 6000
Ph (08) 9268 4400 Fax (08) 9268 4488

LANDCORP

'*' INDICATES A COPY OF AN ORIGINAL SIGNED DRAWING

CLIENT				
LANDCORP				
PROJECT				
BROOME NORTH				
DRAFTER	DRAFTING CHECK	REVIEWED PROJECT MANAGER	APPROVED PROJECT DIRECTOR	
C. LEGERSTEE	T. JOHNSTON	05.10.09	05.10.09	
DESIGNED	DESIGN REVIEW			
A. MICENKO	T. JOHNSTON	*V. WARDLEY	*P. JORDAN	

TITLE
EXISTING AND PROPOSED WATER INFRASTRUCTURE PLAN

SCALE	SKM PROJECT No	DRAWING No	AMDT
1:10000	PB50119	SK002	B

A1

I:\PBIF\Projects\PB50119\Deliverables\Drawings\DE02736_3150 – SK001–SK003.dwg 05/10/09 13:11:54 crayner

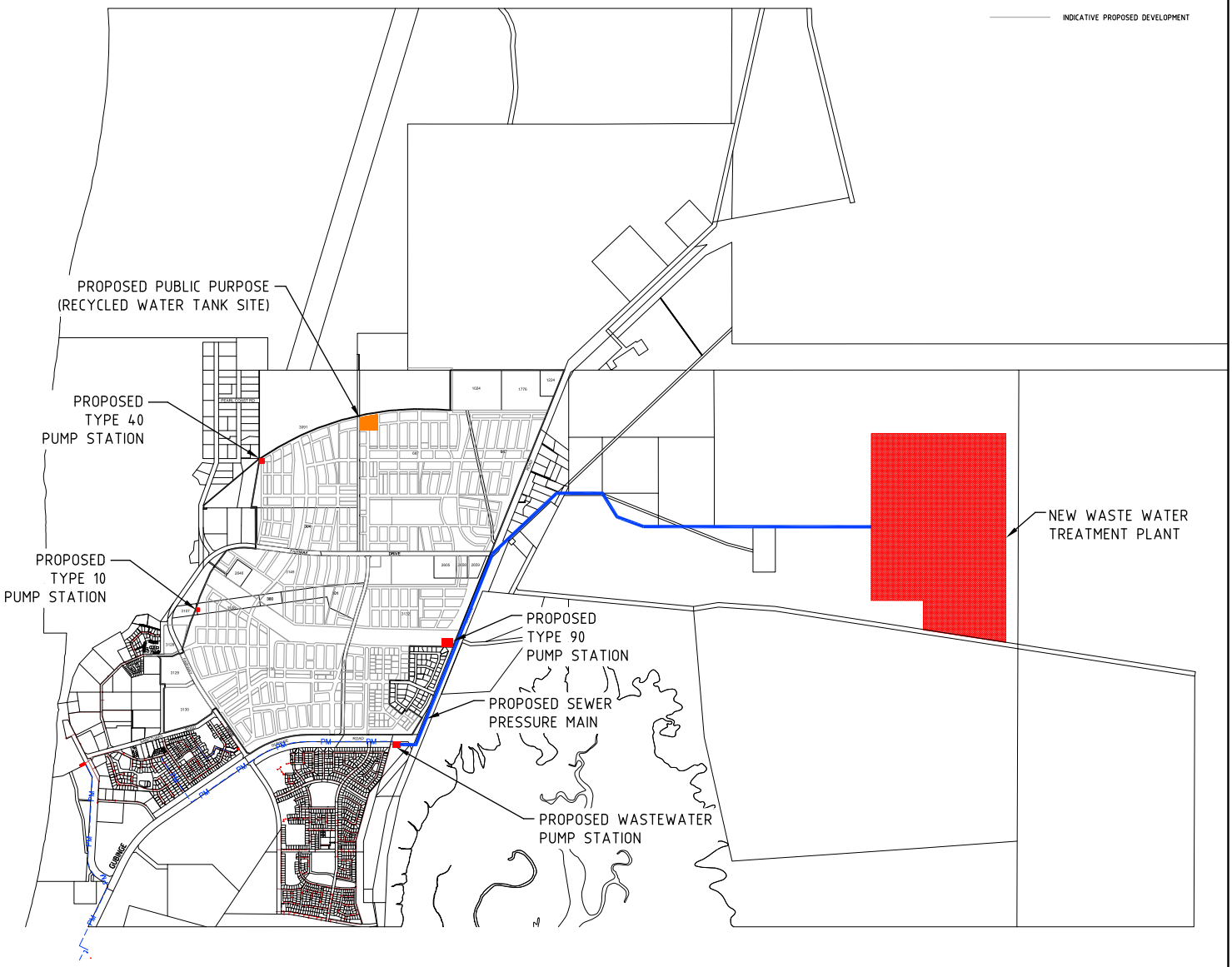
Appendix E Wastewater Infrastructure Plan

NOTES

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE CONTRACT DRAWINGS AND SPECIFICATION.

LEGEND

- EXISTING GRAVITY SEWER
- EXISTING PRESSURE MAIN
- PROPOSED PRESSURE MAIN
- SITE AREA BOUNDARY
- INDICATIVE PROPOSED DEVELOPMENT



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'*' INDICATES A COPY OF AN ORIGINAL SIGNED DRAWING

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B	05.10.09	*TJ	*TJ	*VMW	*PJ	ISSUED FOR ENGINEERING REPORT
A	17.08.09					ISSUED FOR INFORMATION

SKM

Sinclair Knight Merz Pty Ltd
A.C.N. 001 024 095
Durack Centre 263 Adelaide Tce
Perth Western Australia 6000
Ph (08) 9268 4400 Fax (08) 9268 4488

LANDCORP

CLIENT: LANDCORP

PROJECT: BROOME NORTH

DRAFTER	DRAFTING CHECK	REVIEWED PROJECT MANAGER	APPROVED PROJECT DIRECTOR
C. LEGERSTEE	T. JOHNSTON	05.10.09	05.10.09
DESIGNED	DESIGN REVIEW		
A. MICENKO	T. JOHNSTON	*V. WARDLEY	*P. JORDAN

TITLE: EXISTING AND PROPOSED WASTEWATER INFRASTRUCTURE PLAN

SCALE	SKM PROJECT No	DRAWING No	AMDT
1:20000	PB50119	SK003	B

A1

Appendix F Power Plan

ID	NO. OF LOTS	kVA
A	89	997
B	60	360
C	212	1497
D	206	1491
E	160	960
F	225	1350
G	60	360
H	155 SPS	937
I	31	186
J	49	294
K	481	2886
L	383 PRIMARY SCHOOL	2608
M	609	3854
N	382	2492
O	349 SPS	2119
P	288	1928
Q	56 PRIMARY & HIGH SCHOOL	1386
R	229	1374
S	227	1362
T	160	960
U	356 WRT	2161
V	65	390
W	TOURIST SITE	4086
X	INDUSTRIAL SITES	3654
Y	PRIMARY SCHOOL	250
ECC	SPS	58
TOTAL	4842	40000

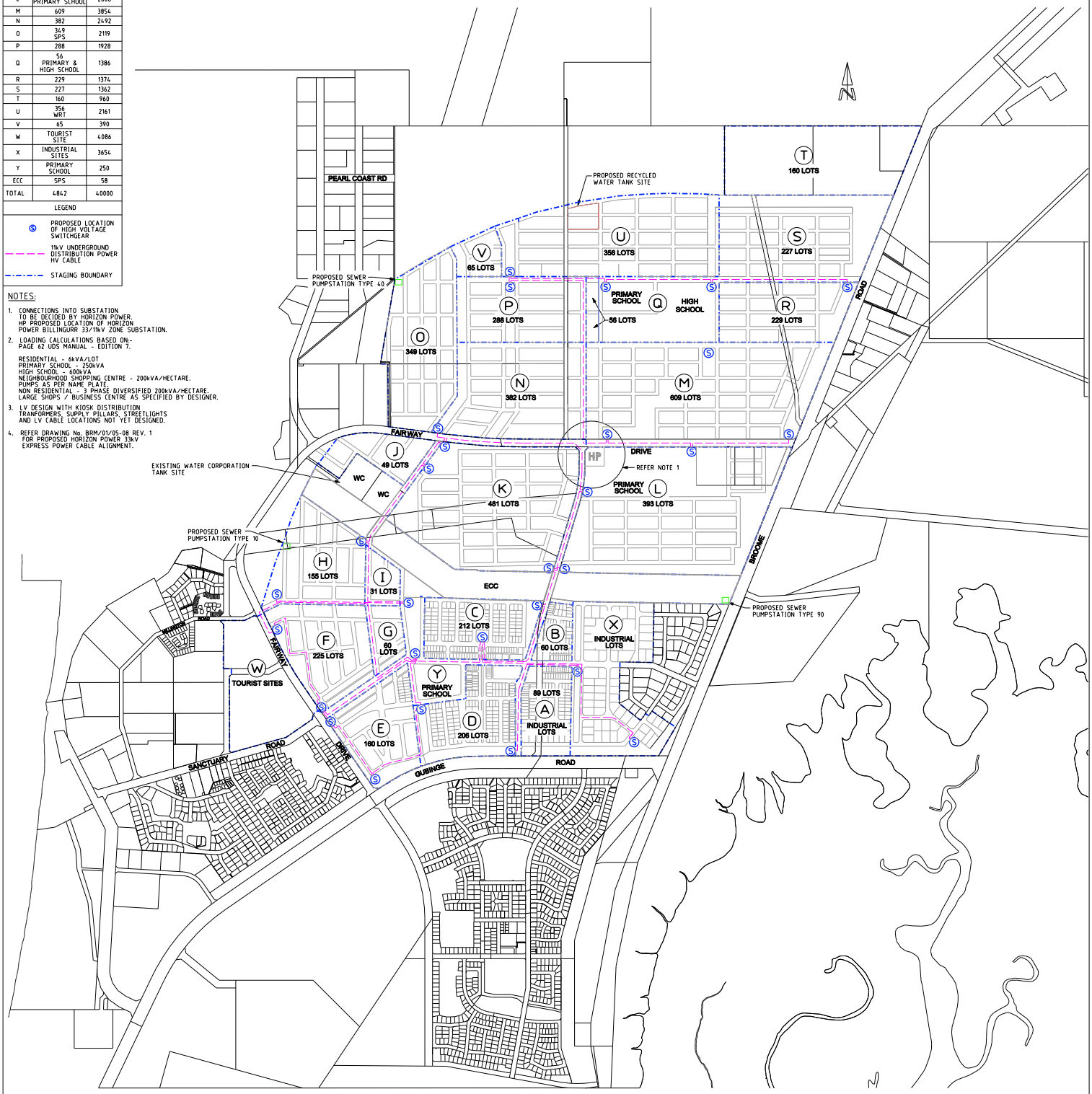
LEGEND

- (S) PROPOSED LOCATION OF HIGH VOLTAGE SWITCHGEAR
- 11kV UNDERGROUND DISTRIBUTION POWER HV CABLE
- STAGING BOUNDARY

NOTES:

1. CONNECTIONS INTO SUBSTATION TO BE DECIDED BY HORIZON POWER. HP PROPOSED LOCATION OF HORIZON POWER BILLINGURR 33/11kV ZONE SUBSTATION.
2. LOADING CALCULATIONS BASED ON:- PAGE 62 UDS MANUAL - EDITION 7.

   RESIDENTIAL - 6kVA/LOT
   PRIMARY SCHOOL - 250kVA
   HIGH SCHOOL - 600kVA
   NEIGHBOURHOOD SHOPPING CENTRE - 200kVA/HECTARE.
   PUMPS AS PER NAME PLATE.
   NON RESIDENTIAL - 3 PHASE DIVERSIFIED 200kVA/HECTARE.
   LARGE SHOPS / BUSINESS CENTRE AS SPECIFIED BY DESIGNER.
3. LV DESIGN WITH KIOSK DISTRIBUTION TRANFORMERS, SUPPLY PILLARS, STREETLIGHTS AND LV CABLE LOCATIONS NOT YET DESIGNED.
4. REFER DRAWING No. BRM/01/05-08 REV. 1 FOR PROPOSED HORIZON POWER 33kV EXPRESS POWER CABLE ALIGNMENT.



FOR INFORMATION ONLY

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1:1000

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B	07.10.09	GN	MC	VW	PJ	POWER AMENDED
A	30.09.09	GN	MC	VW	PJ	ISSUED FOR INFORMATION

SKM
Sinclair Knight Merz Pty Ltd
ACN. 001 024 095
Durack Centre 263 Adelaide Tce
Perth Western Australia 6000
Ph (08) 9268 4400 fax (08) 9268 4488

LANDCORP

CLIENT: LANDCORP

PROJECT: BROOME NORTH

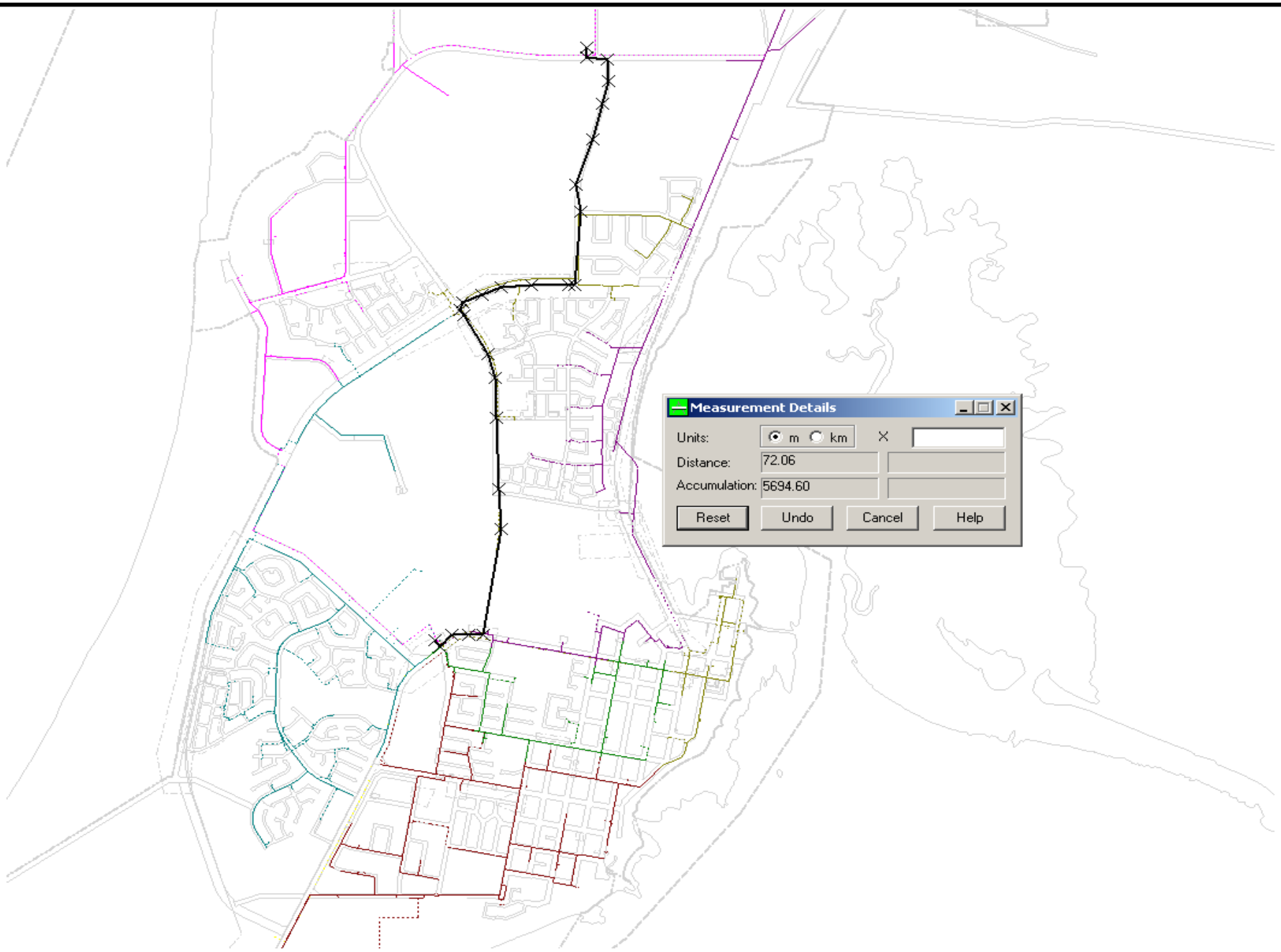
DRAFTER	DRAFTING CHECK	REVIEWED PROJECT MANAGER	APPROVED PROJECT DIRECTOR
L.L. STALS	G. NICHOLS	V. WARDLEY	P. JORDAN
DESIGNED	DESIGN REVIEW		
G. NICHOLS	M. CHARLESWORTH		

TITLE: POWER PLAN
PROPOSED HV DISTRIBUTION
MASTER PLAN

SCALE	SKM PROJECT No	DRAWING No	AMDT
1:1000	PB50119	C500	B

A1

Appendix G Horizon Power Bilingurr Zone Substation Feeder Route Plan



TITLE : Cable Route to Bilingurr S/S through the Runway

Customer: Name

Contact: Name

Drawn **:** Benny Merdi

Date **:** 7/5/08

O dd/mm/yyyy
REVISIONS

Lat ***- 00º 00' 00''S***
Long ***- 000º 00' 00''E***

Map Ref ***-***
Page ***-***

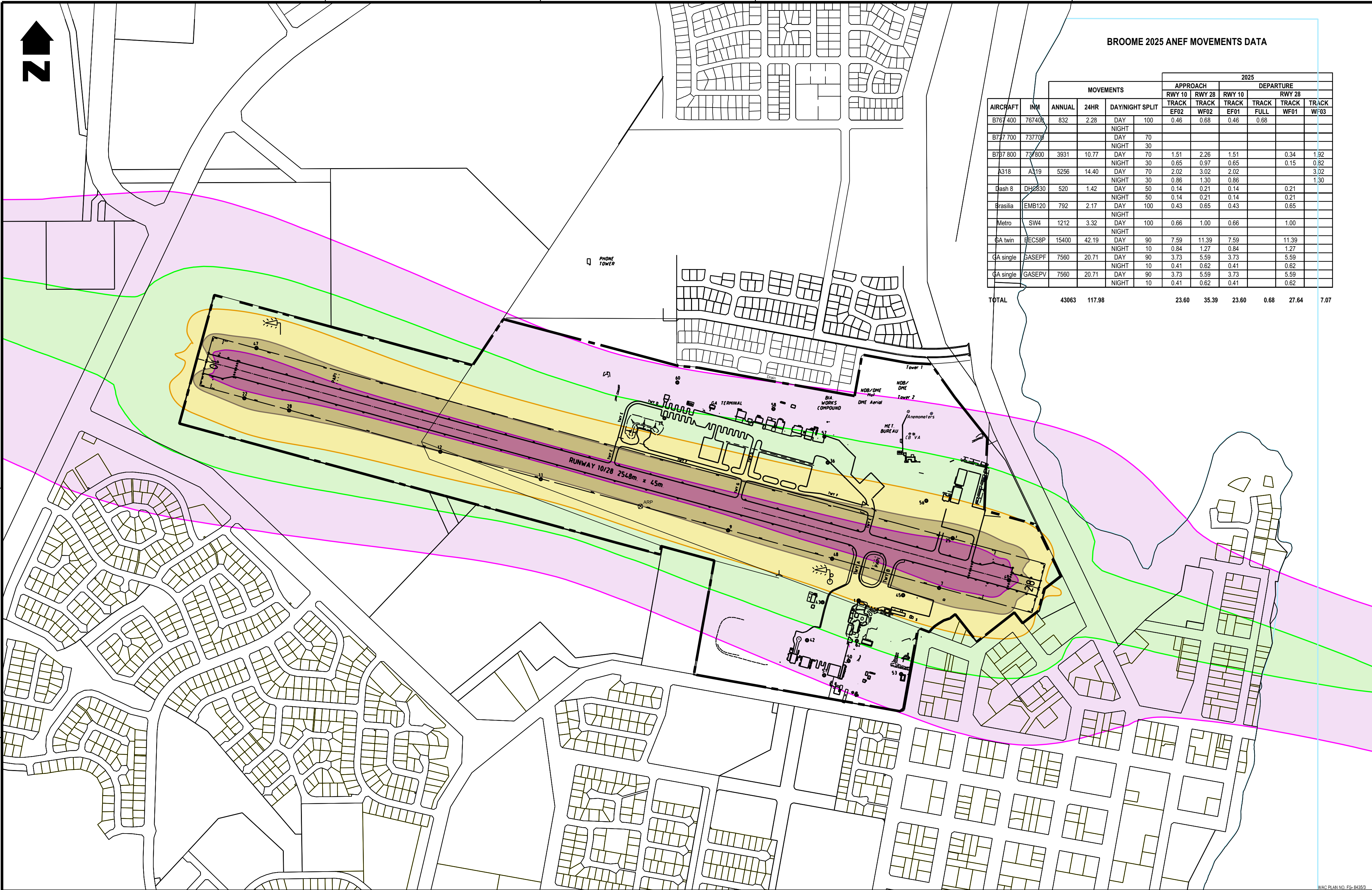
HORIZON POWER

HORIZON POWER

Drg. No. BRM/01/05-08

Rev
1

Appendix H Broome Airport 2025 ANEF



BROOME 2025 ANEF MOVEMENTS DATA

AIRCRAFT	INM	MOVEMENTS				2025 APPROACH RWY 10	APPROACH RWY 28	DEPARTURE RWY 10	DEPARTURE RWY 28		
		ANNUAL	24HR	DAY/NIGHT SPLIT		TRACK EF02	TRACK WF02	TRACK EF01	TRACK FULL	TRACK WF01	TRACK WF03
B767 400	767400	832	2.28	DAY	100	0.46	0.68	0.46	0.68		
				NIGHT							
B737 700	737700			DAY	70						
				NIGHT	30						
B737 800	737800	3931	10.77	DAY	70	1.51	2.26	1.51		0.34	1.92
				NIGHT	30	0.65	0.97	0.65		0.15	0.82
A318	A319	5256	14.40	DAY	70	2.02	3.02	2.02			3.02
				NIGHT	30	0.86	1.30	0.86			1.30
Dash 8	DHC830	520	1.42	DAY	50	0.14	0.21	0.14		0.21	
				NIGHT	50	0.14	0.21	0.14		0.21	
Brasilia	EMB120	792	2.17	DAY	100	0.43	0.65	0.43		0.65	
				NIGHT							
Metro	SW4	1212	3.32	DAY	100	0.66	1.00	0.66		1.00	
				NIGHT							
GA twin	BEC58P	15400	42.19	DAY	90	7.59	11.39	7.59		11.39	
				NIGHT	10	0.84	1.27	0.84		1.27	
GA single	GASEPF	7560	20.71	DAY	90	3.73	5.59	3.73		5.59	
				NIGHT	10	0.41	0.62	0.41		0.62	
GA single	GASEPV	7560	20.71	DAY	90	3.73	5.59	3.73		5.59	
				NIGHT	10	0.41	0.62	0.41		0.62	
TOTAL		**43063**	**117.98**			**23.60**	**35.39**	**23.60**	**0.68**	**27.64**	**7.07**

40+ ANEF
35-40 ANEF
30-35 ANEF
25-30 ANEF
20-25 ANEF

MICROSTATION FILE : 2025 ANEF.DGN

DATA SOURCE : INM 6.1. Movements data supplied by BIA

ORIGINAL ISSUE

DRAWN: NJV DATE: 09.09.03

REV	DRN	AMENDMENTS	APPD	DATE

PERTH AIRPORT

BROOME INTERNATIONAL AIRPORT

2025 AUSTRALIAN NOISE EXPOSURE FORECAST

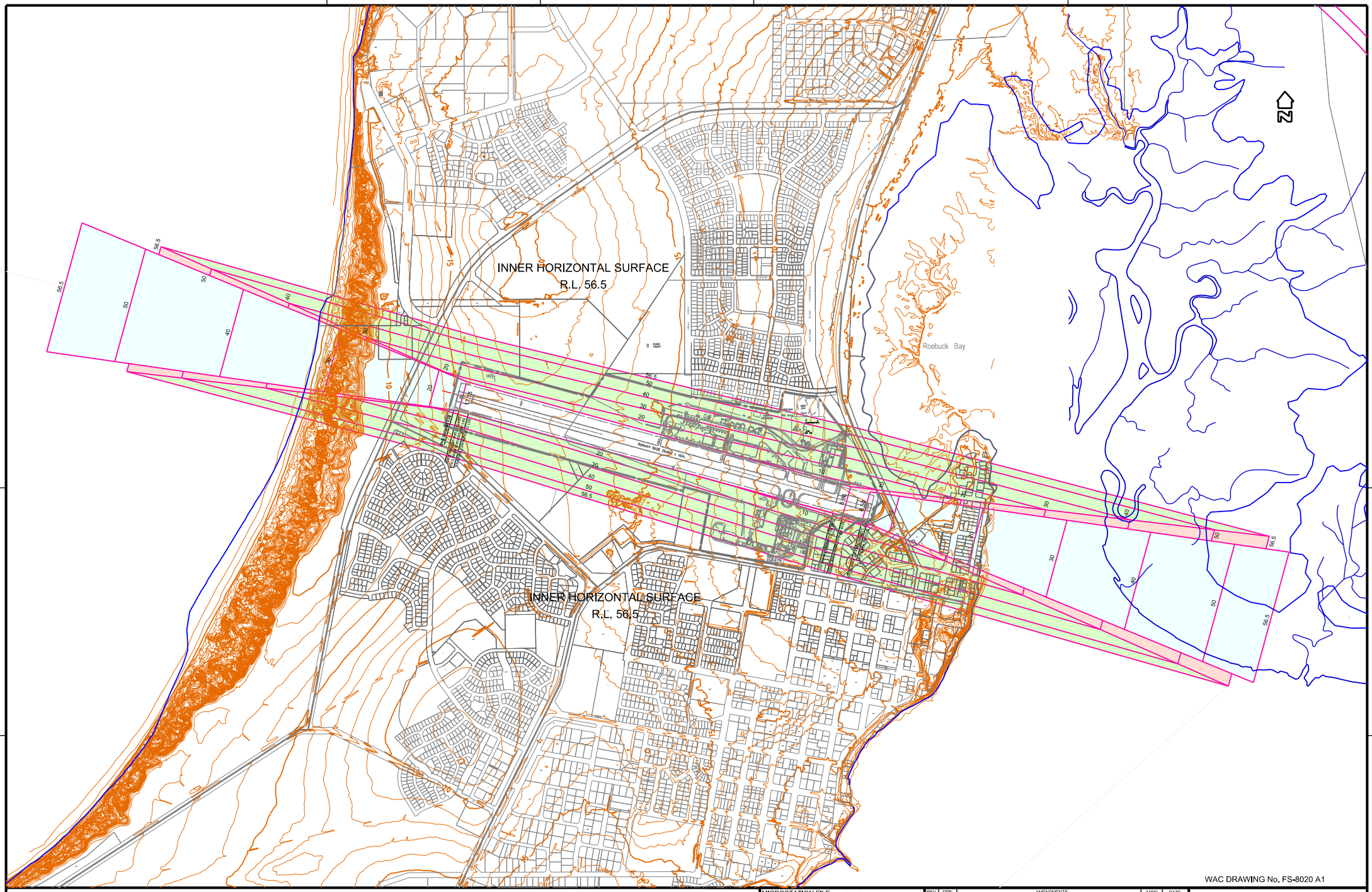
SCALE 1:5000 @ A1 1:10000 @ A3

DRAWING No.

REV No.

INDEX CODE AD/DET/SP

Appendix I Broome Airport OLS Plan



WAC DRAWING No. FS-8020 A1

PERTH AIRPORT

KUBU

BROOME INTERNATIONAL AIRPORT

MICROSTATION FILE : BROOMEOLS10000.DGN

DATA SOURCE :
DOLA - CONTOURS
WHELANS - AIRPORT DETAIL SURVEY

ORIGINAL ISSUE
DESIGN DRAFTSMAN: K. HEALES APPROVED: S.J.E.
DESIGN ENGINEER: S. EMERY DATE: 31.10.00

REV	DRN.	AMENDMENTS	APPD	DATE
0	K.G.H.	ISSUED	S.J.E.	31.10.00
A	K.G.H.	Amended to suit Runway extensions		19.6.03
B	I.F.R.	Amended to suit new ARP (old PSM 10)	R.J.M.	16.04.09
C	I.F.R.	Airport base information updated	R.J.M.	16.04.09

BROOME INTERNATIONAL AIRPORT

OBSTACLE LIMITATION SURFACES

- INNER

DRAWING No.	SCALE	SHEET	REV
BR-4-8-02	1 : 10000	2	C

0

INDEX CODE

Appendix J Broome North Traffic and Access Report

Broome North

TRAFFIC AND ACCESS REPORT

- V2
- 22 January 2010

Broome North

TRAFFIC AND ACCESS REPORT

- V2
- 22 January 2010

Sinclair Knight Merz
ABN 37 001 024 095
11th Floor, Durack Centre
263 Adelaide Terrace
PO Box H615
Perth WA 6001 Australia
Tel: +61 8 9469 4400
Fax: +61 8 9469 4488
Web: www.skmconsulting.com

Contents

Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
V1	23/12/09	E Richardson	K Looby	23/12/09	Final
V2	22/01/10	E. Richardson	K. Looby	22/1/10	Rev1

Distribution of copies

Revision	Copy no	Quantity	Issued to
V1	1 PDF	-	Paul Ferrante (Landcorp), Wayne Silich (Silpro), Dan Pearce (RD) Gary McCarney (DoP), John Willis (SoB)
V2	1PDF	-	Paul Ferrante (Landcorp), Wayne Silich (Silpro), Dan Pearce (RD) Gary McCarney (DoP), John Willis (SoB)

SINCLAIR KNIGHT MERZ

Printed:	22 January 2010
Last saved:	22 January 2010 02:59 PM
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Author:	Danya Alexander
Project manager:	Danya Alexander
Name of organisation:	LandCorp
Name of project:	Broome North
Name of document:	Traffic and Access report
Document version:	V2
Project number:	PB50119

SINCLAIR KNIGHT MERZ

1. Introduction

Sinclair Knight Merz (SKM) was engaged by LandCorp to prepare a Transport Assessment to accompany the structure plan for the proposed Broome North development.

This Transport Assessment has been prepared in consultation with the multi-disciplinary design team, the Shire of Broome, Main Roads Western Australia (MRWA) and Department of Planning (DoP). The report expands on the document '*Broome North Development – Engineering Report Final, Revision 4, 13 October 2009*' prepared by SKM.

The current report covers all main modes of transport and has been prepared in parallel to the structure plan (Development Plan) prepared by Roberts Day. The assessment has been prepared in accordance with the Western Australian Planning Commission draft *Guidelines for Developments, Volume 2 – Structure Plans,* August 2006 (WAPC Guidelines).

1.1 Transport Assessment Objectives

The key objectives of a Transport Assessment for a Structure Plan for an area of this size are:

- to assess the proposed internal transport networks with respect to accessibility and safety for all modes: vehicles, public transport, pedestrians and cyclists;
- to assess the level of transport integration between the Structure Plan area and the surrounding land uses;
- to determine the impacts of the traffic generated by the Structure Plan area on the surrounding land uses; and
- to determine the impacts of the traffic generated by the Structure Plan on the surrounding transport networks.

A number of specific objectives and principles were agreed by a number of key stakeholders at the Planning Design Forum (PDF) for Broome North held in Broome from 19-22 August 2009. The transport objectives included:

Topic	Key objective
Overall	▪ To design and deliver safe, convenient movement system for all people (residents, visitors and business) that contributes to a clean environment, healthy lifestyle and vibrant economy
Transport/ land use integration	▪ Integrate transport and land use to minimise car use and encourage safe walking and cycling
Safety	▪ Safe and secure movement network in Broome North: ▪ Provide a safe network of streets (local connectors and local streets) within Broome North for walking, cycling and relevant traffic

Topic	Key objective
	▪ Provide safe and secure network of footpaths and shared paths on the internal network of streets ▪ Provide a safe off-street network for pedestrians and cyclists within integrated open space areas and ECC's
Public Transport	▪ Plan and promote two bus services in Broome North – one linking to Cable Beach and the other to Chinatown and Broome Town Centre ▪ Plan bus services to be carefully positioned and to serve both neighbourhood centres
Street design	▪ Legible and permeable internal street network in Broome North ▪ Design all local and neighbourhood connector streets in Broome North as low speed streets to discourage through traffic movement and to improve safety for all users ▪ Design all streets to make a contribution to the above ground drainage system ▪ Provide intersection traffic management control where neighbourhood connectors or important local streets intersect to improve safety and reduce speed ▪ Provide a comprehensive, integrated and safe footpath network ▪ Provide a network of linked, safe bicycle routes using a combination of shared paths and on-street facilities within road reserves
Connectivity and legibility	▪ Ensure connectivity and legibility to existing Broome: ▪ Provide a high degree of accessibility to Broome North from the surrounding road network and developed areas ▪ Provide a clear regional structure with legible and direct connections to and between activity centres

1.2 Background

The purpose of the four-day PDF was to:

- Identify what matters to the local community and other key stakeholders in the development of the land;
- Detail the issues, opportunities and values of the site;
- Establish the overarching design principles for future development and how these can be incorporated into a Masterplan;
- Establish principles for a movement network including site access and routes for pedestrians, cyclists and public transport;
- Agree on the best urban design and built form outcomes that celebrate the land's values; and
- Prepare a final design concept that has the support of forum participants.

The traffic and transport environment in Broome is unique due to climate, remoteness and the transient population. Therefore, the application of standard transport and access approaches as outlined in the Western Australian Planning Commissions (WAPC's) Liveable Neighbourhoods design code is not always appropriate or relevant. The key factors taken into account in the planning of the movement network for Broome North include:

- The high cost of housing in Broome means that household sizes tend to be higher than in Metropolitan Perth. This has implications with respect to dwelling size, the number of parking spaces required and the trip generation rates per dwelling.
- Due to the isolated location of Broome, many trips are local in nature, with the most popular destinations being the centre of Broome (Chinatown), Cable Beach, the Port and Airport.
- The mix of residents in Broome North is expected to include retirees, families and people employed on a 'fly-in, fly-out' basis.
- The road network in Broome forms an integral part of the drainage system. The Q100 event is stored fully within the road reservation. A width of 7.4m is generally required for the road pavement to fulfill this function, which has implications for designing streets for low traffic speeds
- The types of pavement treatments available in Broome are limited, due to availability and cost of materials, and the prevalence of pindan. The use of coloured asphalt is cost prohibitive and where differentiations are necessary on the road, line marking and pavers are typically used.
- Medians within the road reserve are typically kerbed in order to prevent infiltration of storm water to the road sub-base at the centre of the road.
- Larger vehicles such as four wheel drives are commonplace, which contribute to faster wear of road surfaces.
- Walking in Broome is not popular for some residents but is an important mode for tourists.
- Cycling as a mode of travel is growing in popularity. The topography in Broome is flat and conducive to cycling. In addition, most travel distances within the township are manageable for cyclists of all abilities.
- There is only a limited public transport service in Broome, but this is likely to expand as the town grows in size.

1.3 Consultation

A collaborative approach to the preparation of this report has been adopted with the Shire of Broome, DoP and MRWA. In particular, trip generation rates (and balance of internal to external trips), trip distribution, geographical area of assessment, site access treatments and methods to assess/ quantify impacts have been pre-agreed with relevant authorities.

1.4 Report Structure

- Section 1 Introduction and background (this section)
- Section 2 Structure Plan outline
- Section 3 Existing transport and access
- Section 4 Future Conditions
- Section 5 Traffic generation
- Section 6 Traffic distribution
- Section 7 Traffic analysis
- Section 8 Planned internal transport network
- Section 9 Public transport
- Section 10 Pedestrians and cyclists
- Section 11 Summary

2. Structure Plan Outline

2.1 Location

The development site is approximately 735Ha in area. It is located north of Broome Airport and bordered by Gubinge Road to the south, Broome Highway to the east, Fairway Drive and Lullfitz Drive to the west, and the Broome Shire refuse area to the north. The area is presently not developed with the exception of the Blue Haze Light Industrial Area at the southeast corner of the site.

Strategic planning by the DoP has identified areas within the site as the next major land supply area for Broome. It is estimated that on average, 100 new residential lots per annum are released in Broome.

2.2 Broome North Structure Plan

The Development Plan for Broome North is shown in Figure 2-1. This is a long term plan and it is expected that it will be at least a 50 year time frame to reach full build-out.

2.3 Proposed Land Uses

The proposed development yield at Broome North, for the purposes of this Transport Assessment, is summarised in Table 2-1.

Table 2-1 Structure Plan proposed land uses

Use	Yield	Unit
Residential	4,833 286.18	Lots Hectares
Education	34.15	Hectares
Retail	7.09	Hectares
Tourism	20.43	Hectares
Industrial[1]	72	Lots

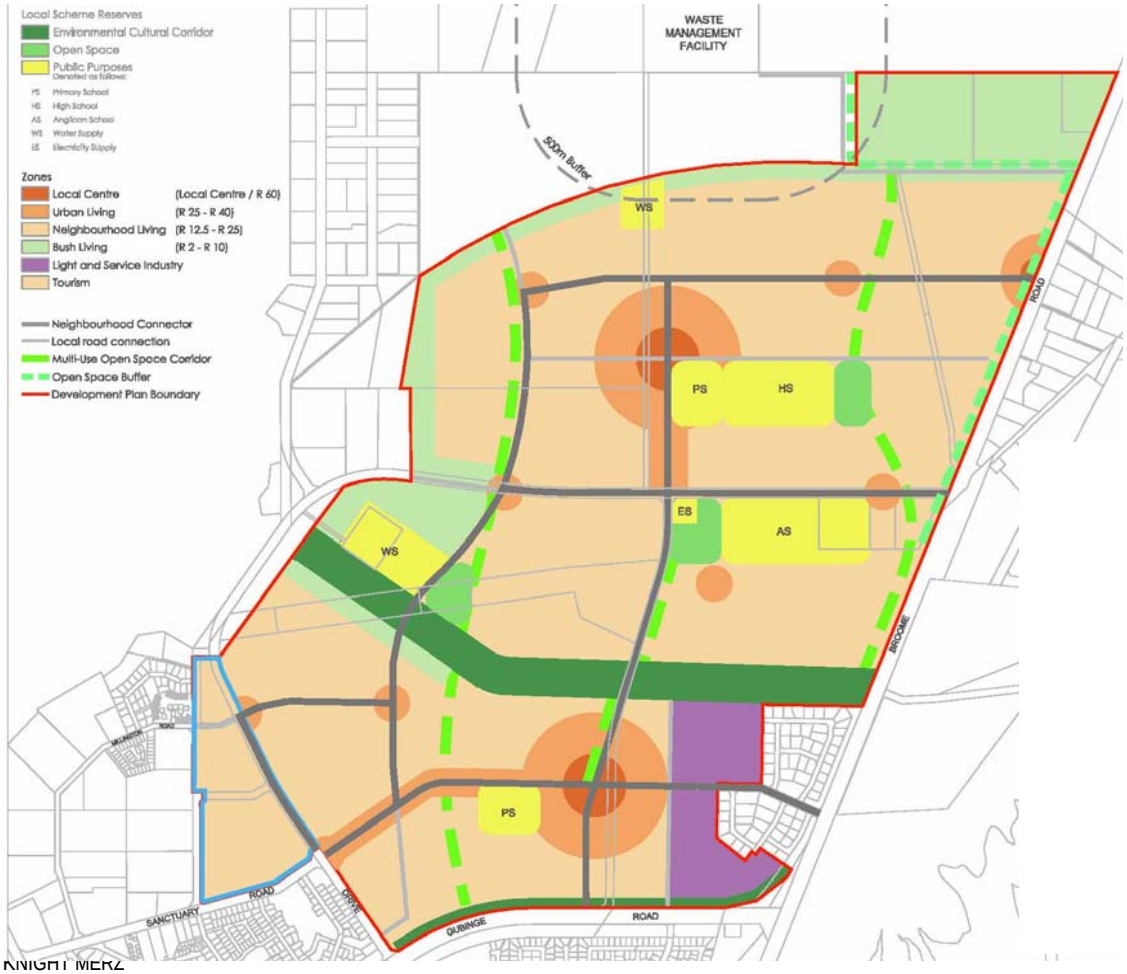
The development is planned to be self-sustaining in relation to education and local shopping needs. Two public primary schools, one public high school and an Anglican school are planned on the site. The town centres are proposed to have a local neighbourhood function and be located so that most of the Broome North catchment is within 800m to 1000m of the centre. The higher density living (R40 zoning), will be principally around the town centres. The bush living and larger lifestyle blocks will be located mostly at the northern fringe of the site.

[1] These are new lots. Total Light Industrial Area is 27 Hectares.

The tourism-related uses will be located on the western side of Fairway Drive, as an extension to the Cable Beach tourism precinct. It is proposed to extend the Blue Haze Light Industrial Area to the west.

Planning for the site has responded to the natural features and a strong desire to retain vegetation belts, which will contribute to the character of the site and serve as green corridors, forming an integral part of the site's drainage system.

- **Figure 2-1 Proposed Broome North Structure Plan (source Roberts Day)**



PLANNING CONDITIONS

1. This District Development Plan (Plan) applies to the land contained within the inner edge of the red line.
2. The purpose of this Plan is to describe the broad land uses (expressed as transect zones), the location of major service infrastructure, main movement systems and major conservation and recreation areas to guide the preparation of Local Development Plans within the Plan area.
3. Residential density throughout the Plan area is expressed as a range for each of the relevant transect zones depicted on the Plan. The extent of the transect zones is indicative and not intended to describe the spatial boundaries of the each zone. Specific residential density codes and land use within each of the transect zones will be applied by a Local Development Plan prepared in accordance with Clause 3 of Part One of the Broome North District Development Plan report.
4. The design of lots and local streets depicted on the Plan is indicative and will be subject to further refinement and modification at the Local Development Plan and subdivision stages respectively.
5. The location and design of Public Open Space (POS) depicted on the Plan is indicative and will be subject to further refinement and modification at the Local Development Plan and subdivision stages respectively. POS will be provided generally in accordance with the requirements of Liveable Neighbourhoods.

3. Existing Transport and Access

3.1 Existing Land Uses

The site is largely undeveloped natural scrub/ bush land incorporating some conservation areas, located at the northern periphery of Broome.

Broome contains a number of key trip attractors and destinations including:

- Broome Town Centre and Chinatown are located approximately 4km south of Gubinge Road. This is the main retailing, administrative and service centre for the town. It is also host to a number of tourism-related land uses.
- The Cable Beach tourism precinct is located to the west of Broome North and accessed via one of three routes - Cable Beach Road West, Fairway Drive/ Sanctuary Road or Murray Road/ Cable Beach Road. There are over 1,300 tourist accommodation units within this precinct.
- Broome International Airport encompasses – an extensive land area located between Broome North and the balance of the Broome Township. Vehicle access to the main terminal buildings is via Frederick Street/ Coghlan Street/ Macpherson Street.
- Broome Port is located at the southern end of the peninsula, 10km south of the township and is accessed via Gubinge Road/ Port Drive.

3.2 Existing Road Network and Traffic Volumes

The Broome Township road network is shown in Figure 3-1. Given that much of Broome North is undeveloped, there is only a limited network of streets throughout the site. Broome Road/ Highway (route H42), to the east of the site, is the only road in and out of the Broome township. It is a declared two lane undivided rural road under the care and control of MRWA. In July 2009, during the peak tourist season, traffic counts were undertaken by the Shire of Broome. The average daily traffic volumes on the road network surrounding Broome North are shown in Figure 3-2. The five-day average 24-hour traffic count on Broome Highway south of Gubinge Road was approximately 5,000 vehicles.

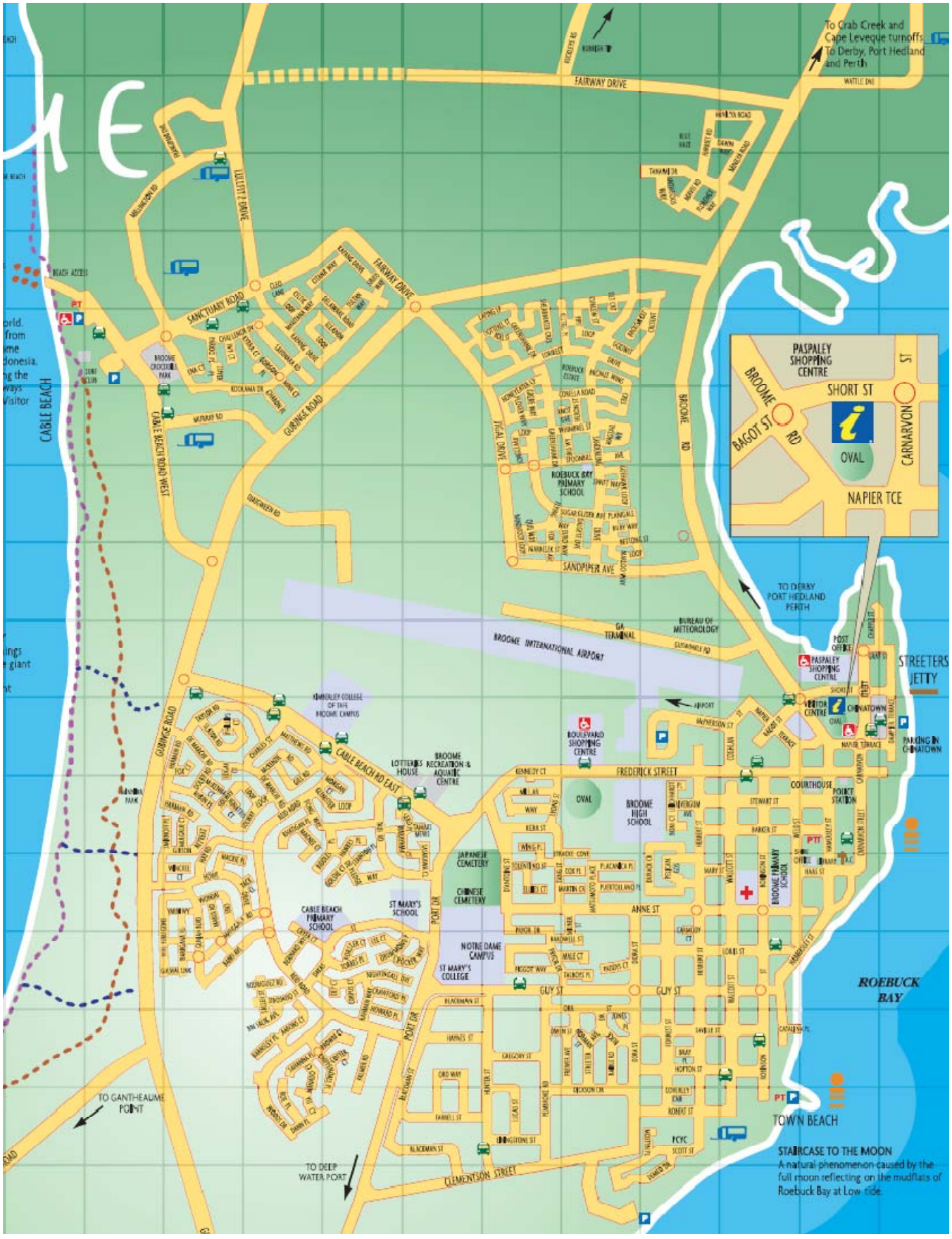
Gubinge Road was developed as a bypass route between Broome Road/ Highway and the Broome Port, reducing the throughput of heavy vehicles in the Broome Town Centre. Heavy vehicles comprise approximately 21% of the typical daily traffic flows on Gubinge Road. At present, Gubinge Road carries an average 2,650vpd east of Fairway Drive.

To the south of the Broome North development site, Gubinge Road is a two lane divided road with a 70km/h speed limit. The road reservation width is 70m and would allow a four lane duplicated cross section in the long term when traffic demands necessitate upgrade.

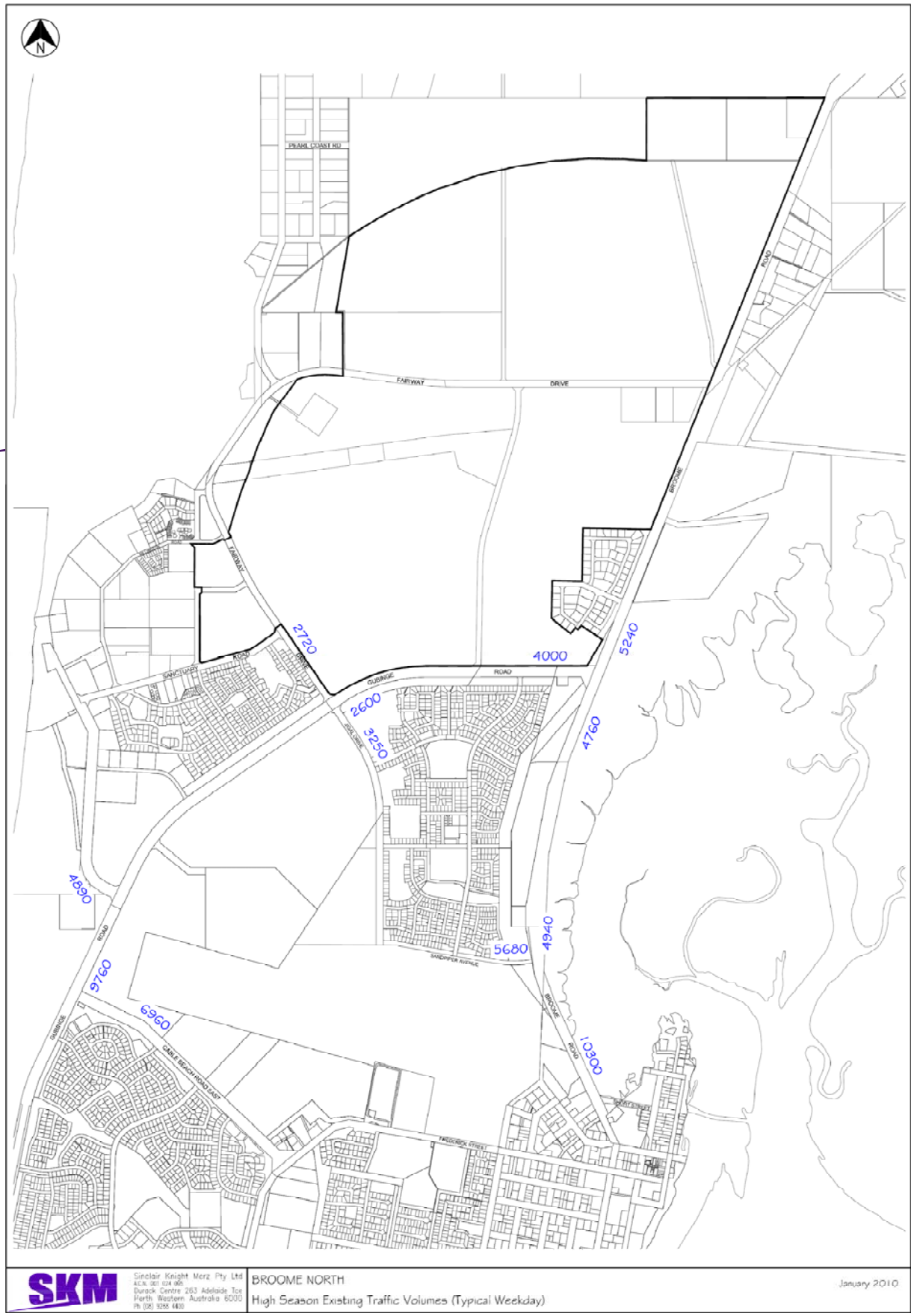
North-South Link Road, also known as Jigal Drive, is the southerly extension of Fairway Drive. It is ultimately planned to connect through the area now occupied by Broome Airport to Frederick Street. The timing of the Airport's relocation is not yet known. Until the Airport is relocated, Jigal Drive provides access to the Broome Town Centre via Sandpiper Avenue and Broome Road.

Magabala Road is presently an informal, unsealed road and carries only light traffic volumes (less than 1,000 vpd). Fairway Drive is also an unsealed road. The surface is well maintained but subject to flooding during the wet season. It connects Broome Road and Gubinge Road but carries low levels of traffic north of Sanctuary Road.

- **Figure 3-1 Broome Township map** (Source: Broome Tourist information Centre)



- **Figure 3-2 Existing High Season Traffic Volumes**



3.3 Existing Walking and Cycling Networks

There is presently no formalised walking and cycling access through the development site. Throughout Broome, most residential streets have footpaths on at least one side of the road. All major roads have footpaths on both sides. Footpaths are most commonly located adjacent to the road kerb, rather than adjacent to the property boundary.

Council has received ongoing funding under the Country Pathways programme to extend and upgrade cycling/ shared use paths. Most shared use paths are 2.0 metres wide.

Gubinge Road has recently been constructed with a shared path on one side. There is also a shared path along the western side of Fairway Drive in the vicinity of Cable Beach.

Currently, traffic volumes are low on Gubinge Road but in view of forecast increases, well located crossing points will be essential, especially to link the Broome North and Roebuck Bay residential areas.

3.4 Existing Public Transport

The current bus service in Broome is a privately operated franchise service geared towards the tourist market. The service operates from Chinatown to Cable Beach and intermittently to the Broome Port. Bus patronage is relatively low in the residential areas serviced such as Roebuck Estate.

4. Future Conditions

4.1 Road Network

The *Broome Highway Planning Study – Route Definition Report* (Western Infrastructure, May 2002) outlines the ultimate access arrangements on to Gubinge Road and Broome Highway in the vicinity of Broome North. These include:

- 40m radius roundabout at the intersection of Gubinge Road/ Fairway Drive/ North-South Link Road (Jigal Drive)
- 3-leg, priority controlled intersection at Gubinge Road/ Magabala Road. Full directional access permitted.
- 3-leg priority controlled intersection at Gubinge Road/ Sanderling Drive. Access to and from Sanderling Drive restricted to left-in/ left-out
- 3-leg, priority controlled intersection at Gubinge Road/ Broome Road/ Broome Highway. Full directional access permitted.
- 3-leg, priority controlled intersection at Broome Highway/ Tanami Drive. Full directional access permitted into and out from the Blue Haze Industrial estate.
- 3-leg priority controlled intersection at Broome Highway/ Fairway Drive. Full directional access permitted.

The plans from the *Broome Highway Planning Study – Route Definition Report* (Western Infrastructure, May 2002) are presented in Appendix A of this report.

All street intersections with Gubinge Road are designed to cater for the turning movement of a 19m semi-trailer.

Gubinge Road is ultimately planned to be duplicated with timing reviewed periodically.

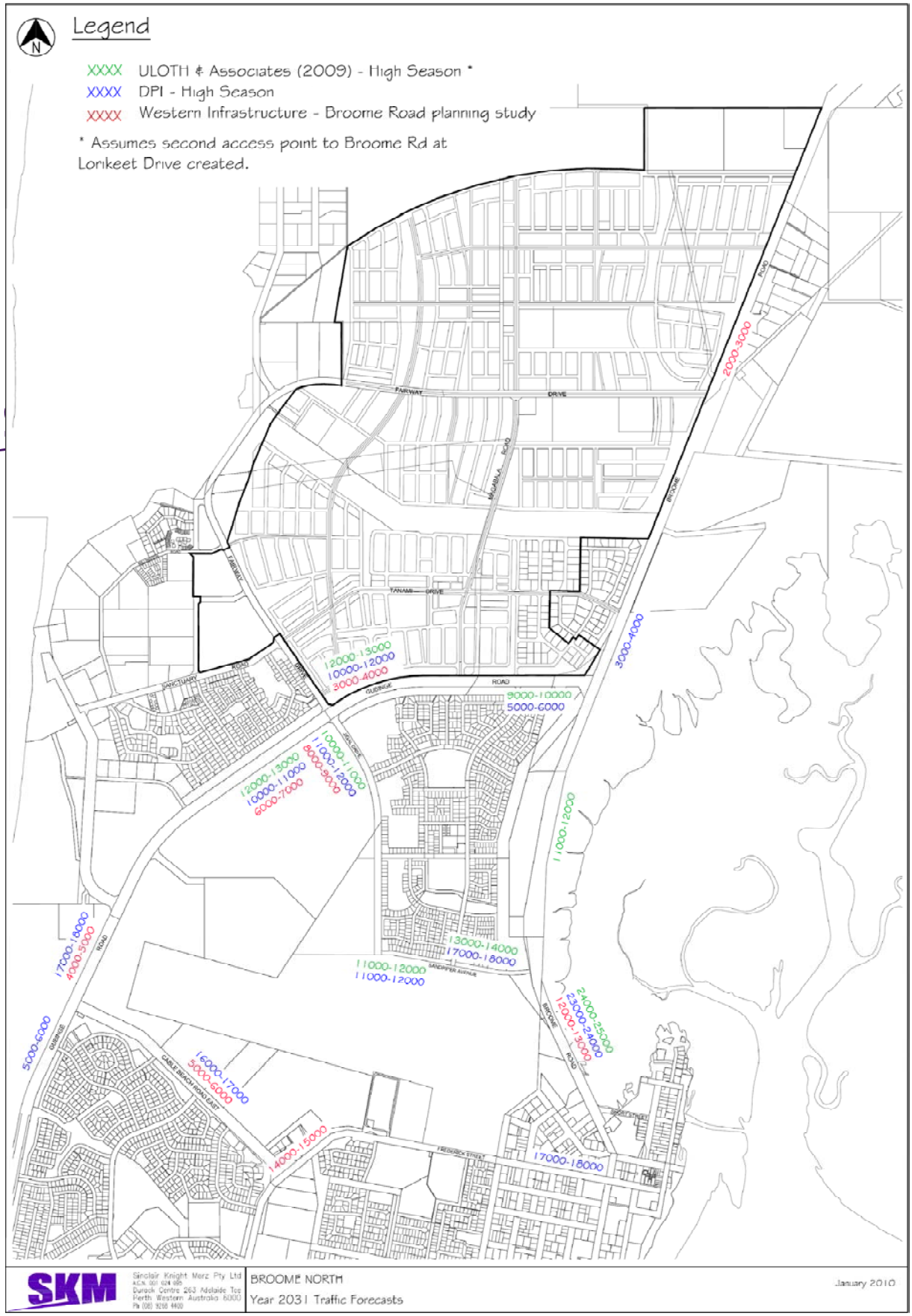
4.2 Traffic Projections

Traffic volume projections for the Broome road network have been made by a number of sources. These include:

- Broome International Airport Group (prepared by ULOTH and Associates) – to understand the impacts of planned development within land owned by the airport group which includes Roebuck Estate. Projections have been developed for the years 2011 and 2031.
- Department of Planning - (formerly Department for Planning and Infrastructure, DPI) – forecasts for the years 2011 and 2031
- Western Infrastructure through the preparation of the Broome Highway Planning Study Route definition report for the year 2031 (March 2003).

The year 2031 projections for key roads around Broome North are presented in Figure 4-1.

- **Figure 4-1 Various Year 2031 Traffic Projections for Broome**

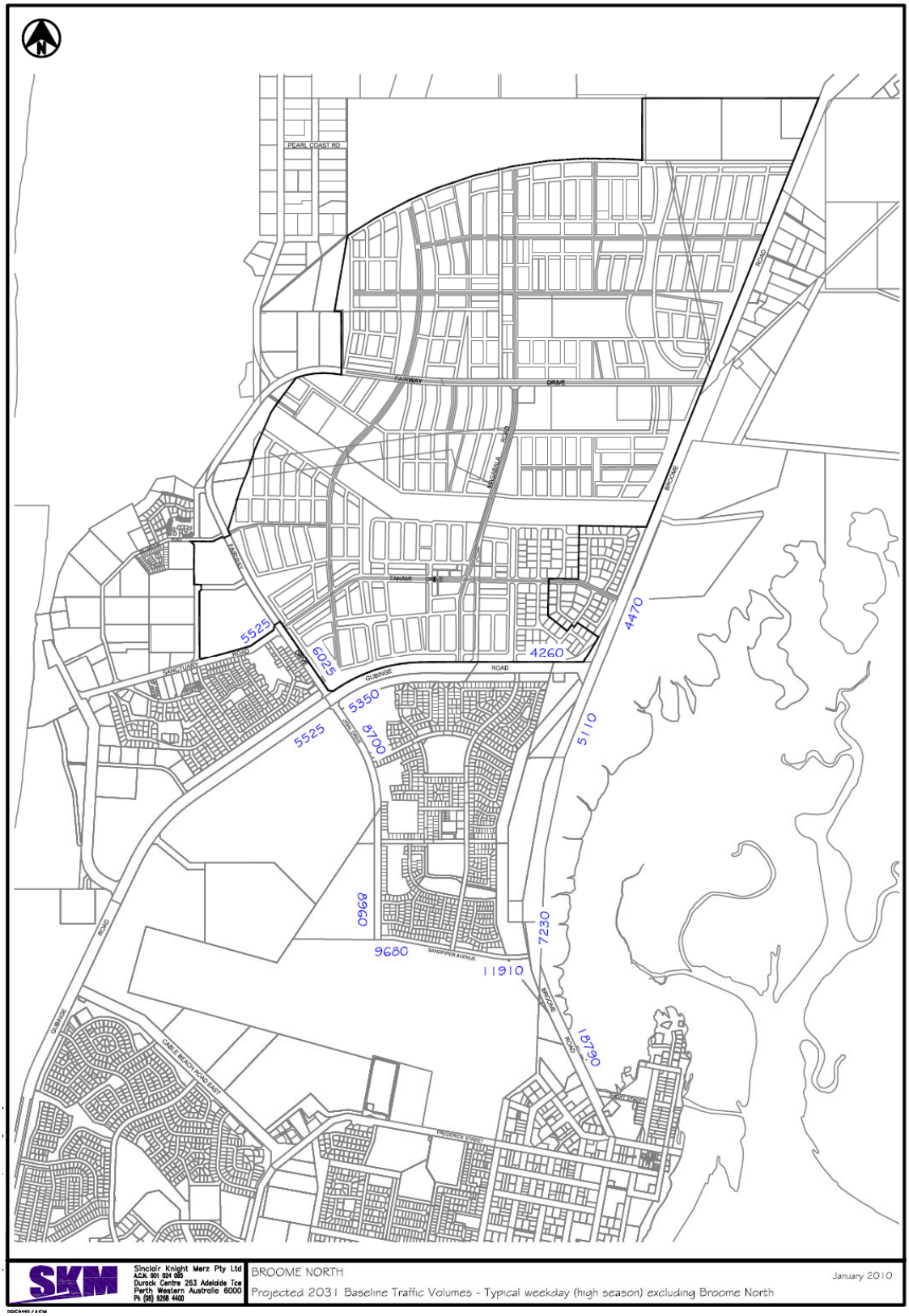


It is noted that these forecasts are not directly comparable as there are inconsistencies in the allowances for residential lot development in Broome (especially Broome North, Roebuck Estate and Cable Beach) and road networks. However there is a large degree of consistency between the DPI (DoP) and ULOTH and Associates projections.

The most recent traffic forecasts are those prepared by ULOTH and Associates. Figure 4-2 shows year 2031 traffic projections prepared by ULOTH which exclude development in Broome North however with some modifications. SKM considers that a more even balance in traffic growth on Sanctuary Road and Gubinge Road west of Fairway Drive will occur. These volumes will be used as the baseline volumes for the 'interim' year assessment for Broome North.

Traffic projections do not extend beyond the year 2031, which is the typical planning horizon.

- **Figure 4-2 Year 2031 volumes – without Broome North development**



5. Traffic Generation

5.1 Methodology and Assumptions

The full build-out of Broome North is expected to occur significantly later than the typical planning horizon for transport assessments which is the year 2031. It has been agreed with the DoP that two development scenarios will be considered to assess the impacts of Broome North:

- **Interim:** year 2031 with 2,000 residential lots, one primary school, one high school, extension to the Blue Haze industrial estate and partial development of one retail centre. This development area is expected to be bounded by Fairway Drive, Broome Highway and Gubinge Road.
- **Ultimate**: notionally year 2051 with full development extending to the existing waste transfer station.

Based on the trends in lots released in Broome North – approximately 100 per annum - the interim scenario is considered a high growth scenario with a medium growth scenario more likely to be around 1,500 lots.

5.2 Assumptions

The assumptions made in undertaking this analysis are presented in Table 5-1.

Table 5-1 Assumed yield for analysis

Use	Interim	Ultimate
Residential lots	2,000	4,800
Education enrolments	500	2,000
Retail (net floor area, sqm)	2,500	6,000
Industrial (gross floor area, sqm)[2]	60,750	60,750

5.3 Trip Generation Rates

Detailed calculations of the trip generation for Broome North are presented in Appendix E and the trip rates are summarised below.

[2] Industrial area is 27ha, 75% net yield, 0.3GFA

Table 5-2 Ultimate Trip Generation

Use	Car driver trip rate
Residential[3]	7.17 trips per dwelling
Education	2 trips per enrolment
Retail[4]	80 per 100 sqm NLA
Industrial	6.5 per 100 sqm GFA

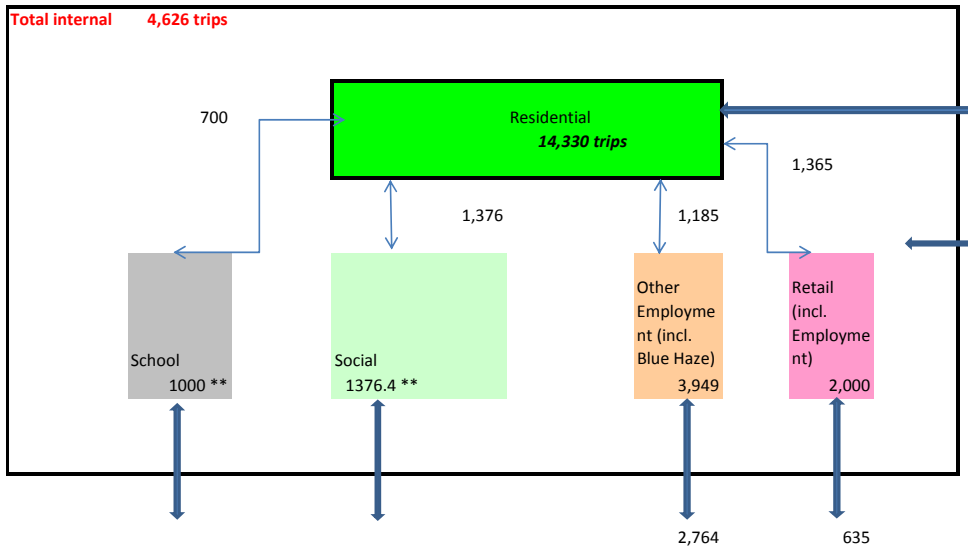
The total trip generation is not calculated by addition of the above trip rates for each use as this would lead to double counting. For example a trip generated from a dwelling to the local shopping centre would be counted twice.

Broome North is expected to have a high degree of self sufficiency which will increase as the development grows and becomes more mixed use. The mix of internal and external trip is shown in Figure 5-1 and Figure 5-2.

[3] Includes 5% non home based trips
[4] Includes employment trips

Figure 5-1 Internal and External Trips Generated at Broome North (Interim development)

Daily internal and external trips



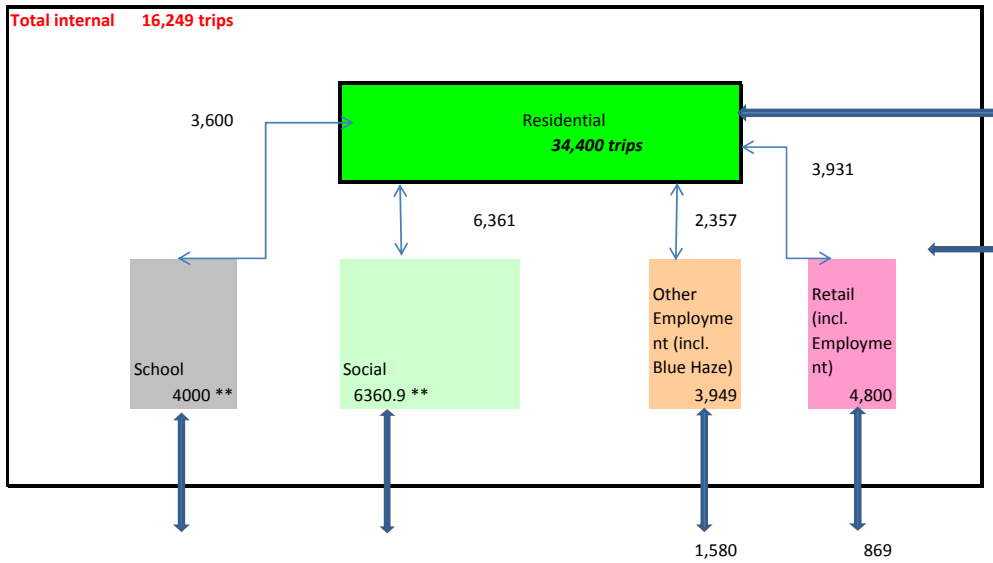
**External trips Included in non home based trips

		1		3		2	
		Cable Beach		Broome town centre, Chinatown		Other (eg Port)	
		%	No.	%	No.	%	No.
School	300	0%	0	0%	0	0%	0
8,390 Social	0						0
Beach, rec	1,945	70%	1361.588	30%	583.5375	0%	0
Other	2,548	20%	509.6	70%	1783.6	10%	254.8
Other Employment	2,228	15%	334.125	75%	1670.625	10%	222.75
Retail	1,365	20%	273	80%	1092	0%	0
683			0		0		0
Non home based trips*	683	15%	102.45	75%	512.25	10%	68.3
	0						
Other employment	2,764	10%	276.4	60%	1658.4	30%	829.2
Retail	635						
Total External	12,468		2,857		7,300		1,375

Notes: *non home based trips includes external trips to schools, social and recreation within Broome North

Figure 5-2 Internal and External Trips Generated at Broome North (Ultimate development)

Daily internal and external trips



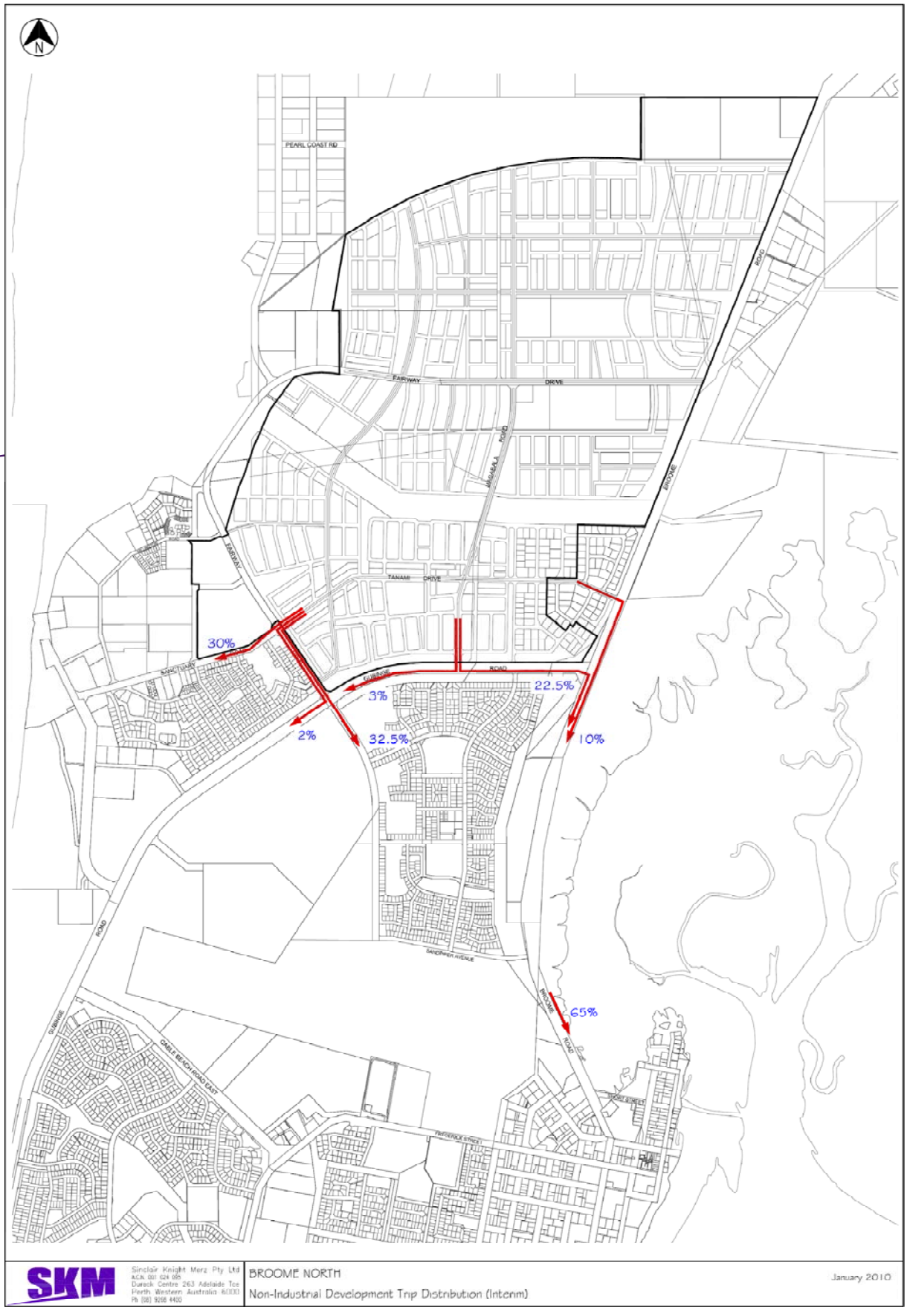
		1		3		2	
		Cable Beach		Broome town centre, Chinatown		Other (eg Port)	
		%	No.	%	No.	%	No.
School	400	0%	0	0%	0	0%	0
Social	0						0
Beach, rec	4,668	70%	3267.81	30%	1400.49	0%	0
Other	3,058	20%	611.52	70%	2140.32	10%	305.76
Other Employment	5,833	15%	874.95	75%	4374.75	10%	583.3
Retail	2,621	20%	524.16	80%	2096.64	0%	0
			0		0		0
Non home based trips*	1638	15%	245.7	75%	1228.5	10%	163.8
	0						
Other employment	1,580	10%	158	60%	948	30%	474
Retail	869						
Total External	20,667		5,682		12,189		1,527

Notes: *non home based trips includes external trips to schools, social and recreation within Broome North

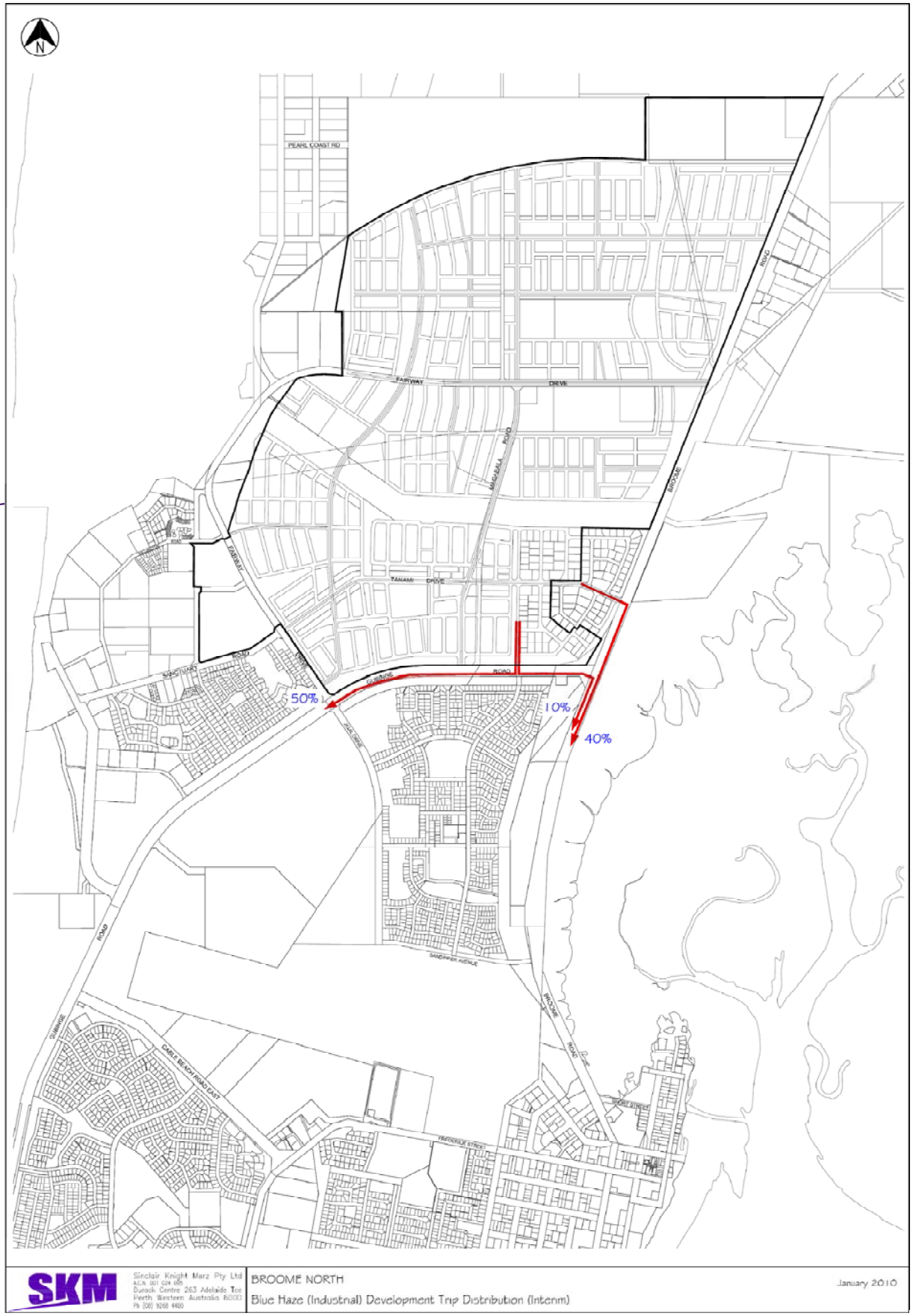
6. Traffic Distribution

The assumed external trip distribution for trips to Blue Haze and all other trips at interim and ultimate development are shown in Figure 6-1 to Figure 6-4.

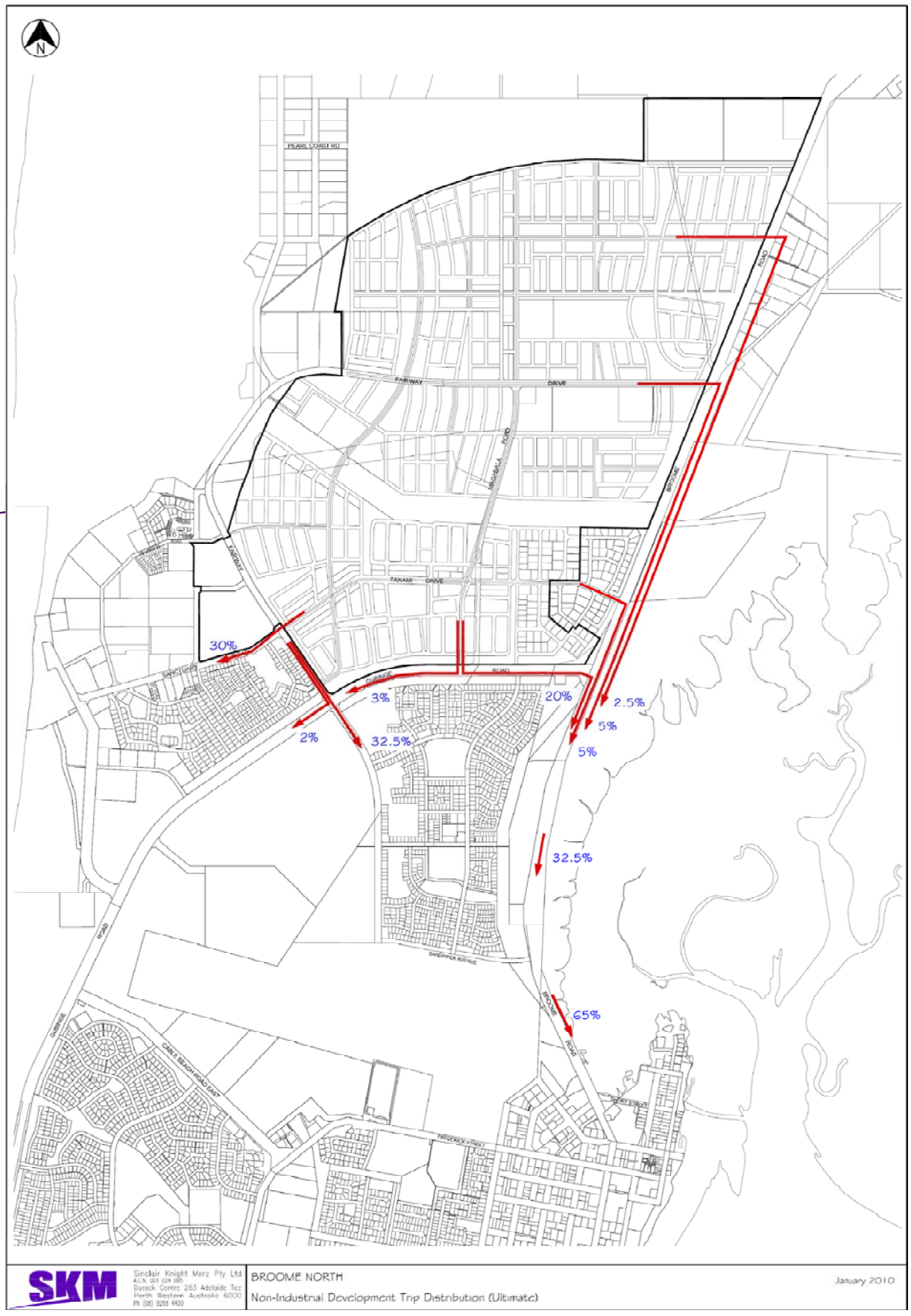
- **Figure 6-1 Non-industrial Trip Distribution – Interim**



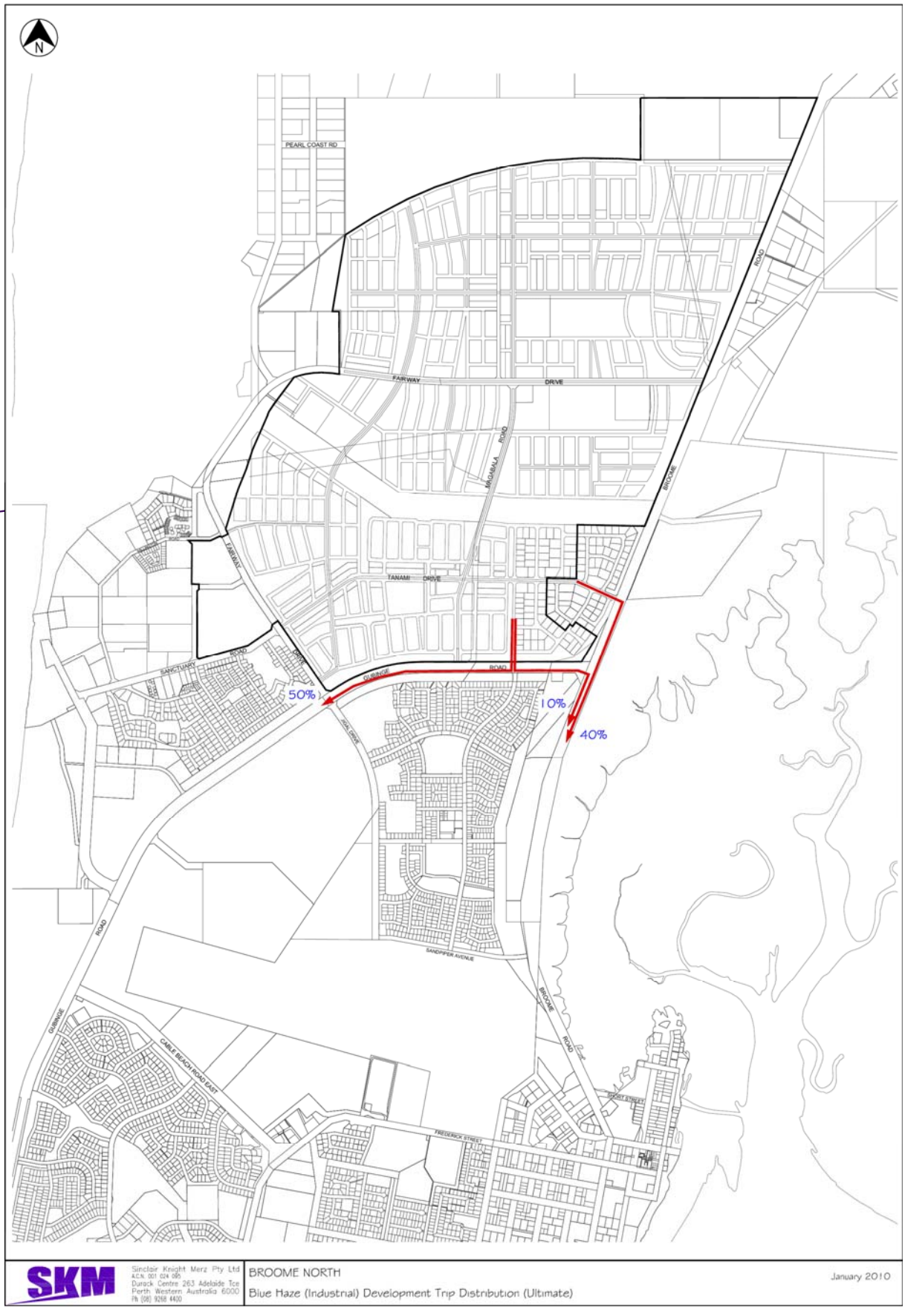
- **Figure 6-2 Industrial (Blue Haze) Trip Distribution – Interim**



- **Figure 6-3 Non-industrial Trip Distribution – Ultimate**



- **Figure 6-4 Industrial (Blue Haze) Trip Distribution – Ultimate**



7. Transport Analysis

7.1 Methodology

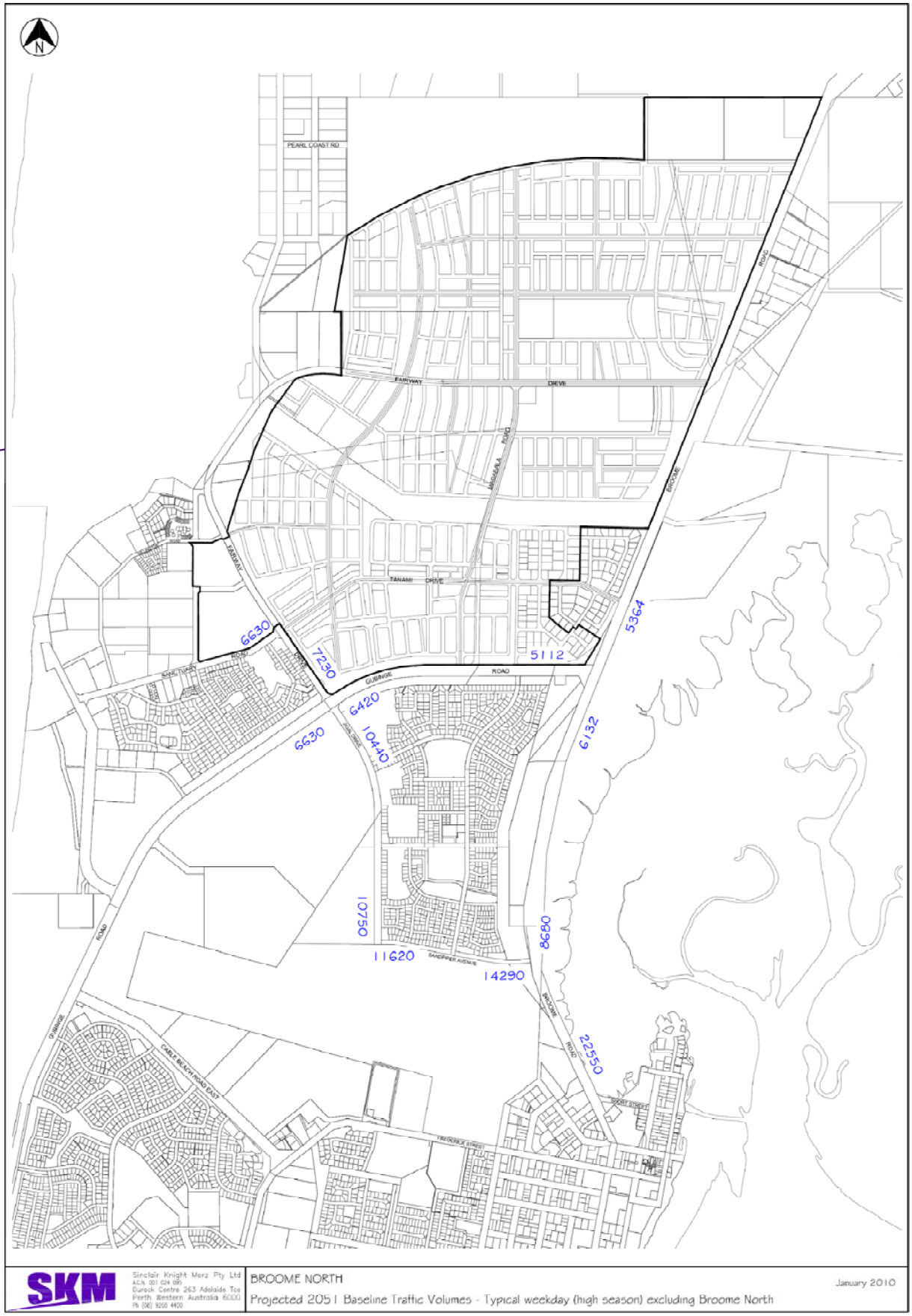
As discussed in Section 13, year 2031 traffic projections prepared on behalf of the Broome International Airport Group by ULOTH and Associates have been used as the baseline of the interim assessment. For the ultimate development, notionally year 2051, the 2031 volumes have been increased by 20% to allow for continued growth external to Broome North. However, it is recognised that most growth within Broome will take place in Broome North during the period 2031 to 2051.

The projected 2051 baseline traffic volumes (excluding the Broome North development) are presented in Figure 7-1.

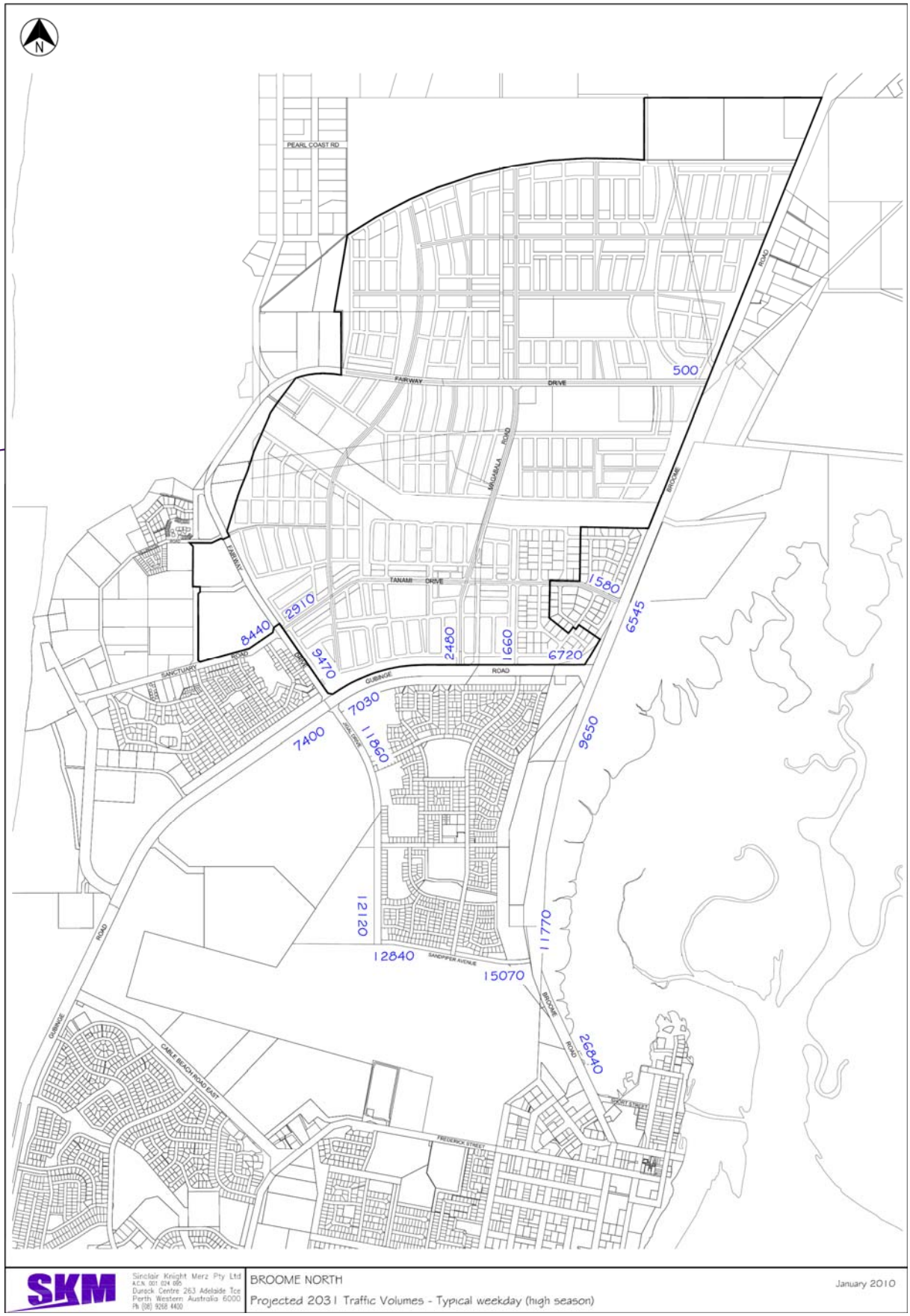
7.2 Forecast Traffic Volumes

The interim and ultimate forecast traffic volumes on the road network surrounding Broome North, including the projected traffic associated with the Broome North development are presented in Figure 7-2 and Figure 7-3.

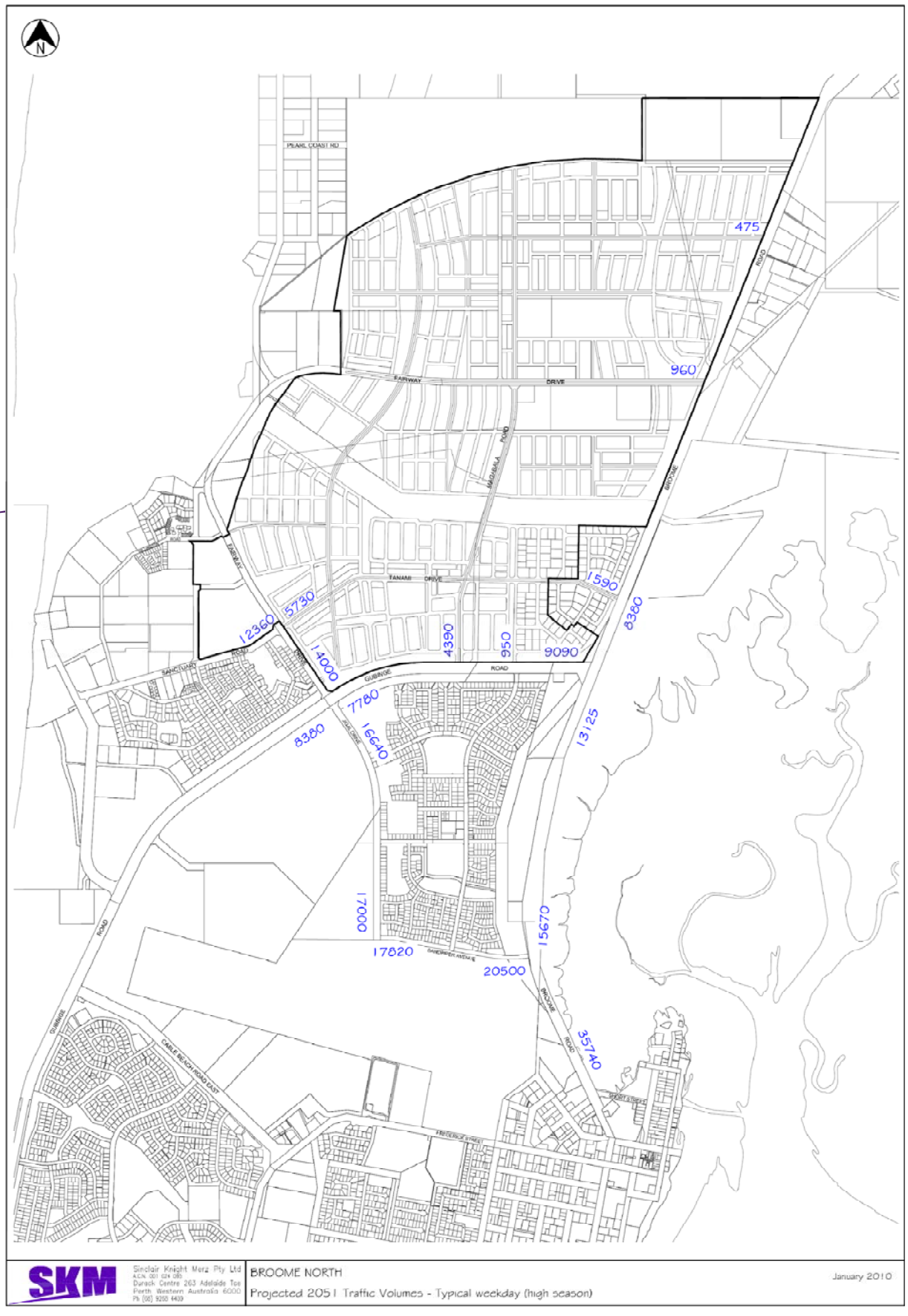
- **Figure 7-1 Year 2051 volumes – without Broome North**



- **Figure 7-2 2031 Forecast Traffic Volumes at Interim Development**



- **Figure 7-3 2051 Forecast Traffic Volumes at Ultimate Development**



7.3 Proposed Access Arrangements

Refer to plans attached as Appendix C.

The proposed external access points to the arterial road network from Broome North and their respective treatments are as follows:

Broome Highway

- Existing entrance to Blue Haze
- Existing Fairway Drive
- One new entrance towards the north of the development.

The existing intersection of Tanami Drive and Broome Highway, which provides access to Blue Haze, will need to be upgraded to include slip lanes as per the *Broome Highway Planning Study – Route Definition Report* (Western Infrastructure, May 2002).

In the long term it is also planned that a new separate entrance is provided to the waste transfer station (for amenity and safety reasons). All intersections will be priority-controlled.

The spacing between these entrances is approximately:

- Blue Haze to Fairway Drive – 1,200 metres
- Fairway Drive to northern entrance – 900 metres
- Northern entrance to access to transfer station – 500 metres.

Gubinge Road

Access to Gubinge Road has been agreed in principle with MRWA as follows:

- Magabala Road, full access
- Blue Haze Light Industrial Area, just west of Sanderling Drive

Copies of correspondence with MRWA are attached as Appendix D.

The intersection of Magabala Road/ Gubinge Road is planned as a full movement T-intersection. It will be priority controlled (GIVEWAY or STOP) until such time that the demand for pedestrian crossing warrants signalisation. The traffic analysis undertaken suggests that it is the demand for pedestrian crossing rather than traffic capacity grounds, which will prompt signalisation of this intersection. Main Roads WA supports this position.

To separate general traffic and heavy vehicles accessing the Blue Haze Light Industrial Area, a second access point from Broome North to Gubinge Road is proposed. This is for both amenity and safety reasons. This access was not considered under the *Broome Highway Planning Study – Route Definition Report*. However, at that time the development potential of Broome North was considered to be significantly less than now proposed.

Most heavy vehicles accessing Blue Haze will be destined for or originate at Broome Port (accessed via Gubinge Road). To discourage heavy vehicle traffic from travelling through the planned town centre on Magabala Road, a secondary access permitting left and right turns out from Blue Haze to Gubinge Road and left turns in from Gubinge Road, is proposed. No right turn in is considered necessary at this location as this would be a low demand movement and can be facilitated at the intersection of Broome Road/ Tanami Drive.

This new access is to be located just west of Sanderling Drive and approximately 300m from Magabala Road, which will be realigned west of its current location. This access arrangement assumes that Sanderling Drive will be limited to left-in/ left-out at Gubinge Road as per the *Broome Highway Planning Study – Route Definition Report.* The conceptual layout of the proposed secondary access Gubinge Road Blue Haze is shown in Appendix C.

The intersection of Gubinge Road and Fairway Drive is roundabout-controlled. The geometry of this intersection (40m radius) caters for triple road trains. This intersection will provide sufficient capacity well into the future. However, to facilitate safe pedestrian crossing of Gubinge Road, it is recommended that this intersection be signalised in the longer term when pedestrian demands necessitate.

The treatment at the intersection of Tanami Drive/ Fairway Drive/ Sanctuary Road is discussed below.

Fairway Drive

The projected traffic volumes at the intersection of Tanami Drive and Fairway Drive require that it is roundabout-controlled at or prior to ultimate development in order to provide satisfactory levels of service.

7.4 Intersection Analysis

The software package SIDRA has been used to assess the interim and long term performance of the following intersections where development of Broome North is expected to have the greatest impact:-

- Gubinge Road/ Fairway Drive/ Jigal Drive
- Broome Road/ Tanami Drive
- Broome Road/ Gubinge Road
- Broome Road/ Sandpiper Avenue
- Broome Road/ Short Street

The intersection controls proposed and analysed for interim and ultimate development are presented in Table 7-1.

Table 7-1 Analysed intersection controls

Intersection	Interim	Ultimate[5]
Gubinge Road/ Magabala Road	Priority	Signals
Gubinge Road/ Blue Haze access	Priority	Priority
Gubinge Road/ Fairway Drive/ Jigal Drive	Roundabout	Signals
Broome Road/ Tanami Drive	Priority	Priority
Broome Road/ Gubinge Road	Priority	Priority
Broome Road/ Sandpiper Avenue	Roundabout	Roundabout
Broome Road/ Short Street	Roundabout	Roundabout

[5] Further traffic planning/ assessment will be required in the future to confirm intersection arrangements beyond 2031 prior to decisions being made on infrastructure upgrades. The analysed intersection performance is notional.

Full details of the intersection analysis results are presented in Appendix E.

7.5 Road Network Improvements

The road network external to the Broome North site is expected to undergo major changes beyond the year 2031. The possible relocation of the Broome International Airport is a significant factor. It is for this reason, combined with the difficulties in projecting traffic growth beyond the year 2031 that it cannot be determined with any certainty at this stage of planning the required infrastructure upgrades beyond 2031. Consequently the focus of this discussion on recommended road infrastructure upgrades is up to and including the year 2031 (ie interim development scenario).

The practical capacity of a two and four lane divided road (with median) is typically 15,000 – 20,000vpd and 35,000-40,000vpd respectively, depending on intersection treatments. Review of the projected traffic volumes at interim development, the following conclusions can be made, assuming that the airport has not relocated:

- Gubinge Road is unlikely to need duplication prior to 2031. Although the forecast volumes in the area investigated are expected to remain less than 15,000vpd the need for a four lane divided road is likely to be brought forward by the high proportion of heavy vehicles.
- Jigal Drive is likely to require to be upgraded to a two lane divided carriageway. Right turn movements should be protected via a median.
- Sandpiper Avenue should be upgraded to a four lane divided carriageway
- Broome Road is expected to require duplication (four lane divided road) south of Sandpiper Avenue by interim development.

At a stage between interim and ultimate development stages there will be a requirement for some of the site access points to be upgraded, this is in part due to the duplication of Gubinge Road and Broome Road (north of Gubinge Road). It is envisaged that this duplication (as outlined in the Broome Road Planning Study prepared by Western Infrastructure) will take place at some stage between 2031 and 2051.

Upgrading the intersections of Gubinge Road/ Magabala Road and Gubinge Road/ Fairway Drive/ Jigal Drive to traffic signals is likely to be triggered by the need to provide for safe pedestrian crossing of Gubinge Road, rather than on traffic capacity grounds.

In addition to the site access points, the development of Broome North is projected to notably impact the intersections of Broome Road/ Gubinge Road and Broome Road/ Sandpiper Avenue. It is forecast that the Broome Road/ Gubinge Road intersection can remain a priority controlled intersection well into the future. It is expected that the current configuration will remain suitable until such time as Gubinge Road and Broome Road north of Gubinge Road are duplicated to a four lane divided carriageway.

The intersection of Broome Road/ Sandpiper Avenue is forecast to require upgrading to a single lane roundabout control by interim development. Extending Jigal Drive south of Sandpiper Avenue through the airport would reduce the traffic volume through the Broome Road/ Sandpiper Avenue intersection and would determine the need to upgrade this intersection to a dual-circulatory lane roundabout beyond 2031.

The SIDRA analysis shows that the intersection of Sandpiper Avenue/ Broome Road is expected to operate with a degree of saturation of 0.85 (Broome North right turn) in the interim for the right turn into Sandpiper Avenue. This is a low demand movement and it is noted that our analysis is based on a worst case scenario of high growth at Broome North. The operation of this movement is therefore not expected to be problematic.

The intersection of Broome Road/ Frederick Street has been recently upgraded to roundabout control. It is expected that this intersection would be upgraded to a two-lane roundabout if/ when Broome Road (south of Gubinge Road) is duplicated.

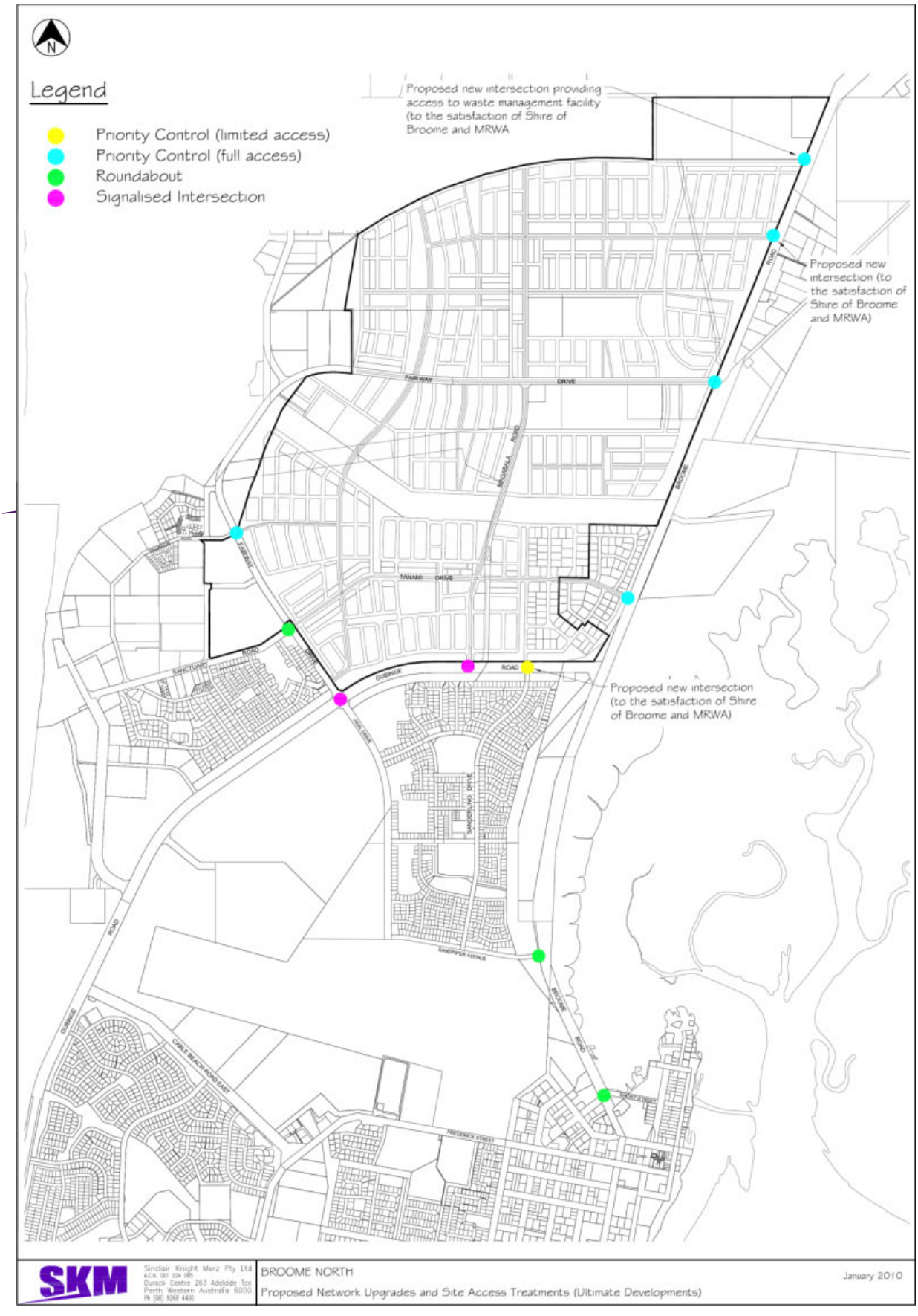
7.6 Summary

The recommended intersection treatments at interim and ultimate development stages are presented in Figure 7-4 and Figure 7-5 respectively. The treatments at ultimate development are notional and would require further investigation in the future to determine the need for upgrade.

It is noted that forecasting traffic volumes at the time of full build out of Broome North is difficult to do with a great deal of certainty due to the very long time horizon which will see a significant transformation of Broome. There are many local and global factors which will influence travel patterns over this period such as housing affordability, technology and peak oil. In Broome there is uncertainty around the timing of the airport relocation and the nature of the development which would take place on the site it now occupies. Spatial planning for road network improvements and associated developer contributions to fund road upgrades post 2031 should be undertaken with caution. It is recommended that a developer contributions plan for Broome North be developed to include road network upgrades to the year 2031.

- **Figure 7-4 Recommended intersection treatments – interim (2031)**

- **Figure 7-5 Recommended intersection treatments – ultimate (2051)**



8. Planned Internal Transport Network

8.1 Objectives

Legible and permeable internal street network in Broome North

Design all local and neighbourhood connector streets in Broome North as low speed streets to discourage through traffic movement and to improve safety for all users

Design all streets to make a contribution to the above ground drainage system

Provide intersection traffic management control where neighbourhood connectors or important local streets intersect to improve safety and reduce speed

Provide a comprehensive, integrated and safe footpath network

Provide a network of linked, safe bicycle routes using a combination of shared paths and on-street facilities within road reserves

At the PDF it was agreed that to implement these objectives a minimum 7.4 metre pavement should be provided between kerbs (and can include traffic lanes, parking and cycle lanes) in order for streets to fulfil a surface drainage function. This requires that a number of the standard Neighbourhood Connector and Local Access Street typologies in Liveable Neighbourhoods need to be adapted for Broome conditions.

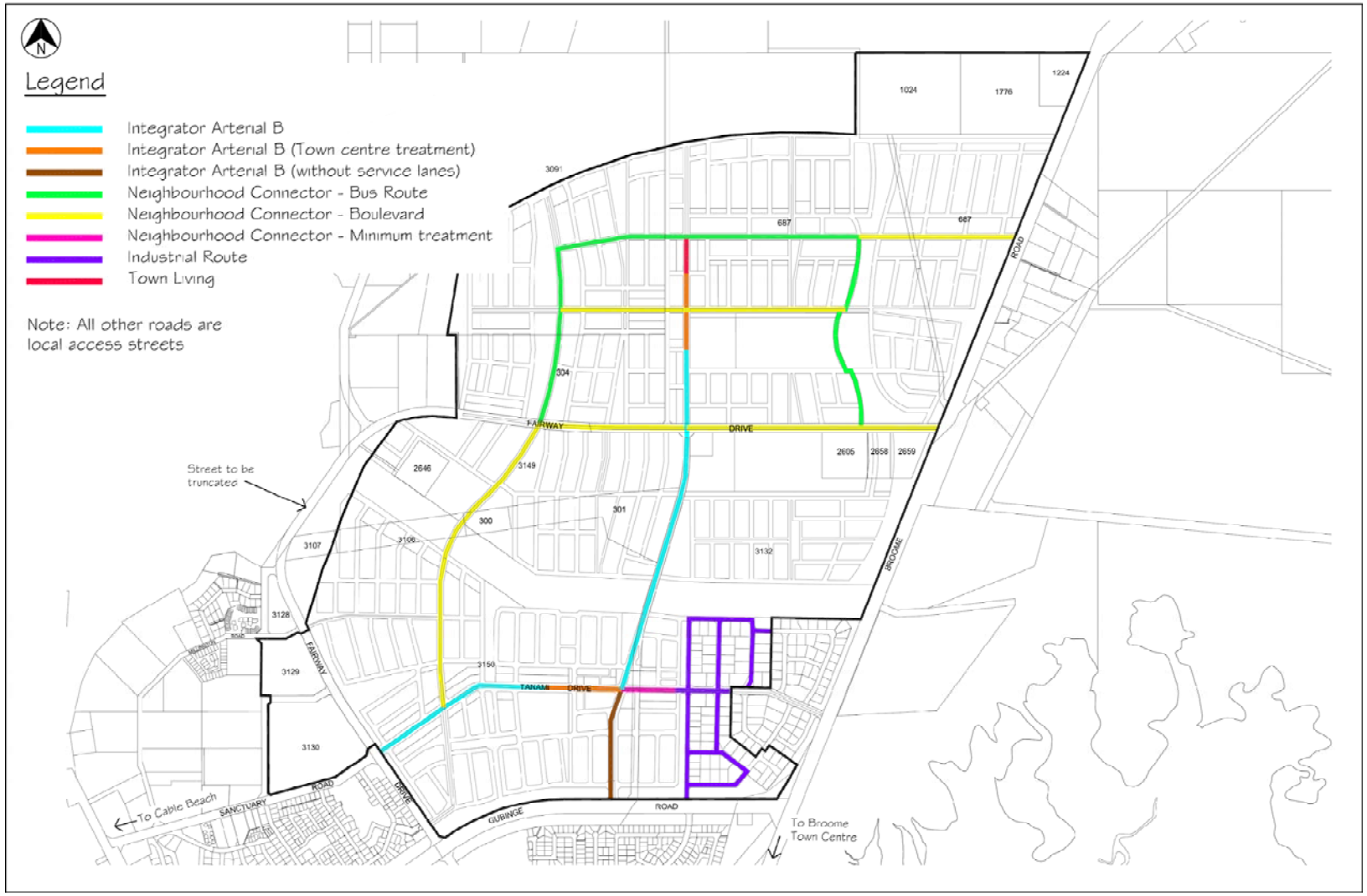
8.2 Hierarchy of Streets

The following principles have been applied:

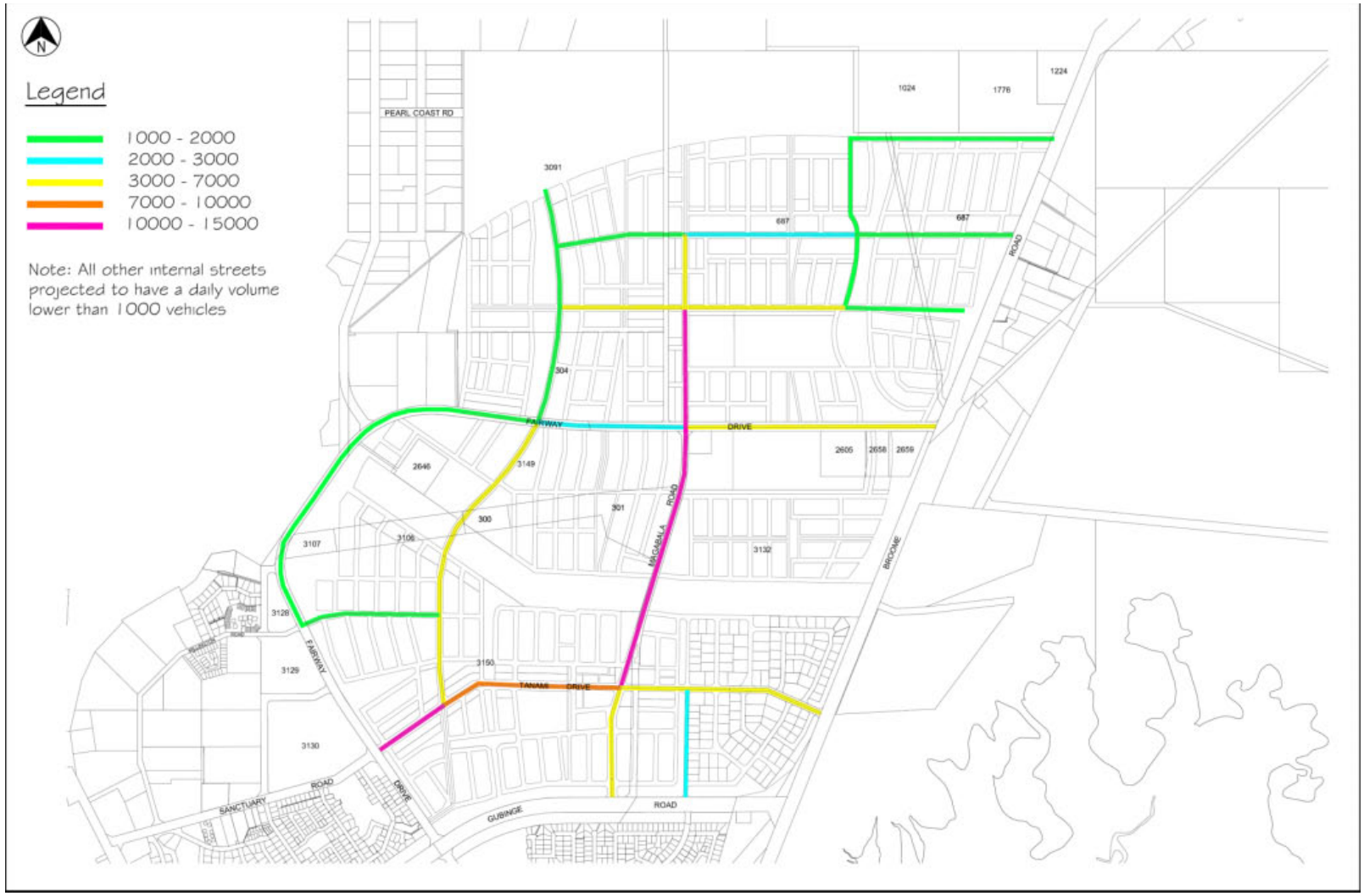
- All roads have a minimum pavement width of 7.4 metres to satisfy drainage requirements
- Where estimated traffic volumes are greater than 7,000 vehicles per day, property access is provided via service roads
- On street parking provision is maximised around town centres
- Schools are accessed via a network of shared paths
- Footpaths are provided on at least one side of all locals streets and both sides of all other streets
- Shared paths are at least 2.5m wide and all footpaths are at least 1.5m wide.

The road hierarchy for Broome North is shown in Figure 8-1. This comprises a network of local access streets, Neighbourhood Connectors and Integrator Arterial B Roads (Magabala Road and Tanami Drive west of Magabala Road). The maximum forecast traffic volume in the development is 14,000vpd on a section of Magabala Road (refer to Figure 8-2).

Figure 8-1 Proposed Street Hierarchy



- **Figure 8-2 Internal Network Volumes – ultimate development**



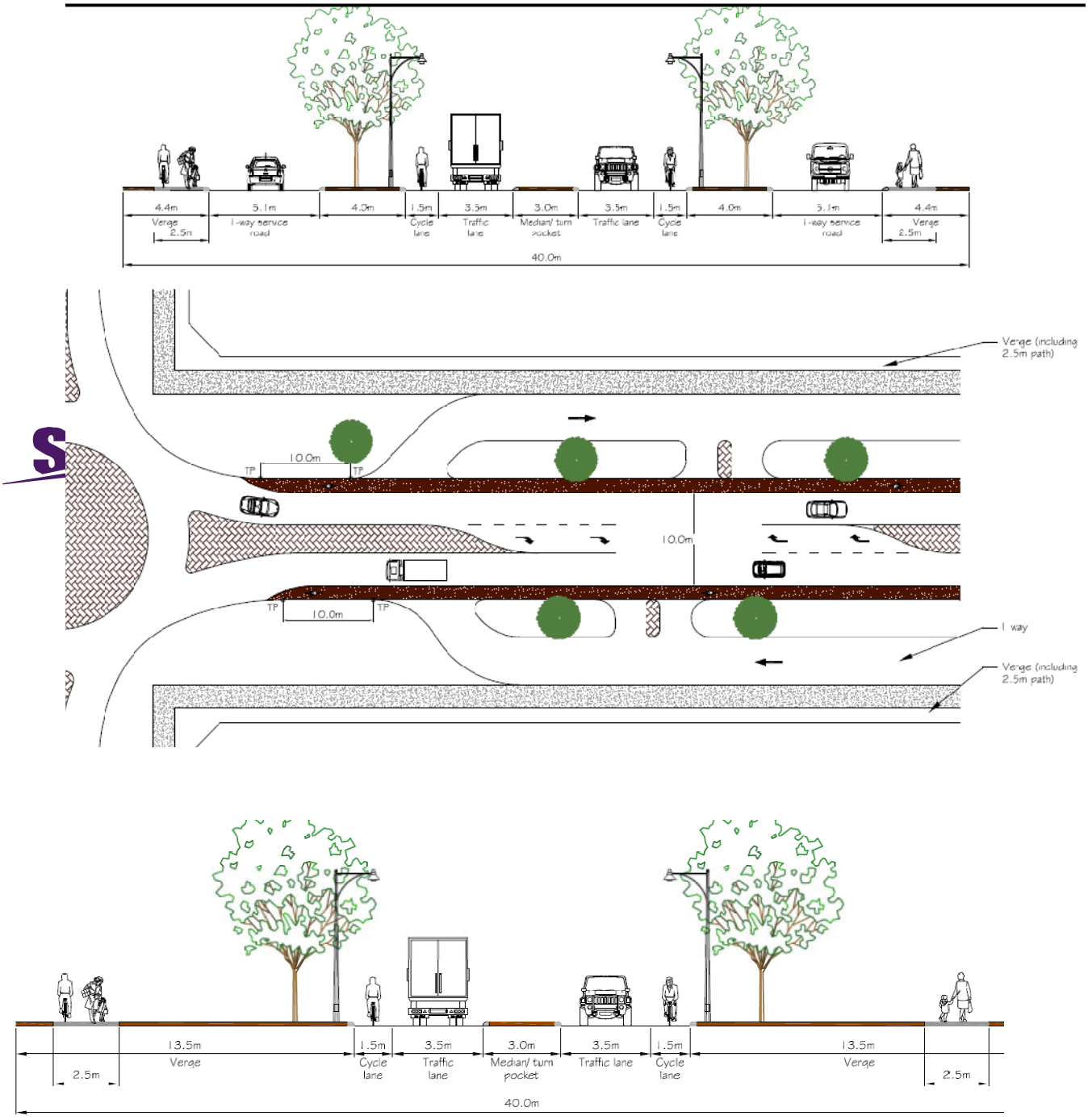
8.3 Street Typologies

Specific cross sections have been created for the town centre to maximise on-street parking provision and for the Blue Haze Light Industrial Estate to provide 19.0m semi trailer access to lots.

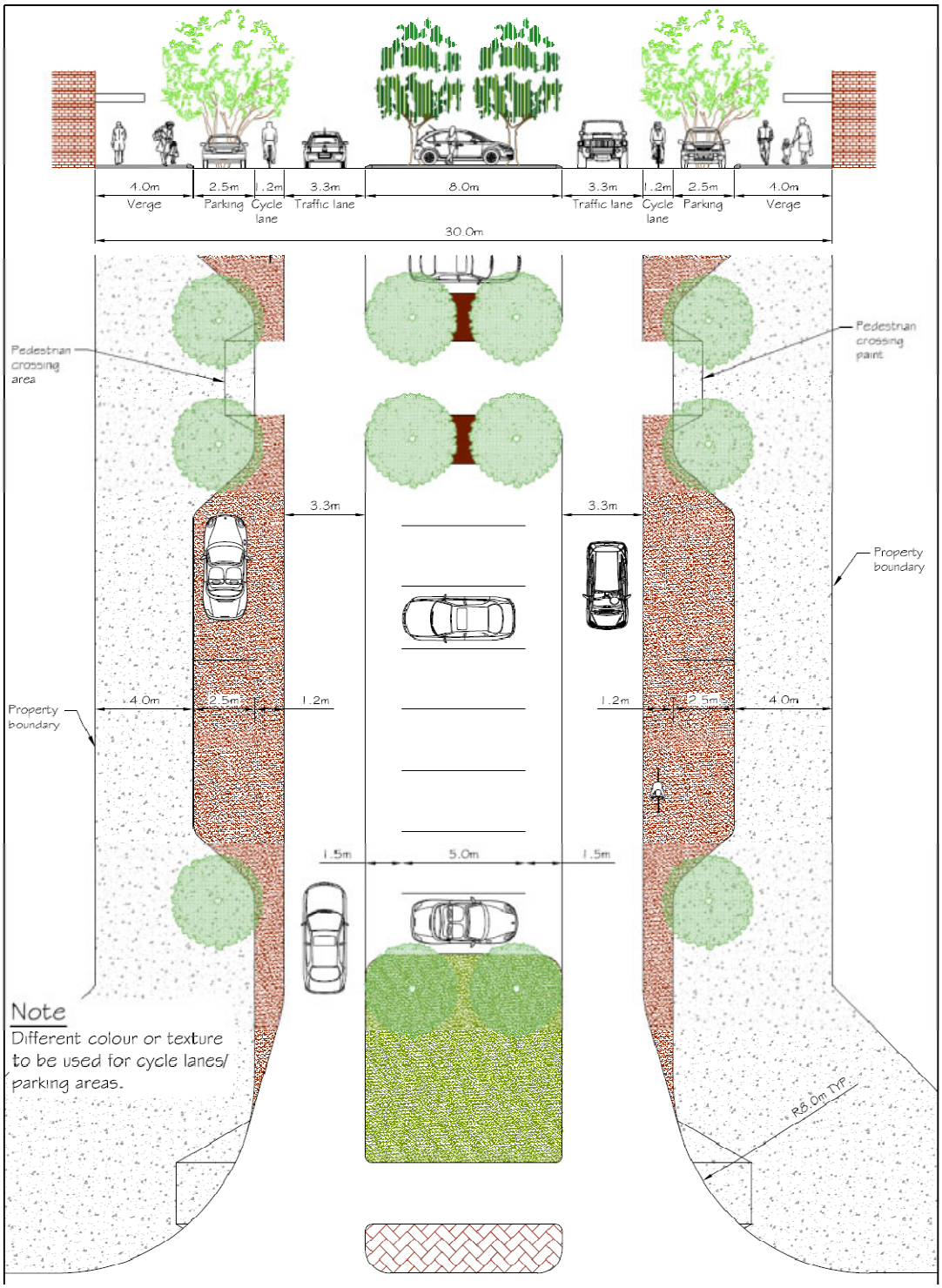
The typical designs for all road types are shown in Figure 8-3 to Figure 8-10.

In accordance with the Liveable Neighbourhoods guidelines the verge width is reduced to 1.0m adjacent to public open space.

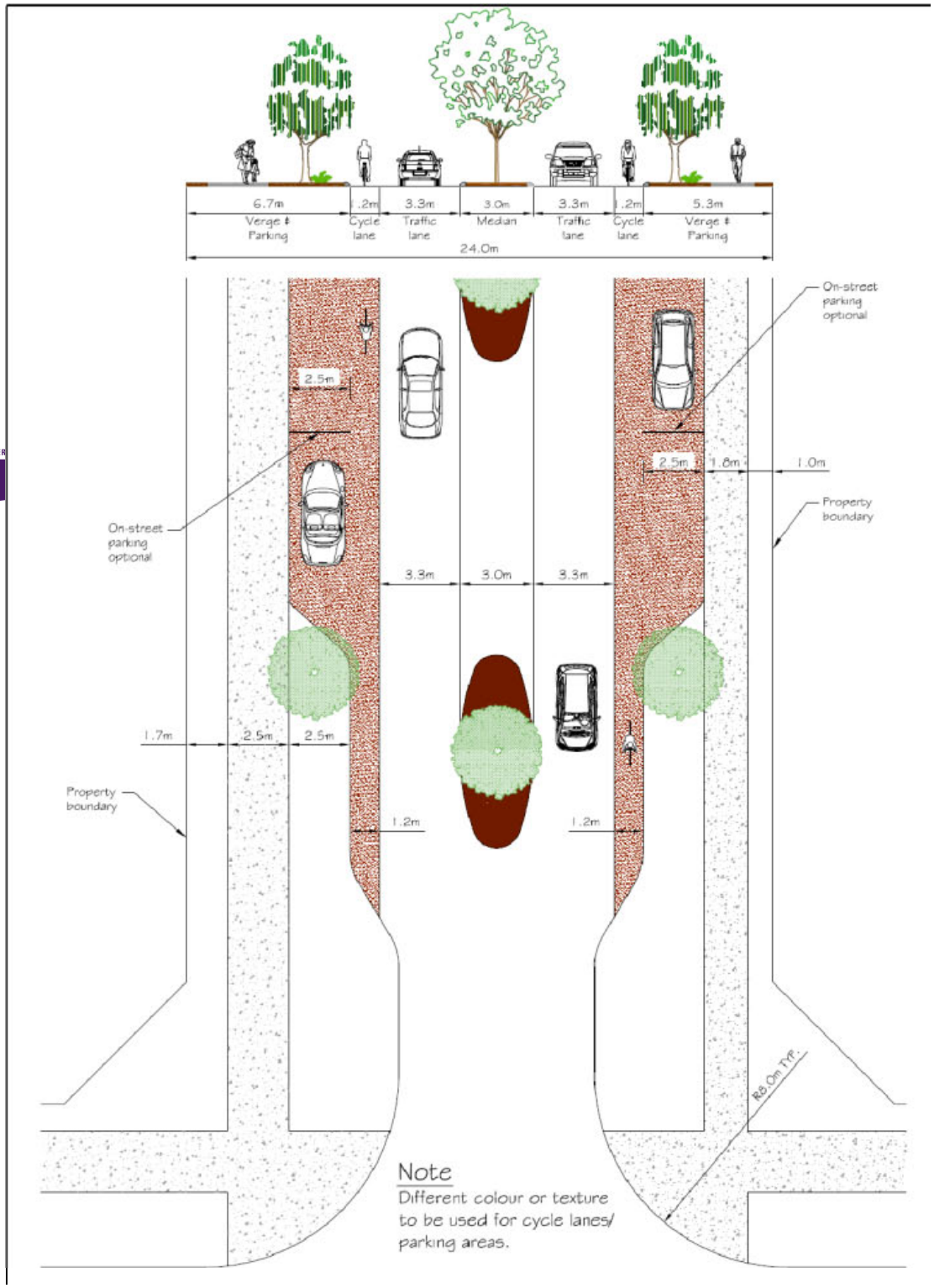
- **Figure 8-3 Integrator Arterial B – with and without service lanes**



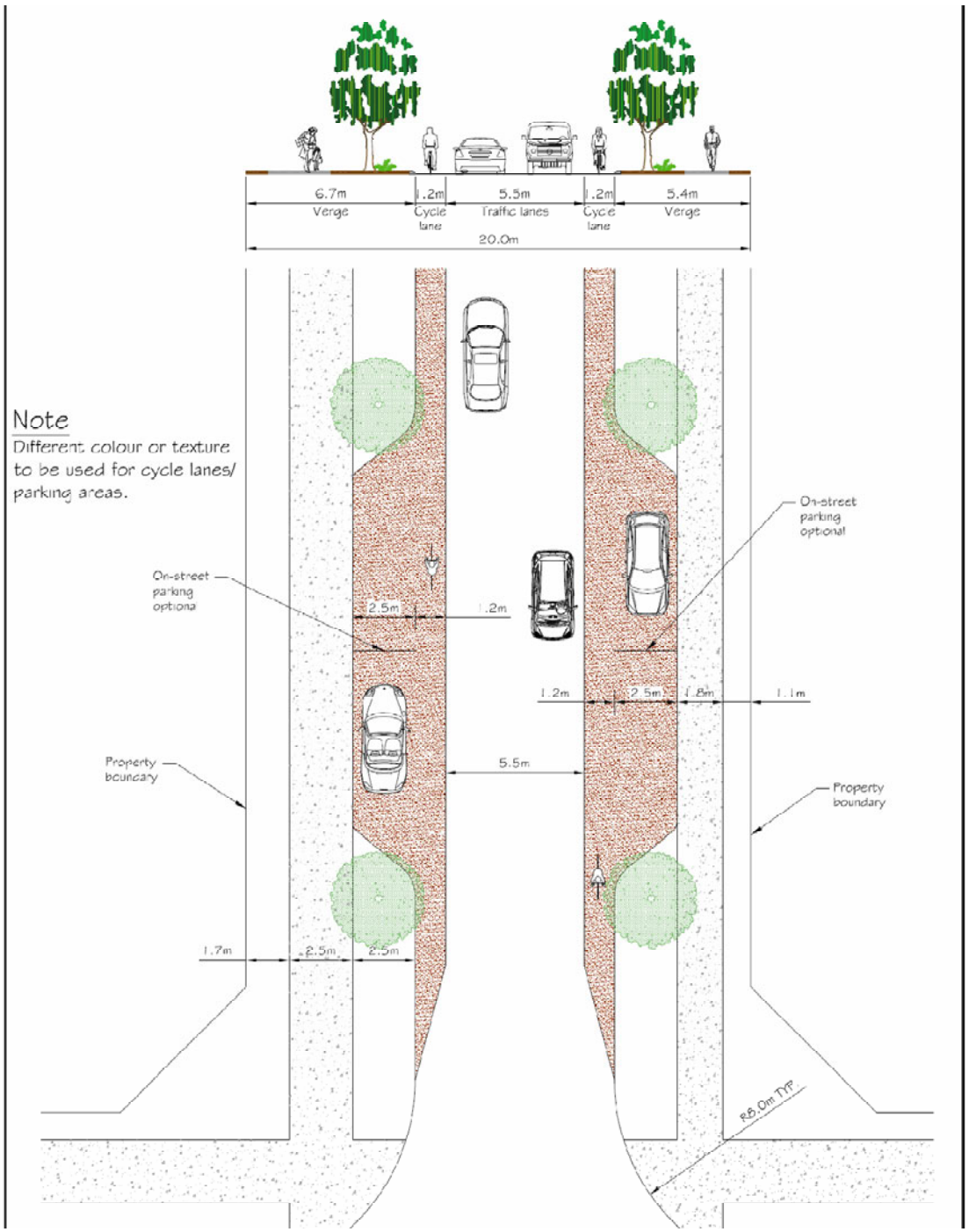
- **Figure 8-4 Integrator Arterial B – town centre treatment**



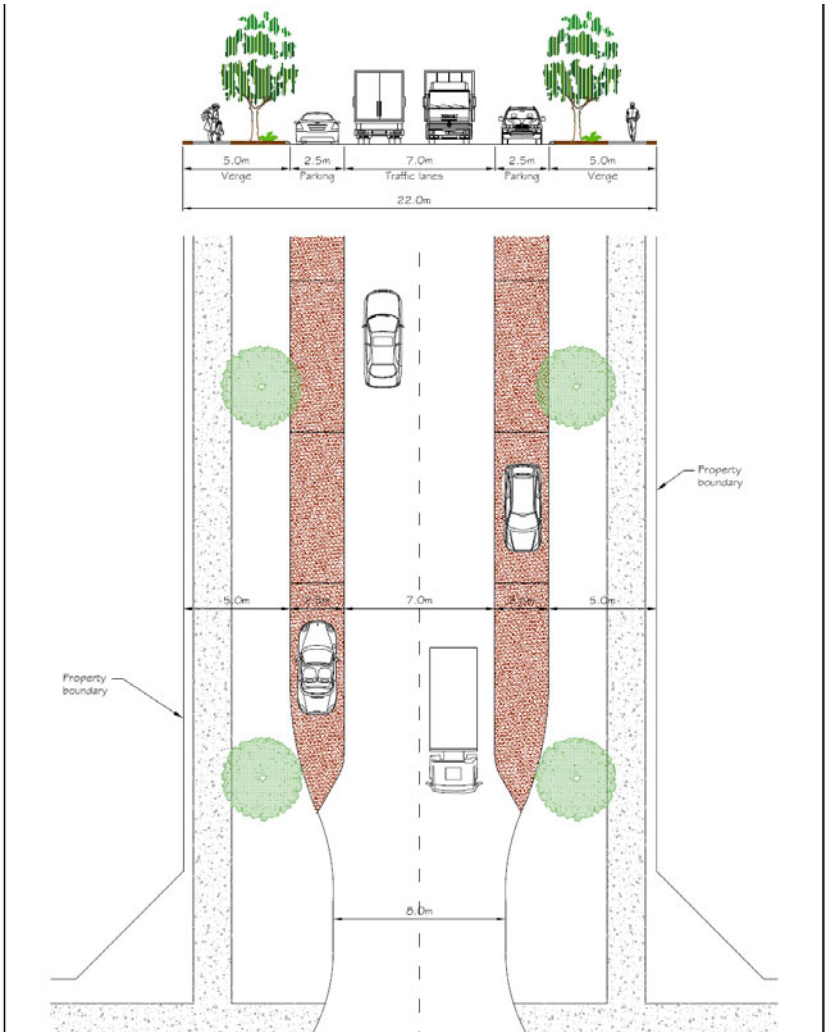
- **Figure 8-5 Neighbourhood connector boulevard**



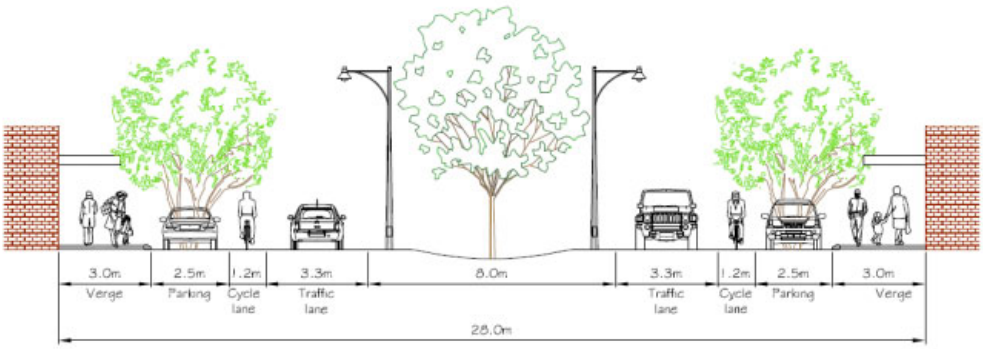
- **Figure 8-6 Neighbourhood Connector – Minimum Treatment**



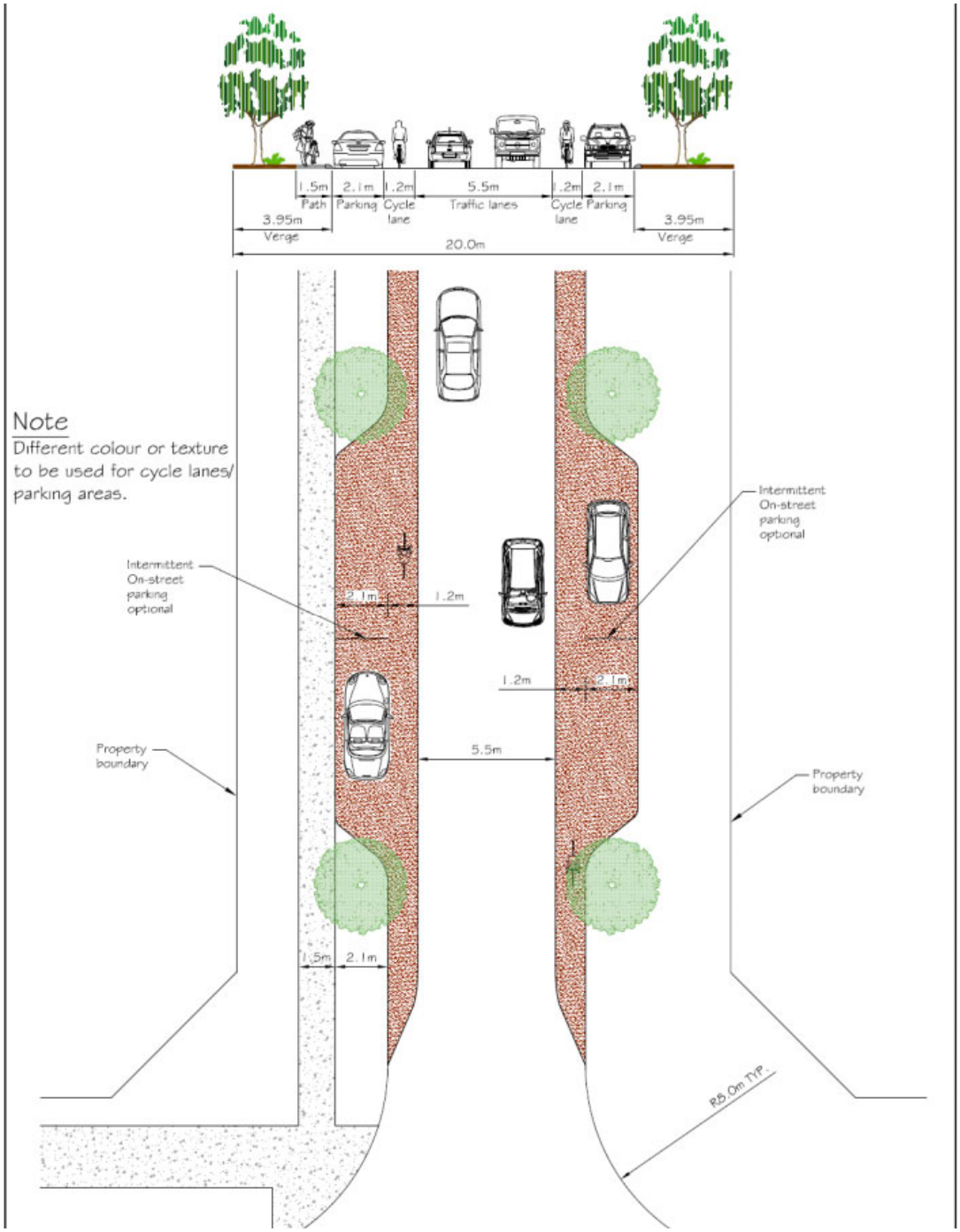
- **Figure 8-7 Industrial Route**



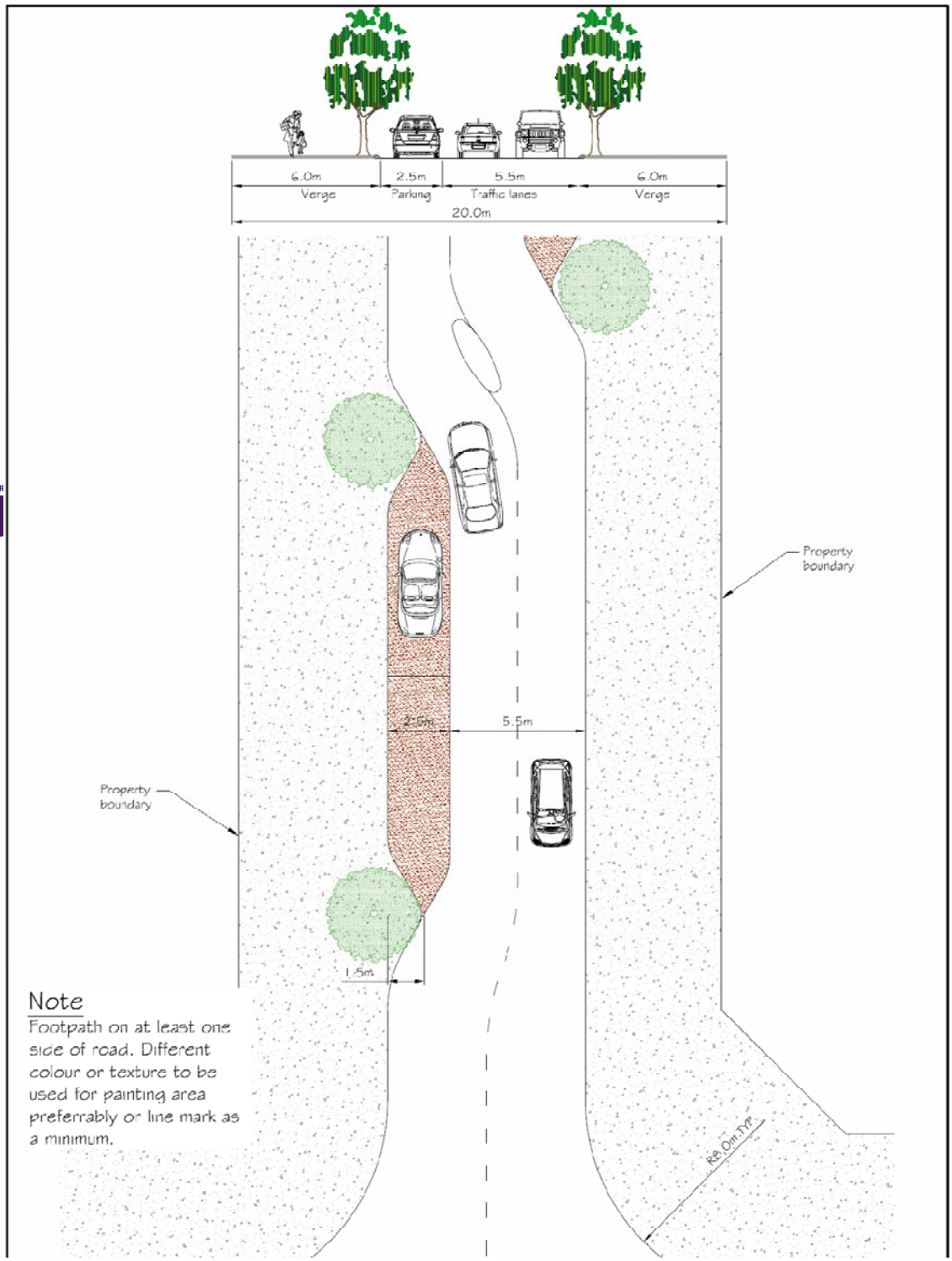
- **Figure 8-8 Town living**



- **Figure 8-9 Local Access Street**



- **Figure 8-10 Local Access Street – Minimum treatment**



9. Public Transport

9.1 Objectives

Plan and promote two bus services in Broome North – one linking Cable Beach and the other to Chinatown and Broome Town Centre

Plan bus services to be carefully positioned and to serve both neighbourhood centres

9.2 Planned Services

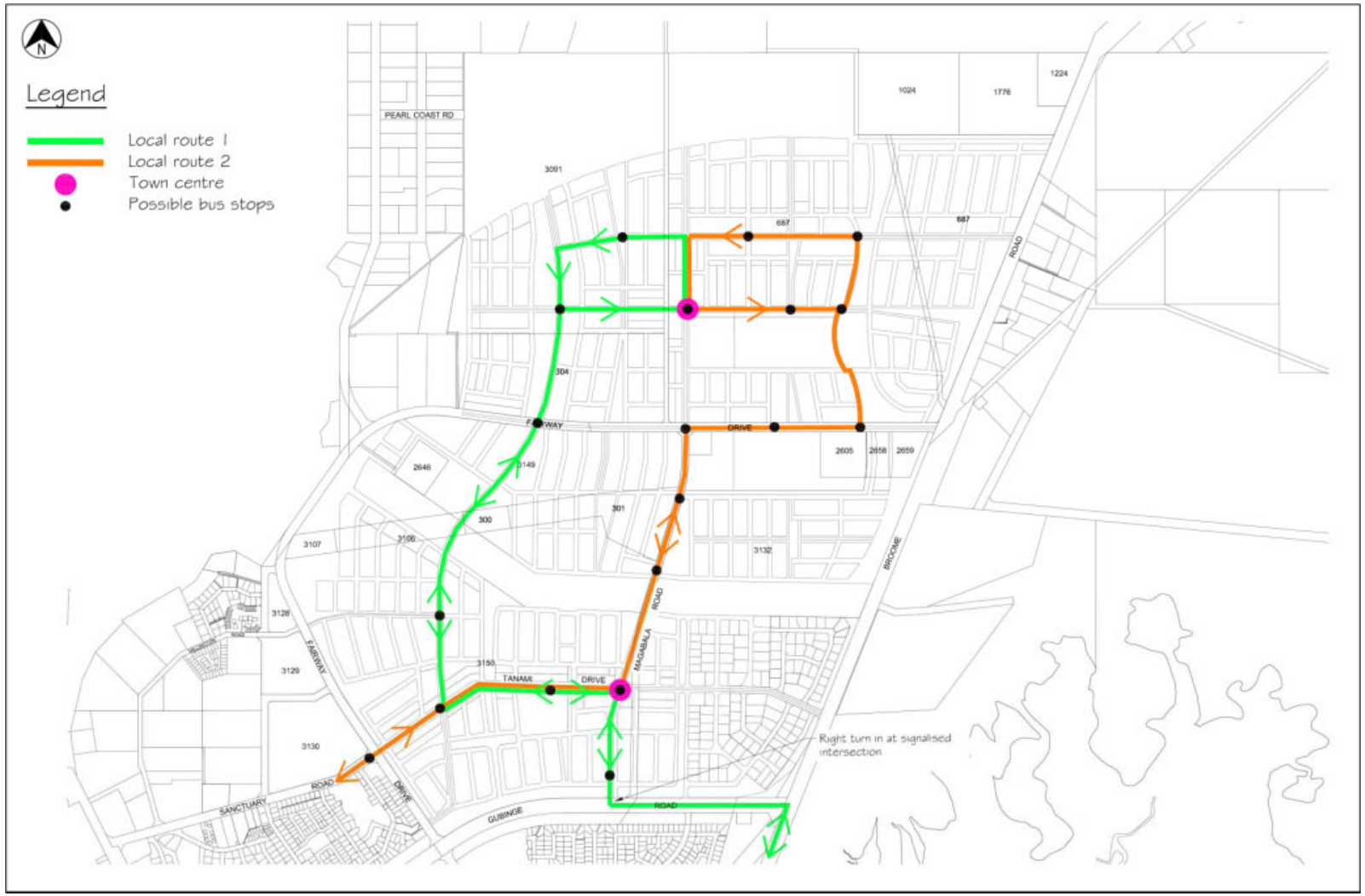
Figure 8.3 shows the planned public transport services through the site as agreed at the PDF. Two local bus routes are proposed: one to link Broome North with the Broome Town Centre and Chinatown and the second with Cable Beach. The service plan through the site aims to maximise the public transport catchment while not creating unnecessarily long or circuitous routes. The majority of the lots will be within 400m of a bus route. The indicative location of stops is shown in Figure 9-1, although these will need to be reviewed as part of detailed design to ensure that stops are located close to trip attractors such as recreation and community centres, shops and schools.

Bus services will operate along the Integrator Arterial B (Magabala Road) and Neighbourhood Connectors. It is proposed that on all Neighbourhood Connectors, stops are not embayed in order to reduce the delays to buses re-entering the traffic stream. On Magabala Road and Tanami Drive (west of Magabala Road) it may become necessary to embay stops in order to maintain traffic flows and reduce queuing on the main traffic spine through the site. This arrangement is to be agreed with the service operator and the Shire of Broome. The divider between the service lane and through traffic lane on the Integrator Arterial Road is 4.0m wide, requiring the bus shelter to be located longitudinal to the bus bay, rather than alongside.

It is projected that on average 3% of trips to/ from within Broome North will be undertaken by public transport. This equates to approximately 1,500 trips per day. Although it could be higher in the long term when as peak oil and affordability become a constraining factor to car use.

As a minimum, the services should operate at 30 minute intervals during peak periods and hourly outside peak hours on a typical weekday. The Cable Beach service should operate at more frequent intervals during the peak holiday season. Bus services should operate seven days a week.

- **Figure 9-1 Proposed Bus Service Routes in Broome North**



10. Pedestrians and Cyclists

10.1 Objectives

Provide a comprehensive, integrated and safe footpath network

Provide a network of linked, safe bicycle routes using a combination of shared paths and on-street facilities within road reserves

Safe and secure movement network in Broome North

Provide a safe network of streets (local connectors and local streets) within Broome North for walking, cycling and relevant traffic

Provide safe and secure network of footpaths and shared paths on the internal network of streets

Provide a safe off-street network for pedestrians and cyclists within integrated open space areas and ECC's

10.2 Planned Pedestrian and Cyclist Provision

The aim is for 12% of trips from Broome North to be made by walking and cycling. The location of schools and the two town centres within Broome North make it viable to walk to local schools and shops from most locations within the site. A walking distance of 800m to 1,000m is equivalent to approximately a 10 to 15 minute journey time. The proposed key cycling and shared path routes throughout Broome North are shown in Figure 10-1.

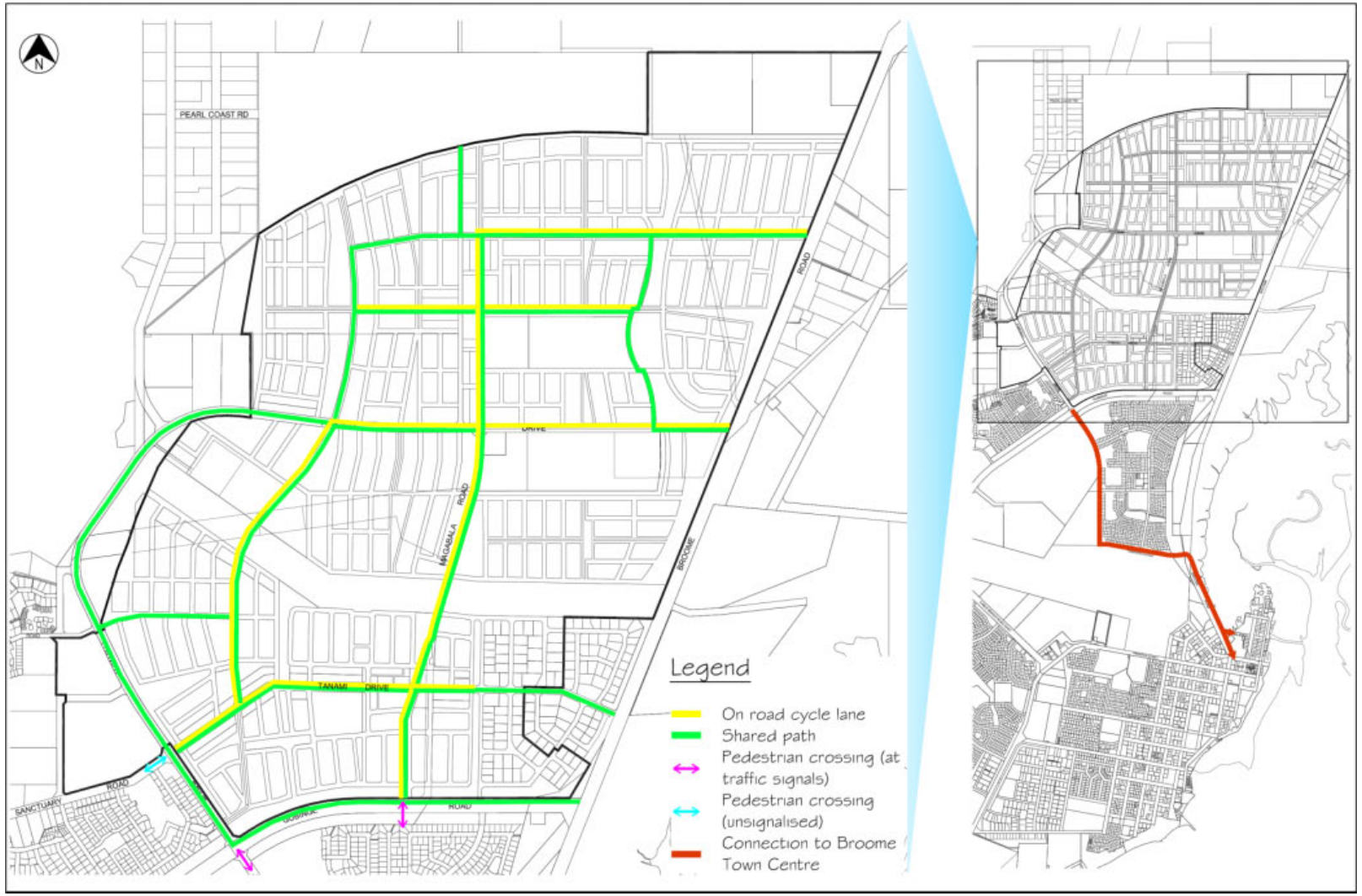
The following guidelines will be important in encouraging walking and cycling as modes of transport:

- Provide footpaths on both sides of major roads and on at least one side of local access streets
- Footpaths should be a minimum of 1.5m wide and shared paths a minimum of 2.5m wide
- Widen footpaths to 2-3 metres in locations with high demand such as town centres and around schools
- Use vegetation and awnings in town centres to shade paths where possible
- Adopt crime prevention through environmental design (CPTED) approaches to path design, landscaping and building orientation to maximise passive surveillance and sight distances
- Provide shared paths around and along key routes to schools
- Integrate off road paths with open space
- Locate convenient, safe and clearly marked crossing points with appropriate treatments (such as tactile paving and hand rails) to support universal access.

These guidelines should be applied throughout more detailed planning phases.

While the Broome town centre and Chinatown are not within a reasonable walking distance from the site, they are within a reasonable distance cycling and this should be encouraged through the provision of suitable north-south linkages such as a shared path along Broome Highway and Jigal Drive.

- **Figure 10-1 Planned Walking and Cycling Network in Broome North**



10.3 Pedestrian Crossings

A key objective is to integrate Broome North with surrounding areas. There is presently no network for cyclists and pedestrians adjacent to Broome North. It is envisaged that as Broome North develops the key pedestrian desire lines will be to/ from external destinations including the Cable Beach tourism precinct and Roebuck Estate, creating crossing demands on Fairway Drive and Gubinge Road. The greatest demand will come from school, retail and recreation related trips.

The draft WAPC Transport Assessment Guidelines require an analysis of the operation and safety of the pedestrian/ cycle networks including identification of which roads could potentially be difficult for pedestrians and cyclists to cross, where safe crossing should be provided, and where safe crossings are proposed. Traffic volumes which adversely impact on the ability of pedestrians to cross safely are:

- 2-lane undivided road – 1,000 vehicles in the peak hour (two-way), equivalent to 10,000 vpd
- 4-lane divided road – 1,500 vehicles in the peak hour (two-way), equivalent to 15,000 vpd

Traffic volumes on Gubinge Road, Broome Road or Fairway Drive are not forecast to meet these thresholds along the Broome North frontage. However, Gubinge Road is an arterial road carrying a significant proportion of heavy vehicles. It is also a wide road reservation, which has the potential to create a barrier to pedestrian movements. For these reasons, it has been agreed with MRWA that strategically placed crossings are required as follows:

- Pedestrian crossing at traffic signals at the intersection of Gubinge Road/ Magabala Road
- Pedestrian crossing at traffic signals at the intersection of Gubinge Road/ Fairway Drive

The installation of traffic signals at these locations will be primarily driven by pedestrian crossing demands rather than traffic capacity grounds. This need should be continually monitored over the course of development of Broome North.

There is a need to provide for safe pedestrian crossings to schools. The primary school in Broome North is planned as part of stage 1. This means that there may be demand for students residing outside Broome North to access the primary schools. The converse may also be true. Safe pedestrian crossing should be provided, as necessary, via a traffic warden controlled children's crossing located just to the east of the Magabala Road/ Gubinge Road intersection. A mini bus service could also operate although is not expected to be needed in light of the warden-controlled crossing.

In the longer term it is expected that the school catchment boundaries for Roebuck Estate and Broome North and will be bordered by Gubinge Road and therefore not overlap.

Within the site, Magabala Road (two-lane cross-section) is forecast to carry more than 10,000 vehicles per day in some locations. Some primary schools are shown in the Structure Plan to be located adjacent to this Integrator Arterial road. This infers that pedestrian crossings will be required across sections of Magabala Road, along pedestrian desire lines. It is recommended that warden crossings should be located on Magabala Road at each of the proposed retail centres. The treatment near schools is discussed below.

10.4 Safe Routes to Schools

The draft WAPC Guidelines require an assessment of safe routes to school by identifying the catchment of each school, identifying the most likely walk and cycle routes, determining any potential deficiencies and proposing measures to address these. However, it is often more relevant for much of this detail to be planned at local Structure Plan or subdivision design phases. The following information addresses access to schools at the District Structure Planning level.

One primary school will have frontage to Tanami Drive where volumes may exceed 7,000 vehicles per day. In this location Tanami Drive has been designed with a wide median, which will enable staged crossing. It is recommended that the main point of access should be via one of the alternative site frontages to preferably a neighbourhood connector. Nevertheless it is recommended that at least one guarded pedestrian crossing be provide adjacent to the school on Tanami Drive. Kerbside parking should not be located where it has the potential to obstruct sight lines to pedestrians.

11. Summary

Sinclair Knight Merz has prepared a Transport Assessment on behalf of LandCorp for the proposed Broome North development. Due to the scale of the site (735Ha) and long development timeline, the assessment has considered two scenarios:

- **Interim:** year 2031 with 2,000 residential lots, one primary school, one high school, extension to the Blue Haze industrial estate and partial development of one retail centre. This development area is expected to be bounded by Fairway Drive, Broome Highway and Gubinge Road.
- **Ultimate**: notionally year 2051 with full development extending northward to the existing waste transfer station. Full development will comprise 4,800 residential lots, two public primary schools, one public high school, an Anglican school, Blue Haze Light Industrial Estate and two town centres.

The development is planned to be self-contained in relation to education and local shopping needs in the medium to long term. The site's planning has been underpinned by a series of transport objectives agreed with a number of community groups and government agencies at a four-day Planning Design Forum.

Traffic generation forecasts for a typical weekday for the interim and ultimate development scenarios are as follows:

- Interim: 4,626 internal, 12,468 external vehicle trips per day
- Ultimate: 16,249 internal, 20,667 external vehicle trips per day.

The site will be accessed in the interim via the following intersections:

- Broome Road/ Fairway Drive – priority controlled
- Broome Road/ Tanami Drive - priority controlled
- Gubinge Road/ Blue Haze access: priority controlled (right turn-in banned)
- Broome Road/ Magabala Road: priority controlled

The site will also be accessed via an easterly extension of Sanctuary Road.

Ultimately as the development extends north, a new access will be created on Broome Road approximately 900m north of the Fairway Drive and a separate access off Broome Highway for the waste management facility installed. At a stage between interim and ultimate development stages there will be a requirement for some of the site access points to be upgraded, this is in part due to the duplication of Gubinge Road and Broome Road (north of Gubinge Road). It is envisaged that this duplication (as outlined in the Broome Road Planning Study prepared by

Western Infrastructure) will take place at some stage between 2031 and 2051.

Upgrading the intersections of Gubinge Road/ Magabala Road and Gubinge Road/ Fairway Drive/ Jigal Drive to traffic signals is likely to be triggered by the need to provide for safe pedestrian crossing of Gubinge Road, rather than on traffic capacity grounds.

In addition to the site access points, the development of Broome North is projected to notably impact the intersections of Broome Road/ Gubinge Road and Broome Road/ Sandpiper Avenue. It is forecast that the Broome Road/ Gubinge Road intersection can remain a priority controlled intersection well into the future. It is expected that the current configuration will remain suitable until such time as Gubinge Road and Broome Road north of Gubinge Road are duplicated to a four lane divided carriageway.

The intersection of Broome Road/ Sandpiper Avenue is forecast to require upgrading to a single lane roundabout control by interim development. Extending Jigal Drive south of Sandpiper Avenue through the airport would reduce the traffic volume through the Broome Road/ Sandpiper Avenue intersection and in this event further upgrade to this intersection may no longer be warranted.

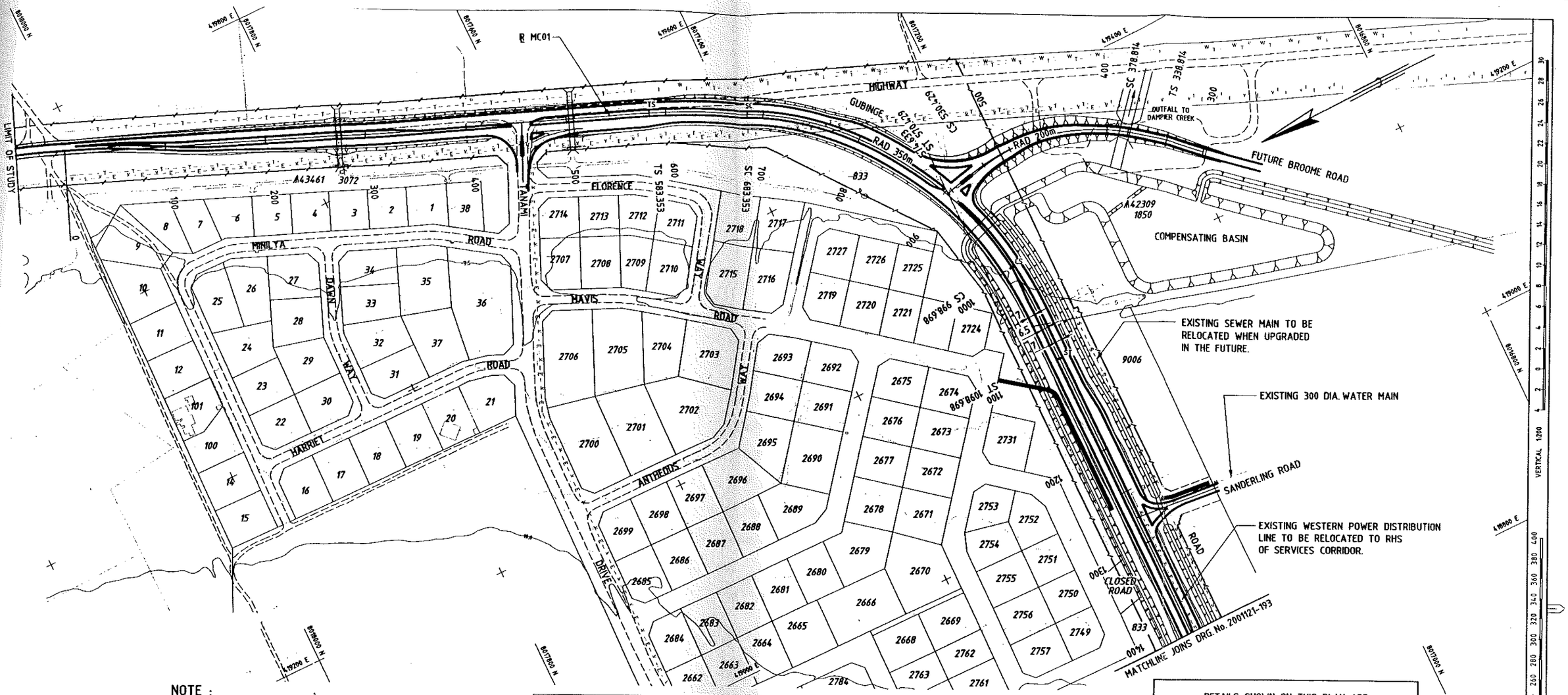
The relocation of the airport and creation of a new arterial north-south route between Broome Road and Gubinge Road will greatly influence travel patterns. The timing of any such development is not yet known. However, if a new north-south road link through the airport is not created by 2051, it is apparent that Broome Road between Gubinge Road and Sandpiper Avenue will need to be duplicated (four lane divided road).

The intersection of Broome Road/ Frederick Street has been recently upgraded to roundabout control. It is expected that this intersection would be upgraded to a two-lane roundabout if/ when Broome Road (south of Gubinge Road) is duplicated.

In terms of sustainable transport, it is recommended that two bus services operate through Broome North – providing connections to cable Beach and Broome Town Centre.

A network of footpaths and cycling routes are planned throughout the Broome North development and integrating with existing infrastructure outside of the development site. A shared path linking Broome North to the Broome Town Centre, preferably along Brome Road, is recommended to encourage cycling as a travel mode.

Appendix A Broome Highway Planning Study Extract

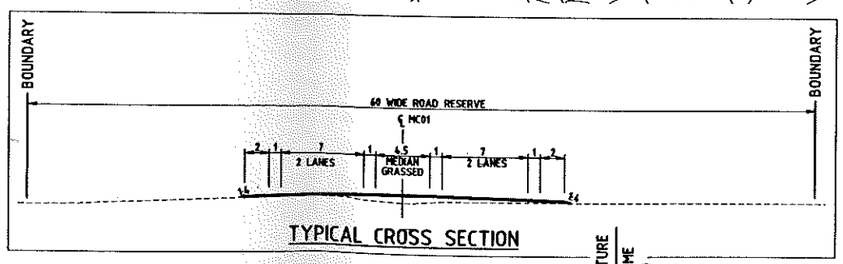


LEGEND:

- DENOTES EXISTING CARRIAGEWAY
- PROPOSED TPS BOUNDARY
- SHARED USE PATH
- UNDERGROUND ELECTRICITY
- OVERHEAD ELECTRICITY
- SEWER
- WATER MAIN
- TELSTRA

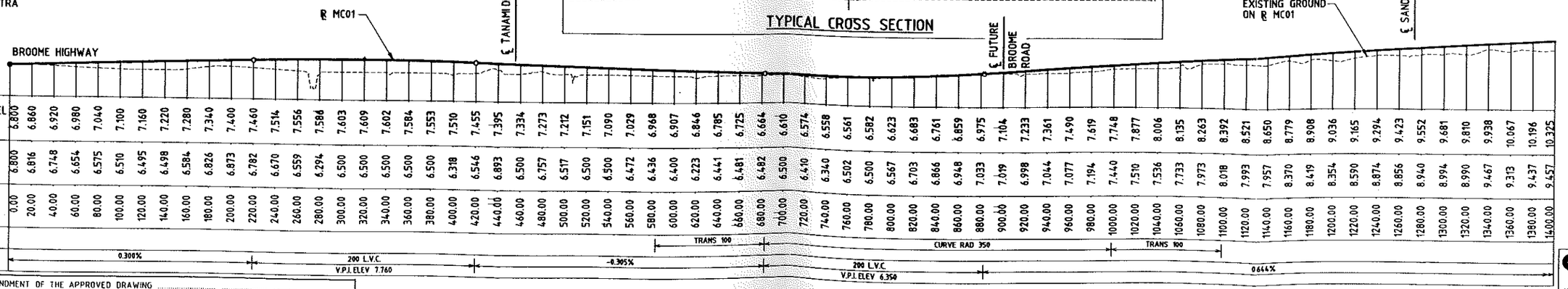
NOTE :

1. FOR LAND PROTECTION PLAN SEE DRG No. 200221-229.
2. DRAINAGE INVESTIGATION SUBJECT TO DETAIL DESIGN
3. DATE OF PHOTOGRAPHY NOVEMBER, 1998.
4. SERVICES SHOWN ON THIS PLAN ARE APPROXIMATE ONLY.
5. FOR CONCEPT PLAN SEE DRG. No. 200221-227 & 200221-228.
6. FOR '40' DIRECTORY SEE R:\DGN_AGD84\MOSS_40\BROOME
7. FOR MICROSTATION DIRECTORY SEE R:\DGN_AGD84\MSTATION\RURAL\BROOME



TYPICAL CROSS SECTION

DETAILS SHOWN ON THIS PLAN ARE PRELIMINARY ONLY. STAGE CONSTRUCTION AND ULTIMATE DEVELOPMENT MAY DIFFER FROM DETAILS SHOWN.



CHAINAGE ON R MC01	PROPOSED LEVEL ON R MC01	EXISTING LEVEL ON R MC01
0.00	6.800	6.800
20.00	6.860	6.816
40.00	6.920	6.748
60.00	6.980	6.654
80.00	7.040	6.575
100.00	7.100	6.510
120.00	7.160	6.495
140.00	7.220	6.498
160.00	7.280	6.584
180.00	7.340	6.826
200.00	7.400	6.873
220.00	7.460	6.782
240.00	7.514	6.670
260.00	7.556	6.559
280.00	7.584	6.294
300.00	7.603	6.500
320.00	7.609	6.500
340.00	7.602	6.500
360.00	7.584	6.500
380.00	7.553	6.500
400.00	7.510	6.318
420.00	7.455	6.546
440.00	7.395	6.893
460.00	7.334	6.500
480.00	7.273	6.757
500.00	7.212	6.517
520.00	7.151	6.500
540.00	7.090	6.500
560.00	7.029	6.472
580.00	6.968	6.436
600.00	6.907	6.400
620.00	6.846	6.223
640.00	6.785	6.441
660.00	6.725	6.481
680.00	6.664	6.682
700.00	6.610	6.500
720.00	6.574	6.410
740.00	6.558	6.340
760.00	6.561	6.502
780.00	6.582	6.500
800.00	6.623	6.567
820.00	6.683	6.703
840.00	6.761	6.866
860.00	6.859	6.948
880.00	6.975	7.033
900.00	7.104	7.019
920.00	7.233	6.998
940.00	7.361	7.044
960.00	7.490	7.077
980.00	7.619	7.194
1000.00	7.748	7.440
1020.00	7.877	7.510
1040.00	8.006	7.536
1060.00	8.135	7.733
1080.00	8.263	7.973
1100.00	8.392	8.018
1120.00	8.521	7.993
1140.00	8.650	7.957
1160.00	8.779	8.370
1180.00	8.908	8.419
1200.00	9.036	8.354
1220.00	9.165	8.590
1240.00	9.294	8.874
1260.00	9.423	8.856
1280.00	9.552	8.940
1300.00	9.681	8.994
1320.00	9.810	8.990
1340.00	9.938	9.467
1360.00	10.067	9.313
1380.00	10.196	9.437
1400.00	10.325	9.457

HORIZONTAL
VERTICAL

THIS DRAWING IS AN AMENDMENT OF THE APPROVED DRAWING .....

NO.	DESCRIPTION	DATE

AMENDMENTS

ORIGINAL DRAWING SIZE A1

IN THE ABSENCE OF THE APPROVED SIGNATURE THIS DRAWING SHALL BE TREATED AS PRELIMINARY

	NAMES PRINTED IN FULL	DATE	SIGNATURES	DATE
DESIGNED	K. WOODS	OCT '02	AUTHORISED	
DRAWN	D. PILSHENKS	OCT '02	RECOMMENDED	
CHECKED	Jeff Barham	20/2/03	APPROVED	

DATUM A.H.D.
GRID AMG84 ZONE 51
FILE NO 90-577-15

BROOME HIGHWAY
CARRIAGEWAY PATTERN AND PROFILE
CHA. 0 TO CHA. 1400

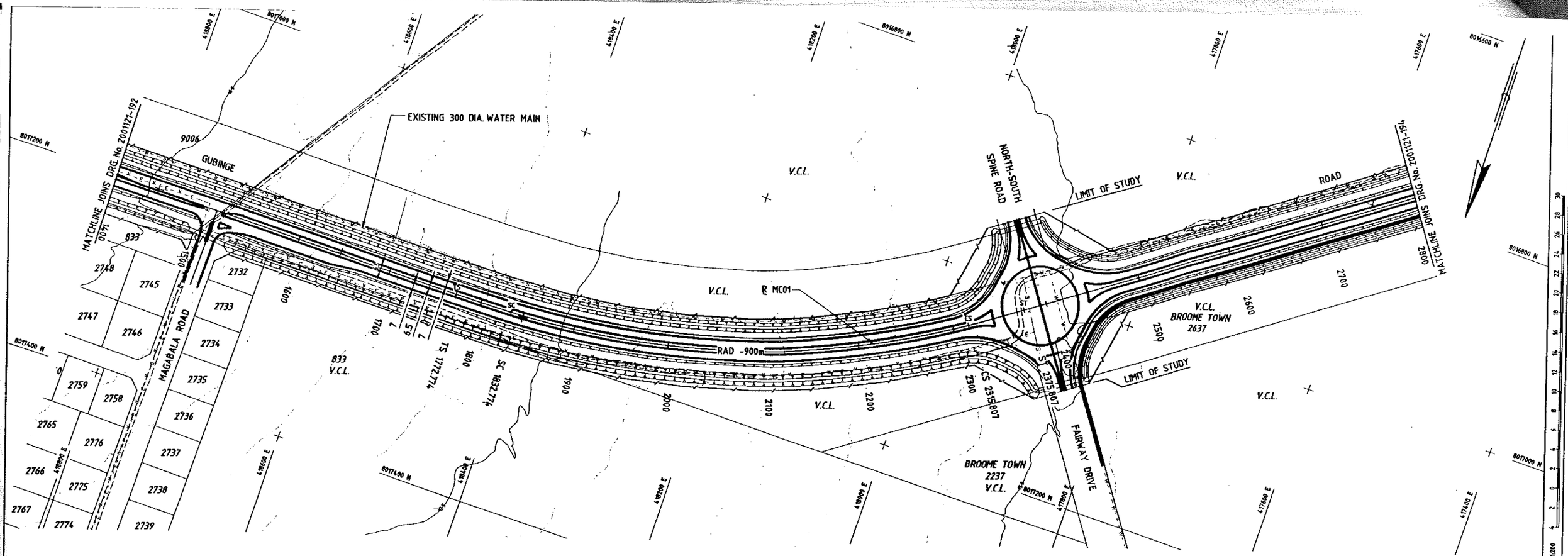
Government of Western Australia
MAIN ROADS Western Australia

ROAD NETWORK PERFORMANCE BRANCH
WATERLOO CRES EAST PERTH 6004
TEL. (08) 9323 4327 FAX (08) 9323 4847

DRAWING TYPE	DRAWING NUMBER	AMEND
04-03	200121-192	

SMEC
SMEC AUSTRALIA PTY LTD
ACN 065 475 149
LEVEL 5, 12 ST GEORGES TERRACE
PERTH WA 6000
PH (08) 9221-3990 FAX (08) 9221-5941

SCALE HORIZONTAL 1:2000 VERTICAL 1:200

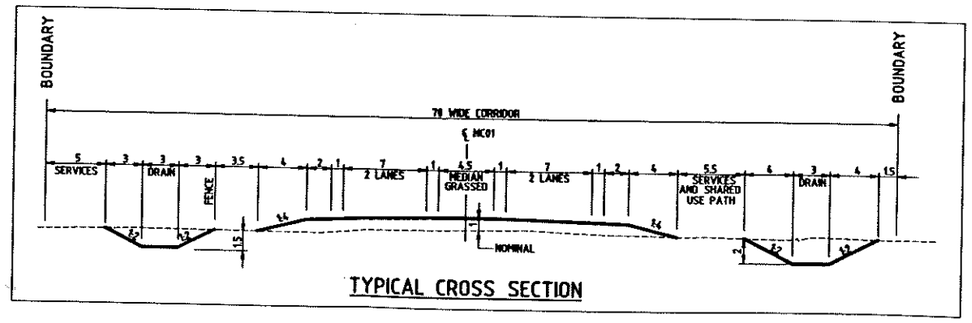


LEGEND:

- DENOTES EXISTING CARRIAGEWAY
- PROPOSED TPS BOUNDARY
- SHARED USE PATH
- UNDERGROUND ELECTRICITY
- OVERHEAD ELECTRICITY
- SEWER
- WATER MAIN
- TELSTRA

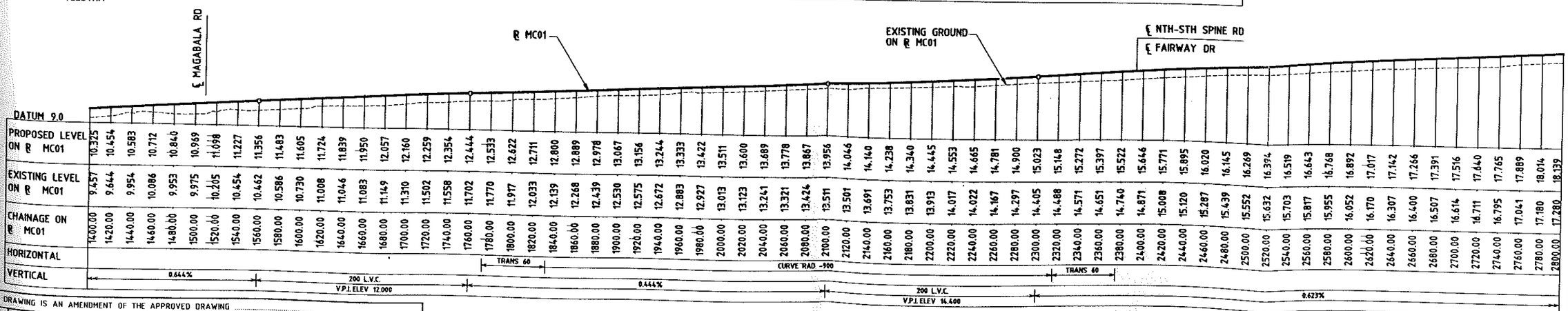
NOTE :

1. FOR LAND PROTECTION PLAN SEE DRG No. 200221-229.
2. DRAINAGE INVESTIGATION SUBJECT TO DETAIL DESIGN
3. DATE OF PHOTOGRAPHY NOVEMBER, 1998.
4. SERVICES SHOWN ON THIS PLAN ARE APPROXIMATE ONLY.
5. FOR CONCEPT PLAN SEE ORG. No. 200221-227 & 200221-228.
6. FOR '4D' DIRECTORY SEE R:\DGN_AGD84\MOSS_4D\BROOME
7. FOR MICROSTATION DIRECTORY SEE R:\DGN_AGD84\MSTATION\RURAL\BROOME



TYPICAL CROSS SECTION

DETAILS SHOWN ON THIS PLAN ARE PRELIMINARY ONLY. STAGE CONSTRUCTION AND ULTIMATE DEVELOPMENT MAY DIFFER FROM DETAILS SHOWN.



THIS DRAWING IS AN AMENDMENT OF THE APPROVED DRAWING .....

ORIGINAL DRAWING SIZE A1		IN THE ABSENCE OF THE APPROVED SIGNATURE THIS DRAWING SHALL BE TREATED AS PRELIMINARY				
		NAMES PRINTED IN FULL		DATE	SIGNATURES	DATE
DATUM	A.H.D.	DESIGNED	K. WOODS	OCT' 02	AUTHORIZED	
GRID	AMG84 ZONE 51	DRAWN	D. PILSNIEKS	OCT' 02	RECOMMENDED	

BROOME HIGHWAY
CARRIAGEWAY PATTERN AND PROFILE
CHA. 1400 TO CHA. 2800

SMEC
SMEC AUSTRALIA PTY LTD
ACN 065 475 149
LEVEL 5, 12 ST GEORGES TERRACE
PERTH WA 6000
PH (08) 9225-5900 FAX (08) 9225-5901

Department of Western Australia — MAIN ROADS Western Australia

ROAD NETWORK PERFORMANCE BRANCH
WATERLOO CRES EAST PERTH 6004
TEL. (08) 9323 4321 FAX (08) 9323 4347

DRAWING TYPE	DRAWING NUMBER	AMEND
PLAN	200221-193	

HORIZONTAL 1:2000 VERTICAL 1:200 SCALE

Appendix B Traffic Generation – Interim and Ultimate

Interim Broome North Trip generation

Revision:	3
Date:	20/11/2009

Development yield

Residential	2,000 lots
Industrial	27 Ha
Retail	2500 sqm
School enrolments	500.00

Assumptions

No through traffic through the site

Industrial 27ha, 75% net yield, 0.3 GFA

Education Trip Generation

School enrolments	500.00	Primary school within site
Trip rate per enrolment	2	
School trips	1,000 trips	
% internal trips	70%	
% external trips	30%	
No. Internal trips	***700 trips***	
No. External trips	***300 trips***	

Industrial trip generation

Gross floor area	60750 sqm
Car driver trips per 100sqm GFA	6.5
Total Industrial trips	3,949 trips
% internal trips	30%
% external trips	70%
No. of internal trips	***1,185 trips***
No. of external trips	***2,764 trips***

Retail Trip Generation

Net floor area	2500 sqm	
Car driver trips per 100sqm NLA (incl.10% workers)	80.0	
Total retail trips	2,000 trips	
Shopping trips		
% internal trips	68%	
% external trips	32%	
No. of internal trips	***1,365 trips***	includes 10% workers trips (ie 393)
No. of external trips	***635 trips***	

Residential trip generation

Occupants per household	3	
Trips per person (all modes)	3.5	
Total generated trips (all modes)	21,000 trips	7.16625
Estimated % car driver trips	65%	
Estimated No. car driver trips (home based)	13,650 trips	
Non-home based trips %	5%	
Estimated No. non-home based trips (into BN)	683 trips	
Total No. car driver trips from/ to/ within Broome North	14,330 trips	
Resultant trip generation rate (residential)	7.17	

Residential trip percentages by purpose -	Total	Internal	External	
Retail	20%	50%	50%	
Employment	25%	35%	65%	Includes internal trips to Blue Haze
Education	12%	70%	30%	
social and recreation				
beach and recreation, restaurants, etc	15%	5%	95%	
other	28%	33%	67%	
Total	100%			

Residential trips by purpose -	Total	Internal	External	
Retail (incl employment)	2,730	1,365	1,365	y
Other employment (incl Blue Haze)	3,413	1,185	2,228	y
Education	1,000	700	300	
social and recreation				
beach and recreation, restaurants, etc	2,048	102	1,945	
other	3,822	1,274	2,548	
Total	13,012.00	4,630.00	8,390.00	

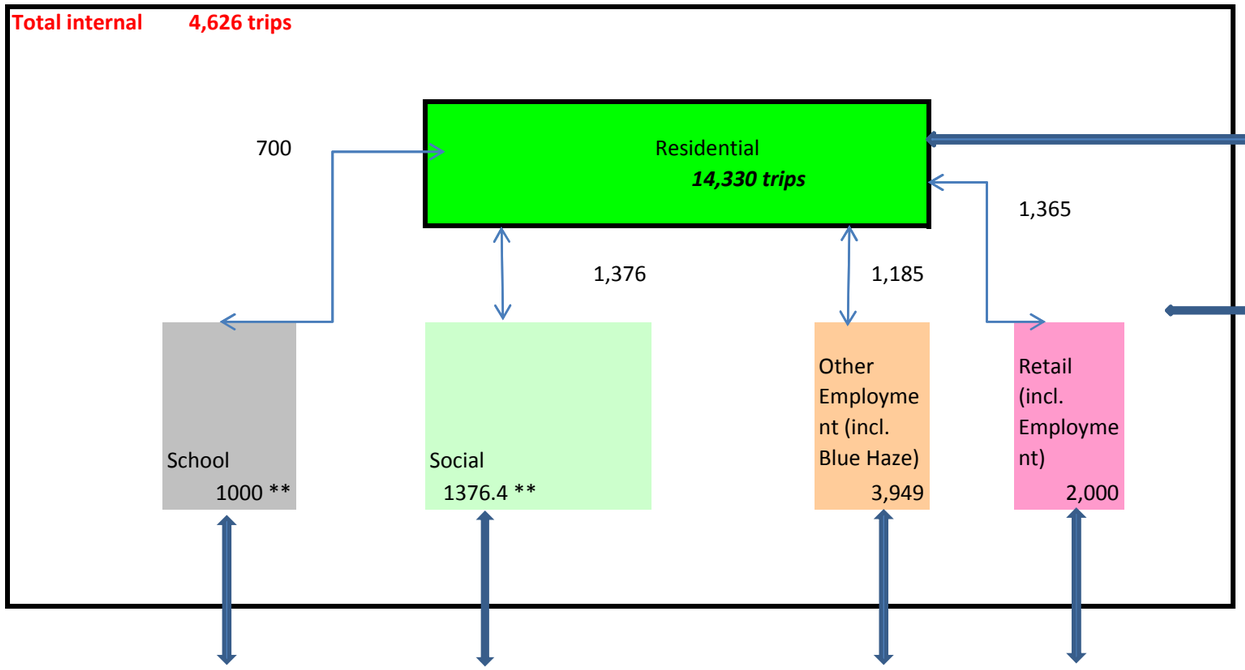
Total External originated trips

Home based trips to external	8,390 trips
Non home based trips (5%)	683 trips
Trips to Blue Haze Industrial Estate	2,764 trips
Trips to retail (incl employment)	635 trips
Total External originated trips	12,472 trips

Total generated trips

Internal	4,630 trips	27%	16640
External	12,472 trips	73%	19408
Total	17,102 trips		
Total trip generation rate	8.6		

Daily internal and external trips

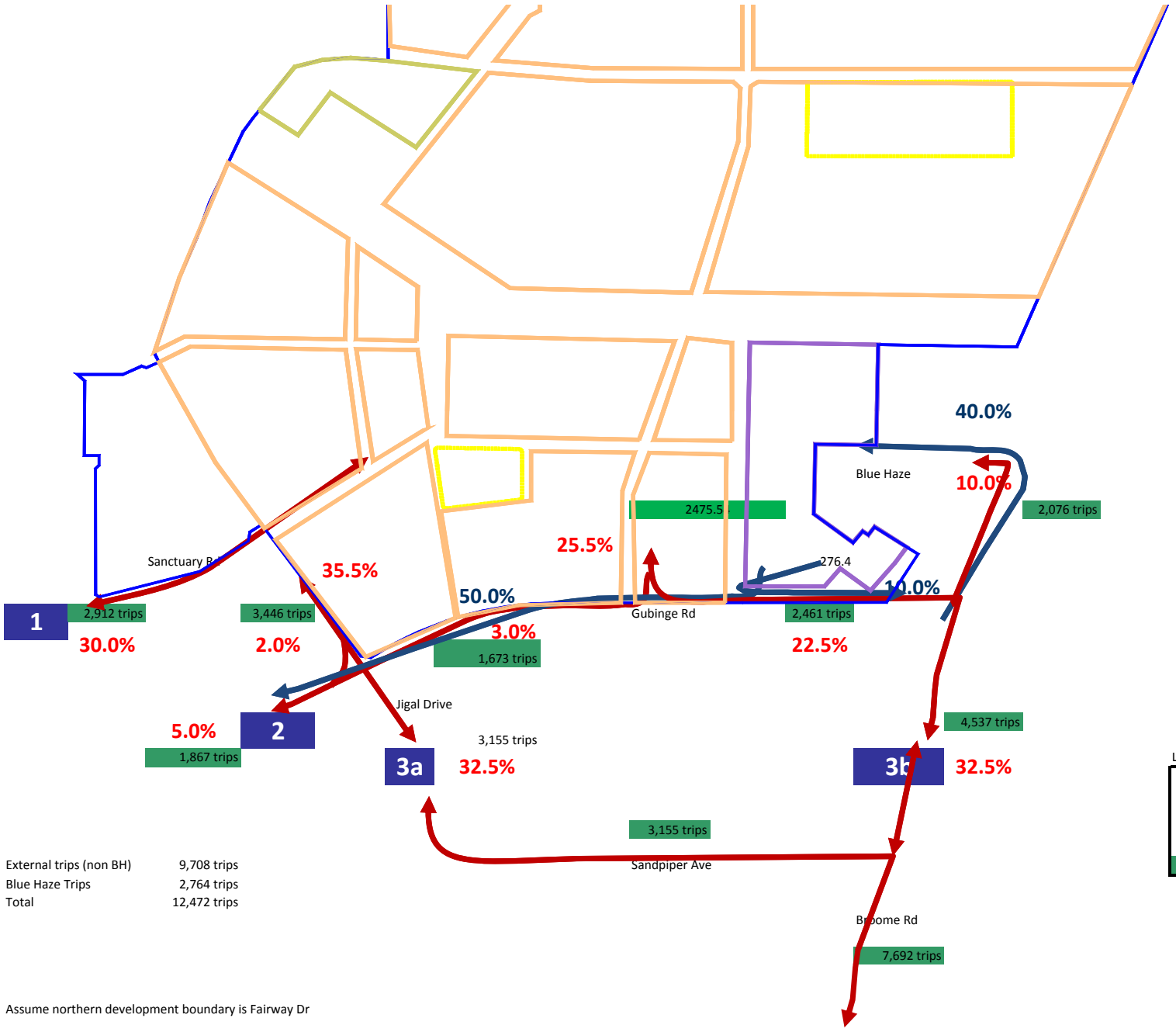


		1		3		2	
		Cable Beach		Broome town centre, Chinatown		Other (eg Port)	
		%	No.	%	No.	%	No.
School	300	0%	0	0%	0	0%	0
Social	0						0
Beach, rec	1,945	70%	1361.588	30%	583.5375	0%	0
Other	2,548	20%	509.6	70%	1783.6	10%	254.8
Other Employment	2,228	15%	334.125	75%	1670.625	10%	222.75
Retail	1,365	20%	273	80%	1092	0%	0
			0		0		0
Non home based trips*	683	15%	102.45	75%	512.25	10%	68.3
Other employment	2,764	10%	276.4	60%	1658.4	30%	829.2
Retail	635						
Total External	**12,468**		**2,857**		**7,300**		**1,375**

Notes: *non home based trips includes external trips to schools, social and recreation within Broome

**External trips Included
in non home based trips

Interim Broome North
generated vehicle trips



External trips (non BH)	9,708 trips
Blue Haze Trips	2,764 trips
Total	12,472 trips

Legend

0.0%	Blue Haze
0.0%	All traffic (ex Blue Haze)
	Total link trips

Assume northern development boundary is Fairway Dr

Ultimate Broome North Trip generation

Revision:	3
Date:	20/11/2009

Development yield

Residential	4,800 lots
Industrial	27 Ha
Retail	6000 sqm
School enrolments	2000.00

Assumptions

No through traffic through the site

Industrial 27ha, 75% net yield, 0.3 GFA

Education Trip Generation

School enrolments	2000.00
Trip rate per enrolment	2
School trips	4,000 trips
% internal trips	90%
% external trips	10%
No. Internal trips	***3,600 trips***
No. External trips	***400 trips***

Industrial trip generation

Gross floor area	60750 sqm
Car driver trips per 100sqm GFA	6.5
Total Industrial trips	3,949 trips
% internal trips	60%
% external trips	40%
No. of internal trips	***2,357 trips***
No. of external trips	***1,580 trips***

Retail Trip Generation

Net floor area	6000 sqm	
Car driver trips per 100sqm NLA (incl.10% workers)	80.0	
Total retail trips	4,800 trips	
Shopping trips		
% internal trips	82%	
% external trips	18%	
No. of internal trips	***3,931 trips***	includes 10% workers trips (ie 393)
No. of external trips	***869 trips***	

Residential trip generation

Occupants per household	3	
Trips per person (all modes)	3.5	
Total generated trips (all modes)	50,400 trips	7.16625
Estimated % car driver trips	65%	
Estimated No. car driver trips (home based)	32,760 trips	
Non-home based trips %	5%	
Estimated No. non-home based trips (into BN)	1,638 trips	
Total No. car driver trips from/ to/ within Broome North	34,400 trips	
Resultant trip generation rate (residential)	7.17	

Residential trip percentages by purpose -	Total	Internal	External	
Retail	20%	60%	40%	
Employment	25%	29%	71%	Includes internal trips to Blue Haze
Education	12%	90%	10%	
social and recreation				
beach and recreation, restaurants, etc	15%	5%	95%	
other	28%	67%	33%	
Total	100%			

Residential trips by purpose -	Total	Internal	External
Retail (incl employment)	6,552	3,931	2,621
Other employment (incl Blue Haze)	8,190	2,357	5,833
Education	4,000	3,600	400
social and recreation			
beach and recreation, restaurants, etc	4,914	246	4,668
other	9,173	6,115	3,058
Total	32,828.80	16,250.00	16,580.00

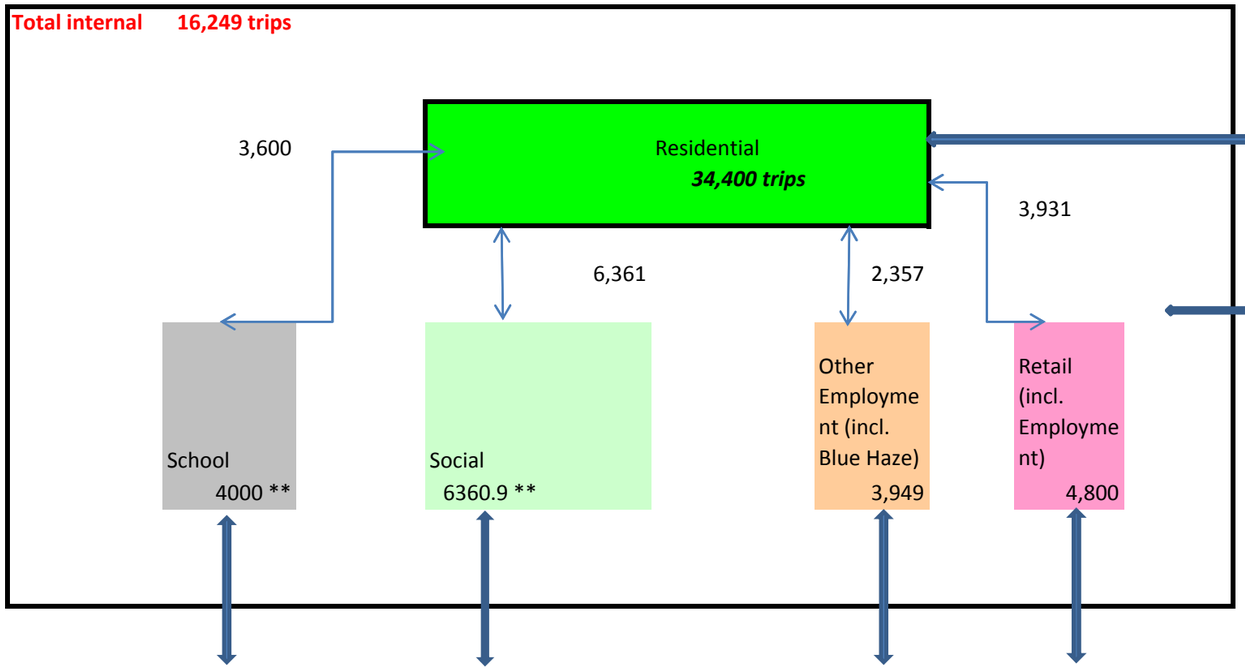
Total External originated trips

Home based trips to external	16,580 trips
Non home based trips (5%)	1,638 trips
Trips to Blue Haze Industrial Estate	1,580 trips
Trips to retail (incl employment)	869 trips
Total External originated trips	20,667 trips

Total generated trips

Internal	16,250 trips	44%	16640
External	20,667 trips	56%	19408
Total	36,917 trips		
Total trip generation rate	7.7		

Ultimate Development
Daily internal and external trips

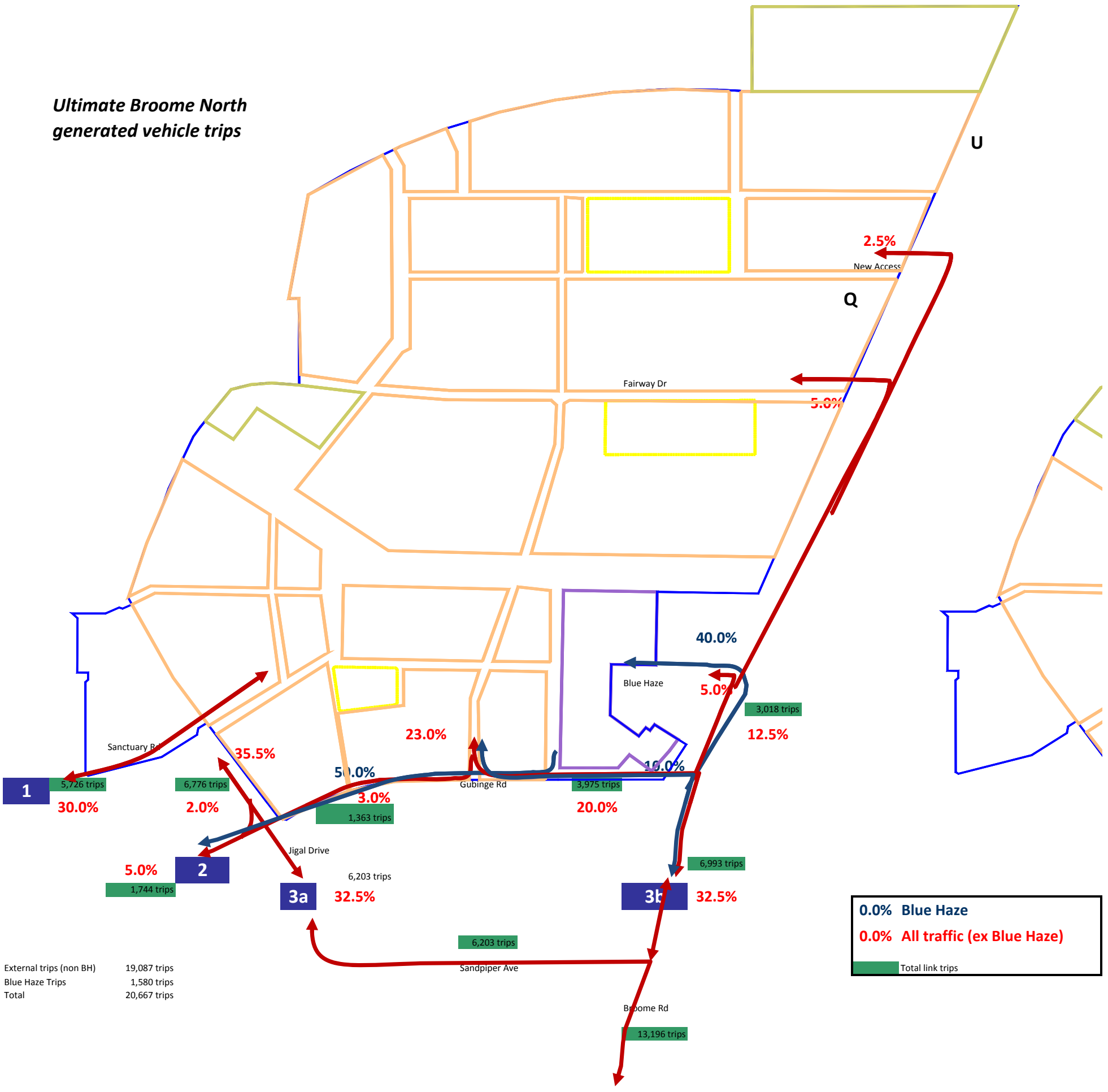


		1		3		2	
		Cable Beach		Broome town centre, Chinatown		Other (eg Port)	
		%	No.	%	No.	%	No.
School	400	0%	0	0%	0	0%	0
Social	0						0
Beach, rec	4,668	70%	3267.81	30%	1400.49	0%	0
Other	3,058	20%	611.52	70%	2140.32	10%	305.76
Other Employment	5,833	15%	874.95	75%	4374.75	10%	583.3
Retail	2,621	20%	524.16	80%	2096.64	0%	0
			0		0		0
Non home based trips*	1638	15%	245.7	75%	1228.5	10%	163.8
	0						
Other employment	1,580	10%	158	60%	948	30%	474
Retail	869						
Total External	**20,667**		**5,682**		**12,189**		**1,527**

Notes: *non home based trips includes external trips to schools, social and recreation within Broome

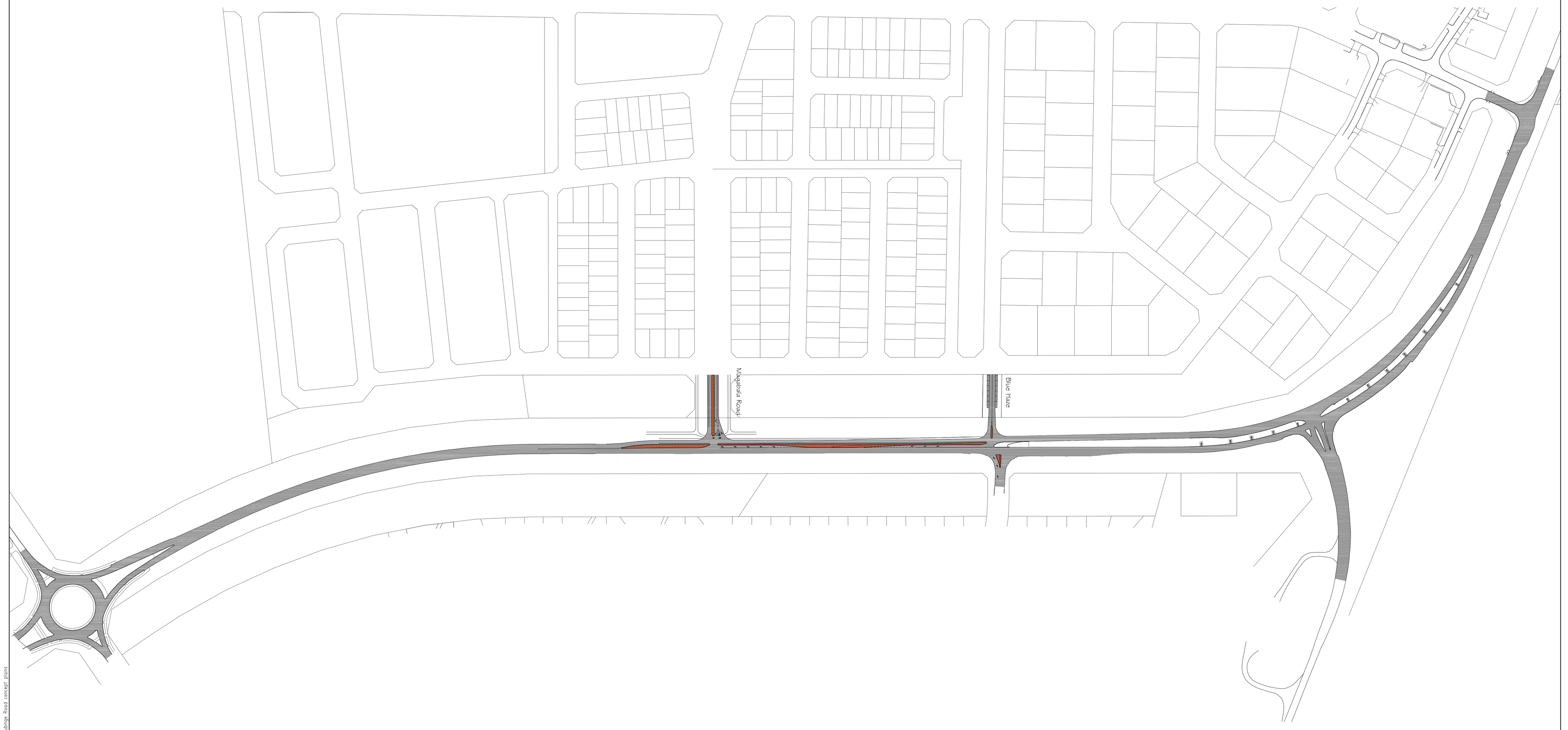
**External trips Included
in non home based trips

Ultimate Broome North generated vehicle trips



External trips (non BH)	19,087 trips
Blue Haze Trips	1,580 trips
Total	20,667 trips

Appendix C Gubinge Road proposed access – Interim and Ultimate

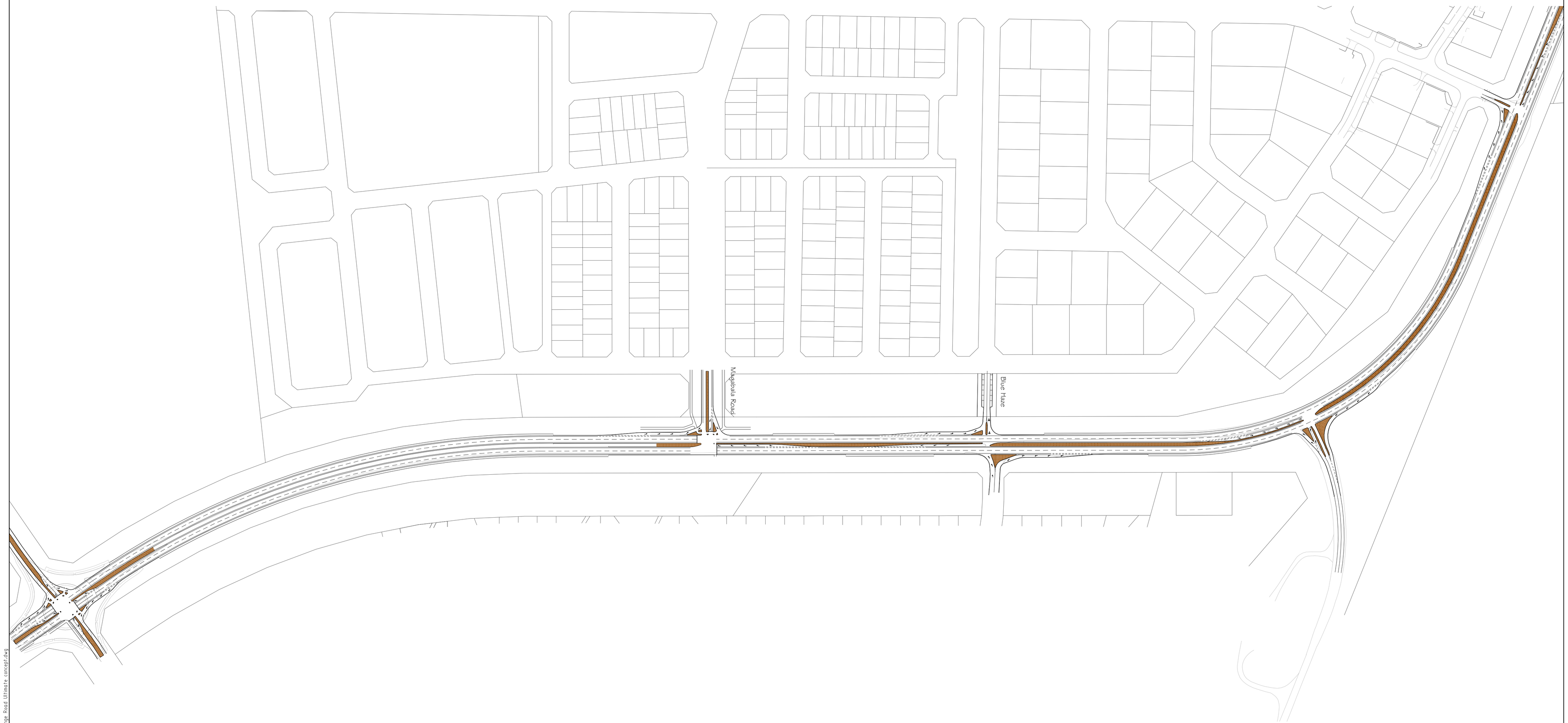


SKM
Sinclair Knight Merz Pty Ltd
A.C.N. 001 024 095
Durack Centre 263 Adelaide Tce
Perth Western Australia 6000
Ph (08) 9268 4400

BROOME NORTH

Gubinge Road Interim concept

Nov 2009



SKM

Sinclair Knight Merz Pty Ltd
A.C.N. 001 024 095
Durack Centre 263 Adelaide Tce
Perth Western Australia 6000
Ph (08) 9268 4400

BROOME NORTH

Gubinge Road ultimate concept

Nov 2009

Appendix D Correspondence with MRWA – Gubinge Road conceptual intersection plan

Sinclair Knight Merz
11th Floor, Durack Centre
263 Adelaide Terrace
PO Box H615
Perth WA 6001 Australia

Tel: +61 8 9469 4400
Fax: +61 8 9469 4488
Web: www.skmconsulting.com

Gary Bradshaw
Network Manager
Main Roads Western Australia

30 November 2009

091127 concept plans note.docx
PB50119

Dear Gary

Broome North - Conceptual Intersection Treatment Plans

Dear Gary,

Following the meeting on 20 November 2009 between SKM, Main Roads WA, Department of Planning (DoP) and LandCorp to discuss the interim and ultimate intersection treatments on Broome Road/ Gubinge Road between Tanami Drive and Fairway Drive, intersection concept plans have been developed for your review.

The interim development comprises 2,000 lots, expansion of the Blue Haze industrial estate, retail land use at one centre and at least one primary school. The exact timing (year) when the 2,000 lots would be built is not clear however assuming the current release rate for Broome continues and that majority of the lots are released in Broome North, the time frame is expected to be post year 2031.

At ultimate development a total of approximately 4,800 lots, two shopping centres, further expansion of the Blue Haze light industrial area, a private school, a high school and two primary schools will be developed.

The intersection treatments on Broome Road and Gubinge Road are summarised in **Table 1**.

Table 1 Proposed Intersection Treatments

Intersection	Interim	Ultimate
Gubinge Rd / Fairway Dr	No change to existing	Signals (if/ when required to facilitate pedestrian crossing)
Gubinge Rd/ Magabala Rd	Priority-controlled (full access)	Signals (if/ when required to facilitate pedestrian crossing)
Gubinge Road / new Blue Haze Industrial access	Priority-controlled (no right turn in)	Priority-controlled (no right turn in)
Gubinge Rd/ Sanderling Dr	Priority-controlled (left in/ out)	Priority-controlled (left in/ out)
Gubinge Rd/ Old Broome Rd	No change to existing	Priority-controlled full access (Gubinge Rd duplicated)
Broome Rd/ Tanami Dr	No change to existing	Priority-controlled full access (Gubinge Rd duplicated)

It is assumed by 'ultimate' development that Gubinge Road/ Broome Road will be a four-lane divided carriageway as per the *Broome Highway Planning Study – Route Definition Report* (Western Infrastructure, March 2003).

Conceptual plans of the proposed intersection treatments are attached for comment. It would be appreciated if we could receive your comments by 7 December 2009 in order to progress planning in line with LandCorp's schedule as agreed with the Shire of Broome and WAPC.

If you have any queries please do not hesitate to contact me on 9469 4577.

Yours sincerely

Danya Alexander
Senior Transport Planner
Phone: 94694577
Fax: 94694488
E-mail: DAlexander@skm.com.au

Encl.

Gubinge Road Interim Concept Plan

Gubinge Road Ultimate Concept Plan

Government of Western Australia

mainroads WESTERN AUSTRALIA

ABN: 50 860 676 021

Enquiries: Gary Bradshaw on 91584 325
Our Ref: 05/7129
Your Ref:

Danya Alexander
Senior Transport Planner (SKM)
Durack Centre
263 Adelaide Terrace
PO Box H615
Perth WA 6001

Dear Danya,

BROOME NORTH – CONCEPTUAL INTERSECTION TREATMENT PLAN

I refer to your correspondence of 30 November 2009 seeking comments on access requirements and conceptual intersection treatments to Broome Highway (Gubinge Road) in relation to the Broome North development.

Main Roads has reconsidered the proposed access from the Blue Haze estate and based on discussions and information supplied Main Roads now supports the proposed access location. The support of this additional access is on the assumption that the need for traffic signals at Gubinge/Magabala intersection would not be required in the short to medium term.

Main Roads supports the interim treatment proposed for the intersections and acknowledges that there may be a need for traffic signals in the longer term. However, to delay the installation of traffic signals an access plan for pedestrian movements across Gubinge Road will be required, especially in the short term where there will be a need for school children to access schools in the Roebuck Estate area.

If you require any further information please contact Gary Bradshaw on 91584 325. In reply please quote file reference 05/7129.

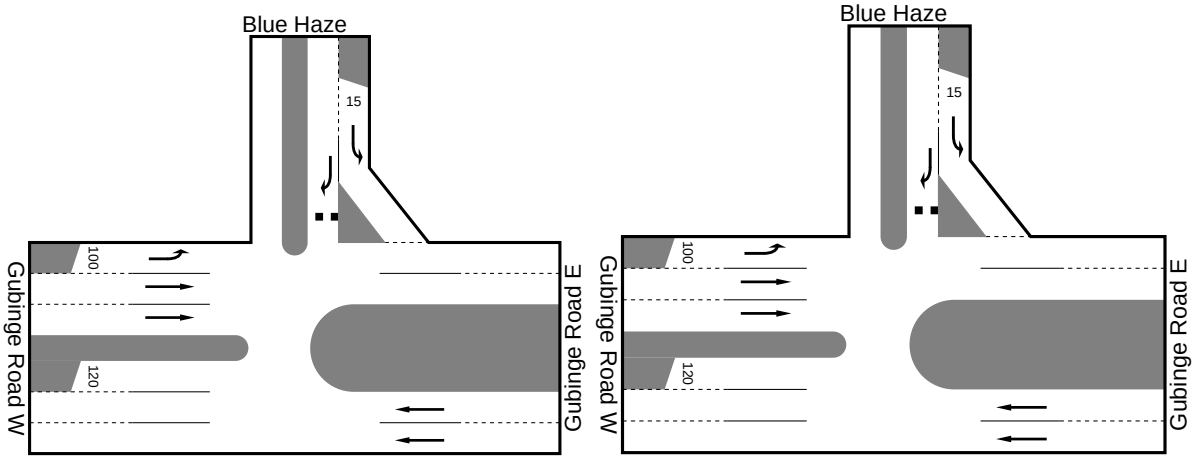
Yours sincerely

Gary Bradshaw
Network Manager
07 December 2009

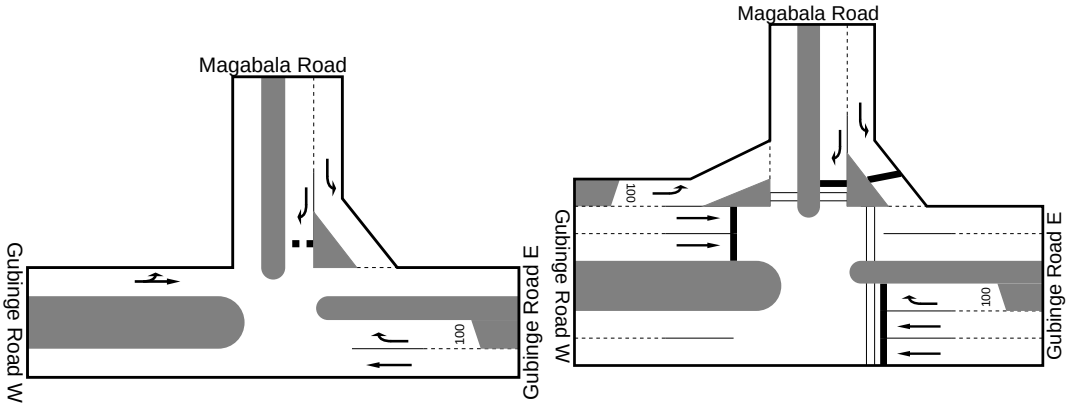
Kimberley Region, Wodehouse Street, Derby or PMB 959, Derby Western Australia 6728
Telephone: (08) 9158 4333 Facsimile: (08) 9158 4334
Email: kimreg@mainroads.wa.gov.au Website: www.mainroads.wa.gov.au

Appendix E Intersection Analysis Results (SIDRA)

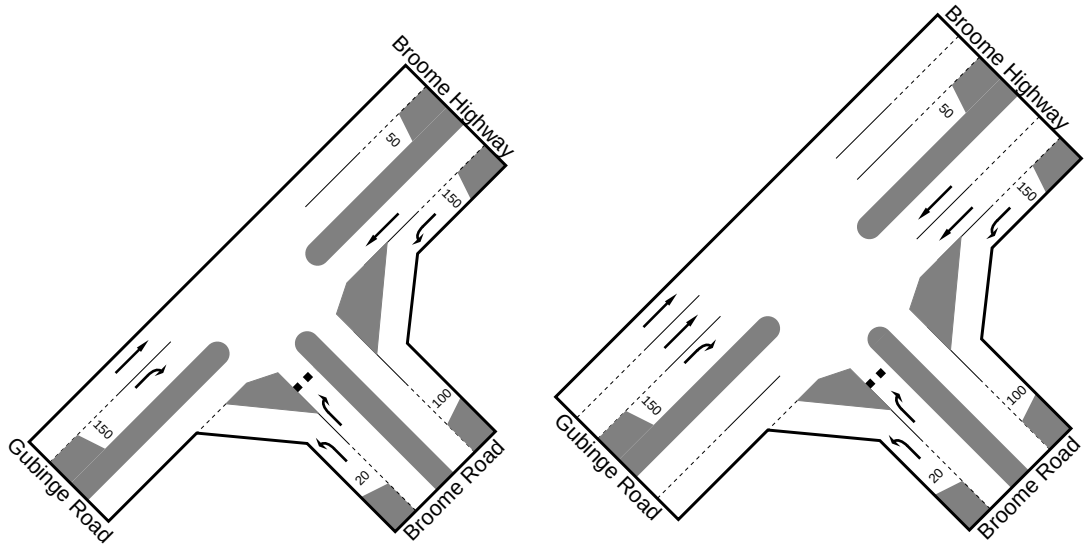
1 Interim & Ultimate



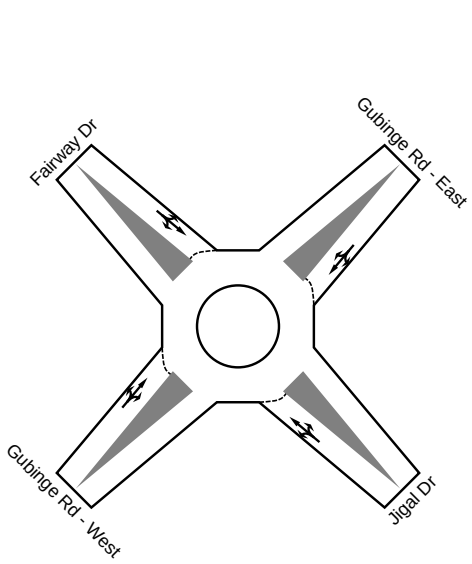
2 Interim & Ultimate

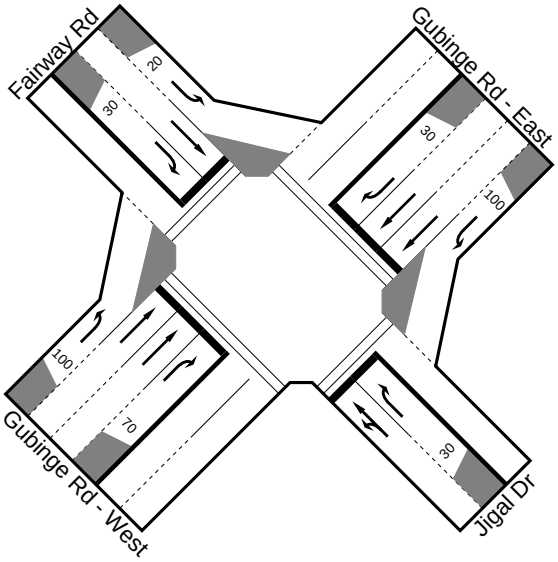


3 Interim & Ultimate

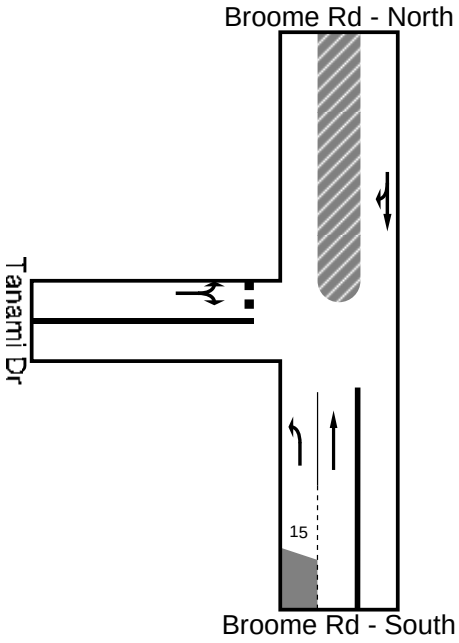


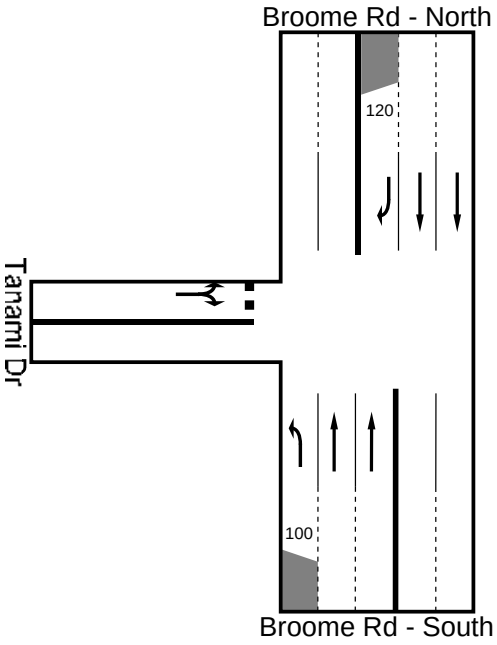
4 Interim & Ultimate





5 Interim & Ultimate





6 Interim & Ultimate

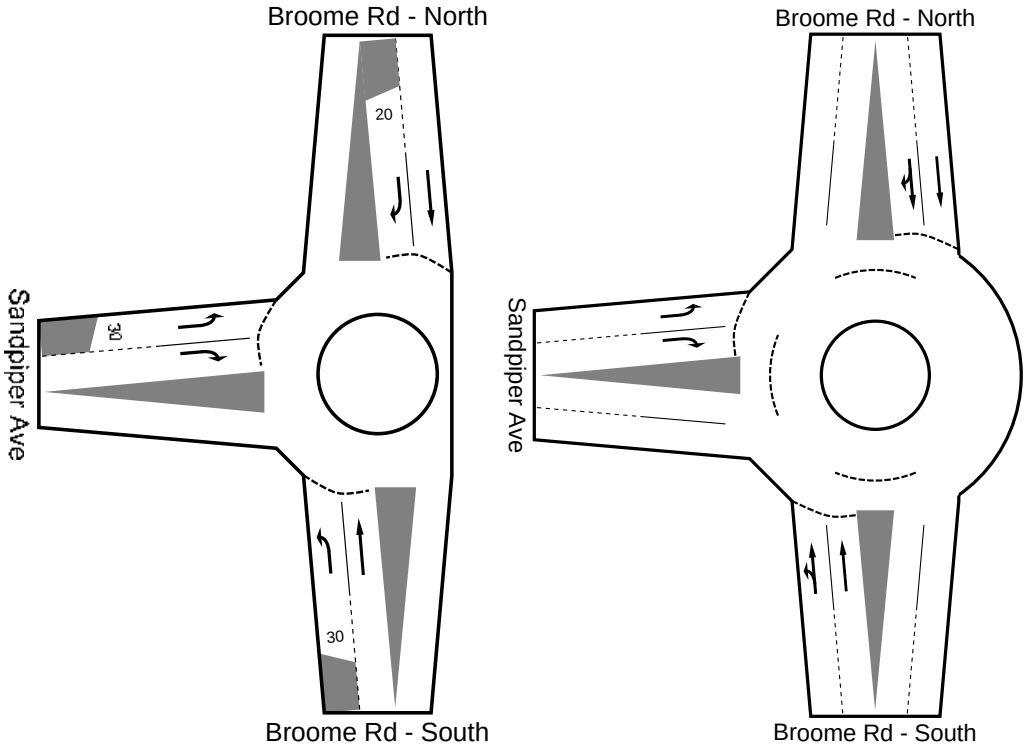
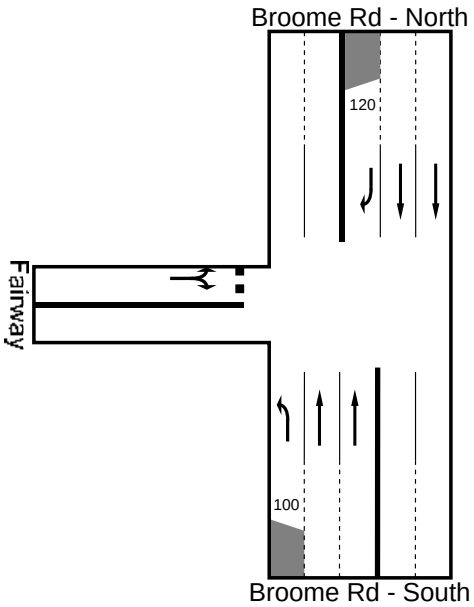


Figure 7 Ultimate



SIDRA INTERSECTION

Movement Summary

Gubinge/ Fairway/ Jigal

Interim - AM Peak

Roundabout

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Jigal Dr										
21	L	112	2.7	0.283	5.5	LOS A	17	0.45	0.45	56.6
22	T	239	2.9	0.283	5.8	LOS A	17	0.45	0.46	56.5
23	R	74	2.7	0.283	14.7	LOS B	17	0.45	0.65	49.5
Approach		**423**	**2.8**	**0.283**	**7.2**	**LOS A**	**17**	**0.45**	**0.49**	**55.0**
Gubinge Rd - East										
24	L	32	9.7	0.203	7.1	LOS A	13	0.65	0.57	54.6
25	T	187	10.1	0.203	7.4	LOS A	13	0.65	0.57	54.5
26	R	11	10.0	0.204	16.3	LOS B	13	0.65	0.71	48.4
Approach		**229**	**10.0**	**0.203**	**7.7**	**LOS A**	**13**	**0.65**	**0.58**	**54.2**
Fairway Dr										
27	L	53	3.8	0.363	6.4	LOS A	24	0.62	0.53	54.9
28	T	412	2.9	0.363	6.8	LOS A	24	0.62	0.54	54.8
29	R	18	5.6	0.360	15.6	LOS B	24	0.62	0.71	48.6
Approach		**482**	**3.1**	**0.363**	**7.1**	**LOS A**	**24**	**0.62**	**0.54**	**54.5**
Gubinge Rd - West										
30	L	13	8.3	0.255	6.1	LOS A	16	0.51	0.49	56.0
31	T	221	10.0	0.255	6.4	LOS A	16	0.51	0.50	55.8
32	R	105	10.4	0.255	15.3	LOS B	16	0.51	0.67	49.2
Approach		**339**	**10.0**	**0.255**	**9.2**	**LOS A**	**16**	**0.51**	**0.55**	**53.4**
All Vehicles		**1473**	**5.7**	**0.363**	**7.7**	**LOS A**	**24**	**0.55**	**0.53**	**54.3**

Symbols which may appear in this table:

Following Degree of Saturation
x = 1.00 for Short Lane with resulting Excess Flow
* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

Site: Gubinge_Fairway_Jigal_AM_Interim
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SIDRA INTERSECTION

Movement Summary

Gubinge/ Fairway/ Jigal

Interim - PM Peak

Roundabout

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Jigal Dr										
21	L	105	2.9	0.385	5.9	LOS A	25	0.55	0.49	55.6
22	T	412	2.9	0.384	6.2	LOS A	25	0.55	0.50	55.5
23	R	32	3.1	0.386	15.1	LOS B	25	0.55	0.67	49.0
Approach		**548**	**2.9**	**0.384**	**6.7**	**LOS A**	**25**	**0.55**	**0.50**	**55.0**
Gubinge Rd - East										
24	L	74	9.6	0.266	6.3	LOS A	16	0.54	0.50	55.7
25	T	221	10.0	0.266	6.6	LOS A	16	0.54	0.51	55.6
26	R	53	9.6	0.267	15.5	LOS B	16	0.54	0.68	49.0
Approach		**346**	**9.8**	**0.266**	**7.9**	**LOS A**	**16**	**0.54**	**0.54**	**54.4**
Fairway Dr										
27	L	11	9.1	0.193	5.9	LOS A	11	0.52	0.48	55.9
28	T	239	2.9	0.193	6.2	LOS A	11	0.52	0.49	55.8
29	R	13	7.7	0.194	15.0	LOS B	11	0.52	0.67	49.1
Approach		**263**	**3.4**	**0.193**	**6.6**	**LOS A**	**11**	**0.52**	**0.50**	**55.4**
Gubinge Rd - West										
30	L	18	11.1	0.273	7.0	LOS A	18	0.65	0.56	54.6
31	T	187	10.1	0.272	7.3	LOS A	18	0.65	0.57	54.5
32	R	112	9.9	0.272	16.2	LOS B	18	0.65	0.71	48.4
Approach		**317**	**10.1**	**0.272**	**10.4**	**LOS B**	**18**	**0.65**	**0.62**	**52.0**
All Vehicles		**1474**	**6.2**	**0.386**	**7.8**	**LOS A**	**25**	**0.56**	**0.54**	**54.2**

Symbols which may appear in this table:

Following Degree of Saturation
x = 1.00 for Short Lane with resulting Excess Flow
* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

Site: Gubinge_Fairway_Jigal_PM_Interim
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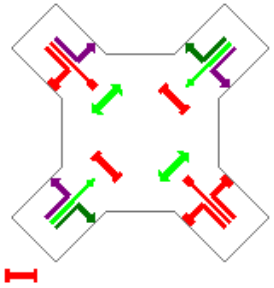
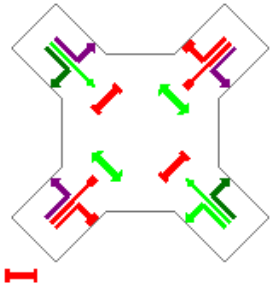
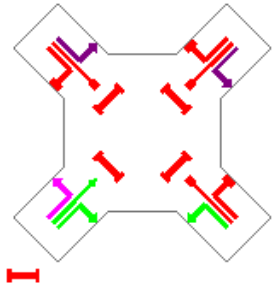
SIDRA INTERSECTION

Phasing Summary

Gubinge Rd / Fairway Dr / Jigal Dr

Ultimate - AM

C = **80** seconds
Cycle Time Option: **Optimum cycle time (Minimum Delay)**
Phase times determined by the program.

Phase B	Phase D	Phase E
		
Green Time = **16** seconds Phase Time = **22** seconds Phase Split = **28** %	Green Time = **34** seconds Phase Time = **40** seconds Phase Split = **50** %	Green Time = **12** seconds Phase Time = **18** seconds Phase Split = **23** %

Normal Movement	Permitted/Opposed
Slip-Lane	Opposed Slip-Lane
Stopped Movement	Continuous
Turn On Red	

SIDRA SOLUTIONS

Site: Gubinge Rd_Fairway Dr_Jigal Dr_ AM _Ultimate
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SIDRA INTERSECTION

Movement Summary

Gubinge Rd / Fairway Dr / Jigal Dr

Ultimate - AM

Signalised - Fixed time **Cycle Time = 80 seconds**

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Jigal Dr										
21	L	179	2.8	0.590	26.1	LOS C	111	0.80	0.84	34.9
22	T	307	2.9	0.590	17.8	LOS B	111	0.80	0.71	40.3
23	R	73	2.8	0.427	41.5	LOS D	27	0.92	0.77	28.1
Approach		**558**	**2.9**	**0.589**	**23.5**	**LOS C**	**111**	**0.82**	**0.76**	**36.4**
Gubinge Rd - East										
24	L	32	3.1	0.038	13.7	LOS B	5	0.47	0.67	43.7
25	T	396	10.1	0.541	31.9	LOS C	67	0.95	0.78	32.0
26	R	16	6.2	0.090	36.9	LOS D	6	0.84	0.70	29.8
Approach		**444**	**9.5**	**0.541**	**30.8**	**LOS C**	**67**	**0.91**	**0.77**	**32.5**
Fairway Rd										
27	L	66	3.0	0.115	8.6	LOS A	3	0.22	0.64	48.6
28	T	584	3.1	0.720	20.8	LOS C	143	0.89	0.79	38.2
29	R	34	2.9	0.186	35.0	LOS D	12	0.82	0.73	30.6
Approach		**685**	**3.1**	**0.720**	**20.3**	**LOS C**	**143**	**0.82**	**0.78**	**38.5**
Gubinge Rd - West										
30	L	20	5.0	0.018	9.5	LOS A	2	0.28	0.64	47.7
31	T	288	10.0	0.186	15.4	LOS B	37	0.66	0.54	42.1
32	R	136	2.9	0.315	25.8	LOS C	34	0.84	0.78	35.1
Approach		**445**	**7.6**	**0.315**	**18.3**	**LOS B**	**37**	**0.70**	**0.62**	**39.9**
All Vehicles		**2132**	**5.3**	**0.720**	**22.9**	**LOS C**	**143**	**0.81**	**0.74**	**36.8**

Pedestrian Movements

Mov ID	Dem Flow (ped/h)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate
P9	53	31.5	LOS D	0	0.89	0.89
P11	53	19.6	LOS B	0	0.70	0.70
P13	53	34.2	LOS D	0	0.93	0.93
P15	53	19.6	LOS B	0	0.70	0.70
All Peds	**212**	**26.2**	**LOS C**	**0**	**0.80**	**0.80**

Symbols which may appear in this table:

Following Degree of Saturation
x = 1.00 for Short Lane with resulting Excess Flow
* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

Site: Gubinge Rd_Fairway Dr_Jigal Dr_ AM _Ultimate
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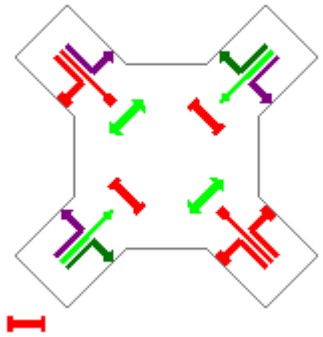
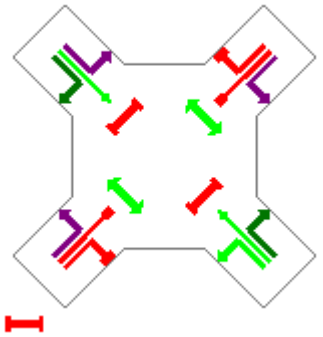
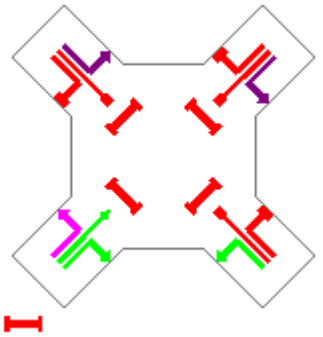
SIDRA INTERSECTION

Phasing Summary

Gubinge Rd / Fairway Dr / Jigal Dr

Ultimate - PM

C = **90** seconds
Cycle Time Option: **Optimum cycle time (Minimum Delay)**
Phase times determined by the program.

Phase B	Phase D	Phase E
		
Green Time = **16** seconds Phase Time = **22** seconds Phase Split = **24** %	Green Time = **44** seconds Phase Time = **50** seconds Phase Split = **56** %	Green Time = **12** seconds Phase Time = **18** seconds Phase Split = **20** %

Normal Movement	Permitted/Opposed
Slip-Lane	Opposed Slip-Lane
Stopped Movement	Continuous
Turn On Red	

SIDRA SOLUTIONS

Site: Gubinge Rd_Fairway Dr_Jigal Dr_ PM _Ultimate2
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SIDRA INTERSECTION

Movement Summary

Gubinge Rd / Fairway Dr / Jigal Dr

Ultimate - PM

Signalised - Fixed time **Cycle Time = 90 seconds**

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Jigal Dr										
21	L	136	2.9	0.771	28.7	LOS C	189	0.88	0.89	33.5
22	T	584	3.1	0.771	20.4	LOS C	189	0.88	0.81	38.4
23	R	32	3.1	0.153	26.2	LOS C	10	0.64	0.71	35.0
Approach		**753**	**3.1**	**0.771**	**22.2**	**LOS C**	**189**	**0.87**	**0.82**	**37.3**
Gubinge Rd - East										
24	L	73	2.8	0.085	10.4	LOS B	8	0.32	0.66	46.8
25	T	288	10.0	0.444	36.6	LOS D	57	0.94	0.76	29.9
26	R	66	3.0	0.419	44.4	LOS D	27	0.91	0.76	27.1
Approach		**427**	**7.7**	**0.444**	**33.4**	**LOS C**	**57**	**0.83**	**0.74**	**31.3**
Fairway Rd										
27	L	16	6.2	0.035	8.8	LOS A	1	0.21	0.63	48.4
28	T	307	2.9	0.328	15.0	LOS B	71	0.65	0.56	42.5
29	R	20	5.0	0.135	43.3	LOS D	9	0.87	0.72	27.4
Approach		**343**	**3.2**	**0.328**	**16.3**	**LOS B**	**71**	**0.64**	**0.57**	**41.4**
Gubinge Rd - West										
30	L	34	2.9	0.040	12.9	LOS B	6	0.42	0.67	44.4
31	T	396	10.1	0.286	21.0	LOS C	59	0.74	0.62	38.0
32	R	179	2.8	0.440	31.2	LOS C	52	0.89	0.80	32.3
Approach		**609**	**7.6**	**0.440**	**23.6**	**LOS C**	**59**	**0.76**	**0.67**	**36.4**
All Vehicles		**2132**	**5.3**	**0.771**	**23.9**	**LOS C**	**189**	**0.79**	**0.72**	**36.2**

Pedestrian Movements

Mov ID	Dem Flow (ped/h)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate
P9	53	36.5	LOS D	0	0.90	0.90
P11	53	17.4	LOS B	0	0.62	0.62
P13	53	39.2	LOS D	0	0.93	0.93
P15	53	17.4	LOS B	0	0.62	0.62
All Peds	**212**	**27.6**	**LOS C**	**0**	**0.77**	**0.77**

Symbols which may appear in this table:

Following Degree of Saturation
x = 1.00 for Short Lane with resulting Excess Flow
* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

Site: Gubinge Rd_Fairway Dr_Jigal Dr_ PM _Ultimate2
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SIDRA INTERSECTION

Movement Summary

Gubinge Rd / Magabala Rd

Interim - AM Peak

Give-way

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Gubinge Road E										
5	T	207	10.1	0.114	0.0	LOS A	0	0.00	0.00	70.0
6	R	42	2.4	0.052	11.9	LOS B	2	0.41	0.72	51.6
Approach		**250**	**8.8**	**0.114**	**2.0**	**LOS A**	**2**	**0.07**	**0.12**	**66.1**
Magabala Road										
7	L	165	3.0	0.142	11.6	LOS B	7	0.55	0.69	51.3
9	R	22	4.5	0.036	13.5	LOS B	1	0.52	0.77	49.7
Approach		**187**	**3.2**	**0.142**	**11.8**	**LOS B**	**7**	**0.54**	**0.70**	**51.1**
Gubinge Road W										
10	L	5	16.7	0.182	9.9	LOS A	0	0.00	0.71	53.9
11	T	324	9.9	0.180	0.0	LOS A	0	0.00	0.00	70.0
Approach		**330**	**10.0**	**0.180**	**0.2**	**LOS A**		**0.00**	**0.01**	**69.6**
All Vehicles		**767**	**8.0**	**0.182**	**3.6**	**Not Applicable**	**7**	**0.16**	**0.21**	**63.0**

Symbols which may appear in this table:

Following Degree of Saturation
x = 1.00 for Short Lane with resulting Excess Flow
* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

Site: Gubinge_Magabala_AM_Interim
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SIDRA INTERSECTION

Movement Summary

Gubinge Rd / Magabala Rd

Interim - PM Peak

Give-way

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Gubinge Road E										
5	T	324	9.9	0.177	0.0	LOS A	0	0.00	0.00	70.0
6	R	165	3.0	0.151	11.3	LOS B	7	0.41	0.69	51.8
Approach		**489**	**7.6**	**0.177**	**3.8**	**LOS A**	**7**	**0.14**	**0.23**	**62.7**
Magabala Road										
7	L	42	2.4	0.045	10.7	LOS B	1	0.33	0.64	52.6
9	R	5	16.7	0.014	16.0	LOS C	0	0.61	0.79	47.2
Approach		**48**	**4.2**	**0.045**	**11.3**	**LOS B**	**1**	**0.36**	**0.66**	**51.9**
Gubinge Road W										
10	L	22	4.5	0.126	9.9	LOS A	0	0.00	0.71	53.9
11	T	207	10.1	0.126	0.0	LOS A	0	0.00	0.00	70.0
Approach		**230**	**9.6**	**0.126**	**0.9**	**LOS A**		**0.00**	**0.07**	**68.1**
All Vehicles		**767**	**8.0**	**0.177**	**3.4**	**Not Applicable**	**7**	**0.11**	**0.21**	**63.4**

Symbols which may appear in this table:

Following Degree of Saturation
x = 1.00 for Short Lane with resulting Excess Flow
* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

Site: Gubinge_Magabala_PM_Interim
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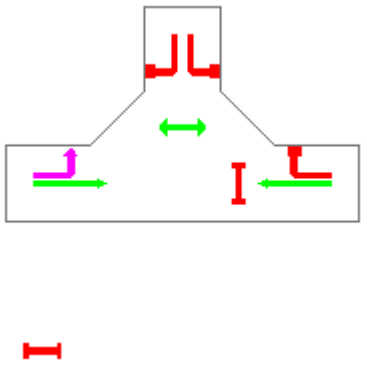
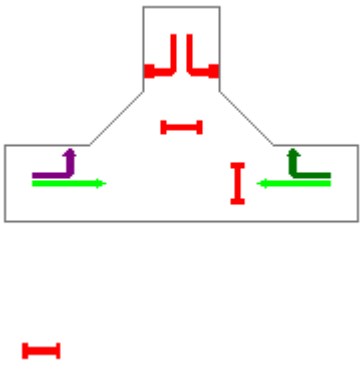
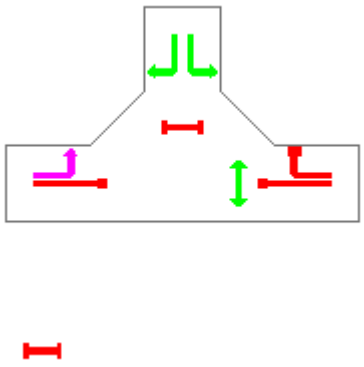
SIDRA INTERSECTION

Phasing Summary

Gubinge Rd / Magabala Rd

Ultimate - AM Peak

C = **60** seconds
Cycle Time Option: **Program calculated cycle time**
Phase times determined by the program.

Phase A	Phase B	Phase C
		
Green Time = **12** seconds Phase Time = **13** seconds Phase Split = **22** %	Green Time = **12** seconds Phase Time = **18** seconds Phase Split = **30** %	Green Time = **23** seconds Phase Time = **29** seconds Phase Split = **48** %

Normal Movement	Permitted/Opposed
Slip-Lane	Opposed Slip-Lane
Stopped Movement	Continuous
Turn On Red	

SIDRA SOLUTIONS

Site: Gubinge_Magabala_AM_Ultimate
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SIDRA INTERSECTION

Movement Summary

Gubinge Rd / Magabala Rd

Ultimate - AM Peak

Signalised - Fixed time **Cycle Time = 60 seconds**

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Gubinge Road E										
5	T	257	10.1	0.169	11.9	LOS B	26	0.66	0.53	51.5
6	R	73	2.8	0.205	32.3	LOS C	19	0.87	0.76	35.4
Approach		**329**	**8.5**	**0.205**	**16.4**	**LOS B**	**26**	**0.71**	**0.58**	**46.9**
Magabala Road										
7	L	289	3.1	0.532	28.9	LOS C	65	0.88	0.82	37.5
9	R	126	3.1	0.182	23.1	LOS C	26	0.70	0.77	41.2
Approach		**417**	**3.1**	**0.532**	**27.2**	**LOS C**	**65**	**0.83**	**0.80**	**38.6**
Gubinge Road W										
10	L	61	3.3	0.040	9.9	LOS A	2	0.14	0.67	53.7
11	T	227	10.1	0.150	11.8	LOS B	23	0.65	0.52	51.6
Approach		**289**	**8.7**	**0.150**	**11.4**	**LOS B**	**23**	**0.55**	**0.55**	**52.1**
All Vehicles		**1035**	**6.4**	**0.532**	**19.3**	**LOS B**	**65**	**0.71**	**0.66**	**44.3**

Pedestrian Movements

Mov ID	Dem Flow (ped/h)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate
P3	53	17.6	LOS B	0	0.77	0.77
P5	53	24.3	LOS C	0	0.90	0.90
All Peds	**106**	**21.0**	**LOS C**	**0**	**0.83**	**0.83**

Symbols which may appear in this table:

Following Degree of Saturation
x = 1.00 for Short Lane with resulting Excess Flow
* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

Site: Gubinge_Magabala_AM_Ultimate
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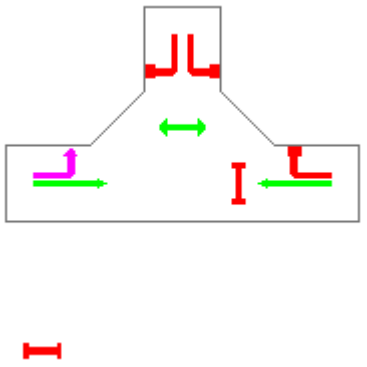
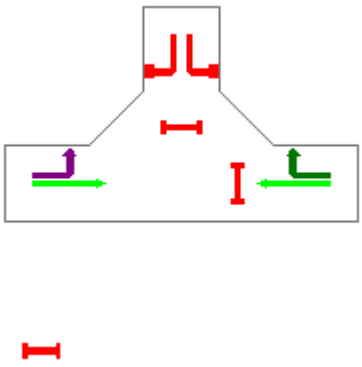
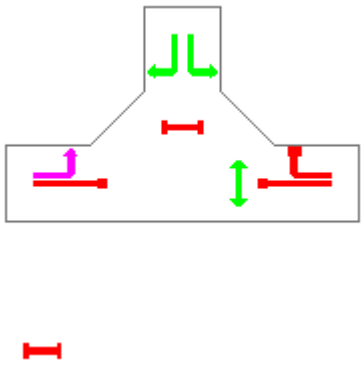
SIDRA INTERSECTION

Phasing Summary

Gubinge Rd / Magabala Rd

Ultimate - PM Peak

C = **60** seconds
Cycle Time Option: **Program calculated cycle time**
Phase times determined by the program.

Phase A	Phase B	Phase C
		
Green Time = **12** seconds Phase Time = **13** seconds Phase Split = **22** %	Green Time = **20** seconds Phase Time = **26** seconds Phase Split = **43** %	Green Time = **15** seconds Phase Time = **21** seconds Phase Split = **35** %

Normal Movement	Permitted/Opposed
Slip-Lane	Opposed Slip-Lane
Stopped Movement	Continuous
Turn On Red	

SIDRA SOLUTIONS

Site: Gubinge_Magabala_PM_Ultimate
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SIDRA INTERSECTION

Movement Summary

Gubinge Rd / Magabala Rd

Ultimate - PM Peak

Signalised - Fixed time **Cycle Time = 60 seconds**

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Gubinge Road E										
5	T	227	10.1	0.113	7.0	LOS A	18	0.51	0.41	57.9
6	R	289	3.1	0.544	28.0	LOS C	63	0.86	0.83	37.9
Approach		**518**	**6.2**	**0.544**	**18.7**	**LOS B**	**63**	**0.71**	**0.64**	**44.7**
Magabala Road										
7	L	73	2.8	0.158	28.9	LOS C	18	0.82	0.75	37.5
9	R	61	3.3	0.134	29.0	LOS C	15	0.81	0.75	37.3
Approach		**133**	**3.0**	**0.158**	**29.0**	**LOS C**	**18**	**0.81**	**0.75**	**37.4**
Gubinge Road W										
10	L	126	3.1	0.093	10.1	LOS B	5	0.21	0.68	53.3
11	T	257	10.1	0.128	7.0	LOS A	20	0.51	0.41	57.8
Approach		**384**	**7.8**	**0.128**	**8.0**	**LOS A**	**20**	**0.41**	**0.50**	**56.2**
All Vehicles		**1035**	**6.4**	**0.544**	**16.1**	**LOS B**	**63**	**0.61**	**0.60**	**47.1**

Pedestrian Movements

Mov ID	Dem Flow (ped/h)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate
P3	53	24.3	LOS C	0	0.90	0.90
P5	53	24.3	LOS C	0	0.90	0.90
All Peds	**106**	**24.3**	**LOS C**	**0**	**0.90**	**0.90**

Symbols which may appear in this table:

Following Degree of Saturation
x = 1.00 for Short Lane with resulting Excess Flow
* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

Site: Gubinge_Magabala_PM_Ultimate
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SIDRA INTERSECTION

Movement Summary

Broome Rd / Gubinge Rd / Broome Hwy

Interim - AM Peak

Two-way stop

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Broome Road										
21	L	126	4.8	0.145	10.8	LOS B	5	0.44	0.62	51.9
23	R	232	5.2	0.241	13.3	LOS B	13	0.66	0.79	50.1
Approach		**358**	**5.0**	**0.241**	**12.4**	**LOS B**	**13**	**0.58**	**0.73**	**50.7**
Broome Highway										
24	L	267	4.9	0.149	9.6	LOS A#	4#	0.00	0.65	54.6
25	T	101	9.9	0.055	0.0	LOS A	0	0.00	0.00	70.0
Approach		**368**	**6.2**	**0.149**	**7.0**	**LOS A**		**0.00**	**0.47**	**58.1**
Gubinge Road										
31	T	134	9.8	0.073	0.0	LOS A	0	0.00	0.00	70.0
32	R	275	5.1	0.178	10.6	LOS B	8	0.30	0.65	52.4
Approach		**408**	**6.6**	**0.178**	**7.1**	**LOS A**	**8**	**0.20**	**0.44**	**57.1**
All Vehicles		**1134**	**6.0**	**0.241**	**8.7**	**Not Applicable**	**13**	**0.26**	**0.54**	**55.2**

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* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

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SIDRA INTERSECTION

Movement Summary

Broome Rd / Gubinge Rd / Broome Hwy

Interim - PM Peak

Two-way stop

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Broome Road										
21	L	274	5.1	0.317	11.1	LOS B	12	0.49	0.65	51.7
23	R	268	4.9	0.210	11.3	LOS B	10	0.47	0.71	51.6
Approach		**542**	**5.0**	**0.317**	**11.2**	**LOS B**	**12**	**0.48**	**0.68**	**51.6**
Broome Highway										
24	L	228	4.8	0.127	9.6	LOS A#	3#	0.00	0.65	54.6
25	T	134	9.8	0.073	0.0	LOS A	0	0.00	0.00	70.0
Approach		**361**	**6.6**	**0.127**	**6.1**	**LOS A**		**0.00**	**0.41**	**59.4**
Gubinge Road										
31	T	101	9.9	0.055	0.0	LOS A	0	0.00	0.00	70.0
32	R	129	4.7	0.092	10.9	LOS B	4	0.37	0.66	52.0
Approach		**230**	**7.0**	**0.092**	**6.1**	**LOS A**	**4**	**0.21**	**0.37**	**58.7**
All Vehicles		**1133**	**5.9**	**0.317**	**8.5**	**Not Applicable**	**12**	**0.27**	**0.53**	**55.3**

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Following Degree of Saturation
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* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

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SIDRA INTERSECTION

Movement Summary

Broome Rd / Gubinge Rd / Broome Hwy

Ultimate - AM Peak

Two-way stop

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Broome Road										
21	L	165	4.8	0.191	10.9	LOS B	7	0.46	0.63	51.8
23	R	312	5.1	0.554	18.2	LOS C	31	0.72	1.04	45.3
Approach		**477**	**5.0**	**0.554**	**15.7**	**LOS C**	**31**	**0.63**	**0.90**	**47.4**
Broome Highway										
24	L	334	5.1	0.186	9.6	LOS A#	5#	0.00	0.65	54.6
25	T	81	9.9	0.022	0.0	LOS A	0	0.00	0.00	70.0
Approach		**415**	**6.0**	**0.186**	**7.7**	**LOS A**		**0.00**	**0.52**	**57.0**
Gubinge Road										
31	T	160	10.0	0.044	0.0	LOS A	0	0.00	0.00	70.0
32	R	422	5.0	0.418	11.1	LOS B	20	0.38	0.68	52.0
Approach		**582**	**6.4**	**0.418**	**8.1**	**LOS A**	**20**	**0.28**	**0.49**	**56.0**
All Vehicles		**1474**	**5.8**	**0.554**	**10.4**	**Not Applicable**	**31**	**0.31**	**0.63**	**53.2**

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Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

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Movement Summary

Broome Rd / Gubinge Rd / Broome Hwy

Ultimate - PM Peak

Two-way stop

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Broome Road										
21	L	420	5.0	0.498	12.9	LOS B	30	0.59	0.76	50.6
23	R	336	5.1	0.479	15.1	LOS C	27	0.62	0.96	48.3
Approach		**756**	**5.0**	**0.498**	**13.9**	**LOS B**	**30**	**0.61**	**0.85**	**49.6**
Broome Highway										
24	L	305	4.9	0.170	9.6	LOS A#	5#	0.00	0.65	54.6
25	T	160	10.0	0.044	0.0	LOS A	0	0.00	0.00	70.0
Approach		**465**	**6.7**	**0.170**	**6.3**	**LOS A**		**0.00**	**0.43**	**59.1**
Gubinge Road										
31	T	81	9.9	0.022	0.0	LOS A	0	0.00	0.00	70.0
32	R	175	5.1	0.218	12.2	LOS B	8	0.47	0.77	51.3
Approach		**256**	**6.6**	**0.218**	**8.4**	**LOS A**	**8**	**0.32**	**0.52**	**56.0**
All Vehicles		**1477**	**5.8**	**0.498**	**10.5**	**Not Applicable**	**30**	**0.37**	**0.66**	**53.3**

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x = 1.00 for Short Lane with resulting Excess Flow
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- Based on density for continuous movements

Following Queue
- Density for continuous movement

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SIDRA INTERSECTION

Movement Summary

Gubinge Rd / Blue Haze

Interim - AM peak

Give-way

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Gubinge Road E										
5	T	203	9.9	0.111	0.0	LOS A	0	0.00	0.00	70.0
Approach		**203**	**9.9**	**0.111**	**0.0**	**LOS A**		**0.00**	**0.00**	**70.0**
Blue Haze										
7	L	1	50.0	0.006	14.6	LOS B	0	0.61	0.60	49.4
9	R	4	25.0	0.004	12.4	LOS B	0	0.46	0.62	51.6
Approach		**6**	**33.3**	**0.006**	**13.1**	**LOS B**	**0**	**0.51**	**0.62**	**50.8**
Gubinge Road W										
10	L	18	22.2	0.011	10.7	LOS B	0	0.00	0.71	53.9
11	T	361	10.0	0.197	0.0	LOS A	0	0.00	0.00	70.0
Approach		**379**	**10.6**	**0.197**	**0.5**	**LOS A**		**0.00**	**0.03**	**69.0**
All Vehicles		**588**	**10.5**	**0.197**	**0.5**	**Not Applicable**	**0**	**0.01**	**0.03**	**69.1**

Symbols which may appear in this table:

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* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

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SIDRA INTERSECTION

Movement Summary

Gubinge Rd / Blue Haze

Interim - PM peak

Give-way

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Gubinge Road E										
5	T	361	10.0	0.197	0.0	LOS A	0	0.00	0.00	70.0
Approach		**361**	**10.0**	**0.197**	**0.0**	**LOS A**		**0.00**	**0.00**	**70.0**
Blue Haze										
7	L	3	25.0	0.007	11.5	LOS B	0	0.43	0.55	52.0
9	R	18	22.2	0.015	11.5	LOS B	1	0.33	0.62	52.2
Approach		**22**	**22.7**	**0.015**	**11.5**	**LOS B**	**1**	**0.35**	**0.61**	**52.2**
Gubinge Road W										
10	L	4	25.0	0.003	10.7	LOS B	0	0.00	0.71	53.9
11	T	203	9.9	0.111	0.0	LOS A	0	0.00	0.00	70.0
Approach		**207**	**10.1**	**0.111**	**0.2**	**LOS A**		**0.00**	**0.01**	**69.6**
All Vehicles		**590**	**10.5**	**0.197**	**0.5**	**Not Applicable**	**1**	**0.01**	**0.03**	**69.0**

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Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

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SIDRA INTERSECTION

Movement Summary

Gubinge Rd / Blue Haze

Ultimate - AM peak

Give-way

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Gubinge Road E										
5	T	266	10.1	0.073	0.0	LOS A	0	0.00	0.00	70.0
Approach		**267**	**10.1**	**0.073**	**0.0**	**LOS A**		**0.00**	**0.00**	**70.0**
Blue Haze										
7	L	2	33.3	0.009	16.9	LOS C	0	0.69	0.67	47.2
9	R	13	23.1	0.030	16.2	LOS C	1	0.57	0.80	47.8
Approach		**16**	**25.0**	**0.030**	**16.3**	**LOS C**	**1**	**0.60**	**0.77**	**47.6**
Gubinge Road W										
10	L	51	20.0	0.031	10.7	LOS B	0	0.00	0.71	53.9
11	T	580	10.0	0.158	0.0	LOS A	0	0.00	0.00	70.0
Approach		**630**	**10.8**	**0.158**	**0.9**	**LOS A**		**0.00**	**0.06**	**68.4**
All Vehicles		**913**	**10.8**	**0.158**	**0.9**	**Not Applicable**	**1**	**0.01**	**0.05**	**68.3**

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Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

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SIDRA INTERSECTION

Movement Summary

Gubinge Rd / Blue Haze

Ultimate - PM peak

Give-way

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Gubinge Road E										
5	T	580	10.0	0.158	0.0	LOS A	0	0.00	0.00	70.0
Approach		**580**	**10.0**	**0.158**	**0.0**	**LOS A**		**0.00**	**0.00**	**70.0**
Blue Haze										
7	L	9	20.0	0.018	11.9	LOS B	1	0.49	0.58	51.7
9	R	51	20.0	0.068	12.5	LOS B	3	0.40	0.70	51.8
Approach		**60**	**20.0**	**0.068**	**12.4**	**LOS B**	**3**	**0.41**	**0.68**	**51.8**
Gubinge Road W										
10	L	13	23.1	0.008	10.7	LOS B	0	0.00	0.71	53.9
11	T	266	10.1	0.073	0.0	LOS A	0	0.00	0.00	70.0
Approach		**280**	**10.7**	**0.073**	**0.5**	**LOS A**		**0.00**	**0.03**	**69.1**
All Vehicles		**920**	**10.9**	**0.158**	**1.0**	**Not Applicable**	**3**	**0.03**	**0.05**	**68.2**

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Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

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SIDRA INTERSECTION

Movement Summary

Broome Rd/ Tanami Dr

Interim - AM peak

Give-way

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Broome Rd - South										
1	L	166	10.2	0.096	10.3	LOS B	0	0.00	0.71	53.9
2	T	169	10.0	0.093	0.0	LOS A	0	0.00	0.00	70.0
Approach		**337**	**10.1**	**0.096**	**5.1**	**LOS A**		**0.00**	**0.35**	**61.0**
Broome Rd - North										
8	T	254	9.9	0.146	1.5	LOS A	10	0.47	0.00	61.8
9	R	11	10.0	0.147	11.8	LOS B	10	0.47	0.73	51.8
Approach		**263**	**9.9**	**0.146**	**1.9**	**LOS A**	**10**	**0.47**	**0.03**	**61.4**
Tanami Dr										
10	L	11	10.0	0.189	14.0	LOS B	7	0.53	0.68	49.5
12	R	113	9.8	0.190	14.0	LOS B	7	0.53	0.85	49.5
Approach		**122**	**9.8**	**0.189**	**14.0**	**LOS B**	**7**	**0.53**	**0.84**	**49.5**
All Vehicles		**722**	**10.0**	**0.190**	**5.4**	**Not Applicable**	**10**	**0.26**	**0.31**	**58.9**

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* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

Site: Broome Rd/ Tanami Dr - Interim AM
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SIDRA INTERSECTION

Movement Summary

Broome Rd/ Tanami Dr

Interim - PM peak

Give-way

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Broome Rd - South										
1	L	114	9.7	0.065	10.3	LOS B	0	0.00	0.71	53.9
2	T	254	9.9	0.138	0.0	LOS A	0	0.00	0.00	70.0
Approach		**366**	**9.8**	**0.138**	**3.2**	**LOS A**		**0.00**	**0.22**	**64.1**
Broome Rd - North										
8	T	169	10.0	0.101	1.6	LOS A	7	0.47	0.00	61.9
9	R	11	10.0	0.101	11.9	LOS B	7	0.47	0.72	51.8
Approach		**180**	**10.0**	**0.101**	**2.1**	**LOS A**	**7**	**0.47**	**0.04**	**61.2**
Tanami Dr										
10	L	11	10.0	0.263	14.2	LOS B	11	0.55	0.73	49.3
12	R	163	9.8	0.263	14.2	LOS B	11	0.55	0.87	49.3
Approach		**173**	**9.8**	**0.263**	**14.2**	**LOS B**	**11**	**0.55**	**0.86**	**49.3**
All Vehicles		**719**	**9.9**	**0.263**	**5.6**	**Not Applicable**	**11**	**0.25**	**0.33**	**59.2**

Symbols which may appear in this table:

Following Degree of Saturation
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* x = 1.00 due to minimum capacity

Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

Site: Broome Rd/ Tanami Dr - Interim PM
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SIDRA INTERSECTION

Movement Summary

Broome Rd/ Tanami Dr

Ultimate - AM peak

Give-way

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Broome Rd - South										
1	L	144	9.7	0.083	10.3	LOS B	0	0.00	0.71	53.9
2	T	333	9.9	0.091	0.0	LOS A	0	0.00	0.00	70.0
Approach		**476**	**9.9**	**0.091**	**3.1**	**LOS A**		**0.00**	**0.21**	**64.2**
Broome Rd - North										
8	T	312	10.0	0.085	0.0	LOS A	0	0.00	0.00	70.0
9	R	11	10.0	0.015	13.3	LOS B	1	0.48	0.73	50.3
Approach		**321**	**10.0**	**0.085**	**0.4**	**LOS A**	**1**	**0.01**	**0.02**	**69.2**
Tanami Dr										
10	L	11	10.0	0.667	45.8	LOS E	32	0.89	1.15	29.4
12	R	103	9.7	0.660	45.7	LOS E	32	0.89	1.14	29.4
Approach		**113**	**9.7**	**0.659**	**45.7**	**LOS E**	**32**	**0.89**	**1.14**	**29.4**
All Vehicles		**910**	**9.9**	**0.667**	**7.4**	**Not Applicable**	**32**	**0.12**	**0.26**	**57.3**

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Following LOS
- Based on density for continuous movements

Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

Site: Broome Rd/ Tanami Dr - Ultimate AM
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SIDRA INTERSECTION

Movement Summary

Broome Rd/ Tanami Dr

Ultimate - PM peak

Give-way

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Broome Rd - South										
1	L	105	10.4	0.061	10.3	LOS B	0	0.00	0.71	53.9
2	T	312	10.0	0.085	0.0	LOS A	0	0.00	0.00	70.0
Approach		**417**	**10.1**	**0.085**	**2.6**	**LOS A**		**0.00**	**0.18**	**65.1**
Broome Rd - North										
8	T	333	9.9	0.091	0.0	LOS A	0	0.00	0.00	70.0
9	R	11	10.0	0.014	12.8	LOS B	0	0.45	0.71	50.8
Approach		**342**	**9.9**	**0.091**	**0.4**	**LOS A**	**0**	**0.01**	**0.02**	**69.2**
Tanami Dr										
10	L	11	10.0	0.833	64.1	LOS F	58	0.94	1.53	23.8
12	R	138	10.1	0.852	64.0	LOS F	58	0.94	1.37	23.8
Approach		**148**	**10.1**	**0.851**	**64.0**	**LOS F**	**58**	**0.94**	**1.38**	**23.8**
All Vehicles		**907**	**10.0**	**0.852**	**11.8**	**Not Applicable**	**58**	**0.16**	**0.32**	**51.8**

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SIDRA SOLUTIONS

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SIDRA INTERSECTION

Movement Summary

Broome Rd/ Fairway

Ultimate - AM peak

Give-way

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Broome Rd - South										
1	L	18	11.1	0.010	10.3	LOS B	0	0.00	0.71	53.9
2	T	343	9.9	0.094	0.0	LOS A	0	0.00	0.00	70.0
Approach		**361**	**10.0**	**0.094**	**0.5**	**LOS A**		**0.00**	**0.04**	**69.0**
Broome Rd - North										
8	T	322	9.9	0.088	0.0	LOS A	0	0.00	0.00	70.0
9	R	5	16.7	0.009	12.7	LOS B	0	0.43	0.69	51.0
Approach		**328**	**10.1**	**0.088**	**0.2**	**LOS A**	**0**	**0.01**	**0.01**	**69.5**
Fairway										
10	L	11	10.0	0.417	32.6	LOS D	17	0.80	0.90	35.3
12	R	73	9.7	0.419	32.6	LOS D	17	0.80	1.01	35.4
Approach		**82**	**9.8**	**0.418**	**32.6**	**LOS D**	**17**	**0.80**	**1.00**	**35.4**
All Vehicles		**771**	**10.0**	**0.419**	**3.8**	**Not Applicable**	**17**	**0.09**	**0.13**	**62.9**

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Following Queue
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SIDRA INTERSECTION

Movement Summary

Broome Rd/ Fairway

Ultimate - PM peak

Give-way

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Broome Rd - South										
1	L	73	9.7	0.041	10.3	LOS B	0	0.00	0.71	53.9
2	T	322	9.9	0.088	0.0	LOS A	0	0.00	0.00	70.0
Approach		**394**	**9.9**	**0.088**	**1.9**	**LOS A**		**0.00**	**0.13**	**66.4**
Broome Rd - North										
8	T	343	9.9	0.094	0.0	LOS A	0	0.00	0.00	70.0
9	R	11	10.0	0.014	12.6	LOS B	0	0.44	0.70	51.0
Approach		**353**	**9.9**	**0.094**	**0.4**	**LOS A**	**0**	**0.01**	**0.02**	**69.3**
Fairway										
10	L	5	16.7	0.120	26.3	LOS D	4	0.73	0.72	39.1
12	R	18	11.1	0.120	26.2	LOS D	4	0.73	0.92	39.2
Approach		**24**	**12.5**	**0.120**	**26.2**	**LOS D**	**4**	**0.73**	**0.87**	**39.2**
All Vehicles		**771**	**10.0**	**0.120**	**1.9**	**Not Applicable**	**4**	**0.03**	**0.10**	**66.3**

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SIDRA INTERSECTION

Movement Summary

Sandpiper Ave/ Broome Rd

Interim - AM peak

Roundabout

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Broome Rd - South										
1	L	485	3.1	0.422	8.6	LOS A	20	0.99	0.21	49.9
2	T	403	9.9	0.279	7.1	LOS A	21	0.12	0.48	57.3
Approach		**889**	**6.2**	**0.422**	**7.9**	**LOS A**	**21**	**0.59**	**0.33**	**53.0**
Broome Rd - North										
8	T	677	10.0	0.733	15.0	LOS B	84	0.97	1.06	48.6
9	R	13	7.7	0.026	16.6	LOS B	1	0.65	0.73	47.5
Approach		**690**	**10.0**	**0.733**	**15.0**	**LOS B**	**84**	**0.97**	**1.05**	**48.6**
Sandpiper Ave										
10	L	18	5.6	0.027	11.3	LOS B	1	0.57	0.63	52.3
12	R	677	3.0	0.571	16.9	LOS B	47	0.76	0.81	47.2
Approach		**695**	**3.0**	**0.571**	**16.8**	**LOS B**	**47**	**0.75**	**0.81**	**47.3**
All Vehicles		**2274**	**6.4**	**0.733**	**12.8**	**LOS B**	**84**	**0.75**	**0.70**	**49.7**

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SIDRA SOLUTIONS

Site: Sandpiper Ave/ Broome Rd - Interim AM roundabout
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SIDRA INTERSECTION

Movement Summary

Sandpiper Ave/ Broome Rd

Interim - PM peak

Roundabout

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Broome Rd - South										
1	L	677	3.0	0.577	8.9	LOS A	30	1.00	0.24	49.8
2	T	677	10.0	0.464	7.1	LOS A	43	0.18	0.47	56.8
Approach		**1354**	**6.5**	**0.577**	**8.0**	**LOS A**	**43**	**0.59**	**0.36**	**53.1**
Broome Rd - North										
8	T	403	9.9	0.371	8.9	LOS A	24	0.67	0.66	52.7
9	R	18	5.6	0.031	15.4	LOS B	1	0.55	0.71	48.3
Approach		**421**	**9.7**	**0.371**	**9.2**	**LOS A**	**24**	**0.66**	**0.66**	**52.5**
Sandpiper Ave										
10	L	13	7.7	0.023	14.0	LOS B	1	0.71	0.69	49.3
12	R	485	3.1	0.513	19.6	LOS B	42	0.87	0.92	44.8
Approach		**499**	**3.2**	**0.513**	**19.5**	**LOS B**	**42**	**0.87**	**0.92**	**44.9**
All Vehicles		**2274**	**6.4**	**0.577**	**10.8**	**LOS B**	**43**	**0.66**	**0.54**	**50.9**

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SIDRA SOLUTIONS

Site: Sandpiper Ave/ Broome Rd - Interim PM roundabout
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SIDRA INTERSECTION

Movement Summary

Sandpiper Ave / Broome Rd

Ultimate - AM peak

Roundabout

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Broome Rd - South										
1	L	619	3.1	0.375	6.1	LOS A	25	0.11	0.49	50.8
2	T	547	10.0	0.375	5.2	LOS A	25	0.12	0.41	52.1
Approach		**1167**	**6.3**	**0.375**	**5.7**	**LOS A**	**25**	**0.11**	**0.45**	**51.4**
Broome Rd - North										
8	T	980	10.0	0.781	14.6	LOS B	63	0.91	1.12	43.2
9	R	15	6.7	0.789	22.0	LOS C	57	0.90	1.15	38.4
Approach		**995**	**9.9**	**0.781**	**14.7**	**LOS B**	**63**	**0.91**	**1.12**	**43.1**
Sandpiper Ave										
10	L	28	3.4	0.592	10.2	LOS B	42	0.70	0.85	47.0
12	R	1179	3.0	0.593	15.6	LOS B	42	0.71	0.92	42.9
Approach		**1208**	**3.0**	**0.593**	**15.5**	**LOS B**	**42**	**0.71**	**0.92**	**43.0**
All Vehicles		**3370**	**6.2**	**0.789**	**11.9**	**LOS B**	**63**	**0.56**	**0.82**	**45.5**

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Following Queue
- Density for continuous movement

SIDRA SOLUTIONS

Site: Sandpiper Ave/ Broome Rd - Ultimate AM
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SIDRA INTERSECTION

Movement Summary

Sandpiper Ave/ Broome Rd

Ultimate - PM peak

Roundabout

Vehicle Movements

Mov ID	Turn	Dem Flow (veh/h)	%HV	Deg of Satn (v/c)	Aver Delay (sec)	Level of Service	95% Back of Queue (m)	Prop. Queued	Eff. Stop Rate	Aver Speed (km/h)
Broome Rd - South										
1	L	1179	3.0	0.702	6.3	LOS A	72	0.24	0.47	49.9
2	T	980	10.0	0.702	5.4	LOS A	72	0.28	0.41	50.8
Approach		**2159**	**6.2**	**0.702**	**5.9**	**LOS A**	**76**	**0.26**	**0.44**	**50.3**
Broome Rd - North										
8	T	547	10.0	0.333	7.2	LOS A	17	0.64	0.62	48.3
9	R	28	3.4	0.333	13.6	LOS B	16	0.64	0.85	44.0
Approach		**577**	**9.7**	**0.333**	**7.5**	**LOS A**	**17**	**0.64**	**0.63**	**48.1**
Sandpiper Ave										
10	L	15	6.7	0.469	14.4	LOS B	33	0.87	1.00	43.0
12	R	619	3.1	0.470	20.3	LOS C	33	0.87	1.02	39.5
Approach		**634**	**3.2**	**0.470**	**20.1**	**LOS C**	**33**	**0.87**	**1.02**	**39.6**
All Vehicles		**3370**	**6.2**	**0.702**	**8.8**	**LOS A**	**72**	**0.44**	**0.58**	**47.4**

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SIDRA SOLUTIONS

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