Fitzroy Urban Background Report

December 2015

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Queensland, Australia

FITZROY BASIN ASSOCIATION

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1. Introduction

1.1. The FBA Project

The Fitzroy Basin Association (FBA) is implementing the "***Fitzroy Basin and Coastal Catchments WQIP review and update***" project. Amongst other things the WQIP will include new science and current best management practice incorporating coastal management planning, water sensitive urban design and management strategies to address concerns associated with port expansion in the region.

Water Quality Improvement Plans (WQIP) aim to reduce pollution being released into aquatic ecosystems with high ecological, social and/or recreational values. Part of the project involves a review of the FBA 2008 Water Quality Improvement Report to produce a WQIP covering six coastal basins flowing directly to the Great Barrier Reef (GBR). The review and preparation of the WQIP is an adjunct to, and will integrate with, the Regional Natural Resources Management Plan (Central Queensland Strategy for Sustainability).

This report is a collection of background material used to inform the Fitzroy Region Urban Scoping Report (Gunn 2015) for the FBA's WQIP review and update project.

1.2. Historic Context

The history of settlement in the Central Queensland region (Rockhampton and Gladstone) is a function of the prevailing technology and socio-economic drivers at the time. The main driver during the 1800's was the need to establish infrastructure to support the agricultural and mining industries. This was based on port facilities in the first instance as there was no real road or rail structure and coastal shipping therefore was the main form of transport for people and goods. This was particularly so for the opening up of Central and North Queensland.

The settlement of Rockhampton was preceded by an attempt to establish a settlement at Port Curtis (1846/47) which William Ewart Gladstone (English Chancellor of the Exchequer) intended to become the administrative centre of a separate North Queensland colony. A change of government in Great Britain put an end to that idea and after less than six months the settlement was 'disbanded' in 1847.

Pastoral runs had been established in the Port Curtis catchments (Calliope River, Boyne River and Baffle Creek) and there was pressure on the colonial government (New South Wales) from settlers to establish port facilities to service the expanding agricultural industry. Gladstone town was named and surveyed in 1853 at roughly the same time that the Archer brothers were exploring the district in the vicinity of the mighty river they named the Fitzroy.

The Archers returned in 1855 to establish their sheep station at Gracemere and in November that year they despatched their first clip of wool by a sailing vessel (the Elida) "*to the rising town of Gladstone for transhipment to Sydney*" (Bird 1904, p.5). Soon after arrangements were made for the conveyance of the balance of the wool to Sydney using a temporary wharf that erected on the banks of the Fitzroy River where the town of Rockhampton was subsequently established. The wool was loaded onto the steamer Albion, which operated out of Gladstone.

This was the early genesis of the relationship between Rockhampton and Gladstone and saw the commencement of what was to become a commercial rivalry based on the dominance of port facilities and the competition for port based trade.

The rise of Gladstone as Central Queensland's premier port commenced after the downturn in trade caused firstly by the economic depression of 1930s and then the Second World War (WWII). Gladstone Harbour emerged from the WWII on a strong financial footing partly due to the revenue derived from the use of the harbour by the United States and Australian military forces during the war.

Land reclamation, which began in the late 1920s continued after WWII and more industrial land was 'created' with water frontage close to port facilities. Industrial development during the 1960s spurred Gladstone's growth and after the most suitable sites had been built out by the 1980s the growing need for industrial and port land was met in part by the reclamation by landfill of the tidal flat foreshore to the west of the main Gladstone harbour area. In 1990 there were 18 kilometres of foreshore and waterway shoreline reserved for port activities including facilities for bulk coal, grain, clinker, bauxite, petroleum and chemicals.

A history of the development of Rockhampton and Gladstone and the interrelationship between the two cities is included in Appendix A.

2. Local Government Evolution

2.1. Urban Governance

Local authorities were first established in Queensland under the *Municipalities Act 1858* (New South Wales legislation) prior to Queensland enacting its own legislation after it became a separate colony in 1859. Under the Act municipal districts (minimum population of 500 and a maximum area of 129.5 km^2) and boroughs (minimum population of 1,000 and a maximum area of 23.3 km^2) could be created upon petition by residents to the Governor. Once a municipality had been proclaimed by the Governor ratepayers could elect a council to represent them. 10 municipalities were created under this legislation including Rockhampton and Gladstone.

The *Municipal Institutions Act 1864* (Qld) replaced the *Municipalities Act 1858* (NSW) and was the first significant piece of Queensland local government specific legislation and provided local authorities with the power to manage their appointed areas. The Act allowed municipalities to charge rates, borrow money, enact by-laws, control or regulate public infrastructure and utilities, and provide public amenities such as gardens and hospitals. Under this legislation nine new municipalities were created and one was abolished. Elections were held annually with one third of Councillors required to retire at each election.

The *Local Government Act 1878* followed on from the *Municipal Institutions Act 1864* and made provision for the creation of additional municipality types to be known as Cities or Shires. In most other respects, the Act followed on from the 1864 Act. The function of municipal councils under the Act was to maintain "*the good rule and government of the municipality*" and to provide public services and amenities such as water and sanitation services, public health, fire prevention, the regulation of building construction and the regulation and issuing of a range of licences for uses of land. Transport infrastructure within municipalities was also the responsibility of the local authority

including roads, bridges, wharves and street lighting. The Act proved unsuitable in the Queensland context as it was modelled on the Victorian *Local Government Act 1874* and did not take into account the large and sparsely populated areas that formed the colony.

The Government's response was the *Divisional Boards Act 1879* which extended the authority of local government to areas of Queensland which could not be included in municipalities due to the size and population restrictions of the previous Acts. The Act divided all lands in Queensland not already included in municipalities into 74 divisions. This enabled Divisional Boards (local authorities/Councils) to manage these larger areas including the provision of public services and amenities for small towns and the construction and maintenance of rural roads.

The next major piece of legislation was the *Local Authorities Act 1902* which extended Councils' authority over the areas they controlled. Local authority name changes occurred from Municipality to City or Town, Division to Shire and Borough to Town or Shire. Under this Act the frequency of elections was changed from annual to every three years in 1921.

Local authorities became known as local government with the introduction of the *Local Government Act 1936*. This Act remained in place until 1993 when updated legislation was introduced (*Local Government Act 1993*) to provide greater financial accountability and meet the needs for installation and management of infrastructure for Queensland's expansion.

2.1.1. Rockhampton and Livingstone

The Borough of Rockhampton, located on the south bank of the Fitzroy River with an area of 13 km^2, was proclaimed as Queensland's fourth municipality on 13 December 1860. Rockhampton attempted to expand its area southwards to include Gracemere and Bouldercombe in the 1870s however this move was thwarted by opposition from influential squatters in the area.

The Gogango Division surrounded the Rockhampton municipality with an area of 16,239 km^2 when Divisions were created in 1879. The Borough of North Rockhampton was proclaimed in September 1883, a year after a bridge was built across the Fitzroy River. The Fitzroy Division was separated from the Gogango Division in 1899 and later became Fitzroy Shire (1903). The remainder of the Gogango Division would later be renamed Livingston Shire.

Rockhampton became a City, along with Brisbane and Townsville, in 1903 following the passing of the *Local Authorities Act 1902*. North Rockhampton became the Town of North Rockhampton. North Rockhampton struggled along for another 16 years before being amalgamated with the wealthier and more influential Rockhampton City after State Government intervention following separate water infrastructure projects being proposed by each local authority. An amalgamation referendum held in North Rockhampton was passed in January 1919 by 85% of voters.

Rockhampton City grew northwards by annexing Parkhurst from the Shire of Livingstone in 1984 including to encompass the area where its water treatment facility was being constructed. A further attempt to expand the City area into the Fitzroy Shire was defeated at a referendum in 1991.

2.1.2. Gladstone

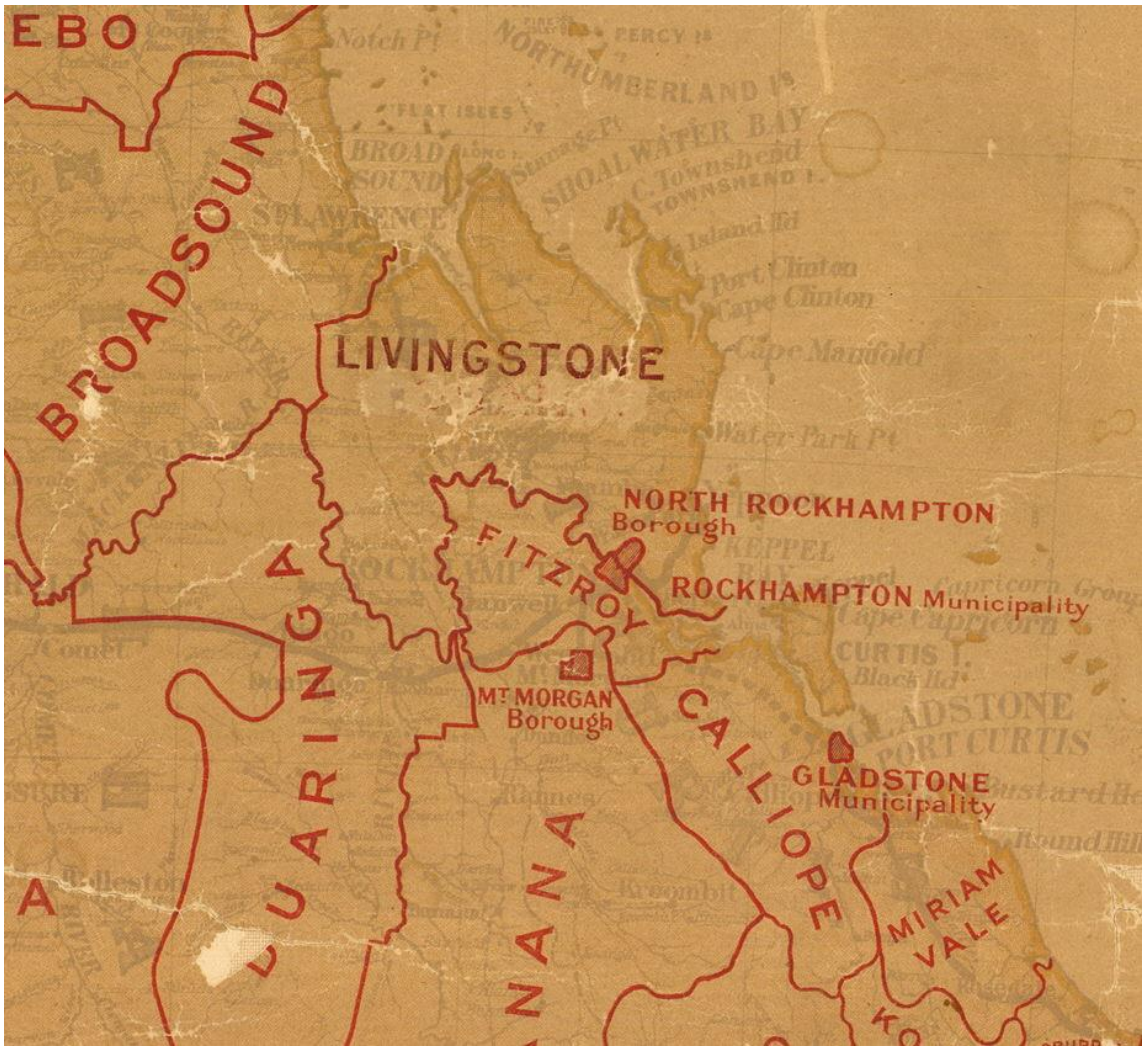
The town of Gladstone was named and surveyed in 1853 however it was not until 1863 that it was proclaimed a municipality with an area of 22 km^2. At the time Gladstone had 10 miles of streets and 350 dwellings. In 1903 Gladstone Municipality became the Town of Gladstone and then in 1976

Gladstone was proclaimed a City. A summary of the rise of local government in the Fitzroy region coastal areas and the introduction of key local government legislation is provided in Table 2-1.

Table 2-1: Queensland Legislation and Local Government Evolution

Year	Event
1853	Gladstone named and the town area is surveyed
1858	*Municipalities Act 1858* (New South Wales) applies
1859	Queensland becomes a separate colony after annexation from New South Wales
1860	Borough of Rockhampton proclaimed as Qld's fourth municipality
1863	Gladstone Municipality proclaimed
1864	*Municipal Institutions Act 1864* (Qld) replaces the *Municipalities Act 1858* (NSW). Council elections are held annually and voting rights are limited to municipal ratepayers. Council members elect the mayor / chairman from among themselves
1878	*Local Government Act 1878* introduced based on the Victorian *Local Government Act 1874*
1879	*Divisional Boards Act 1879* introduced to overcome the limitations of the 1878 act
1879	Divisions established around Rockhampton (Gogango) and Gladstone (Calliope)
1882	Parts of Gogango Division transferred to Broadsound and Duaringa Divisions
1883	Borough of North Rockhampton proclaimed (separated from Gogango Division)
1890	Borough of Mount Morgan established (separated from Banana Division)
1899	Fitzroy Division annexed from Gogango Division
1902	Separate Miriam Vale Division created from part of the Calliope Division
1902	*Local Authorities Act 1902* introduced
1903	Rockhampton becomes a City, North Rockhampton Borough, Mt Morgan Borough and Gladstone Municipality become Towns. Divisions are renamed Shires including Fitzroy, Gogango, Miriam Vale and Calliope
1903	Shire of Gogango is renamed Shire of Livingstone
1909	Area surrounding the Town of Mt Morgan was incorporated as Shire of Calliungal
1919	Town of North Rockhampton amalgamated with Rockhampton City
1920	The *Local Authorities Act Amendment Bill* was extending voting rights to residents
1921	Local councils to be elected every three years instead of annually. Mayors and shire chairmen to be elected directly by the electorate and minimum standards of competency required for town and shire clerks
1931	Calliungal Shire and Mt Morgan Town merged to form the Shire of Mount Morgan
1936	*Local Government Act 1936* introduced. Categories of local government areas are naming convention with no practical meaning under the Act although a City had to be proclaimed by the Governor following certain criteria being met
1984	Parkhurst included in Rockhampton City LGA
1993	*Local Government Act 1993* replaces the 1936 version
2007	*Local Government (Reform Implementation) Act 2007*
2008	Amalgamation of local government areas including the formation of Rockhampton Regional Council and Gladstone Regional Council
2009	*Local Government Act 2009* replaces the 1993 act
2013	*Local Government (De-amalgamation Implementation) Regulation 2013* enacted
2014	Livingston Shire recreated (1 January) after de-amalgamation from Rockhampton Regional
2015	Boundary realignment muted for Livingstone/Rockhampton LGAs. Still undecided

Figure 2-1: Fitzroy Coastal Municipalities and Divisions circa 1902



2.2. Local Government Reform

State government concern about the sustainability of Queensland local governments caused the Local Government Association of Queensland (LGAQ) to propose a reform process for local government with 118 of 156 councils agreeing to investigate their long-term future through the Size, Shape and Sustainability (SSS) program. The Minister for Local Government wrote to all Mayors in March 2007 requesting a time frame for progressing the SSS reform agenda. The responses showed that significant reform was not going to be achieved through the SSS program before the next local government elections due in March 2008.

A financial sustainability review for 105 councils by the Queensland Treasury Corporation assessed 40% of the councils as being financially weak, very weak or distressed. Other independent studies also found similar financial problems with the local government sector. This was in part due to the number of councils with small populations in rural areas dating from earlier times when industry and population had justified their creation and viability.

The Local Government Reform Commission was established on 1 May 2007 to review local government operations and recommend the most appropriate future structure and boundaries for local government in Queensland. The Commission reported back on 27 July 2007, recommending massive amalgamations all over the State into 'regions' administered by regional councils based in major towns and/or regional centres.

On 10 August 2007, the Commission's amalgamation recommendations passed into law as the *Local Government (Reform Implementation) Act 2007*. Local Transition Committees (LTCs) were created for each new local government area (LGA) made up of Councillors and staff from the original LGAs. On 15 March 2008 the old local government entities formally ceased to exist with elections held to fill the new councils.

3. Local Government Area and Structure

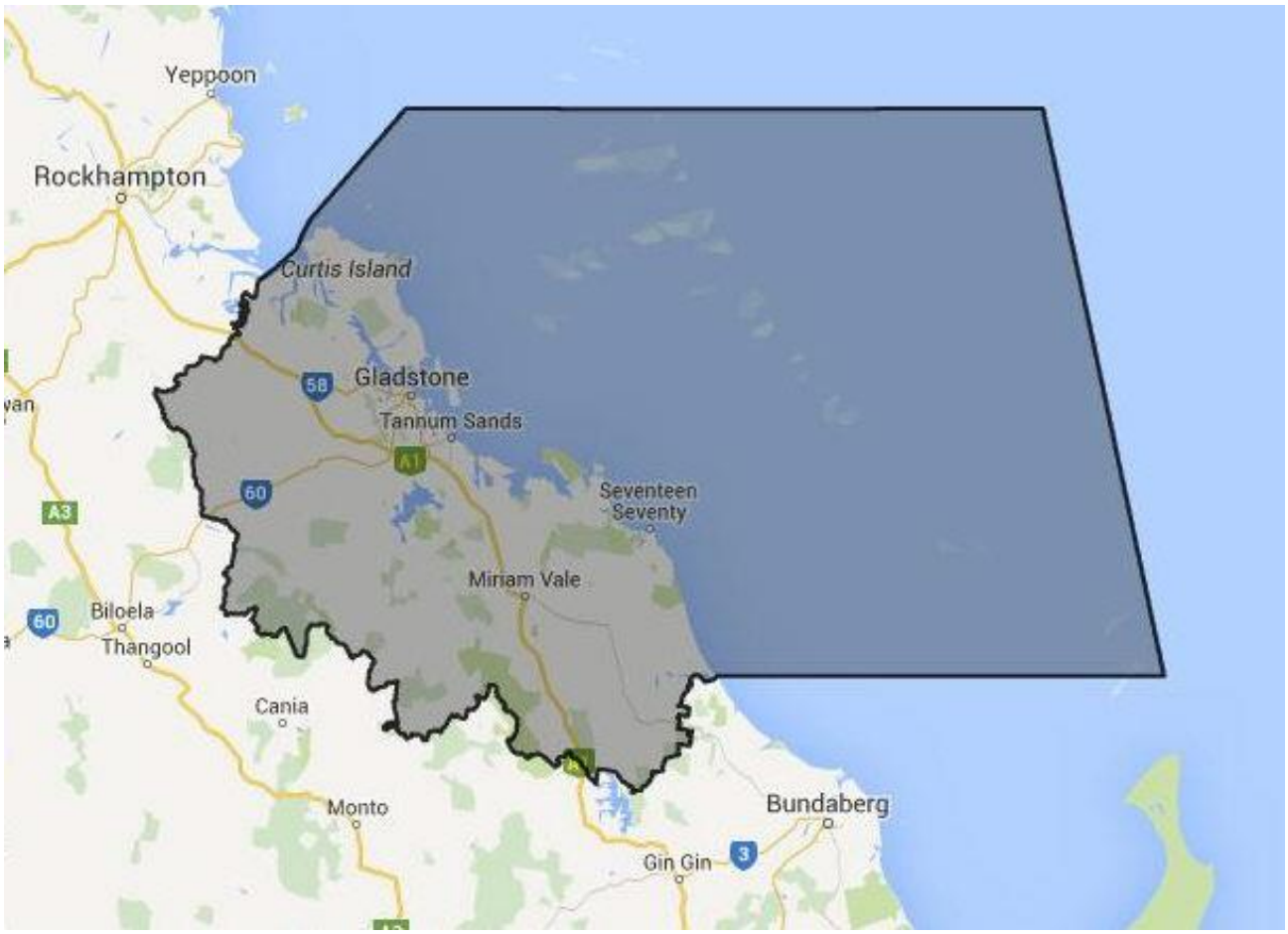
3.1. Gladstone Regional Council

The *Local Government (Reform Implementation) Act 2007* saw the amalgamation of Gladstone City (198km^2) with Calliope Shire (5,875km^2) and Miriam Vale Shire (3,800km^2) to form Gladstone Regional Council.

3.1.1. Local government area

The current Gladstone Regional Council local government area (LGA) is approximately 10,400 square kilometres in size. Most of the GRC LGA consists of rural land north, west and south of Gladstone City. The Gladstone Regional Council LGA is shown in Figure 3-1.

Figure 3-1: GRC Local Government Area



3.1.2. Elected representatives

Gladstone Regional Council comprises of a Mayor and eight Councillors. The Mayor and Councillors are elected on an undivided basis which means there are no electoral divisions in Gladstone Regional Council LGA. Information about the current (2015) elected representatives of Gladstone Regional Council can be found at http://www.gladstone.qld.gov.au/contact-a-councillor.

3.1.3. Council organisational structure

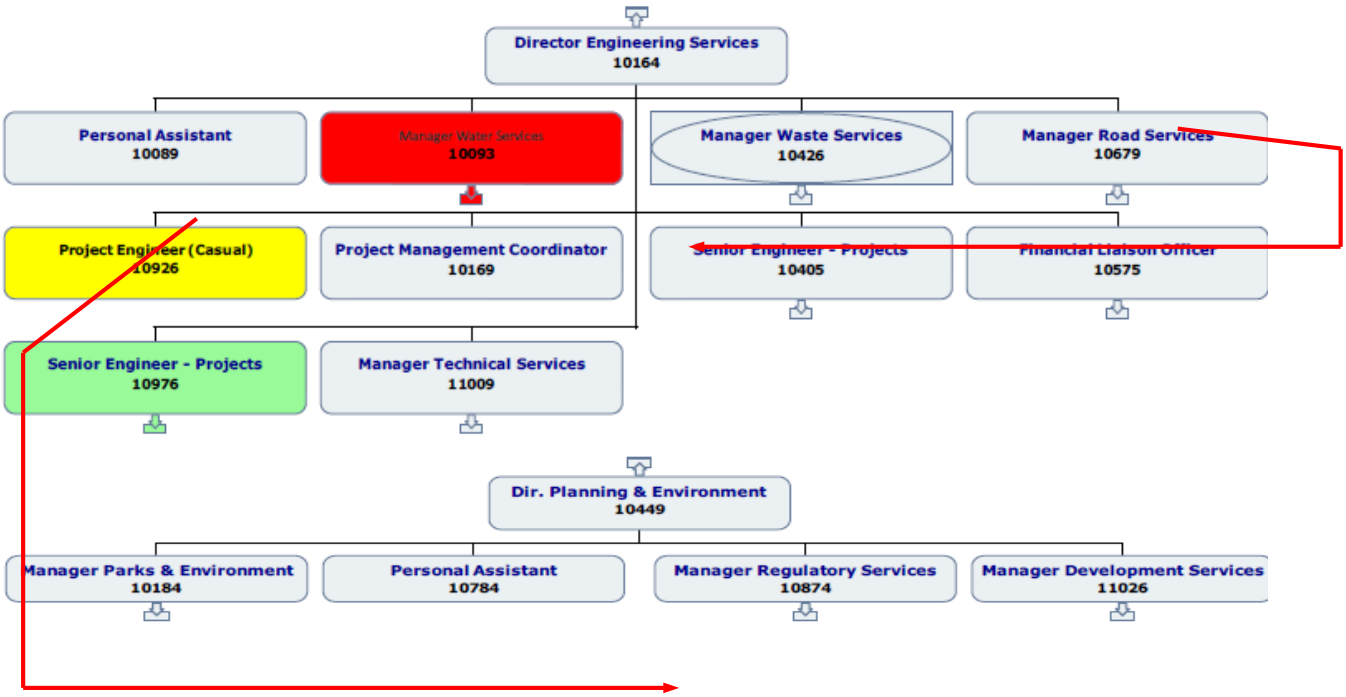
The organisational structure of Gladstone Regional Council (GRC) is evident in the Organisational Chart on the GRC website at http://www.gladstone.qld.gov.au/ (follow the links from Your Council).

There are three main departments in GRC being; Corporate and Community Services, Engineering Services, and Planning and Environment.

In addition to the main departments the Chief Executive Officer is supported by administrative and financial staff. Key pages from the Organisational Chart are shown in Figure 3-2.

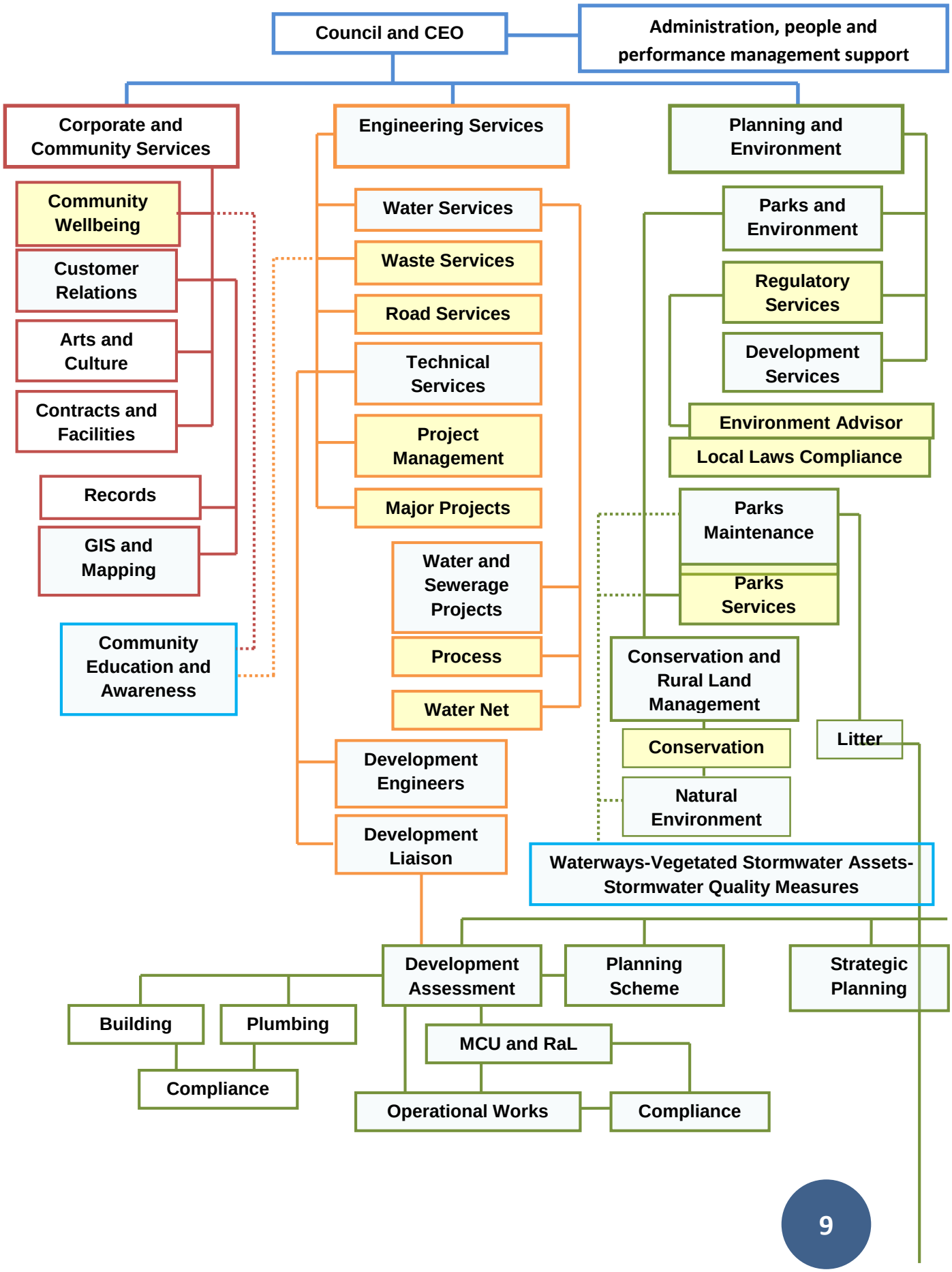
The main elements within the GRC organisational structure relevant to water quality management and improvement are illustrated in Figure 3-3.

Figure 3-2: Organisational Chart Extracts



Note: Organisational Chart available at: http://www.gladstone.qld.gov.au/documents/1570002/2220234/Web%20Site%20Reports%20To%20Org%20Chart.pdf.pdf

Figure 3-3: GRC Organisational Structure Relevance



Notes: GRC has three main departments; Corporate and Community Services, Engineering Services and Planning and Environment. Engineering Services and Planning and Environment are the most relevant to water quality management however there are integrated roles across the organisation. The most relevant components of the GRC organisation structure that do or could contribute to water quality improvement are highlighted in blue. Yellow highlight indicates relevance albeit less direct than the blue components. (Note that the diagram has not been reviewed/confirmed by GRC)

3.2. Rockhampton Regional Council

The City of Rockhampton and the Shires of Livingstone, Fitzroy and Mount Morgan were amalgamated to form the initial Rockhampton Regional Council at the March 2008 election. The area of the newly amalgamated regional Council (see Figure 3-4) was 18,300km^2 with an estimated population of 109,336 at the 2011 Census, according to the Australian Bureau of Statistics (ABS).

Figure 3-4: Rockhampton Regional Council LGA 2008

Note: The red line indicates the boundary of the amalgamated LGA (marine extent not included).

The expanded LGA was relatively short-lived with former Livingstone Shire residents electing to de-amalgamate at a poll held on 9 March 2013. Livingstone Shire Council (LSC) subsequently separated from Rockhampton Regional Council and reformed on 1 January 2014.

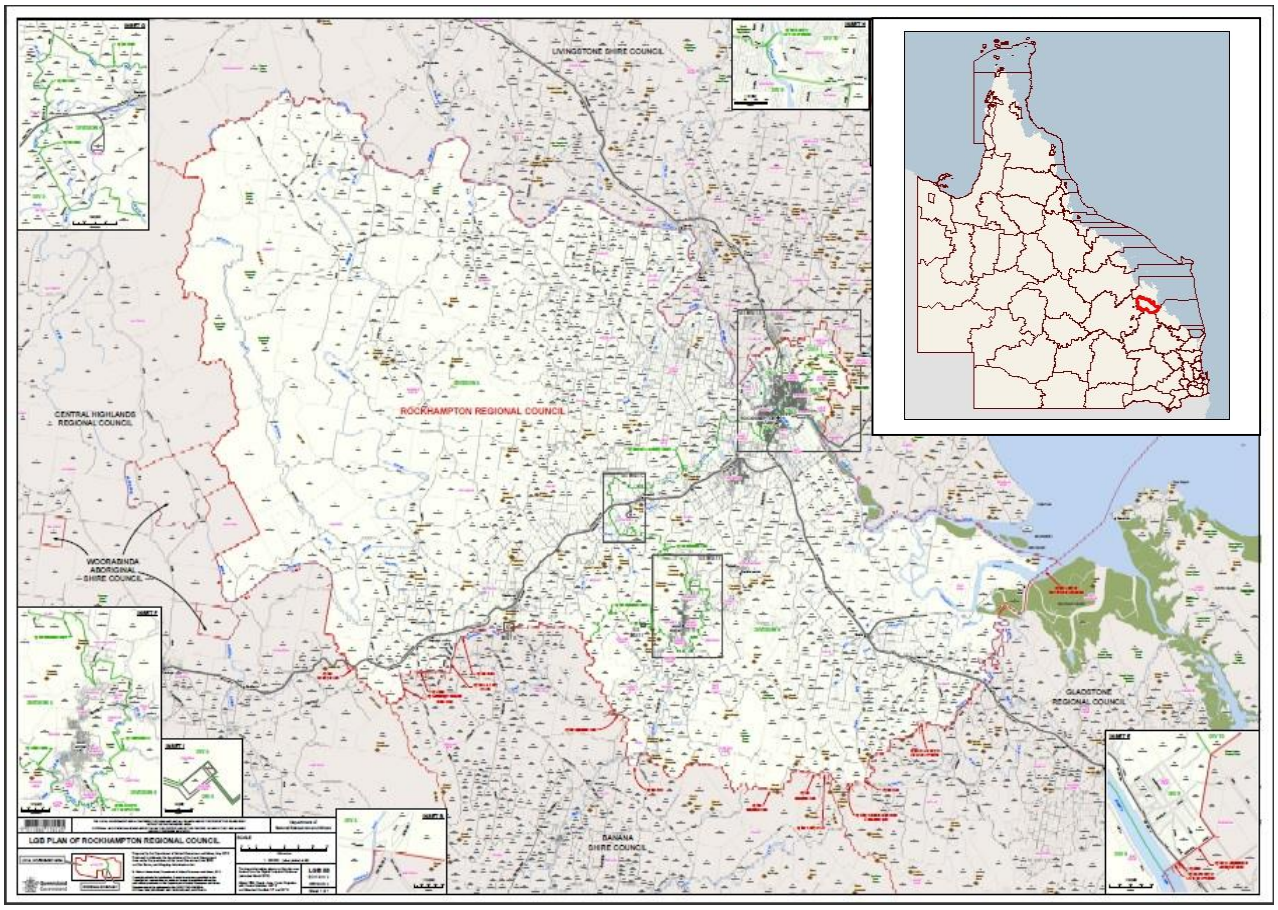
The number of former LSC residents voting in favour of a de-amalgamation was 10,862 with 8,331 opposed. 75% of voters in Nerimbera, Rockyview, Glenlee, and Glendale localities were in favour of remaining with Rockhampton Regional Council. This inspired the former Mayor of LSC (Bill Ludwig) to call for a realignment of the local government boundaries to include the localities adjoining the northern urban expansion areas of Rockhampton within the Rockhampton Regional Council LGA. A voluntary ballot was held in November 2014 in the Livingstone suburbs where 2013 voters wanted to stay with Rockhampton Regional Council. 2014 ballot results in favour of being part of the Rockhampton LGA were Glenlee (71.5%), Rockyview (75%) and Glendale (61.9%) while Nerimbera residents voted narrowly to stay in Livingstone Shire (52.6%).

The location and terms of a boundary realignment have yet to be agreed by both Councils and any such realignment may not occur until the 2020 election as the next local government election is March 2016.

3.2.1. Current Rockhampton Regional Council

The current Rockhampton Regional Council local government area (LGA) is approximately 6,600 square kilometres in size. Most of the LGA consists of rural land to the west and south of Rockhampton. Rural land is used mainly for cattle grazing with smaller areas devoted to pineapple growing, fruit growing, forestry and mining. Power generation and tourism are also considered to be important industries. The current extent of the Rockhampton Regional Council LGA is shown in Figure 3-5.

Figure 3-5: Rockhampton Regional Council Local Government Area



Note: Source is Department of Natural Resources and Mines (2013), LGB Plan of Rockhampton Regional Council (LGB 58 Edition 2 Version 2).

3.2.2. RRC LGA boundary

The boundary of Rockhampton Regional Council (RRC) LGA is a combination of waterway centre lines, ridgelines and cadastral boundaries (related and unrelated) with the occasional unnamed road and 'random' joining line. A description of the boundary location is provided in the text box below. RRC has common boundaries with Livingstone Shire Council (see section 3.3), Woorabinda Aboriginal Shire Council, Banana Shire Council and Gladstone Regional Council.

Rockhampton Regional Council (RRC) local government area (LGA) boundary description

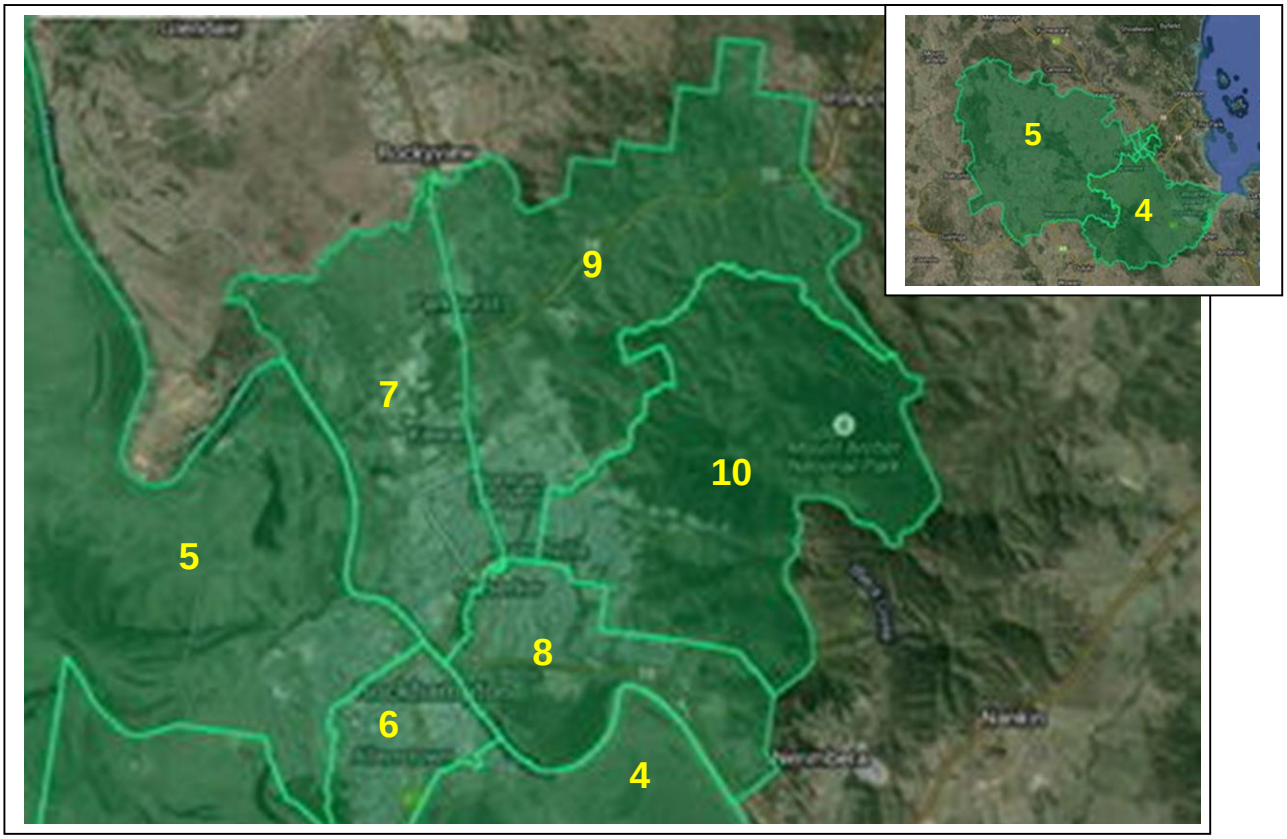
The eastern most point of the RRC LGA is also a common point with Livingstone Shire Council (LSC) and Gladstone Regional Council (GRC). The RRC boundary is then by the Fitzroy River (upstream), which is also the adjoining boundary with the LSC LGA. The boundary follows the centreline of the river to Nerimbera where it turns north overland (initially along Hartington Street) and then follows a ridgeline of the Berserker Range (and part of the boundary of Lot 126 on NPW651 – Mount Archer National Park) passing through Mount Berserker, Mount Birkbeck,

Mount Risien and Mount Nicholson before descending and joining Limestone Creek. The boundary then follows Limestone Creek to form the north eastern boundary (Livingstone Shire Council western boundary) to a point just north of Yeppoon Road. The boundary then changes to become a series of north/south and east/west straight lines and steps following cadastral boundaries (incorporating the locality of Limestone Creek with a NW corner being Lot 7 on RP615656) to a point near the Bruce Highway (Yaamba Road adjoins Lot 500 on SP258697 to the east) where it meets and Ramsay Creek (Rockview is north east and Glenlee is north west in LSC). The boundary then follows Ramsay Creek downstream to its confluence with the Fitzroy River (near the eastern point of Lot 2 on RP601957) and then follows the Fitzroy River upstream to Marlborough Creek and then along Marlborough Creek and subsequently Develin Creek to a point at the west corner of Lot 5 on LI16 and Lot 20 on LI312. A little further south where the LGA boundary forms a point the adjoining LGA changes from Livingstone Shire to Central Highlands Regional. The LGA boundary then follows cadastral boundaries near or at the top of the catchment including; Lot 20 on LI312, Lot 16 on NPW598 (Goodedulla National Park), Lot 7 on SP118531 (adjoins Woorabinda Aboriginal Shire Council land at this lot), Lot 5 on RP619714, Lot1 on SP132038 and Lot 3 on LR37 before joining the Mackenzie River near the south west 'corner' of the LGA. The boundary follows the Mackenzie River to the confluence with the Dawson River, which then becomes the Fitzroy River. The boundary follows the Fitzroy downstream for a distance of approximately 17 kilometres before again following cadastral boundaries (commencing at Lot 25 on PN118) including along a ragged boundary (a ridgeline) including Lot 10 on SP167118, Lot 95 on SP209758, Lot 2 on RP855501, Lot 2 on PN835005 and Lot 2 on RP617267 (adjoining LGA changes to Banana Shire at this lot). The cadastral boundaries then straighten out (including by Grantleigh Pheasant Creek Road) and trend north, east and north again eventually meeting Sebastopol Creek at Lot 3 on RP603999. The boundary follows Sebastopol Creek for approximately 8 kilometres then turns east (corner of Evergreen Road and Lot 382 on PAK406), crosses the Capricorn Highway at Westwood and follows cadastral boundaries and/or ridgelines and trending south (commencing at the SW corner of Lot 120 on LN422 and including Lot 45 and Lot 46 on RN245 and an unnamed road) before crossing the Dawson Highway and joining the Dee River at Wura (Lot 13 on RN281). The boundary follows the Dee River for approximately 7 kilometres and then across country along cadastral boundaries and/or ridgelines including Lot 27 on RN283, Lots 3 to 5 on RN47, Lot 148 on DS151 (adjoining LGA changes to Gladstone Regional at this lot) and unnamed roads while also passing through Piebald Mountain, Sentry Mountain, Mount Hope, Mount Gelobera and Mount Kelly before descending to join Horrigan Creek in the vicinity of Lot 59 on SP198262. The boundary follows Horrigan Creek (trending east and then north) to the confluence with Raglan Creek and then along Raglan Creek to its mouth and the confluence with Casuarina Creek at Port Alma. The LGA boundary is then the same as the eastern boundary of the Parish of Casuarina before it meets the Fitzroy River mouth at the eastern and starting point of the RRC LGA.

3.2.3. RRC Electoral Divisions

When RRC was formed in 2008 the LGA consisted of 10 divisions with each division having one elected Councillor. The Mayor was elected by all voters within the Region. Livingston Shire de-amalgamated between electoral cycles in 2014 (2012 and 2016) and as a result divisions 1, 2 and 3 of RRC were transferred to Livingstone Shire Council and became the reformed Livingstone LGA. RRC now consists of seven divisions as illustrated in Figure 3-6.

Figure 3-6: Local Electoral Divisions



Notes: Available online at http://www.ecq.qld.gov.au/electoraldistricts/localgovernmentareas/local-government-electoral-maps-new#interactiveMapIFrame. Inset shows the whole RRC LGA at a larger scale.

3.2.4. Elected representatives

Councillors elected in 2012 for each division are shown in Table 3-1. Additional information about Councillors roles and responsibilities for various action portfolios and representation on committees etc. is available at http://www.rockhamptonregion.qld.gov.au/About_Council/.

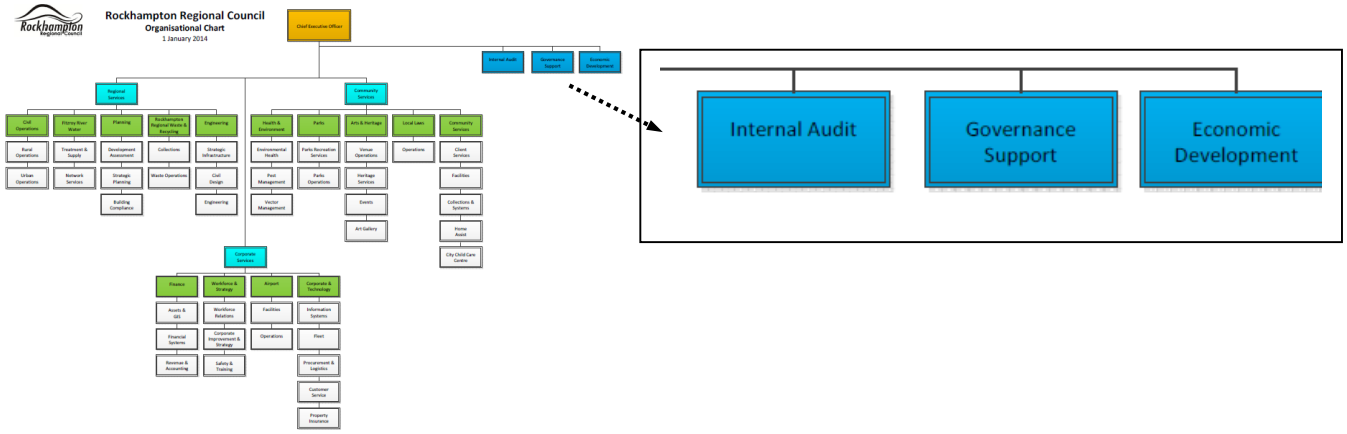
Table 3-1: Mayor and Councillors by Division

Mayor Margaret Strelow	Division 7 Cr Stephen Schwarten
Division 4 Cr Ellen Smith	Division 8 Cr Tony Williams (Deputy Mayor)
Division 5 Cr Cherie Rutherford	Division 9 Cr Rose Swadling
Division 6 Cr Greg Belz	Division 10 Cr Neil Fisher

3.2.5. Organisational Structure

The organisational structure of Rockhampton Regional Council consists of three main 'departments' (Regional Services, Community Services and Corporate Services) with an additional branch supporting the Chief Executive Officer (CEO). The overall organisational structure is shown in Figure 3-7 along with an expanded view of the CEO's support 'arm'.

Figure 3-7: Overall Structure



Notes: Source is Rockhampton Regional Council Organisational Chart (1 January 2014) available at http://www.rockhamptonregion.qld.gov.au/About_Council/Council_Management. CEO is the orange box at the top of the structure. The light blue boxes are the three departments i.e. Regional Services (see Figure 3-8), Community Services (see Figure 3-9) and Corporate Services (see Figure 3-10).

In terms of total water cycle and water quality management Regional Services is the most relevant with all of the sub-departments (green boxes) having some relevance. Civil Operations, Engineering and Planning are the most relevant sub departments for diffuse source pollutants with Fitzroy River Water and Rockhampton Regional Waste and Recycling being relevant for point sources and environmentally relevant activities.

The Community Services department (see Figure 3-9) is also relevant to stormwater management as the Parks sub department is responsible for maintaining park land including vegetated elements of the stormwater management system and other open space areas. In addition Corporate Services is

responsible for Safety and Training and Assets and GIS, which services are relevant including for capacity building (training), catchment profiling, decision support and monitoring and assessment.

Figure *3-8: Regional Services*

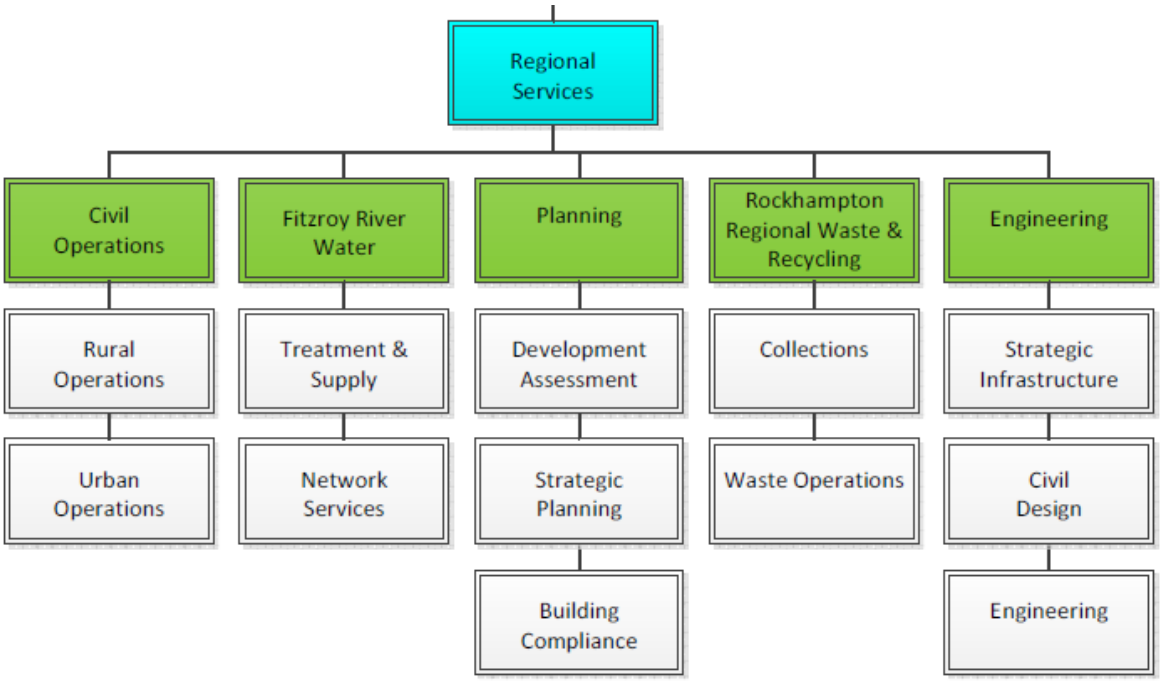


Figure *3-9: Community Services*

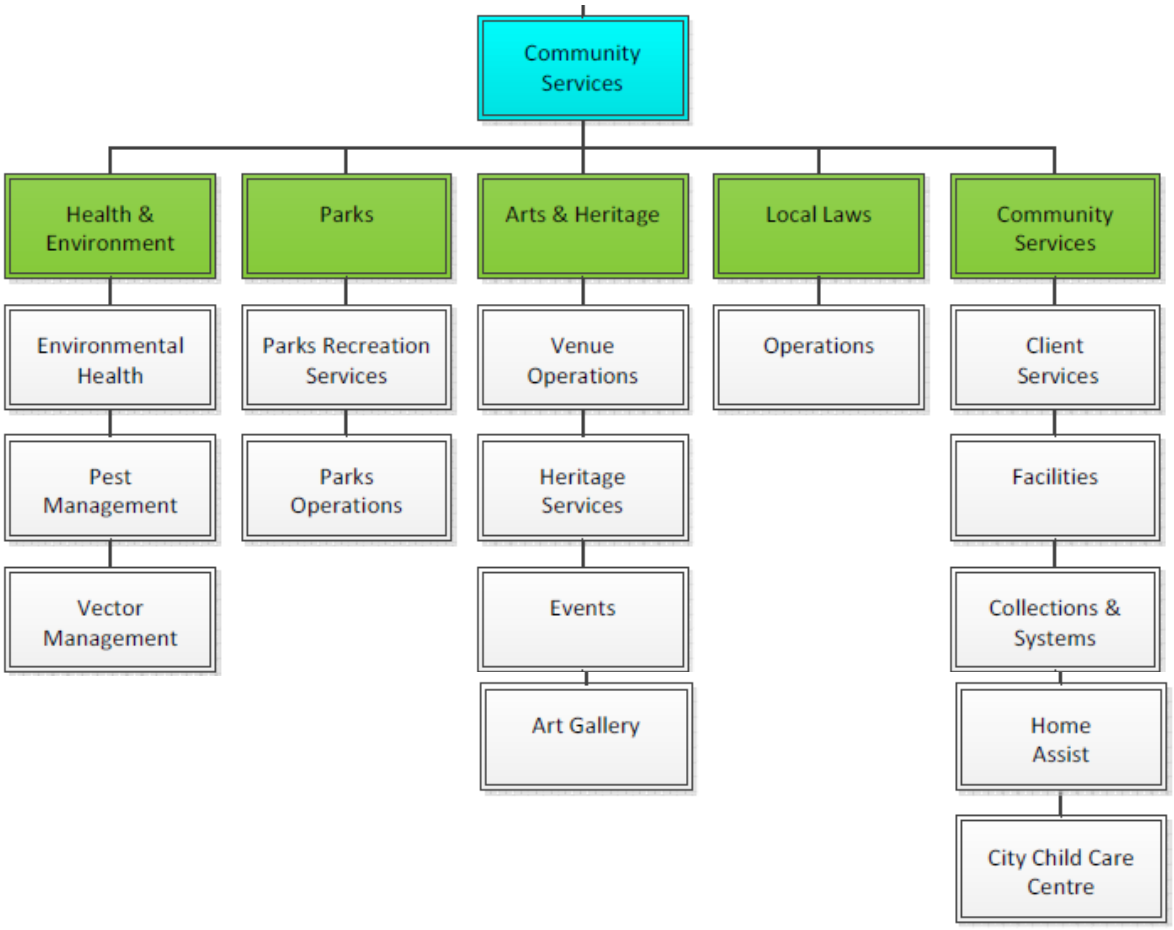
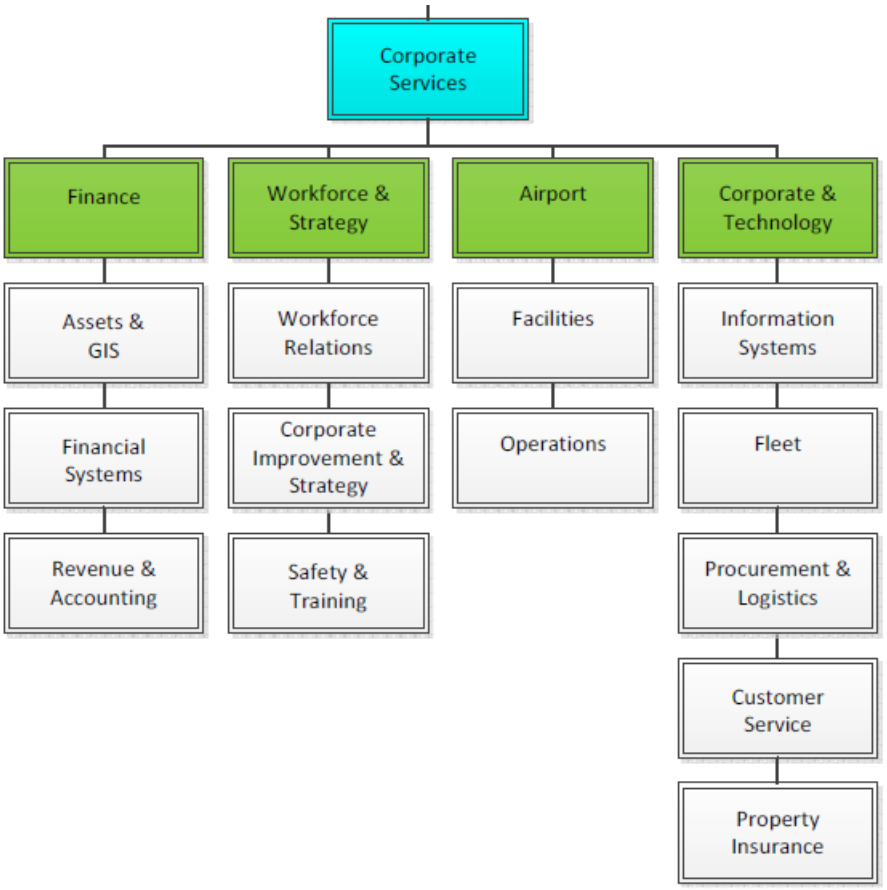


Figure *3-10: Corporate Services*



3.3. Livingstone Shire Council

As mentioned Livingstone Shire Council was reformed in January 2014 after the de-amalgamation from Rockhampton Regional Council LGA. The Livingstone Shire LGA is shown in Figure 3-11.

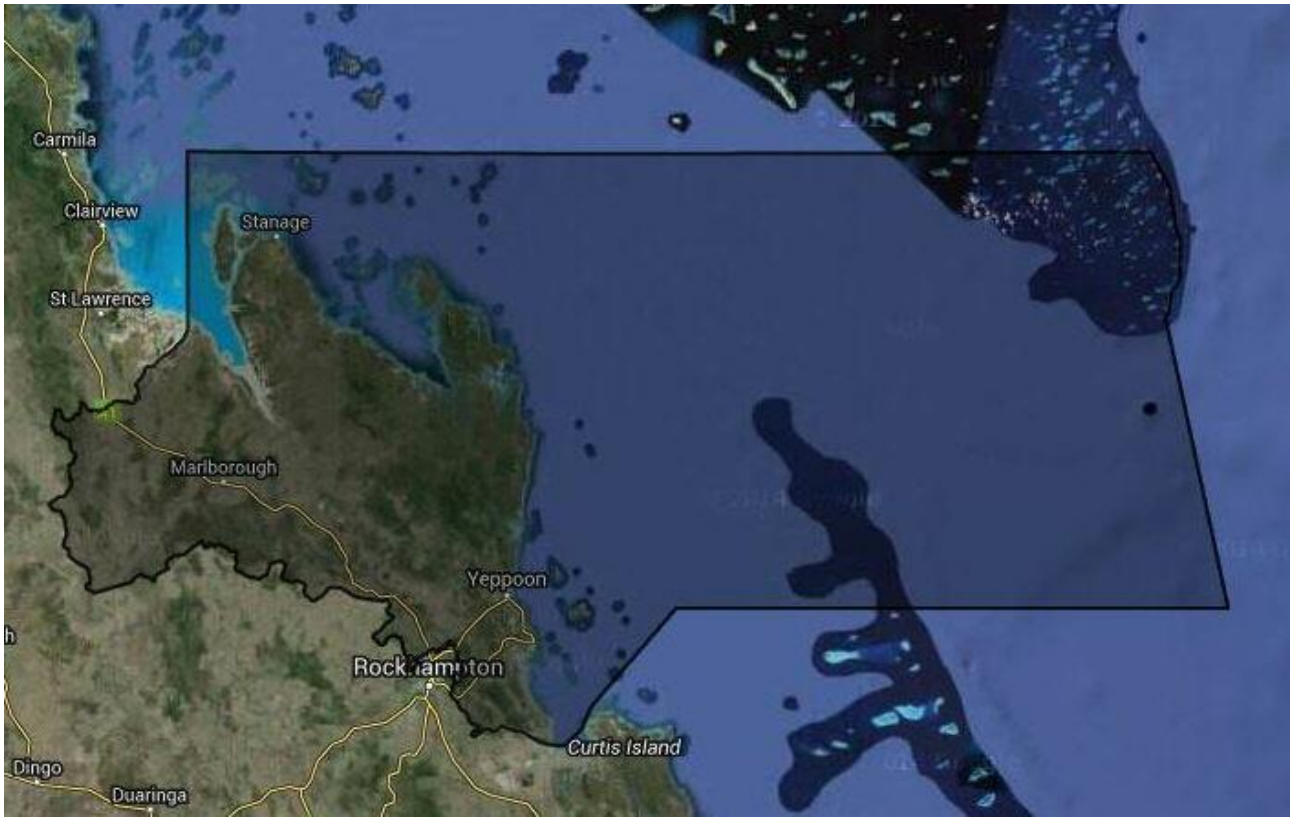
3.3.1. LGA boundary

A description of the Livingstone Shire LGA boundary is provided in the text box below. As with the RRC LGA the LSC LGA is often defined by waterways and catchment boundaries.

Commencing at the mouth of the Fitzroy River the boundary follows the Fitzroy upstream to Nerimbera sharing the boundary with Rockhampton Regional LGA. The boundary then follows a ridgeline of the Berserker Range (Mt Archer) to Limestone Creek and then follows Limestone Creek to form the western boundary to a point just north of Yeppoon Road. The boundary then becomes a series of north/south and east/west straight lines prior to again following cadastral boundaries to a point east of the Bruce Highway where the LGA boundary follows Ramsay Creek. Ramsay Creek (north) heading west around the lagoon to the Fitzroy River then along the river to Marlborough Creek then along the creek to Develin Creek then along the creek to a point on the

west where the boundary may follow the top of the catchment / ridgeline. Then links up with a cadastral boundary before joining the Mackenzie River. At this point LSC boundary departs from RRC boundary and adjoins Central Highlands LGA. Then follows the Mackenzie River (a branch of) upstream to a point just downstream with the confluence of the Isaac River where the boundary turns north east along a straight line forming a central western point of the LGA. The boundary then crosses the Marlborough-Sarina Road and follows ridgelines and/or cadastral boundaries to the north west corner before trending easterly and joining Granite Creek at a central northern point. The boundary then follows Granite Creek to its confluence with Tooloombah Creek where the Styx River is formed. Then follows the Styx to its mouth at Shoalwater Bay. The boundary then heads north across the water, turns east and then south and then west and finally south west to join the Fitzroy River at the commencing point.

Figure *3-11: Livingstone Shire LGA*



3.3.2. Elected representatives

Livingstone Shire is an undivided electorate with all Councillors representing the whole of the LGA. The elected representatives are listed in

Table 3-2 along with their portfolio responsibilities.

Table 3-2: Livingstone Shire Councillors

Councillor	Portfolio
Bill Ludwig	Mayor
Tom Wyatt	Sport, recreation, parks and community facilities
Glenda Mather	Civil operations – Roads
Jan Kelly	Community development and support
Adam Belot	Water, waste management and the environment. Also Council's representative on the Local Marine Advisory Committee (LMAC)
Nigel Hutton	Administration and finance with sub portfolio of youth development and the arts as well as Council's representative to the Regional Arts Development Fund (RADF) committee
Graham Scott	Planning and strategic infrastructure including economic development and tourism

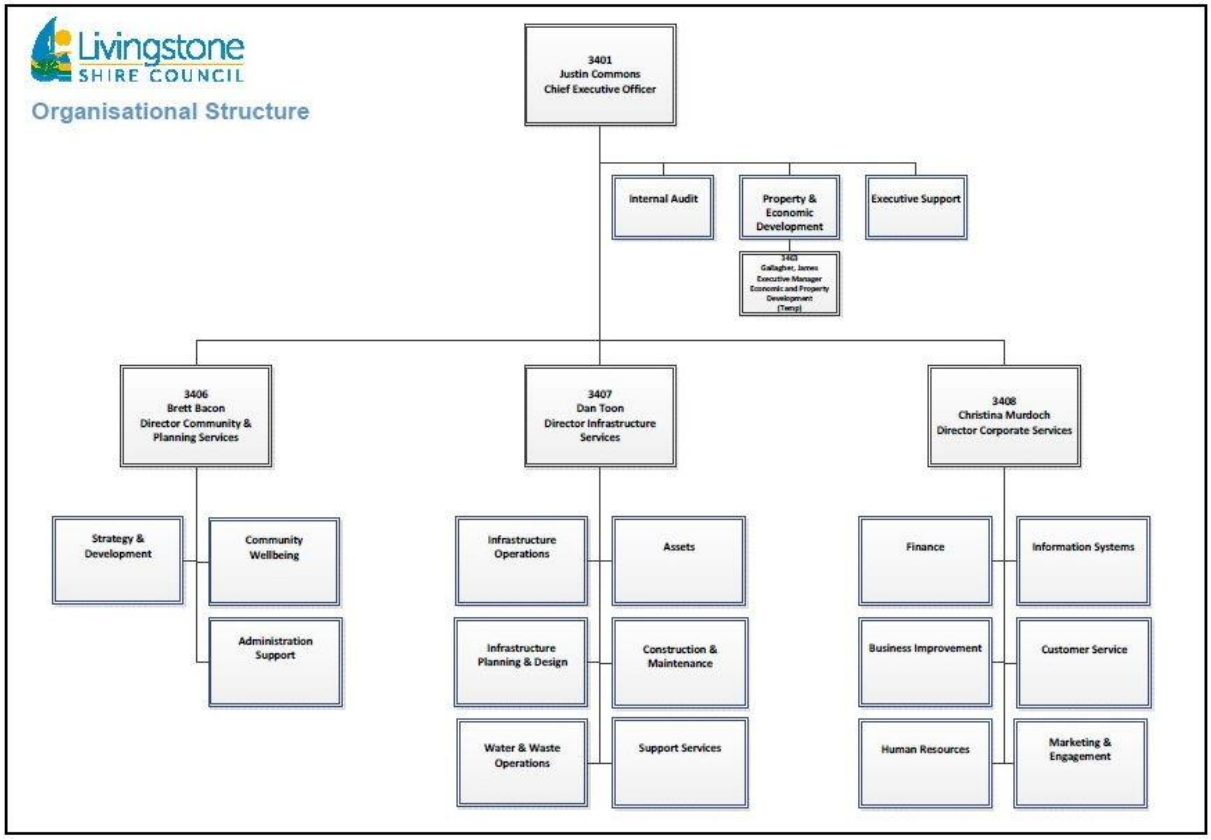
3.3.3. Organisational structure

The organisational structure of Livingstone Shire Council is shown in Figure 3-12.

The main structural components and water quality relevant sub components are:

- Community and Planning Services;
  - Strategy and development,
  - Community well-being.
- Infrastructure Services;
  - Infrastructure operations,
  - Infrastructure planning and design,
  - Water and waste operations,
  - Construction and maintenance.
- Corporate Services;
  - Information systems.
- CEOs Office.

Figure *3-12: LSC Organisational Structure*



4. Urban Catchments

4.1. Gladstone Urban Centres and Catchments

The main urban centres in the Gladstone Regional Council LGA are labelled on the aerial photograph in Figure 4-1 along with some key adjacent industrial dominated localities. The urban areas are described briefly below with reference to the FBA's water quality improvement plan catchments.

Figure *4-1: Gladstone Region Main Urban Centres*

Note: Urban areas are labelled yellow with localities light orange. Baffle Creek mouth is at the bottom right of frame.

4.1.1. Gladstone

Most of the central Gladstone urban area was previously included in the Gladstone City Council LGA. The City of Gladstone also adjoins the Port of Gladstone and industrial areas to the north, west and east. The Gladstone urban area is expanding into the hinterland with a spine of development

adjoining the main road between Gladstone and Calliope with relatively large scale developments at Glen Eden and surrounds. While most of the central Gladstone area is within the Calliope River sub catchment the eastern side of the city, including Barney Point, is part of the Boyne River sub catchment (see *Figure* 4-2).

4.1.2. Boyne Island and Tannum Sands

The Boyne Island-Tannum Sands urban and industrial area is separated from Gladstone City by South Trees Inlet. The area is almost entirely within the Boyne River sub catchment with the exception of the southeast extent of Tannum Sands which is in the Baffle Creek Basin.

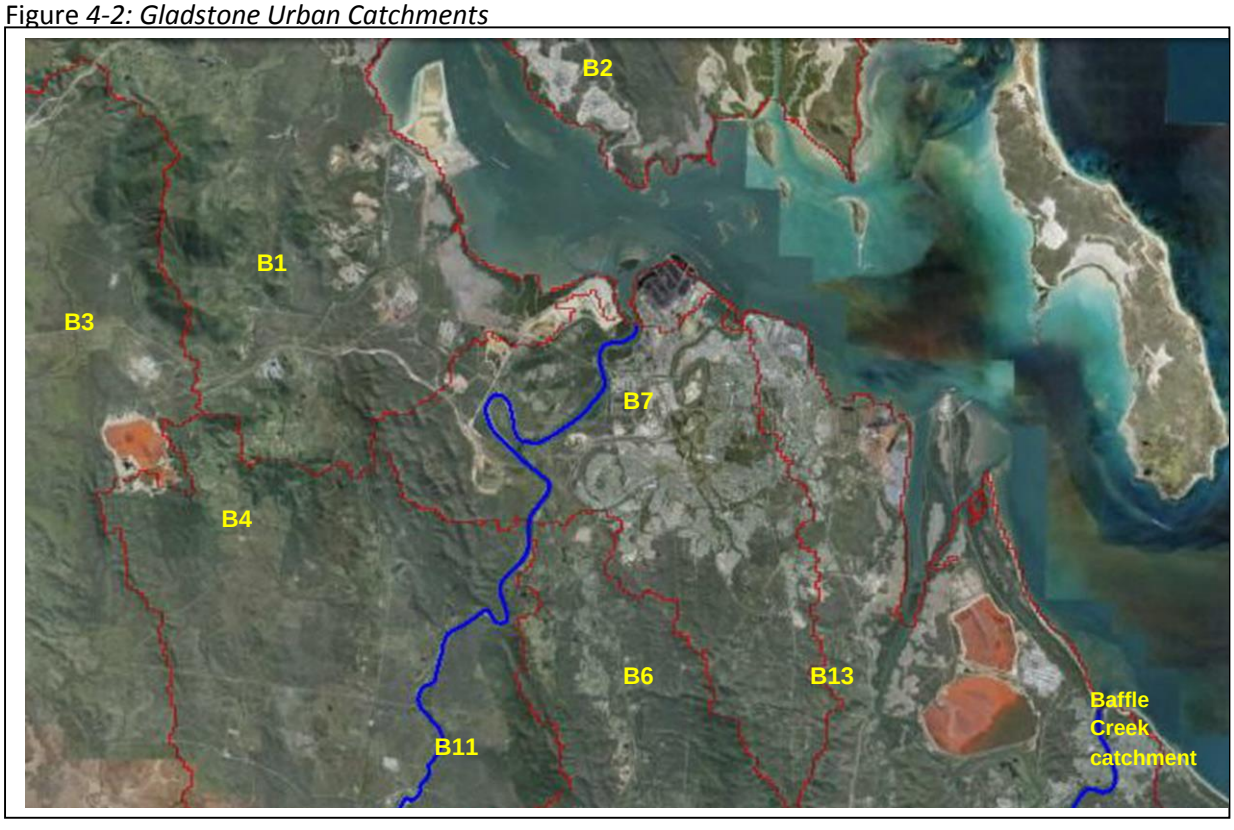
4.1.3. Calliope

Prior to the amalgamation with Gladstone City and Miriam Vale Shire in 2008 Calliope Shire Council was headquartered in Calliope. Calliope is a significant urban area approximately 30 kilometres southwest of Gladstone and is wholly within the Calliope River sub-catchment. The former Calliope Shire encompassed the other main Gladstone urban and industrial area of Boyne Island-Tannum Sands as well as a number of rural townships including Benaraby (the largest); Ambrose, Mount Larcom, Raglan and Yarwun and settlements in the Boyne Valley including Builyan, Many Peaks, Nagoorin and Ubobo.

4.1.4. Urban catchments

The location of Gladstone urban areas within the FBA WQIP sub-catchments are illustrated in Figure 4-2 and briefly described in Table 4-1.

Figure *4-2: Gladstone Urban Catchments*



Note: FBA sub catchments are labelled in yellow (B1 etc.). The Baffle Creek catchment is in the Burnett Mary NRM

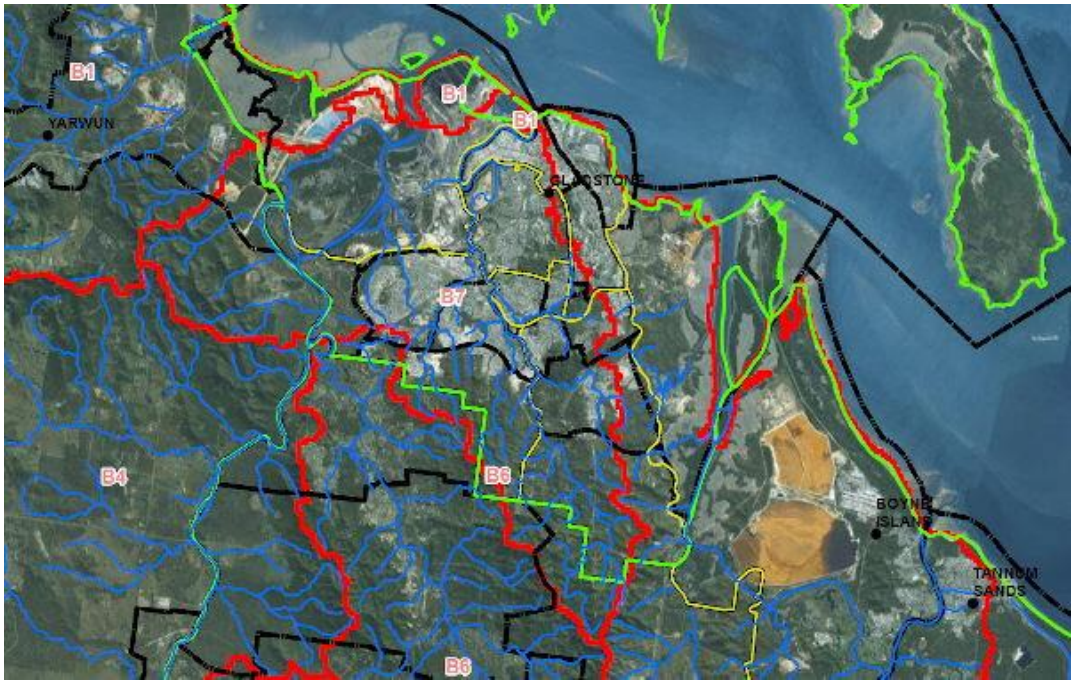
Table 4-1: Gladstone Urban Catchments

Sub Catchment	Notes and sub catchment area	km²
Calliope River B6	Includes the urban spine on the main road between Gladstone and Calliope	77
Calliope River B7	Includes the Auckland Creek catchment and most of the Gladstone urban area	91
Calliope River B11	Includes the main area of Calliope. Drainage runs west to the Calliope River	61
Calliope River B1	Includes Yarwun and adjoins the Western Basin industrial development	349
Calliope River B3	Contains the majority of the Aldoga refinery tailings dam/s	420
Calliope River B4	Mostly rural land use with a portion of the Aldoga industrial site (northwest)	123
Curtis Island B2	Mostly industrial including infrastructure associated with natural gas production	568
Boyne River B13	Encompasses Boyne Island, Tannum Sands, Barney Point and east Gladstone	235
Boyne River B12	Awoonga Dam catchment (upstream/south of B13)	229

4.1.5. Urban population by catchment

In the urban setting statistical areas and units are used for estimating population growth and associated housing demand and urban expansion. The statistical areas need to be related to water catchments to enable water quality issues associated with population growth and urban expansion to be mapped with reference to receiving waters. The relationship between ABS statistical areas and FBA WQIP water sub catchments for the Gladstone urban area is shown in *Figure* 4-3. See Appendix C for information on statistical areas with reference to the FBA sub catchments.

Figure *4-3: Gladstone FBA Catchments and Statistical Areas*



Notes: FBA water quality improvement plan sub catchments are shown in red and labelled B7 etc. Statistical areas (SA) level 2 are yellow. Statistical local areas (SLA) are green. Localities are black. Waterways are blue.

Areas (hectares) of level 2 SAs by water catchment are shown in Table 4-2. As can be seen in *Figure* 4-2 and *Figure* 4-3 the majority of the Gladstone urban area is located in FBA sub catchment B7. This is not readily reflected in Table 4-2 due to the large area of rural land in the Boyne Island - Tannum Sands SA skewing the figures.

Table 4-2: FBA Sub Catchments by Statistical Areas

Statistical area (SA2)	SA code	FBA WQIP sub catchments (hectares)					
		B1	B4	B6	B7	B13	Total
Boyne Is.- Tannum Sands	308021196					7,363	7,363
Callemondah	308021197	1,085			1,879		2,964
Clinton - New Auckland	308021198		1	189	2,121		2,311
Gladstone	308021199	5			326	671	1,002
Kin Kora-Sun Valley	308021201				269		269
South Trees	308021202					1,562	1,562
Telina - Toolooa	308021203				1,539	797	2,336
West Gladstone	308021204				673		721
Gladstone urban/industrial		1,090	1	189	6,807	10,441	18,528
Gladstone Hinterland	308021200	33,790	12,283	7,493	2,271	13,075	68,912
Total hectares		34,880	12,284	7,682	9,078	23,516	87,440

Notes: Gladstone Hinterland includes an additional area in sub catchments; B2, B3, B8-B12, B15-B19 of 433,235 hectares. Calliope, Benaraby and other smaller urban areas are included in Gladstone Hinterland SA.

Another way of looking at land use involves zoning in planning schemes. GIS zoning data for the new Gladstone Regional Council (GRC) planning scheme was not available during the preparation of this report however zoning information from the pre-amalgamation planning schemes was provided by GRC to provide an indication of the various land uses within the GRC local government area (LGA) to relate to the FBA WQIP sub-catchments. A summary of land use from the Gladstone City and Calliope Shire planning schemes by FBA WQIP sub-catchments is provided in Table 4-3.

Table 4-3: Planning Scheme Zoning Land Use Summary

FBA WQIP sub catchments	B1	B6	B7	B13	Total	%
Gladstone urban hectares	0	60	2,711	486	3,257	4.9
Gladstone urban sub catchment %	0	1.3	58.5	10.5	70.2	
Calliope urban hectares	7	16	0	1,358	1,381	2.1
Calliope urban sub catchment %	0.15	0.34	0	29.3	29.8	
Urban total hectares	7	76	2,711	1,844	4,638	6.9
Urban total sub catchment %	0.15	1.6	58.5	39.8	100.00	
Gladstone peri-urban hectares	0	36	384	25	445	0.7
Gladstone peri-urban sub catchment %	0	1.2	12.9	0.84	15.0	
Calliope peri-urban hectares	5	1,689	14	819	2,527	3.8
Calliope peri-urban sub catchment %	0.17	56.83	0.47	27.56	85.03	
Peri-urban total hectares	5	1,725	398	844	2,972	4.4
Peri-urban total sub catchment %	0.17	58.04	13.39	28.40	100.00	
Gladstone industrial hectares	386	2	644	720	1,752	2.6
Gladstone industrial sub catchment %	3.59	0.02	5.98	6.69	16.27	
Calliope industrial hectares	7,982	43	286	703	9,014	13.5
Calliope industrial sub catchment %	74.14	0.4	2.66	6.53	83.73	

Industrial hectares	8,368	45	930	1,423	10,766	16.1
Industrial sub catchment %	77.73	0.42	8.64	13.22	100.00	
Gladstone rural / conservation hectares	735	51	1,648	1,170	3,604	5.4
Gladstone rural / conservation sub c %	1.52	0.11	3.41	2.42	7.46	
Calliope rural / conservation hectares	22,088	5,206	1,879	15,565	44,738	67.0
Calliope rural / conservation sub c %	45.69	10.77	3.89	32.2	92.54	
Rural / conservation hectares	22,823	5,257	3,527	16,735	48,342	72.4
Rural / conservation sub catchment %	47.21	10.87	7.30	34.62	100.00	
Gladstone total hectares	1,121	148	5,611	2,467	9,347	14.0
Calliope total hectares	30,083	6,961	2,179	18,220	57,443	86.0
Combined total hectares	31,204	7,109	7,790	20,687	66,790	100.0

Notes: [1] in these notes indicates the zone is from the Calliope planning scheme and [2] is from Gladstone planning scheme zoning. Unnumbered means the zone is common to both planning schemes.
Zones included in Urban are: Commercial, Community use[1]/purpose[2], Open space[2] and recreation[1], Mixed industry and business[2], Residential and Residential (higher density)[2].
Zones included in Peri-urban are: Rural residential[1] / Park residential[2], Urban expansion and Village[1].
Zones included in Industrial are: GSDA[1] (State development area)[2], Local industry, Major industry[1] and infrastructure[2], Major infrastructure[1] and Strategic port land.
Zones included in Rural and conservation are: Conservation, Forestry and Rural.

4.2. Rockhampton Urban Centres and Catchments

The two main urban centres (Rockhampton City and suburbs and Gracemere) within the local government area (LGA) are labelled on the aerial photograph in Figure 4-4. The other urban area within the Rockhampton LGA is Mount Morgan (population approximately 3,000) while there are a number of smaller towns and localities including Bouldercombe and Westwood.

4.2.1. Rockhampton and suburbs

Rockhampton is the main regional service centre in the Fitzroy Basin with a large socio-economic catchment including a significant area devoted to cattle grazing/beef production as well as smaller areas of cropping land e.g. Central Highlands, and the coalfields of the Bowen Basin.

The Rockhampton urban area spans both sides of the Fitzroy River and consists of Rockhampton City and the suburbs of Allenstown, Berserker, Depot Hill, Fairy Bower, Frenchville, Kawana, Koongal, Lakes Creek, Limestone Creek, Mount Archer, Norman Gardens, Park Avenue, Parkhurst, Port Curtis, The Common, The Range, Wandal and West Rockhampton.

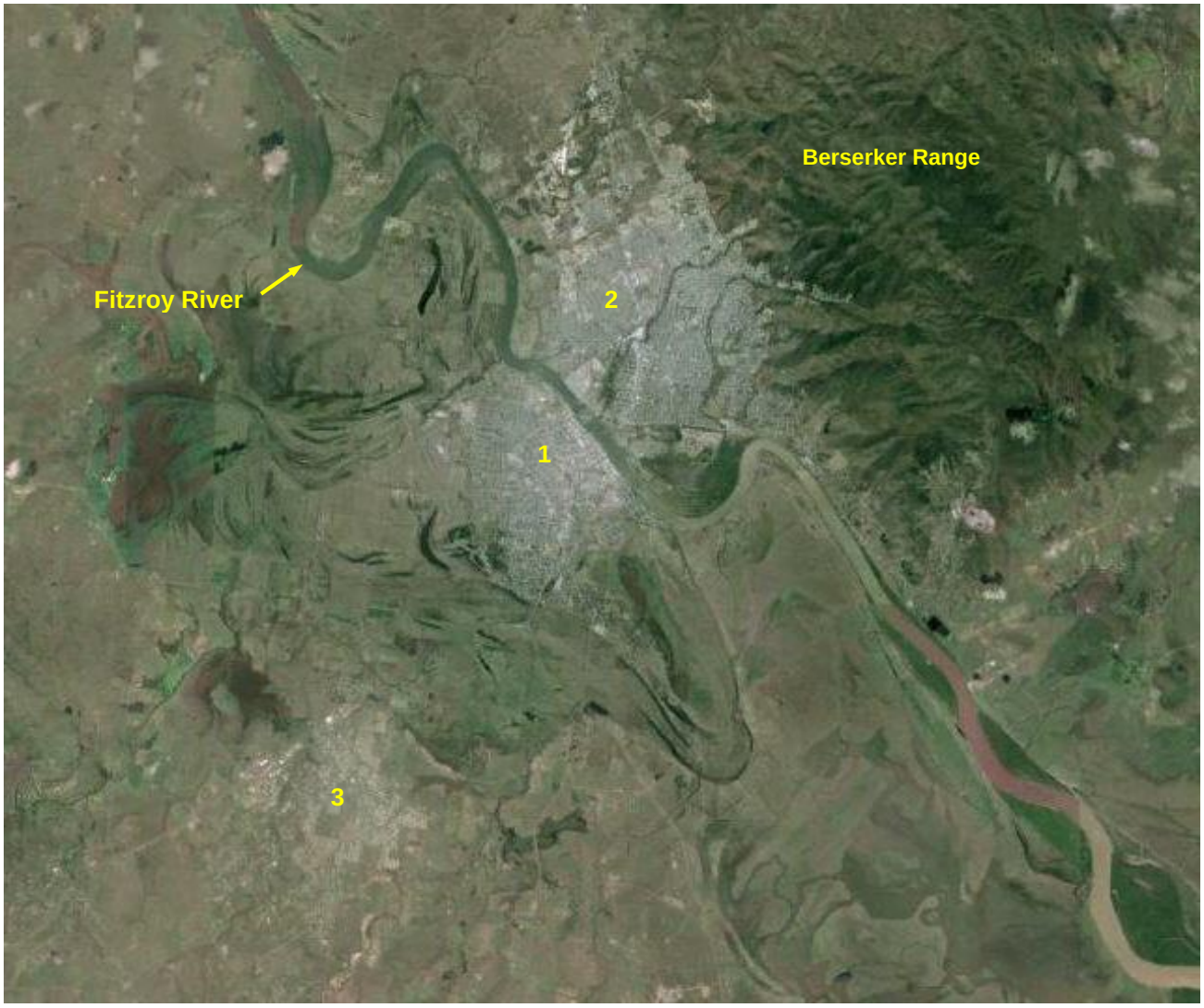
The dominant geographical features of the Rockhampton urban area are the Fitzroy River and associated tributaries, lagoons and overflow paths, and the Berserker Range (includes Mount Archer). Both these features are also the main constraints to urban expansion. The main urban expansion is taking place on the northern edge of the local government area in the Limestone Creek catchment.

4.2.2. Gracemere

Gracemere was selected as the initial settlement site for the Rockhampton region in 1853 due to the presence of a freshwater lake in the vicinity. At one stage, prior to Land Act changes, the Gracemere pastoral run extended from the Bajool scrub to near Morinish with the Fitzroy River forming the eastern boundary for a length of approximately 110 kilometres. The sheep (pastoral) run included what would become the town of Rockhampton.

Gracemere was previously the main urban centre within the Fitzroy Shire Council LGA and is approximately 10 kilometres southwest of Rockhampton. While infrastructure was independently established for Gracemere by the Fitzroy Shire Council it is now managed by Rockhampton Regional Council and included in its integrated management structure. The individual water quality impacts of the Gracemere urban area are not taken into consideration in this report however its significance in future population growth projections for the Rockhampton Region is noted in section 5.3.1.

Figure *4-4: Rockhampton Urban Areas*



Notes: 1 is Rockhampton City (south), 2 is North Rockhampton, 3 is Gracemere.

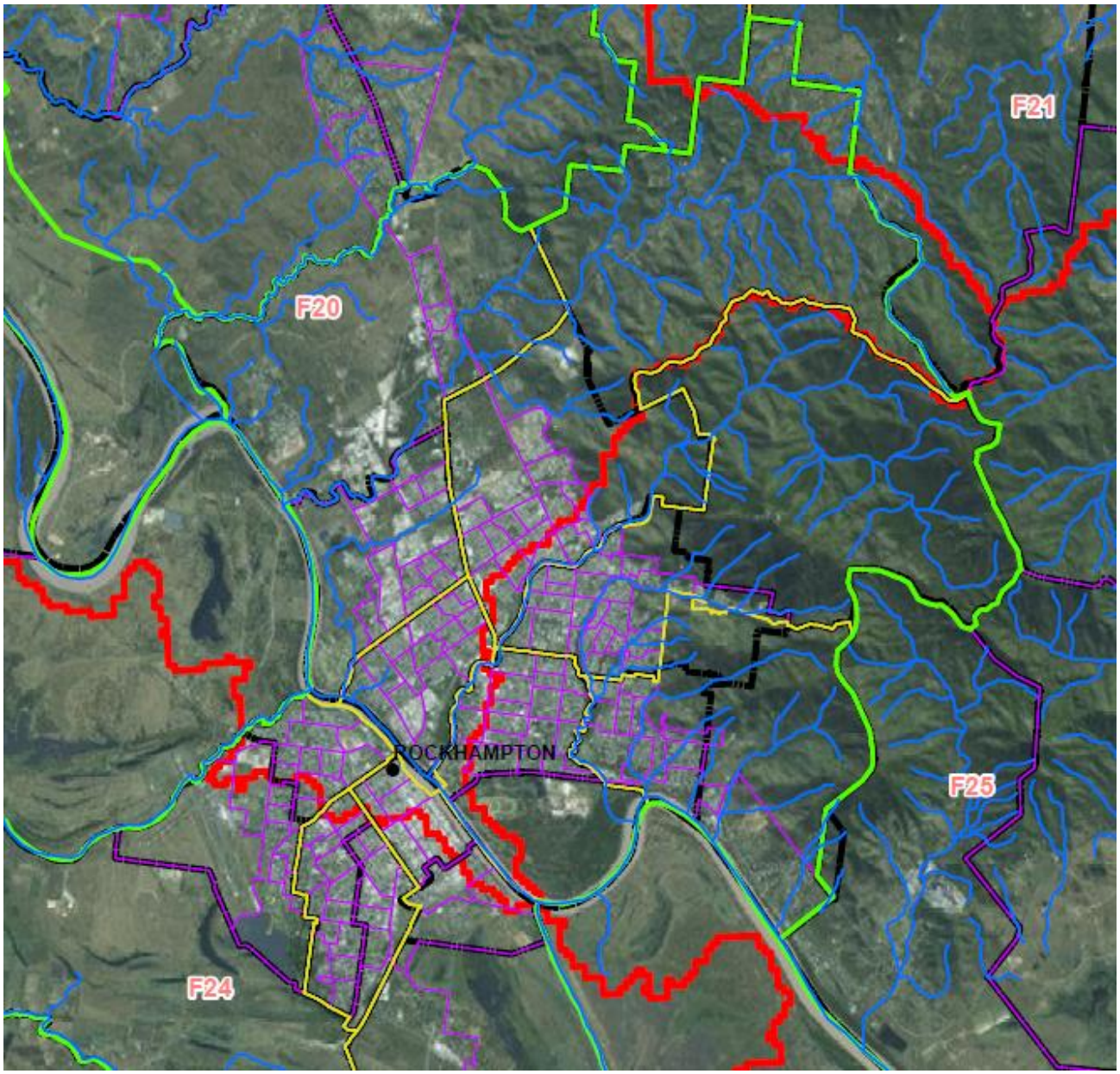
4.2.3. Urban catchments

The location of Rockhampton urban areas within the FBA WQIP sub-catchments is illustrated in *Figure* 4-5 (Rockhampton) along with ABS statistical areas. Areas (hectares) of level 2 SAs by FBA sub catchment are shown in Table 4-4. As can be seen in *Figure* 4-5 the majority of the Rockhampton urban area is located in three FBA sub catchments i.e. F20, F24 and F25. This is reflected in Table 4-4

however it should be noted that some of the statistical areas contain large areas of rural land and/or open space, which should not be included in urban area calculations.

Rural, open space and urban areas need to be separated to enable the actual extent of current urban areas to be calculated to compare with population growth/urban expansion scenarios. This involves disaggregating level 2 statistical areas into level 1 statistical units to obtain the appropriate level of resolution for determining the actual extent of urban areas while still being able to use ABS population data to calculate population growth projections (see description in Appendix C of the ABS statistical units in the Fitzroy District and Rockhampton region).

Figure *4-5: Water Catchments and Statistical Areas*



Notes: FBA water quality improvement plan sub catchments are shown in red and labelled F20 etc. Statistical areas (SA) are; level 2 yellow and level 1 purple. Statistical local areas (SLA) are green. Waterways are blue.

Table 4-4: RRC LGA Urban Statistical Areas by Sub Catchment

		FBA WQIP sub catchments					
Statistical area (SA)	**SA code**	**F20**	**F21**	**F23**	**F24**	**F25**	**Totals**
		Hectares					
Berserker	308031205	182				820	1,020
Frenchville - Mount Archer	308031208	21				2,996	3,017
Lakes Creek	308031211					1,681	1,681
Norman Gardens	308031213	2,871	262			482	3,615
Park Avenue	308031214	485				11	496
Parkhurst - Kawana	308031215	2,843					2,843
Rockhampton - West	308031216	322		23	3,114		3,459
Rockhampton City	308031217	203			3,417	1,500	5,120
The Range - Allenstown	308031222	20			529		549
Total hectares		6,947	262	23	7,060	7,491	**21,783**
Gracemere	308031210			11,078	4,336		15,415
Rockhampton + Gracemere		6,947	262	11,101	11,396	7,491	**37,198**
		F20	**F21**	**F12**	**F13**	**F19**	
Glenlee – Rockyview [1]	308031209	17,155	395	1	2,613	639	**20,803**

Note: [1] is part of Livingstone Shire Council LGA adjoining RRC LGA to the north and has been included in Rockhampton urban area table as it likely to become part of RRC through a future boundary realignment.

4.3. Livingstone Shire Urban Areas and Catchments

Urban areas in the Livingstone Shire Council LGA are concentrated in the stretch from Yeppoon to Rosslyn Bay and from Emu Park south. This includes the near coastal village communities and 'holiday' locations as well as the more recent 'sea change' urban expansion areas on the hills behind Yeppoon and the 'greenfields' development southwest of Zilzie (Emu Park).

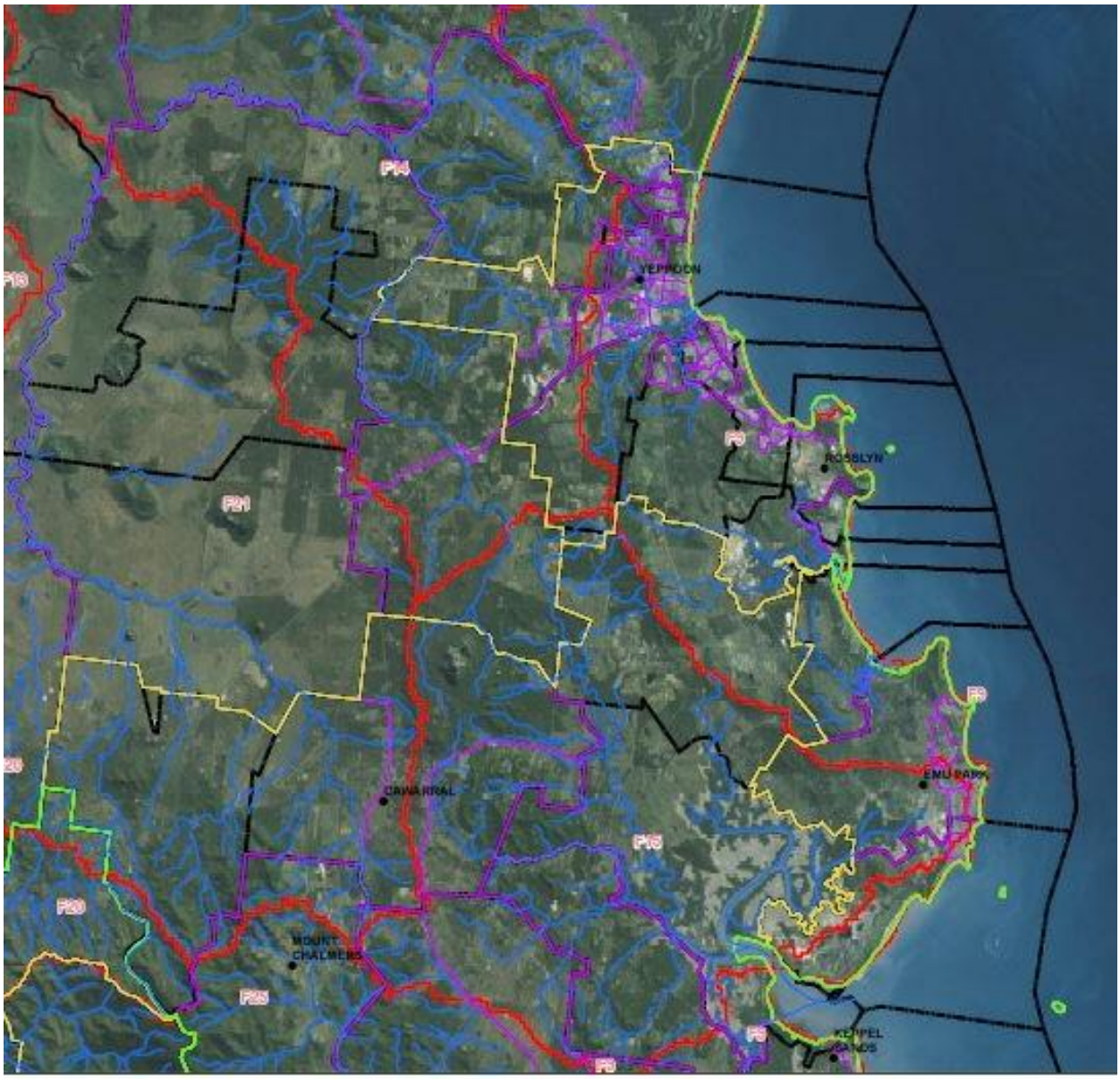
Livingstone Shire urban areas and FBA WQIP sub catchments are illustrated in Figure 4-6 along with ABS statistical areas. Statistical areas by FBA sub catchment are listed in Table 4-5.

Table 4-5: Livingstone Shire Statistical Areas by Sub Catchment

	Statistical area (SA2)		FBA WQIP sub catchments			
Statistical area (SA)	**Code**	**Ha [1]**	**F9**	**F14**	**F15**	**Totals[2]**
Emu Park	308031207	4,084	2,332		1,717	4,049
Yeppoon	308031223	7,856	5,237	2,432	133	7,802
Capricorn Coast urban		11,940	7,569	2,432	1,850	11,851
Statistical area (SA)	**Code**	**Ha [1]**	**F9**	**F14**	**F15**	**Other**
Rockhampton Region - East	308031218	68,017	13,900		12,183	40,896
Rockhampton Region - North	308031219	756,689	27,162	18,417	1,133	686,592
Shoalwater Bay	308031221	317,696	112,193			193,126
Glenlee – Rockyview[3]	308031209	20,803	(**Note**: included in Rockhampton figures in Table 4-4)			

Note: [1] SA2 hectares are from the concordance spreadsheet and are not a true indication of the actual extent of urban areas. SA1 units would need to be interrogated for more realistic areas. [2] Totals is statistical areas from GIS intersect of FBA sub catchments with SAs. Rockhampton Region – East, Rockhampton Region – North and Shoalwater Bay are part of the Livingstone (S) SA3 and do not encompass any of the urban areas. [3] included in in Table 4-4.

Figure 4-6: Water Catchments and Statistical Areas (Livingstone)



4.4. Environmental Values and Water Quality Objectives

The *Environmental Protection Act* 1994, through the Environmental Protection (Water) Policy 2009 (EPP (Water), provides a pathway for:

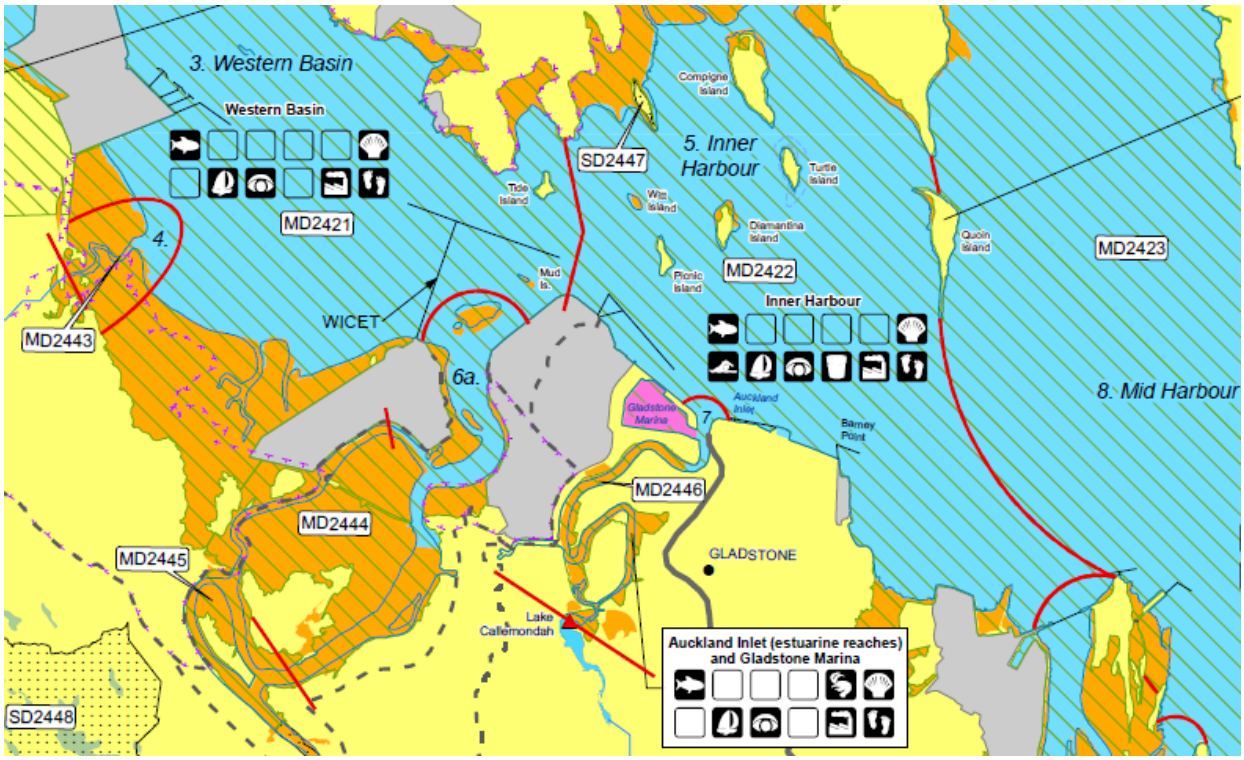
- identifying environmental values (EVs) for Queensland waters;
- deciding the water quality objectives (WQOs) to protect or enhance those;
- gazetting the identified EVs and WQOs under Schedule 1 of the EPP (Water).

"*The aquatic ecosystem EV is a default applying to all Queensland waters, and therefore the WQOs for aquatic ecosystems form the minimum WQOs for all waters. Where no human use EVs are identified, the WQOs identified for aquatic ecosystem protection remain applicable*". (EHP 2014. p.28).

4.5. Gladstone

EVs and WQOs have been identified for Basins 131, 132 and 133 (see Geoscience Australia 2004), including all waters of Gladstone Harbour, the Narrows, Curtis Island, Calliope and Boyne River basins, and adjacent coastal waters with the EVs and WQOs documented in, Curtis Island, Calliope River and Boyne River Basins Environmental Values and Water Quality Objectives (Department of Environment and Heritage Protection (EHP) 2014). The document is accompanied by plans showing the extent of high ecological value (HEV) waters and human use EVs.
(Available at http://www.ehp.qld.gov.au/water/policy/schedule1/capricorn-curtis-scheduled-evs-wqos.html)

Figure 4-7: Gladstone Calliope Catchment



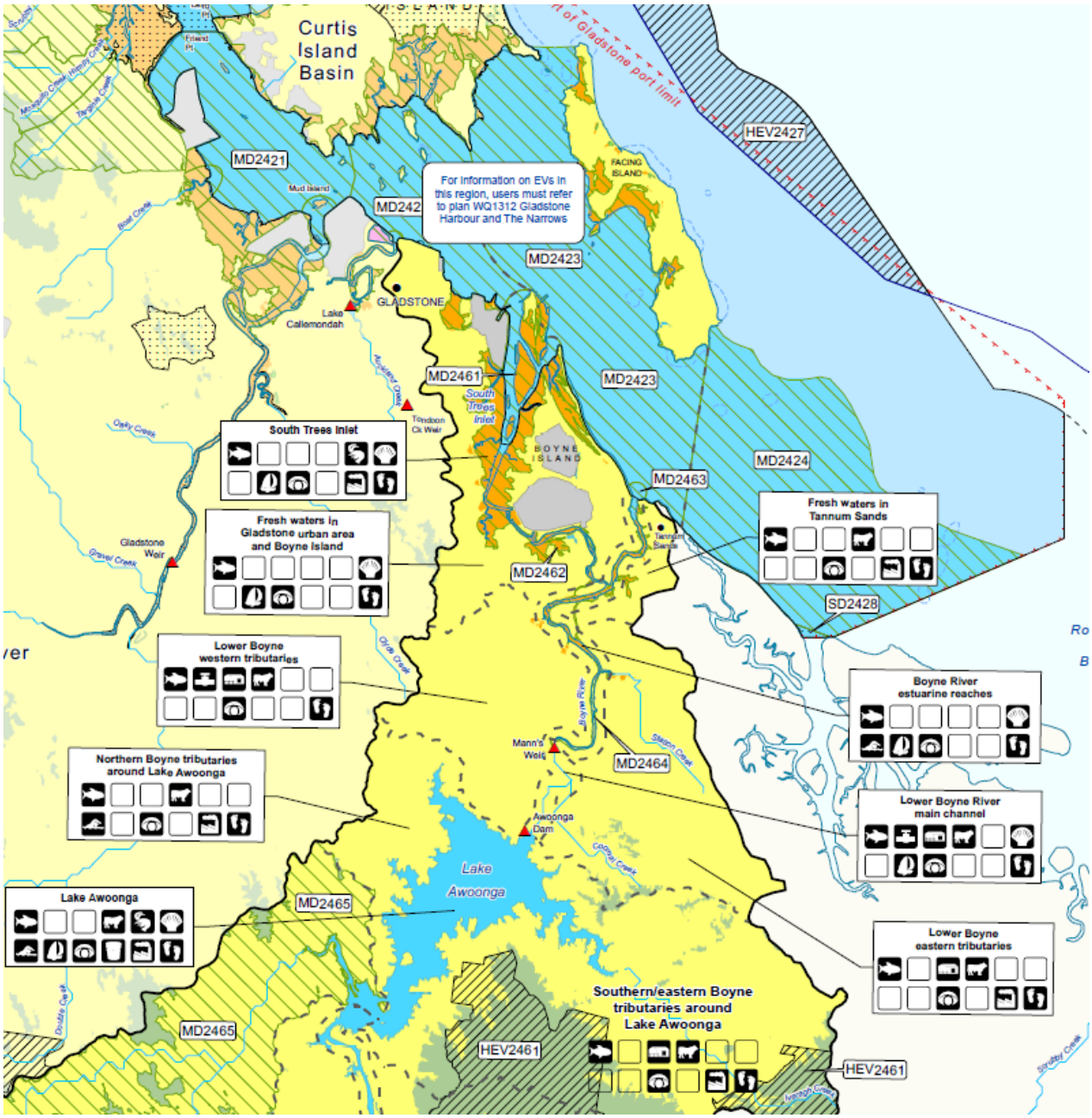
Note: Source map is WQ1312 Gladstone and The Narrows (EHP 2014).

Sections of the document identifying EVs with reference to the relevant maps showing aquatic ecosystem and human use EVs with relevant aquatic ecosystem WQOs are listed in Table 4-6. Portions of the EV maps relevant to the Gladstone urban area are shown in Figure 4-7 and 4-8.
.

Table 4-6: Gladstone Region EVs and WQOs Key

Basin and/or water type	Environmental values	Map	Water quality objectives
Gladstone Harbour and adjacent coastal waters, mainland estuaries, the Narrows and Fitzroy Delta	Table 1A (pp.11-14)	WQ1312	Table 2A, 2B, 2C and 2D (pp.30-39)
Boyne River Basin	Table 1B (pp.15-18)	WQ1331	Table 2E (pp.40-2)
Calliope River Basin	Table 1C (pp.19-22)	WQ1311	Table 2F (pp.43-6)
Curtis Island Basin	Table 1D (pp.23-26)	WQ1311	Table 2G (pp.47-56)
Coastal waters		WQ1272	
Groundwater		WQ1273	Table 14 (pp.82-91)[1]

Figure *4-8: Boyne Catchment*



Note: Source map is WQ1331 Boyne. The boundaries in the plans WQ1311 (Curtis Island and Calliope River), WQ1312 (Gladstone Harbour and the Narrows), WQ1331 (Boyne River), WQ1272 (coastal waters) and WQ1273 (groundwaters) are indicative only.

There are no HEV waters identified within the vicinity of the Gladstone urban area. The nearest HEV area (HEV2461) is located south of Awoonga Dam and is indicated by forward slanting lines.

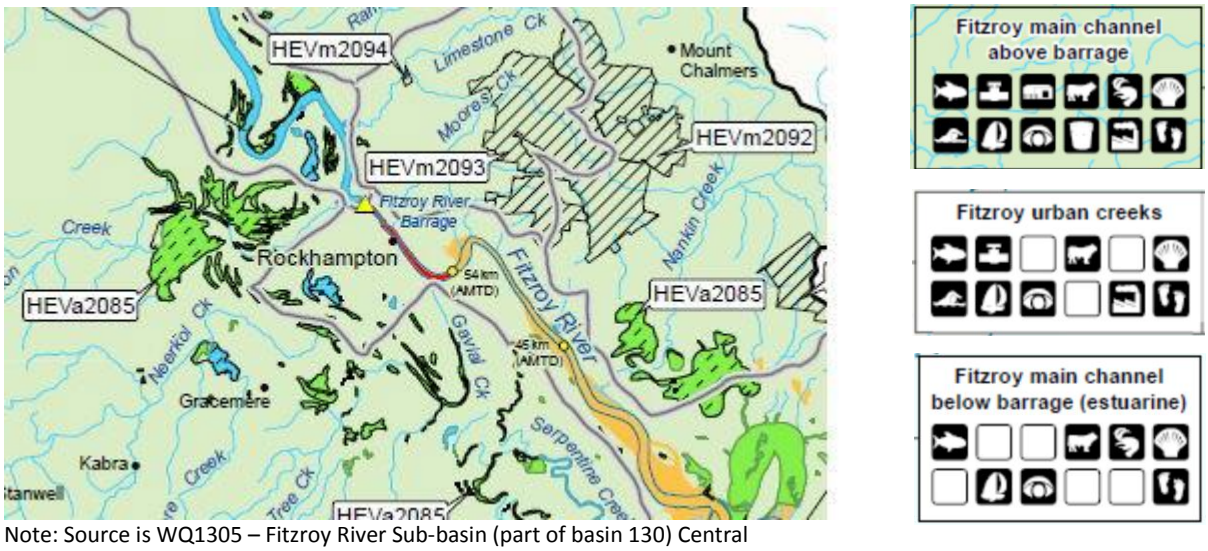
Section 3.2 (tables 3 to 12) of the document provides WQOs for EVs other than aquatic ecosystem. These are the human use EVs and include recreational water use, agricultural use e.g. irrigating crops

and stock water, raw drinking water. Where more than one EV applies to a given water e.g. aquatic ecosystem and recreational use, the most stringent WQO for each water quality indicator applies. This will then protect all identified EVs.

4.6. Rockhampton

EVs and WQOs have been identified for Basin No. 130 (see Geoscience Australia 2004) (part), including all waters of the Fitzroy River Sub-basin (EHP 2013). The area in the vicinity of Rockhampton from the Environmental Values map is shown on Figure 4-9.

Figure *4-9: Rockhampton Environmental Values*

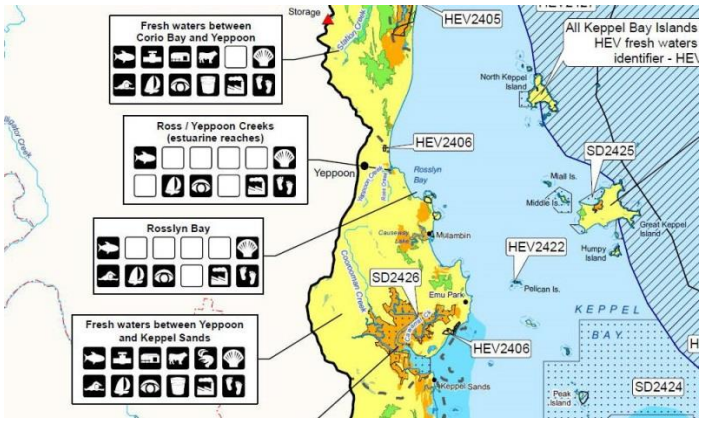


Note: Source is WQ1305 – Fitzroy River Sub-basin (part of basin 130) Central Queensland Map Series. Queensland Government 2013.

4.6.1. Livingstone

The coastal catchments of the Capricorn Coast are part of the Water Park Creek Basin and are included in the Styx River, Shoalwater Creek and Water Park Creek Basins Environmental Values and Water Quality Objectives document for Basins 127, 128 and 129, including all waters of the Styx River, Shoalwater Creek and Water Park basins and adjacent coastal waters. An extract from the map is provided in Figure 4-10.

Figure *4-10: Capricorn Coast Environmental Values*



5. Population and Urban Expansion

5.1. Population Growth

Increasing urban pressures on water quality from population growth and urban expansion manifests in three main ways:

1. Increased nitrogen and phosphorus loads due to higher volumes of wastewater being treated/discharged;
2. Sediment discharge spikes during the development and construction phase of urban expansion;
3. Increase in stormwater runoff and pollutant loads from impervious surfaces.

5.2. Contemporary Population

Tools on the Queensland Government Statistician's Office (QGSO) website enable preparation of statistical reports on a range of Queensland community types including local government areas. These reports are generated automatically using the latest demographic, social and economic data available. Communities of interest can be selected for profiling with the smallest geographical region available for selection being Statistical Area Level 2 (SA2) (see Appendix C for explanation). This is useful for gaining a general understanding of existing urban areas and areas of recent urban expansion.

5.2.1. Rockhampton region

Information for Rockhampton generated through the QGSO regional profile web page is included in Table 5-1.

The Rockhampton table includes a number of combinations of SA2 areas which help to illustrate current and potential future urban expansion sites. Dividing the population by the SA2 area (hectares) gives an indication of population density (final column). These figures need to be viewed in the context of the particular SA2 unit so that interpretations are not skewed due to 'logical' assumptions. An example is the Rockhampton City unit, which one could logically assume is all built out. The population density however is the lowest of any of the urban units. We could assume that

the CBD is not heavily populated however there is likely to be more high and medium density residential in and around the CBD, which would 'compensate' for the lower population density in the commercial CBD area.

An examination of the Rockhampton City SA2 unit in relation to its ten smaller SA1 units (see Appendix C) shows that the majority of the SA2 unit is occupied by one SA1 unit and consists of open space and/or wetlands. This illustrates the need to examine and customise statistical areas to ensure the spatial units used for assessing urban water quality issues are appropriate and in context. This has been done to some extent by .id, commissioned by Rockhampton Regional Council to generate demographic profiles for the region (see Appendix C).

5.2.2. Livingstone Shire

A contemporary population profile for Livingstone Shire is provided in Table 5-2. There are a number of permutations including figures for RRC and LSC combined.

Table 5-1: Rockhampton Urban Population Profile 2004-2014

Location	Population			Annual % increase		Area (ha) and %	[4]Pop. density
	2004	2009	2014p	2004–14p	2009–14p		
Berserker	7,193	7,379	7,711	0.7	0.9	1,002	7.70
Frenchville - Mount Archer	9,266	9,466	9,832	0.6	0.8	3,017	3.26
Lakes Creek	4,966	5,166	5,519	1.1	1.3	1,681	3.28
Norman Gardens	7,686	8,871	9,719	2.4	1.8	3,614	2.69
Park Avenue	5,611	5,571	5,940	0.6	1.3	496	11.97
Parkhurst - Kawana	6,136	6,622	7,156	1.5	1.6	2,843	2.52
Rockhampton - West	6,122	6,192	6,257	0.2	0.2	3,453	1.81
Rockhampton City	3,601	3,702	3,821	0.6	0.6	5,121	0.75
The Range - Allenstown	8,571	8,518	8,659	0.1	0.3	550	15.76
Rockhampton City and suburbs	59,152	61,487	64,614	0.9	1.0	21,777	2.97
Percentage of RRC LGA	81.7%	79.4%	77.4%			3.3%	
Glenlee-Rockyview	3,828	4,566	5,073	2.9	2.1	20,803	0.24
Rockhampton urban/peri-urban[3]	62,980	66,053	69,687	1.1	1.1	42,580	1.64
Gracemere	5,592	8,229	10,658	6.7	5.3	15,415	0.69
Percentage of RRC LGA	7.7%	10.6%	12.8%			2.3%	
Rockhampton Urban region[1]	64,744	69,716	75,272	1.5	1.5	37,192	2.2
[1]Percentage of RRC LGA	89%	90%	90%			5.7%	
Mount Morgan	3000	3,000	3,000	0	0	49,068	0.06
Percentage of RRC LGA	4.1%	3.9%	3.6%			7.5%	
Rockhampton non-urban[2]	4,676	4,732	5,167	1.1	1.8	569,769	0.01
[2]Percentage of RRC LGA	6.5%	6.1%	6.2%			86.7%	
Rockhampton (R) LGA	72,420	77,448	83,439	1.4	1.5	657,200	0.13

Notes: Main data source is Queensland Regional Profiles Resident Profile - people who live in the region. Rockhampton Urban region compared with Rockhampton Regional Council Local Government Area (LGA), (p.5). Available at: http://statistics.qgso.qld.gov.au/qld-regional-profiles. Source data: ABS 3218.0, Regional Population Growth, Australia, 2013-14. [1]The Rockhampton Urban region comprises the 10 statistical area level 2s (SA2's) of Berserker, Frenchville - Mount Archer, Gracemere, Lakes Creek, Norman Gardens, Park Avenue, Parkhurst - Kawana, Rockhampton - West, Rockhampton City and The Range – Allenstown (covering an area of 372.8 km^2). [2] Rockhampton non-urban includes the remainder of the population not residing in Rockhampton, Gracemere and Mount Morgan (set at 3,000 people all years), including peri-urban areas. Rockhampton non-urban equates to Bouldercombe (20.4% of RRC area) and Rockhampton Region – West (66.3% of RRC area) SA2 units.

[3] Rockhampton urban/peri-urban is Rockhampton City and suburbs and Glenlee-Rockyview, which is the northern extremity of the urban growth area (Livingstone Shire Council LGA). [4] Pop. density is 2014 population density(people per hectare and for urban areas is subject to adjustment due to the actual areal urban extent in the SA2 unit.

Table 5-2: Livingstone Urban/Peri-urban Population

Location	Population			Annual % increase		Area (ha) and %	[2]Pop. density
	2004	2009	2014p	2004–14p	2009–14p		
Emu Park	3,678	4,377	5,248	3.6	3.7	4,084	1.29
Yeppoon	13,594	16,097	18,216	3.0	2.5	7,856	2.32
Coastal urban total	17,272	20,474	23,464	3.6	3.7	11,939	1.97
% of LSC	61.3%	63.0%	64.5%			1.0%	
Glenlee-Rockyview	3,828	4,566	5,073	2.9	2.1	20,803	0.03
% of LSC						1.8%	
Livingstone Peri Urban[1]	21,100	25,040	28,537	3.1	2.6	32,743	0.87
% of LSC	74.9%	77.1%	78.4%			2.8%	
Shoalwater Bay						317,696	
Rockhampton Region - North						756,689	
Rockhampton Region - East						68,017	
Livingstone rural	7,059	7,434	7,841	1.1	1.1	1,142,402	0.01
% of LSC	25.1	22.9	21.6			97.2%	
Livingstone (S) LGA	28,159	32,474	36,378	2.6	2.3	1,175,145	0.24
LSC % of RRC and LSC	28.0	29.5	30.4				
RRC and LSC combined	100,579	109,922	119,817	1.8	1.7	1,832,345	0.07

Notes: [1] Livingstone peri-urban area consists of Emu Park, Yeppoon and Glenlee-Rockyview SA2 units. [2] Pop. density is 2014 population density(people per hectare) and for urban areas is subject to adjustment due to the actual areal urban extent in the SA2 unit.

5.2.3. Gladstone

Recent population figures for Gladstone are provided in Table 5-3.

Table 5-3: Gladstone Population Figures

Location/SA2	Population			Annual % increase		Area (ha) and %	[1]Pop. density
	2004	2009	2014p	2004–14p	2009–14p		
Boyne Is. - Tannum Sands	8,560	9,623	10,744	2.3	2.2	12,229	0.88
Callemondah	35	45	52	4.0	2.9	3,057	0.02
Clinton - New Auckland	9,528	11,089	13,391	3.5	3.8	2,311	5.79
Gladstone	5,842	6,233	7,193	2.1	2.9	1,014	7.09
Kin Kora - Sun Valley	3,900	4,223	4,417	1.3	0.9	269	16.45
South Trees	0	0	0	-	-	2,087	0.00
Telina - Toolooa	4,252	5,204	6,472	4.3	4.5	2,336	2.77
West Gladstone	5,072	5,251	5,766	1.3	1.9	721	8.00
Gladstone urban/industrial[2]	37,189	41,668	48,035	2.6	2.9	24,100	2.00
Gladstone urban area[3]	37,154	41,623	47,983	2.6	2.9	18,881	2.54
Gladstone hinterland	12,328	15,378	18,062	4.7	1.9	645,637	0.03
Gladstone (R) LGA	49,517	57,046	66,097	2.9	3.0	1048,900	0.1

Note: Regional profiles are available at: http://statistics.qgso.qld.gov.au/qld-regional-profiles. Information source for the table is ABS 3218.0, *Regional Population Growth, Australia, 2013-14*.

[1] Pop. density is population density as people per hectare.

[2] Gladstone urban/industrial is the eight statistical area level 2s (SA2's) of Boyne Island - Tannum Sands, Callemondah, Clinton - New Auckland, Gladstone, Kin Kora - Sun Valley, South Trees, Telina - Toolooa and West Gladstone.

[3] urban is urban/industrial minus South Trees and Callemondah, which are principally industrial areas.

5.3. Population Growth Estimates

The Australian Bureau of Statistics (ABS) census data is most commonly used to estimate population growth however an understanding of regional population growth drivers and local factors and dynamics is required to enhance the usefulness of the ABS figures and enable reasonable estimates of local and regional population growth and urban expansion rates. The population estimates combined with locally relevant factors including recent development patterns/locations, land use constraints and development approval (legislative) requirements can provide realistic areal urban expansion locations which can then be overlain on water catchments and used in modelling to determine future pressures on water quality from current and projected urban land use and associated infrastructure e.g. waste water treatment plants.

5.3.1. Rockhampton region

.id forecasts (see Appendix C) are the most appropriate readily available source of data to use as a starting point to estimate urban expansion in the Rockhampton region. The .id forecast period is from the 2011 census to 2036 in increments based on census years.

The 2036 figures have been extrapolated out to 2050 (34 years from 2016) to cover the 'life' of the Reef 2050 Long Term Sustainability Plan. Such an extrapolation is indicative of population increase only as defining specific areas of urban expansion in sub catchments over that timeframe requires the consideration of a greater range of socio-economic and environmental factors. The figures can however form the basis for estimating the pollutant discharge from wastewater treatment plants assuming population trends continue on the same gradient as predicted to 2036 and land based reuse is not introduced in the meantime.

The .id population projections have been adapted to provide projections for the Rockhampton urban area and Gracemere while the Rockhampton urban/peri-urban area projections are a composites of the .id forecast and QGSO (ABS) projections. Livingstone figures, relevant to the Rockhampton urban/peri-urban area, are based on QGSO (ABS) projections only as Livingstone Shire Council does not subscribe to the .id forecasts.

Population projections for Rockhampton region urban and peri-urban areas along with projections for the other statistical areas in the Rockhampton Regional Council LGA are shown in Table 5-5: with .id forecast increase in dwellings provided in Table 5-6 along with figures extrapolated from 2036 to 2050.

5.3.2. Livingstone Shire

Population projections for Livingstone Shire urban areas are provided in Table 5-4 with projected population increases provided in Table 5-8.

Table 5-4: Projected Population

	2011(a)	2016	2021	2026	2031	2036	2050
Yeppoon	16,815	20,201	23,333	26,682	31,253	35,810	46,736
Emu Park	4,661	6,592	7,731	9,227	10,950	11,967	15,730
Glenlee - Rockyview	4,579	4,882	5,051	5,404	5,420	5,440	5,831
LSC Peri Urban Region	**26,055**	**31,674**	**36,114**	**41,312**	**47,623**	**53,218**	**68,299**
LSC (other)	7,339	7,703	7,958	8,512	8,782	9,008	9,921
Livingstone (S) LGA	**33,394**	**39,377**	**44,072**	**49,824**	**56,405**	**62,226**	**78,220**
	Population as a percentage of LSC LGA population						
	2011(a)	**2016**	**2021**	**2026**	**2031**	**2036**	**2050**
Yeppoon	50	51	53	54	55	58	60
Emu Park	14	17	18	19	19	19	20
Capricorn Coast	64	68	70	72	75	77	80
LSC Peri Urban	78	80	82	83	84	86	87
LSC (other)	22	20	18	17	16	14	13
LSC LGA	100	100	100	100	100	100	100

Note: Source is Table 4 Projected population by SA2, Livingstone Peri Urban region and Livingstone Shire LGA (p.8) from Queensland Government Statistician's Office (9 July) 2015, Queensland Regional Profiles: Resident Profile - people who live in the region - Livingstone Peri Urban region compared with Livingstone Shire Local Government Area (LGA), © The State of Queensland (Queensland Treasury) (http://www.qgso.qld.gov.au). (a) 2011 data are estimated resident population (ERP).

Livingstone Peri Urban region (LPUR) has been derived using statistical area level 2s and consists of Yeppoon, Emu Park and Glenlee - Rockyview. Capricorn Coast consists of Yeppoon and Emu Park. The 2050 population projection has been calculated from the average annual increase from 2016 to 2036 from the QGSO Table 4 figures.

Table 5-5: Rockhampton Region Urban Population Projections

	Population			Increase 2011-2016			Pop.	Increase 2011-36			Pop.	Increase 2016-50	
Suburb/Locality	**2011**	**2016**	**[1]LGA**	**People**	**%**	**[2]Ur %**	**2036**	**People**	**[2]Ur %**	**[3]AA%**	**[4]2050**	**[5]People**	**[2]Ur %**
Rockhampton urban													
Allenstown	3,013	3,195	3.8	182	6.0	5.1	3,764	750	3.3	*1.0	4,184	989	3.1
Berserker and The Common	7,449	7,761	9.4	312	4.2	8.8	8,364	915	4.1	0.5	8,877	1,116	3.6
Frenchville	9,370	9,504	11.9	134	1.4	3.8	9,728	358	1.6	0.2	9,929	425	1.4
Kawana	4,857	5,011	6.2	154	3.2	4.3	5,747	890	4.0	0.7	6,246	1,235	3.9
Koongal - Lakes Creek	5,279	5,280	6.7	1	0.0	0.0	5,655	376	1.7	0.3	5,865	585	1.9
Norman Gardens	8,917	10,517	11.3	1,600	17.9	45.2	14,568	5,651	25.2	*2.5	17,732	7,215	23.0
Park Avenue	5,498	5,540	7.0	42	0.8	1.2	5,680	182	0.8	0.1	5,781	241	0.8
Parkhurst - Limestone Creek - Mount Archer	2,165	2,829	2.7	664	30.7	18.7	12,704	10,538	47.0	*19.5	18,605	15,776	50.2
Rockhampton City and Depot Hill	3,419	3,679	4.3	260	7.6	7.3	5,565	2,146	9.6	*2.5	6,767	3,088	9.8
The Range	5,480	5,608	6.9	128	2.3	3.6	5,752	272	1.2	0.2	5,904	295	0.9
Wandal and West Rockhampton	6,183	6,248	7.8	65	1.1	1.8	6,516	334	1.5	0.2	6,703	455	1.4
Rockhampton urban total	61,630	65,172	78.1	3,542	5.7	(100)	84,043	22,413	(100)	1.5	96,594	31,422	(100)
Glenlee-Rockyview	4,579	4,882		303	7.0		5,440	841			5,922	1,040	
[6] **Rockhampton urban/peri-urban total**	66,209	70,054		3,845			89,483	23,254			102,516	32,462	
Gracemere urban													
Gracemere (North)	3,359	4,527	4.3	1,168	34.8	29.2	7,034	3,675	33.5	*4.4	9,092	4,566	34.8
Gracemere (South)	5,280	8,106	6.7	2,826	53.5	70.8	12,563	7,284	66.5	*5.5	16,642	8,536	65.2
Gracemere urban total	8,639	12,633	10.9	3,994	44	(100)	19,597	10,598	(100)		25,734	13,102	(100)
Mount Morgan District (total)	3,102	3,092	3.9	-10			3,078	-24		0			
Rural South East	2,676	2,674	3.4	-2			2,914	238		*0.4			
Rural West	2,889	2,966	3.7	77	2.7		3,464	575		*0.8			
Rural total	5,565	5,640	7.1	75	1								
Rockhampton Regional Council LGA (total)	78,936	86,536		7,600	9.6		113,096	34,160		*1.7	132,225	45,689	

Note: Population numbers in forecast.id for the 2011 base year are derived from Estimated Resident Population from the Australian Bureau of Statistics. These differ from (and are usually higher than) Census counts as they factor in population missed by the Census and population overseas on Census night. They are generally considered a more accurate measure of population size than Census counts. 2011/2016 increase average percentage per annum is 1.3% for Rockhampton, 8.8% for Gracemere, 0.3% for Rural and 1.9% for the Rockhampton Regional Council LGA. * indicates .id forecast figures were different to those calculated using their data and have been adjusted accordingly. [1] is the change number as a percentage of the total LGA population for the 2011 census year. [2] Ur % is

the suburb/locality change as a percentage of the urban increase for the period. [3] AA% is the average annual percentage change from 2011 to 2036. [4] populations extrapolated from the 2011-2036 projection using the average annual population increase from 2011 to 2036 as the variable for extrapolation. [5] People is the change from 2016 to 2050 (to align with the Reef 2050 LTSP timeframe). [6] Rockhampton urban/peri-urban is Rockhampton urban plus Glenlee-Rockyview which is part of the Livingstone Shire LGA.

Table 5-6: Rockhampton Dwellings Projection

	Population		Dwellings / [1]% of LGA dwellings				Increase 2011-36		Dwellings		Increase 2016-2050		
Suburb/Locality	**2011**	**2036**	**2011**	**[1]%**	**2036**	**[1]%**	**No.**	**[2]%**	**2016**	**2050**	**No.**	**[2]%**	**[3]%**
Rockhampton urban													
Allenstown	3,013	3,764	1,592	4.9	1,810	3.9	218	13.7	1,636	1,932	296	18	0.5
Berserker and The Common	7,449	8,364	3,362	10.4	3,776	8.1	414	12.3	3,445	4,008	563	16	0.5
Frenchville	9,370	9,728	3,741	11.5	4,027	8.6	286	7.6	3,798	4,187	389	10	0.3
Kawana	4,857	5,747	1,851	5.7	2,299	4.9	448	24.2	1,941	2,550	609	31	0.9
Koongal - Lakes Creek	5,279	5,655	2,027	6.2	2,243	4.8	216	10.7	2,070	2,364	294	14	0.4
Norman Gardens	8,917	14,568	3,444	10.6	5,796	12.4	2,352	68.3	3,914	7,113	3,199	82	2.4
Park Avenue	5,498	5,680	2,344	7.2	2,423	5.2	79	3.4	2,360	2,467	107	5	0.1
Parkhurst - Limestone Creek - Mount Archer	2,165	12,704	774	2.4	4,898	10.5	4,124	532.8	1,599	7,207	5,609	351	10.3
Rockhampton City and Depot Hill	3,419	5,565	1,581	4.9	2,722	5.8	1,141	72.2	1,809	3,361	1,552	86	2.5
The Range	5,480	5,752	2,012	6.2	2,126	4.6	114	5.7	2,035	2,190	155	8	0.2
Wandal and West Rockhampton	6,183	6,516	2,601	8.0	2,747	5.9	146	5.6	2,630	2,829	199	8	0.2
Rockhampton urban total	61,630	84,043	25,329	78.0	34,867	74.9	9,538	37.7	27,237	40,208	12,972	48	1.4
Glenlee-Rockyview (Livingstone Shire Council)	4,579	5,440	1,240	-	1,584	-	344	27.7	1,310	1,786	476	36	1.0
Gracemere urban													
Gracemere (North)	3,359	7,034	1,376	4.2	2,744	5.9	1,368	99.4	1,650	3,510	1,860	113	3.3
Gracemere (South)	5,280	12,563	1,942	6.0	4,774	10.3	2,832	145.8	2,508	6,360	3,852	154	4.5
Gracemere urban total	8,639	19,597	3,318	10.2	7,518	16.1	4,200	126.6	4,158	9,870	5,712	137	4.0
Mount Morgan District (total)	3,102	3,078	1,534	4.7	1,585	3.4							
Rural South East	2,676	2,914	1,068	3.3	1,192	2.6							
Rural West	2,889	3,464	1,213	3.7	1,411	3.0							
Rural total	5,565	6,378	2,281	7.0	2,603	5.6							
Rockhampton Regional Council LGA (total)	78,936	113,096	**32,462**		**46,573**		**14,111**	**43.5**	**35,283**	**54,474**	**19,191**	**54**	**1.6**

Notes: [1] is the percentage of dwellings by suburb/locality as a percentage of total dwellings in the RRC LGA. [2] is the total increase of dwellings during the time period as a percentage of the start year for the period. [3] is the annual average percentage increase of dwellings during the time period.

Table 5-7: Gladstone Population Projections

	Pr. Population			Increase 2011-2016			Pr. Pop.	Increase 2011-36			Pr. Pop.	Increase 2016-50	
Suburb/Locality	**2011**	**2016**	**[1]LGA**	**People**	**%**	**[2]Ur %**	**2036**	**People**	**[2]Ur %**	**[3]AA%**	**[4]2050**	**[5]People**	**[2]Ur %**
Boyne Island - Tannum Sands	9,950	12,341	16.7	2,391	17.6	30.1	32,095	22,145	48.0	8.9	44,496	32,155	50.3
Callemondah	52	45	0.1	-7	0.1	-0.1	45	-7	0.0	-0.5	41	-4	0.0
Clinton - New Auckland	11,363	13,950	19.1	2,587	19.9	32.6	19,886	8,523	18.5	3.0	24,659	10,709	16.7
Gladstone	6,497	7,560	10.9	1,063	10.8	13.4	12,157	5,660	12.3	3.5	15,327	7,767	12.1
Kin Kora - Sun Valley	4,252	4,540	7.2	288	6.5	3.6	8,488	4,236	9.2	4.0	10,860	6,320	9.9
South Trees	0	0	0.0	0	0.0	0.0	0	0	0.0		0	0	0.0
Telina - Toolooa	5,701	6,581	9.6	880	9.4	11.1	7,188	1,487	3.2	1.0	8,021	1,440	2.3
West Gladstone	5,350	6,091	9.0	741	8.7	9.3	9,399	4,049	8.8	3.0	11,666	5,575	8.7
Gladstone Urban region	43,165	51,109	72.6	7,943	72.9	100	89,258	46,093	100	4.3	115,070	63,961	100
Gladstone LGA balance	16,296	18,989	27.4	2,693	27.4		32,008				40,807	21,818	
Gladstone (R) LGA	59,461	70,098	100	10,637	100		121,266				155,877	85,779	

Note: Pr. Population (Pop.) is projected population. [1] is the change number as a percentage of the total LGA population for the 2011 census year. [2] Ur % is the suburb/locality change as a percentage of the urban increase for the period. [3] AA% is the average annual percentage change from 2011 to 2036. [4] populations extrapolated from the 2011-2036 projection using the average annual population increase from 2011 to 2036 as the variable for extrapolation. [5] People is the change from 2016 to 2050 (to align with the Reef 2050 LTSP timeframe).

Table 5-8: Projected Population Increase

	2011-2021 increase			2016-36 increase			2016-50 increase	
Suburb/Locality	**People**	**%**	**AA%**	**People**	**%**	**AA%**	**People**	**%**
Yeppoon	6,518	38.8	3.9	15,609	77.3	3.9	26,535	131.4
Emu Park	3,070	65.9	6.6	5,375	81.5	4.1	9,138	138.6
Capricorn Coast	9,588	44.6	4.5	20,984	78.3	3.9	35,673	133.1
LSC Peri Urban	10,059	38.6	3.9	21,544	68.0	3.4	36,625	115.6
LSC (other)	619	8.4	0.8	21,544	16.9	0.8	36,625	28.8
LSC LGA	10,678	32.0	3.2	22,849	58.0	2.9	38,843	98.6

Notes: People is the projected population increase for the period. % is the total increase as a percentage of the start year. AA% is the average annual percentage increase for the period.

5.3.3. Gladstone region

QGSO (ABS) projections for the Gladstone region are provided in Table 5-7 along with figures extrapolated from 2036 to 2050.

5.4. Population Growth and Urban Expansion

Population and dwelling projections need to be translated to an areal increase in urban land use over time and then related to water catchments to enable urban water quality impacts to be calculated. This should be done collaboratively with local government to ensure all the local factors are taken into account including:

- local development history and urban development patterns including availability of land;
- trends in inner city urban living including higher density development;
- rates of infill development and redevelopment in existing urban areas including the CBD.

Some of this work may have been undertaken by Councils as part of planning studies during planning scheme preparation, road infrastructure projections, water demand or wastewater treatment needs.

5.5. Broadhectare Studies

Broadhectare studies are carried out by the Queensland Government Statistician's Office (QGSO) to identify the location and quantity (area in hectares), timing of development and dwelling yield of larger land parcels to house Queensland's growing population. The most recent QGSO broadhectare studies covering the Fitzroy region were conducted in 2012.

5.5.1. Rockhampton / Livingstone region

When the last Broadhectare Study was carried out (2012) Livingstone Shire Council was still part of the Rockhampton Regional Council LGA. These combined results are difficult to separate into individual figures for the Rockhampton Regional Council (RRC) and Livingstone Shire Council LGAs.

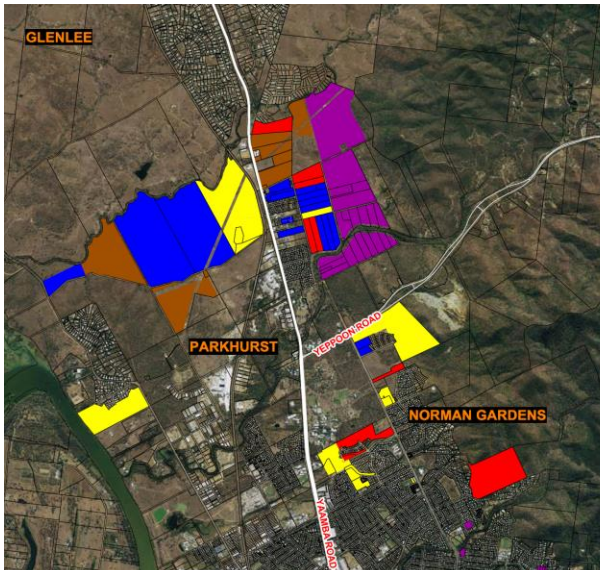
The study concluded "*that the total area of broad hectare land available for residential development is approximately 3,000 hectares. If this land was fully developed it could potentially yield approximately 10,200 dwellings and accommodate approximately 24,600 persons, using current average household sizes. Based on current medium series household projections and a reduced broadhectare dwelling yield (to account for economics of development and ownership issues), the available residential land stock indicates 13 years of supply*." (QGSO - Queensland Treasury and Trade 2012, p.3).

An example of Broadhectare Study mapping is shown in Figure 5-1 (QGSO 2012, p.5). While these maps indicate areas of potential expansion they do not provide specific data for the mapped areas to enable figures for local government areas or statistical areas to be quantified.

RRC LGA projected population growth to 2036 is 34,160 with 22,400 in the urban area alone. The Broadhectare study is not particularly relevant to the timeframe of the Reef 2050 LTSP and is also no longer relevant to RRC or LSC separately due to the de-amalgamation in 2014.

General assumptions used in the Broadhectare Study could however be applied to urban expansion predictions as part of the activities required to quantify potential impacts of urban expansion in the Fitzroy region for water quality improvement decision making.

Figure *5-1: Broadhectare Mapping*



Legend

Broadhectare land Rockhampton RC

Timeframe	Urban residential	Low density residential
0 – 2 years	220 ha	59 ha
2 – 5 years	306 ha	23 ha
5 – 10 years	294 ha	20 ha
10+ years	425 ha	127 ha
Not specified	213 ha	11 ha

Land suitable and potentially available for residential development. Timeframes are indicative only.

5.5.2. Preliminary assessment

As a preliminary indicative assessment we are using simple assumptions and generalisations to provide an indication of future urban growth regardless of the actual location of these potential urban growth areas.

Assumptions are:

- Average household size will remain steady at 2.5 people;
- Standard urban residential development (600m^2 to 1,000m^2 suburban block) will account for 85% of all urban development. The remainder will be higher density infill and redevelopment and will not result in an increase in urban area;
- Average lot size is 800m^2 i.e. 10 lots per hectare (theoretical yield is 12.5 lots per hectare but assume 80% yield and the other 20% is roads, parks etc.)
  (**Note**: QGSO Broadhectare study 2012, (p.1) – "*Standard urban density refers to development yielding between 4 and 15 dwellings per hectare*")

2011 to 2036 urban expansion example: Population increase is 22,400 people x 85% = 19,040 people requiring urban housing. Divide by 2.5 (average household size) = 7,616 dwellings. At ten (800m2) lots with single dwellings per hectare equates to 760 hectares of urban increase.

The .id forecast of new urban dwellings required for Rockhampton by 2036 is 9,538. If we apply the same lot per hectare rule that equates to 950 hectares of urban land required to meet 'demand'.

It should be noted that the Broadhectare Study (QGSO 2012) assumed an average rate of development of 3.4 lots (dwellings) per hectare. At that rate the estimate of urban expansion would be around 2,200 hectares within the Rockhampton Regional Council LGA by 2036 and 3,600 hectares by 2050.

5.5.3. Gladstone region

Summary results of the Broadhectare Study for Gladstone are shown in Table 5-9.

Table 5-9: Gladstone Broadhectare Study Results

Broad hectare stock (hectares)					Theoretic yield	Expected dwelling yield (dwellings) [c]			
Timeframe	Higher density	Stand. urban density	Lower density	Total stock	Dwellings [b]	Higher density	Standard urban density	Lower density	Total dwellings
0–<2 years	36	166	67	269	2,124	1,109	941	74	2,124
2–<5 years	9	429	204	643	2,330	210	1,714	183	2,107
5–<10 years	15	202	47	264	2,132	437	1,430	63	1,929
10+ years	7	200	0	207	1,891	229	1,437	0	1,666
Not specified	11	63	140	214	619	244	207	106	557
Total	78	1,060	458	1,596	9,096	2,229	5,729	426	8,384

Notes: Source is Table 2: Gladstone (R) broad hectare stock and dwelling yield [a] (QGSO 2102, p.).
(a) Components may not sum exactly to totals due to rounding. (b) Yield if all broad hectare stock is developed irrespective of ownership and/or fragmentation. (c) Yield has been reduced to account for likelihood of development due to factors such as ownership and fragmentation.

The study concluded that the broadhectare land available for residential development is 1,600 hectares, which if fully developed could yield approximately 8,400 dwellings and accommodate approximately 21,200 people based on 2011 average household sizes (Note: the average household size for the Gladstone urban area in 2011 was 2.5).

This equates to ten years supply of land for residential development i.e. approximately to 2022. Maps from the study identifying likely expansion areas are included in Appendix D.

If the findings of the broad hectare study (Table 5-9) are extrapolated forward based on the population projections in Table 5-7 then the approximate area of urban expansion from 2016 to 2050 would be around 5,000 hectares (50km^2). The sub catchments where urban expansion to 2050 is likely to occur have not been identified as part of the Fitzroy urban scoping study as further consultation with Council is required.

As previously mentioned understanding the local market and demand type is essential to using population projection data to arrive at a realistic number of hectares of urban expansion and to be able to relate the increase in urban land use to water catchments. This will allow us to estimate the potential ongoing impacts of urban land use on water quality, hydrology and ecosystem health and provide baseline data to identify the type and location water quality improvement measures to mitigate the impacts of urban expansion.

5.6. Point Source - Wastewater Treatment Plants

Treated wastewater (from sewage) discharge is a significant population growth pressure associated with urban areas and is generally the most significant point source activity impacting water quality. Estimating the impact of population growth on treated wastewater discharge rates is more easily quantified than the urban expansion rate due to standard assumptions developed from the operation and monitoring of sewage treatment plants (STP) over time e.g. equivalent person (EP) output of nitrogen to wastewater is approximately 5kg/annum (Jon Brodie pers. comm.).

When these assumptions are combined with discharge figures and water quality monitoring results and reporting associated with licence conditions imposed through the governing legislation (Environmental Protection Act 1994), then a reasonably accurate estimate of future impacts can be calculated and added to catchment models to estimate contributions to end of catchment loads.

5.6.1. Rockhampton region

Rockhampton currently has three wastewater (sewage) treatment plants (STP) servicing the Rockhampton urban area with a fourth plant located at Gracemere. Basic information about the Rockhampton STPs is provided in Table 5-10.

Table 5-10: Rockhampton STPs

	Rockhampton North	Rockhampton South[2]	Rockhampton West[2]	Rockhampton Total	Gracemere
Built	1986	1983	1962		1984, 2004
Treatment type	Extended Aeration / AS	Activated Sludge (AS)	Trickling Biofilter		Continuous Flow EA
Contaminants[1]	SS, BOC, N, BP	SS, BOC, BP	SS, BOC, BP		
Population Served				59,700	5,478
Capacity (Design)	47,000 EP	34,000 EP	11,000 EP	92,000	8,100 EP
Utilisation[3]	46,000 EP	19,120 EP	6,172 EP	71,292	
Utilisation[4]	41,600 EP	22,000 EP	4,600 EP	68,200	6,300 EP
Connections				23,603	1,692
Average day flow	10.4 ML	5.5 ML	1.15 ML	17ML	0.93 ML
Reuse				0%	100%
Annual TN load[5]				71,760kg	na
Annual TP load[5]				52,000kg	na
TN concentration[6]				11.5mg/L	na
TP concentration[6]				8.4mg/L	na

Note: Source is RRC (circa 2009/10) 14172-141009-035906-Sewerage_Infrastructure_Information.pdf and *Sewage Treatment Plants Strategy Planning Study* (SKM 2013) for Rockhampton Regional Council / Fitzroy River Water. Capacity and Utilisation are measured as equivalent persons (EP). EA is Extended Aeration and AS is Activated Sludge.

[1] contaminants are SS = suspended solids, BOC = biodegradable organic carbon, N = total N and BP = Bacterial Pathogens (includes indicators of faecal contamination such as *E. coli*).

[2] not designed for Nitrogen removal. [3] Utilisation is at 2012. [4] Utilisation is at 2009/10.

[5] is as per the long term allowable average (not measured) from licence conditions (see Table 5-11).

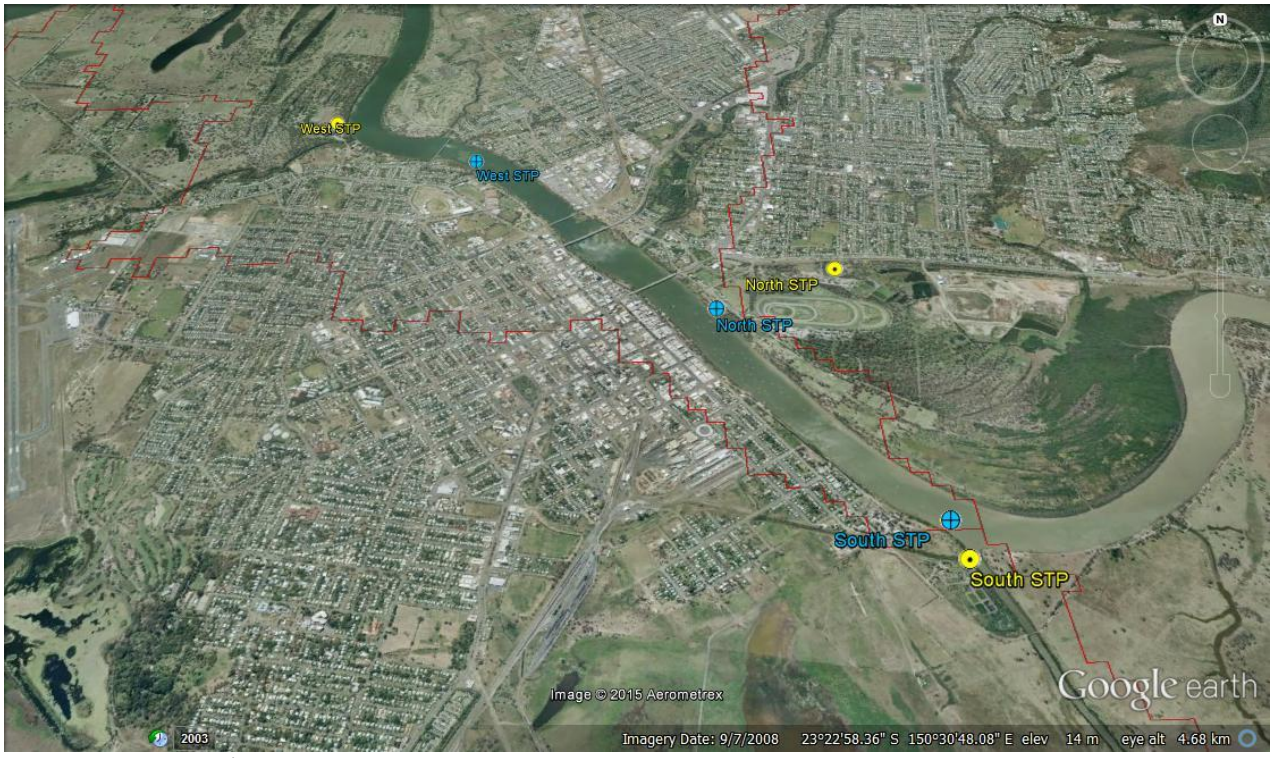
[6] this is a theoretical concentration (not measured) based on Annual load and Average day flow.

5.6.2. Discharge and reuse

Currently the three Rockhampton STPs discharge 100% of treated throughput to the Fitzroy River estuary below the barrage (see Figure 5-2) in accordance with a shared load-based environmental licence. The existing licence allows 1,380kgTN/week and 1,000kgTP/week (50 percentile long term

average) to be released to the Fitzroy River. Maximum weekly release requirements also apply. Effluent standards associated with licence conditions are listed in Table 5-11 for the Rockhampton (TN and TP combined load) and Gracemere (TN and TP concentration) STPs.

Figure *5-2: Rockhampton STPs*



Note: STP location and/or discharge points are shown in yellow. Water quality monitoring points are shown in blue.

Table 5-11: STP Effluent Standards

Parameter	**Effluent standards (Rockhampton combined)**
BOD5	<20 mg/L
DO	>6 mg/L
Suspended solids	<30 mg/L
pH	6.5 - 8.5
Residual Cl2	<0.7mg/L
Faecal Coliforms	<1,000 FC/100 mL median; <4,000 FC/100 mL 80th percentile
Total Nitrogen (TN)[2]	1,380 kg/week Long term 50th percentile; 4,140 kg/week maximum
Total Phosphorus (TP)[2]	1,000 kg/week Long term 50th percentile; 3,000 kg/week maximum
Parameter	**Effluent standards (Gracemere)**
BOD5	<20 mg/L
DO	Na
Suspended solids	<30 mg/L
pH	6.5 - 8.5
Residual Cl2	<0.7mg/L
Faecal Coliforms	<100 FC/100 mL median; <150 FC/100 mL 80th percentile
Total Nitrogen (TN)	8 mg/L 80th percentile
Total Phosphorus (TP)	20 mg/L 80th percentile

Notes: Source is RRC (circa 2009/10) 14172-141009-035906-Sewerage_Infrastructure_Information.pdf. [1] is at 2009/10. [2] is combined calculated mass release rates.

The Gracemere STP has an established recycling scheme in place with close to 100% of the treated wastewater disposed of by irrigation of nearby land. Gracemere also has a high population growth rate and will require upgrades to the plant and the recycling system.

5.6.3. STP upgrades and Improvements

The three Rockhampton STPs (West, South and North) and the Gracemere STP were the subject of review in 2013/14 (SKM 2013) and subsequently a strategy was recommended to Council to ensure the STPs are able to meet both the existing licence conditions and the demands of population growth including an anticipated increase of 8,000 people in North Rockhampton up to 2021. Recommendations included augmentation and upgrades with the main action being an upgrade of the South STP to treat nitrogen and the diversion of sewage from the oldest STP (West) to an upgraded South STP. The West STP is the oldest plant and does not have the capability to remove nitrogen from the waste stream. After the necessary works are carried out the West STP will be decommissioned.

The review also investigated the potential for establishing water recycling schemes for the Rockhampton STPs with favourable and relatively low cost solutions proposed. If implemented these schemes could see a significant reduction in the amount of treated wastewater being discharged to receiving waters from the Rockhampton STPs.

5.6.4. Projected water quality pollutant increase

RRC's planning assumption model (PAM) developed EP projections for STP capacity estimates over time and the review then examined past average dry weather flows (ADWF) and equivalent persons (EP) loads as a 'sanity' check of the PAM projected population growth and future capacity demand (see Table 5-12).

Table 5-12: Draft Projected EPs for Rockhampton STPs

STP	2011	2016	2027	2042	2050
North Rockhampton	6,160 EP	6,191 EP	6,259 EP	6,354 EP	
South Rockhampton	18,700 EP	19,751 EP	22,277 EP	26,250 EP	
West Rockhampton	50,430 EP	53,804 EP	62,017 EP	75,276 EP	
Total	75,200 EP	79,746 EP	90,553 EP	107,880 EP	116,313 EP

Note: Source is Table 2-2 Rockhampton STPs EP projections (SKM 2013, p.13). Figures may be subject to change following a raw sewage characterization study prior to final design for STP upgrades. Total 2050 figure has been extrapolated from the projections in the source table based on the calculated average annual increase of 1,054 between 2011 and 2042.

ADWF values of 220-250 litres per EP per day were adopted for use in the study based on one year of inflow data. More detailed examination of ADWF, EP and EP loads with a larger data set was recommended prior to final design of upgrades. Detailed checks can also be done for EP contribution of ammonia, TKN and TP in raw sewage to enable calculation of potential water quality impacts of an increase in population over time. Initial values nominated by RRC were: CODt (125g/EP/day), BOD (58g/EP/day), TN (13g/EP/day), Ammonia-N (9g/EP/day) and TP (2.3g/EP/d). These are considered typical for Australian conditions and could be used in the absence of any improved data. Based on these figures a preliminary estimate of pollutants delivered to Rockhampton STPs (combined) as population increases is included in Table 5-13.

Table 5-13: Water Quality Pollutant Estimated Increases

Year	Population	CODt	BOD	Ammonia-N	TN	TP
2011	75,200 EP	3,431	1,592	247	357	63
2016	79,746 EP	3,638	1,688	262	378	67
2027	90,553 EP	4,131	1,917	297	430	76
2042	107,880 EP	4,922	2,284	354	512	91
2050	116,313 EP	5,307	2,462	382	552	98

Note: Figures are tonnes per year and are based on figures adopted by RRC in the planning assumption model (PAM) study mentioned above.

Trade waste also needs to be considered when calculating potential future loads and current water quality impacts from industry. Collaboration with Fitzroy River Water is required to determine the implications of the STP review and strategy and to convert preliminary figures in Table 5-13 (pollutants delivered to Rockhampton's STPs) to future pollutant discharge loads and/or concentrations based on actual water quality monitoring results and licence conditions.

5.6.5. Livingstone Shire facilities

Livingstone Shire Council operates and maintains two sewerage schemes along the Capricorn Coast collecting sewage from approximately 11,000 properties. The sewage is transported through 252 kilometres of mains or pipes to two sewage treatment plants (STPs) at Yeppoon (West) and Emu Park.

The Yeppoon sewerage system provides a sewerage service to a population of approximately 15,500 at the localities of Yeppoon, Pacific Heights, Meikleville Hill, Barlow's Hill, Cooee Bay, Taranganba, Lammermoor Beach, Statue Bay, Mulambin Waters and Rosslyn Bay. The Yeppoon West Sewage Treatment Plant has an average dry weather flow (ADWF) design capacity of approximately 1,319 megalitres/year. The system is monitored via a radio telemetry system. Approximately 50% of the Yeppoon STP treated water is reused for irrigation purposes (parks, golf courses and other open space areas).

The Emu Park sewerage system provides a sewerage service to a population of approximately 3,500 at the localities of Tanby Point, Emu Park, Zilzie and the Great Barrier Reef Resort. The sewage treatment plant is located beside the Emu Park Golf Club on the Emu Park Rockhampton Road and uses extended aeration conventional technology with no nutrient removal treatment process. The plant has the capacity to treat 246 megalitres/year.100% of the Emu Park STP treated water is used for irrigation of the golf course. Effluent standards for the two sewage treatment plants associated with ERA licence conditions are listed in Table 5-14 along with general treatment and capacity information.

Table 5-14: Livingstone Coastal STP Effluent Standards

Effluent standards	Yeppoon West STP	Emu Park STP
Parameter		
BOD5	<20 mg/L	<35 mg/L
DO	>2 mg/L	>2 mg/L
Suspended solids	<30 mg/L	<45 mg/L
pH	6.5 - 8.5	6.5 - 8.5
Residual Cl2	1.0 mg/L	1.0 mg/L
Faecal Coliforms	<10 FC/100 mL median <20 FC/100 mL 80th percentile	<10 FC/100 mL maximum

Total Nitrogen (TN)	5 mg/L 50th percentile; 10 mg/L maximum	30 mg/L maximum
Total Phosphorus (TP)	2 mg/L 50th percentile; 3 mg/L maximum	12 mg/L maximum
General information	**Yeppoon West STP**	**Emu Park STP**
Capacity / utilisation	21,000EP / 16,500EP	5,000EP / 3,300EP
ADWF design capacity	1,319 megalitres/year	246 megalitre/year
Treatment process	3 stage Bardenpho	Extended aeration
Average day flow	3.3 ML/d	0.63 ML/d
Annual TN load[1]	12,600kg of N/year	6,900kg of N/year
Annual TP load[1]	3,600kg of P/year	2,800kg of P/year
Reuse	50% - parks, golf course and open space	100% - golf course irrigation

Note: Source is RRC circa 2009/10. 14172-141009-035906-Sewerage_Infrastructure_Information.pdf and https://www.livingstone.qld.gov.au/447/Sewerage-Infrastructure. [1] annual loads are theoretical and calculated from maximum effluent standard multiplied by average day flow.

5.6.6. Gladstone's existing facilities

Gladstone Regional Council has a number of wastewater treatment plants (WWTPs) as summarised in Table 5-15.The (Calliope River) Sewage Treatment Plant (STP) (see Figure 5-3) treats about 97% of Gladstone's sewage to a secondary standard with disinfection prior to release.

Figure *5-3: Gladstone STP (Calliope River Estuary)*

Note: The location of the Calliope River Sewage Treatment Plant (Gladstone WWTP) is shown in red.

Table 5-15:Gladstone Region WWTPs Summary

Treatment Plant	Discharge Point	Capacity	[1]Discharge	Typical Concentrations
Gladstone WWTP	Calliope River	57,400	7.3 ML/d	TN typically <50mg/L TP typically <5mg/L
South Trees WWTP	South Trees Inlet	5,000	0.59 ML/d	Ammonia typically <2mg/L TP typically <2mg/L
Yarwun WWTP	On site irrigation	2,500	0.21 ML/d	Not required to monitor
Boyne Island WWTP	Environmental overflows	8,000	0.85 ML/d	Not required to monitor
Tannum Sands WWTP	Boyne River	15,000	1.2 ML/d	TN typically <4mg/L TP typically <1 mg/L
Calliope WWTP	[2]Unnamed creek	6,000	0.8 ML/d	Not required to monitor

Note: EP is equivalent persons. Capacity is EP. [1] Discharge volumes are approximations. [2] the unnamed creek is a tributary of the Calliope River.

5.6.7. Treated wastewater recycling

The good news story for Gladstone is all the water from the Gladstone WWTP (Calliope River STP) is recycled with the majority of the treated water supplied to Queensland Alumina Limited (QAL) for use in their industrial processing. A portion is used by NRG and a small amount is used on site to irrigate gardens around the treatment plant. The majority of the reused water ends up in shallow tailings dams and evaporates leaving residual nutrients in the tailings sludge. Reuse information for all Gladstone WWTPs is provided in Table 5-16.

Table 5-16: Gladstone WWTP Reuse

Treatment Plant (Location)	Reuse Data	TN load	TP load
Gladstone WWTP (Albert Road, Callemondah)	Industrial reuse - QAL and NRG	133,225	13,323
Yarwun WWTP (Reid Road)	N/A	na	na
Boyne Island WWTP (Handley Drive)	Industrial reuse - QAL	na	na
South Trees WWTP (Wapentake Road)	N/A	430[1]	430
Tannum Sands WWTP (Tannum Sands Road)	Industrial reuse - QAL Irrigation - sport fields / golf course	1,750	440
Calliope WWTP (Stowe Road, Calliope)	Irrigation - golf course	na	na

Note: Loads are kilograms per year and are based on typical nutrient concentrations and (approximate) discharge volumes in Table 5-15. 1 is ammonia not TN. N/A and na is not available and/or not applicable.

5.6.8. Upgrades and improvements

Population growth will result in the need to upgrade the main STP and/or construct an additional plant sometime in the future and increased discharge volumes will also need to be disposed of. Gladstone Regional Council will need to be consulted with regard to long-term planning and their wastewater treatment strategies however GRC has no plans for WWTP upgrades in the short to medium term.

The reuse situation is likely to continue into the future as industry demand for raw water has significantly increased in recent times (see section 6.2.2) and wastewater reuse is seen as a more sustainable alternative than drawing additional water from the finite resource of Awoonga Dam.

5.7. Raw Drinking Water

Another urban related population growth issue is the availability of raw water to treat for household and commercial use. As with wastewater treatment the supply of potable water is a responsibility of local government and is subject to regulation and strict health standards. Water treatment is an environmentally relevant activity (ERA).

While the provision of potable water is not a direct pressure on water quality, except perhaps during the construction of the requisite infrastructure, the water storage infrastructure is usually sited in-stream and can impact river function and ecosystem health.

The main issue associated with the provision of potable water is the quality of the raw water prior to its treatment. Poorer quality raw water requires additional treatment and is more expensive than treating good quality raw water.

5.7.1. Rockhampton region

Rockhampton's raw drinking water is drawn from the Fitzroy River above the Fitzroy Barrage and treated at the Glenmore Water Treatment Plant prior to distribution through the reticulation network.

5.7.2. Livingstone Shire

The Water Park Creek weir is the primary source of raw water for the Capricorn Coast from Yeppoon to Emu Park. Water from the 1.3m high concrete weir, which has a storage capacity of 300ML, is pumped from the Water Park Creek Weir to Kelly's Storage adjacent to the Woodbury Water Treatment Plant (WTP). The Woodbury WTP is located 17 kilometres north of Yeppoon. In 2010, when Livingstone Shire was part of the Rockhampton Regional Council LGA, the Capricorn Coast water supply was supplemented by a potable supply from Fitzroy River Water delivered via the Rockhampton to Yeppoon Pipeline.
(**Note**: Information derived from https://www.livingstone.qld.gov.au/441/Water-Treatment-Plants and https://www.livingstone.qld.gov.au/444/Dams-and-Weirs and https://www.livingstone.qld.gov.au/446/Rockhampton-to-Yeppoon-Pipeline)

Figure *5-4: Fitzroy Barrage and Glenmore WTP*

5.7.3. Gladstone region

Gladstone's raw water is supplied by the Gladstone Area Water Board (GAWB) from Awoonga Dam, which is fed by the Boyne River. Raw water is treated by Gladstone Regional Council at GAWB's two plants:

- Gladstone Water Treatment Plant (Bruce Street) - constructed in 1972 as a 14 megalitre per day plant. Current capacity is 57 megalitres per day with average daily production around 24 megalitres;
- The Yarwun Water Treatment Plant (Reid Road - Yarwun Industrial Estate) - constructed in 1989 as a 3 megalitre per day plant. Recent upgrade to 5 megalitres per day to meet increasing demand in the northern industrial region. Daily production is around 4.3 megalitres.

The responsibility for the source water infrastructure rests with the GAWB and they are required to operate in accordance with their resource operations licence conditions under the Water Act 2000 (see section 6.2.2) (**Note**: waste from the treatment of source water is pumped to STPs for treatment).

5.7.4. Dam influences

On the upside of the water supply process the Awoonga Dam reduces the amount of sediment and nutrients reaching the marine environment as small to medium rainfall events are generally not large enough to result in water overflow from the dam. Sediment and nutrient from the upstream catchment is trapped in the water body behind the dam wall. This is in part due to the relatively large storage capacity of the dam (777, 00ML) in relation to the catchment size (2, 230km2) (see Figure 5-).

Figure *5-5: Lake Awoonga Catchment*

Notes: Map drawn using Qld Globe (© State of Queensland) with catchment and sub catchment boundary GIS information provided by FBA i.e. red and yellow lines.

Exceptions to the norm include extreme events such as happened in 2013 where water was overtopping the spillway to a depth of eight metres.

The dam and its effect on sediment and nutrient loads from the catchment reaching the marine environment need to be factored into calculations during modelling of total catchment and downstream catchment impacts. For most years this would mean treating the Boyne catchment downstream of Awoonga Dam as the marine waters discharge catchment.

In relative terms this would make the urban influence greater as urban land use (Boyne Island/Tannum Sands and east Gladstone) is a significantly higher percentage of the downstream catchment than it is of the total Boyne River catchment (see Table 5-17 and Table 4-2).

There is only one sub catchment (B13) downstream of Awoonga Dam (see Figure 5-).

Table 5-17: Boyne River Catchment Sub Catchments Area

Sub catchment	B12	B13	B15	B16	B17	B18	B19	Total
Area (hectares)	22,928	23,515	47,662	64,594	15,950	22,485	46,144	243,278
% of Boyne R. c.	9.4	9.7	19.6	26.6	6.6	9.2	19.0	100

Note: Boyne R. c. is Boyne River catchment total area.

5.8. Diffuse Source

The land development and construction phase presents as a water quality hazard due to the likelihood of erosion and sediment movement and subsequent potential for harm to water quality and ecosystem health, especially in the near vicinity of the development. As such all urban expansion areas have some level of risk.

In general terms, for existing urban areas (post construction), the larger the impervious surface in urban areas the greater the amount of run-off and the greater the amount of pollutants in the run-off. When impervious surfaces are connected directly to the hard stormwater system (pipes and concrete drains) virtually all the pollutants from urban areas are transported to receiving waters.

Understanding the impact of existing urban areas on water quality therefore requires an understanding of:

- Development patterns and impervious surface percentage;
- Stormwater systems and impervious surface connectedness (see Figure 5-);
- The ratio of 'hard' and 'soft' stormwater systems;
- The presence/absence of stormwater quality improvement measures.

5.9. High Risk Development Areas

The high risk water quality impact areas in terms of urban land use are different to rural risk areas identified through spatial analysis coupled with water quality monitoring and catchment modelling e.g. catchments susceptible to erosion. Defining water quality risk from urban areas requires separate processes for (future) developing urban areas and existing urban areas.

5.9.1. Development and Construction Phase

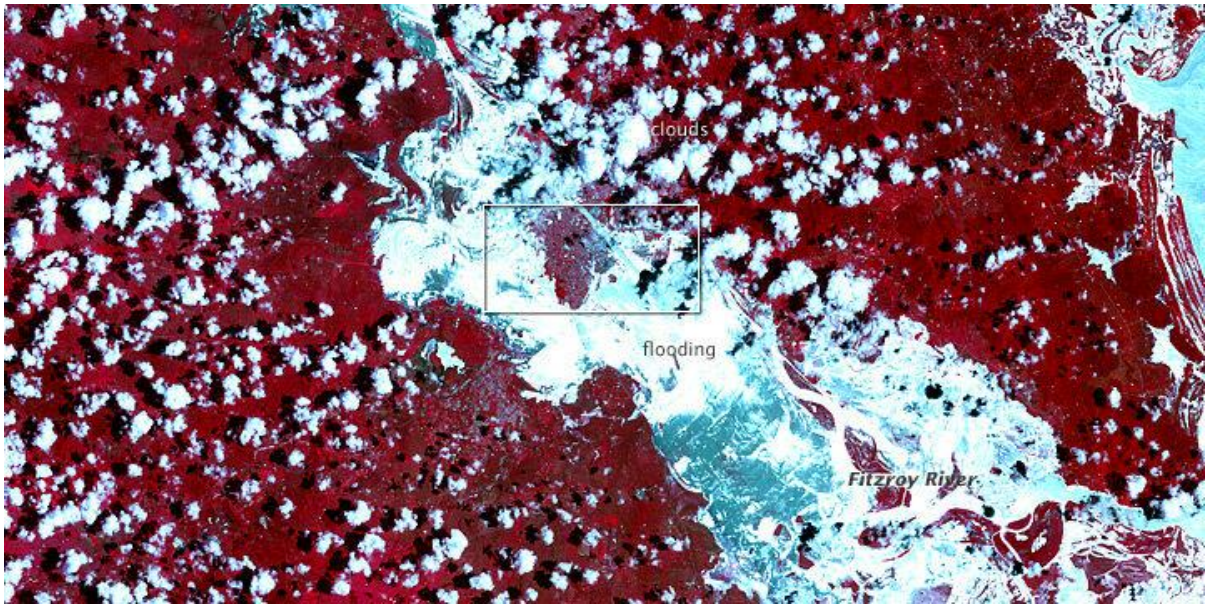
Urban expansion has some level of risk during the development and construction phase due to the exposure of soils to erosive processes. Existing development approval mechanisms have an in built 'risk management process' in the form of identified development hazards and constraints (overlays). This applies to flood prone areas, steep lands and other physical limitations that would place people, property and/or the environment at risk. Land use planning studies and methodologies utilised by local government to prepare their planning schemes and planning scheme policies could be used as a base for quantifying theoretical risk levels to receiving waters associated with urban development.

Actual risk to receiving waters associated with future urban development areas requires a method that takes into account the existing development approval mechanisms as it is assumed that most high risk areas have already been excluded from development by planning scheme hazard and constraint overlays. Quantitative and qualitative filters for the method will include:

- The physical properties of development sites (e.g. slope, geology and soils);
- The values and characteristics of receiving waters;
- Proximity to receiving waters;
- Legislative and regulatory constraints;
- Development approval conditions;
- Capacity of local government and state agencies to ensure compliance with development permits.

This will provide a likelihood component of the risk assessment to accompany the hazard component which is included in planning studies and/or can be derived from land use and physical constraints mapping and analysis.

Figure *5-6: Rockhampton 2011 Flood Extent*



Note: The inset shows south Rockhampton urban (darker) area surrounded by flood waters (lighter).

An example of areas where standard development would not be approved was captured by satellite imagery when flood water from the Fitzroy River isolated Rockhampton in 2011 (see Figure 5-).

A significant risk component associated with developing urban areas is the amount of soil exposed and/or disturbed at any point in time. This varies from site to site and by development and construction operant. It also involves the policy settings of the administering authority (usually local government) and the level of resources available to ensure compliance with development conditions. This component is difficult to quantify however it is an extremely important aspect of stormwater quality management and needs to be factored into the risk assessment process.

5.9.2. Existing urban (post-construction)

The ongoing long-term water quality impact of existing urban areas needs to be quantified before any realistic hazard and risk assessment for water quality can be carried out. This involves, among other things, identifying:

- Urban stormwater sub catchments in relation to WQIP sub catchments;
- The ratio of impervious surfaces by urban stormwater sub catchment;
- The level of connectedness of impervious surfaces to 'hard' stormwater systems;
- The values and characteristics of receiving waters;
- Presence/absence of stormwater quality treatment measures by stormwater sub catchment;
- Efficacy of stormwater quality treatment measures including maintenance regimes;
- Potential for regional stormwater quality treatment measures.

This information will enable meaningful analysis of impact risk and provide a base for prioritising interventions.

Stormwater systems have historically been designed based on the hydrological capacity of the pipes and concrete drains constructed to transport stormwater away from urban areas to reduce flood impacts. Stormwater systems were not designed with consideration for the environmental values of natural waterways and receiving waters in mind.

Accurate location of stormwater system catchments is important as they are artificial constructs and may not necessarily mimic natural water catchments or discharge to the nearest natural drainage line. Often the location of the natural and altered drainage system is not overly accurate and this may require an extra level of GIS processing prior to embarking on catchment delineation. This is relatively easy now with GIS tools and the use of a LIDAR, if available, to define waterway locations and catchment boundaries.

5.10. Gladstone Region

Gladstone Regional Council has provided GIS data showing their mapped stormwater systems as a starting point to assess the water quality impacts associated with urban stormwater runoff from existing urban areas (see Figure 5- and Figure 5-). Additional information is required to complete the risk analysis.

An example of a stormwater system in a developing urban area in the Gladstone hinterland, where the majority of future development is likely to occur, is shown in Figure 5-.

Figure *5-7: Gladstone Core Existing Urban Area*

Notes: Orange lines indicate the location of stormwater system pipes in the central Gladstone urban area.

Figure *5-8: Inner Gladstone Stormwater Management System*

Note: Orange lines indicate the location of sub surface stormwater drainage (pipes). Yellow is open drains and purple is 'roof lines' i.e. ridges defining catchments. Red lines are FBA WQIP sub catchment boundaries (see *Figure* 4-3). The Calliope River STP is indicated by the red dotted circle.

Figure 5-9: Developing Urban Area Hazard

Notes: Orange lines indicate the location of sub surface stormwater drainage (pipes). Yellow is open drains and purple is 'roof lines' i.e. ridges defining catchments.

5.11. Rockhampton Region

In some parts of the Rockhampton CBD impervious surfaces are close to 100% with all the run-off from roofs, pavement and other impervious surfaces using roads as the drainage system on the way to receiving waters.

Rockhampton Regional Council has some base mapping and studies that can be collated to assist with determining the water quality impact of existing urban areas. Given Rockhampton's location next to the Fitzroy River and the history of flooding the mapping and studies viewed to date are more relevant to flooding and stormwater quantity management however water quality relevant information is also embedded in the studies and mapping including the location of stormwater infrastructure, hydrology, flood hazard areas and other development constraints.

5.12. Climatic Considerations

Climate change possibilities need to be considered in any risk assessment process as rainfall distribution and intensity is particularly relevant in the context of developing urban areas and the potential for sediment movement to receiving waters. Changes to urban catchment hydrology from increased impervious surfaces also has implications for local stream and ecosystem health in existing urban areas if rainfall intensity and/or storm frequency increases as a climate change effect.

5.12.1. Current climate

The Tropic of Capricorn passes through the Fitzroy region so technically Rockhampton and the Capricorn Coast would be classed as tropical while Gladstone would be classed as sub-tropical. In reality the climate of the Fitzroy region near coastal urban areas is not defined by such definitions. While climate is somewhat similar in terms of average annual rainfall (815mm to 915mm) and average temperature range (28°C to 17°C) there are variations associated with local geography and topographic features e.g. Rockhampton is approximately 40 kilometres from the coast. As a result of Rockhampton's inland location it has greater temperature variations (high, low and averages) compared to the coastal urban centres of Gladstone and Yeppoon.

Average annual rainfall is also less for Rockhampton (see Table 5-19) with Yeppoon (see Table 5-20) receiving the greatest average precipitation of the three areas. While amounts may vary the pattern of precipitation is similar for all three centres (see Table 5-18) as reflected in historic climatic figures for Gladstone (see Table 5-21).

The figures show 65% of the average precipitation falls during the wet season i.e. five months from November to March, with 47% usually falling between December and February. 72% of Gladstone's annual precipitation is generally received from October to March (six months) with June to September being the driest period (15.2% combined total).

Table 5-18: Rainfall Seasonal Comparison

Urban centre	Monthly average rainfall (mm)					Percentage of annual average			
	Nov	Dec	Jan	Feb	Mar	De-Fe	No-Ma	Oc-Ma	Jun-Se
Gladstone	74.2	128.8	143.4	143.4	82.6	47.2	65.0	72.1	15.2
Yeppoon	71.3	122.6	133.3	173.6	136.6	43.8	64.9	69.6	16.1
Rockhampton	68.6	107.8	132.2	143.2	101.0	47.0	67.8	73.9	14.9

Notes: Percentage of annual average refers to the amount of rainfall in each time period i.e. De-Fe is December to February (most intensive), No-Ma is November to March (wet season), Oc-Ma is October to March (the six month period with highest rainfall averages) and Jun-Se is June to September (the driest quartile).

5.12.2. Climate change reporting

Broad climate change studies covering the Fitzroy region have been undertaken including studies specific to particular industries e.g. beef cattle and natural gas. Some of these studies and coverage areas include:

1. The East Coast cluster - six coastal regions from Rockhampton to Sydney including;
    a. Climate Change and Agriculture: a study for the Fitzroy Basin Association (2014).
2. Practical Adaptation to Climate Change in Regional Natural Resource Management including;
    a. Queensland Case Studies – Fitzroy Basin Report - Part A – Production and natural resource indicators in beef systems under climate change conditions (2009).
3. ClimateQ: toward a greener Queensland;
    a. Climate change in the Central Queensland Region (Queensland Climate Change Centre of Excellence (QCCCE) 2009).
4. Responding to Climate Change in the Fitzroy Basin (Routley, R. 2009, QPI and F, Toowoomba).

For most part these studies and reports (see extracts in Appendix E) base their climate change projections on the 2007 publication Climate Change in Australia Technical Report, produced by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of

Table 5-19: Climate Data for Rockhampton (Airport)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °C	42.5	43.3	42.1	35.4	32.6	32.3	30.6	35.1	37.1	41.1	45.3	41.3	45.3
Average high °C	31.9	31.2	30.5	28.8	26.0	23.5	23.1	24.8	27.3	29.6	31.2	32.1	28.3
Average low °C	22.1	22.1	20.8	17.9	14.1	10.9	9.5	10.7	13.7	17.0	19.5	21.2	16.6
Record low °C	16.3	16.2	11.0	4.7	2.9	−1.0	−0.9	−0.3	3.4	7.0	9.4	10.2	−1.0
Average rainfall mm	132.2	143.2	101.0	44.2	47.7	38.5	29.9	28.5	24.3	49.7	68.6	107.8	814.8
Average rainy days (≥ 0.2 mm)	11.2	12.3	10.1	6.6	6.2	5.0	5.2	4.3	4.1	6.5	7.8	9.8	89.1
Average relative humidity (%)	53	57	54	49	47	46	42	40	40	42	46	49	47

Source is *Climate statistics for Rockhampton*, Australian Bureau of Meteorology (http://www.bom.gov.au/climate/averages/tables/cw_039083_All.shtml) retrieved 20 June 2013 at https://en.wikipedia.org/wiki/Rockhampton.

Table 5-20: Climate data for Yeppoon (The Esplanade)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °C (2011)	29.3	29.3	28.4	26.6	24.2	21.9	21.4	22.1	24.3	26.1	27.4	28.8	25.8
Average high °C (2014)	29.3	29.2	28.3	26.6	24.1	21.9	21.4	22.1	24.4	26.1	27.5	28.7	25.8
Average low °C (2011)	23.7	23.7	22.4	19.7	15.6	13.3	11.7	12.7	15.6	19.1	21.3	22.8	18.5
Average low °C (2014)	23.7	23.6	22.4	19.7	15.7	13.4	11.8	12.6	15.7	19.0	21.3	22.7	18.5
Average precipitation mm (2011)	123.5	170.4	90.1	70.4	74.4	59.1	25.6	40.3	36.8	48.8	74.5	131.0	928.8
Average precipitation mm (2014)	133.3	173.6	136.6	73.8	78.7	55.5	29.6	36.4	36.6	45.9	71.3	122.6	981.7

Source is *"Climate statistics for Yeppoon AWS"* Australian Bureau of Meteorology. December 2011 (retrieved 27 December 2011 at https://en.wikipedia.org/wiki/Capricorn_Coast and *Climate statistics for Yeppoon AWS*, Australian Bureau of Meteorology, March 2014 (retrieved 1 April 2014 at https://en.wikipedia.org/wiki/Yeppoon.

Table 5-21: Gladstone Climatic Information

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °C	38.3	40.1	42.0	34.4	31.3	29.7	29.4	31.6	33.8	40.0	40.1	39.8	42.0
Average high °C	31.2	30.9	30.2	28.4	25.7	23.2	22.8	24.0	26.4	28.4	29.9	31.0	27.7
Average low °C (°F)	22.5	22.4	21.5	19.6	17.0	14.3	13.3	14.2	16.4	18.7	20.5	21.9	18.5
Record low °C (°F)	12.8	17.2	16.2	11.0	8.5	6.1	4.4	4.7	9.6	10.9	14.7	12.4	4.4
Average precipitation mm	143.4	143.4	82.6	46.2	60.5	39.4	35.2	32.4	26.5	62.3	74.2	128.8	880
Percentage of average prec.	16.3	16.3	9.4	5.3	6.9	4.5	4.0	3.7	3.0	7.1	8.4	14.6	100

Source: Australian Bureau of Meteorology (June 2011. Retrieved 11 May 2009) adapted from https://en.wikipedia.org/wiki/Gladstone,_Queensland

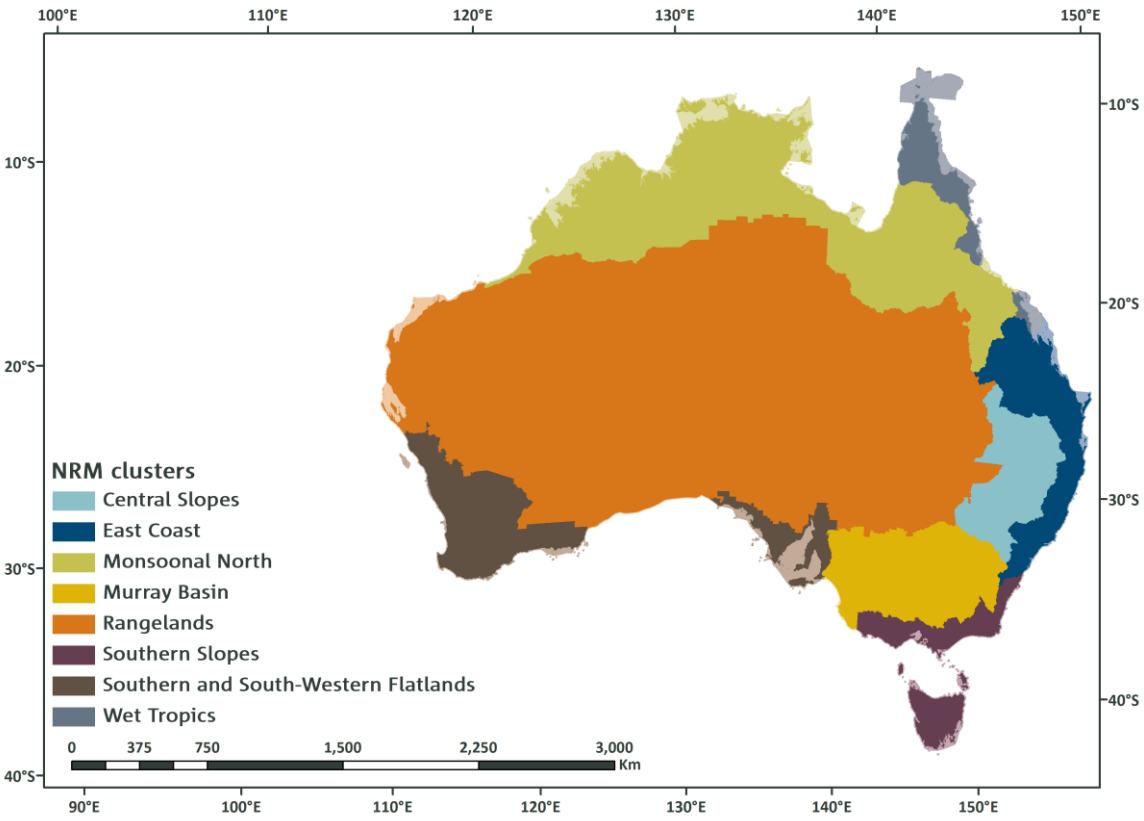
Meteorology (BoM). Climate Change in Australia was based on international climate change research including conclusions from the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) along with a large body of climate research undertaken for the Australian region by CSIRO, BoM and the Australian Greenhouse Office.

The above reports have no information directly related to water quality and urban areas however there is reference to agriculture and the potential for increased amounts of sediment and nutrients being delivered to waterways from rural areas under different scenarios. In his climate change review Ross Garnaut (2008, p.120) noted the likelihood of urban water supplies being impacted by climate change if lower rainfall trends continued on the same trajectory as a decrease in rainfall can result in a two to threefold decrease in stream flow. Again there was no mention of water quality implications.

Climate Change in Australia was updated and reissued in 2015 following the release of the IPCC's Fifth Assessment Report. A significant addition was the production of cluster reports based on a combination of 'climatic' regions and natural resource management (NRM) regions. The Fitzroy region is included in the north sub-cluster of the East Coast cluster (see Figure 5-) along with the Burnett-Mary and SEQ NRM regions.

In the absence of any urban specific projections for Gladstone or Rockhampton the East Coast Cluster Report (Dowdy, A. et al 2015) is the most relevant and up to date information to consult when considering climate change impacts on urban areas for the Fitzroy region.

Figure *5-10: Climate Change in Australia NRM Clusters*



Note: Source is Dowdy, A. et al 2015, Figure 2.1 (p.16). Creek to Coral commissioned CSIRO to prepare climate change projections for Townsville during preparation of the Townsville WQIP.

5.12.3. Projected climate changes

The East Coast Cluster Report (Dowdy, A. et al 2015) provides a summary of relevant biophysical and climatological features with climate change projections presented for the two sub-clusters i.e. the Queensland side (East Coast North) and the New South Wales side (East Coast South). Observed and predicted climate changes for the East Coast Cluster (ECC) include:

- Mean surface air temperature has increased by about 1°C between 1910 and 2013 (ECC North);
- Substantial warming for ECC for mean, maximum and minimum temperatures are projected with *very high confidence*;
    - Near future (2030), the mean warming is around 0.4 to 1.3 °C above the climate of 1986–2005,
    - Late in the century (2090) it is 1.3 to 2.5°C for RCP4.5 and 2.7 to 4.7 °C for RCP8.5.
- A substantial increase in the temperature reached on the hottest days, the frequency of hot days and the duration of warm spells is projected with *very high confidence*,
    - Correspondingly, a substantial decrease in the frequency of frost risk days is projected by 2090 with *high confidence*.
- The ECC experienced prolonged periods of extensive drying in the early 20th century. No annual rainfall long-term trend evident throughout the 20th century;
- A *high confidence* that natural climate variability will remain the major driver of rainfall changes in the next few decades with;
    - 20-year mean changes of -15 to +10% annually, and
    - -30 to +20% seasonally (relative to the climate of 1986–2005).
- Models show a broad range of results for ECC (North) by 2090 with the median generally indicating little change or decrease, particularly in winter and spring[1];
- *High confidence* that the intensity of heavy rainfall events will increase;
- Greater time spent in meteorological drought is projected with *medium confidence* by 2090;
- Increase in the frequency and duration of extreme drought is projected with *low confidence*;
- Little change in mean surface wind speed is projected by 2030 (*high confidence*) and with *medium confidence* by 2090;
- Tropical cyclones are projected to become less frequent but with increases in the proportion of the most intense storms (*medium confidence*);
- Little change is projected for solar radiation for 2030 with *high confidence*;
- There is *high confidence* in little change in relative humidity for the near future (2030);
- *Medium confidence* in a decrease in relative humidity (-3.5 to 1.9 % for 2090;
- Potential evapotranspiration increases in all seasons by 2090 (*high confidence*);
- Only *medium confidence* in the magnitude of evapotranspiration increases;
- Soil moisture overall seasonal decreases for 2090 (*medium confidence*) (Note: Changes are strongly influenced by changes in rainfall but tend to be more negative due to the increase in potential evapotranspiration);
- Runoff is projected to decrease by 2090 (*low confidence*[2]) depending on rainfall trends;
- *High confidence* that climate change will result in a harsher fire-weather climate in the future[3];
- Relative sea level has risen around Australia at an average rate of 1.4mm per year from 1966–2009;
- *Very high confidence* that sea level will continue to rise during the 21st century;
    - The projected range of sea level rise for the EEC coastline is 0.08 to 0.18m above the 1986–2005 level by 2030,
    - A sea level rise of 0.44 to 0.88m by 2090.

- Sea surface temperature (SST) warming is projected to continue with *very high confidence*;
- V*ery high confidence* that the ocean around Australia will become more acidic;
  - By 2030, pH is projected to fall by up to 0.08 units in the coastal waters of the cluster. By 2090,
  - Decreases in pH of up to between 0.1 and 0.14 by 2090.
- H*igh confidence* that the rate of ocean acidification will be proportional to carbon dioxide emissions.

[**Notes**: [1]Contrasting model simulations highlight the potential need to consider the risk of both a drier and wetter climate in impact assessment in this cluster. [2]Hydrological modelling is needed to confidently assess changes to runoff. [3] *low confidence* in the magnitude of change due to significant uncertainties in the rainfall projection.]

5.12.4. Climate change scenarios

What does this mean for urban areas? Scenarios need to be investigated using parameters with very high and high confidence projections as constants while parameters with medium and low confidence projections would be variables. This would result in the generation of a range of scenarios which could then be used as an adjunct to the risk assessment process for future urban development areas and existing urban areas. The main climate change issue associated with urban expansion would be the potential for increased erosion while existing urban areas could be threatened by the potential degradation of stormwater management assets and a subsequent reduction in their effectiveness.

The East Coast Cluster Report provides guidance on how climate projections can be framed in the context of climate scenarios using tools such as the Climate Futures web tool (available on the Climate Change in Australia website - http://www.climatechangeinaustralia.gov.au/). Chapter 9 of the Climate Change in Australia Technical Report (CSIRO and Bureau of Meteorology 2015) describes these products in detail. Analysis of climate change scenarios for urban areas would be a function of future investigations as there is no useful reference material available on the subject for the Fitzroy region at present.

Based on the projections in the East Coast Cluster Report future investigations for potential impacts on urban water quality would involve scenarios based on:

- Increasing temperature;
- Increase temperature of hottest days, the frequency of hot days and the duration of warm spells;
- Increase in intensity of heavy rainfall events;
- Increasing evapotranspiration;
- Harsher fire-weather climate.

Scenario variables would include; mean rainfall, run-off, soil moisture and drought frequency and extent.

Climate change effects associated with the marine environment would be considered as a separate exercise and would be related mostly to property damage as a result of sea level rise and the subsequent changes to the frequency of extreme sea levels e.g. storm surge especially associated with cyclones, and any perceived need to modify planning provisions to reduce the possibility of development occurring in coastal hazard areas.

5.13. Atmospheric Deposition

Atmospheric deposition is the settling of gaseous or particular material suspended in the atmosphere as wind-blown particles (dry deposition) or as wash down by rain (wet deposition). The quantum of atmospheric deposition is particularly relevant to urban areas due to the amount of impervious surfaces and the reduced opportunity for pollutants to be removed from stormwater prior to reaching receiving waters.

A variety of atmospheric deposition studies have been undertaken principally to determine the impact of anthropogenic activities on the environment and built infrastructure. Studies initially focused on industrial activities due to the observed impacts of acid rain (sulphur and nitrogen compounds) in Europe and North America with more recent studies investigating agricultural activities.

Depending on the purpose of studies atmospheric deposition is measured in different ways. Measured pollutant concentration in rainfall is useful for wet deposition while total annual deposition per hectare is useful if available. Due to a general lack of atmospheric deposition research in rural and regional Australia assumptions may need to be made based on relevant Australian and international literature.

"*In 1995, the first global precipitation chemistry assessment was released as a World Meteorological Organization publication (Whelpdale and Kaiser, 1996).*" A follow up (second) assessment "*presents a global overview of worldwide deposition"* using quality assured precipitation chemistry and deposition measurements obtained from regional and national monitoring networks *"to complement and validate the best available global models*." (Vet et al 2014). Vet et al (2014) found that there was less dry deposition than wet deposition measurements with dry deposition estimates being complicated by different methodologies used in different parts of the world. The assessment "*does not attempt to address deposition from fog, clouds, and dust storms*" or "*the wet and dry deposition of organic nitrogen due to the lack of network measurements*" even though "*organic nitrogen may account for about 30% of total airborne nitrogen*" (Vet et al 2014, p.5). The data set and maps generated through the assessment is available at the World Data Center for Precipitation Chemistry website (http://www.wdcpc.org/assessment).

Atmospheric deposition was investigated during the preparation of the Black Ross (Townsville) WQIP with a section devoted to the subject in the Water Quality Pollutant Types and Sources Report (Gunn and Barker 2009). Atmospheric deposition rates (the sum of dry and wet deposition) used for the Townsville WQIP to estimate end of catchment load contributions from that source were: PM10 15 kg/ha/year, N 4kg/ha/yr and P 0.4 kg/ha/year (Gunn and Barker 2009, p.91).

Research findings reported by Anderson and Downing (2006) in Water, Air, and Soil Pollution (2006 176: 351-374), provides some pertinent points about dry and wet atmospheric deposition of nitrogen, phosphorus and silicon (particulates) in an agricultural region which are relevant to urban areas. They also interrogated sampling methods used in previous studies and found some issues which may have skewed results towards underestimates for dry deposition. A summary of their results is included in the text box below.

Anderson and Downing (2006) "measured atmospheric nutrient deposition as wet deposition and dry deposition to dry and wet surfaces." They analysed the measurements and provide "estimates of atmospheric transport of nitrogen (N), phosphorus (P) and silicon (Si) in an agricultural region."

Annual dry and wet deposition was estimated as:

- 0.3 kg of P / ha / year;
- 7.7 kg of N / ha / year;
- 6.1 kg of Si / ha / year.

The estimates were lower than or similar to values measured in other landscapes. "Wet deposition estimates were consistent over hundreds of km, but dry deposition estimates were influenced by animal confinements and construction." "Precipitation wash-out of atmospheric nutrients was substantial but larger rain events yielded higher rates of wet deposition." Other key points are:

"N:P and Si:N imply that atmospheric deposition enhances P and Si limitation";

- "Most P and soluble reactive P (SRP) deposition occurred as dryfall";
- "Most dry-deposited P was SRP so would be more readily assimilable by plant life than rainfall P";
- "Dry deposition of N to wet surfaces was several times greater than to dry surfaces, suggesting that ammonia (NH_4) gas absorbtion by water associated with wet surfaces is an important N transport mechanism";
- Annual wet deposition and dry deposition of N to wet surfaces were approximately equal, owing to very large NH_x-N deposition derived from gas transport;
- "Deposition of all nutrients peaked when agricultural planting and fertilization were active [spring]";
- "Ratios of NH_x:nitrate (NO_x) reflected the predominant use of NH_x fertilizer.";
- It is essential to measure dry deposition and wet deposition when estimating budgets of N, P, or Si.

"*Methodological results showed that local dust contaminated wet deposition more than dry; insects, bird droppings and leaves may have biased past deposition estimates; and estimating dry deposition to dry plastic buckets may underestimate annual deposition of N, especially* NH_x". "*Atmospheric nutrient deposition varies seasonally and may be related to tillage and fertilization schedules in agricultural areas as well as other activities in the airshed.*" "*Dry deposited nutrients appear to be driven somewhat by more local disturbance, and extrapolation to areas of divergent land use may be inaccurate.*" (Anderson and Downing 2006, p.351 and 4. Conclusions, pp.370-1)

While the results of Anderson and Downing were not included in the Townsville WQIP literature review (Gunn and Barker 2009) they provide an additional insight into atmospheric deposition sources and pathways which can be used as a 'check' for urban areas. In particular "*the data indicated that dry deposition can be more important than wet deposition, especially for P and* NH_x" (Anderson and Downing 2006, p.359) while "*dry deposition appears to be driven by more localised processes than wet deposition*" (p.363). These factors should be noted and considered when estimating atmospheric deposition rates to model contributions of nutrients from urban areas to receiving waters.

An example of this local context is the substantial difference in total nitrogen (TN) atmospheric deposition estimates between Anderson and Downing and that used for the Townsville WQIP. The difference is a result of the research context as Anderson and Downing were measuring agricultural input in an agricultural region. As they noted "*nutrients peaked when agricultural planting and fertilization were active*" and was generally associated with the use of ammonia based fertilisers. The TN and NH_x deposition would be expected to be lower in urban areas without the influence of those agricultural land use inputs.

Rates of atmospheric deposition of nitrogen, phosphorus and particulate material as measured and/or estimated in various studies and literature reviews are discussed briefly below.

5.13.1. Nitrogen

Nitrogen is a macro-nutrient that is essential for all living things. Atmospheric nitrogen generally exists as a stable compound i.e. N_2, which requires an input of energy to break the atomic bonds and enable a chemical transformation to an oxide (NO_x). Lightning can provide the required energy as can forest fires, volcanism and lava flows. The other significant type of atmospheric nitrogen is ammonia (NH_x) with natural sources including N_2 conversion by nitrogen fixing bacteria.

Fossil fuel combustion, animal husbandry practices, nitrogen fertilizer production and application, and other human activities add substantial amounts of nitrogen compounds to the atmosphere every year. Higher airborne nitrate and ammonium concentrations from these activities increases the wet and dry deposition rates of nitrogen.

"*International research indicates that human activities such as the burning of fossil fuels and the production and application of fertiliser have resulted in an increase in the rate of atmospheric deposition of reactive nitrogen of between two and ten times pre-industrial levels (Clark and Tilman 2008; Bergstrom and Jansson 2006). Further, over 80% of global nitric oxide emissions and 70% of ammonia emissions are thought to be generated by anthropogenic sources (Vitousek et al)*." (in Gunn and Barker 2009, p.52).

As well as the 'normal' background levels of TN atmospheric deposition (wet and dry) urban areas would be expected to have higher NO_x levels due to vehicle and industrial emissions while NH_x (ammonia) levels would be lower than in agricultural areas. Some measured and estimated nitrogen concentrations in rainfall and/or areal deposition rates (dry and/or wet) from reviewed literature are included in Table 5-22.

5.13.2. Phosphorus

"*The phosphorus cycle does not contain any long-lived gaseous forms and as such contributes little to the atmosphere*." (Gunn and Barker 2009, p.55). "*P deposition originates from soil and does not become incorporated into rainfall to a great degree*" (Anderson and Downing 2006, p.359). It is assumed that atmospheric deposition of phosphorus will be a result of wind erosion and in particulate form attached to fine soil particles and therefore dry deposition is the more important pathway for P while washout in rainfall contributes to P deposition to a lessor degree. Measured and estimated P concentrations in rainfall and/or areal deposition rates (dry and/or wet) from reviewed literature are included in Table 5-22.

5.13.3. Particulate material

Particulate material is the term used to describe solid particles that are suspended in the air. Size is the main determinant of the behaviour of an atmospheric particle influencing the aerodynamic properties and falling speed. Larger particles (greater than 50µm) usually only remain in the air for a few minutes before settling out of the air column (dry deposition). Smaller particles (less than 10µm, referred to as PM_{10}) can remain in the air for several days and can be spread by winds over wide areas or long distances from the original source before settling.

Finer particles (between 0.1-2.5µm) may remain in the atmosphere indefinitely. Particulate material is also deposited in rainfall (wet deposition) and is usually referred to as washout. Washout is important in scavenging the finer particles (<1µm) and 'cleaning' the air. [**Note**: The average human hair has a diameter of 60µm].

Windblown dusts, pollens from plants, sea salts and bushfires are natural sources of particles in the atmosphere while agricultural and forest hazard-reduction burning release smoke particles into the air. Combustion processes using coal and other fossil fuels, such as power generation, industrial operations and motor vehicle fuels, emit most of the particulate matter in urban areas (Gunn and Barker 2009, p.64). Measured and estimated areal particulate deposition rates (dry and/or wet) from reviewed literature include:

- 36 kg/ha/year measured at Adelaide Wilkinson et al 2006 (G&B);
- 33 to 123 kg/ha/year in a French forest and open field (Lequy et al 2014).

To put it in perspective 100kg/ha/year of particulate deposition is equivalent to a depth of 0.01 millimetres so the quantum of particulate sediment is not a water quality issue in itself. Atmospheric deposition of particulate material is however the delivery mechanism for a variety of pollutants including particulate phosphorus and heavy metals e.g. zinc, copper, lead and mercury.

5.14. Environmentally Relevant Activities

The *Environmental Protection Act 1994* (EP Act) defines environmentally relevant activities (ERA) in general terms as an activity that will or may result in a contaminant being released into the environment that will or may cause environmental harm (see Gunn 2015, Fitzroy Region Urban Scoping Report). ERA are in effect the high risk activities that may impact water quality (see section 5.6)

The *Environmental Protection Regulation 2008* lists ERAs including point source emitters such as wastewater (sewage) treatment plants (see section 5.6). While wastewater treatment is the main ERA that discharges pollutants to receiving waters from urban centres there are other ERAs that have the potential to impact water quality.

5.14.1. Gladstone region

The Gladstone region has a large industrial base and many of the industries would involve ERAs. Determining the impacts of industry on water quality would require a collaborative effort in partnership with the Department of Environment and Heritage Protection (EHP), the government department responsible for licencing and compliance monitoring of ERAs. Industrial ERAs are not addressed in this report.

5.14.2. Rockhampton region

Rockhampton Regional Council provided information on the landfill ERA including a report on the artificially created wetlands that resulted from clay extraction when the landfill was established in 1980. Further investigations are required to determine the likelihood of any water quality impacts associated with the ERA and any environmental values associated with the wetland. The area may be suitable to implement regional water quality improvement measures.

Table 5-22: N and P Atmospheric Deposition

Study	Location	TN [1]	TP [1]	TN (kg/ha/year)	TP (kg/ha/year)	Notes
Vet et al 2014 (Addendum)	Global assessment	90 µg per litre		1.39		Australian estimate
Furnas 2003 (G&B)	Great Barrier Reef	100 µg per litre	7 µg per litre			Rainfall to GBR lagoon
Wilkinson et al (2006) (G&B)	Adelaide	403 µg per litre		0.3 to 8.1		Industrial area influence
Turner et al 1996	NSW state forests			0.18 to 10.9	0.02 to 0.29	Forest areas
McDowell and Sharpley 2009	Pennsylvania			2.33	0.36	Woodland
Hall and Matson 2003 (G&B)	Global deposition			2		Pre industrial estimate
Holland et al 2001 (G&B)	Global tropical			1.6[2] [1.19 to 1.85]		Pre industrial estimate
Lohse et al 2008	Phoenix, Arizona			<6		Arid urban centre
Vet et al 2014 (Addendum)	Global assessment				0.22	Global average
ATM Inc. and JE Inc. 2012	Florida, USA			3.96[2] [2.90 to 4.87]		Calculated results
ATM Inc. and JE Inc. 2012	Florida, USA			3.69[2] [3.03 to 4.60]		Modelled results
Anderson and Downing 2006	Iowa, USA	485 µg per litre	9.8 µg per litre	7.71	0.3	Agricultural area
Mordy 1953	Hawaii	230 µg per litre				Agricultural area
USGS 1999	South Texas, USA	420 µg per litre		3.1[2] [1.76 to 4.24]		Agricultural area
Kingston et al 2001	Nebraska to Ohio			7		Agricultural areas
Wood et al 1999	Southeast USA			5.6 to 11.2		Agricultural areas
McDowell and Sharpley 2009	Pennsylvania			10.71 / 8.06	1.93 / 1.10	Cropping / pasture
G and B, p.58	Lake Michigan				0.22 to 0.36	Water inputs
G and B, p.58	Torrens Lake, SA				0.2	Water inputs
Hendry et al, 1981[3]	Florida			7.70 to 11.30	0.24 to 0.96	Water inputs
Eisenreich et al 1977[3]	Lake Michigan				0.29	Water inputs
Johnson & Eisenreich 1979[3]	Lake Superior			9.20		Water inputs
Shawero et al 1989[3]	Narrow Lake, Canada			4.24	0.20	Water inputs
Cape et al 2012	Europe (Lat. 68 to 42)			6.12[2] [1.42 to 9.96]		NitroEurope project
Hall and Matson 2003 (G&B)	Europe/North America			100 / 30		Heavily industrialised
Vet et al 2014	Global assessment	Data available at http://www.wdcpc.org/assessment including for CSIRO contribution to assessment data (Lab 700007 Australia) and data from 2 Australian sites (Coffs Harbour and Wagga Wagga)				

Note: G&B is referenced in Gunn and Barker (2009). [1] is concentration measured in rainfall. [2] is the average (mean) of a number of results using average annual rainfall figures for the location. Figures in square brackets indicate the range. [3] is referenced in Anderson and Downing 2006.

6. Water Quality

6.1. Local Authority Water Quality Monitoring

Local government is required to undertake water quality monitoring as a function of licence conditions attached to their main environmentally relevant activities (ERAs). The relevant ERAs and associated services are:

- Water treatment - raw water treatment and potable water distribution;
- Wastewater treatment – collection, treatment and disposal.

Monitoring associated with their statutory requirements is discussed below for each of the three Councils.

6.2. Water Treatment (Potable Water)

The supply of potable water is usually a role of local government while the supply of raw water to water treatment plants may be a function of a water board e.g. Gladstone Area Water Board. Water supply and treatment arrangements and associated water quality monitoring for the Fitzroy region's main urban areas is discussed below.

6.2.1. Rockhampton potable water supply

Rockhampton City Council was granted a Resource Operations License (ROL) under the Water Act 2000 in 2004 to operate and manage the Fitzroy Barrage Water Supply Scheme. The ROL is now managed by Rockhampton Regional Council through Fitzroy River Water (FRW). The Barrage Water Supply Scheme has an area of influence from the Barrage (59.6km AMTD) to the upstream limit of the Barrage Pondage (115.0km AMTD). The storage has a nominal capacity of 80,000ML and supplies:

- RCCs annual 50,000 ML high priority quota;
- Stanwell Power Station's annual 24,000ML allocation (in conjunction with the SunWater owned and managed Lower Fitzroy Water Supply Scheme i.e. the Eden Bann weir (143 km AMTD to 183km AMTD), Stanwell Pipeline (28km) and Stanwell Pump Station);
- 200 medium priority irrigator allocations totalling 12,345 ML/a.

As a condition of the ROL RRC has a number of monitoring, operational and reporting requirements that it must fulfil including:

- Continuous time series height and flow data recording for four locations on the Fitzroy River;
- Water quality sampling representative of Barrage inflow, storage and outflow (monthly at least 3 weeks apart with samples taken on the same day) (see);
- Monitoring bank slump and erosion in the ponded area of the Barrage storage after rapid water level changes or large flows (originally quarterly - July, October, January, April). This is done using a boat and video footage;
- Monitoring of cyanobacteria (Blue Green Algae) in the storage.

Table 6-1: Water Quality Sampling Locations

Location	Site Description	Km AMTD
Fitzroy Barrage Inflow	Wattle bank gauging station	139 km AMTD
Fitzroy Barrage Storage	Immediately adjacent to GWTP intake structure	64 km AMTD
Fitzroy Barrage Outflow	Fish ladder intake or as appropriate during high flows	59.6km AMTD

Note: Source is Table 3: Water Quality Sampling Locations (p.96) in McKenzie et al 2006). AMTD is adopted middle thread distance and is an indication of the distance upstream from the mouth of the stream.

Fitzroy River water quality sampling locations associated with raw water supply for the Glenmore WTP are included in Table 6-1. Water quality parameters sampled and recorded for each location include temperature, dissolved oxygen, pH, electrical conductivity, total nitrogen (TN) and total phosphorus (TP). Sulphide is also monitored in the Barrage Outflow. "Prior to the ROP implementation, while raw water parameters were monitored for operational control, no regular analysis of water quality was required."

"*Monitoring of blue green algae has been standard practice for many years due to the Barrages susceptibility to blooms and the need to ensure the quality of potable water supplied. Surveys will usually begin after mid-winter, as the storage may also be prone to blooms of green algae, predominantly Eudorina and Dinoflagellates in the colder months. Seven sites are monitored for water temperature, turbidity and Secchi depth as well as general climatic conditions. The first site is slightly north of the old intake at Yaamba some 40 kilometers north-west of the present location of the Glenmore Water Treatment Plant. These sites are reflective of the needs of the river users including; irrigators, major industrial usage, potable water and recreational pursuits*" (McKenzie et al 2006, pp.95-97).

6.2.2. Gladstone raw water supply and treatment

Gladstone Area Water Board (GAWB) is the resource operations licence (ROL) holder for the Awoonga Water Supply Scheme under the Water Act 2000. GAWB's ROL responsibilities and rights are included in the Boyne River Basin Resource Operations Plan 2013 (ROP), which was prepared in part to implement the Water Resource (Boyne River Basin) Plan 2013 (WRP). The ROP came into effect one day after the WRP was enacted i.e. 20 December 2013, replacing the previous WRP (2000) and ROP.

GAWB supplies bulk water from Lake Awoonga in two forms:

- Raw water for industry (~77% of the water supplied by GAWB);
- Treated drinking water (the other 23%) (to Gladstone, Calliope, Tannum Sands, Benaraby, Mt Larcom).

As reported in the National Performance Report 2013–14: urban water utilities (BOM 2015) GAWB experienced a substantial increase in demand for sourced (raw) water (52%) from 2012/13 to 2013/14. This corresponded with a 2% increase in revenue ($2.7m) and a 2% increase in operating costs ($0.1m) indicating the supply of raw water is relatively inexpensive (mostly pumping costs) compared to the supply of treated drinking water for urban consumers.

Staff monitor water quality (chemistry) in the dam at different depths principally for pH and dissolved oxygen as both factors can affect the organic and inorganic chemistry of the water in the dam including the growth of organisms. Seasonal stratification has a big effect on water movement

and the distribution of oxygen through the water column. Test results are used to determine the level from which source (raw) water is drawn and the type of treatment process required at the water treatment plant.

GAWB monitors the quality of treated water and when it meets the required standards (National Health and Medical Research Council's Australian Drinking Water Guidelines) it is pumped to supply storages and Gladstone Regional Council (GRC) then distributes the potable water to its domestic and commercial customers through its reticulation system.

The ROP requires GAWB to undertake monitoring associated with the operation of the Awoonga Water Supply Scheme including:

- Water quantity;
  - storage water level (continuous time series storage water level data at Awoonga Dam Headwater),
  - stream flow data including daily base flow volume (continuous time series height and flow data at Milton (GS133004A) (Boyne River) and Marlua (GS133003A) Diglum Creek,
  - releases from Awoonga Dam including volume, rate and reason,
  - water taken by each (licenced) water user
- Impact on natural ecosystems;
  - monitor and record water quality data in relation to relevant infrastructure,
  - banks inspection for evidence of collapse and/or erosion identified within ponded areas of Awoonga Dam and downstream reaches influenced by infrastructure operations including following rapid water level changes and large flows through the storage,
  - fish stranding in watercourses and ponded areas associated with the ROL/ROP infrastructure,

(**Note**: GS is gauging station. Source includes http://www.gawb.qld.gov.au/water-quality and /water-treatment)

GAWB provides online water quality monitoring results as a part of its service charter (see example of Table 6-2).

Table 6-2: GAWB Water Quality Monitoring Results Online

SOURCE WATER QUALITY – LAKE AWOONGA –May 2015				
	Unit of measure	Average	Minimum	Maximum
pH	-	7.66	7.44	7.8
Colour	HU	9	6	14
Turbidity	NTU	2	1.24	2.56
Alkalinity	mg/L as CaCO3	80	76	87
Aluminium	mg/L	0	0	0
Iron	mg/L	0.033	0.02	0.04
Manganese	mg/L	0.035	0.028	0.048
Conductivity	mS/cm	248.5	237	262
Hardness	mg/L as CaCO3	75.25	74	76
Dissolved Oxygen	% saturation	66.3	58.3	79.5
E.coli	MPN/100ml	0	0	0
Total Cyanobacteria Count	Cells/mL	13905	1640	39440

(Available at http://www.gawb.qld.gov.au/documents/40241572/40254632/May%2015%20WQ%20Awoonga.jpg?t=1433810673178)

6.3. Wastewater Treatment

Wastewater treatment is an ERA with licence conditions imposed under the *Environmental Protection Act 1994*. The conditions generally require water quality monitoring in the vicinity of the discharge point where treated effluent is released to receiving waters. Water quality monitoring associated with wastewater (sewage) treatment plants (STPs) is discussed below.

6.3.1. Rockhampton wastewater treatment

Fitzroy River Water (FRW) conducts a water quality monitoring program at locations on the Fitzroy River downstream of treated wastewater discharge points. Monitoring is principally for total nitrogen and total phosphorus. Weekly grab sampling is used with average dry weather flow (ADWF) data to calculate weekly nutrients to compare to mass load targets for TN and TP.

Figure *6-1: Rockhampton STP Downstream Monitoring Points*

Note: The red lines indicate the location of FBA WQIP sub catchment boundaries.

Exceedances of licence conditions are reported to the administering authority i.e. the Queensland Department of Environment and Heritage Protection (EHP). Water quality sampling locations for Rockhampton's STPs are illustrated in Figure 6-1.

Results of water quality monitoring with reference to licence conditions are provided in a summary form in a report prepared for Rockhampton Regional Council by SKM (2013) and are reproduced with modifications in the *Fitzroy Region Urban Scoping Report* (Gunn 2015).

Accessing and analysing water quality data from the Rockhampton STPs monitoring sites requires an agreement with Rockhampton Regional Council (Fitzroy River Water).

6.3.2. Livingstone Shire wastewater treatment

Livingstone Shire Council treats wastewater at plants located near Yeppoon and Emu Park. Access to discharge and water quality monitoring data would require an agreement with Livingstone Shire Council.

6.3.3. Gladstone wastewater treatment

Gladstone Regional Council conducts a water quality monitoring program of treated wastewater prior to release for industrial reuse by QAL and NRG. This monitoring data is not relevant at this point in time as there is no direct discharge of pollutants to receiving waters.

This information would be useful in the future to develop scenarios around the discontinuation of reuse and implications for the Calliope River estuary. Access to such information would require an agreement with Gladstone Regional Council.

6.4. Water Quality Trends

As there is no urban specific water quality monitoring undertaken by the Fitzroy region Councils, Queensland Government or other organisations there are no records or specific analysis of urban water quality trends for Rockhampton, Livingstone Shire or Gladstone.

Existing non-Council water quality monitoring programs are discussed below. It should be noted that Councils may be partners in some of the monitoring program and be represented on committees but do not undertake the monitoring or generally take part in the analysis of results.

6.5. Rockhampton

6.5.1. Fitzroy Partnership for River Health reports

The Fitzroy Partnership for River Health (FPRH) is a collective of government, agriculture, resources, industry, research and community interests formally established in February 2012. The FPRH has issued four report cards to date for years 2010/11, 2011/12, 2012/13 and 2013/14. The first report was released in May 2013. The reports are available at http://riverhealth.org.au/reports/report-card-downloads/.

While these report cards do not provide any indication of urban water quality or the contribution of urban land use to water quality issues it is a platform that could be added to when results are available from an urban ‘paddock to reef’ style monitoring program if such a program were to be established. A summary of report card results for the Fitzroy catchment is provided in Table 6-3.

Table 6-3: Fitzroy Catchment Report Card Results

Report year	2010/2011		2011/2012		2012/2013		2013/2014	
Indicator group	**Fresh**	**Estuary**	**Fresh**	**Estuary**	**Fresh**	**Estuary**	**Fresh**	**Estuary**
Physico-chemical							Good	Good
Nutrients							Good	Good
Toxicants							Fair	
Ecology							no data	Fair
Overall grade	C	C	B	C	B	B	B	B
Drinking water					A		A	

Note: 2013/2014 was the first year that individual indicator groups were included in the report card.

The urban relevant component of the report card is for treated drinking water quality however this does not relate to the impacts of urban areas on water quality but rather to the efficiency of water treatment plants. As this is a regulated activity A grades are invariably achieved.

When the Fitzroy River is in flood or being flushed the quality of raw water may impact the performance of the water treatment plant and result in 'sub standard' treated water e.g. discolouration.

6.5.2. Future water supply projects

While the impacts on water quality is unknown it is worth noting that investigations into water supply options are ongoing to meet future needs of urban areas and industry as well as looking at the possible expansion of irrigated agriculture as a component of regional development. Regional development now has a higher profile as a result of the release of the White Paper on Developing Northern Australia.

A water supply related infrastructure project connecting the Fitzroy River and Gladstone is mentioned in the text box below.

Lower Fitzroy Infrastructure Project

SunWater is working in conjunction with the Gladstone Area Water Board to investigate the options for water infrastructure on the Fitzroy River.

The Lower Fitzroy River Infrastructure Project is investigating new water storage infrastructure, specifically weirs, on the Fitzroy River. This potential development was identified in the Central Queensland Regional Water Supply Strategy to help meet future demand for water from urban populations, industry and agriculture in Rockhampton, Gladstone and the Capricorn Coast.

SunWater is working in conjunction with the Gladstone Area Water Board to investigate the options for water infrastructure on the Fitzroy River.

The project encompasses two sites – Eden Bann Weir and Rookwood Crossing. The potential development options that are being investigated are:

- Raising the existing Eden Bann Weir to a number of levels
- Constructing a new weir near Rookwood Crossing, again with a number of levels being considered

- Options comprising a combination of the above

The feasibility of the options for new water infrastructure at these sites will focus on whether these options will provide an increase in water reliability and security for existing regional water users and enable further regional development.

http://www.sunwater.com.au/future-developments/lower-fitzroy-river-infrastructure-project/overview

7. Local Government Response

7.1. Policy

Rockhampton Regional Council (RRC) and Gladstone Regional Council (GRC) have a variety of policies for different levels of operation with some being specific to particular applications e.g. planning scheme policies. Council policy and policy areas are discussed below in relation to water quality improvement and Council operations.

7.2. Environmental policy

7.2.1. Rockhampton Regional Council

At the higher principle level the two most significant RRC policies may be the Development Incentive Policy (Adopted 10 June 2014) and the Environmental Policy (Adopted 25 January 2011). These are the two elements that Councils are tasked with 'balancing' i.e. economic development (growth) and environmental protection. Key components of RRC's environmental policy are included in the text box below.

1. Scope

This Policy applies to all Rockhampton Regional Council (RRC) employees and elected members.

2. Purpose

To provide a Policy that supports:

- Council's commitment to regional development and which encourages and supports sustainable growth whilst protecting the environment for future generations.
- Active development and support of sustainability initiatives and practices that both benefit the region and contribute to a wider global response to protecting our environment.

5. Context

Rockhampton Regional Council will incorporate ecologically sustainable development into its business and decision making processes to ensure the region's environment is protected and enhanced over time.

Council will achieve this through the management of the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural well-being and for their health and safety by adherence to the following guiding principles:

(a) Complying with and where practical, exceeding the requirements of relevant legislation, policies and standards to continually improve our environmental performance.

(b) Working in partnership with the region's communities and organisations to enhance the region's environmental quality, while respecting cultural, social and economic values.

(c) Improving our environmental performance through setting measurable objectives and targets.

(d) Ensuring our employees, suppliers and contractors are aware of, and are able to respond to, their environmental responsibilities.

(e) Developing and implementing waste reduction, reuse and recycling programs and strategies across the region.

(f) Reducing our resource consumption, including energy use.

(g) Giving purchase preference, based on specific criteria, to re-usable, recycled and environmentally-friendly products.

(h) Undertaking effective education and awareness raising within the community.

(i) Taking appropriate action to confront climate change.

(j) Being a leader in our community on environmental matters.

These guiding principles will be reflected through the development of an environmental action plan/s.

7. Responsibilities

Sponsor: Chief Executive Officer

Business Owner: General Manager, Infrastructure and Planning Services

Policy Owner: Strategic Manager, Land Use

Policy Compliance; Governance and Innovation

(**Note**: Livingstone Shire Council adopted the RRC Environmental Policy in March 2015)

At the time the environmental policy was adopted RRC included the now de-amalgamated Livingstone Shire LGA and RRC had a different organisational structure. Infrastructure and Planning Services is now part of Regional Services while Land use may now be part of the CEOs Office (Regional Development).

The environmental action plan/s referred to in the policy could be utilised to incorporate water quality improvement principles into Council's operation and thereby help implement the environmental policy.

7.2.2. Gladstone Regional Council

GRC adopted its current Environmental Policy in October 2013 to provide direction for its operations "*to enable the sustainable, environmentally managed growth and the preservation and enhancement of environmental values for the Gladstone Region*". The policy replaces the previous policy originally adopted in April 2010. Extracts from GRC's environmental policy are included in the text box below.

2.0 Scope
"Gladstone Regional Council provides services and infrastructure including environmental protection and regulation, waste management, construction and maintenance of roads, land and planning management, maintenance of parks and gardens, and the provision of water and waste water services."

"Council activities have been assessed for their impact on the environment and have been classified into nine (9) key aspects. These aspects include; Air Emissions, Cultural Heritage Land Use, Discharges to Waterways, Flora and Fauna, Ground Contamination, Natural Resource Use, Noise Emissions, Spills and Leaks and Waste to Landfill." (p.1)

5.0 Definitions
"Environmental Value means quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety." (p.2)

6.0 Policy Statement
6.1 Overview
Gladstone Regional Council's Environmental Policy is central to meeting our vision and recognising environmental responsibilities related to our region's growth and sustainable development.

6.1.1 Sustainable, Environmentally Managed Growth
GRC aims to achieve sustainable, environmentally managed growth through the following actions:

- Implement GRC's Environmental Management System.
- Promote waste reduction, reuse and recycling to minimise the pollution potential of all activities.
- Actively report pollution incidents to minimise impacts and take action to reduce further occurrences.
- Set measureable environmental objectives and targets when developing operational management plans.
- Encourage the preferred purchase and use of recycled, reusable and environmentally friendly products and services.
- Include the use of recycled, reusable and environmentally friendly products and services in Council's purchasing and contract's policies.
- Actively reduce resource consumption and encourage the use of renewable resources. (p.2)
- Incorporate environmental, social, cultural and financial considerations when planning for future development.

Promoting Biodiversity Protection and Management
6.1.2 Education, Programs and Partnerships
- Educate all employees and contractors of GRC to ensure they conduct all activities in an environmentally responsible manner.
- Commit to partnerships that encourage a healthy and balanced natural environment.
- Promote education programs to advocate the protection and enhancement of the environmental values of the region.

6.1.3 Continual Improvement
- Through continuous improvement achieve and where possible exceed compliance with all relevant permits, legislation, polices and standards.
- This policy will form part of GRC's Environmental Management System which assists in the management and documentation of Council's environmental impacts and management methods.
- Audits and reviews of GRC's impacts and mitigation methods will be used in comparison with relevant legislation, policies and standards to continually improve environmentally sustainable growth of the region. (p.3)

While the environmental policy does not refer directly to water quality it is implied in statements such as "*conduct all activities in an environmentally responsible manner*". This provides the policy base for water quality protection but may not be 'strong' enough to promote water quality improvement.

7.3. Practice

Council's main corporate directional document is its Corporate Plan. The introductory components of the Corporate Plan provide an indication of Council's policy position and this is then reflected in the plan outcomes, objectives and strategies. The strategic direction and policy in the Corporate Plan is translated to an Operational Plan annually in conjunction with the preparation of the annual budget.

7.3.1. Rockhampton Regional Council

RRC's Vision, Mission and Values from its Corporate Plan are provided in the text box below. These components of the Corporate Plan are very service orientated and do not appear to have any imbedded environment related policy elements.

Our Vision
One Great Region

Our Mission
To create a region that our community values and others admire.

Our Council Values
1. Consistency and Fairness
We will deal with all issues, including the management of change by achieving the fairest outcome possible and by being consistent in our decision making.

2. Results
We are focussed on achieving results and in creating value for our customers.

3. Integrity and Honesty
We will operate with honesty and integrity, fostering transparency in whatever we do and promoting public trust and continued confidence.

4. Teamwork and Staff Development
We value collaborative effort by staff and are committed to encouraging professional development and learning as important across the organisation.

5. Inclusiveness and Fair Representation
We will listen to, respect the views of, strive to engage with and meet the reasonable expectations of our communities in a professional, compassionate and responsive manner.

6. Continuous Improvement and Innovation
We will achieve value for our communities by utilising more innovative, effective and efficient ways of producing results for our customers.

7. Accountability
In focussing on results and creating value for our customers, we own our successes and failures.

8. Leadership
We will demonstrate high standards of leadership in guiding the community to support and participate in achieving Council's vision and mission. (RRC 2012, p.4)

The Corporate Plan has a number of elements or themes which are cross-related to service delivery areas and business units within Council's organisational structure (see section 3.2.5). The themes and outcomes from the Corporate Plan are included in the text box below.

- Infrastructure:
  - Outcome - Safe, secure and reliable infrastructure serving current and future community needs.
- Environment:
  - Outcome - A healthy and liveable environment for everyone to enjoy.
- Living, Learning and Leisure:
  - Outcome - A safe, caring and healthy community that we all belong to.
- Economy:
  - Outcome -Grow a strong, resilient and diversified economy.
- People, Places and Planning:
  - Outcome - Liveable and distinctive communities that we are proud to be part of.
- Leadership, Partnering and Support:
  - Outcome - Focus everyone on real community outcomes.

7.3.2. Gladstone Regional Council

Gladstone Regional Council's charter as it appears in the Corporate Plan is reproduced in the text box below.

We are Gladstone Regional Council. Our Charter defines who we are and guides how we work.

Our Vision is to be the best local government in Queensland.

Our Purpose is to improve our community.

Our Mission is to do the everyday things well, every day.

Our Values

- We value respect;
  - for our community,
  - for the environment, and
  - for each other.

We are Successful When

- Our community's needs are met.

- Our natural and built environment is preserved and enhanced to the benefit of our current generation, without disadvantaging the next.
- Our people enjoy a sense of both purpose and accomplishment each working day. (p.6)

"*The 2013/2017 Corporate Plan is based on the platform of the Gladstone Region Community Plan* [adopted 2010]. *The Community Plan is Council's long-term planning document, developed to steer the Gladstone Region toward a future that is defined by balance and achieving the best integration of community wellbeing, environmental protection, industry and commerce.*" (GRC 2013, p.10)

The Corporate Plan provides medium-term strategic direction for Council. GRC Corporate plan theme outcomes and strategies relevant to water quality improvement are listed in Table 7-1.

Table 7-1: Corporate Plan Components

Economic opportunity theme - Outcomes and strategies
Outcome 1.1 Growth in urban centres is accommodated
strategy 1.1.1 - Increase the efficiency of development and regulatory processes for well-prepared development proposals in identified growth areas
strategy 1.1.2 - Provide for innovative planning approaches to growth challenges and development opportunities
strategy 1.1.3 -- Ensure enabling infrastructure is available in identified growth greenfield and in-fill areas
Outcome 1.2 Council infrastructure planning and delivery enjoys an integrated approach, with community infrastructure that supports the lifestyle of our community and offers equity across the region
strategy 1.2.2 - Implement an asset renewal strategy that keeps pace with technology and the changing way the community uses public facilities
strategy 1.2.3 - Ensure the provision of a sustainable and cost effective water and wastewater network that meets community needs
Outcome 1.3 The diversity and prosperity of the region's economy is increased
strategy 1.3.3 - Engage and advocate for responsible economic, environmental and social outcomes when external authorities approve large scale industrial development projects
Environmental management theme - Outcomes and strategies
Outcome 3.1 A Council workforce that operates with a reduced environmental impact and seeks to enhance and preserve the region's natural environment
strategy 3.1.1 - Foster the balance between growth and conservation
strategy 3.1.2 - Increase energy efficiency and the use of alternative energy within Council
strategy 3.1.3 - Foster the preservation of the region's green belts, wildlife corridors and natural assets
strategy 3.1.4 - Encourage the reduction of environmental risks within the region
Outcome 3.2 Council and the community exhibit positive attitudes and behaviours toward the environment
strategy 3.2.1 - Form alliances with, and provide opportunities for community members and groups to participate in events and initiatives that have a green focus
strategy 3.2.2 - Encourage energy efficiency and the use of alternative energy within the community
strategy 3.2.3 - Foster community attitudinal change, personal responsibility and respect for the environment
green attitudes | energy efficiency |open space | preservation | alternative energy | green living

Note: Extracts from Corporate Plan 2013/2017 (GRC 2013) pages 12-13 and 16-17.

7.3.3. Livingstone Shire Council

Livingstone Shire Council's Corporate Plan and Operational Plan have not been reviewed. Livingstone Shire Council (LSC) policy, practices and capacity has not been reviewed due to limited contact with LSC staff and information deficiencies associated with this lack of consultation.

Publicly available background information about Livingstone Shire is included in section 3.3 and Appendix D (Reef Guardian Councils).

7.4. Practices

While it may not be directly evident in the Corporate Plan both Rockhampton and Gladstone Regional Councils are actively involved in water quality improvement through a variety of operational and regulatory roles and practices including;

- Development assessment, setting development approval conditions and subsequent compliance monitoring e.g. erosion and sediment control (ESC);

- Maintenance of and upgrades to stormwater systems;
- Wastewater treatment and reuse;
- Engineering technical services involvement in strategic planning;
- Preparation and operation of a new planning scheme incorporating water quality state interests as per the State Planning Policy (SPP 2013);
- Urban stormwater quality management planning (GRC specific. See section);
- Community education programs;
- Involvement in the Reef Guardian Council program;
- Participation in the Reef Urban Stormwater Management Improvement Group (RUSMIG).

The main Council practices that have the greatest potential for future water quality improvement include implementation of relevant provisions of the new planning schemes (both Councils), internal capacity building (both Councils), land based reuse of wastewater (RRC) and implementation of an urban stormwater quality management plan (GRC).

7.5. Operational Plans

Council practices in the form of strategies and activities are documented in the annual Operational Plan. As with all Councils the roles performed by RRC and GRC are in keeping with community expectations of 'standard' service provision and responsible fiscal management as outlined in the Operational Plan and accompanying budget.

7.5.1. Rockhampton Regional Council

RRC's 2015/16 Operational Plan and Budget (RRC 2015) provides a snapshot of operational outcomes planned for the year with reference to the strategic plan outcomes and strategies. The budget summary with reference to RRC's operational units is provided in Table 7-2.

Table 7-2: RRC Operational Plan Budget Summary

	Expenses		% unit		% RRC	
RRC operating unit	**Operating**	**Capital**	**Op.**	**Cap.**		
CEOs Office summary						
CEOs Office (Total)	$8,126,142	$0	100		4.0	
CEO Directorate	$1,126,302	$0	13.9		0.5	
Governance Support (3 sub units[1])	$3,245,612	$0	40.0		1.6	
Internal Audit	$260,893	$0	3.2		0.1	
Regional Development (3 sub units [2])	$3,493,335	$0	43.0		1.7	
Corporate Services summary						
Corporate Services (Total)	$35,975,516	$6,645,000	100		17.5	9.6
Corporate Services Directorate	$534,011	$0	1.5		0.3	
Airport Services *	$16,117,904	$1,695,000	44.8	25.5	7.8	2.4
Corporate and Technology Services [3]	$9,345,135	$4,950,000	26.0	74.5	4.5	7.1
Finance [4]	$5,968,618	$0	16.6		2.9	
Workforce and Strategy [5]	$4,009,848	$0	11.1		2.0	
Regional Services summary						
Regional Services (Total)	$110,000,861	$56,610,705	100		53.5	81.5
Regional Services Directorate	$783,989	$0	0.7		0.4	

Civil Operations [6]	$29,999,160	$35,614,203	27.3	62.9	14.6	51.3
Development and Building [7]	$2,868,828	$0	2.6		1.4	
Engineering Services [8]	$4,194,868	$200,000	3.8	0.4	2.0	0.3
Fitzroy River Water [9] *	$56,234,135	$17,796,502	51.1	31.4	27.4	25.6
R'htn Regional Waste and Recycling [10] *	$15,919,881	$3,000,000	14.5	5.3	7.7	4.3
Community Services summary						
Corporate Services (Total)	$51,378,391	$6,219,000	100		25.0	9.0
Corporate Services Directorate	$1,021,575	$0	2.0		0.5	
Arts and Heritage [11]	$7,184,156	$302,000	14.0	4.9	3.5	0.4
Communities and Facilities [12]	$18,719,843	$1,797,000	36.4	28.9	9.1	2.6
Community Standards and Compliance [13]	$5,082,486	$0	9.9		2.5	
Parks [14]	$19,370,331	$4,120,000	37.7	66.2	9.4	5.9
Rockhampton Regional Council	$205,480,910	$69,474,805			100	100

Notes: * Commercial business unit. [1] Executive Support, Committee Support and Communications. [2] Regional Promotions, Strategic Planning and Economic Development.[3] Customer Service Centre, Procurement and Logistics, Information Systems, Property and Insurance and Fleet Services. [4] Assets and GIS, Financial Systems and Revenue and Accounting. [5] Safety and Training, Human Resources and Payroll, Industrial Relations and Investigations and Corporate Improvement and Strategy. [6] Urban Operations and Rural Operations. [7] Building Compliance, Development Assessment and Planning Administration. [8] Infrastructure Operations, Civil Design, Strategic Infrastructure, Support Services and Disaster Management. 9 Treatment and Supply and Network Services. [10] Collections and Waste Operations. [11] Venue Operations, Heritage Services and Art Gallery. [12] Library Unit (Client Services, Collections and Systems), Facilities, Home Assist, City Child Care Centre and Communities and Facilities Management. [13] Pest Management, Vector Management, Local Laws and Community Standards and Compliance Management. [14] Parks Recreation Services, Parks Operations and Parks Management.

7.5.2. Gladstone Regional Council

The 2014/15 Operational Plan and Budget (GRC 2014) provides a snapshot of operational outcomes and practices planned for the year with reference to the strategic plan outcomes and strategies. Highlights in terms of potential water quality improvement outcomes included:

- A proactive erosion and sediment control compliance program is maintained [CPS 3.2.3];
- Effective management of high risk environmental aspects of Council's operations [CPS 3.1.4];
- Completion of implementation of new Planning Scheme within statutory timelines The new Planning Scheme is developed in line with statutory timeframes including, including State interest check, public consultation and finalisation of scheme document [CPS 1.1.2];
- Engineering Development Standards are updated [CPS 1.1.1].

(**Note**: CPS is the relevant strategic Corporate Plan strategy number)

The budget section provides a more detailed indication of resource allocation. The Planning and Environment Directorate section showed the largest proportion of funds were allocated to the maintenance and development of parks and public amenities with planning (regulatory and strategic) and regulatory and certification services (building and plumbing) having similar budgets.

The Engineering Services Directorate budget contained the big ticket items of; roads, sewerage, water and waste. Technical services and stormwater maintenance were also included in the Engineering Services budget. Technical services provide advice to Planning and Environment on development applications and strategic planning. Stormwater maintenance included four expenditure categories:

- Open Drain, Detention/Retention Basin Maintenance;
- CCTV Drainage Inspection and Cleaning Program;
- Drainage Structure Repairs General Maintenance;
- Clean GPT's (Grease Pollutant Traps).

There were no water quality specific items evident in the Operational Plan and Budget and it was unclear who was responsible for the maintenance of water quality improvement measures installed in new developments as per the State Planning Policy (SPP 2013) (formerly SPP 4/10 Healthy Waters).

While Council policy in the form of the Corporate Plan and Charter advocate environmental outcomes at this stage it does not appear that the environmental policy intent has been translated directly to water quality improvement actions in the 2014/15 Operational Plan. The (recently released) 2015/16 Operational Plan and Budget provides an indication of Council expenditure for the next year. The main components in the operating budget ($172m) for 2015/16 are:

- $44.4m - Provision of water and sewerage infrastructure and services (Capital Expense (CE) $25m);
- $20.4m - Maintenance of parks, playgrounds, open space, amenities and rural land services (CE $8m);
- Wheelie bin collection and management of waste facilities ($16.5m);
- Arts and culture facilities and services ($9m);
- Community donations programs ($741,000).

49% of the $81m capital budget is for the road and drainage networks with 12% for parks and environment. It should be noted that Operational Plans and budgets are generally prepared between February and April for adoption by Council in May or June to enable the plan to be enacted in the new financial year.

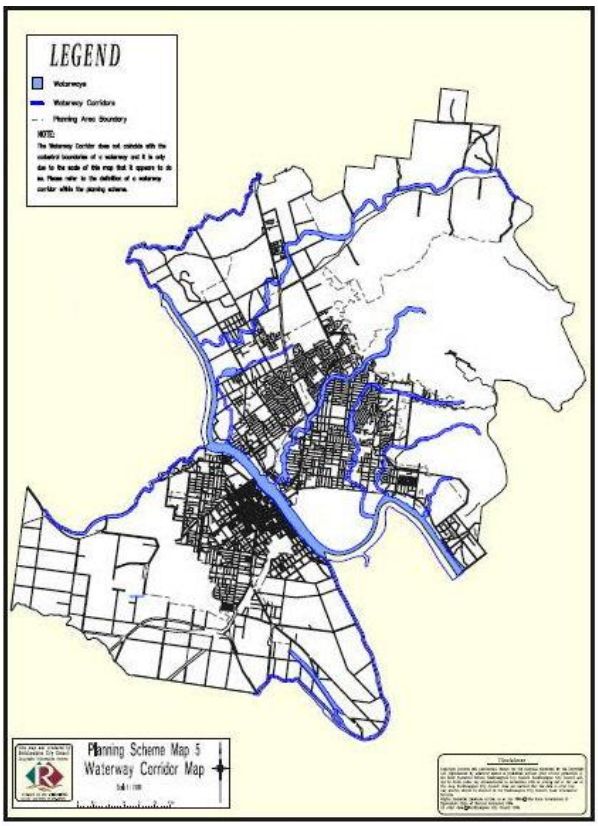
7.6. Planning Schemes

Preparation of planning schemes and management of the development assessment process are key areas of Council practice that can have a significant impact on water quality. This applies principally to developing urban areas with water quality in existing urban areas being reliant on the appropriate management of stormwater systems (see section 7.7.1) and potential retrofitting of regional water quality improvement measures into the urban landscape.

7.6.1. RRC planning scheme/s and studies

Prior to August 2015 development in the RRC LGA was assessed via two planning schemes prepared in accordance with the *Integrated Planning Act 1999* (IP Act). The planning scheme for the City of Rockhampton (Rockhampton City Plan 2005) is relevant to 'old' Rockhampton and the northern suburbs where the majority of Rockhampton's residential development is occurring while Fitzroy Shire planning scheme (2005) had jurisdiction over Gracemere and environs.

Figure *7-1: Waterway Corridors (PSM5)*



The expansion of urban land use within the Rockhampton City LGA is constrained by the Fitzroy River i.e. flood prone areas, and the Berserker Range with the only feasible growth area being the northern section of the LGA where it borders Livingstone Shire Council (LSC).

This expansion and potential encroachment on LSC land was recognised by Rockhampton City Council and a land use study was commissioned for three planning areas defined in Rockhampton City Plan (2005) (City Plan) being:

1. Parkhurst East Residential Area;
2. Parkhurst Future (Post 2015) Residential Area; and
3. Yeppoon Road Corridor Environmental Protection Area.

The northern and eastern edges of the study area are defined by the boundary between Rockhampton City and Livingstone Shire, including Ramsay Creek at the northern edge of the Parkhurst area. (GHD 2007, p.10)

The study concluded that the area of suitable land required for residential development up to 2020 was available in the study area however the study area lacked infrastructure and services to accommodate the projected future urban growth. The study did not consider commercial premises and other development that may accompany the urban expansion. The area of jurisdiction of the superseded Rockhampton City Plan is shown in Figure 7-1.

7.6.2. RRC amalgamated planning scheme

Following the formation of Rockhampton Regional Council in 2008 it appeared that the planning issues associated with separate LGAs could be largely resolved through the preparation of a single planning scheme for the amalgamated area (see Figure 3-4). Planning studies were commissioned from 2010

to inform a new planning scheme. These studies are also relevant to Livingstone Shire Council, as it was part of the Rockhampton Regional Council LGA until January 2014 (see section 3.2).

Relevant studies include:

- a master plan for the Northeast Parkhurst priority future growth area based on the outcomes of the previously adopted Parkhurst and Yeppoon Road Corridor Structure Plan (see section 7.6.1);
- Regional open space plan;
- Industrial Land Use Study;
- Natural Environment Study;
- Natural Hazards and Climate Change Study;
- Rural Lands Study;
- Population and Residential Study and Appendices.

During the preparation of this report RRC received notification that the draft planning scheme had passed the ministerial review and Council formally resolved to adopt the Rockhampton Region Planning Scheme commencing on and from Monday 24 August 2015 (see text box below).

Rockhampton Regional Council has resolved to adopt the Rockhampton Region Planning Scheme, a new planning scheme for our local government area. The Rockhampton Region Planning Scheme is Council's most important tool for guiding the Region's future growth and development.

The Rockhampton Region Planning Scheme commences on Monday 24 August 2015.

View the Rockhampton Region Planning Scheme through Rock e Plan, Council's online planning portal.
(http://rockeplan.rockhamptonregion.qld.gov.au/)

Fact Sheets
The following fact sheets have been prepared to assist residents understand the Rockhampton Region Planning Scheme. The information is a general overview only and for full details and applicable planning provisions, please refer to the Rockhampton Region Planning Scheme.

Tables of Assessment Fact Sheet
Residential Zones Fact Sheet
Centre Zones Fact Sheet
Industry Zones Fact Sheet
Overlays Fact Sheet
Flood Overlays Fact Sheet
Bushfire Overlay Fact Sheet

Last Updated: 25/08/2015
http://www.rockhamptonregion.qld.gov.au/Council_Services/Planning_and_Development/Rockhampton_Region_ Planning_Scheme

Given the impending introduction of the new planning scheme reviewing the previous planning schemes (Rockhampton City and Fitzroy Shire) would have been a redundant exercise and instead RRC provided a copy of the draft planning scheme (RRC March 2015) to inform this report. The review of the Ministerial Review draft provided by RRC showed a variety of planning scheme elements that could contribute significantly to water quality improvement if implemented in full. These are listed below in the order of the planning scheme parts:

- The Strategic Framework (Part 3) - "*The strategic framework sets the policy direction for the planning scheme and forms the basis for ensuring appropriate development occurs in the planning scheme area for the life of the planning scheme*";
  - Settlement pattern theme,
    - Element - Nature conservation, open space and natural corridor or link.
  - Natural environment and hazards theme,
    - Element - Areas of environmental significance,
    - Element - Natural hazards and climate change,
    - Element - Water resources, catchment management and healthy waters
  - Natural resources and economic development,
    - Element – Rural land,
    - Element – Marine resources,
    - Element - Extractive and mineral resources.
- Local government infrastructure plan (Part 4) – "*integrate infrastructure planning with the land use planning identified in the planning scheme*" to accommodate urban growth up to 2031 for the following networks; water supply, sewerage, transport, stormwater public parks and land for community facilities;
  - Stormwater network desired standards of service.
- Zones (Part 6) including;
  - Environmental zones,
    - Environmental management and conservation zone code.
  - Other zones category,
    - Rural zone code.
- Overlays (Part 8);
  - Acid sulfate soils overlay code,
  - Biodiversity overlay code,
    - Matters of state and local (high) environmental significance,
    - Biodiversity corridors,
    - Wetlands and waterways,
    - Hydrology,
    - Ongoing management, construction and operation.
  - Extractive resources overlay code,
  - Water resource catchments overlay code,
    - Separation distances,
    - Stormwater management,
    - On-site sewerage facility,
    - Operational work (including work associated with reconfiguring a lot),
    - Reconfiguring a lot.
- Development codes (Part 9);
  - Statewide codes;

        - Reconfiguring a lot (subdividing one (1) lot into two (2) lots) and associated operational work code.
    - Other development codes;
        - Filling and excavation code,
        - Reconfiguring a lot code,
        - Self-assessable works code,
        - Stormwater management code,
        - Water and sewer code.
- Planning scheme policies (Schedule 6);
    - Bushfire management planning scheme policy,
    - Coastal protection management planning scheme policy,
    - Ecological assessment planning scheme policy,
    - Stormwater management planning scheme policy,
    - Structure plan planning scheme policy,
    - Water supply infrastructure planning scheme policy.

The local government infrastructure plan (Part 4) includes assumptions about population growth, dwellings and non-residential floor space. The infrastructure plan, along with the studies used to inform the planning scheme, could be the most useful information source for assessing future pressures on water quality from population growth and expanding urban land use.

7.6.3. Gladstone Regional Council

Gladstone City, Calliope Shire and Miriam Vale Shire Councils all had planning schemes prepared in accordance with the *Integrated Planning Act 1999* (IP Act). The Gladstone (2006) and Calliope (2007) planning schemes are relevant to development assessment in the main urban areas of the amalgamated Gladstone Regional Council (GRC) local government area (LGA).

In addition to any matters included in the existing planning schemes GRC has prepared a supplementary publication Stormwater Management Guideline (February 2014 Rev.02), which provides advice to development applicants and consultants on recent legislative requirements and locally specific requirements to meet statutory planning obligations with regard to stormwater management (quantity and quality). It is assumed that much of this guidance will be imbedded in the new planning scheme in the form of development requirements.

7.6.4. The new planning scheme

After the formation of GRC in March 2008 the newly elected Council resolved to prepare an amalgamated planning scheme to replace the three inherited planning schemes. As part of the IP Act planning scheme preparation process GRC released a number of planning scheme Issues Papers in 2009 (http://www. gladstone.qld.gov.au/planning-scheme-archives).

During this process the planning legislation changed and the IP Act was repealed and replaced by the *Sustainable Planning Act 2009* (SP Act). GRC adapted to the change and the Statement of Proposals it was preparing as part of the IP Act process was amended to become a Discussion Paper issued in mid-2010. Following a review of Discussion Paper submissions a series of planning studies were prepared (2010 to 2013) (http://www.gladstone.qld.gov.au/ background-studies) prior to the preparation of the new planning scheme.

Following the public consultation process the amended draft planning scheme (Our Place Our Plan Gladstone Regional Council Planning Scheme) was submitted to the Queensland Government for review and approval (March 2015).

The draft planning scheme (Our Place Our Plan) includes a number of elements aimed at the protection of waterways, wetlands, water quality, environmental values, connecting corridors and significant environmental infrastructure and natural assets. These include:

- The Strategic Framework ('Our Environment and Heritage' theme and the 'Sustainable management of the natural environment and resources' element in particular);
- Zones including;
  - Low density residential,
  - Low-medium density residential,
  - Medium density residential,
  - Character residential,
  - Medium impact industry,
  - Environmental management,
  - Conservation,
  - Open space,
- Mapping overlays and Overlay codes;
  - Acid sulfate soils,
  - MSES (matters of state environmental significance) Overlays,
    - MSES – regulated vegetation (intersecting a watercourse),
    - MSES – high ecological value waters,
    - MSES – high ecological value waters (wetland),
    - MSES - high ecological significance wetlands,
    - MSES – wildlife habitat,
    - MSES - regulated vegetation,
    - MSES – marine park,
    - MSES – legally secured offset area
  - Biodiversity Overlay code,
  - Water resource catchment Overlay code.
- Development codes including;
  - Reconfiguring a lot,
  - Development design,
  - Operational works.
- Planning scheme policy (PSP) - Engineering design.

The Queensland Government announced approval for Gladstone Regional Council to adopt "Our Place Our Plan" on 21 September 2015. On 6 October 2015, Gladstone Regional Council adopted the Gladstone Regional Planning Scheme which commenced operation on 12 October 2015. The Regional Planning Scheme replaces the previous Planning Schemes for Gladstone City, Calliope Shire and Miriam Vale Shires providing a consolidated planning document for all planning and development across the region (http://www.gladstone.qld.gov.au/planning-scheme).

The new planning scheme has the potential to provide a higher level of protection for Gladstone's waters and other environmental assets if adequate resources are available to apply appropriate conditions to development approvals and then ensure compliance with such conditions.

Outside the jurisdiction of the local government planning scheme is development on Strategic Port Land. This process is managed by the Gladstone Ports Corporation through a strategic land use plan (http://www.gpcl.com.au/development/strategy-and-planning). In addition the Coordinator-General is responsible for managing land use within State Development Areas (SDA) such as the Gladstone SDA (http://www.statedevelopment.qld.gov.au/coordinator-general/gladstone-state-development-area.html).

Two Priority Development Areas (PDAs) exist within the Gladstone Region at Clinton (Hillclose Estate) and Tannum Sands (Tannum Blue) (http://www.statedevelopment.qld.gov.au/infrastructure/economic-development-queensland/residential-development.html). PDAs are subject to different requirements than those that apply to the rest of the LGA as defined in the planning scheme.

7.7. Urban Stormwater Management

7.7.1. GRUSQMP

A considerable amount of effort has been put into preparing the final draft of the Gladstone Regional Urban Stormwater Quality Management Plan (GRUSQMP) Phase 3 Report for Gladstone Regional Council (BMT WBM 2015). The preparation process for the GRUSQMP is shown in Figure 7-2. As illustrated in the process diagram there were two preceding stages which involved collation of background information and consultation. Background reports produced during the first two phases included:

- *Gladstone Regional Stormwater Quality Management Plan Phase 1A Preliminary Activities Phase 1 Workshop Summary* (O2 Environment and Engineering 2011);
- *Gladstone Regional Stormwater Quality Management Plan Phase 1B Risk Assessment* (O2 2011);
- *Gladstone Regional Council Stormwater Quality Management Plan Phase 2 Broad Scale Quality and Quantity Assessment* (O2 Environmental Pty Ltd 2012).

As a result of this effort and the relevance of the content of the GRUSQMP to diffuse source water quality improvement a significant amount of the material included in the GRUSQMP will be directly relevant and potentially translatable to the Fitzroy WQIP urban scoping process.

Investigating the final version of the GRUSQMP and associated background reports and integrating relevant components with other Council practices and FBA urban water quality improvement activities has been included as a key action for GRC in the draft set of urban actions for consideration for future implementation as part of the Fitzroy WQIP (see section 9 in the *Fitzroy Region Urban Scoping Report*).

7.8. Education and Awareness

Education and awareness is a relatively low cost, high return activity for behaviour change if properly ‘researched’, planned, designed and implemented. However in most cases education and awareness programs are ad hoc and based on a conventional provision of information approach. While the provision of information approach is necessary for administrative purposes e.g. notification of legislative requirements, it is far less effective in creating real changes in behaviour.

To influence individual, organisational and community behaviour requires a more thoughtful approach that both provokes engagement with the topic in a meaningful way and is relevant to the audience.

Three key approaches for promoting behaviour change have been used successfully in Townsville by Creek to Coral (Townsville City Council's healthy waters initiative) since 2005.

Figure *7-2: GRUSQMP Preparation Process*

Note: Source is "The process used in developing, implementing and reviewing the GRUSQMP" (BMT WBM 2015, p.8).

The Creek to Coral behaviour approaches were incorporated in the Black Ross (Townsville) WQIP (Gunn and Manning 2010) and included:

- Community based social marketing;
- Thematic interpretation;
- Collective social learning.

Councils in the Fitzroy region have not yet embraced the behaviour change approach however they do provide a variety of information fact sheets and other publications that are available online and promote water quality protection and other environmentally responsible behaviour. An example is provided in the text box below.

Soil erosion from building, development and construction sites is a major source of stormwater pollution. Erosion and sedimentation (such as soil, sand, silt and mud) washes into our waterways from exposed sites after rain, and can cause both short and long term environmental problems.

The Environmental Protection Act 1994 places a legal responsibility on all persons who cause land disturbance to minimise or prevent environmental harm.

Property developers and other development industry members, such as consultants and contractors, are also subject to requirements under the Sustainable Planning Act 2009. This includes development conditions requiring adequate erosion and sediment control (ESC) measures to be implemented and maintained on construction sites.

Gladstone Regional Council officers randomly inspect development sites and can issue warnings or penalty infringement notices to those that do not comply with these legislative requirements. The maximum penalty for noncompliance of the written notice is $30,000. If harm is wilfully caused to the environment, the maximum penalty can go up to $83,500. Officers can also temporarily shut down developments if the project site fails to ensure adequate sedimentation and erosion control is in place.

Council's approach to ESC
As a result of rapid growth in the Gladstone Region, particularly in and around Gladstone city, Council has embarked on a program designed to improve industry practice on erosion and sediment control (ESC). The program aims to educate residents, businesses, builders and developers about the importance of minimising soil and sediment runoff.

Council has also implemented strategic approaches to mitigate sedimentation and erosion, which include:

- Setting out high standards in new planning schemes;
- Implementing strict conditions on development approvals;
- Allocating adequate resources and training of development assessment officers and enforcement officers;
- Educating development industry and promoting good practices; and
- Strong enforcement with statutory/regulatory tools under the Sustainable Planning Act and the Environmental Protection Act (i.e. warnings, penalty infringement notices, prosecution in case of non-compliance).

Education is our main strategy in managing this problem, providing detailed information and advice to anyone managing erosion issues. Please refer to the following links for more information.

Fact Sheet
For more information, and tips, on best practice techniques to minimise stormwater pollution (http://www.gladstone.qld.gov.au/c/document_library/get_file?uuid=01510189-dfd4-40a4-acdf-62ef061f8648&groupId=1570002)

Useful links
Read the section of the Act to which compliance applies:
http://www.austlii.edu.au/au/legis/qld/consol_act/epa1994295/s440zg.html

Visit http://waterbydesign.com.au/factsheets/ which also relates to the Gladstone Region, providing advice, checklist and tips for developers and residents.

Contact
Contact Council's Operational Works Unit on (07) 4975 8414 for Council's policies and information about the ongoing audit program
http://www.gladstone.qld.gov.au/erosion-and-sediment-control

7.9. Common Ground

Local government across the GBR catchment are involved in a variety of collaborative activities with other Councils, State and Australian Government agencies and non-government organisations (NGOs). Two of these collaborations involving Fitzroy region Councils are the Reef Guardian Councils program and the Reef Urban Stormwater Management Improvement Group (see Gunn 2014b).

7.10. RUSMIG

Both Rockhampton Regional Council (RRC) and Gladstone Regional Council (GRC) have been involved in the Reef Urban Stormwater Management Improvement Group (RUSMIG) since it was established in 2009 to provide a collaborative learning approach to urban stormwater management including to gain a better understanding of the implications of the impending introduction of new urban stormwater quality management legislation in the form of the State Planning Policy (SPP) Healthy Waters (see the Fitzroy Region Urban Scoping Report).

7.10.1. RUSMIG/Water by Design collaboration

Increasing the capability of local government staff to implement stormwater quality measures in the urban setting was a key component of the RUSMIG/Water by Design project (2013/14) titled ***Collaboration to the rescue***. The project was funded through the former Australian Government's Caring for our Country program (Reef Rescue component). Both GRC and RRC participated in the practical training and facilitated guidance provided through the project as indicated in the text box below.

Erosion and Sediment Control capacity improvement
Delivery of workshops with local government sediment and erosion control officers to improve their ability to apply erosion and sediment control (ESC) within local government's own projects and/or undertake compliance activities.

ESC training workshops / field days held:
Mackay – 19 and 20 May 2014
- Bundaberg - 27 and 28 May 2014
- Rockhampton - 2 and 3 June 2014
- Gladstone – 4 and 5 June 2014
- Tablelands (Atherton) - 16 and 17 June 2014
- Townsville – 18 and 19 June 2014

Bioretention training course
Delivered to a multidisciplinary audience of Council officers and industry by Water by Design to increase knowledge of best practice bioretention design and construction following the update of the bioretention design guidance material.

Training held:

- Mackay – 8th July 2014
- Townsville – 15th July 2014
- Gladstone – 22nd July 2014
- Bundaberg – 29th July 2014

The complementary Vegetated Asset maintenance workshop was also delivered to Rockhampton as part of this project. It complements training delivered as part of a Queensland Government funded project to local government officers in Townsville, Mackay, Gladstone, Bundaberg, Hervey Bay and Gympie.

Construction and Establishment of Vegetated Stormwater Assets training course
Delivered by Water by Design to increase staff knowledge and skills in the area of vegetated stormwater asset management and maintenance.

Training held:

- Mackay – 9th July 2014
- Townsville – 16th July 2014
- Gladstone – 23nd July 2014
- Bundaberg – 30th July 2014

Water Sensitive Urban Design capacity workshop series
Workshops conducted with local governments to facilitate self-assessments of their organisations' capacity for Water Sensitive Urban Design and potential management strategies that they could undertake to drive Water Sensitive Urban Design incorporating:

Stage 1 - workshops using the Rapid Assessment of Institutional Capacity in Local Government Agencies Tool delivered to Rockhampton (13 March 2014), Gladstone (14 March 2014), Mackay (27 March 2014) and Tablelands (Atherton) (4 April 2014) Regional Councils.

Stage 2 - follow up action planning workshops with Rockhampton (30 April 2014), Gladstone (31 April 2014), Mackay (8 May 2014) and Tablelands (9 May 2014) Regional Councils.

Councils are identifying and committing to key actions to build staff and executive capacity and support, share resources within council and the region to better deliver WSUD.

RRC involvement included:

- Prioritising project activities;
- Water by Design training;
    - Erosion and sediment control compliance course (2 and 3 June 2014).
- Water sensitive urban design (WSUD) capacity workshops;
    - Stage 1 – Capacity review (13 March 2014),
    - Stage 2 – Action plan (30 April 2014).

GRC involvement included:

- Prioritising project activities;
- Water by Design training;
    - Erosion and sediment control compliance course (4 and 5 June 2014),
    - Bioretention design (22 July 2014),
    - Construction and Establishment of Vegetated Stormwater Assets (23 July 2014).
- Water sensitive urban design (WSUD) capacity workshops;
    - Stage 1 – Capacity review (14 March 2014),
    - Stage 2 – Action plan (31 April 2014).

Livingston Shire Council (LSC) was not involved in the Water by Design WSUD capacity workshops however LSC staff members participated in the Water by Design training courses hosted by RRC.

7.11. Reef Guardian Councils

The Reef Guardian Council program is run by the Great Barrier Reef Marine Park Authority (GBRMPA) to showcase and encourage environmentally sustainable practices undertaken by councils in the Great Barrier Reef catchment in the following areas:

- Water management - waterways rehabilitation, water monitoring, urban stormwater treatment, wastewater and trade waste treatment;
- Waste management - waste avoidance, waste reuse and recycling;
- Land management - vegetation and pest management, resource assessment, erosion control, and land planning and management;
- Climate change - planning and policy, energy and resource efficiency, and community education;
- Community - education, capacity building and developing partnerships.

In conjunction with GBRMPA Reef Guardian Councils develop annual Action Plans which provide an insight into Council's land based day-to-day activities that contribute to the protection of the health and values of the Great Barrier Reef. Internally the plan can be used as a focus document to enable a greater integration of related activities that may otherwise operate in compartments (silos) within the organisation due to structural constraints and the need to meet specific key performance indicators or other targets of departments associated with operational and corporate plans.

7.11.1. Rockhampton Regional Council

RRC is a Reef Guardian Council Reef (see text box below) with the first Reef Guardian Council Action Plan prepared by RRC in 2010 when still amalgamated with Livingstone Shire Council (LSC). LSC is now also a Reef Guardian Council (RGC). The RRC staff members responsible for preparing the annual Action Plan are now staff members at LSC.

Rockhampton Regional Council a proud Reef Guardian Council
Rockhampton Regional Council has been a member of the Great Barrier Reef Marine Park Authority's (GBRMPA) Reef Guardian Councils Program since July 2010 and is making progress in their efforts to reduce the impact our Region's activities could have on the Great Barrier Reef World Heritage Area.

Chair of Rockhampton Regional Council's Environment Committee, Cr Sandra O'Brien praised Council's work achieving better environmental outcomes for the Great Barrier Reef as a Reef Guardian Council, and encouraged the regional community to support these efforts wherever they can.

Cr O'Brien explained the Reef Guardian Council program is focussed around four key theme areas: Land Management, Waste Management, Water Management and Community Capacity. Council has been carrying out activities under these themes over the last 12 months from its Action Plan 2010/11 with support from officers of GBRMPA.

[section deleted]

"Some of the other activities we have undertaken over the past 12 months include using biocontrol methods to treat weeds such as use of the beetle Cyrtobagous salviniae to treat Salvinia; undertaking rehabilitation activities in disturbed coastal riparian areas; adopting a 'no net tree loss' principle when removing trees for infrastructure development; and our successful program for collecting and recycling waste oil filters.

"Each step we take to reduce waste, recycle and to be waterwise is a step in the right direction, and I thank the businesses and residents in our Region for respecting and caring for our environment," she said. Great Barrier Reef Marine Park Authority Reef Guardian Director, Karen Vohland said that Rockhampton Regional Council was a key contributor to the Reef Guardian Council program. "Local government plays an important role in helping to protect the Great Barrier Reef for the future," Ms Vohland said.

"I congratulate Rockhampton Regional Council who are demonstrating their commitment to the program and to improving the health of the reef through the range of projects currently being undertaken," she said.

Last Updated: 25/05/2011
http://www.rockhamptonregion.qld.gov.au/About_Council/News_and_Announcements/Latest_News/ Rockhampton_Regional_Council_a_proud_Reef_Guardian_Council

The RRC and LSC Action Plans need to be prepared separately to fit into the separate programs of each Council however it would be useful to collaborate on the Action Plans as the two Councils have some common issues that could be better addressed through a common, regional approach.

Additional information on Reef Guardian Councils and RRC and LSC RGC Action Plans is provided in Appendix D.

7.11.2. Gladstone RC

GRC is a Reef Guardian Council (see Appendix D). Water quality improvement outcomes may be accelerated in the GRC LGA if the Fitzroy WQIP is embraced by GRC and integrated with the Reef Guardian Council action plan and the draft GRUSQMP (see section 7.7.1).

7.12. Water quality improvement outcomes

7.12.1. Point Source Wastewater Management

Along with diffuse source stormwater management practices mentioned above Councils are also responsible for the management of point source discharges associated with wastewater (sewage) treatment plants (STPs). Most of the treated wastewater from Gladstone's STPs is reused by industry and as a result that source of water quality pollution has been addressed.

7.12.2. RRC wastewater reuse

Wastewater from RRC's Gracemere sewage treatment plant (STP) (8,000 EP) is reused in the local area (see section 5.6.3) however no recycled water schemes have yet been established for any of the Rockhampton STPs (see Table 7-3). This has been attributed to the lack of sufficient demand for recycled water in Rockhampton along with the ability of Fitzroy River Water to comply with the existing load based licence conditions for discharge of treated effluent to the Fitzroy River.

Table 7-3: Summary Information for the Rockhampton STPs

	North Rockhampton STP	South Rockhampton STP	West Rockhampton STP
Year Built	1986	1983	1962
Design	Extended Aeration	Activated Sludge	Trickling Biofilter
Contaminants Removed [a]	Bacterial Pathogens, SS, N BOC	Bacterial Pathogens, SS, BOC (no N removal)	Bacterial Pathogens, SS, BOC (no N removal)
Original Capacity (EP)	50,000	34,000	11,000
Current Utilisation (EP)	46,000	19,120	6,172

Note: EP is equivalent persons. [a] SS = suspended solids, BOC = biodegradable organic carbon, N = total N, Bacterial Pathogens includes indicators of faecal contamination such as *E. coli*. Source is RRC Water Committee Agenda 5 February 2014 (p.7).

Recycled water use has the potential to provide an effective long term, low cost means of reducing the volume of treated effluent discharged to the Fitzroy River with a corresponding reduction in costs of process upgrades of the STPs in order ensure environmental discharge limits are met for the larger volumes of sewage (population growth) being treated (RRC Water Committee Agenda 5 February 2014, p.9).

7.13. Capacity

Gauging the capacity of an organisation is a difficult task especially during a period of transition from an entrenched and accepted way of doing things to a new and unfamiliar system. In addition assessing the capacity of an organisation where the governance body is elected and the management body is selected is a complicated matter.

7.13.1. WSUD capacity

Water by Design conducted workshops with Rockhampton Regional Council (RRC) and Gladstone Regional Council (GRC) (see *Figure* 7-3) as indicated in section 7.10.1 (above). Results of the Water by Design workshops provide an indication of both Councils' capacity to become a more water

quality conscious organisation. Results of the Rockhampton and Gladstone WSUD capacity workshops are included in Appendix B.

Figure *7-3:Workshopping WSUD Capacity*

Note: Gladstone WSUD capacity workshop (Photo: Water by Design).

7.14. Resources and Capacity

Capacity to implement water quality improvement measures is reliant on the allocation of adequate resources. At the local government level resource allocation is based on:

- Legislative responsibilities of local government;
- Community expectations of service provision translated into policy and then action;
- Internal culture and drive to find ways to implement new responsibilities i.e. reduced resistance to change.

Capacity is therefore closely linked to community priorities and electorate mandates to take action along with internal support (Councillors and management) and the ability to implement the necessary reform. Both Councils have the internal desire to implement water quality improvement however the policy settings to enable allocation of resources are not yet in place thereby reducing the capacity of both Councils to accelerate water quality improvement actions beyond the level of their current legislative responsibility. Councils' capacity, as defined in their operational plans and budgets, is discussed briefly below.

7.14.1. Rockhampton Regional Council

The three 'big ticket' items for water quality improvement in the RRC LGA all fall within the portfolio of Regional Services (see section 3.2.5). These areas of influence are shown in Table 7-4.

Table 7-4: RRC Regional Services Relevant Units

Regional Services	
Regional Services Directorate	Overall corporate management and coordination of the service delivery and strategic direction of Civil Operations, Planning, Engineering, Fitzroy River Water and Rockhampton Regional Waste and Recycling. The directorate also provides media and community awareness programs for those areas
Civil Operations	
Urban Operations	Manages the construction and maintenance of road pavements and surfacings, bridges, kerb and channel, footpaths and cycle ways, stormwater drainage systems, guardrail, street signs, line marking and traffic signals that are not on State controlled roads, and road lighting for the urban areas of Rockhampton, Parkhurst, Gracemere and Mt Morgan
Rural Operations	Manages the construction and maintenance of sealed and unsealed road pavements, bridges, stormwater drainage systems, guardrail, road signs and line marking in the rural towns and areas of the Region
Development and Building	
Development Assessment	Manages development applications for material changes of use, reconfigurations of lots, operational works and building works assessable against the planning scheme through the Integrated Development Assessment System under the Sustainable Planning Act 2009.
Engineering Services	
Infrastructure Operations	Responsible for the provision of engineering advice, assessment of development applications and compliance inspections involving reconfiguration of lots, material change of use and operational works as they relate to traffic, transport, stormwater, water supply and sewerage reticulation networks
Strategic Infrastructure	Responsible for the investigation and planning of new and upgraded infrastructure within the roads, pathways, cycle paths, public transport, stormwater, floodplain management, reticulated water supply and sewerage networks within the Region.
Fitzroy River Water	
Treatment and Supply	Manages the planning, construction, operations and maintenance of water and sewage treatment plants, water and sewage pump stations, water reservoirs, and water storages enabling the delivery of high quality, safe, reliable and cost effective water and sewerage services to our customers. The unit also manages trade waste licensing, drinking water and environmental compliance reporting for FRW

The 2015/16 budget (see Table 7-2) shows that Regional Services is responsible for 53% of RRC's operational expenses and 81% of the capital expenses. A further breakdown of the figures would probably show that most of the 51% of RRC's capital budget administered by Civil Operations would be related to road works with a small proportion of this destined for the stormwater network. Over

half of Regional Services operating expenses are attributable to the supply of water and the sewerage network (Fitzroy River Water).

7.14.2. Gladstone Regional Council (GRC)

A good example of GRC's move towards water quality improvement outcomes is the draft GRUSQMP (see section 7.7.1) which is now at the implementation stage and awaiting the allocation of resources.

As indicated previously (and in the draft GRUSQMP) stormwater management (drainage) is primarily the responsibility of GRC's Engineering Services Directorate and is a component of the 'roads and drainage networks' budget.

The 2014/15 budget shows a stormwater maintenance allocation of $2m (design and capital works $4m) while roads maintenance allocation was $21m (capital works $29m). This is understandable as the road network is constantly used by the community and visitors while the stormwater network is only utilised when it rains.

In the 2015/16 budget roads and drainage constitutes 49% of capital expenditure and 12% of operational costs.

While both are continually expanding and require maintenance the figures illustrate the relative importance of the two separate and associated systems i.e. roads are the priority, and the limited capacity of GRC to implement stormwater quality improvement with current resources.

8. Information Accessed

8.1. Information Requested

Rockhampton Regional Council and Gladstone Regional Council were approached through the RUSMIG network with a request to provide available information that could assist identify Council's current water quality improvement related activities and that would be useful in the context of scoping an urban component of the Fitzroy WQIP. Information requested from RRC is shown in the text box below.

Livingstone Shire Council (LSC) was not a RUSMIG member so there was no established contact to pursue information requests. Starting from scratch with local government is time consuming and was not feasible in the timeframe for this project. Making access to LSC more difficult was the impact of Cyclone Marcia and priorities associated with clean up and reconstruction efforts. LSC were therefore not in a position to assist with the collation of information for the background report or scoping study. As a result only publicly available information has been summarily reviewed.

RRC information requested:

A. Mapping/GIS showing stormwater management systems and relationship to urban waterways and catchments including location of stormwater treatment devices and water sensitive urban design (WSUD) measures i.e. to establish relationships between urban stormwater management systems and the wider Fitzroy sub catchments

B. Matters included in the draft Rockhampton Regional Council Planning Scheme relating to water quality and the State Planning Policy (2013) (SPP) including policies, overlays, codes and development guidelines
C. Mapping/GIS associated with planning reports and the new planning scheme and in particular population and urban expansion projections, zones, overlays, natural assets and environmental constraints
D. Process for determining water quality related development conditions and compliance management associated with development and construction activities e.g. erosion and sediment control and incorporation of WSUD as per the SPP stormwater management objectives
E. Management/maintenance system for stormwater systems and WSUD measures and interface with natural areas and parklands
F. Internal system for managing water quality impacts of RRC development and construction works and maintenance works
G. Water quality monitoring programs including data storage and analysis
H. Partnerships and community education and involvement programs relevant to water quality and aquatic ecosystem health e.g. litter, Waterwatch, Catchment Care, Friends of the Wetlands
I. Water supply and relevance of water quality including costs associated with poor raw water quality
J. Wastewater treatment plant locations and discharge points, plant capacity, discharge volumes, nutrient concentrations, recycling/reuse and water quality monitoring. Future expansion and/or upgrade requirements
K. Any other ERAs within RRC that may impact water quality
L. Anything else water quality related specific to RRC not included above

Additional request [email 20150702] for mapping/GIS information including:

- stormwater system layout;
- waterways, wetlands and catchments;
- location of stormwater treatment devices and water sensitive urban design (WSUD) measures;
- anything else that may be relevant to stormwater management and interaction with natural areas;
- Council owned land;
- location of raw water supply catchments;
- treated water delivery system;
- wastewater/sewerage removal system and treatment plants;
- most recent aerial photography (at least urban areas);

From the planning scheme side of things:

- anything that shows areas of local environmental significance;
- mapping associated with planning studies;
- planning scheme zones and overlays;
- projected growth areas;
- development underway/approved;
- environmental constraints and hazards;
- flood prone areas;
- environmental features.

The information requested from GRC was similar to RRC and is included in the text box below.

A. Mapping/GIS showing stormwater management systems and relationship to urban waterways and catchments including location of stormwater treatment devices and water sensitive urban design (WSUD) measures;
B. Relationship between Gladstone Port stormwater management system and GRC general urban stormwater management system;
C. Matters taken into consideration when developing the Gladstone Regional Urban Stormwater Quality Management Plan (GRUSQMP) including background reports and mapping (may be related to above points);
D. Matters included in the new Gladstone Regional Council Planning Scheme relating to water quality and the State Planning Policy (2013) (SPP) including policies, overlays, codes and development guidelines I can extract these if I have access to the draft scheme and associated reports etc.);
E. Mapping/GIS associated with planning reports and the new planning scheme and in particular population and urban expansion projections, zones, overlays, natural assets and environmental constraints;
F. Process for determining water quality related development conditions and compliance management associated with development and construction activities e.g. erosion and sediment control and incorporation of WSUD as per the SPP stormwater management objectives;
G. Management/maintenance system for stormwater systems and WSUD measures and interface with natural areas and parklands;
H. Internal system for managing water quality impacts of GRC development and construction works and maintenance works;
I. Water quality monitoring programs including data storage an analysis;
J. Partnerships and community education and involvement programs relevant to water quality and aquatic ecosystem health e.g. litter, Waterwatch, Catchment Care, Friends of the Wetlands;
K. Water supply and relevance of water quality including costs associated with poor raw water quality;
L. Wastewater treatment plant locations and discharge points, plant capacity, discharge volumes, nutrient concentrations, recycling/reuse and water quality monitoring. Future expansion and/or upgrade requirements;
M. Any other ERAs within Gladstone RC that may impact water quality;
N. Anything else water quality related specific to GRC not included above.

8.2. Information Accessed

Information received either formally or in conversation with RRC contacts with reference to the above list is noted in Table 8-1. Some of the information was gathered from publicly available sources e.g. websites.

Table 8-1: Accessed Information - Rockhampton

Data	Notes
A	No GIS information provided. Additional request made (see item M)
B	The draft planning scheme with maps was provided on DVD and a preliminary review was undertaken (see section 7.6.2)
C	No GIS information provided. Additional request made (see item M)
D	Examples of Standard water quality conditions provided: • CONDITIONS FOR RECONFIGURING A LOT (Updated 25 May 2015); • CONDITIONS FOR A MATERIAL CHANGE OF USE (Updated 25 May 2015).
E	No documented system in place for management/maintenance of stormwater systems and WSUD measures. Responsibility lies with Civil Operations however Parks may also be involved (see section 3.2.5)
F	No system information provided
G	No water quality monitoring programs apart from wastewater treatment plants. Basic information provided (see section 5.6.1)
H	Reef Guardian Councils and RUSMIG (see section 0 and 7.11)
I	No specific information
J	Location of wastewater treatment plant discharge and monitoring points provided. Plant capacity and other information supplied in the form of a report on plant upgrades. Some information extracted for the profile (see section 6.3.1)
K	Report on the RRC Lakes Creek landfill provided
L	No other additional matters identified
M	GIS department contacted and explained requirements (July 2015)

Information received either formally or in conversation with GRC contacts with reference to the above list is noted in Table 8-2. Some of the information was gathered from publicly available sources e.g. websites.

Table 8-2: Accessed Information - Gladstone

Data	Notes
A	Data provided through a Licence to Use Digital Data with GRC is: • Planning scheme zones (Gladstone City, Calliope Shire and Miriam Vale); • GRC Stormwater Open Drains; • GRC Stormwater System Pipes; • GRC Water Quality Device (points); • Roof water lines (stormwater system catchment upper boundaries lines); • Waterways. (**Note**: see Figure 5- and Figure 5- for examples of data use)
B	The relationship was not established and it is assumed that the systems are separate
C	Attended a GRC and key stakeholder's workshop to review the draft GRUSQMP Stage 3 Report. No additional information supplied
D	The draft planning scheme was provided and a preliminary review was undertaken (see section 7.6.4)
E	This material will not be available until the draft planning scheme is adopted by GRC
F	Requires further consultation with Engineering Services (Technical Services) after the new planning scheme is operational
G	More time is required to investigate this aspect in conjunction with appropriate GRC staff
H	No system/s currently in place
I	No water quality monitoring beyond regulatory requirements for wastewater treatment and water supply. General information about WWTPs supplied
J	No information supplied. Inferences drawn from public domain information
K	A function of Gladstone Area Water Board (GAWB) and not seen as directly relevant to the preparation of the scoping report so not pursued
L	No information provided. Public domain information used for this report
M	Not a function of Council. This needs to done in collaboration with the Queensland Department of Environment and Heritage Protection (EHP)
N	No additional information provided. All matters included in this report are in the public domain

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Living Waterways Scoring Guide
http://healthywaterways.org/u/lib/mob/20141010122444_0e4b3b2743623768a/2014_livingwaterwaysscoring-9mb.pdf

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http://healthywaterways.org/u/lib/mob/20151210163229_0a6365a745613dd21/8306_20101105_wsudbuscaseapp_v1_1.pdf

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http://healthywaterways.org/u/lib/mob/20141010170212_3e5978d7416c75828/2012_protectwaterwayswithwsud-06mb.pdf

Factsheet: Protecting our Waterways using Water Sensitive Urban Design
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Queensland Legislation

Aboriginal Cultural Heritage Act 2003

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Environmental Protection Act 1994

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Sustainable Planning Act 2009

Sustainable Planning Regulation 2009

Vegetation Management Act 1999

Water Act 2000

Water Regulation 2002

Water Supply (Safety and Reliability) Act 2008

Water Supply (Safety and Reliability) Regulation 2011

Appendix A: Historic Context

Rockhampton

Historic Regional and Catchment Influences

The location and configuration of Rockhampton was integrally related to the characteristics of the catchments and the relationships of the pioneers and pastoralists with productive land and water availability along with the socio-economic drivers and transport technology of the time. The history of Rockhampton provides an insight to the relationship of the urban areas with the catchments and the catchment characteristics that influenced the establishment of Rockhampton and its ongoing growth.

The sheep's back

For much of the 1800s wool was the most important product to the economy of Australian. The demand for wool on the international market drove the expansion of the pastoral industry in Australia and enabled vast areas to be 'opened up'. By 1840, Australia was producing more than two million kilos of wool each year. The buying and selling of wool was the principal business of the Sydney Wool Exchange where wool was shipped prior to despatch to overseas markets, principally through London. It was the search for grazing land for sheep that instigated the initial settlement of the Rockhampton region and western catchment areas and helped define the location of Rockhampton.

A large area 'centred' on Gracemere was selected by the Archer brothers as their sheep run when they 'discovered' the area in 1853 "*relying on Dr Leichhardt's opinion as to the probable character of the country*" (Bird 1904, p.3). Leichhardt had passed through the hinterland in 1844 and noted that two large rivers (the Mackenzie and Dawson) would most likely come together to the east to form a river of significant size with associated flats and potential grazing and farming land.

The Archer bothers travelled from their home in the Burnett district to Rannes station, the most northerly settlement at the time (occupied by Messrs. Leith-Hay). They then set off northwards reaching and naming Mt Spencer (16 kilometres west of Dundee township) before turning more easterly to reach the Dee River and Dee Range. From the top of the Dee Range they sighted a large river running to the sea. This they assumed was the speculative river of Leichhardt, which they subsequently named the Fitzroy after the Governor of the colony (New South Wales) at that time.

The Archer party headed towards the river encountering a fresh water lake on the way, which they named Grace Mere. "*The fine lake naturally attracted the attention of the explorers, and no doubt it was decided to make a settlement there should they ever return*". (Bird 1904, p.4) The party then proceeded to the river and found their way to the rocks in the vicinity of where the Rockhampton barrage is now located. At that time the banks were fringed with mangroves and it was obvious to the explorers that the river at this point was tidal and would make an excellent inland port.

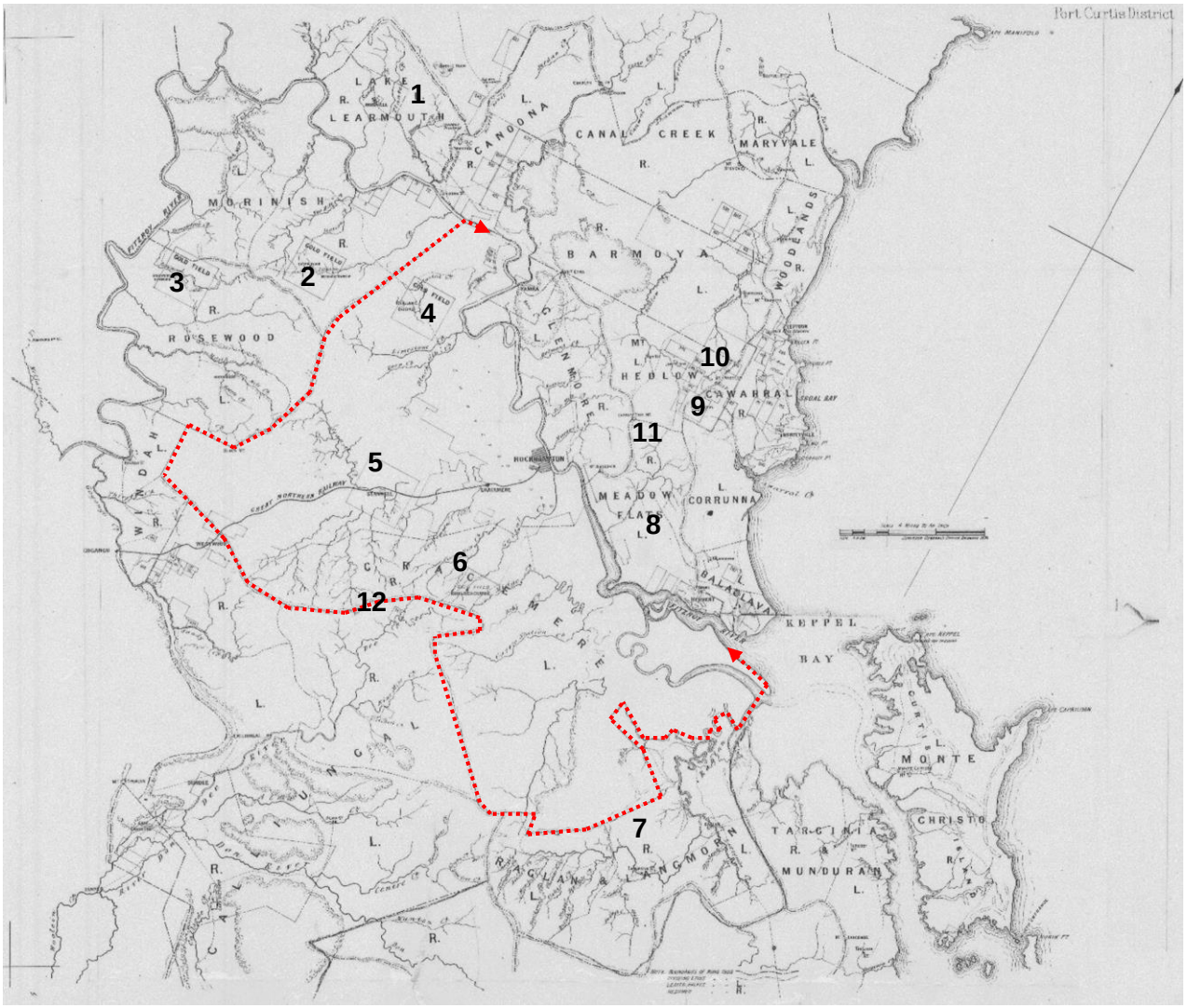
"*The country from the Dee Range must have seemed to the new-comers an ideal spot for a large sheep station, with its lagoons and creeks in profusion, with a tidal river to carry away wool and bring up stores at a cheap rate, and with heavily-grassed pastoral and agricultural lands all along the frontage*." (Bird 1904, p.4)

Before returning to their station on Burnett River the country was 'surveyed' in preparation for applying to the New South Wales Government for their selection. An indicative area for a port town by the river, downstream of 'the rocks', was also noted.

On the 2nd of July 1855 the Archers set out to establish their new home and pastoral activity. Mr. Charles Archer was in charge of the party, with the late Mr. H. W. Risien second in command. The remainder of the party consisted of Mr. Charles Beeman (storekeeper), fourteen Europeans, four native police with their female Aboriginal partners and four Burnett Aboriginal men. (Bird 1904, pp.3-4)

"*The party brought several thousand sheep, together with, bullock teams, horses, and all the varied impedimenta, for starting a home in a new country*." (Bird 1904, p.5) The Archer's land (see Figure A) extended from the Bajool scrub to near Morinish with the Fitzroy River forming the eastern boundary for a length of approximately 110 kilometres, incorporating what would become the town of Rockhampton. The settlement at Gracemere took shape as the party proceeded to clear land, build huts and erect yards to protect the sheep. "*The sheep had then to be shorn, and the wool prepared for despatch to a southern market*." (Bird 1904, p.5)

Figure *A: Pastoral Runs 1874*



Note: The original boundary of the Gracemere pastoral holding is highlighted in red with arrows indicating the boundary then follows the Fitzroy River. As with other runs in Queensland the Government resumed half of each run to subdivide and make more land available. Source map is available at: http://www.qld.gov.au/recreation/arts/heritage/museum-of-lands/maps-plans/cadastral/ (Port Curtis Consolidated Runs (Sheet 2 of 3) compiled in 1874). Rockhampton is centre frame. Gold fields and/or diggings are numbered. 1 is Canoona, 2 is Morinish, 3 is Rosewood, 4 is Ridgelands, 5 is Stanwell, 6 is Bouldercombe, 7 is Ragland and Langmorn, 8 is Meadows Flats, 9 is Cawarral , 10 is Mt Wheeler, 11 is New Zealand Gully and 12 is Mount Morgan (see Table A).

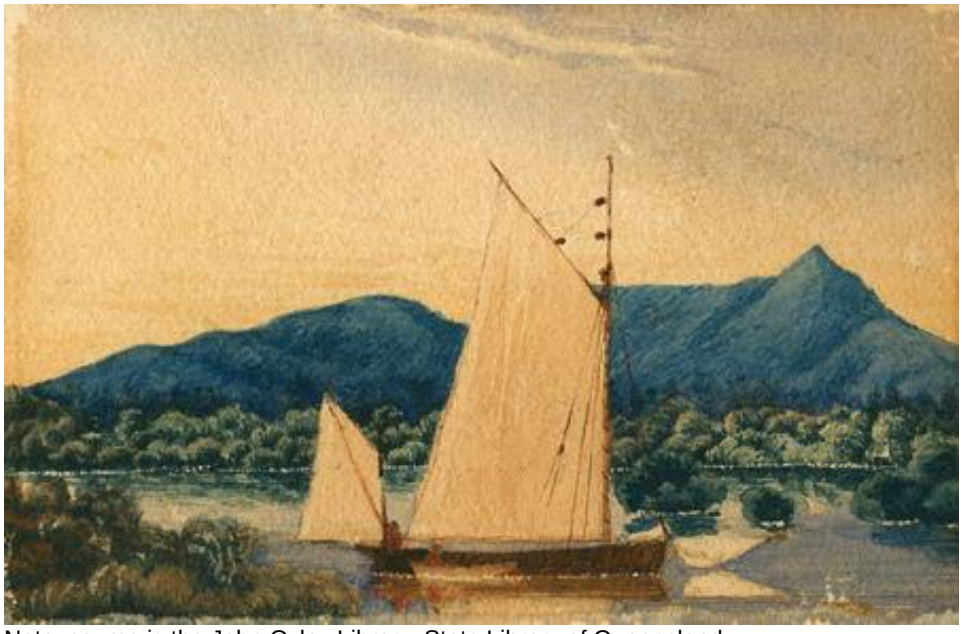
Mr. W. H. Wiseman, Crown Lands Commissioner, came to Gracemere later in 1855 to set up headquarters. Mr. Wiseman and Mr. Charles Archer soon after chose the site of the town of Rockhampton.

While the Gracemere settlement was being established Charles Archer's brother Colin was having a sailing vessel (cutter) built in Maryborough (the Elida) (see *Figure* B) to bring provisions up the

Fitzroy River to the settlers. Mr. Colin Archer, Mr Elliott and one sailor arrived in the Elida on the 1st of September 1855 opposite where the present town is now located. "*In November the first export of wool was despatched in the Elida, in which, it was taken to the rising town of Gladstone for transhipment to Sydney*." (Bird 1904, p.5) Gladstone was the closest established port at that time.

Soon after arrangements were made for the conveyance of the balance of the wool to Sydney using a temporary wharf that was erected opposite the later constructed Belle Vue Hotel. The wool was loaded onto the steamer Albion, which operated out of Gladstone. "*Thus in less than six months the enterprising settlers had travelled a couple of hundred mile into a new country, established a little settlement, shorn their sheep, and sent away the first clip*." (Bird 1904, p.6) Thus the Archer party with their flock of sheep was the catalyst for the establishment of Rockhampton.

Figure B: The Elida on the Fitzroy River 1855



Note: source is the John Oxley Library, State Library of Queensland.

Shortly after their first shipment of wool in 1856 the Elliotts moved their flock from the Archer's Gracemere station to establish their own Canoona station to the north of Yaamba. In April 1856 a census of the residents of the district was taken and recorded as 35 white males. Later in 1856 the first urban commercial enterprise was established in the form of a store (northern side of Fitzroy Street opposite the present Criterion Hotel) to service the pastoral industry, which at that time consisted of the Archers at Gracemere and the Elliotts at Canoona. A public house, the Bush Inn, was established across the road from the store in 1857 (Bird 1904, pp.7-8).

By 1874 all the available pastoral land had been taken up and settled in the Port Curtis District (see Figure A) and the Leichhardt District to the west. At this time the first stage of government land resumption had occurred to enable more settlers to lease or purchase pastoral land.

River port town

The pattern of settlement was fairly typical for the time with country being opened up for wool production and a port established in the most convenient location to enable the inflow of provisions and the outflow of production from the surrounding region. For Rockhampton this was 58 kilometres (AMTD) upstream of the Fitzroy River mouth. The road network consisted of rough tracks cut through the bush so the most expedient form of transport, in both time and expense, was by sea.

In 1858, prior to the proclamation of Queensland, Rockhampton was declared a port of entry by the New South Wales Government and Rockhampton became a river port town. Apart from anything else this resulted in the appointment of some of the first government officials in Rockhampton. Early officials, like most other town residents, were accommodated in tents.

The navigation of the Fitzroy River was difficult and dangerous especially for inexperienced sailors due in part to the variations in the current and the shallows which changed with the tide and would be shown to vary over time with flood flows. The significant increase in water traffic associated with the Canoona gold rush resulted in the government appointing a pilot to ensure the safe movement of vessels from Keppel Bay to Rockhampton. In 1890 Customs House was erected on Quay Street using stone quarried from near Stanwell.

As the Fitzroy River was only navigable by vessels with a relatively shallow draft sea ports were established on the coast, adjacent to the mouth of the river. Broadmount was established on the northern side (1880s) and Port Alma on the south (1890s). Railways were subsequently constructed to carry goods to the wharves at these locations. The Broadmount rail line opened in January 1898 and Port Alma line in October 1911.

The port of Rockhampton, with its sea ports, remained the most important terminus in Central Queensland for the main form of commercial transport, sail and steam, until the rail and road networks became a more viable proposition in the early and mid-1900s respectively. The Broadmount rail line ceased operation in the 1920s and the line was effectively closed in July 1930 after the wharf caught fire. The line to Port Alma remained operational until 15 October 1986.

Figure *C: The Lucinda and Crew on Rockhampton Wharves circa 1890*

Note: Source is the Rockhampton Regional Library History Centre.

Figure *D: Shipping at Rockhampton Wharves circa 1887*

Note: Source is the John Oxley Library, State Library of Queensland.

Mining and urban expansion

While wool production was the catalyst for the establishment of Rockhampton mining was the accelerator of growth and creator of wealth during the later 1800s. Prospecting was actively encouraged by the colonial government with rewards offered for the discovery of viable gold fields. As a result settlers and their employees as well as free-lance prospectors were always on the lookout for gold in likely gullies. This fortune seeking activity commenced in earnest in 1858 with Queensland's first gold rush to Canoona, north of Rockhampton. At the time Rockhampton consisted of the Bush Inn (later rebuilt as the Criterion Hotel), Mr. Palmer's store across the road, a rough woolshed and a few humpies. There was also a rickety wharf near the end of Fitzroy Street built by Mr Palmer to unload provisions for his store. Rockhampton expanded rapidly to service the transient population while continuing to service the small agricultural sector in the surrounding hinterland.

People rushed to the Canoona goldfield, using Rockhampton on the Fitzroy River as the nearest port. The Canoona field was not extensive enough to support the thousands of gold seekers (estimated at between 15,000 and 25,000 people), and communications were not fast enough to prevent more people 'rushing' to the field. As a result many later arrivals did not even disembark the vessels that brought them to Rockhampton while others were 'stranded' at Rockhampton with no funds for the return journey south.

By the middle of September 1858 there were thousands of people camped on the site of Rockhampton town with tents erected from the river to the [Athelstane] range. Timber frames covered with canvas had formed a sort of street along what is now Quay Lane and grog shanties and billiard saloons were numerous as people had come prepared to open hotels and stores to cater for the 'miners'.

Most of the Canoona rush gold seekers returned south however some stayed, whether by design or necessity, adding to the population of the infant town and increasing the potential labour force for the expansion of the town and to service the needs of the hinterland. Seasoned prospectors continued to explore the region and areas to the west.

New gold fields continued to be discovered in the region and to the west with Rockhampton acting as the main port of entry for the ongoing influx and exit of gold seekers and for the provision of supplies to Rockhampton and the Fitzroy Basin hinterland. A list of the main mining activity that added to the wealth and commercial viability of Rockhampton and fuelled urban growth is provided in Table A.

Table A: Mining Driving Rockhampton

Disc.	Field	Location	People	Longevity and yield
1858	Canoona	Canoona station - 58 km north	15,000 [1] 3,000 [2] 20 [3]	4 months. Some rich patches but limited extent with a total of 40,000 ounces produced up to 1860 Some continued to work the field after the rush
1858	unnamed	Gracemere home paddock	50 [2]	Some miners returning from Canoona discovered gold in a shallow gully within a few hundred metres of the homestead. It was soon worked out
1861	Peak Downs	Clermont – 370 km west / north west	3,000 [1] 2,000 [2] 500 [3]	Gold was found in the bed of a gully running into Sandy Creek close to what is now the town of Clermont. There were about 30 diggers in the area in 1862 and a store and hotel was opened. Prospecting continued with new areas discovered and worked. By 1863 word had reached Rockhampton and hundreds of people headed to the Peak Downs field. By 1885 much of the shallow ground had been worked out and deeper ground being less attractive many diggers returned to Rockhampton and commenced prospecting around the area nearer the coast
1862	Copperfield	6km south of Clermont	3,000 [4] 800 [3]	A rich deposit with an interesting history which was cut short as a result of the tyranny of distance and poor management decisions. It operated profitably until 1876 when the mine was sold to local and Rockhampton investors. The mine floundered on for more 5 years then closed. At one time there were 5 smelters operating and the town of Copperfield had 3,000 residents
1863	unnamed – Ross's Gully	2km north of Cawarral stn – 30 km north east	20 [1] 4 [3]	4 prospectors working the area claimed they could earn £1 per day per man by panning. The area was abandoned as Rockhampton people who ventured to Ross's could not repeat the 'feat'

1864	unnamed - Stony Creek	12 km south west of Stanwell	40 [2]	A section of gully (450 metres) was worked for three months by a small party before they were discovered and joined by others. Other gullies in the vicinity were worked for a total yield of <1,000 ounces
1865	Gavial Creek	25 km south	400 [1]	Shallow ground was relatively rich and lucrative for some however the deeper ground was soon reached and most diggers had worked out their payable areas and had left by early 1886. Gavial Creek is the left branch of Crocodile Creek.
1866	Crocodile Creek - Gavial Creek	As above	3,000 [2] 400 [3]	The bed of the creek was initially excavated and then claims were taken up on the banks and the 'flats'. This was a substantial field and yielded in the vicinity of 100,000 ounces over 3 years at £3 15s. per oz. One third of diggers were Chinese
1866	Hector Reef	As above	40 [3]	The Hector Reef was opened nearby and following amalgamation with the Pioneer Quartz Crushing Company 10,000 tons of ore was crushed for a return of 2 to 7 ounces per ton. This was the first reef worked in Queensland
1866	Morinish	Morinish stn. – 50 km north west	300 [2 3]	Gold was found in a number of gullies and early in 1867 Morinish assumed an air of prosperity. Several gold-bearing reefs were discovered including the Kennedy (or Pioneer), Nonpareil, Alliance, and Welcome, all of them turning out a lot of gold
1867	Ridgelands	35 km north / northwest and south of Morinish Road	1,000 [2] 400 [3]	Decomposed reef with minimal alluvial material worked with several puddling machines. In 1868 a crushing machine was erected near the road and was kept busy for one to two years, Variable yields with some rich areas
1867	Rosewood	65 km north west	1,000 [2] 300 [3]	Very patchy with a small amount of background gold and small, rich patches e.g. 100 ounces. ~70,000 ounces yielded over 3 years
1867	Raglan	60 km south	200 [2] 20 [3]	A few gullies turned out well with 'easy' digging in shallow ground. Many hard-up diggers have made a good living there
1867	Langmorn	70 km south	400 [2] 30 [3]	4 dwt. to 2 oz. of gold to the load. Fluctuating results for a few years
1867	Blackfellows Gully	65 km from R.	40 [3]	A small field with the principal gully and a few others soon worked. Good quality reefs were opened and worked for good returns with 10 ounces to the ton reported. Three stamper mills operated there at one stage
1867	Herbert's Creek	Various local fields	1,000 [1]	People rushed there from other fields (Bird 1904, pp.220-1)
1868	Cawarral	30 km north east	400 [2]	Patchy alluvial diggings which led to the discovery of reefs including the Helena, Royal, Alfred, Hibernian and others. At least two machines were erected to treat the reef material and yielded good returns for a number of years. A second rush occurred in 1870 to the alluvial flats with good returns in a dozen claims but otherwise patchy
1868	Mount Wheeler	32 km north east	300 [2] 30 [3]	The largest nugget found in the region weighing 258 oz. 11 dwt. caused a rush from town. The field had a limited

				extent and only small number of claims provided good returns in a short period of time. Reefs were explored and the Galawas was worked some years later by F. A. Morgan and another near Limestone Creek for many years. The Mt Wheeler reefs produced 26,502 oz of gold between 1881 and 1922
1869		Near Archer's Fifteen-mile Station	200 [2] 40 [3]	Diggings that lasted a considerable time were opened up
1869	Cania and Kroombit	Various local fields		Turned out considerable quantities of gold (Bird 1904, pp.220-1)
1870	New Zealand Gully	25 km east	1,000 [2] 200 [3]	Alluvial gold from the surface to 4 metres with the better claims yielding from £8 to £12 per week per man (3 to 4 ounces). A number of quartz veins and reefs were opened, and a lot of gold obtained from the casing and loose rubble
1870	Cox's Creek	10 km from Westwood	300 [1] 20 [3]	Nice gold in the creek with several claims getting on to rich gold. Emu Creek and Native Cat nearby followed later and turned out a lot of gold. At Native Cat a crushing mill was erected, and the quartz reef proved payable so long as the oxidised stone lasted (Bird 1904, pp.220-1)
1882	Mt Morgan	40 km	100 to 1,500 3,000 [4]	A world class gold and copper deposit that contributed substantially to the economy of the region stimulating further growth in Rockhampton

Notes: Source information is Bird 1904 (pp.9-18 and pp.206-222). Disc. is the year the discovery of the deposit became known to the general public starting a 'rush'. Location is in relation to Rockhampton. People is [1] estimated number of people who rushed to the field (whether they worked it or not), [2] the maximum number of people working the field at any one time, [3] the average number of people that worked the field after the initial rush and at least made a living and 4 is the size of the town established near the mine/field. Goldfields and diggings as numbered as they appear on Figure A are 1 Canoona, 2 Morinish, 3 Rosewood, 4 Ridgelands, 5 Stanwell (Stony Creek), 6 Bouldercombe, (Gavial Creek and Crocodile Creek) 7 Ragland and Langmorn, 8 Meadows Flats, 9 Cawarral, 10 is Mt Wheeler and. 11 is New Zealand Gully.

The history of the Mount Morgan mine is well documented due to its importance to Rockhampton and the Queensland economy. Mount Morgan was originally thought to be an ironstone deposit and was discovered by accident when Mr F. A. Morgan was looking for a copper deposit in the vicinity on advice of an employee working at his Galawa hard rock mine near Mount Chalmers.

A syndicate was formed by Morgan (50% Morgan family and 50% investors) and a ten head stamper battery was erected near the Dee River with initial crushing commencing early in 1883. The results are not known but must have been encouraging as another battery was erected in late 1883 and production accelerated to 230 tons per week working night and day when there was enough water. Water supply issues were 'solved' by constructing a dam in the Dee after a temporary solution pumped from a waterhole in the river bed about 800 metres from the batteries. Actual gold production during this time is not known but given the richness of the deposit it would have been nothing less than 5 ounces per ton of treated material. The income enabled further exploration of the deposit including the sinking of shafts to intercept the ore at depth.

In 1886 the Morgans sold their interest in the mine and a (public) company limited by shares was formed with one million shares paid up to 17s. 6d. per share. This provided the capital required to

expand mining operations and also fuelled speculation in the shares with astute investors buying and selling on a rising market until 1888 when the shares reached £17 10s. After this the share price steadily declined to closer to the real value i.e. £5, as 'gamblers' sold stock to reduce their losses.

The original shareholders became exceedingly wealthy and the mine was a cornerstone of Rockhampton and Queensland's wealth and the state's main gold producer until the 1920s. During the proving and exploration stage (1884) the mine employed 100 men and 20 years later was a major regional employee with 1,500 people on the books.

"At Mount Morgan — the show mine of Queensland, and one of the greatest in the world — there has been quarried out of the hill and dug from the depths beneath stone that, under treatment by works in every way worthy of such a mine, has, in a little over twenty-two years, yielded gold to the value of over £13,760,000; has paid in wages and other expenditure about £7,000,000….." (Queensland Government 1909, p.146). It was largely due to the wealth of Mount Morgan that Rockhampton weathered the severe economic depression of the 1890s and constructed grand bu

Copper was discovered in the lower workings and copper production commenced alongside the gold operations in 1902. Operations were successful until after World War I when the fall in the price of copper and rising underground mining costs made economic mining difficult. In 1925 the underground workings were gutted by fire and the mine was flooded to bring it under control. The company went into voluntary liquidation in 1927. By this time the Mount Morgan Gold-mining Company had treated 9,307,000 tons of ore for 5,345,000 oz of gold and 140,000 tons of copper. The mine was later re-opened as an open-cut operation and following that successfully retreated the tailings using improved extraction technology.

In a 1959 publication it was stated that "the famous gold and copper mine of Mount Morgan Ltd…. employs 82 per cent of the working men of the shire." (Cilento and Lack).

While Mount Morgan was the main mining enterprise boosting the early fortunes of Rockhampton, smaller mining operations continued around the district after 1870 with noticeable 'spikes' in activity associated with government policy and economic conditions. For example in the depression of the 1930s people were encouraged to prospect for gold and were paid for their efforts whether or not they found any minerals.

Notes on some other notable post 1870s mining activity around Rockhampton is provided below:

Mount Chalmers (29.5km by rail north-east of Rockhampton) was the most important mine in the Cawarral Goldfield. The ore body was first worked in 1891 and went through a number of transformations before Great Fitzroy Gold and Copper Mines Limited began large scale mining in 1907. Total ore production from the mine over its life was 428,000 tons which yielded 10,059 tons of copper, 51,022 oz of gold and 181,027 oz of silver;

Cawarral and New Zealand Gully in particular continued to be worked for over 30 years following the initial rush;

Gavial Creek (Bouldercombe) a number of reefs were opened and worked, re-opened and tailings re-treated between 1890 and 1936. There was a number of attempts to dredge the alluvium between 1901 and 1944 with little success;

Rich alluvial deposits were worked at Struck Oil and Dee River (8km from Mount Morgan) with the Dee River noted for the size of nuggets obtained. Miners still prospect there occasionally;

Reef and alluvial deposits were worked, on and off, at most of the Rockhampton Goldfields (Canoona, Rosewood, Ridgelands, Stanwell, Morinish and Ulam) and diggings from 1870 to 1910 and again in the 1930s.

An indication of the importance of mining (gold and copper) to the Rockhampton (Fitzroy) region is shown in the Table B. The Central region is roughly equivalent to the Fitzroy region.

Table B: Population on Goldfields by Region

Region and Year	Goldfields	Total	Proportion on goldfields
Northern			
1896	34,102	93,377	36.5
1901	41,023	112,567	36.4
1911	34,944	121,708	28.7
Central			
1896	8,949	56,127	15.9
1901	12,241	64,840	18.9
1911	18,298	74,669	24.5
Southern			
1896	14,808	322,675	4.6
1901	17,168	333,108	5.2
1911	18,714	425,752	4.4
Total			
1896	57,859	472,179	12.3
1901	70,432	510,515	13.8
1911	71,956	622,129	11.6

Notes: Adapted from Table 3.3 Population (a) on the goldfields and total population by region (b), Queensland, 1896-1911 (pp.66-7) in Queensland Government Statistician's Office 1998, *Queensland Past and Present: 100 Years of Statistics, 1896-1996*, Queensland Government, Brisbane.

Table Notes: Source is Registrar-General, *Statistics of the State of Queensland,* various years, and *Vital Statistics: Annual Report of the Registrar-General,* various years (a) At 31 December.

(b) From 1933 Southern regi and Northern region includes Far North, North West and Northern SDs. Prior to 1933 regions referred to the three financial divisions of Queensland.on includes Brisbane, Moreton, Wide Bay-Burnett, Darling Downs and South West statistical divisions (SDs); Central region includes Fitzroy, Central West and Mackay SDs;

Immigration

The new Queensland Parliament wanted to build up the population of the fledgling colony as rapidly as possible by enticing immigrants to Queensland. Queensland had to compete with New South Wales and Victoria for immigrants and in 1861 a public lecturer was appointed and went to Great

Britain to explain the benefits of immigrating to Queensland. One of the attractions was the land-order system whereby those who paid their passages to Queensland would obtain an £18 land-order, which could be used in part payment for any land taken up. After a continuous residence of two years in Queensland another land order for £12 was given.

The 'populate or perish policy' saw immigrants pour into the ports of Queensland from 1863 onward for a few years creating a severe oversupply of labour in south Queensland with wages in many vocations reduced by fifty per cent for a time. This was not such an issue at Rockhampton principally because a number of alluvial goldfields were opened; sheep runs required labour and builders and construction workers were required for the new town and surrounding areas. In fact the arrival of immigrants in Rockhampton caused a good deal of excitement as householders, station-owners and others were on the look-out for servants while local men, who significantly outnumbered the women, were looking for wives from among the female passengers. Every immigrant ship that arrived invariably brought more males than females so the previous disparity between the sexes remained. As well as finding work locally men and women took engagements on newly settled hinterland stations and may have had to walk there (300-600 km) before wages commenced. A decent wage at the time was about £40 to £50 per year.

The rapid influx of immigrants saw 23,000 or 24,000 people landed in Queensland over the three years from 1863 to 1866. From 1860 till 1870 inclusive some 53,535 immigrants were landed in Queensland.

The first immigrant vessel to come to Central Queensland was the ship Persia, which docked in Gladstone on the 16th of November 1861. The fact that a ship with Government immigrants had been sent to Port Curtis instead of Keppel Bay irritated Rockhampton residents and "*a requisition was sent to the Government asking that some of the immigrants be allowed to come to Rockhampton. The Colonial Secretary, Mr. R. G. W. Herbert, replied that as many of the immigrants as desired could go to Rockhampton. He also stated that instructions had been sent to the Emigration Agent in London, to lay on ships for Keppel Bay direct, as circumstances warranted*." (Bird 1904, pp.65-70). Immigrant ships bound for Rockhampton in the 1860s are listed in Table C.

Table C: Rockhampton's Early Immigrants

Arrived	Vessel	From	Passengers*	Notes
[1] November 1861	Persia	Plymouth	454	1,600 tons. Government immigrants had been engaged for Gladstone and district at from £35 to £40 per annum. £40 to £45 per annum offered to entice them to Rockhampton (on Eagle steamer)
November 1862	Eutopia	Plymouth	324	949 tons. The first immigrant ship sent direct to Keppel Bay. 105 day voyage. Mostly English and Scottish. The s.s. Boomerang brought the passengers from the bay to Rockhampton
June 1863	Beejapore	Queenstown (Ireland)	>700	1,676 tons. Ninety one days voyage. The bulk of immigrants and passengers were from County Tipperary, Ireland with free immigrants from Lancashire. 457 of the passengers came to Rockhampton by the s.s. Queensland with the remainder travelling to Brisbane. Great demand for carpenters who obtained engagement at 12s. per day.
[2] June 1863 July 1863	Hannah More	Liverpool	420	1,129 tons. 130 day voyage. The second ship laid on for Keppel Bay. Immigrants chiefly from Lancashire. Required repairs at Bristol. Immigrants transported to Rockhampton by the s.s. Clarence. 38 deaths on route
September 1863	Saldanha	Greenock (Scotland)	620	1,562 tons. 106 day voyage. Scarlet fever and measles on board resulted in a quarantine for fourteen days on the south side of the Fitzroy River at Brown's Crossing where there was a fine lagoon of fresh water. Passengers were transferred in the schooner Policeman and tents were erected. After the quarantine period they were brought to town
October 1863	Rockhampton	Liverpool	454	1,065 tons. 116 day voyage. 20 deaths on route. Charges were made against the captain and purser, the latter of whom apparently was held responsible for the short supply of food and medical comforts. Accommodation in all parts of the vessel was quite inadequate, and the ventilation worse. Passengers were brought to town by the s.s. Star of Australia. 134 English, 134 Scottish, and 186 Irish. Single girls employed earned 8s. to 10s. per week
May 1864	Bayswater	Liverpool then Greenock	435	1,200 ton. 107 day voyage. The passengers were brought to Rockhampton by the s.s. Diamantina. While the vessel was in Keppel Bay five of the sailors managed to escape in one of the ship's boats and got safely ashore on the mainland

November 1884	Fiery Star	Queenstown	478	1,360 tons. 86 day voyage. The ship was reported to have been afterwards burnt at sea
May 1865	Landsborough	Plymouth	-	1,166 tons. 102 day voyage. The ship established a record in the fact that no deaths occurred on the trip out, neither was there any infectious disease on board
July 1865	The Royal Dane	London	540	93 day voyage. Measles was the chief sickness on board. Altogether there were thirty two deaths during the voyage. The vessel was kept in quarantine for a few days before the s.s. Leichhardt brought 404 of the passengers to Rockhampton. The Royal Dane appears to have been a favourite emigrant vessel, as she came on three or four occasions to Rockhampton, and a few times to Brisbane
September1 865	Empress of the Seas	Gravesend	491	1,243 tons. 96 day voyage. There were thirty-two deaths on board, and the passengers suffered greatly from insufficiency of nutritious food
January 1886	Bayswater	Queenstown	444	1,200 ton. 116 day voyage. Passengers were brought to town by the s.s. Williams. When the immigrants left the ship a lot of the sailors followed, and were duly brought up at the Police Court and sent to gaol till required
July 1866	Great Pacific	Liverpool	644	2,088 tons. 106 days voyage. The immigrants were brought up in the Government steamer Platypus. Many of the immigrants were intended for making the railway then in progress between Rockhampton and Westwood. The Great Pacific brought out a large quantity of railway iron

Note: Vessels docked in Keppel Bay unless otherwise indicated and were transferred to Rockhampton via smaller vessels. [1] indicates the vessel docked at Port Curtis/Gladstone. [2] indicates the vessel docked at Moreton Bay. * figures include Government immigrants and free immigrants as well as fair paying passengers. Not all passengers were bound for Rockhampton (Bird 1904, pp.69-83).

"By the end of 1866 the distress in Queensland through so much labour having been introduced and the stagnation in various industries became acute. Accordingly, few if any immigrant vessels were sent to the colony for some time. By 1870 the colony had recovered itself, and immigration was resumed with considerable vigour" (Bird 1904, p.84), including to Rockhampton with German immigrants joining the British immigrants for the first time.

Other vessels to use the Fitzroy River and/or Rockhampton wharves in the 1860s included:

The Ocean Chief (990 tons) from Brisbane anchored inside the mouth of the river in January 1863 and was loaded with wool for London. The vessel had a 21ft draft and could not use the wharves;

The Panama (414 tons) arrived from Dunedin, New Zealand in February 1864 with 147 gold-miners, bound for the Peak Downs;

The Vanguard (1,303 tons) arrived from London in 1867 with cargo and a few first-class passengers;

The City of Melbourne (175 tons) arrived in Keppel Bay in December 1867 with 103 South Sea Islanders (the first shipment of Kanakas to reach Rockhampton and possibly the first to reach Queensland). (Bird 1904, p.84)

Commerce and transport

The total population of Queensland on the 31st of December 1860 was estimated at 28,056 with "most of these people being more or less concentrated in the towns. The rest were scattered sparsely over the country between the southern boundary and the tropic of Capricorn for a distance of about 250 miles back from the coast-line. Rockhampton was then the most northerly port of entry" Bundaberg, "Mackay, Bowen, Townsville, Ingham, Geraldton, Cairns, Port Douglas, Cooktown and the Thursday Island settlement were non-existent" (Queensland Government 1909, pp.15-16).

The Canoona gold rush had provided an unexpected influx of people some of whom saw the potential of the region and stayed. Grazing runs had expanded rapidly in all directions following the lead of the Archers at Gracemere and there was a need by all the squatters to get their supplies and send away their produce from some port. At this time Rockhampton was the most northerly port so Gladstone, which was established earlier and a superior port, competed with Rockhampton for the rapidly increasing trade to and from the western districts.

As an exporter of primary products commerce in Australia is heavily reliant on transport. The import of materials to build the colony was also essential as Australia in the 1800s did not have a steel industry or the capacity to manufacture many of the goods required, which were available in Great Britain. The principal 'industrial' activities of the colony were sawmills and flourmills, soap and candle works and some boiling down establishments.

As the main transport method for goods was horse and dray the shortest and least tortuous route to a port was the preferred one. For much of the Fitzroy Basin that was Rockhampton while Gladstone serviced the Boyne and Callide catchments. Yaamba was an important part of the Fitzroy 'road' network in the early years with goods sent to Yaamba by small sailing craft and punts to avoid land transport routes.

Mining was the other key primary industry with transport issues. The opening of the Peak Downs Goldfield in 1861 saw a steady stream of traffic and supplies from Rockhampton via Yaamba to Peak Downs (Clermont) with the road passing through Marlborough. About 1864 a new road was cut through the scrub from Rockhampton to the Peak Downs via Westwood reducing the distance by 80 kilometres and as a result this route became the new 'highway' making Yaamba redundant for western trade. This route is closely aligned to the current Capricorn Highway to Emerald and the Gregory Highway to Clermont.

The next big advance was the establishment of a railway to link the western hinterland with the port of Rockhampton. The value of a railway was recognised by the residents of Central Queensland as roads were rudimentary and often difficult to pass especially during the wet season. A journey of

300 or 400 kilometres could take two or three weeks in light buggies with plenty of horses and the transport of heavy goods was unreliable and expensive. In the early 1860s the Government was approached to build a railway in a westerly direction from Rockhampton to the junction of the Clermont and Springsure Roads.

The Queensland Parliament saw the sense of the request and allocated the first funds to build a railway from Rockhampton to Westwood. This was part of an emerging strategy to construct east/west trunk lines to connect the main ports with their socio-economic catchment areas. Turning the first sod was ceremoniously carried out by Sir George Bowen (Governor of Queensland) accompanied by the Secretary for Lands and Works (the Hon. A. Macalister), the Colonial Treasurer (the Hon. J. Bramiston) and others on the 27th of September 1865. The construction of the first section of the Great Northern Railway (later renamed the Central Railway and then the Central West line) was expected to take twelve months however due to financial issues associated with expenditure overruns on the previously commenced Main Line from Ipswich to Toowoomba and Government loan facilities, the contractors did not receive construction materials and agreed payments. As a result the line was not completed until August 1867. The line was formally opened on the 19th of September 1867 and the time to travel the fifty kilometres from Rockhampton to Westwood was reduced from a day or more to two hours.

"*Thus Rockhampton at last had its railway, which was neither much good nor harm. Anthony Trollope, the novelist, who visited Rockhampton in 1872, described it as a railway that started in the bush and led to nowhere. The line was a subject of derision for some years, and as time went on it began to look as though no advance at all would be made with the westward extension*." (Bird 1904, p.339)

Following the resolution of financial issues, which was mostly due to the income being generated from gold mining (Gympie in particular), the Parliament approved the funding for the second section of the route in 1872. Funding was subsequently approved for the continuation and completion of the line. Summary details of the progressive completion of the line and other Rockhampton rail links are listed in Table D.

Table D: Rail to Port

From	To	Distance	Start	Completed	Cost
The Great Northern Railway (renamed the Central Railway)					
Rockhampton	Westwood	50 km	October 1865	August 1867	
Westwood	Comet	180 km	February 1873	March 1878	£480,000
Comet	Emerald	41 km	March 1978	May 1879	
Emerald	Withersfield	63 km		October 1880	
Withersfield	Bogantungan	38 km		September 1881	
Bogantungan	Pine Hill	41 km		November, 1883	
Pine Hill	Jericho	88 km		June 1885	
Jericho	Barcaldine	88 km		December, 1889	
Barcaldine	Longreach	110 km		February 1892	
Central Railway branch lines					
Emerald	Clermont	103 km		February 1884	
Emerald	Springsure	68 km		August 1887	
Coastal connections					
North Rockhampton	Emu Park	48 km		December 1888	
Nankin Creek	Broadmount	25 km		January 1898	

Note: The Broadmount line to the sea port junctions with the Emu Park line at Nankin Creek. The Great Northern Railway was renamed the Central Railway with the 'new' Great Northern Railway connecting Townsville to Mt Isa.

In addition to the above the "railway to connect the existing Central and Emu Park lines included the erection of the Alexandra Bridge over the Fitzroy River, one of the finest structures of the kind in Queensland. The line was opened for traffic on the 6th of November, 1899". (Bird 1904, p.348).

When it was decided to construct a bridge over the Fitzroy River to connect Rockhampton and North Rockhampton by rail the line from Rockhampton station along Denison Street was chosen to avoid land purchase costs for an alternate route through or around the town. That decision resulted in the current alignment which is still utilised today. This section is the only line in Queensland to have been opened as dual track. It was subsequently reduced to a single track to ensure two trains are not on the Alexandra Bridge at the same time given its age (constructed 1897) and limited load capacity. The Queensland rail network in 1925 is illustrated in Figure E showing the western trunk lines and the North Coast Line, which was completed in 1924.

Rail transport integration

Railway construction in Queensland prior to 1950 can be divided into a number of overlapping 'eras' being:

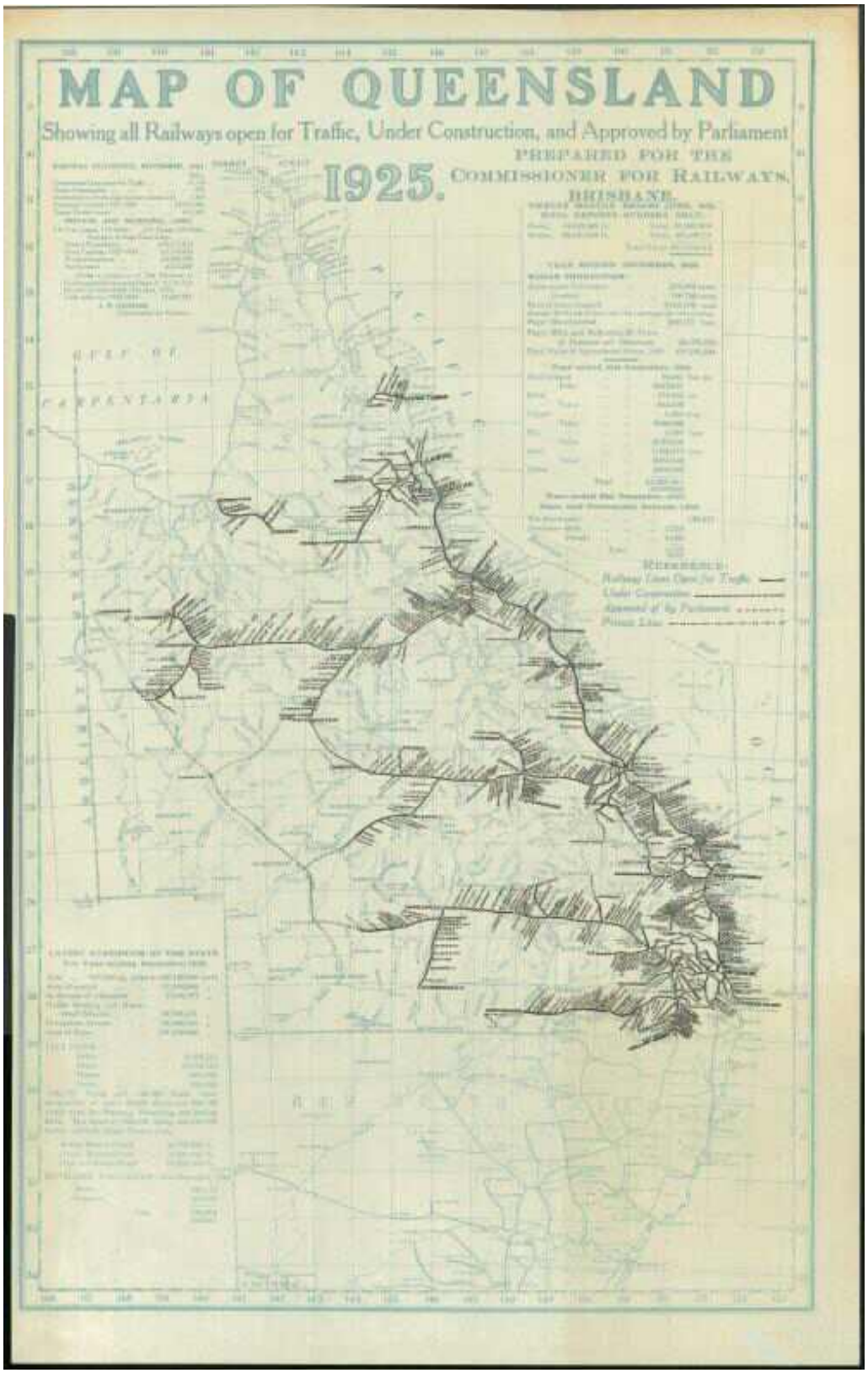
- Access to the interior via trunk lines from western areas to ports - 1865 to 1932;
- Access to mining areas - 1881 to 1929;
- Traditional branch lines - 1882 to1930;
- System integration and particularly the North Coast trunk line - 1883 to present.

From the 1950s onwards steam was phased out as diesel engines took over. Contemporary heavy haulage rail lines were constructed as required to move vast amounts of coal to the bourgeoning ports

of the next era. This involved duplication and/or upgrading of existing lines as well as the construction of new lines and 'missing links".

As the initial construction of railway lines for port access in the 1860s was done as expediently and inexpensively as possible by the 1880s Queensland had a 'disjointed' railway network with 11 separate and unconnected systems. A first move toward system integration was made by the Queensland government in 1883 when the linking of the Brisbane and Maryborough rail systems and construction of a line to Gladstone was approved. This was the start of the North Coast Line (NCL) with the section linking Gladstone to Brisbane completed in 1887.

Figure *E: The Queensland Rail Network 1925*



Note: Source is Collection of the Workshops Rail Museum, Ipswich (January 1925) available at http://www.qhatlas.com.au/map/extent-queensland-railway-network-1925/

The first section of what was to become the NCL was built to connect the mining town of Gympie to a river port at Maryborough. That line opened in August 1881.

The NCL had reached Rockhampton by the time the *North Coast Railway Act 1910* was passed committing the government to linking Cairns, Townsville and Mackay to Rockhampton and Brisbane. It authorised Queensland Rail to construct 731 km of new line and purchase the 192 km of tramways that would become part of the route. The NCL was seen as mainly benefiting passengers as bad weather frequently disrupted coastal shipping especially during the cyclone season.

Construction was divided into 5 regions / sections being:

Rockhampton to St Lawrence;

St Lawrence to Mackay;

Mackay to Proserpine, Bobawaba (end of the Bowen line) to the Burdekin River and upgrading the Proserpine tramway;

Burdekin River to Ayr, Townsville to Cardwell and upgrading the Ayr tramway;

Cardwell to Babinda and upgrading the tramway to Cairns.

The main works involved bridges over the numerous coastal river systems which was the main impediment to the earlier construction of a coastal line. Upgrade of existing tramways to the same standard as the line being constructed was also required.The construction of the NCL north of Rockhampton was undertaken intermittently due to physical and financial constraints, and World War One. Rockhampton was connected to Mackay in 1921 and in 1924 the Cairns and the Tablelands network were connected to the remainder of the Queensland rail system.

Too late

The Emerald-Clermont branch of the Central Rail line was built principally to service the Peak Downs copper mine, which struggled with transport delays and exorbitant freight costs from the start of development in 1863. By the time the rail line reached Clermont the copper mine had succumbed to issues associated with the tyranny of distance and getting its product to markets in a timely manner and had all but ceased production. The Clermont line instead serviced good quality grazing and cropping land and gold miners and remained viable even without the copper mine trade. The line returned to being a mining line in 1910 when an extension from the Blair Athol coal mine, to the north of Clermont, opened.

While not too late the other significant mining related line linked to Rockhampton was the Mount Morgan line. It is considered that the rail line to Mount Morgan was warranted at least ten years before it was opened in November 1898. The route has a rack line over Razorback, the only railway of that kind in Queensland. If legislation allowed this could have become a successful example of a

public private partnership as the line would have significantly reduced costs for what turned out to be one of Queensland's richest mines.

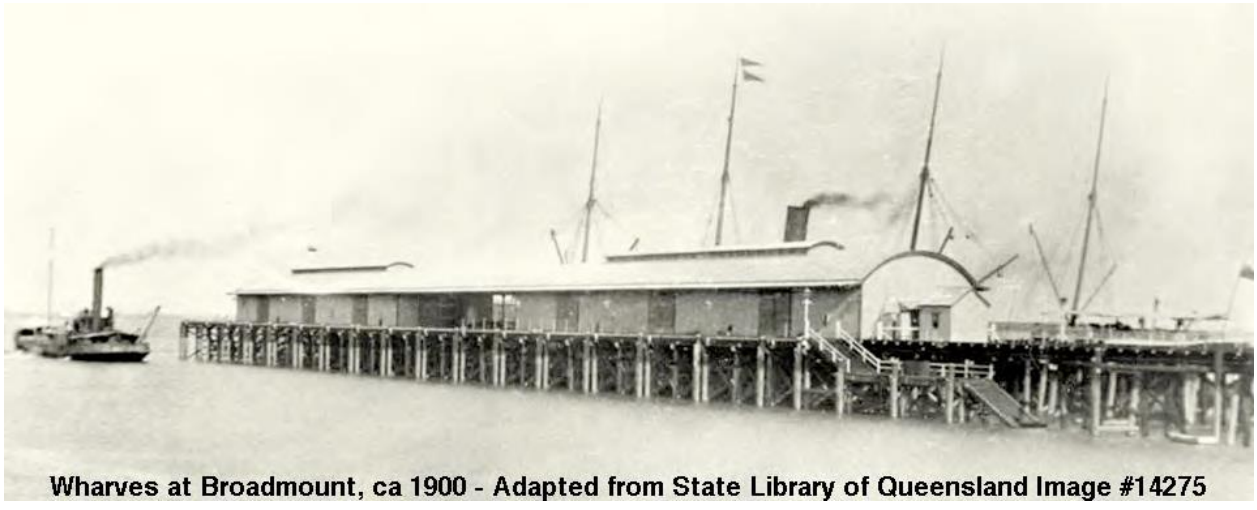
Port vs port

As previously mentioned the ports at Rockhampton and Gladstone were competing to service the needs of the settlers of Central Queensland. Gladstone was the superior port while Rockhampton was closer to the action as a result of Queensland's first big gold rush to Canoona in 1858 and the second smaller rush to the Peak Downs field from 1861. If that initial mining activity had not been centered on Rockhampton Gladstone would most likely have become the preeminent township in Central Queensland.

While the establishment and subsequent integration of the rail system was seen as a positive move for Queensland, Rockhampton business interests were very successful in resisting the construction of a railway south of their city in order to prevent freight from the Central Line travelling to Gladstone and its deep water port. As a result of this political activity in 1898 the government established an overnight steamer service between Gladstone and Rockhampton, as a rail 'substitute', to convey the mail and passengers.

The mail delivery to Gladstone departed Brisbane by rail at 9pm three days per week. After arriving at Gladstone the mail would be transferred to the steamer which would not depart for Rockhampton until the tide was suitable. This gave a minimum journey time of 22 hours between Brisbane and Rockhampton. If the train arrived just after a suitable tide the transit time could be extended by 11 hours.

Figure F: Broadmount Wharf



Wharves at Broadmount, ca 1900 - Adapted from State Library of Queensland Image #14275

The steamer docked at Broadmount wharf (see Figure F) and passengers transferred to the waiting train. Until the Fitzroy River was bridged in 1899 the train terminated at North Rockhampton and passengers and mail would have to be transferred to Rockhampton on the south side of the river by road or ferry. Rockhampton's port and rail network is illustrated in Figure G.

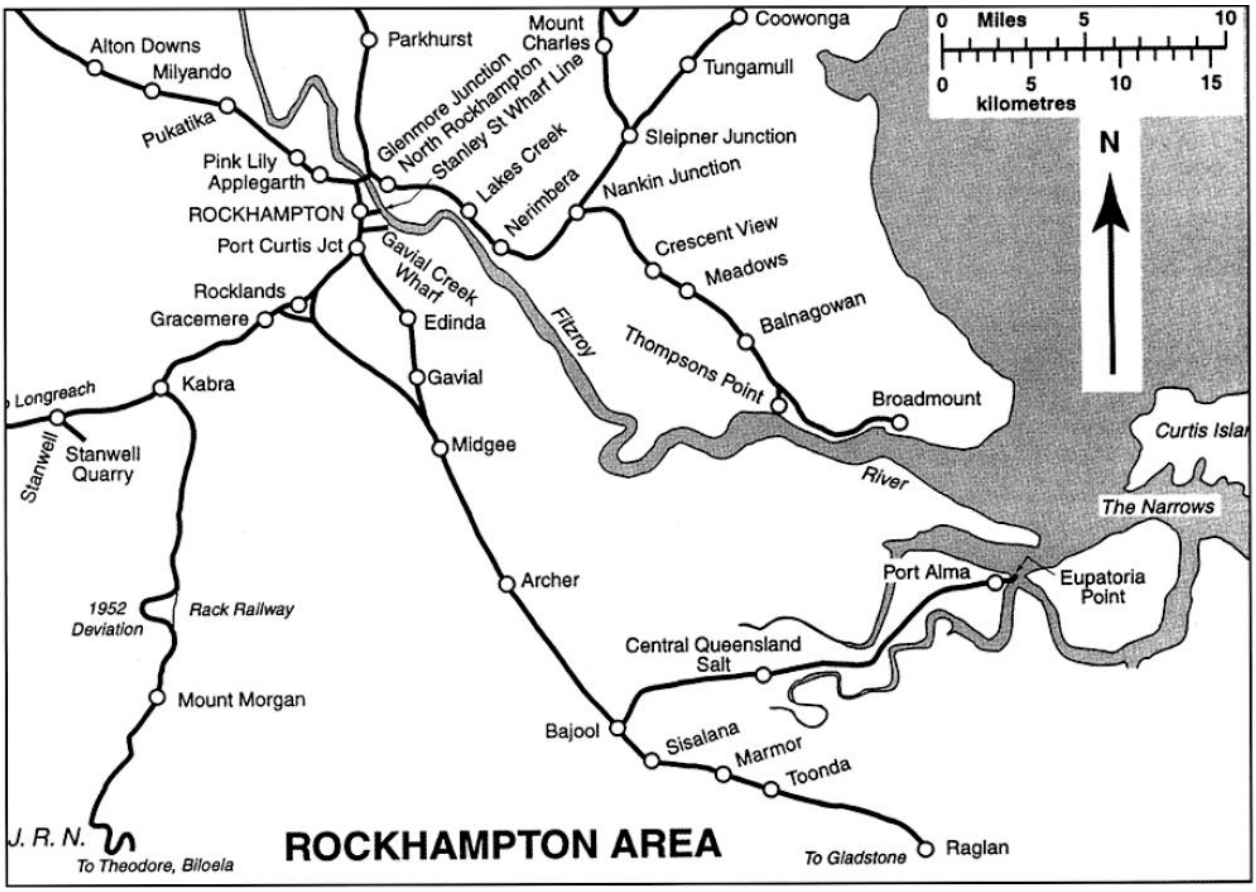
Rockhampton's resistance to surrendering port trade to Gladstone was understandable as the amount of trade coming through the river port in the 1880s and 1890s made Rockhampton the second largest port in the colony. The advantages of the coastal connection and the removal of the timing issues associated with the tides finally outweighed local resistance and in 1900 the Queensland Parliament approved the construction of the Gladstone to Rockhampton line. The entire 101 kilometre section of the North Coast Line opened in 1903.

The Broadmount line, which had only been opened in 1898 to improve Rockhampton's access to a sea port, became largely redundant once the NCL from Gladstone was opened, although the largest tonnage recorded through Broadmount (62,522) was in 1911. The Broadmount line later created history in 1929 as the first branch line to close in Queensland. The rail line from Nankin Junction to Broadmount had been removed by 1931.

The NCL provided another opportunity for Rockhampton port and a rail link to Port Alma, from Bajool, was opened in 1912. Port Alma never reached any great heights with the maximum annual tonnage recorded in 1938 (52,102 tons). "*Regular shipping services from southern ports and overseas vessels reach Port Alma through which most of the export trade of the district flows*." (Cilento and Lack 1959) A road to Port Alma was completed in 1961. The rail line limped along with little traffic until its closure in 1986.

Rockhampton town wharves had its best freight throughput year by weight in 1910 with 212,814 tons being shipped. The use of the wharves ebbed and flowed after the North Coast Line was completed and finally declined to the point where the port at Quay Street closed in the 1950s. This also corresponded to the transition of the railways from steam to diesel engines. The Rockhampton river port closed officially in 1965.

Figure *G: Rockhampton Port and Rail*



Note: Source is Archer Park Rail Museum available at http://qldrailheritage.com/archerpark/notes/04-rokports.pdf, incorporating John Kerr in ARHS Bulletin August 2001, Politics – Priority over Practicality: the Port Railways of Rockhampton. Figure F is from the same publication.

Rockhampton rail services

The branch line to Yeppoon via Mt Chalmers from Sleipner Junction on the Emu Pak branch line was opened in 1909 enabling locals and visitors to Rockhampton to enjoy the sea side 'resort'.

In 1903 the Rockhampton Mail began running 3 times per week departing Brisbane at 10pm and arriving at Rockhampton 4pm the following day, a total of 18 hours. Average speed was 64 kilometres per hour (40 mph). There were six Rockhampton Mail trains per week from 1914 however this was reduced to 5 a week in the 1930s. Services improved for passengers and until the road network was improved became the favoured form of transport in Queensland. With the introduction of diesel locomotives in 1952 the time to travel from Rockhampton to Brisbane was reduced to 16 hours.

Further improvements overtime included:

- the introduction of air-conditioned carriages and express services (Sunlander);
- replacement of the wooden carriages of the Rockhampton Mail with the air-conditioned Capricornia (14.25 hours travel time to Brisbane) and then the Spirit of the Outback;
- electrification of the line;
- introduction of the Spirit of Capricorn (9 hours travel time to Brisbane); and

- introduction of Australia's first electric Tilt Train in 1998. Maximum speed is 160 km/hand with a transit time of 7 hours 25 minutes to Brisbane.

Urban growth to 1900

In 1858, the town of Rockhampton was officially proclaimed and surveyed. One of the surveyors had previously assisted in laying out the city of Melbourne and he adopted a similar style when surveying Rockhampton, which consisted of broad streets and narrow lanes alternating from east to west. Little Quay Street (now Quay Lane) was the principal thoroughfare of the town for some years.

The first sales of building allotments took place in November 1858 with fancied lots fetching good prices. At the time land sale was one of the main forms of government revenue to 'reinvest' in public infrastructure so the land sales were an encouraging sign for the future growth of Rockhampton. 1859 was a busy year with considerable investment in buildings. 1860 was slower paced however by 1861 the town boasted a regular newspaper, banks, a court house and a School of Arts. The population of Rockhampton had increased from 35 males (European) in 1856 to 698 at the 1861 census consisting of 439 males and 259 females. Gladstone at the same time had a population of 215 (122 males and 93 females).

Growth accelerated in 1861 with news of the Peak Downs gold and copper finds. The land sale in September 1861 was well patronised with astute investors getting into the market at that early stage. There was no immediate rush to the Peak Downs with memories of Canoona still fresh in people's minds however there was a steadily increasing stream of people venturing to the area and/or settling in Rockhampton prior to the mini rush to Peak Downs in 1864. As a result construction continued at a good pace to meet increasing demand without the boom and bust that had occurred in 1858. By 1865 the population of Rockhampton was estimated at 5,000 or 6,000 with quite a bit of movement of residents between the town and gold field settlements. (Bird 1904, pp.20-22)

During the 1860s and 1870s Rockhampton became the main port in Central Queensland servicing the developing pastoral and mining industries of the Fitzroy hinterland with regular shipments of imported goods, mostly from Great Britain, while the main export was wool to Sydney or direct to the 'motherland'.

Rockhampton weathered the severe economic depression of the 1890s due mostly to the wealth of Mount Morgan. Many of the town's substantial brick and stone public buildings were built during this period to bolster the local economy. Quay Street still displays a number of substantial historic buildings erected at a time when Rockhampton was envisaged as being the capital of a separate state of North Queensland. The most prominent of these is the sandstone Customs House, built in the late 1890s when the Rockhampton river port was at its peak (opened 1901).

Other important nineteenth century buildings include the Supreme Court House (1888), the Post Office (1892), St Joseph's Cathedral (1892), the School of Arts (1894), the Commercial Hotel (1898) and the Harbour Board Office (1898). Educational institutions included the Rockhampton Grammar School (1881), a boarding and day school, and the Rockhampton Girls Grammar School (1892), which offered boarding facilities for country girls. Prior to the building boom of 1880s and 1890s a public hospital was built on the crest of Athelstane Range (1868) and the city's Botanic Gardens, one of the first in Australia, opened in 1873.

Mining and the connection of the hinterland to the port by rail have been mentioned above and the importance of those activities to the growth of Rockhampton cannot be overstated however it was the steady increase in agricultural activity and Rockhampton's role as the main regional centre for Central Queensland that has enabled its continuing growth and relative stability post 1900.

Peri-urban industry

The pastoral and grazing industry utilised Rockhampton's location and urban resources and in 1871 a meat works was established on the banks of the Fitzroy River at Lakes Creek by an English company registered as the Central Queensland Meat Preserving Company. This was the start of the facility that is still in the same location albeit with significant modifications. The works made a good start but soon ran into difficulties due to drought and high cattle prices combined with low prices for produce in the export market.

The works closed in January 1874 and were not reopened until 1877 when the Messrs. Whitehead and Co. bought them from the liquidator. The owners moved their preserving and boiling down equipment from their existing operation at Laurel Banks. They improved the Lakes Creek plant in various ways and erected additional buildings and cottages for the employees. While the Lakes Creek operation was profitable Whitehead and Co. went into liquidation in 1880 as a result of other investments. The business was purchased by a local syndicate registered as Central Queensland Meat Export Company Limited.

Work continued profitably and the new company added a freezing facility in 1883. Prior to the first large shipment of frozen meat being despatched in September 1883 a fire broke out and burnt most of the works extensive network of buildings to the ground. The only part of the works not destroyed were the refrigerating premises, machinery compartment, hide house and sawyers' shed. These rooms contained the refrigerating machinery and engines and the engines and boilers for the other works. The shareholders resolved to continue and after a substantial rebuild and improvements works recommenced in 1884, about 11 months after the fire.

The financial burden caused by rebuilding and the loss of revenue and markets in the interim resulted in the company going into liquidation in 1885. The property and company was purchased by a Melbourne company in early 1886. The business was restructured whereby the work of killing, freezing and conveying the product to London was done on commission for squatters and others thereby removing the vagaries associated with weather and cattle prices. The works operated successfully using this system until 1901 when it was sold to a *new* company formed in London.

In 1904 the Lake's Creek Works were the largest meat preserving and freezing establishment in the Commonwealth incorporating the most modern machinery and conveniences. Along with the works buildings, plant and machinery, there were about seventy cottages for workers. The area of land held by the company was 18,400 hectares of which 8,400 hectares are freehold. All up the enterprise was valued at £250,000. When the works were in full swing the number of employees was between 700 and 1000 and since its establishment contributed about £900,000 to the local economy through wages and salaries. (Bird 1904, pp.237-244)

Post 1900

Some notable events of the 1900s associated with the growth of Rockhampton are included in a chronology at the end of this section.

Droughts, cyclones and flooding rains

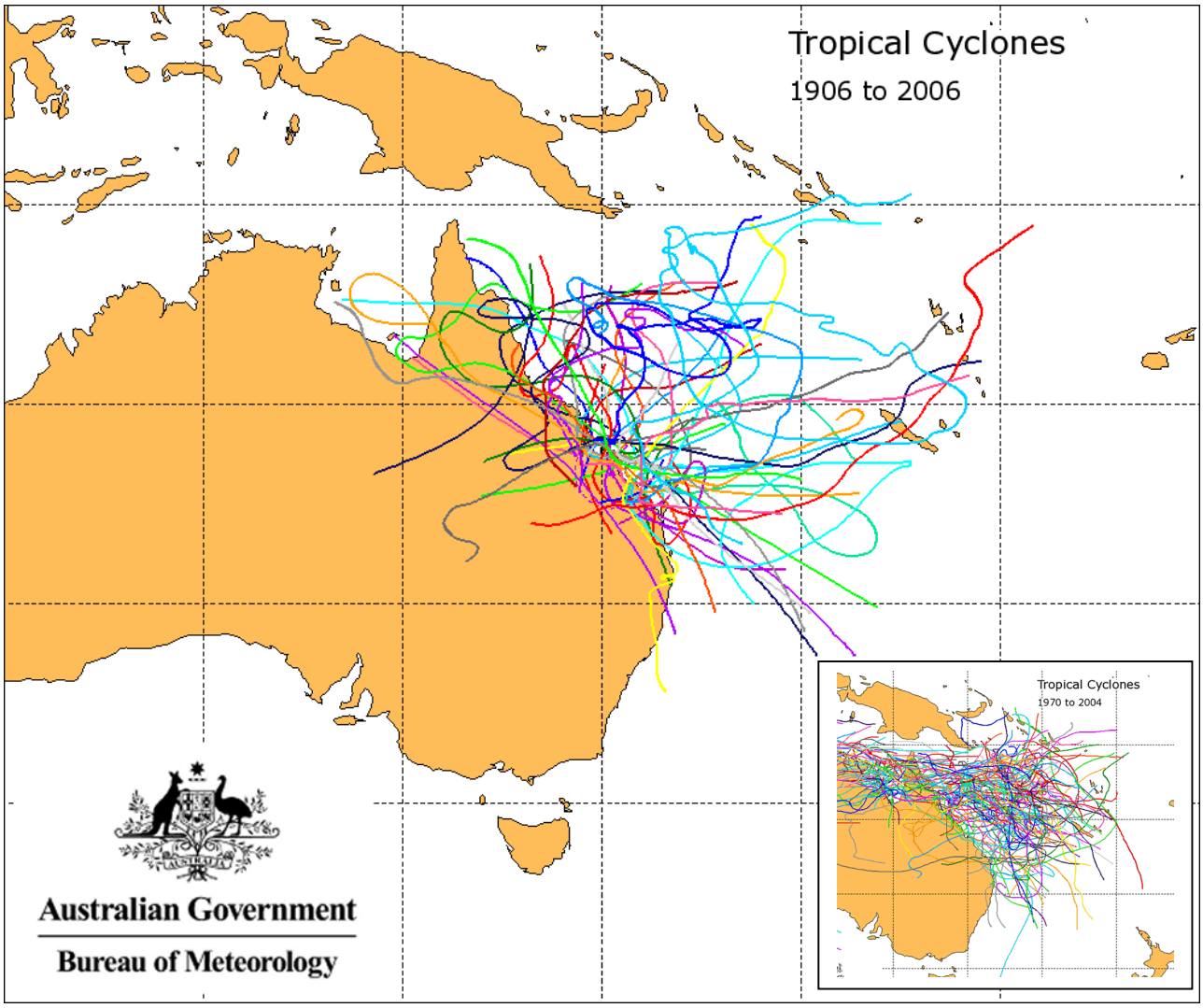
Rockhampton is located close to the Tropic of Capricorn and is subject to the destructive impacts of tropical cyclones. This was displayed recently (February 2015) when Cyclone Marcia crossed the coast near Shoalwater Bay as a category 5 system and caused significant damage particularly at Yeppoon on the Capricorn Coast where sustained winds were measure at 120kph with gusts to 160kph. The more likely scenario is heavy rainfall and flooding during the wet season (November to April) associated with low pressure cells, including ex-cyclones, due to the immense size of the Fitzroy River catchment.

Rockhampton is around 40 kilometres from the coast and 400 kilometres from the Drummond Range which forms the western boundary of the catchment. All the run-off from the upstream catchments comes together about 100 kilometres west of Rockhampton where the Mackenzie and Dawson Rivers meet to form the Fitzroy River. The combined waters are capable of severe flooding following heavy rainfall events in one or more of its major tributaries i.e. the Dawson, Nogoa, Mackenzie, Isaac and Connors Rivers. Significant flooding in the Rockhampton area can also occur from heavy rain in the local area.

In the early days of Rockhampton the Fitzroy River was seen only as an asset with little understanding of the volume of water that could accumulate in the huge catchment (up country) and make its way downstream to discharge in Keppel Bay. The flood history of Rockhampton with reference to the Fitzroy Basin is summarised in Appendix E.

The paths of cyclones that have impacted Rockhampton from 1906 to 2006 are illustrated in Figure H.

Figure *H: Cyclones Impacting Rockhampton*



Note: Inset is all tropical cyclones (eastern Australia) from 1970 to 2004.

Floods have been a feature of Rockhampton since the first indication of what was to come was shown to the new settlers in 1859. By this time the town area had been surveyed and the Canoona gold rush had resulted in the expansion of the town near the Fitzroy River. The first significant flood occurred in 1862 and was soon followed by the 'big' flood of 1864.

Reports of the flood showed that the locals were cognisant of the dangers associated with the location of the town beside the river (see text box below) and were also constrained by the need to be as close as possible to the main form of commercial transport at the time i.e. coastal shipping from the river port.

1862 – On the 31st March and 1st April there was 568mm of rainfall in thirty-nine hours at Rockhampton. Rain was heavy in the Don, Dee and Dawson catchments. At Yaamba "*An unprecedented flood in the Fitzroy River has so far established the high-water level of this township*". "*Very heavy rain had fallen in the Rockhampton and Gladstone districts and many casualties occurred through trying to swim creeks and flooded watercourses. 2,000 sheep drowned*

about 2 km from Rockhampton and the back country was under water for miles." On the 1st of April the Fitzroy River was 6 metres above the highest spring tides.

1864 - The flood reached its highest point on the 19th of March, when it was 4.4 metres over the Fitzroy Street wharf. "*Boats were sent out to rescue people who were surrounded by the floods*." "*The flood of 1864, though it brought considerable destruction in life and property, was of service to settlers in various ways. It showed that much of the lower portion of the town was subject to inundation, though not to an equal extent*." (Bird 1904, pp.352-361)

From early settlement days flood and river levels throughout the Fitzroy Basin were measured at the same places on rivers where settlements were located and later at railway bridges and other transport infrastructure. Rockhampton river and flood levels were related to the height above or below the town wharves while at Yaamba the more important issue was the proximity of flood waters to the township.

In later years official gauging stations were established throughout the basin often based on the early measurement sites. In most cases, for inland areas, the river height zero reading is the lowest water level that is reached during dry conditions. In most tidal areas, as with the Fitzroy River at Rockhampton, river levels are now expressed in metres above mean sea level or Australian Height Datum (AHD). Prior to the establishment of these official gauging stations river levels may have been related to the height above the highest known tides i.e. springs.

Historic river levels have been collated by the Australian Bureau of Meteorology (BOM) to provide a long term picture of flooding and providing an indication of the severity of floods. This picture is highly variable across the Fitzroy Basin over time and geographically given the size of the catchment (143,000 km^2) and potential for weather and rainfall variation across the main river catchments. This variation and potential for flooding as assessed by BOM is provided in the text box below.

Fitzroy River Catchment – Assessment of the Flood Potential

Major flooding requires a large scale rainfall situation over the vast Fitzroy River catchment. The following can be used as a rough guide to the likelihood of flooding in the catchment:

Average catchment rainfalls of in excess of 200mm in 48 hours may cause significant moderate to major flooding and traffic disabilities to develop, particularly in the middle to lower reaches of the Dawson River catchment downstream of Taroom, the Mackenzie River downstream of Tartrus and the Isaac River downstream of Connors Junction, and extending downstream to the Fitzroy River below Riverslea and finally Rockhampton.

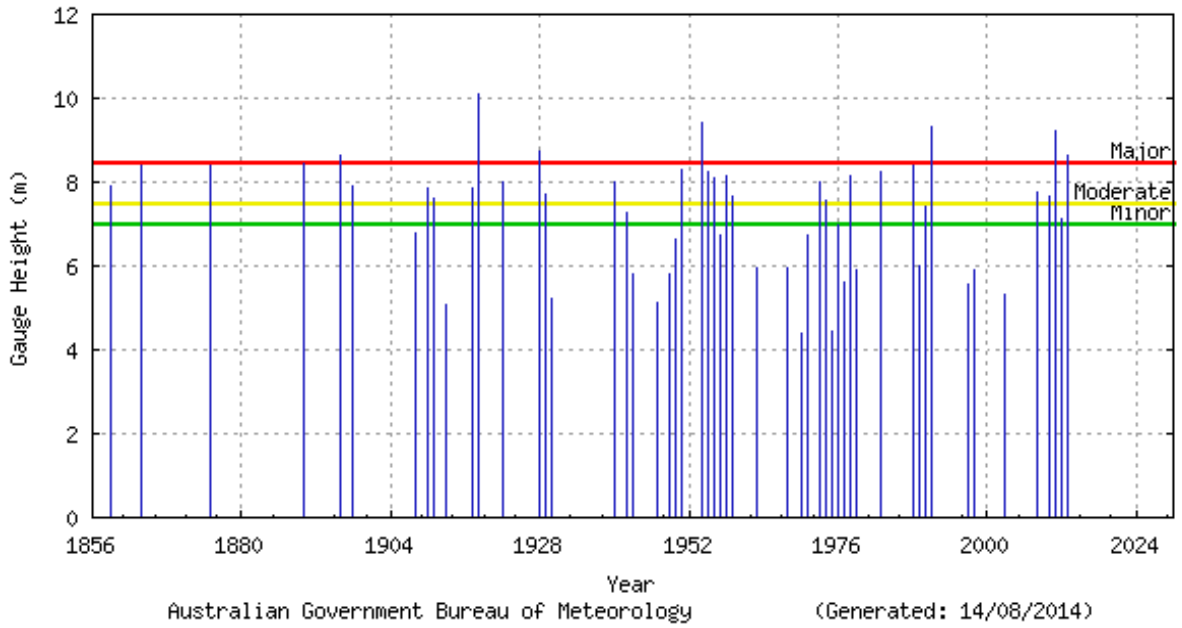
Average catchment rainfalls of in excess of 300mm in 48 hours may cause significant major flooding and traffic disabilities to develop, particularly in the middle to lower reaches of the Dawson River catchment downstream of Taroom, the Mackenzie River downstream of Tartrus and the Isaac River downstream of Connors Junction, and extending downstream to the Fitzroy River below Riverslea and finally Rockhampton. (http://www.bom.gov.au/qld/flood/brochures/fitzroy/fitzroy.shtml)

A graphical history of Rockhampton's floods is shown in Figure I. The modern flood warning system operated by BOM is show in Figure K.

Floods are categorised as minor, moderate and major at each flood warning river height station according to the effects caused in the local area and/or in nearby downstream areas. These flood classifications for the Fitzroy River at the Rockhampton gauging station, in terms of river height, are shown in Figure J with BOM commentary on the classifications.

A summary of Rockhampton's 'big' floods is provided in Table E.

Figure *I: Fitzroy River Flood Peaks at Rockhampton - 1856 to 2004*



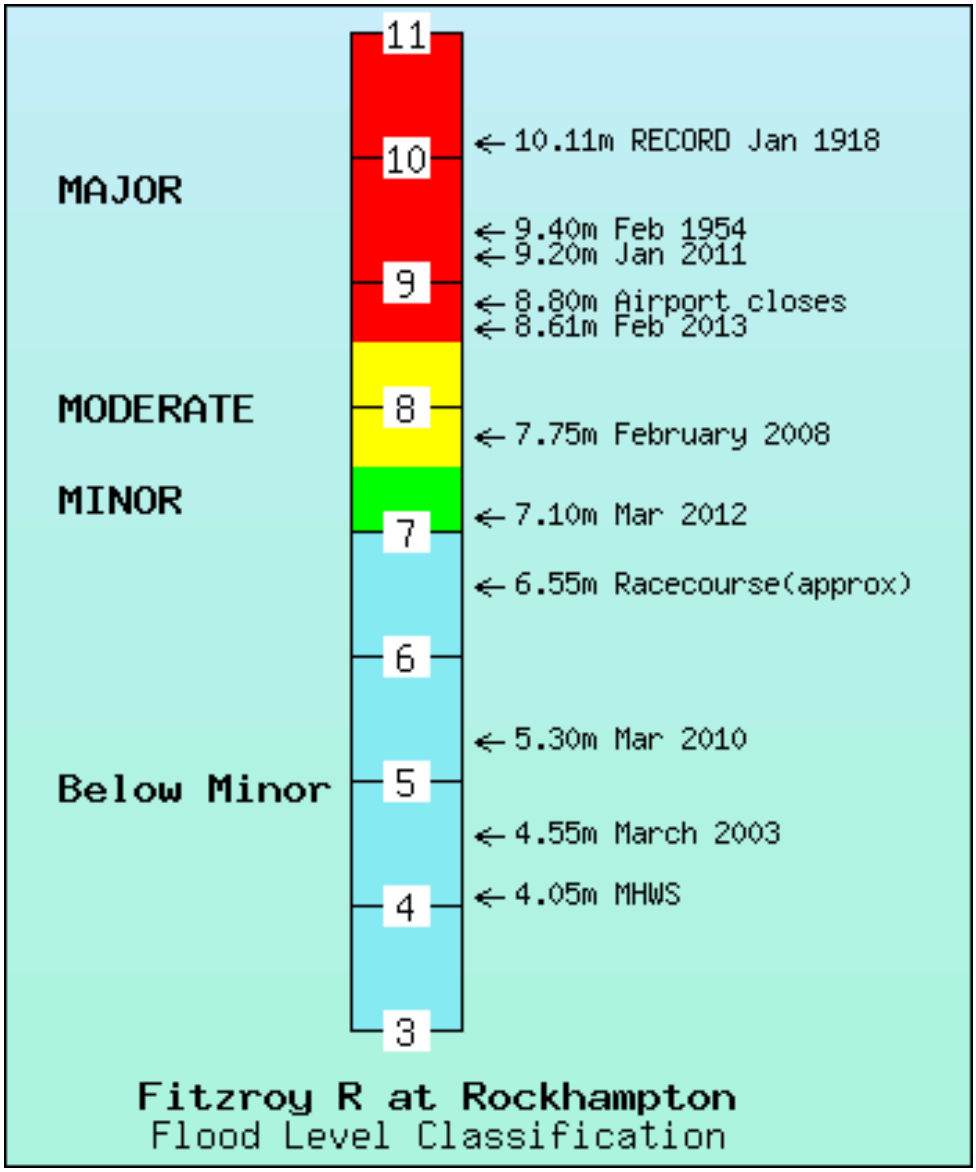
Note: Source is Flood Warning System for the Fitzroy River available at: http://www.bom.gov.au/qld/flood/brochures/fitzroy/fitzroy.shtml.

Table E: Rockhampton's Big Floods

Event	Yaamba	Rockhampton	Notes
March 1864		Late 1800s benchmark	4.4 metres over the Fitzroy Street wharf. Estimated rainfall January into March was 826mm.
March 1875		100mm below	860mm in four days. Town outskirts - waters were 250mm higher than in 1864 as a result of local rain
April 1890		50mm below	
February 1896	+ 350mm	100mm above	The highest flood recorded in the 1800s
January 1918	17.32	10.11	The highest recorded flood and, so far, the only flood above 10 metres
February 1954	16.59	9.40	
January-February 1978	14.75	8.15	
May 1983	14.97	8.25	
January 1991	16.65	9.30	
Jan 2008	14.25	7.50	
December 2010 / January 2011	16.55	9.20	Largest floods on record for Emerald (Nogoa), Rolleston (Comet) and Theodore (Dawson)
February/March 2012	13.50	7.10	
January-February 2013	15.70	8.61	

Note: Figures are river height in metres at the Yaamba and Rockhampton BOM river warning gauging stations. Flood levels in the 1800s are relative to the flood of 1864 i.e. above or below. 1864 is estimated to have been 8.6 metres

Figure *J: Rockhampton Flood Categories*



Note: Source is http://www.bom.gov.au/qld/flood/brochures/fitzroy/fitzroy.shtml.

Minor Flooding: Causes inconvenience. Low-lying areas next to watercourses are inundated. Minor roads may be closed and low-level bridges submerged. In urban areas inundation may affect some backyards and buildings below the floor level as well as bicycle and pedestrian paths. In rural areas removal of stock and equipment may be required.

Moderate Flooding: In addition to the above, the area of inundation is more substantial. Main traffic routes may be affected. Some buildings may be affected above the floor level. Evacuation of flood affected areas may be required. In rural areas removal of stock is required.

Major Flooding: In addition to the above, extensive rural areas and/or urban areas are inundated. Many buildings may be affected above the floor level. Properties and towns are likely to be isolated and major rail and traffic routes closed. Evacuation of flood affected areas may be required. Utility services may be impacted.

Figure K: Fitzroy Basin Catchments and Flood Warning System

Note: Available at http://www.bom.gov.au/qld/flood/brochures/fitzroy/map.shtml

Urban catchment context

The history of the settlement of the Fitzroy region and the selection of Rockhampton's location as a function of the prevailing technology and socio-economic drivers provides the context for the growth of Central Queensland's largest regional centre. When this is considered in conjunction with the key catchment characteristics of the Fitzroy Basin i.e. area, main catchment relationships, weather variability and flood potential, it provides a better understanding of past urban growth and the current urban configuration. It also provides a partial platform for interpreting the impact of the Rockhampton urban area on local waterways and its contribution to water quality pollutant loads discharging from the Fitzroy River to Keppel Bay.

Figure *L: Rockhampton Nearly 100 Years Ago*

Flooding, East Street, Rockhampton, 1918.

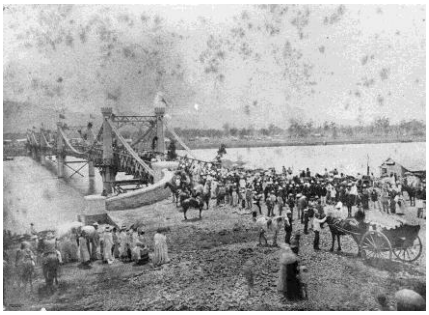
Note: Source is Queensland Government 1998 (p.42).

Figure M: Rockhampton Fitzroy River Flood Marker

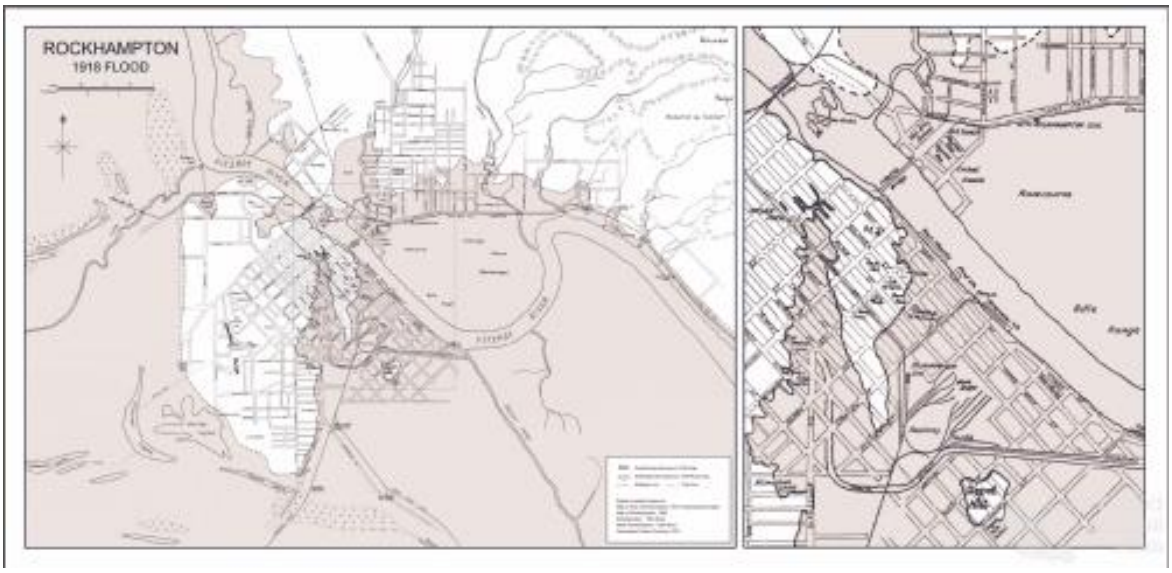
Chronology of Important Events

Events important to the establishment of Rockhampton and Queensland include:

- 1855 – Gracemere established as a sheep run. The first wool clip departs Rockhampton town site;
- 1856 – The second sheep run is established at Canoona. The region's European population is 35 men;
- 1856 – The first store is established on the north side of what is now Fitzroy Street;
- 1857 – The first hotel is established opposite the store where the Criterion Hotel now stands;
- 1858 – Queensland's first gold rush (>15,000 people) to the Canoona field via Rockhampton;
- 1858 – Rockhampton township is proclaimed and surveyed and the first land sales take place;
- 1858 – Rockhampton is declared a port of entry;
- 1859 – Queensland separates from New South Wales and is proclaimed as a separate colony;
- 1860 - Rockhampton was proclaimed a municipality on the 15th of December;
- 1860 – Queensland's first suite of land acts introduced including *Alienation of Crown Lands Act*;
- 1861 - The first Council was elected on the 26th of February;
- 1861 – Queensland Parliament resolves to encourage immigration. Land-order system established;
- 1862 – Queensland's second, more cautious, gold rush to Peak Downs via Rockhampton;
- 1863 – Queensland's first copper mine Copperfield, on the Peak Downs Gold Field, begins operating;
- 1863 - Government immigration program commences to boost the Queensland population/work force;
- 1863 – The first ship with Rockhampton bound immigrants anchors in Keppel Bay;
- 1863 to 1870 – various gold fields (eight) opened around Rockhampton and are worked with mixed results;
- 1864 – Rockhampton town's first big flood (estimated at 8.6 metres);
- 1864 – A new road to the Peak Downs, via Westwood cut through the scrub, was opened;
- 1865 – Construction of the Great Northern Railway from Rockhampton to the west commences;
- 1866 – First hard rock mining in Queensland (Hector Reef) commences near Bouldercombe, south of Rockhampton;
- 1867 – Stage one of the Central (West) Railway (originally named Great Northern) to Westwood opens;
- 1867 – Queensland's second 'big' Gympie gold rush attracted 15,000 people to that region. The richness and extent of the field 'saved' Queensland from imminent financial ruin in its early years;
- 1868 - Public hospital built on the crest of Athelstane Range at the site of the current regional hospital;
- 1871 - The first meat works is established at Lake's Creek at the site of the current operations;
- 1872 – Charters Towers field discovered. Queensland's first stock exchange opened later;
- 1873 – Construction of the Central Queensland Railway section from Westwood to Comet commenced;
- 1873 - The city's Botanic Gardens, one of the first in Australia, opened in 1873;
- 1874 – Pastoral run maps are prepared showing the Port Curtis and Leichhardt districts fully occupied;
- 1879 – The Central Railway reaches Emerald. Branch lines to Clermont and Springsure started;
- 1881 – The Peak Downs Copper Mine at Copperfield (south of Clermont) ceases operations;



- 1881 – The first bridge over the Fitzroy River opens (image right);
- 1883 – Mount Morgan mine commences small scale operation using conventional methods;
- 1883 – Much of the Lake's Creek meat works is burnt to the ground in Rockhampton's biggest fire;
- 1883 – Approval to link Brisbane and Maryborough rail systems and extend the line to Gladstone;
- 1884 – The Central Railway branch line to Clermont opens;
- 1886 – Mount Morgan Gold Mining Company commences gold production with new technology;
- 1886 – Lake's Creek meatworks purchased by a Melbourne company and successfully restructured;
- 1888 - Rockhampton North proclaimed a separate local government area;
- 1888 – The North Rockhampton to Emu Park rail line opens;
- 1892 – The Rockhampton Post Office is constructed in East Street;
- 1892 – The final section of the Central Railway (Barcaldine to Longreach) opens;
- 1887 - The North Coast Line (NCL) section linking Gladstone to Brisbane completed;
- 1898 – The rail branch line to the Broadmount wharf opens. Highest throughput was 1911 (62,522 ton);
- 1898 – The rail line to Mount Morgan is, somewhat belatedly, opened;
- 1898 – An overnight steamer service established between Gladstone and Rockhampton (Broadmount) and conveys the mail;
- 1898 - Extended period of drought commences in Queensland;
- 1899 – The Alexandra Bridge is built over the Fitzroy River and the Denison Street rail line constructed;
- 1901 – The Lakes' Creek meatworks are purchased by a London based company and soon become the largest meat preserving and freezing establishment in the Commonwealth;
- 1901-02 - Severe Queensland drought with devastating effect on stock, crops, and pastures;
- 1902 – Copper mining and extraction commences alongside gold mining at Mount Morgan;
- 1902 - The *Local Government Act* is gazetted and the City of Rockhampton is proclaimed;
- 1903 – Rockhampton rail connected to Brisbane and the mail train commences operations;
- 1905/6 – Revenue from all other minerals (includes coal) exceeds revenue from gold for the first time;
- 1909 – A steam tramway system commences operating in south Rockhampton with 10 kilometres of tracks;
- 1910 – A rail extension from the Blair Athol coal mines links to the Central Railway (Clermont branch);
- 1910 – The *North Coast Railway Act* passed to link Cairns, Townsville and Mackay to Rockhampton and Brisbane;
- 1910 - Rockhampton town wharves best freight throughput year by weight with 212,814 tons;
- 1912 – The branch rail line to Port Alma is opened. Wharf throughput peaked in 1938 at 52,102 tons;
- 1918 – Rockhampton experiences its highest ever flood (see map of flood water extent below);



- 1919 - The first State High School was established in Bolsover Street;
- 1925 – Fire in the Mount Morgan mine extinguished by flooding the workings. All works ceased;
- 1925/26 – Drought in much of Queensland;
- 1927 – The Mount Morgan Gold Mining Company goes into receivership;
- 1929 – The branch rail line to Broadmount wharf ceases operations;
- 1939 – The steam tram way is replaced by a bus system operated by the Rockhampton City Council;
- 1939/1945 - A US army base was established outside the city and hosted up to 70,000 servicemen;
- 1950 – The Rockhampton town wharves cease operation;
- 1950s – Transition to diesel engines from steam on the Queensland rail network;
- 1965 – Rockhampton Port is officially closed;
- 1971 - The Fitzroy River Barrage was commissioned by Council as Rockhampton's water source;
- 1971 - Rockhampton's first tertiary 'college' opens (Capricornia Institute of Advanced Education);
- 1986 – The branch railway line to Port Alma closes;
- 1991-94 – The Central Queensland University 'replaces' the Capricornia Institute;
- 1998 - Australia's first electric Tilt Train starts operating after major rail line upgrades (Brisbane-Cairns);
- 2008 – Wide scale amalgamation of local government in Queensland;
- 2014 – Livingstone Shire de-amalgamates from Rockhampton Regional Council;
- 2015 – Cyclone Marcia crosses the Capricorn Coast at Shoalwater Bay causing serious damage along the Capricorn Coast;
- 2015 – Rockhampton Regional Council's new planning scheme commences operation.

Gladstone

Events relevant to the establishment of Gladstone as Central Queensland's main port city include:

- 1802 - Port Curtis named by Matthew Flinders;
- 1845 – The idea of Port Curtis being settled muted by William Ewart Gladstone (English Chancellor of the Exchequer) and instructions issued to the Governor of NSW (Sir Charles Fitzroy) to proceed;
- 1846 – Colonel Barney and Captain Perry are dispatched by Governor Fitzroy to survey the land and sea in the vicinity of Port Curtis;
- 1846 – Gladstone's government losses office and orders to settle Port Curtis are rescinded (November);
- 1847 – Sailing vessel, *Lord Auckland*, brings the first European settlers to Port Curtis under the command of Colonel Barney, to establish a settlement to be the administrative centre of the colony of North Australia. Orders to abandon the settlement are received by Colonel Barney in April and everyone is subsequently relocated to Sydney;
- 1850 - Pressure from hinterland pastoral settlers for the port to be opened as a livestock shipping outlet;
- 1850s - Gladstone's 'wharves' were crude structures in Auckland Creek, near where it enters Port Curtis. The Commercial Wharf (private) is constructed and becomes the main 'facility';
- 1853 – The town is surveyed and named after W. E. Gladstone;
- 1854 - The first sale of town and suburban allotments takes place in Gladstone;
- 1855 –The first wool clip from Gracemere run departs Rockhampton town to Gladstone for on shipment to Sydney;
- 1858 – Queensland's first gold rush (>15,000 people) to the Canoona field, via Rockhampton diverts attention from Gladstone and slows its expansion as a port town;
- 1860/1 - Customs house constructed at Gladstone;
- 1862 – John Powe and Henry Friend construct their own wharf due to high cost and poor facilities provided by Gladstone's Commercial Wharf;
- 1863 – Gladstone is proclaimed a municipality and a Mayor and five Councillors are subsequently elected. Gladstone has 10 miles of streets, 350 dwellings and an area of 8.5 square miles;
- 1863 – Construction begins on the Government wharf (the Cattle Wharf) (later (1937) named O'Connell Wharf) to be operated by the newly formed Gladstone Municipal Council;
- 1863 - Government immigration program commences to boost the Queensland population/work force and the first ship with Government immigrants docks at Gladstone/Port Curtis;
- 1864 - The first school is constructed in Gladstone;
- 1869 - Presbyterian church constructed in Gladstone;
- 1874 - Catholic and Church of England churches constructed in Gladstone;
- 1874 – Pastoral run maps are prepared showing the Port Curtis and Leichhardt districts fully occupied;
- 1879 - Calliope Division was created under the *Divisional Boards Act 1879* (1 of 74 Qld divisions);
- 1880 - The *Gladstone Observer and Port Curtis Advertiser* began publication;
- 1883 – Approval to link Brisbane and Maryborough rail systems and extend the line to Gladstone;
- 1885 – A deep water jetty at Auckland Point, funded by the Queensland Government, is completed and placed under the charge of the Customs Department with plans to link it to the rail network in the future;
- 1890 - Hospital opened in Gladstone;
- 1890 – Attempts to dredge the Narrows were abandoned;

- 1893 – Approaches to Gladstone harbour buoyed and beaconed for night use;
- 1896 - The Gladstone Meat Works commences operations;
- 1896 - The North Coast Line (NCL) section from Bundaberg opened linking Gladstone to Brisbane. Gladstone port enjoys a temporary advantage over Rockhampton port;
- 1898 – An overnight steamer service commences operation between Gladstone and Broadmount wharf (near the mouth of the Fitzroy River), to convey the mail between Brisbane and Rockhampton;
- 1901-02 - Severe Queensland drought with devastating effect on stock, crops, and pastures;
- 1902 - Separate Miriam Vale Division created from part of the Calliope Division;
- 1902 - The *Local Authorities Act* is gazetted and the Town of Gladstone is proclaimed along with the Shire of Miriam Vale and Shire of Calliope (Calliope Council Hall located in Gladstone);
- 1903 – The Gladstone to Rockhampton North Coast Line section opens replacing the steamer mail service;
- 1905/6 – Revenue from all other minerals (includes coal) exceeds revenue from gold for the first time in Queensland;
- 1906 - Port Curtis Dairy Cooperative opens with dairy produce transported to the factory by rail;
- 1910 – The *North Coast Railway Act* passed to link Cairns to Brisbane;
- 1910 - Rockhampton town wharves best freight throughput year by weight with 212,814 tons. At this time Gladstone port annual throughput is still less than 20,000 tons;
- 1914 – Gladstone Harbour Board appointed by the Queensland Government;
- 1916 – Town water supply established following the construction of Toondoon Dam;
- 1917 – Municipal Wharf purchased from Gladstone Council by the Harbour Board;
- 1918 – Auckland Point Jetty berth dredged to a safe draft of 25ft;
- 1920 – 1950 Gladstone's economic mainstays are the Port Curtis dairy factory and the meat works;
- 1923 – Extension to Auckland Point jetty is completed and dredging carried out;
- 1924 – Port trade decline in favour of rail after completion of the final link in the North Coast (rail) Line to Townsville (and Cairns);
- 1925 – The first 'significant' coal exports commence from Gladstone;
- 1926 – 15 ton electric crane installed for 'bulk' handling (100 ton per hour) to export Blair Athol coal railed to Gladstone;
- 1926 – Gladstone Port throughput exceeds 30,000 tons with 24,000 tons of exports;
- 1927 – A report to the Commonwealth Government names Gladstone as the 'best' deep sea port in Queensland once facilities are constructed;
- 1929 – The Shell Oil Company completed installation of a bulk oil facility on reclaimed land at Auckland Point and becomes the first lucrative trade for the Harbour Board;
- 1930 – Gladstone exports peak at 83,000 tons prior to a slump during the depression. No coal exported until after the Second World War;
- 1932 – Maintenance dredging at Auckland Point jetty carried out by the Gladstone Harbour Board;
- 1932 – Construction of Auckland Point to Barney Point retaining wall commences using the Relief Workers Scheme (a depression initiative) to eventually reclaim land for industrial and port use;
- 1934 – Gladstone Town Hall constructed in Goondoon Street (now a museum and art gallery);
- 1934 – Export trade from Gladstone wharves had grown to over 47,000 tonnes;
- 1937 – Harbour Board secures funds for reconstruction and repairs of the Auckland Point Jetty and Parson's Point Meat Wharf undergoes berth deepening;
- 1940 – Construction of landings on Curtis Island and Facing Island completed;
- WWII - Reduced commercial throughput for Gladstone port;

- 1943 – Gladstone Port becomes a centre for United States of America naval vessels and Australian navy vessels with harbour changes paid by the United States government and then the Commonwealth Government. As a result the Harbour Board is able to pay off its debt to the state Government. US troops stationed at Rockhampton (up to 70,000) were shipped in and out through Gladstone;
- 1944 – Central Wharf built to provide extra capacity near O'Connell Wharf for the Australian Navy;
- 1945 – Pikes Crossing Weir constructed on the Boyne River as Gladstone's raw water supply;
- 1948 – Callide Valley coal first shipped through the port;
- 1950 – The Rockhampton town wharves cease operation;
- 1952 – Caltex Oil Terminal completed;
- 1956 – Extension to the Auckland Point Jetty completed with improved coal loading facilities;
- 1956 - Aerodrome, jointly backed by Gladstone and Calliope Shire, opened;
- 1959 - Coal shipped through Gladstone for 'large' Japanese contracts;
- 1962 - The Commonwealth Aluminium Corporation Pty Ltd (Comalco) announced plans to build an alumina refinery at Gladstone to process bauxite from Weipa;
- 1963 - Former Swift's Meatworks site at Parsons Point purchased by Comalco consortium;
- 1960s – (early) meat works closes;
- 1964 – construction of the bridge and causeway from Parsons Point to South Trees and construction of South Trees Wharf (QAL) commences;
- 1965 – Rockhampton Port (Fitzroy River) is officially closed. Port Alma continues operating;
- 1967 - Gladstone Power Station opens to provide power for the aluminium refinery;
- 1967 – Comalco aluminium refinery begins production;
- 1967 - Thiess Peabody Mitsui Coal Pty Ltd Barney Point facility (port land) opens to export Moura coal;
- 1968 - Railway line from the Moura open cut mine to Gladstone opened;
- 1969 - Massive redevelopment and expansion of the Port Alma Shipping Terminal opens;
- 1973 – Following two expansions Gladstone (Boyne Island) alumina refinery is the largest in the world;
- 1975 – Construction of the Boyne Wharf commences to service Comalco Ltd's proposed Boyne Island aluminium smelter (Boyne Smelters Limited - BSL);
- 1976 – Gladstone is proclaimed a City;
- 1977 - Clinton Coal Facility (later renamed RG Tanna Coal Terminal) approved for construction;
- 1980 - Clinton Coal Facility opens. BHP Co Ltd exports coking coal to Japanese steel mills;
- 1980 - Coal is 47% of the Gladstone port's throughput;
- 1981 - Single-berth wharf completed at Fisherman's Landing for Queensland Cement Ltd clinker plant;
- 1981 - Queensland Cement and Lime opens its clinker plant;
- 1982 – Boyne Island aluminium smelting facility opened;
- 1982 – New Civic Centre constructed in Goondoon Street;
- 1988 - The Tondoon Botanic Gardens (83 hectares) opens including the Toondoon dam site;
- 1989 - Chlorine and cyanide manufacturing plant opened;
- 1998 - Gladstone Port Authority (now Gladstone Ports Corporation) becomes owner/operator of the Barney Point facility. List of cargoes handled at the terminal diversified;
- 1990s – (late) reclamation work continued and a second berth at Fisherman's Landing was completed;
- 2000 – Coal is now over 65% of Gladstone Port's throughput;

- 2003 - Third Fisherman's Landing berth completed for Comalco Yarwun Alumina Refinery (now operated by Rio Tinto);
- 2008 – Wide scale amalgamation of local government in Queensland;
- 2015 – (May) The first shipment of coal from the Wiggins Island Coal Terminal (WICT);
- 2015 – (August) GPC announces cessation of coal shipments from Barney Point facilities from 2016 to focus on other dry bulk products and possible new opportunities;
- 2015 - Gladstone Regional Council new planning scheme comes into effect.

Appendix B Collaboration to the rescue

The material below was developed through the Reef Rescue project (funded through the Australian Government's Caring for our Country program) titled ***Collaboration to the rescue***, which was a joint venture between the Reef Urban Stormwater Management Improvement Group (RUSMIG) and Water by Design (the urban water quality management component of Healthy Waterways).

Water by Design resources including those developed during the ***Collaboration to the rescue*** project are included in Section 6.14 and Section 6.15 of Gunn 2014(a), *Urban Land Use in Great Barrier Reef Water Quality Improvement Plans: Background Report and Considered Guidance*, Reef Urban Stormwater Management Improvement Group (RUSMIG), Water by Design and Creek to Coral, Townsville.

WSUD capacity workshop results are included below for Rockhampton Regional Council and Gladstone Regional Council.

Brief Report – Rapid Assessment of Rockhampton Regional Council's Institutional Capacity for delivering Water Sensitive Urban Design (Workshop 1)

Rockhampton Regional Council participated in a Rapid Assessment Workshop on the 13th of March to identify high priority capacity building needs for Water Sensitive Urban Design (WSUD). This workshop provided participants with an introduction to WSUD; described elements of institutional capacity that researchers have identified as being instrumental in driving the adoption of WSUD within and around organisations like councils; and provided a process for participants to reflect on this information and work in facilitated small groups to conduct a rapid assessment of the current capacity of the organisation to drive WSUD. The process involved working through a series of worksheets based on the 5 capacity building interventions.

Table 1 lists and ranks seven high priority capacity building needs as scored by the two workshop groups.

Table 1: High Priority Capacity Building Needs*

Capacity Building Need	Group 1 scoring			Group 2 scoring			Priority average
	Benefit	Possible	Priority	Benefit	Possible	Priority	
1.8 Pilot projects are used to generate new knowledge regarding the local application of WSUD	4	4	**16**	5	5	**25**	20.5
4.6 The organisation manages a system to ensure that its WSUD assets are maintained.	5	4	**20**	5	4	**20**	20
2.1 Local practitioners have the necessary technical knowledge and skills to implement WSUD	4	4	**16**	5	4	**20**	18
5.8 WSUD information is managed and shared so that stakeholders have easy access to the information they need	4	4	**16**	5	4	**20**	18
2.5 For agencies yet to reach the growth developmental phase: Strategies are in place to move the organisation to the Growth phase as a first step in encouraging WSUD champions	5	3	**15**	5	4	**20**	17.5
1.1 The core knowledge that local practitioners need to implement WSUD is available	4	4	**16**	4	4	**16**	16
3.2 Responsibilities for implementing WSUD are clear at an organisational and individual level and people are accountable for fulfilling their responsibilities	5	4	**20**	4	4	**16**	18
Need number	**Comments**						

1.8	[1] Opportunity to focus on local pilot projects
4.6	[1] Costly, not easy/not easily available [2] Require annual maintenance budget
2.1	[1] Skills and training needed and can be implemented
5.8	[1] Can do cheaply with little effort [2] Development forums
2.5	[1] WQIP does provide a vehicle to do this. It is regulatory and can't be avoided.
3.2	[1] Change through influence. A basic building block [2] Go to person in the short term

Notes: * to be addressed in the Action Planning workshop. Priority score is Benefit x Possible. Group 1 is Rod's group. Group 2 is Jonathan's group.

Table 2 (Additional Needs) lists projects scored significantly differently by the two small groups. These capacity building differences will need to be resolved as a first step at workshop 2.

Table 2: Additional Needs (to be confirmed*)

Capacity Building Need	Group 1 scoring			Group 2 scoring			Priority average
	Benefit	Possible	Priority	Benefit	Possible	Priority	
1.4 Knowledge of technical WSUD tools is available to help local practitioners implement WSUD	0	0	**0**	5	4	**20**	10
2.3 Local practitioners have the necessary leadership skills to implement WSUD	4	3	**12**	0	0	**6**	9
3.4 High levels of collaboration occur within the organisation to help implement WSUD	4	4	**16**	4	2	**8**	8
4.1 Mandatory planning controls are in place that require WSUD to be implemented through new development	4	4	**16**	5	2	**10**	12
4.3 The organisation has a management plan / strategy for implementing WSUD	4	5	**20**	4	2	**8**	14
5.2 Council promotes WSUD and leads by example through its own capital works projects	4	2	**8**	5	4	**20**	14
Need number	**Comments**						
2.3	[1] Difficulty in getting traction on this. Used to be one but budget cuts resulted in losing the champion (HR and CEO)						
3.4	[1] Collaborate when we get together. Still focussed on day to day operations [2] This would happen anyway						
4.1	[1] Model codes and major amendments [2] A lot of work to move from broad to specific						
4.3	[2] Resources!						
5.2	[2] New construction higher benefit than retrofitting existing						

Notes: * to be addressed in the Action Planning workshop. Priority score is Benefit x Possible. Group 1 is Rod's group. Group 2 is Jonathan's group.

(WSUD capacity sub project)
Rockhampton Regional Council Action Plan (Final)

Priority Capacity Building Need	Specific Outcome to be addressed	Action	Responsibility	Timeframe
Knowledge that is needed to encourage WSUD				
1.1 The core knowledge that local practitioners need to implement WSUD is available (including WSUD tools)	Increase knowledge of Council staff	Implement/arrange training for Council and relevant industry	Coordinator Infrastructure Operations (in conjunction with Coordinator Design Services) Coordinator Development Assessment to work with industry	October 2014
		Arrange site visits to show good/bad examples of WSUD	Coordinator Infrastructure Operations	November 2014
1.8 Pilot projects are used to generate new knowledge regarding the local application of WSUD	Showcase good examples of WSUD through pilot projects	Work with developers to showcase good examples of WSUD	Coordinator Infrastructure Operations and Manager Parks and Gardens	Development dependant
		Document, monitor, learn to ensure long term maintenance retains integrity and function	Coordinator Infrastructure Operations and Manager Parks and Gardens	Development dependant
Professional Development Activities to encourage WSUD				
2.3 Local practitioners have the necessary leadership skills to implement WSUD	Increased knowledge and acceptance of WSUD at the political level	Explore options to increase high level buy-in for WSUD	Coordinator Infrastructure Operations/Manager Parks and Gardens	May – December 2014
		Identify relevant external stakeholders who may be able to help to secure support for WSUD	Coordinator infrastructure Operations	Ongoing
		Review Business Case for Vegetated Stormwater Assets and adapt for RRC	Coordinator Infrastructure Operations	June 2014
2.5 For agencies yet to reach the growth developmental phase: Strategies are in place to move the organisation to the Growth phase as a first step in encouraging WSUD champions	Political and executive support for WSUD secured	Identify political and executive champion/leaders	Coordinator infrastructure Operations/Manager Engineering Services	May 2014
		Meet with Manager Engineering Services to develop a strategy for this approach	Coordinator Infrastructure Operations/Manager Engineering Services	May 2014
Organisational strengthening activities to encourage WSUD				
3.2 Responsibilities for implementing WSUD are clear at	Responsibilities for WSUD are clear at an organisational	Identify departmental advocates/champions	All	End 2015
		Define responsibilities and functions for each component	Manager Engineering Services	End 2015

an organisational and individual level and people are accountable for fulfilling their responsibilities	and individual level	of WSUD eg. Planning, design, maintenance etc.		
		Define the change process to be undertaken	Manager Engineering Services	December 2014
3.4 High levels of collaboration occur within the organisation to help implement WSUD	Regular progress meetings with internal and external stakeholders	Organise meetings and issue minutes	Coordinator infrastructure Operations	As needed
		Provide progress updates in newsletters and through other communication networks	Coordinator infrastructure Operations/Coordinator Development Assessment	As needed
Directive reforms to encourage WSUD				
4.1 Mandatory planning controls are in place that require WSUD to be implemented through new development	Planning controls are in place	Review existing planning controls and update to reflect current WSUD intent in Council	Coordinator Development Assessment/Development Engineer	July 2014
		Include updated requirements in C.M.D.G.	Coordinator Infrastructure Operations/Coordinator Design Services	December 2014
4.3 The organisation has a management plan/strategy for implementing WSUD	WSUD Action Plan endorsed	Finalise WSUD Action Plan and have it endorsed through the Executive/Council as appropriate	Coordinator Infrastructure Operations/Manager Engineering Services	May 2014
		Outcomes are regularly reported to the executive, Council and other stakeholders	Coordinator Infrastructure Operations	May 2014
		RRC reports back to Healthy Waterways regarding progress and implementation of the action plan	Coordinator Infrastructure Operations	Ongoing
4.6 The organisation manages a system to ensure that its WSUD assets are maintained.	Council has a system for maintaining WSUD assets in the long term Council recoups the benefits of WSUD assets through appropriate investment and implementation	Work with Asset Management to determine how WSUD assets should be constructed, established and maintained.	Manager Parks and Gardens Coordinator infrastructure Operations	July 2014
		Internal guidelines/procedures are updated to include WSUD	Coordinator Infrastructure Operations in conjunction with Water by Design	July 2014
Facilitative reforms to encourage WSUD				
5.2 Council promotes WSUD and leads by example through its own capital works projects	Incorporate WSUD into Council projects where appropriate	Investigate whether WSUD can be incorporated into Council works/projects	Coordinator Design Services	Early 2015

5.8 WSUD information is managed and shared so that stakeholders have easy access to the information they need	WSUD information is shared between key stakeholders	Industry guidelines are provided via Intranet links eg. C.M.D.G., Healthy Waterways	Coordinator Infrastructure Operations	July 2014
		Liaise with Healthy Waterways about accessibility to information including data sharing and licence agreements	Coordinator Infrastructure Operations	July 2014

Note: Source is Rockhampton Regional Council Action Plan (Final) developed by Water by Design through ***Collaboration to the rescue*** (RUSMIG/Water by Design 2014).

Brief Report – Rapid Assessment of Gladstone Regional Council's Institutional Capacity for delivering Water Sensitive Urban Design (Workshop 1)

Gladstone Regional Council participated in a Rapid Assessment Workshop on the 14th March 2014 to identify high priority capacity building needs for Water Sensitive Urban Design (WSUD). This workshop provided participants with an introduction to WSUD; described elements of institutional capacity that researchers have identified as being instrumental in driving the adoption of WSUD within and around organisations like councils; and provided a process for participants to reflect on this information and work in facilitated small groups to conduct a rapid assessment of the current capacity of the organisation to drive WSUD. The process involved working through a series of worksheets based on the 5 capacity building interventions.

Table 1 lists and ranks seven high priority capacity building needs as scored by the two workshop groups.

Table 1: High Priority Capacity Building Needs*

Capacity Building Need	Group 1 scoring			Group 2 scoring			Priority average
	Benefit	Possible	Priority	Benefit	Possible	Priority	
1.4 Knowledge of 'technical WSUD tools' is available to help local practitioners implement WSUD	5	4	20	5	5	25	22.5
2.1 Local practitioners have the necessary technical knowledge and skills to implement WSUD	5	4	20	4	5	20	20
4.5 The organisation manages development assessment and enforcement processes to ensure that WSUD assets are delivered through new development	5	4	20	5	4	20	20
1.1 The core knowledge that local practitioners need to implement WSUD is available	5	4	20	4	4	16	18
1.8 Pilots projects are used to generate new knowledge regarding the local application of WSUD	5	4	20	4	4	16	18
1.2 Knowledge of natural resources in the region is available to help local practitioners implement WSUD	5	3	15	4	5	20	17.5
3.2 Responsibilities for implementing WSUD are clear at an organisational and individual level, and people are accountable for fulfilling their responsibilities	5	4	20	5	3	15	17.5

Need number	Comments
1.4	[1] have MUSIC; standard checklists exist 2 MUSIC available to developers
2.1	[1] Good internal staff knowledge
4.5	[1] restrictions due to lack of knowledge and policies; maintenance - more training required [2] once assets are off maintenance it falls over; at construction stage
1.1	more consistency on design
1.8	[1] having a standard bioretention basin to refer back to
1.2	[1] Costly, not easy/not easily available [2] full scale study exists for region 3/4 complete; GPCL stakeholders
3.2	[1] Development assessments; applying WSUD to current organisational structure; planning strategies; define roles [2] "ugly cousin"

Notes: * to be addressed in the Action Planning workshop. Group 1 = Emma's group. Group 2 = Celisa's group.

Table 2 (Additional Needs) lists projects scored significantly differently by the two small groups. These capacity building differences will need to be resolved as a first step at workshop 2.

Table 2: Additional Needs (to be confirmed*)

Capacity Building Need	Group 1 scoring			Group 2 scoring			Priority average
	Benefit	Possible	Priority	Benefit	Possible	Priority	
1.7 Local practitioners have access to trusted, reliable science that relates to WSUD	4	4	**16**	3	2	**6**	11
2.2 Local practitioners have the necessary technical knowledge and skills to implement WSUD	5	5	**25**	4	2	**8**	11
2.3 Local practitioners have the necessary leadership skills to implement WSUD	5	1	**5**	4	4	**16**	10.5
3.1 There is strong managerial and political commitment to implementing WSUD at the local and state government level	5	4	**20**	5	2	**10**	15
3.3 The organisation's dominant organisational culture is actively by executives so that it is supportive of WSUD	5	5	**25**	5	2	**10**	17.5
3.5 High levels of collaboration occur between organisations in the region to help implement WSUD	5	4	**20**	4	3	**12**	16
4.4 A set of 'design objectives' that are used to clearly communicate what outcomes WSUD must achieve when applied to a project	5	4	**20**	4	1	**4**	12
5.5 'Bridging organisations' operate in the region to foster WSUD	5	5	**25**	4	3	**12**	18.5
5.7 Meaningful incentives are in place to encourage WSUD	5	3	**15**	4	1	**4**	9.5

Need number	Comments
1.7	[1] harbour water quality monitoring; reef guardian project [2] CQ potential monitoring, calibration and models
2.2	[1] Already have knowledge but need more [2] Currently reactive
2.3	[1] need WSUD champions within the organisation [2] Not a current priority
3.1	[1] local government and state government involvement already [2] compliance level
3.3	[1] supportive executives are necessary in implementation [2] WSUD money; requires good examples to justify
3.5	[1] depending on needs and support of other organisations [2] process of joining Capricornia standards; incorporates/fosters the various regions
4.4	[1] some objectives exist but not all; condition; resources available? [2] water conservation not touched on by Council; quality and quantity ok; raise Councillor awareness if clearly communicated
5.5	[1] Healthy Waterways (Water by Design)

	[2] many out there but engineering team at GRC not aware of them
5.7	[1] No incentives currently; need direction from executive [2] capped charges' = council not achieving full cost recovery; many of the incentives are restricted due to current development environment

Notes: * to be addressed in the Action Planning workshop. Group 1 = Emma's group. Group 2 = Celisa's group.

(WSUD capacity sub project)
Gladstone Regional Council Action Plan (Final)

Priority Capacity Building Need	Specific Outcome to be addressed	Action	Responsibility	Timeframe
Knowledge that is needed to encourage WSUD				
1.1 The core knowledge that local practitioners need to implement WSUD is available	Increase knowledge of Council staff and developers	Develop training plan	Manager Technical Services (Learning & Development)	End 2014
		Develop best practice guideline	Manager Technical Services (Senior Design & Senior Development)	End 2014
1.2 Knowledge of natural resources in the region is available to help local practitioners implement WSUD	Increased availability to local natural resource knowledge.	Create a central access point to access local natural resource knowledge	Strategic Planning	August 2014
1.4 Knowledge of 'technical WSUD tools' is available to help local practitioners implement WSUD	Increased knowledge of available tools for council staff	Council representative to inform staff about new guidelines	Senior development & Senior Design	End 2014
		Develop central access point for WSUD information	Development Engineer – Technical Services	August 2014
1.7 Local practitioners have access to trusted, reliable science that relates to WSUD	Council has access to trusted reliable science	Involve university in pilot projects	Learning and Development	End 2014
		Develop additional links to healthy harbour initiative	Senior Compliance and Quality Control Technical Officer	End 2014
		Investigate additional monitoring of outflow from development sites	Senior Compliance and Quality Control Technical Officer / senior development	End 2014
		Investigate condition of private treatment devices	Environment	End 2014
1.8 Pilot projects are used to generate new knowledge regarding the local application of WSUD	Generate local WSUD knowledge Increase awareness of WSUD in local area through pilot projects	Identify suitable greenfield and brownfield sites	Senior Technical Officer Development , Senior Design, Senior Development	End 2014
		Approach local developers to gauge interest in their involvement in pilot projects	Senior Technical Officer Development , Senior Design, Senior Development	End 2014
		Develop case studies of pilot projects	Senior Technical Officer Development , Senior Design, Senior Development	End 2014

		Investigate monitoring of pilot projects	Senior Technical Officer Development , Senior Design, Senior Development	End 2014
Professional Development Activities to encourage WSUD				
2.2 Local practitioners have the necessary leadership skills to implement WSUD	Enhance leadership skills in Gladstone Regional Council staff to drive WSUD	Identify and support WSUD champions	Manager Technical Services / Senior Development	September 2014
Organisational strengthening activities to encourage WSUD				
3.1 There is strong managerial and political commitment to implementing WSUD at the local and state government level	Stronger managerial and political commitment in council	Communicate the idea of WSUD to Councillors (education meeting)	Manager Technical Services / Director Engineering Services	End 2014
		Identify key Councillors to support WSUD	Manager Technical Services/Director Engineering Services	September 2014
		Engage managers and secure executive support	Manager Technical Services/Director Engineering Services/Director Planning and Environment	End 2014
3.2 Responsibilities for implementing WSUD are clear at an organisational and individual level, and people are accountable for fulfilling their responsibilities	Defined roles and responsibilities at organisation and individual level	Include WSUD in management meetings	Manager Technical Services	June 2014
		Establish WSUD management team to encourage implementation	Manager Technical Services	September 2014
		Include WSUD responsibilities in position descriptions	Manager Technical Services	End 2014
3.3 The organisation's dominant organisational culture is actively managed by executives so that it is supportive of WSUD	An organisational culture that is supportive of WSUD	Management promote their support of WSUD	Manager Technical Services / Director Engineering Services Manager Technical Services	End 2014
		Create a WSUD policy or update Stormwater policy to include WSUD principles	Manager Technical Services	End 2014
3.5 High levels of collaboration occur between organisations in the region to help implement WSUD	Stronger relationships formed between organisations in the region to implement WSUD	Staff engage with relevant regional organisations regarding WSUD and share at WSUD management team meetings	Manager Technical Services / Director Engineering Services / Director Planning and Environment	End 2014
Directive reforms to encourage WSUD				

4.3 The organisation has a management plan/strategy for implementing WSUD	Endorse GRC action plan for WSUD	Implement Action Plan for WSUD	Director Engineering Services	January 2015
		Incorporate actions into Corporate and Operational Plans	Manager Technical Services/Director Engineering Services	January 2015
		Review Action Plan	Manager Technical Services	July 2015
		Report back to Healthy Waterways regarding progress so that appropriate assistance can be provided where possible	Development Engineer	July 2015
4.4 A set of 'design objectives' that are used to clearly communicate what outcomes WSUD must achieve when applied to a project	Clearly communicated design objectives	Develop / adopt a set of WSUD objectives	Manager Technical Services/Senior Development/Senior Design	January 2015
		Develop / adopt specific design objectives for various WSUD assets	Manager Technical Services/Senior Development/Senior Design	January 2015
		Create a WSUD package of information for developers (standard drawings, deemed to comply solutions)	Manager Technical Services/Senior Development/Senior Design	July 2015
4.5 The organisation manages development assessment and enforcement processes to ensure that WSUD assets are delivered through new development	Organisation has strong development assessment and enforcement processes	Complete gap analysis of current processes	Manager Technical Services / Senior Development	July 2015
		Develop new processes for gaps identified	Manager Technical Services / Senior Development	July 2015
4.6 The organisation manages a system to ensure that its WSUD assets are maintained	WSUD assets are adequately maintained	Locate all devices in the region (including private treatment devices) and record in the asset register	Assets	End 2014
		Ensure budget is set aside for WSUD maintenance	Manager Technical Services (in conjunction with planning)	June 2015
Facilitative reforms to encourage WSUD				
5.5 'Bridging organisations' operate in the region to foster WSUD	Council is aware of and engaging with bridging organisations	Continue working with existing organisations Fitzroy Basin Association, Healthy Waterways	Parks (FBA), Development Engineer (Healthy Waterways)	End 2014

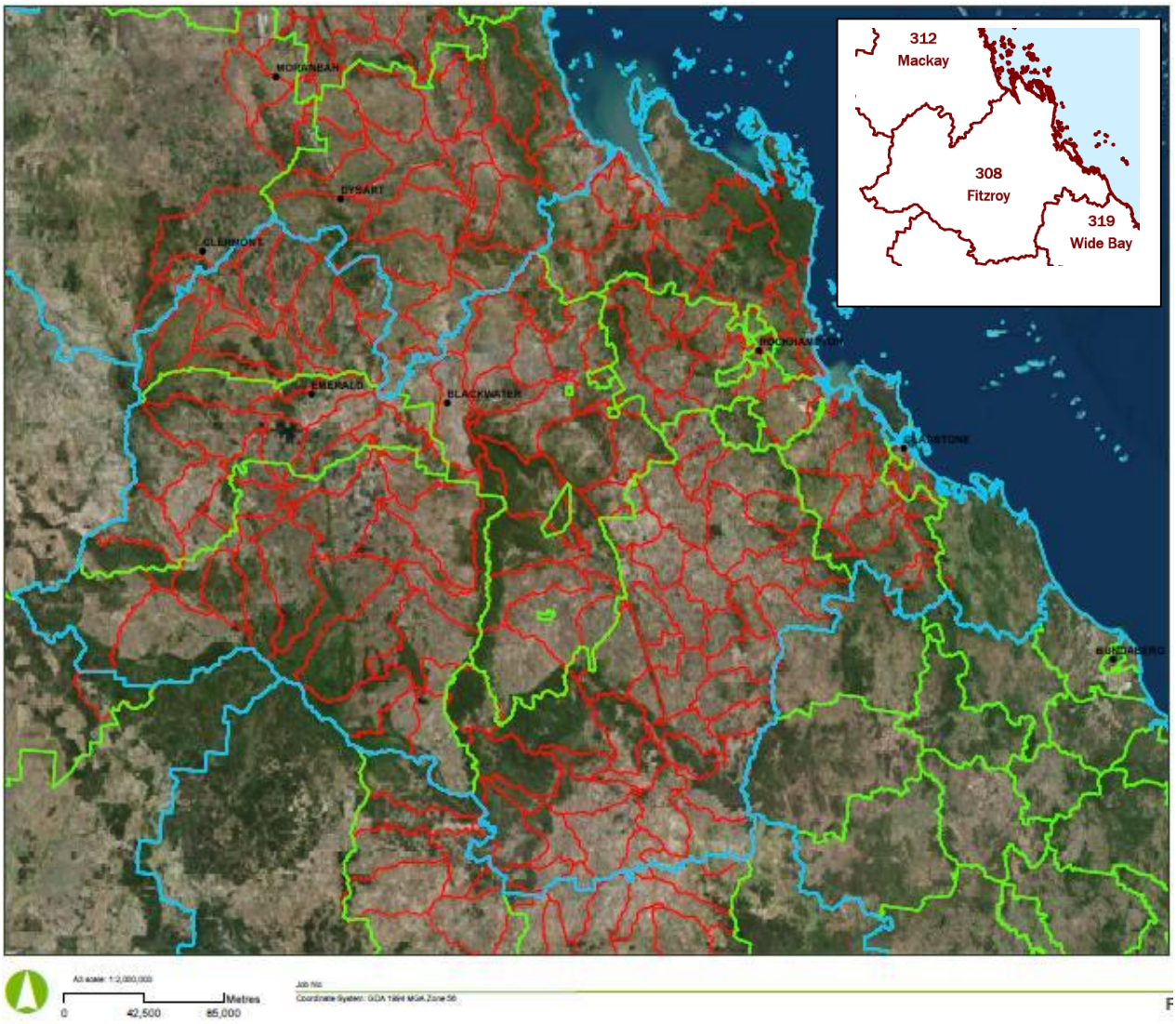
		Identify other organisations within the region	All	End 2014

Note: Source is Gladstone Regional Council Action Plan (Final) developed by Water by Design through ***Collaboration to the rescue*** (RUSMIG/Water by Design 2014).

Appendix C Statistical Areas

The Australian Bureau of Statistics (ABS) has a four-tiered (hierarchical) geographical system used for collection and analysis of census data and other purposes. The system is based on spatial units defined under the Australian Statistical Geography Standard (ASGS). Gladstone Regional Council, Rockhampton Regional Council and Livingstone Shire Council are all within the Fitzroy (308) level 4 statistical area (SA) the largest Queensland unit (see FigureA).

Figure *A: Fitzroy SA4 and SLAs*

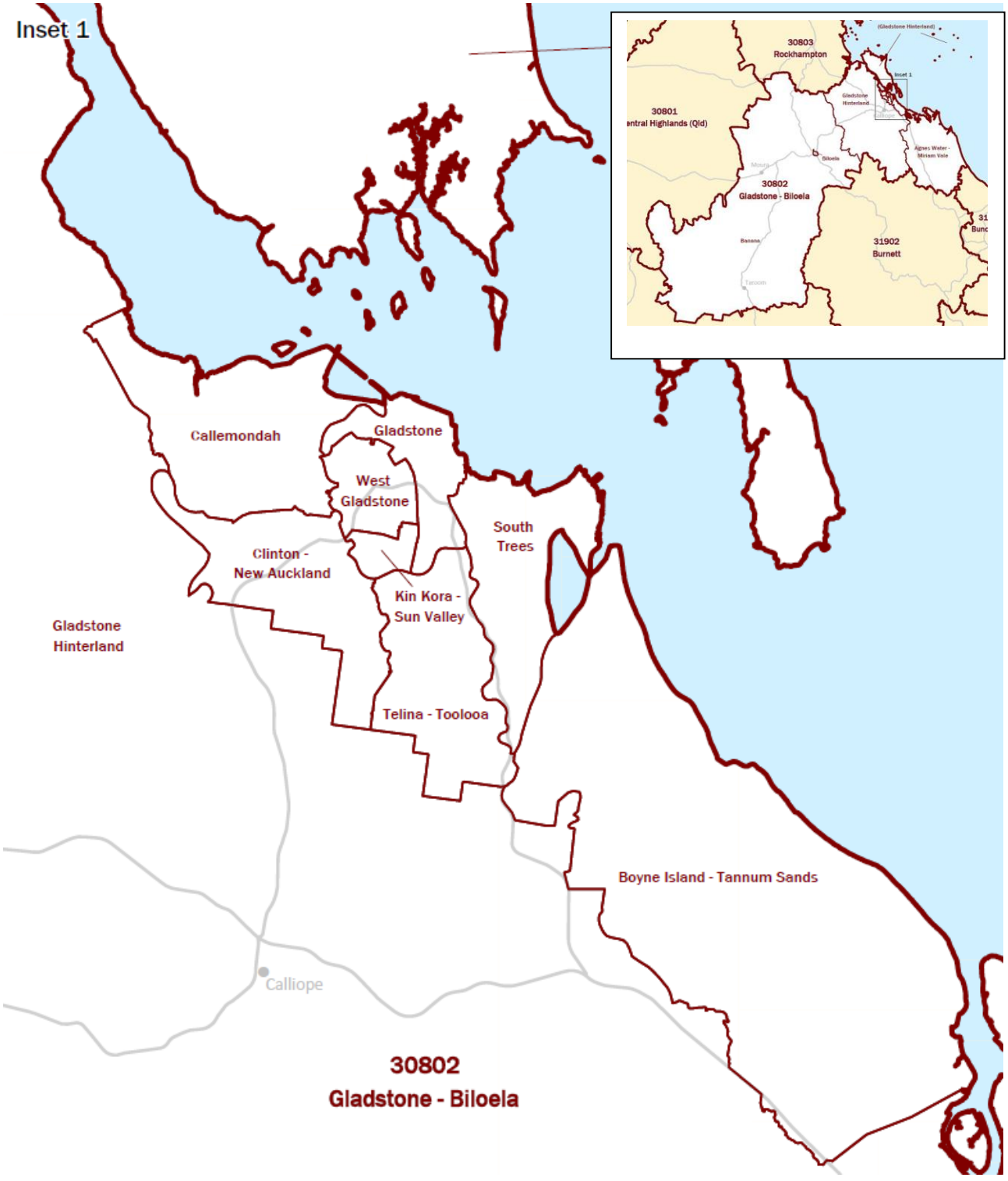


Notes: Map prepared by Aurecon using catchment boundary data supplied by the FBA and public domain ABS Census data statistical areas. Blue lines indicate the boundary of level 4 statistical areas, green lines show statistical local area boundaries while Fitzroy Basin water quality improvement plan sub catchments are shown in red. Lake Maraboon (Fairbairn Dam) is a significant water feature visible south southwest of Emerald. The inset shows the Fitzroy SA4 (308).

The relevant level 3 SA units for these local government areas are titled Gladstone-Biloela and Rockhampton (Livingstone is included in the Rockhampton SA3 unit). These units are then divided into level 2 SA units (see Figure B), which consist of sub regions for rural areas and localities and/or suburbs within the urban areas. The Gladstone SA2 region (6,712 km^2) comprises the nine statistical area level 2s (SA2's) of Boyne Island - Tannum Sands, Callemondah, Clinton – New Auckland, Gladstone,

Gladstone Hinterland, Kin Kora - Sun Valley, South Trees, Telina - Toolooa and West Gladstone. These are then divided into level 1 statistical areas, which are smaller than suburbs and are identified by codes rather than being named. The code has two digits added to the named level 2 statistical areas code (see Table A).

Figure *B: Level 2 Statistical Areas*



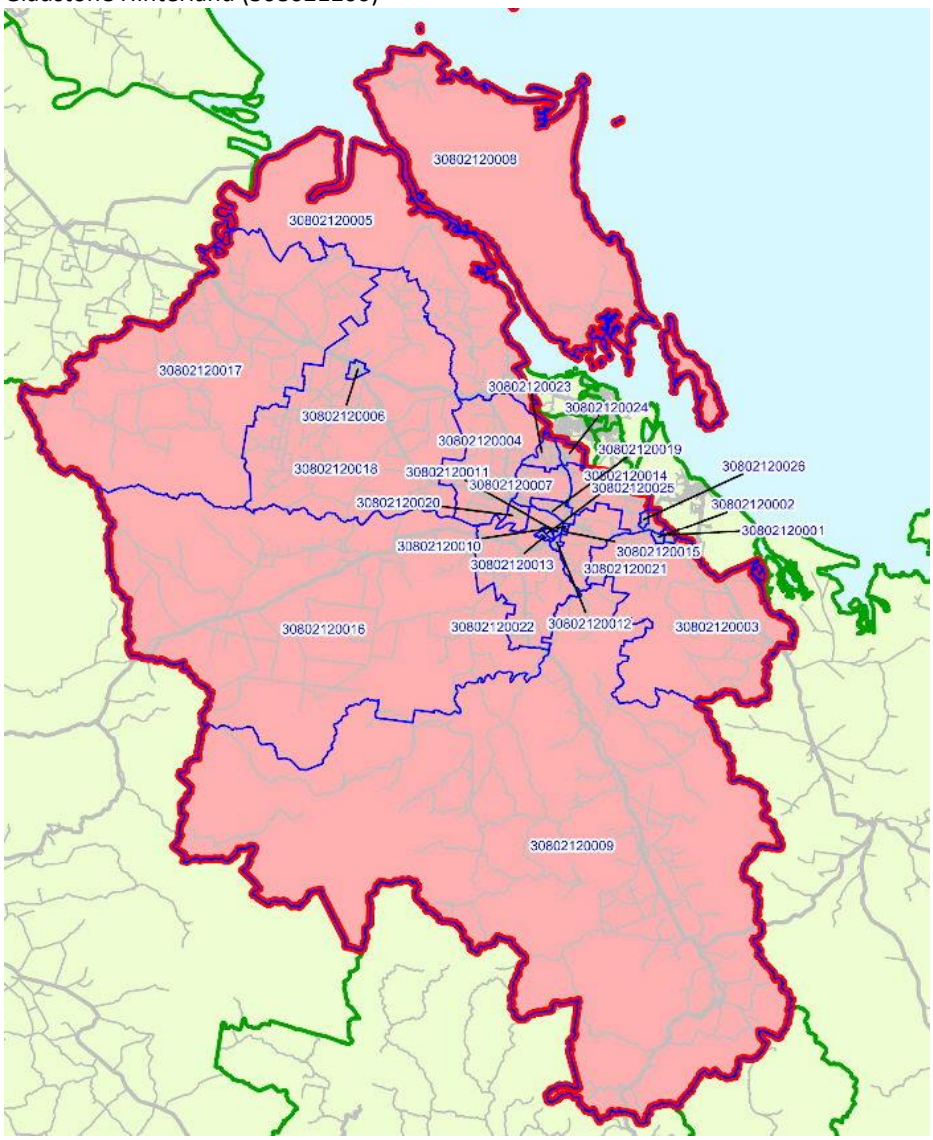
Note: Gladstone-Biloela SA3 (30802) is shown in the inset (top right) with SA2 divisions shown in the main diagram. Source document is Australian Statistical Geography Standard (ASGS) Volume 1 - Queensland Maps July 2011 (Brian Pink Australian Statistician - ABS 2011) showing level 4, 3 and 2 statistical areas (SA).

Statistical local areas (SLA) are another geographic unit often used in Queensland and particularly when comparing rural and urban areas. These units are based on 'old' shire and city local government areas and may be useful when analysing urban statistics. The Gladstone (R) – Gladstone SLA (ASGC Code 330056366) is shown in Figure C. A concordance is available when using SLAs to relate the ABS statistical areas to the local government aligned statistical local areas.

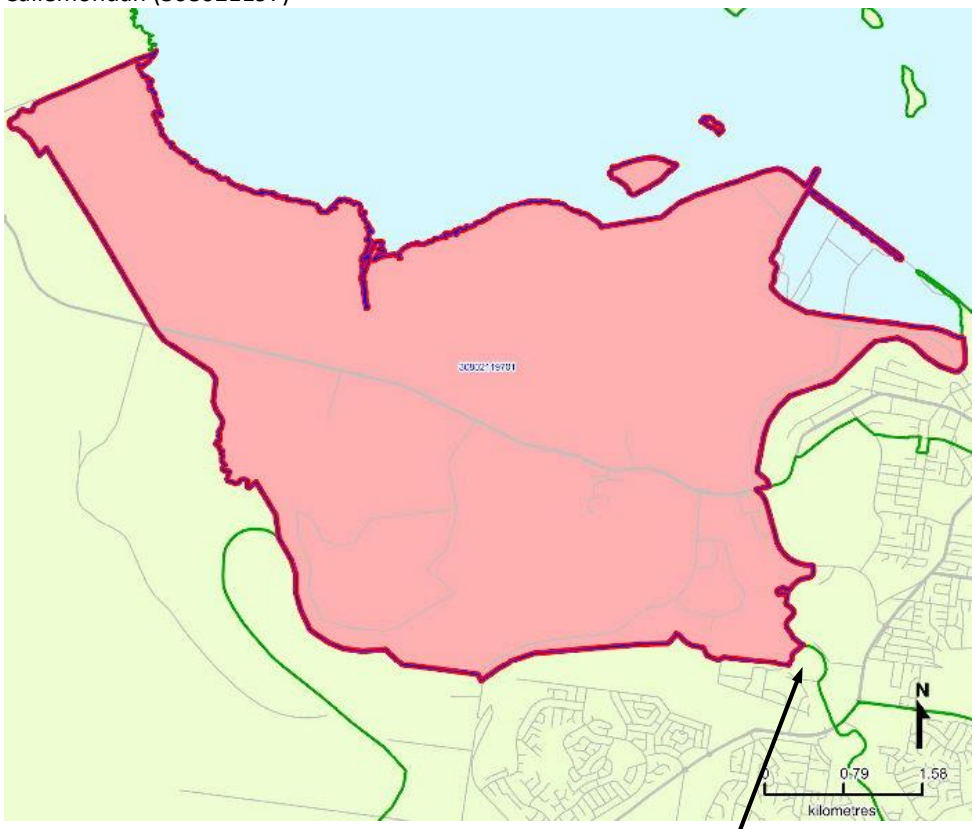
Table A: SA2 with SA1

Statistical area (SA2)	SA2 code	SA1 code
Boyne Island-Tannum Sands	308021196	30802119601 to 30802119622
Callemondah	308021197	30802119701
Clinton-New Auckland	308021198	30802119801 to 30802119828
Gladstone	308021199	30802119901 to 30802119917
Gladstone Hinterland	308021200	30802120001 to 30802120026
Kin Kora-Sun Valley	308021201	30802120101 to 30802120110
South Trees	308021202	30802120201
Telina-Toolooa	308021203	30802120301 to 30802120313
West Gladstone	308021204	30802120401 to 30802120413

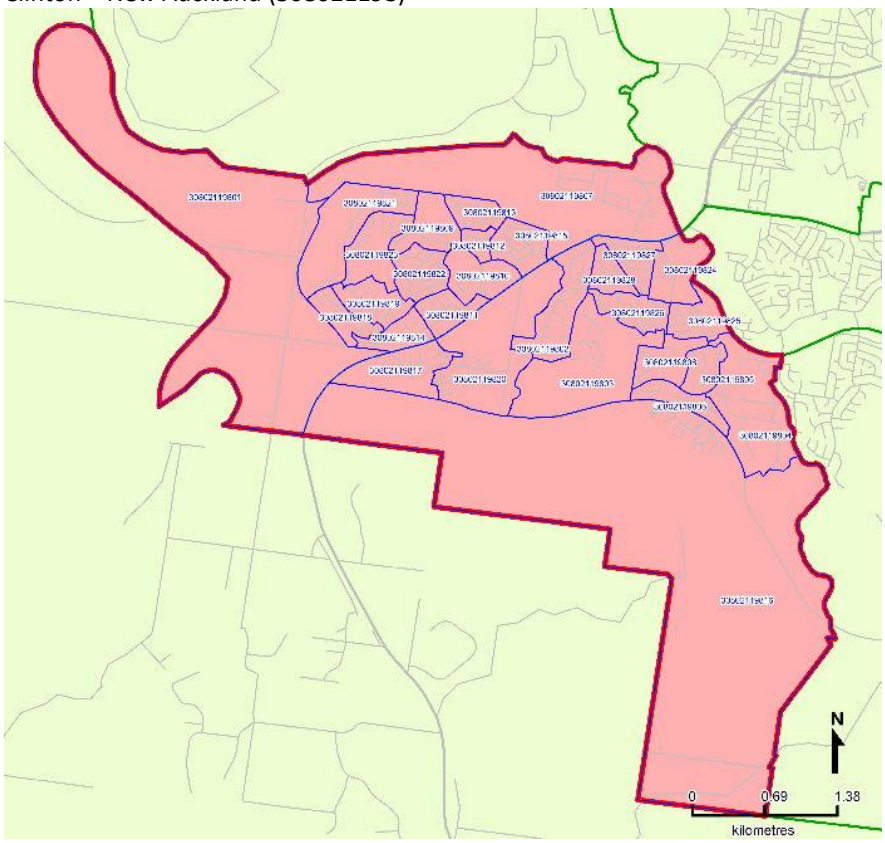
Gladstone Hinterland (308021200)



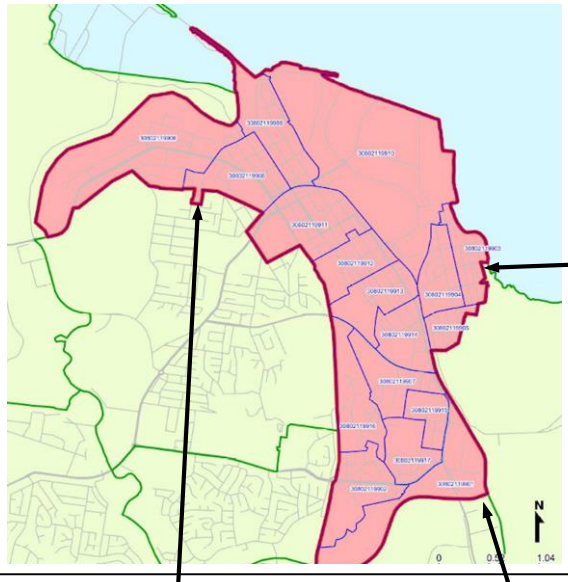
Callemondah (308021197)



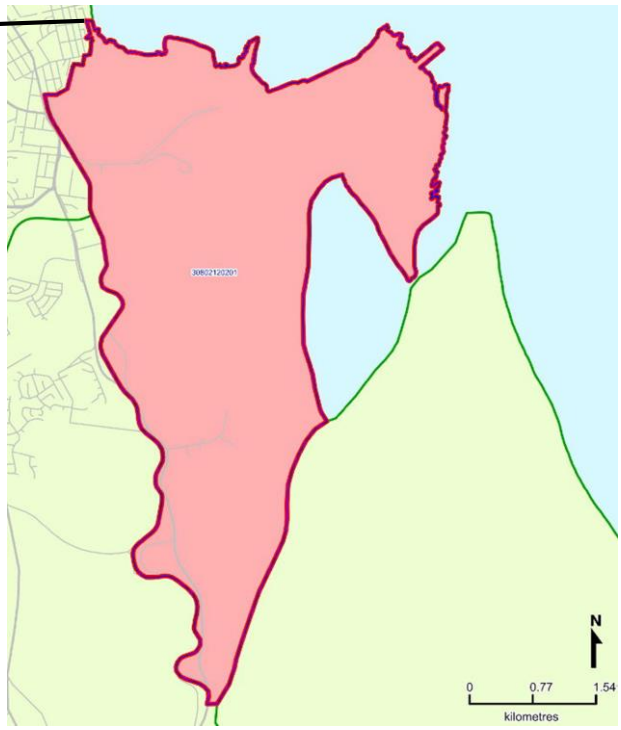
Clinton – New Auckland (308021198)

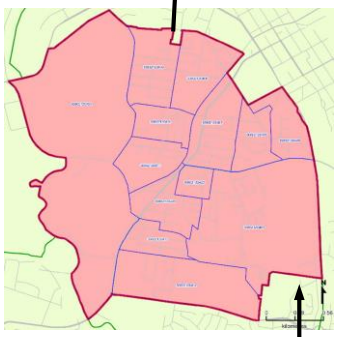


Gladstone

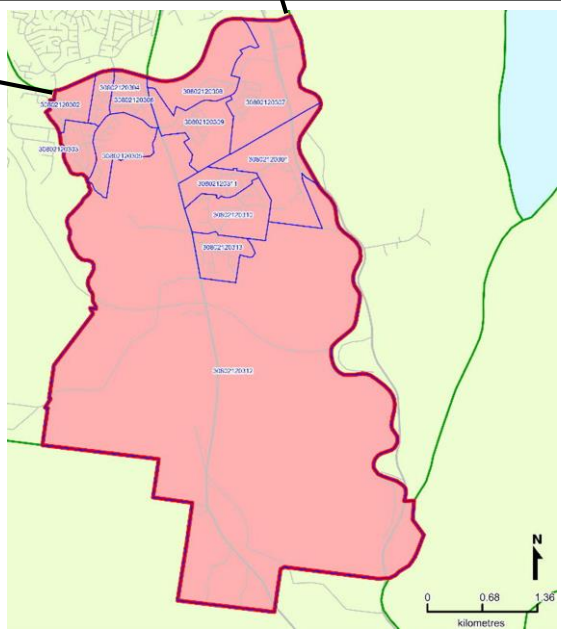


South Trees



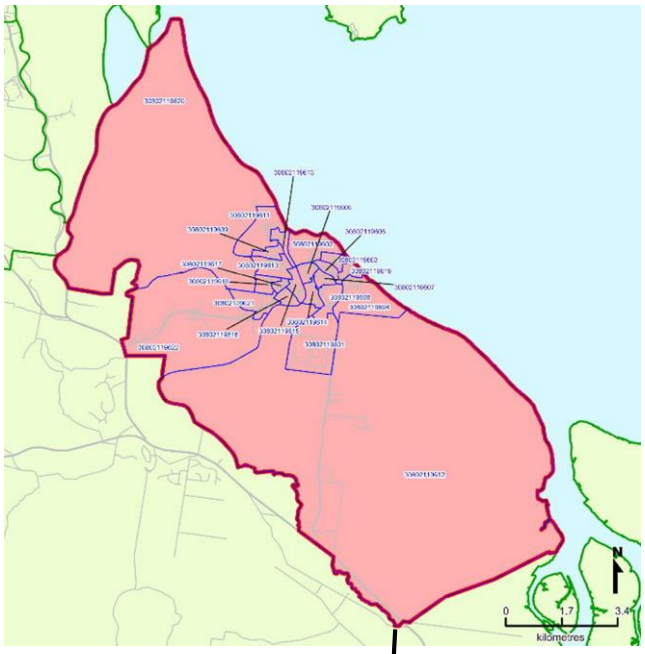


West Gladstone



Telina-Toolooa

Boyne Island-Tannum Sands



Gladstone Hinterland

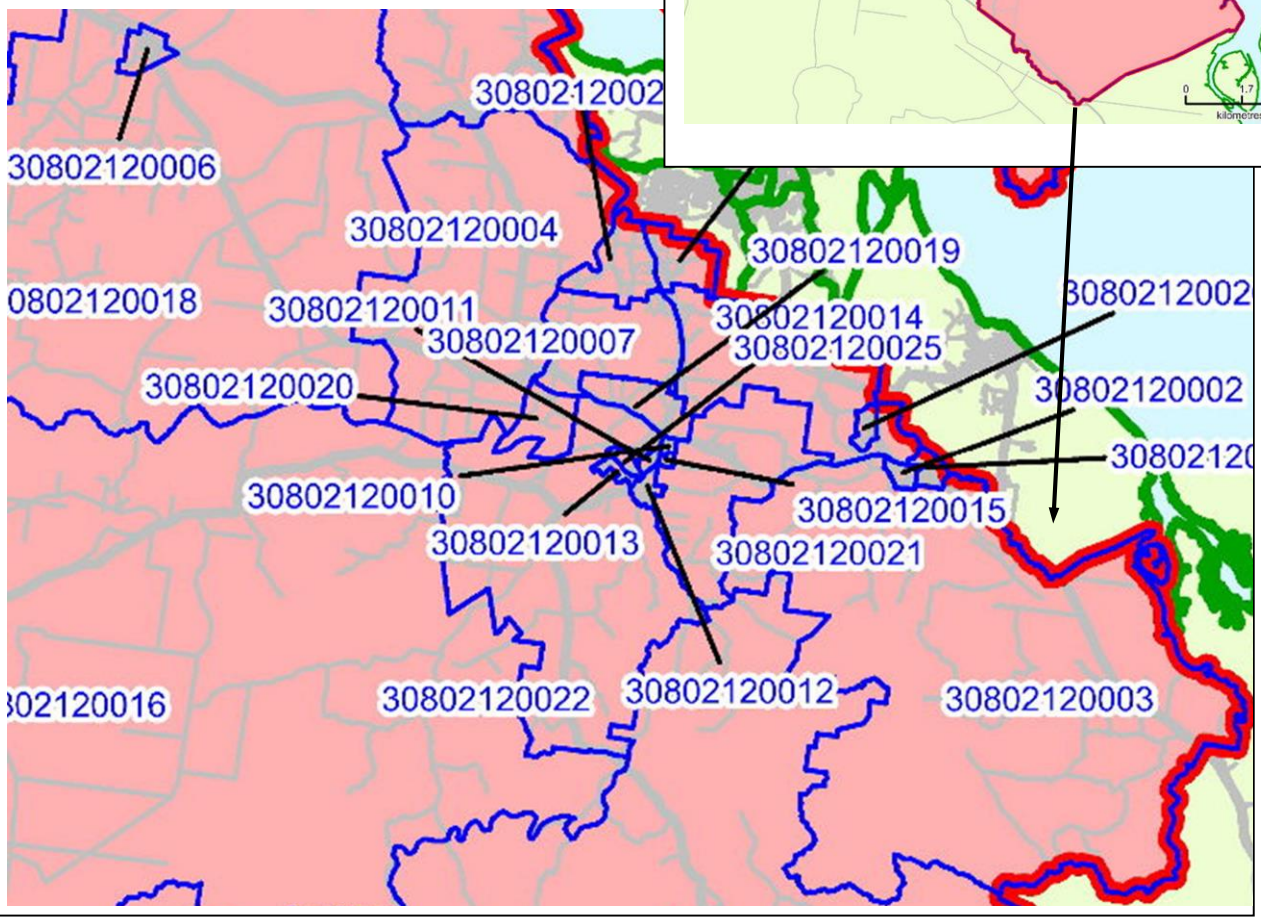
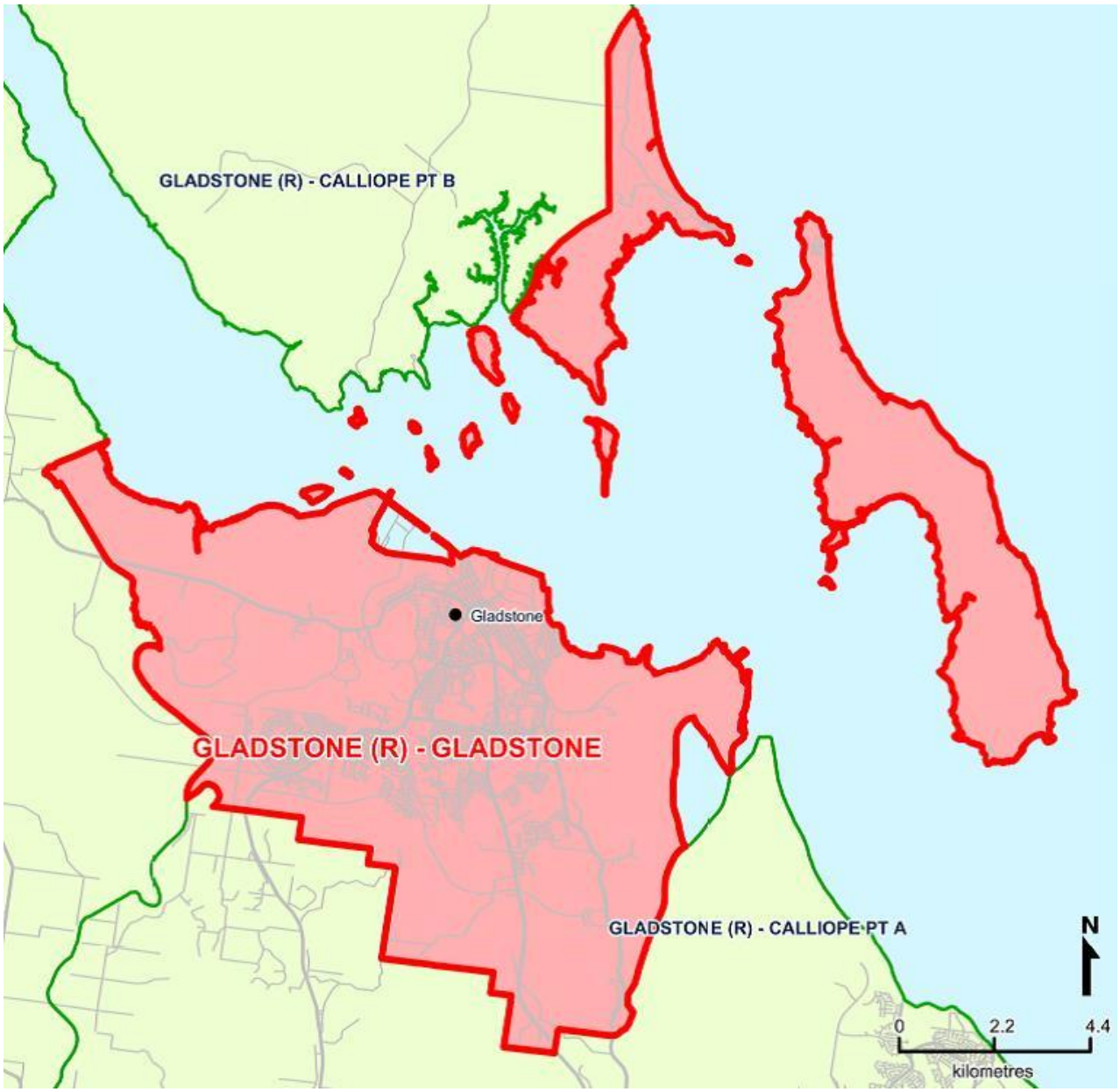
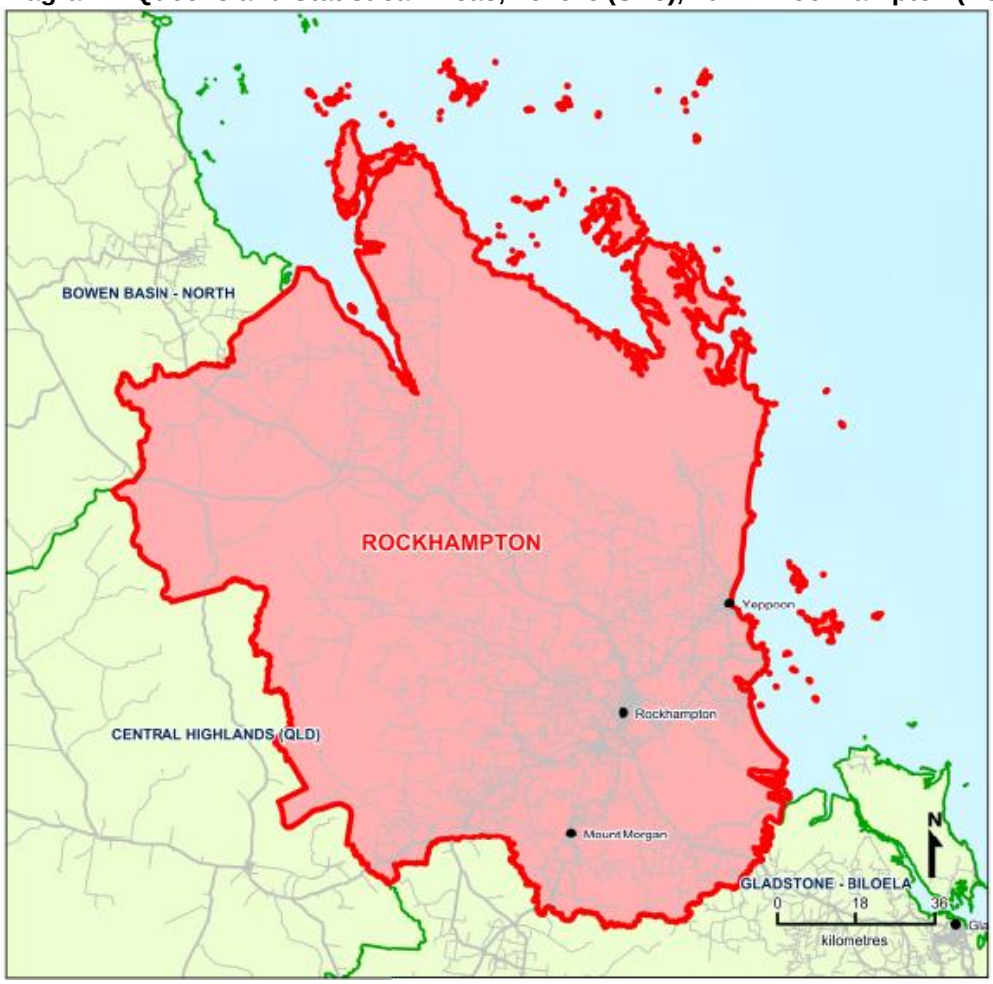


Figure *C: Gladstone Statistical Local Area*



Note: Gladstone (R) - Gladstone statistical local area (ASGC Code 330103366) is equivalent to the former Gladstone City Council LGA.

Diagram 4 Queensland Statistical Areas, Level 3 (SA3), 2011 - Rockhampton (ASGS Code 30803)



Note: Available at: http://www.qgso.qld.gov.au/products/maps/qld-sa3-asgs-2011/index.php

Table A: SA2 Unit Areas Rockhampton and Livingstone Urban

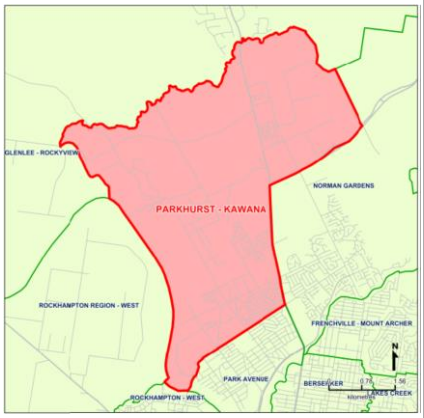
Rockhampton urban SA2s	Hectares	Livingstone SA2s	Hectares
Berserker	1,002	Emu Park	4,084
Frenchville - Mount Archer	3,017	Yeppoon	7,856
Lakes Creek	1,681	Coast/urban/peri urban total	11,939
Norman Gardens	3,614		
Park Avenue	496	Glenlee - Rockyview	20,803
Parkhurst - Kawana	2,843		
Rockhampton - West	3,453	Shoalwater Bay	317,696
Rockhampton City	5,121	Rockhampton Region - East	8,153
The Range - Allenstown	550	Rockhampton Region - North	756,689
	21,777		1,115,281

Source: Australian Bureau of Statistics, Australian Statistical Geography Standard (ASGS): Volume 1 - Main Structure and Greater Capital City Statistical Areas, July 2011, cat. no. 1270.0.55.001 (Source file: qld-conc-sa1-2011-sa2-sa3-sa4-gccsa-2011.xlsx)

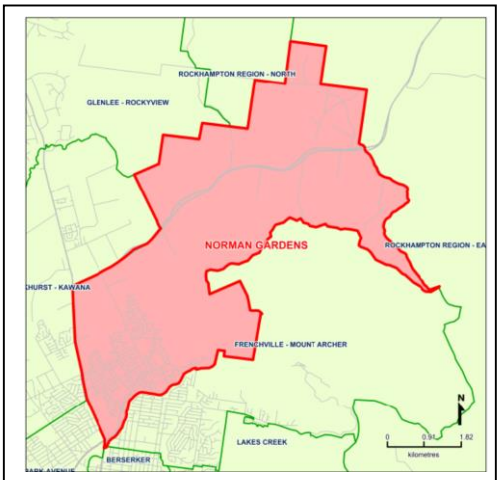
Rockhampton Urban Level 2 (SA2) Queensland Statistical Areas included in Rockhampton (ASGS Code 30803) SA3 unit (Note: Arranged north to south and not to scale)

Diagram 5 North Rockhampton (Fitzroy River north)

Queensland Statistical Areas, Level 2 (SA2), 2011 – Glenlee - Rockyview (ASGS Code 308031209)

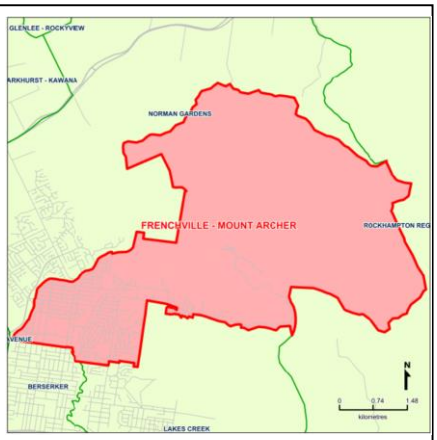


Queensland Statistical Areas, Level 2 (SA2), 2011 – Parkhurst - Kawana (ASGS Code



Queensland Statistical Areas, Level 2 (SA2), 2011 –

Queensland Statistical Areas, Level 2 (SA2), 2011 – Park Avenue (ASGS Code

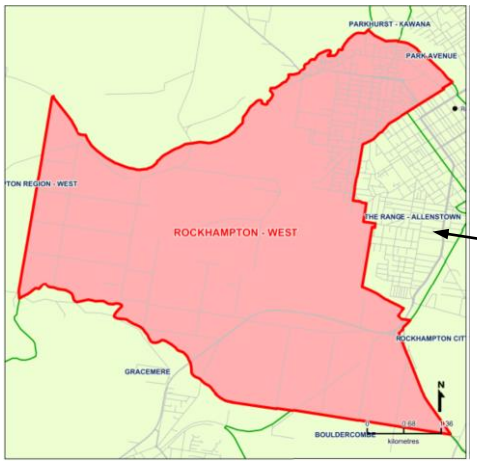


Queensland Statistical Areas, Level 2 (SA2), 2011 – Frenchville – Mt Archer (ASGS Code

Queensland Statistical Areas, Level 2 (SA2), 2011 – Berserker (ASGS Code 308031205) (RRC)

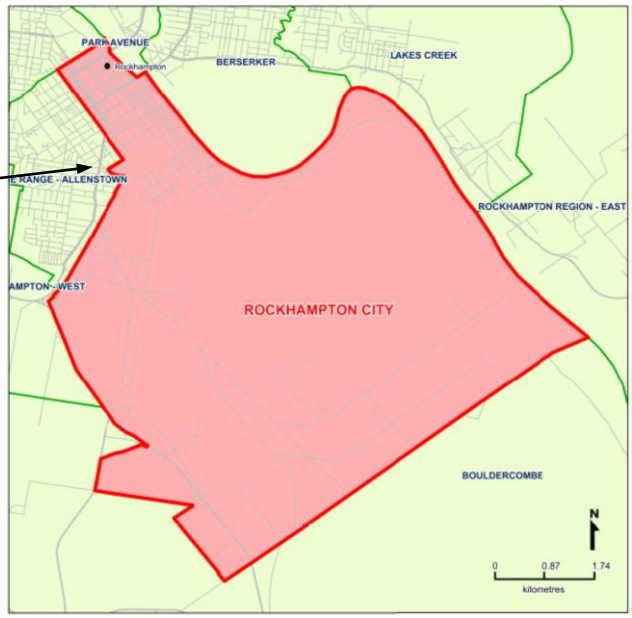
Queensland Statistical Areas, Level 2 (SA2), 2011 – Lakes Creek (ASGS Code

Diagram 6 South Rockhampton (Fitzroy River south)



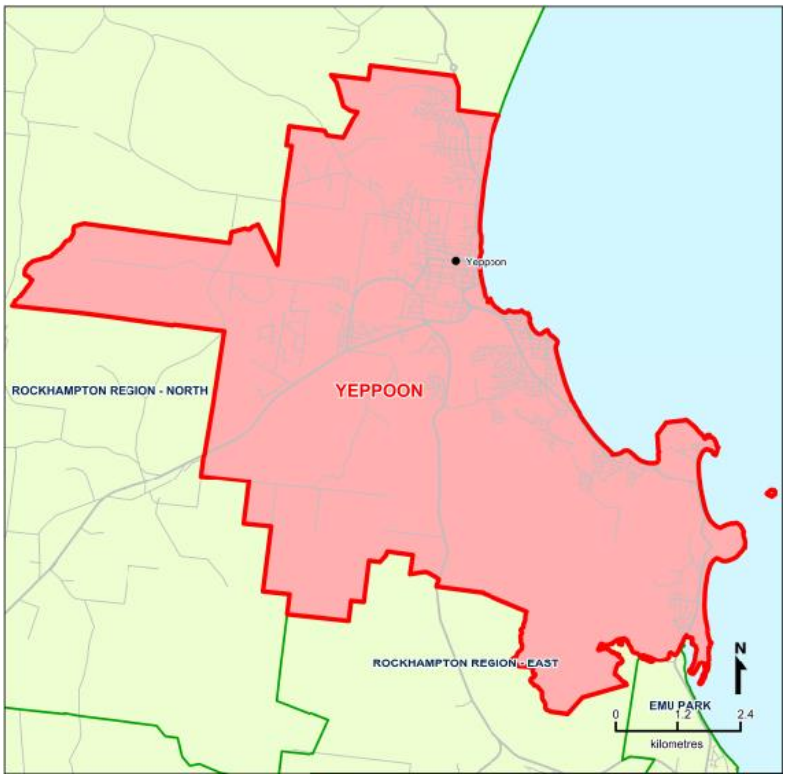
Queensland Statistical Areas, Level 2 (SA2), 2011 – Rockhampton - West (ASGS Code 308031216) (RRC)

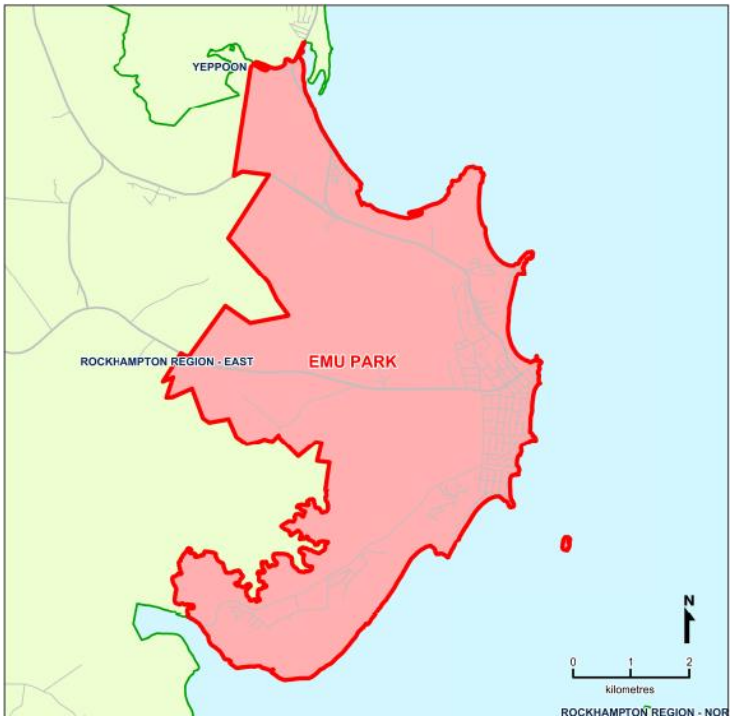
Queensland Statistical Areas, Level 2 (SA2), 2011 – The Range - Allenstown (ASGS Code 308031222) (RRC)



Queensland Statistical Areas, Level 2 (SA2), 2011 – Rockhampton City (ASGS Code 308031217) SA1 01-10 (RRC)

Diagram 7 Livingstone Shire Council urban Level 2 (SA2)
(Queensland Statistical Areas included in Rockhampton (ASGS Code 30803) SA3 unit)





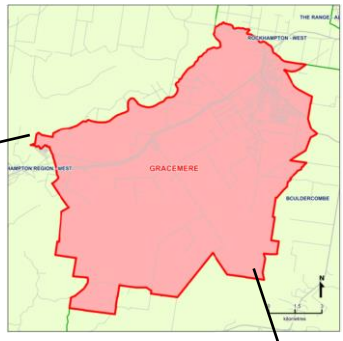
Emu Park (ASGS Code 308031207)

Diagram 7 Rural Level 2 (SA2) Units (included in Rockhampton (ASGS Code 30803) SA3 unit)

Shoalwater Bay (ASGS Code 308031221)

(above) Emu Park (ASGS Code 308031207) and Yeppoon (ASGS Code 308031223) – urban areas (in Livingstone Shire Council LGA)

Rockhampton Region - West (ASGS Code 308031220)



Gracemere (ASGS Code 308031210)

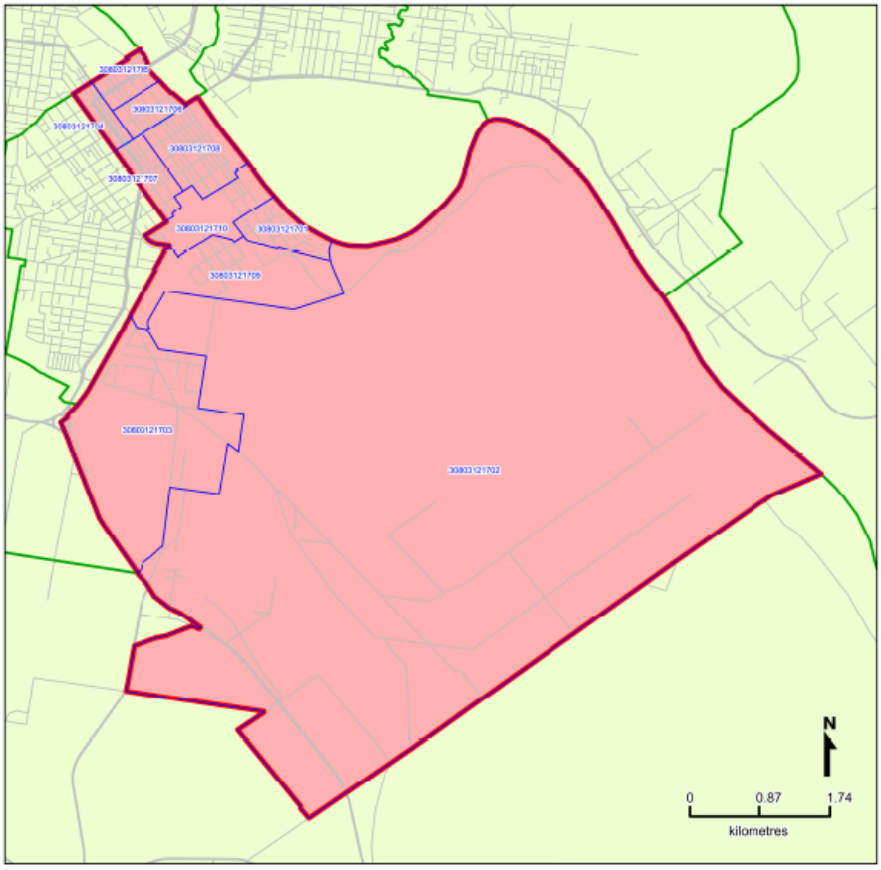
Rockhampton Region - East (ASGS Code 308031218)

Note: Available at http://www.qgso.qld.gov.au/products/maps/qld-sa2-asgs-2011/index.php

Mt Morgan (ASGS Code 308031212)

Bouldercombe (ASGS Code 308031206)

Diagram 8 Example Level 1 statistical areas (SA1) 2011 (within Rockhampton City SA2)



Note: Available at http://www.qgso.qld.gov.au/products/maps/qld-sa1-asgs-2011-within-sa2/index.php

Table B: Rockhampton Urban Statistical Areas in Context

Queensland Level 4 SAs	Fitzroy Level 3 SAs	Rockhampton Level 2 SAs
Brisbane - East	Bowen Basin North	Rockhampton Region - North
	Central Highlands	Shoalwater Bay
Brisbane - North		Rockhampton Region - West
Brisbane - South	**Rockhampton**	Gracemere
Brisbane - West		Rockhampton Region - East
Brisbane Inner City	Gladstone - Biloela	Bouldercombe
Cairns		Mount Morgan
Darling Downs - Maranoa		**Yeppoon**
Fitzroy	Livingstone Shire SAs	**Emu Park**
Gold Coast		**Glenlee - Rockyview**
Ipswich		**Berserker**
Logan - Beaudesert		**Frenchville – Mount Archer**
Mackay		**Lakes Creek**
Moreton Bay - North		**Norman Gardens**
Moreton Bay - South		**Park Avenue**
Queensland - Outback		**Parkhurst – Kawana**
Sunshine Coast		**Rockhampton City**
Toowoomba		**Rockhampton West**
Townsville		**The Range - Allenstown**
Wide Bay		

Note: Red indicates Rockhampton Regional Council urban areas and blue indicates Rockhampton urban areas in Livingstone Shire Council LGA. Green is coastal urban areas in the Livingstone Shire Council LGA.

Table C: Rockhampton and Livingstone Statistical Areas Level 2

LGA	Level	SA2 Code	SA2 Name	Area (ha)
Rockhampton (R)	SA2	308031205	Berserker	1,002
Rockhampton (R)	SA2	308031206	Bouldercombe	133,870
Rockhampton (R)	SA2	308031208	Frenchville - Mount Archer	3,017
Rockhampton (R)	SA2	308031210	Gracemere	15,415
Rockhampton (R)	SA2	308031211	Lakes Creek	1,681
Rockhampton (R)	SA2	308031212	Mount Morgan	49,068
Rockhampton (R)	SA2	308031213	Norman Gardens	3,614
Rockhampton (R)	SA2	308031214	Park Avenue	496
Rockhampton (R)	SA2	308031215	Parkhurst - Kawana	2,843
Rockhampton (R)	SA2	308031216	Rockhampton - West	3,453
Rockhampton (R)	SA2	308031217	Rockhampton City	5,121
Rockhampton (R)	SA2	308031220	Rockhampton Region - West	435,899
Rockhampton (R)	SA2	308031222	The Range - Allenstown	550
			Total	656,029
LGA	**Level**	**SA2 Code**	**SA2 Name**	**Area (ha)**
Livingstone (S)	SA2	308031207	Emu Park	4,084
Livingstone (S)	SA2	308031209	Glenlee - Rockyview	20,803
Livingstone (S)	SA2	308031218	Rockhampton Region - East	68,017
Livingstone (S)	SA2	308031219	Rockhampton Region - North	756,689
Livingstone (S)	SA2	308031221	Shoalwater Bay	317,696
Livingstone (S)	SA2	308031223	Yeppoon	7,856
			Total	1,175,145

Source: Concordance of Local Government Area (ASGS 2011) and Statistical Area, Level 2 (ASGS 2011) to Local Government Area (ASGS 2014).

.id demographics

(http://home.id.com.au/about-us/)

.id is a service provider specialising in converting demographic and economic data into online decision making tools across Australia and New Zealand. .id is engaged to produce demographic information for local government areas and these demographic websites become a public resource for everyone to access. Rockhampton Regional Council engaged .id and as result there is a suite of web based demographic information available online to interrogate and download results/reports. These fall into four categories:

- Rockhampton community profile – a demographic analysis for the Regional Council and its suburbs based on ABS results from the 2011, 2006, 2001, 1996 and 1991 Censuses of Population and Housing (http://profile.id.com.au/rockhampton);
- atlas.id - .id compiled enumerated data (persons) from the 2011 census and presents it in an interactive mapping social atlas page (Source: Australian Bureau of Statistics, Census of Population and Housing, 2011 (Enumerated data). A number of demographic parameters can be explored and results displayed on maps. A spreadsheet (CVS file) and/or an image file (see ***Diagram 9 Figure***) can be downloaded as required (http://atlas.id.com.au/rockhampton);
- forecast.id - population and household forecasts showing how the population, age structure and household types are expected to change in five year increments between 2011 and 2036. These forecasts were last updated in October 2014 to reflect the changed local government area configuration following the de-amalgamation of Livingstone Shire Council (http://forecast.id.com.au/rockhampton);
- Economic Profile - presents economic information derived from official sources of information (Australian Bureau of Statistics) as well as Australia's leading economic modellers, NIEIR (http://economy.id.com.au/rockhampton).

Diagram 9 Figure Population Density Example from atlas.id

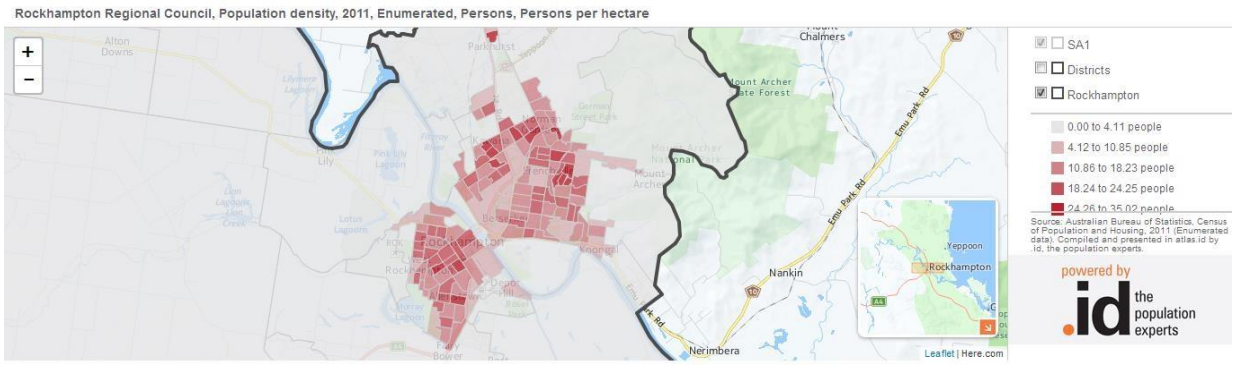


Table D: Statistical Units Key

Forecast.id urban units	Equivalent Queensland Statistical Areas - Level 2 and 1
Allenstown	The Range - Allenstown (ASGS Code 308031222) 18-22, 05-07
Berserker and The Common	Berserker (ASGS Code 308031205)
Frenchville	Frenchville – Mt Archer (ASGS Code 308031208) (minus level 1 unit 15)
Kawana	Parkhurst - Kawana (ASGS Code 308031215) - units 02, 07 to 17
Koongal / Lakes Creek	Lakes Creek (ASGS Code 308031211)
Norman Gardens	Norman Gardens (ASGS Code 308031213) 01 to 07, part of 08 and 09-17
Park Avenue	Park Avenue (ASGS Code 308031214)
Parkhurst / Limestone Creek / Mount Archer	Frenchville – Mt Archer (ASGS Code 308031208) (01 to 25 except unit 15) Parkhurst - Kawana (ASGS Code 308031215) (01 and 03-06) Norman Gardens (ASGS Code 308031213) (most of 08)
Rockhampton City and Depot Hill	Rockhampton City (ASGS Code 308031217) (minus level 1 units 02 and 03)
The Range	The Range - Allenstown (ASGS Code 308031222) 01-04, 08-17
Wandal and West Rockhampton	Rockhampton - West (ASGS Code 308031216)

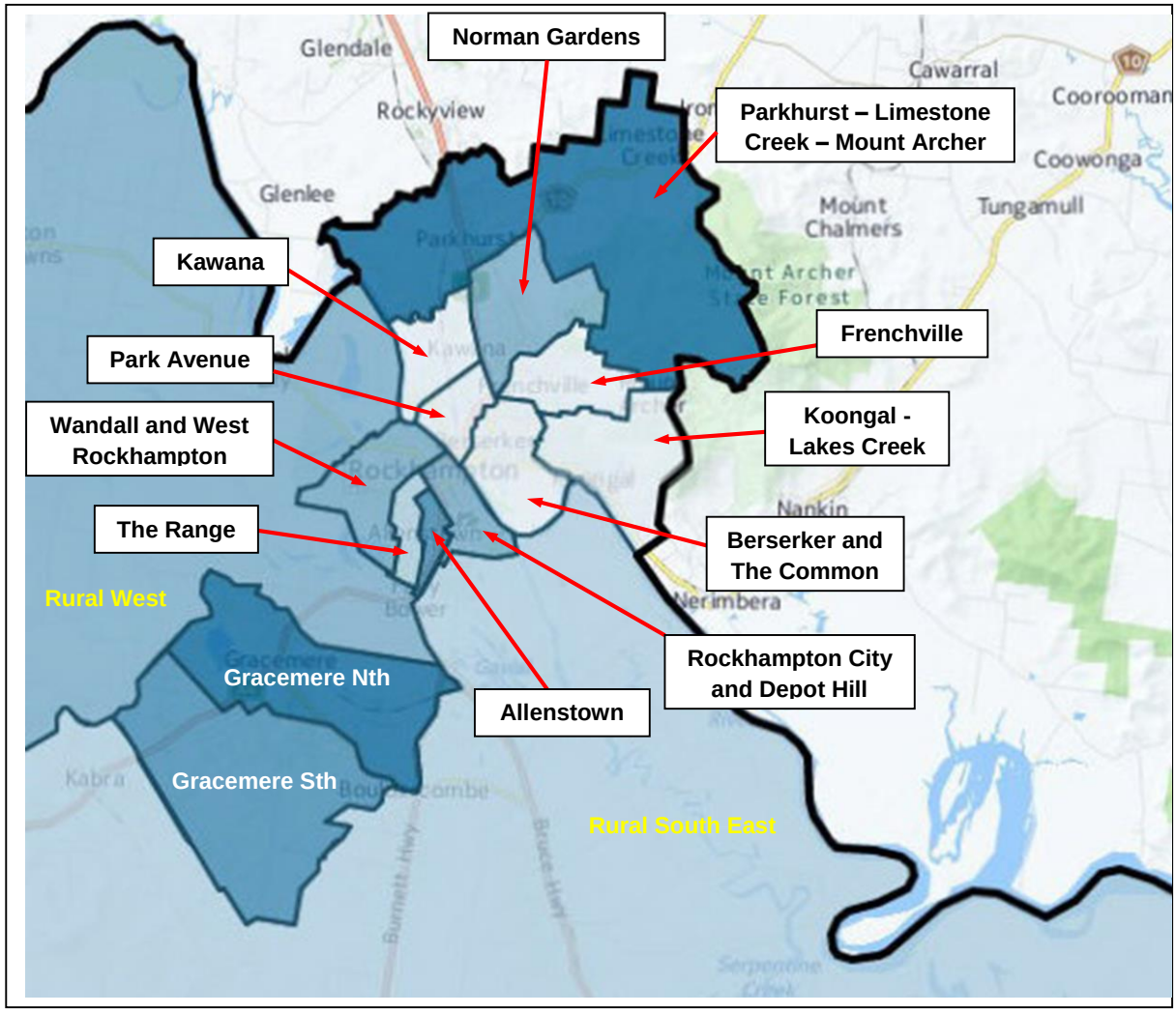
.id has used a combination of ABS level 2 and level 1 units to analyse demographic data for the Rockhampton Regional Council LGA. The forecast.id units and equivalent ABS level 2 and level 1 units are listed in Table E. As can be seen four of the forecast.id units are directly aligned to the level 2 SA units. The units used by .id are shown on Diagram 10.

Table E Rockhampton LGA and Urban Centre Population (2011)

Suburb units	2011	LGA%	Locality	2011	LGA%
Rockhampton urban			**Gracemere urban**		
Allenstown	3,013	3.8	Gracemere (North)	3,359	4.3
Berserker and The Common	7,449	9.4	Gracemere (South)	5,280	6.7
Frenchville	9,370	11.9	**Gracemere total**	**8,639**	**10.9**
Kawana	4,857	6.2	Mt Morgan District		
Koongal / Lakes Creek	5,279	6.7	Mt Morgan total	3,102	3.9
Norman Gardens	8,917	11.3	Rural		
Park Avenue	5,498	7.0	Rural South East	2,676	3.4
Parkhurst / Limestone Creek / Mount Archer	2,165	2.7	Rural West	2,889	3.7
Rockhampton City and Depot Hill	3,419	4.3	Rural total	5,565	7.1
The Range	5,480	6.9	**Rockhampton Regional Council LGA Total**	**78,936**	
Wandal and West Rockhampton	6,183	7.8			
Rockhampton urban total	**61,630**	**78.1**			

Note: Population numbers in forecast.id for the 2011 base year are derived from Estimated Resident Population from the Australian Bureau of Statistics. These differ from (and are usually higher than) Census counts as they factor in population missed by the Census and population overseas on Census night. They are generally considered a more accurate measure of population size than Census counts.

Diagram 10 Rockhampton .id Urban Statistical Divisions



Statistical Areas

The Australian Bureau of Statistics (ABS) has a four-tiered (hierarchical) geographical system used for collection and analysis of census data and other purposes. The system is based on spatial units defined under the Australian Statistical Geography Standard (ASGS). Rockhampton Regional Council, Livingstone Shire Council and Gladstone Regional Council are all within the Fitzroy level 4 (largest unit) statistical area (SA4).

Queensland Government Statistician's Office

Welcome to the Queensland Government Statistician's Office (QGSO) website. This site contains a wide range of demographic, economic and social data relating to the state of Queensland, as well as information about using statistics and the services we provide.
http://www.qgso.qld.gov.au/index.php

Geographies and Maps

Statistical geographies and maps of Queensland and its regions, including thematic maps are available at:
http://www.qgso.qld.gov.au/products/maps/index.php

Queensland Local Government Areas (LGA), 2014

Local Government Areas (LGA) are one of the non-ABS structures that sit within the Australian Statistical Geography Standard (ASGS). On 1 January 2014, the four local government areas of Noosa (S), Livingstone (S), Mareeba (S) and Douglas (S) were established as a result of recent elections held to decide on de-amalgamation. These LGA boundaries are currently in effect and were officially incorporated into the ASGS on 1 July 2014.

The table below provides individual maps for each of the 78 local government areas within Queensland, in a pdf format.

Note: (C) = City (R) = Regional Council (S) = Shire (T) = Town
http://www.qgso.qld.gov.au/products/maps/qld-lga-2014/index.php

Queensland Local Government Areas (LGA), 2011 *(archived)*
http://www.qgso.qld.gov.au/products/maps/qld-lga-asgc-2011/index.php

Queensland Local Government Areas (LGA), 2008 *(archived)*

This page has been marked as archived and there are no plans to update content. Access has been maintained for historical and research purposes.
The boundaries for each local government area can also be downloaded in a kml format.
http://www.qgso.qld.gov.au/products/maps/qld-lga-asgc-2008/index.php

Queensland concordance - LGA (ASGS 2011) and SA2 (ASGS 2011) to local government area (2014 edition)

On 1 January 2014, the four local government areas of Noosa (S), Livingstone (S), Mareeba (S) and Douglas (S) were established as a result of recent elections held to decide on de-amalgamation. These LGA boundaries were integrated into the 2014 edition of the ASGS Non-ABS structures.

The Queensland Government Statistician's Office has released a number of products on the local government area 2014 edition. Historical estimates for these local government areas have been derived using the concordance provided below.
http://www.qgso.qld.gov.au/products/maps/qld-conc-lga-sa2-2011-lga-2014/index.php

Australian Bureau of Statistics (ABS) home page
http://www.abs.gov.au/websitedbs/D3310114.nsf/home/home?opendocument#from-banner=GT

Australian Statistical Geography Standard (ASGS)
http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/1270.0.55.001Main+Features1July%20201 1? OpenDocument

INTRODUCTION
The ASGS brings together all the regions on which the ABS publishes statistics within the one framework. It will be used for the 2011 Census of Population and Housing and progressively introduced into other ABS data collections from 1 July 2011.

For support and further information about the implementation of the ASGS please refer to the ABS website at http://www.abs.gov.au/geography or email geography@abs.gov.au.

CLASSIFICATION STRUCTURES
The ASGS classification structures are split into two broads groups, the ABS Structures and the Non-ABS Structures.

The ABS Structures are hierarchies of regions defined and maintained by the ABS. The regions that comprise the ABS Structures will remain unchanged until the next Census of Population and Housing in 2016.

The Non-ABS Structures are hierarchies of regions which are not defined or maintained by the ABS, but for which the ABS is committed to providing a range of statistics. They generally represent administrative units such as Postcode and Local Government Areas.

The ABS Structures are built directly from Mesh Blocks. Non-ABS Structures are approximated by either Mesh Blocks, the Statistical Areas Level 1 (SA1s), or the Statistical Areas Level 2 (SA2s).

ABS STRUCTURES

The ABS Structures comprise six interrelated hierarchies of regions. They are:

- Main Structure
- Indigenous Structure
- Urban Centres and Localities/Section of State Structure
- Remoteness Area Structure
- Greater Capital City Statistical Area (GCCSA) Structure
- Significant Urban Area Structure.

The Main Structure and GCCSA Structure are discussed in more detail in Chapters 3 and 4. The remaining ABS Structures will be described in later volumes of the ASGS. For details of their release, see Chapter 2.

Diagram 1 (below) depicts the various ABS Structures, their component regions and how they interrelate.

Main structure units (see Table 2 below)

- Australia
- S/T is State and Territory
- Statistical Area Level 4 (SA4) - The SA4 regions are the largest sub-State regions in the Main Structure of the ASGS
- Statistical Area Level 3 (SA3) - The SA3s provide a standardised regional breakup of Australia;
- Statistical Area Level 2 (SA2) - The SA2s are a general-purpose medium-sized area built from whole SA1s;
- Statistical Area Level 1 (SA1) - The SA1s have been designed as the smallest unit for the release of Census data;
- Mesh Block - Mesh Blocks are the smallest geographic region in the ASGS and form the basis for the larger regions of the ASGS.

Diagram 1 ABS Structures

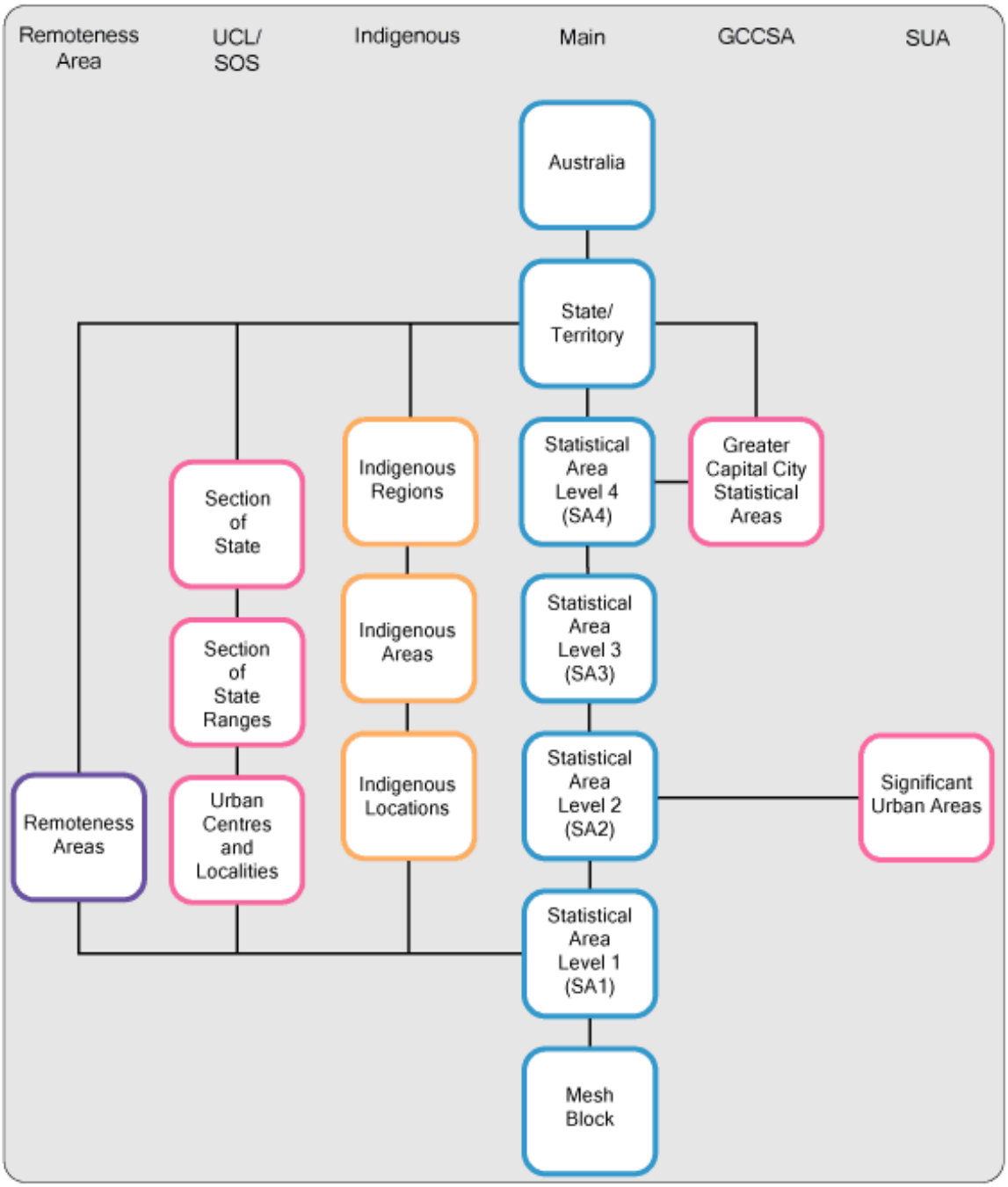


Table 2: Summary of Main and GCCSA Units at 1 July 2011

Spatial Unit	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT	OT	Aust.
S/T	1	1	1	1	1	1	1	1	1	9
GCCSA	4	4	4	4	4	4	4	3	3	34
SA4	30	19	21	9	11	6	4	3	3	106
SA3	93	67	82	30	35	17	11	11	5	351
SA2	540	435	528	172	252	100	70	112	5	2 214
SA1	17,895	13,339	11,043	4,091	5,512	1,450	541	920	14	54,805
Mesh Block	107,325	81,377	67,900	28,209	40,534	12,992	3,198	6,013	79	347,627

http://www.abs.gov.au/AUSSTATS/abs@.nsf/Latestproducts/0A9EA8C0BC932712CA257801000C6478?opendocument

NON-ABS STRUCTURES

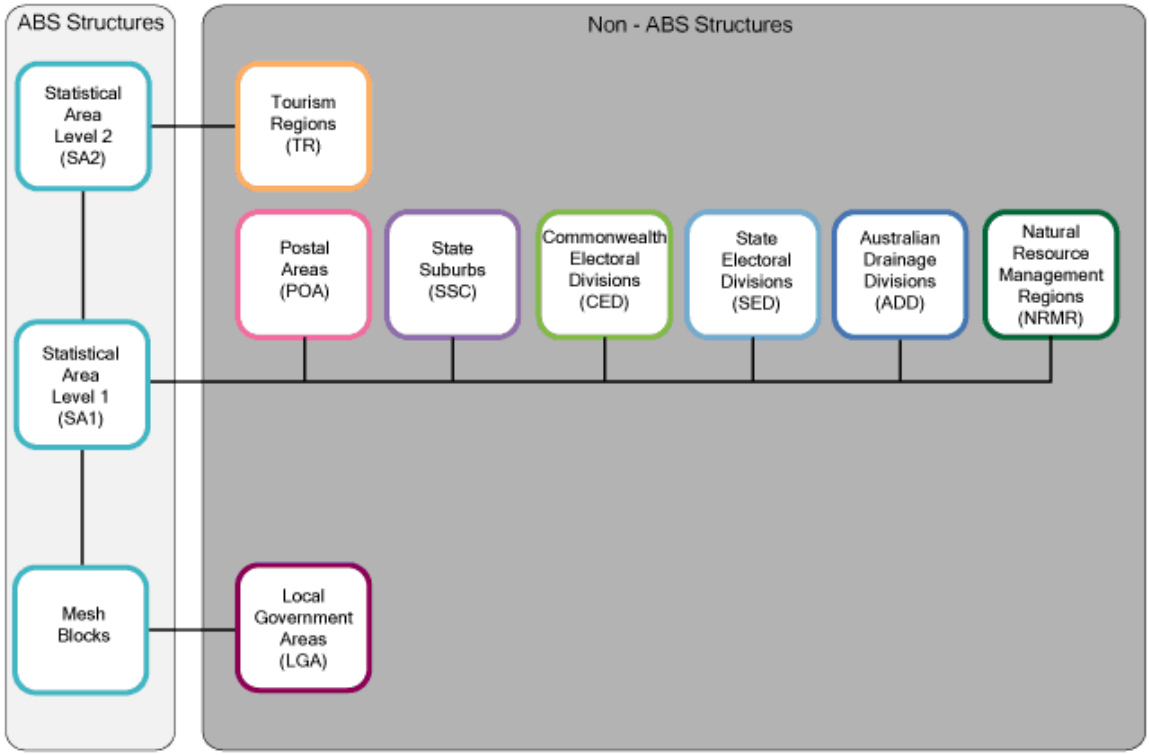
The Non-ABS Structures comprise eight hierarchies of regions which are not defined or maintained by the ABS, but for which the ABS is committed to providing a range of statistics. They generally represent administrative regions and are approximated by Mesh Blocks, SA1s or SA2s. They are:

- Local Government Areas (LGAs)
- Postal Areas
- State Suburbs
- Commonwealth Electoral Divisions
- State Electoral Divisions
- Australian Drainage Divisions
- Natural Resource Management Regions
- Tourism Regions.

These structures will be the subject of Volume 3 of the ASGS which will be released in July 2011 along with their digital boundaries, codes and labels.

Diagram 2 (below) depicts the various ASGS Non-ABS Structures, their component regions and how they interrelate.

Diagram 2 Non-ABS Structures



Brian Pink (Australian Statistician) 2010, *Australian Statistical Geography Standard (ASGS): Volume 1 – Main Structure and Greater Capital City Statistical Areas, Australia July 2011, 1270.0.55.001*, Produced by the Australian Bureau of Statistics (ABS), Commonwealth Government, Canberra.

This publication is the first volume of a series detailing the new Australian Statistical Geography Standard (ASGS). It deals with the ASGS Main Structure (Statistical Area Levels 1 - 4) and the Greater Capital City Statistical Areas.

The ASGS brings all the regions for which the ABS publishes statistics within the one framework and will be used by the ABS for the collection and dissemination of geographically classified statistics from 1 July 2011. It is the framework for understanding and interpreting the geographical context of statistics published by the ABS. The ABS also encourages the use of the ASGS by other organisations to improve the comparability and usefulness of statistics generally. (p.vii)

While there are superficial similarities between the ASGS and the Australian Standard Geographical Classification (ASGC), it is important to recognise that the two are fundamentally different and there are significant differences between their respective regions, both in their geographical extent and their conceptual foundation. As a whole, the ASGS represents a more comprehensive, flexible and consistent way of defining Australia's statistical geography than the ASGC.

The purpose of this publication is to outline the conceptual basis of the ASGS Main Structure and the Greater Capital City Statistical Areas (GCCSAs) and their relationships to each other. The digital boundaries, maps, codes and labels for each of these regions are defined and can be obtained from the ABS website free of charge at <http://www.abs.gov.au/geography>.

The main purpose of the ASGS is for disseminating geographically classified statistics. It provides a common framework of statistical geography which enables the publication of statistics that are comparable and spatially integrated. When the ASGS is fully implemented within the ABS, statistical units such as households and businesses will be assigned to a Mesh Block. Data collected from these statistical units will then be compiled into ASGS defined geographic regions which, subject to confidentiality restrictions, will be available for publication. (p.viii)
http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/D3DC26F35A8AF579CA257801000DCD7D/$File /1270055001_july%202011.pdf

Australian Statistical Geography Standard (ASGS) publications and data

http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/1270.0.55.001July%202011?OpenDocument

Queensland Concordance - SA1 (ASGS 2011) to SA2, SA3, SA4 and GCCSA (ASGS 2011)
This concordance file provides a list of Statistical Areas, Level 1 (SA1) within Queensland and their corresponding larger spatial units of Statistical Area, Level 2 (SA2), Statistical Area, Level 3 (SA3), Statistical Area, Level 4 (SA4) and Greater Capital City Statistical Area (GCCSA).
http://www.qgso.qld.gov.au/products/maps/qld-conc-sa1-2011-sa2-sa3-sa4-gccsa-2011/index.php

Statistical local areas (SLA) are another geographic unit often used in Queensland and particularly when comparing rural and urban areas. These units are based on 'old' shire and city local government areas and may be useful when analysing urban statistics. A concordance is available when using SLAs to relate the ABS statistical areas to the local government aligned statistical local areas.

Queensland Statistical Local Areas (SLA) 2011 *(archived)*
This page has been marked as archived and there are no plans to update content. Access has been maintained for historical and research purposes. The content does not necessarily represent the current view of Queensland Treasury or the Queensland Government. Where available, links to related data are provided at the bottom of this page.

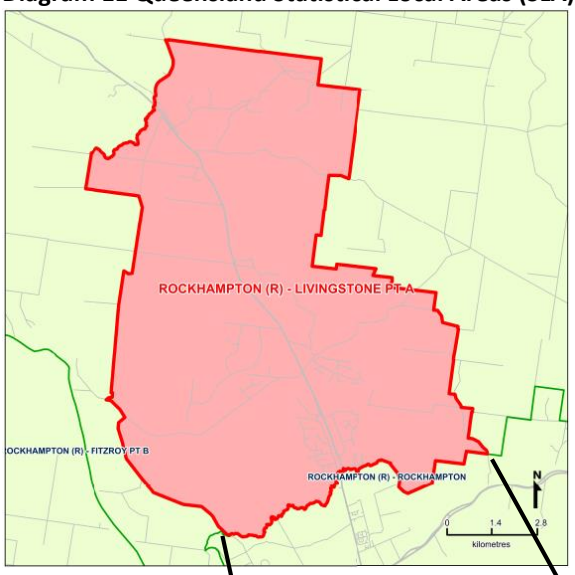
Statistical Local Areas (SLA) are one of the spatial units defined under the Australian Standard Geographical Classification (ASGC).

The ASGC is a hierarchical geographical classification, defined by the Australian Bureau of Statistics (ABS), which is used in the collection and dissemination of official statistics. The ASGC provides a common framework of statistical geography and thereby enables the production of statistics which are comparable and can be spatially integrated. From 1 July 2011, the ASGC will be progressively replaced by the new Australian Statistical Geography Standard (ASGS). As a whole, the ASGS provides a more comprehensive, flexible and consistent way of defining Australia's statistical geography than the ASGC. For further information about the transition from ASGC to the ASGS please refer to the Australian Bureau of Statistics website at http://www.abs.gov.au/geography.

The table below provides individual maps for each of the 475 statistical local areas within Queensland in a pdf format.

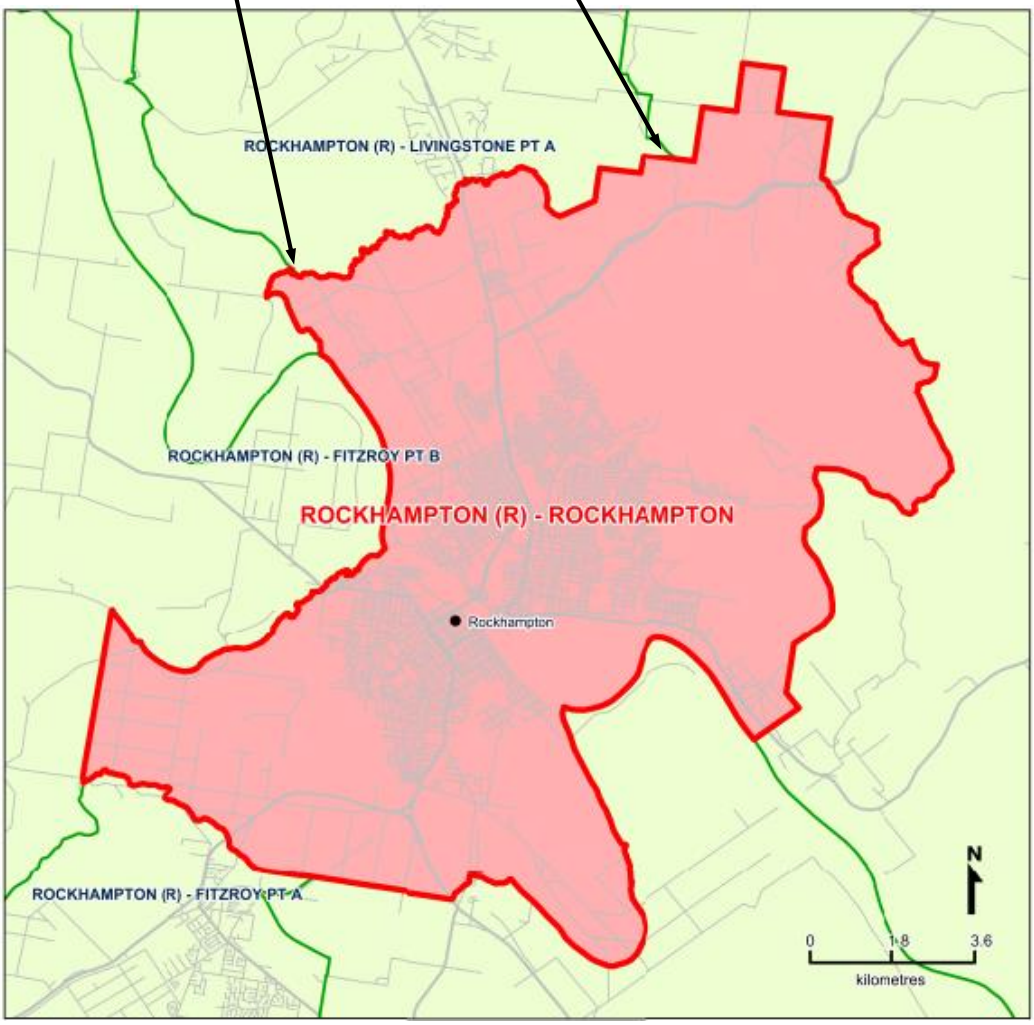
Note: (C) = City (R) = Regional (S) = Shire (T) = Town
http://www.qgso.qld.gov.au/products/maps/qld-sla-asgc-2011/index.php

Diagram 11 Queensland Statistical Local Areas (SLA), 2011 – Rockhampton (R)



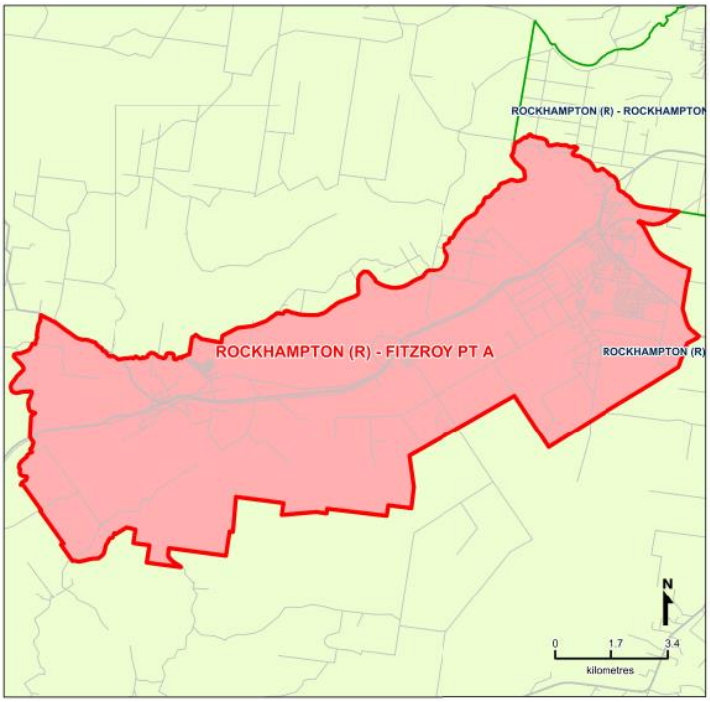
Note: Left is Livingstone Part A (ASGC 330056365) and below is Rockhampton (ASGC 330056368) in Queensland Statistical Local Area (SLA), 2011 – Rockhampton (R)

Based on the pre-2008 Livingstone Shire LGA and includes the northern Rockhampton suburbs/localities of Glenlee and Rockyview.



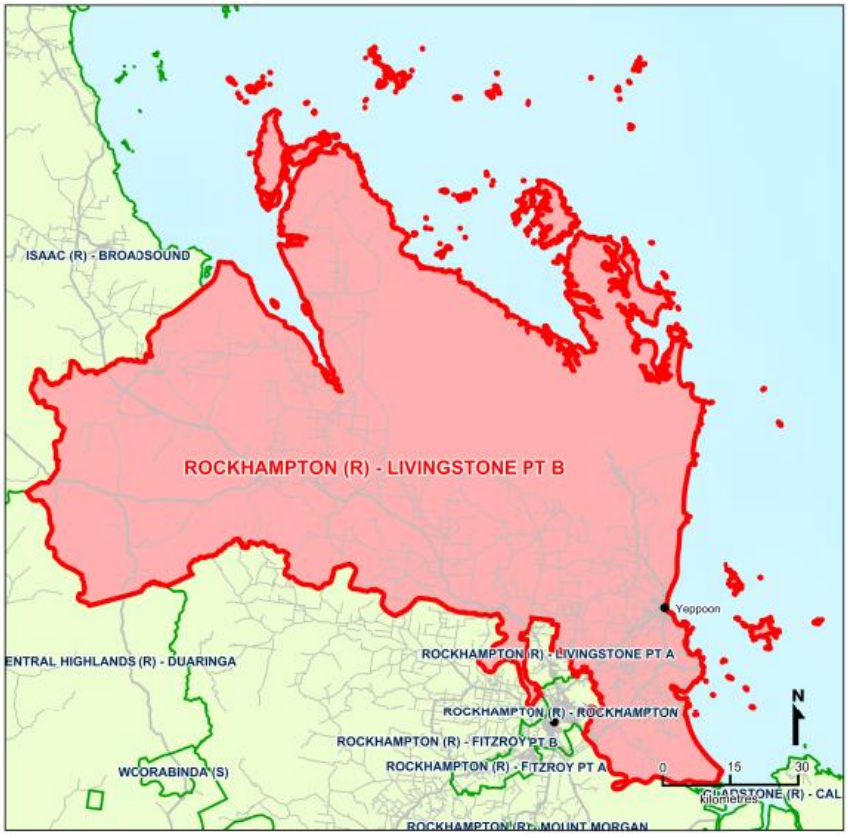
Note: Based on the pre-2008 Rockhampton City LGA and includes the Rockhampton urban area.

Diagram 12 Fitzroy Part A (ASGC 330056362) (Part of Rockhampton (R) Queensland SLA)



Note: Based on the pre-2008 Fitzroy Shire LGA and includes the Gracemere urban area.

Diagram 13 Livingstone Part B (ASGC 330056366) (Part of Rockhampton (R) Queensland SLA)



Note: Based on the pre-2008 Livingstone Shire LGA and includes the coastal stretch from Yeppoon to Emu Park.

Understanding population statistics

There are two ways the Australian Bureau of Statistics (ABS) determines the size and characteristics of the population: the five-yearly Census and quarterly estimates of the resident population.

Census

Every five years the ABS conducts the Census of Population and Housing. The census results are released as two types of population counts:

- Census count based on usual residence
- Census count based on place of enumeration.

Also available from the Census are results by counts of:

- working population
- families
- households.

Census counts: place of enumeration versus place of usual residence

The Census attempts to count every person in Australia on census night. This includes people on vessels in or between Australian ports, or on long-distance trains, buses or aircraft. It also includes people entering Australia from overseas before midnight on census night and Australian residents located in Antarctica.

The census count by place of enumeration is a count of every person based on where they are located on census night. In some cases, this is the same place as where they live; in other cases, people are counted away from home.

The census count based on usual residence is a count of people based on the place where they usually live. This information is determined from responses to the question of usual residence on the census form. The number of visitors to an area is not included in the usual residence census count.

In popular holiday destinations the census counts based on place of enumeration are normally larger than the census counts based on usual residence. For example, there were 520,686 people enumerated in Gold Coast City local government area on census night, of which only 494,501 were usual residents.

Estimated resident population

The estimated resident population (ERP) figure is the official population estimate published by the ABS, and represents the best possible estimate of the resident population.

ERP for each state and territory is updated *quarterly* using births, deaths, and overseas and interstate migration data until the next census data are available. For sub-state geographies, estimated resident population figures are updated *annually* using a model which includes administrative data that indicate population change, such as dwelling approvals, Medicare enrolments and electoral enrolments.

Initially, all estimates of resident population are released as preliminary figures, designated (p). Subsequently, the figures are revised and designated (r). Estimated resident population figures

prepared between census dates are revised using the most recent census data. These are called the 'rebased' estimates.

Determining estimated resident population figures from a census count

Estimated resident population figures in the census year are based on census usual resident counts. Table 1 outlines the process for the preparation of Queensland's final ERP for the 2011 census year.

Once a census count based on usual residence is determined, an estimation of census undercount and residents temporarily overseas, plus other smaller factors, are added to calculate Queensland's estimated resident population at 9 August 2011 (the date of the 2011 Census). This estimate is then adjusted back to arrive at an estimate for 30 June to account for those who were born, those who died, and those who moved into or out of the state during the period from 1 July 2011 to 9 August 2011.

Table 1: Adjustment components of estimated resident population, Queensland, final, 30 June 2011

Components at 9 August 2011	Persons ('000)
Census count, actual location	*4,457.9*
- plus - residents absent interstate	45.9
- less - interstate visitors	105.2
- less - overseas visitors	65.8
- equals - Census count, place of usual residence	*4,332.7*
- plus - allowance for undercount (a)	77.2
- plus - demographic adjustment	2.6
- plus - residents temporarily overseas	73.3
- equals - estimated resident population at 9 August 2011	*4,485.8*
Backdating components to 30 June 2011	
- less - births (b)	6.7
- plus - deaths (b)	3.4
- less - net interstate migration (b)	1.2
- less - net overseas migration (b)	4.5
- equals - final estimated resident population at 30 June 2011	*4,476.8*

(a) Includes Census net undercount from the 2011 Post Enumeration Survey and minor adjustments to address additional data coherence and quality matters.
(b) Component data calculated for the period 1 July to 9 August 2011.
Source: ABS 3101.0 *Australian Demographic Statistics, Dec 2012*

Difference between census counts and estimated resident population

Compared with the estimated resident population figures, the census count based on place of usual residence does not include people who did not fill out a census form, and people temporarily overseas on census night, and therefore not required to fill out a census form. Some further

differences may appear if significant change has occurred in the population and the process for estimating the resident population did not accurately reflect these changes.

When an estimated resident population figure is compared with a census count based on place of enumeration, differences are likely to appear if there were visitors present in the area and if any usual residents were away from the area on census night.

Table 2 provides a summary of population estimates available.

Table 2: Types of population estimates

Name of population estimate	Coverage	Reference date
Census count: place of enumeration	A count of every person located in an area on census night, including visitors.	Census night date
Census count: usual residence (UR)	A count of every person who usually lives in an area on census night, excluding visitors.	Census night date
Estimated resident population (ERP): census year	Official estimate of the population based on census counts of usual residents that are adjusted to account for usual residents missed in the Census. These estimates are considered final.	30 June of the census year
Estimated resident population (ERP): non-census year	Official estimate of the population based on the previous census year ERP. These estimates are considered preliminary and are subject to ongoing revision. Final ERPs for the intercensal period are established after the next Census.	Quarterly at the national, state and territory level Annually (30 June) at the sub-state level

Other counts available from the Census

Estimated working population

The census count of the working population includes all people who were employed in the week prior to the Census. Responses to the census question concerning location of workplace are used to determine the number of people working in particular locations. Along with information on how these people travelled to work, these counts are important in planning for services for the daytime populations of employment locations and for transport planning.

Number of families versus number of households

A family is defined by the ABS as two or more people, with one person aged 15 years or more, who are related by blood, marriage (registered or de facto), adoption or fostering or in a stepfamily relationship and who are usually resident in the same household. In contrast, a household is defined by the ABS as one person or two or more related or unrelated persons who usually live in the same private dwelling. The basis of a family then is either a couple relationship, a lone parent–child relationship or other blood relationship. Thus it is possible for more than one family to live in the same household and for non-family members to be household members. A non-family household is either a lone-person household or a group household. All other households are made up of different family compositions.

Number of visitors in an area

People who are visiting Australia at the time of the Census are counted regardless of how long they have been in the country or how long they plan to stay.

Since the 2001 Census, overseas visitors were those people who said they would be usually resident in Australia for less than one year. In earlier censuses, overseas visitors were those who said they would be usually resident in Australia for less than six months. The number of visitors from within Australia is separately identified in census data and a range of characteristics can be provided for these visitors. In contrast, the only data for overseas visitors are age, sex and marital status.

References

- ABS 2901.0 *2001 Census dictionary*
- ABS 2901.0 *2006 Census dictionary*
- ABS 2901.0 *2011 Census dictionary*
- ABS 3101.0 *Australian Demographic Statistics, Dec 2011*
- ABS 2914.0.55.002 *2006 Census of Population and Housing: Media releases and fact sheets, 2006*, 'The difference explained: comparing the census population count and the estimated resident population'

Further information

For further information contact Queensland Government Statistician's Office.
Visit the Australian Bureau of Statistics website (http://www.abs.gov.au/) to obtain census counts or the latest estimated resident population figures.

Suggested reading

The December quarter 2012 issue of *Australian Demographic Statistics* (ABS 3101.0) features an article, Final Rebasing of Australia's Population Estimates, September Quarter 2006 – June Quarter 2011.

A description of the range of population estimates, and their scheduled release dates, available following the 2011 Census rebasing cycle can be found in Information paper: Rebasing population estimates, Australia, 2011 (ABS 3101.0.55.001).

A detailed description of the concepts, sources and methods used by the ABS in the production of population estimates can be found in Population estimates: Concepts, sources and methods, 2009 (ABS 3228.0.55.001). Additional information on population concepts can be found in Information paper: Population concepts, 2008 (ABS 3107.0.55.006).

Information about the future of population estimates under the new statistical geography standard can be found in Information paper: Population estimates under Australia's new statistical geography (ABS 3219.0.55.001).
Last reviewed 4 March 2015
http://www.qgso.qld.gov.au/about-statistics/understanding-population-statistics/index.php

Appendix D Reef Guardian Councils

Reef Guardian Councils

The Reef Guardian Council program showcases environmentally sustainable practices undertaken by councils in the Great Barrier Reef catchment.

The program recognises the effective management and protection of the Reef requires a coordinated effort from industries, communities and all levels of government.

There are 16 councils between Bundaberg and Cooktown in the Reef Guardian Councils program undertaking a range of projects. This covers a 300,000 square kilometre area and a population of almost 900,000 people.

These councils are working together to protect and conserve the Marine Park through activities that improve the health and resilience of the Reef.

Many local residents assume their councils only deal with rates, roads and rubbish but Reef Guardian Councils are doing much more than this in an effort to protect the Great Barrier Reef.

Reef Guardian Councils undertake environmental initiatives in the following areas:

- Water management - waterways rehabilitation, water monitoring, urban stormwater treatment, wastewater and trade waste treatment
- Waste management - waste avoidance, waste reuse and recycling
- Land management - vegetation and pest management, resource assessment, erosion control, and land planning and management
- Climate change - planning and policy, energy and resource efficiency, and community education
- Community - education, capacity building and developing partnerships.

Reef Guardian Councils have an important role in planning for sustainable population growth, approving environmentally sound developments, and preparing the community for climate change impacts.

Whether Reef Guardian Councils and their communities are large or small, they are all making continuous improvements to help the Great Barrier Reef.

Program participants

- Bundaberg Regional Council
- Burdekin Shire Council
- Cairns Regional Council
- Douglas Shire Council
- Cassowary Coast Regional Council
- Cook Shire Council
- Gladstone Regional Council
- Hinchinbrook Shire Council
- Isaac Regional Council
- Mackay Regional Council
- Rockhampton Regional Council

- Livingstone Shire Council
- Mareeba Shire Council
- Townsville City Council
- Whitsunday Regional Council
- Central Highlands Regional Council

http://www.gbrmpa.gov.au/our-partners/reef-guardians/reef-guardian-councils

Gladstone Regional Council

Council commits to program to protect Great Barrier Reef

Gladstone Regional Council is committed to protecting the Great Barrier Reef through its partnership with the Great Barrier Reef Marine Park Authority (GBRMPA) Reef Guardian Council program. The innovative Reef Guardian Councils program recognises Council's environmentally sustainable practices and encourages identification of future opportunities and actions that will help to protect the Great Barrier Reef. (http://www.gladstone.qld.gov.au/reef-guardian-council)

By way of an annual action plan [2011/12], Gladstone Regional Council aims to protect and conserve the reef by focusing on five initiatives.

1. Water management - waterways rehabilitation, water monitoring, urban stormwater treatment, wastewater and trade waste treatment.

Council is currently drafting a Stormwater Management Plan for implementation across the region. The plan will incorporate various aspects including water sensitive urban design, and erosion control measures.

Council and Queensland Alumina Limited (QAL) have jointly funded a project to reduce water usage at the QAL refinery. The initiative will reduce wastewater discharge by approximately 1100kL per annum.

Council is active in maintaining significant wetlands within the Gladstone Region. Management Plans are being drafted for Byellee Wetlands as well as Wapentake to ensure the environmental values of the wetlands are protected and enhanced, contributing to the recovery of threatened species, the improvement of water quality, coastal protection and improved aesthetics and pollution control including erosion and run off control.

2. Waste management - waste avoidance, waste reuse and recycling, and recovery of energy. Council promotes diversion through Sort 'N' Save by having dedicated areas for recycling material including co-mingled cardboard, waste oil, batteries, scrap metal, clean timber, green waste, clean fill, oil drums, chemical containers (through drum muster program), and mobile phones (through mobile muster program).

Council proactively recycles bio-solids by way of incorporating green waste, composting and utilising for erosion management at the landfill site. Mulched green waste is also made available to Gladstone residents, and delivered free to schools in the region when requested.

Council is also pursuing landfill gas management.

Council is scheduled to conduct its triennial waste audit. Comparisons will be drawn with the last waste audit in 2009, when recycling had just been introduced into the smaller urban areas of our region. Since this time, recycling initiatives have also been expanded to include more remote properties.

3. Land management - vegetation and pest management, resource assessment, erosion control, and land planning and management.

As part of Council's weed seed spread prevention strategy, Council regularly facilitate pest management forums for landholders to discuss pest plant and animal issues and strategies. In addition, Council provides officers to assist in educating landholders on the identification, control and prevention of spread of pest species, as well as equipment to assist in the control of weed species. A number of spray units can be hired out to landholders. A wash down facility, constructed in Calliope, is also available.

Routine revegetation of streetscapes, gardens and old quarry and landfill sites is ongoing. Specific sites include the Northern Alignment Agnes Water Desalination Plant access road, intake/discharge works and Seventeen Seventy reservoir site.

Successful erosion control of Council's operations can be attributed to the provision of engineered sediment control diagrams developed in conjunction with Council's Design Services Department, as well as up-to-date training.

Council continues coastal restoration activities with the help of Volunteer Groups.

4. Climate change - planning and policy, energy and resource efficiency, and community education

Council has employed the services of Planet Footprint to monitor Council's electricity and fuel consumption. This service enables the identification of areas where abatement measures can be implemented. Energy efficiency tips are also distributed to the local community through the Council's information distribution tools.

Council also provides guidelines to householders in order to best adapt to climate change including housing orientation, cyclone ratings, insulation and window spacing.

5. Community - education, capacity building and development of partnerships
Council has developed partnerships with many organisations, to implement environmentally sustainable practices, including:

- Natural Resource Management Groups;
    - Fitzroy Basin Association,

    - Burnett Mary Regional Group.
- Port Curtis Integrated Monitoring Program;
- Central Queensland University;
- Queensland Alumina Limited (QAL); and
- Central Queensland Local Government Association.

Council and the Gladstone Region Environment Advisory Network (GREAN) facilitate an annual forum for industry, local business and community groups, on topical environmental issues.
To help raise awareness of the importance of protecting the environment Council is involved in many community projects including revegetation, Toad Buster programs, Community Weeding Days, Earth Hour and Clean-Up Australia Day. Council also provides sewerage treatment plant, landfill and waste transfer station site visits for schools. Pest Plant & Noxious Weed education sessions have been held with local schools.

Council's environmental activities:

- **Ecofest** - Gladstone Regional Council runs Ecofest each year to celebrate environmental initiatives of businesses and industries to raise awareness on how residents can be more environmentally friendly.
- **Earth Hour** - Council participates annually in Earth Hour, a World Wildlife Fund (WWF) initiative encouraging communities to turn off their lights between 8.30pm and 9.30pm on the last Saturday in March.
- **Clean Up Australia Day** - Gladstone Regional Council helps coordinate Clean Up Australia Day, held on the first Sunday of March, by providing trucks and staff to collect and dispose of the rubbish collected during the day.

For further information on the Reef Guardian Program, click here to access the Great Barrier Reef Marine Park Authority website: http://www.gbrmpa.gov.au/our-partners/reef-guardians

Livingstone Shire Council

Livingstone Shire Council showed its commitment to protecting the Great Barrier Reef by partnering with the Great Barrier Reef Marine Park Authority (GBRMPA) to officially become a Reef Guardian Council on 27 March 2014.

Livingstone Shire Council - ORDINARY MEETING AGENDA 11 FEBRUARY 2014 (pp.16-19)

12 REPORTS
12.1 REEF GUARDIAN COUNCIL PROGRAMME
File No: EM11.12.3
Attachments: 1. Attachment 1 - Memorandum of Understanding between Livingstone Shire Council and the Great Barrier Reef Marine Park Authority *(Under Separate Cover)*
2. Attachment 2 - Livingstone Shire Council Reef Guardian Council Action Plan 2013-14 (pp.20-24)
3. Attachment 3 - Terms of Reference for the Steering Committee for the Reef Guardian Council Programme (pp.25-29)

Responsible Officer: Ian Dare - Manager Community Wellbeing
Brett Bacon - Director Community and Planning Services
Author: Matthew Baldock - Senior Sustainability Officer

SUMMARY
The Reef Guardian Council programme promotes Great Barrier Reef protection through education, information sharing and involvement in on-ground actions. Livingstone Shire Council was previously a member of the programme in 2007 up until amalgamation with other local government areas in 2008. Many Reef Guardian Council activities occurred within the area now under the jurisdiction of Livingstone Shire Council during Rockhampton Regional Council's membership of the programme between 2010 and 2013. Now as a new entity, Livingstone Shire Council will need to go through a particular process to again be part of the Reef Guardian Council programme. This involves Livingstone shire Council signing a Memorandum of Understanding with the Great Barrier Reef Marine Park Authority, which includes the development of an Action Plan. The Action Plan for 2013-14 has been developed and will incorporate a number of existing activities as well as some new ones.

Livingstone Shire Council will also need to have an elected member on the Reef guardian Council Steering Committee which essentially guides the Reef Guardian Council programme. Approval is sought from Council to join the Reef Guardian Council programme, approve the Action Plan 2013-14, and nominate a representative for the Reef Guardian Council's Steering Committee.

In September 2004, the Reef Guardian Councils concept was presented by officers of the Great Barrier Reef Marine Park Authority at the Local Government Association of Queensland conference in Mackay. Following this conference, approximately forty Great Barrier Reef catchment Councils were contacted regarding the concept and councils supportive of the concept agreed to participate in a Steering Committee to guide the development of the Reef Guardian Council programme. Livingstone Shire Council was on the Steering Committee. The Steering Committee consequently developed the Reef Guardian Council programme. The former Livingstone Shire Council participated as an inaugural member council in the programme from 2007 until amalgamation with Rockhampton City, Mount Morgan Shire and Fitzroy Shire Councils in 2008.

Following amalgamation, Rockhampton Regional Council commenced the process of joining the Reef Guardian Council programme and became a member in 2010. Rockhampton Regional Council developed and implemented four Action Plans between 2010 and 2013.

Many of the actions incorporated under the Action Plans were carried out within the area now under the jurisdiction of Livingstone Shire Council. With de-amalgamation of Livingstone Shire Council from Rockhampton Regional Council commencing in 2014, advice was provided by the Great Barrier Reef Marine Park Authority that if Livingstone Shire Council chose to be part of the Reef Guardian Council programme, it would need to join as a new member, including developing its own Action Plan.

Livingstone Shire Council Action Plan

The Livingstone Shire Council Action Plan 2013-14 contains actions Council will undertake during the financial year. The Action Plan has been developed based on consultation with relevant Council departments and the Great Barrier Reef Marine Park Authority. The selection process for the 2013-14 actions was based upon:

1. An assessment of existing projects that will continue; and
2. New actions that can easily be undertaken with available resources.

The Action Plan is a living document and can be amended at any time especially when activities cease or new ones commence.

The following provides a summary of some of the activities incorporated into the Livingstone Shire Council Action Plan 2013-14:

1. ***Pest Management Planning***: Development of the Livingstone Shire Council Pest Management Plan.
2. ***Pest Management Education and Awareness Raising***: Includes:
   - facilitation of pest management workshops (x2) for landholders to discuss pest plant and animal issues and strategies; provision of local government extension officers to landholders;
   - raising community awareness of pest species through mechanisms such as the Weedbusters programme and shows; and participation in collaborative partnerships with natural resource management bodies to reduce the impacts of pest species.
3. ***Planning for Environmental Protection***: Ensuring measures are included in the new Planning Scheme which contribute to protecting the environment such as through the use of relevant zonings, overlays and planning scheme policies.
4. ***Environmental Education Programmes***: for example, Reef Guardian Schools.
5. ***Community Participation Programmes***: such as Weedbusters, World Wetlands Day, and National Tree Day.
6. ***Sewer Main Upgrades and Refurbishment***: Relining and associated works, refurbishment and design and augmentation and duplication of sewer mains throughout the region.
7. ***Gundoo Junior Rangers project***: in partnership with the Fitzroy Basin Elders Group, Fitzroy River and Coastal Catchments and the Great Barrier Reef Marine Park Authority, facilitate the Rangers' involvement in a series of environmental projects around the region.
8. ***Protecting Biodiversity in Capricorn Coast Ecosystems***: A project which addresses threats to important natural coastal ecosystems, with the aim of strengthening the natural vegetation linkages from the hills to the beaches, improving the ecological health of waterways and increasing native biodiversity.
9. ***Future Leaders Eco Challenge***: An event to be held for Reef Guardian School participants, potentially at Kinka Wetlands for 2014.
10. ***Kinka wetlands protection***: Development and implementation of a suite of projects to protect and enhance the wetlands. A discussion paper on management and use options for the wetlands has been produced by the Central Queensland University. Community engagement/events to be carried out as well as funding sourced for on-ground works.

For further detail of all actions contained in this financial year's Action Plan please refer to the Action Plan 2013-14 document (Attachment 3)

BUDGET IMPLICATIONS
There will be no additional budget on top of already allocated budgets for each project.

Livingstone Shire Council - ORDINARY MEETING AGENDA 24 MARCH 2015
12.9 REEF GUARDIAN COUNCIL ACTION PLAN 2014-15 (pp.172-191)
The following provides a summary of some of the activities incorporated in the Livingstone Shire Council Action Plan 2014-15:
(a) ***Pest management planning***: Development of the Livingstone Shire Council Pest Management Plan.
(b) ***Pest management education and awareness raising***: Includes: facilitation of pest management workshops (two workshops) for landholders to discuss pest plant and animal issues and strategies; provision of local government extension officers to landholders; raising community awareness of pest species through mechanisms such as the Weedbusters programme and shows; and participation in collaborative partnerships with natural resource management bodies to reduce the impacts of pest species.
(c) ***Planning for environmental protection***: Ensuring measures are included in the new Planning Scheme which contribute to protecting the environment such as the use of relevant zonings, overlays and planning scheme policies, including newer mechanisms such as biodiversity corridors and environmental offsets.
(d) ***Environmental education programmes***: for example, Reef Guardian Schools.
(e) ***Community participation programmes***: such as Weedbusters, World Wetlands day, National Tree Day.
(f) ***Sewer main upgrades and refurbishment***: Relining and associated works, refurbishment and design and augmentation and duplication of sewer mains throughout the region.
(g) ***Gundoo Junior Rangers projects***: In partnership with the Fitzroy Basil Elders Group, Fitzroy River and Coastal Catchments and the Great Barrier Reef Marine Park Authority, facilitation of the Rangers' involvement in a series of environmental projects around the region.
(h) ***Australian Marine Debris Initiative***: Network of volunteers and partners monitoring the impacts of marine debris along the coastline. Actions involve clean-up events, data collection and tracking debris to the source. In collaboration with partners, specific Source Reduction Plans are created to prevent marine debris from entering the environment in the first place.
(i) ***Kinka Wetlands protection***: development and implementation of a suite of projects to protect and enhance the Wetlands. A community survey and management planning have occurred with a Management Plan and various community engagement events to be carried out. Funding has been sourced to carry out initial on-ground works such as feral pig control, weed eradication and the first stages of rehabilitating the former quarry through bunding works, revegetation etc. Investigations are currently occurring into interpretive signage and the placement of bird hides at the Wetlands.
(j) ***Plastic Bag Free Initiative***: Initiative to ban single-use plastic bags throughout the Livingstone Shire. Business Plan developed and survey of local businesses to gauge interest in trialling bio-recyclable bags. A trial in businesses is to commence later in 2015. The State government has been lobbied to consider the development of a waste strategy which amongst other things considers the possible use of legislation to reduce or ban use of plastic bags.

For further detail of all actions contained in this financial year's Action Plan please refer to Attachment One, Draft Action Plan 2014-15.

Rockhampton Regional Council

RRC Facebook (7 October 2013)

Council has long been a supporter of the Great Barrier Reef and today made a decision to continue its support of the Reef Guardian Councils' program.

Some of the new activities include school students taking part in a Future Leaders Eco Challenge on North Keppel Island, and the Gundoo Junior Rangers getting a boost with our support of a series of environmental projects.

Check out the Council agenda (8 October) to view the new action plan for the coming year.
https://www.facebook.com/RockhamptonRegionalCouncil?fref=nf

11.2 REEF GUARDIAN COUNCILS' ACTION PLAN 2013-14 (pp.169-175)
File No: 1171
Attachments: 1. Attachment 1 - Reef Guardian Councils' Action Plan for Rockhampton Regional Council 2013-14
Responsible Officer: Brett Bacon - Strategic Manager Land Use
Robert Holmes - General Manager Regional Services
Author: Matthew Baldock - Senior Environmental Sustainability Planner

BACKGROUND
The Reef Guardian Councils' programme promotes Great Barrier Reef protection through education, information sharing and involvement in on-ground actions. The focus of the programme is on improving land management practices and water quality in the Great Barrier Reef catchment. It centres on what Council is doing under five categories: land management, water management, waste management, community involvement and climate change. Rockhampton Regional Council has been a member of the programme since 2010 and has previously developed and implemented three Action Plans, for 2010-11, 2011-12 and 2012-13. As an obligation of the Reef Guardian Councils' programme, Council is required to submit an Action Plan for 2013-14.

Upon advice from the Great Barrier Reef Marine Park Authority, the Action Plan 2013-14 has been developed to reflect all actions being carried out by the current Rockhampton Regional Council. After 1 January 2014, the continuing Rockhampton Regional Council will retain its membership of the Reef Guardian Councils' programme and the Action Plan can be amended accordingly to reflect the activities the continuing Council will undertake. The new Livingstone Shire Council will need to go through a separate process to join the Reef Guardian Councils' programme and develop its own Action Plan.

DISCUSSION
The Action Plan 2013-14 contains actions the continuing Council will undertake during the financial year. The Action Plan has been developed based on consultation with relevant Council departments and the Great Barrier Reef Marine Park Authority. The selection process for the 2013-14 actions was based upon:

1) existing projects that will continue; and

2) new actions that can easily be undertaken with available resources.
A number of actions contained in previous Action Plans will continue through to 2013-14. The following provides a summary of some of these activities:

(i) ***Pest Management Planning:*** Review, update and ongoing implementation of the Rockhampton Regional Council Pest Management Plan.

(i) ***Pest Management Education and Awareness Raising***: Includes: facilitation of pest management workshops (four) for landholders to discuss pest plant and animal issues and strategies; provision of local government extension officers to landholders; raise community awareness of pest species through mechanisms such as Weedbusters week and shows; and participate in collaborative partnerships with natural resource management bodies to reduce the impacts of pest species.

(ii) ***Vegetation Management:*** Roadside and other infrastructure vegetation assessment and management through the *Nature Conservation Act 1992* and *Vegetation* Management *Act 1999* permit requirements.

(iii) ***Planning for Waterways/Wetland Protection:*** such as ensuring appropriate measures are included in the new Planning Scheme through the Biodiversity Overlay.

(iv) ***Environmental Education Programmes***: for example, Reef Guardian Schools.

(v) ***Community Participation Programmes:*** such as Weedbusters, National Recycling Week and National Tree Day.

(vi) ***Fitzroy Partnership for River Health:*** Information gathering and sharing for improved management of waterways between stakeholders such as Department of Natural Resources and Mines and the Fitzroy Basin Association.

(vii) ***Sewer Main Upgrades and Refurbishment:*** Relining and associated works; refurbishment and design and augmentation and duplication of sewer mains throughout the region.

A number of new activities will be incorporated into this year's Action Plan. These include the following:
(i) ***Rockhampton Airport Stormwater Improvement and Upgrade***: Includes Apron environmental control of stormwater and replacement of existing stormwater infrastructure.

(ii) ***Moores Creek Environmental Amenity Paper***: Identifies and discusses the environmental features of Moores Creek (including vegetation, weeds, physical geography, natural linkages and potential projects) based on field surveys and desktop analysis.

(iii) ***Gundoo Junior Rangers Project***: in partnership with the Fitzroy Basin Elders Group, Fitzroy River and Coastal Catchments and the Great Barrier Reef Marine Park authority, facilitate the Rangers' involvement in a series of environmental projects around the region. The first project is the Creek Discovery Day focusing on keeping Moores Creek healthy.
(iv) ***Protecting Biodiversity in Capricorn Coast Ecosystems***: Project which addresses threats to important natural coastal ecosystems, with the aim of strengthening the natural vegetation

linkages from the hills to the beaches, improving the ecological health of waterways and increasing native biodiversity.
(v) ***Facilities Management***: Trial of voltage power optimisation units at City Hall, Pilbeam Theatre and Dooley Street Depot to achieve greater energy efficiency within the organisation.

(vi) ***Future Leaders Eco Challenge***: An event to be held at the North Keppel Island Environmental Education Centre for Reef Guardian School participants with activities on sustainable land management, an interpretive ecosystem walk, reef management and zoning, human impacts on the reef and marine pests.

(vii) ***Queensland Bushfire Risk Planning Project***: Administered by the Department of Community Safety with the Rockhampton Regional Council area identified as a case study area for input to the development and implementation of a new methodology for determining bushfire hazard in Queensland. A fuel load assessment has previously been carried out at various sites throughout the region and involved field surveys and desktop analysis of bushfire loads in those areas.

For further detail of all actions contained in this financial year's Action Plan please refer to Attachment 1 – Action Plan 2013-14.

BUDGET IMPLICATIONS
There will be no additional budget on top of already allocated budgets for each project.

LEGISLATIVE CONTEXT
There are no legislative consequences arising from this report.

LEGAL IMPLICATIONS
There are no known legal implications that arise from this report.

STAFFING IMPLICATIONS
Staff members have been scheduled to carry out the actions contained in the Action Plan as part of their usual operational programmes. Staff resources from the Natural Resource Management Unit will manage the Reef Guardian Councils' programme on behalf of Council until 31 December 2013. From 1 January 2014 a staff resource will need to be allocated to manage the programme on behalf of the continuing Rockhampton Regional Council

CONCLUSION
A new Reef Guardian Councils' Action Plan for 2013-14 has been developed, which further consolidates Rockhampton Regional Council's membership of the programme and its contribution to the protection of the Great Barrier Reef Marine Park. Approval is sought from Council for the Action Plan.

Appendix E Climatic Extremes – Rockhampton and Qld

1855/1856 - A dry period. The first settlers (Charles Archer and party) arrived at Gracemere to find the lagoon dried out

1857 - Rain commenced in January and was sufficiently heavy to cause a considerable fresh in the Fitzroy River but did riot rise high enough to flood

1859 - The first real flood witnessed by the new settlers

1862 - Heavy rains fell late into March and at the beginning of April. Most rain fell in the Dee and the Don catchments causing a rise in the Dawson as well as in the Fitzroy River catchment.

Rainfall measured at Rockhampton was; 30th March (at 9 a.m.) – 31mm, 31st March – 308mm, 1st April (7 a.m.) – 262mm including 568mm in thirty-nine hours

On the 1st of April the Fitzroy River reached its highest level being 6 metres above the highest spring tides.

The flood waters arrived at Yaamba and were reported in the Rockhampton Bulletin. "Yaamba, 5th April. 1862 - An unprecedented flood in the Fitzroy River has so far established the high-water level of this township, and it would be well that surveyors, who are paid by the job, would again inspect some of the farms only recently laid out on Alligator Creek. …Traffic is at a standstill."

Very heavy rain had fallen in the Rockhampton and Gladstone districts and many casualties occurred through trying to swim creeks and flooded watercourses. 2,000 sheep drowned about 2 km from Rockhampton and the back country was under water for miles. The Archers sailed 12 km from their Gracemere station to within a short distance of Rockhampton. The new saw-mill was covered. The water extended from the town as far as the eye could see and joined with the Yeppen Yeppen (Yeppen Lagoon), which rose 5.5 metres above its normal level. The wharves and boat sheds were covered.

21st April - Fresh in the river caused by the late heavy rains considerably decreased and the river almost at its ordinary level. The lower part of the Dawson was very high and the whole of the country between Rannes and the Dee River, a distance of 23 km, was flooded. At the township of Rannes the rise in the river was about 12 metres. In the vicinity of Knebworth the Dawson rose 9 metres above its usual height. Rapid rise at Yaamba and the river reached its greatest height being within 1.8 metres of the level of the township about twelve hours earlier than at Rockhampton.

1863 January - 16th, Heavy flood on the Fitzroy River with severe floods on the Fitzroy River on the 24th. 16th December, copious rains with the Fitzroy River at Yaamba swollen.

1864 - Referred to as 'the big flood' for many years and became a period from which to date nearly everything. It happened before the big flood, or just after, as the case might be. The rain began, on Christmas Eve 1863 and continued intermittently for many weeks. If not raining the days were hot and steamy. The streets turned to mud and were a great nuisance.

Towards the end of January the rain began to fall incessantly and continued for a week. By that time the flats about the town were flooded and the river had risen considerably. On the 10th of February, the river appeared to have attained its maximum height being 1.5 metres over tie wharves.The next day the rain commenced again and the river rose once more.

18th February – Fitzroy River within a metre of the summit of the second bank with low-lying huts, boathouses and other buildings submerged.

The flood waters increased and by the 20th of February had risen over all known flood levels, the previous highest being in 1859. The news from the country districts included deaths by drowning and cases of hunger and privation from being caught between two uncrossable rivers or creeks.

The flood water remained almost stationary for a day or two and then began to recede. By the end of February the country was beginning to be passable.

On the 4th of March heavy rain set in again and continued for nearly a week. There is no doubt this rain was also general and the country having received such a soaking only a week or two before the flood waters soon rose.

By the 16th of March the rains had ceased for some days and the day was bright and clear in Rockhampton. However higher floods were recorded in the Dawson (3.4 metres higher than previous flood levels), Mimosa, and Brown Rivers than ever known before and the up-country water was coming down in great force. The water was 3.4 metres over the Fitzroy-street wharf and nearly up to the level of a few weeks previously.

On March 17th the rain set in again, and that night the wind blew with terrific force, while the rain fell in torrents.

Rockhampton was indeed in a terrible state. The river was 4.1 metres over the Fitzroy Street wharf, and about 0.5 metres higher than the February flood. The homeless and flooded-out residents found temporary accommodation in the New Gaol and Church of England. Boats were sent out to rescue people who were surrounded by the floods. From outside places news came in every day of the devastation caused by the swift waters. There were no telegraphs in those days and news had to come by letter or word of mouth. At Yaamba the river had risen about 20 metres and was 0.6 metres over the banks. The town was submerged.

The flood reached its highest point on the 19th of March, when it was 4.4 metres over the Fitzroy Street wharf.

Unofficial rainfall for January was 240mm, February 385mm and a portion of March 298mm a total of 826mm. Those who remember that terrible season will be inclined to think the quantity here given is much below what really fell.

On 21st March at Knebsworth at least 24 metres of water in the Dawson River and nearly all the town flooded.

26th March - Fitzroy River commenced to fall. Brown River1.2 km wide. Dawson River flood at Knebsworth being 3.6 metres higher than any previous occasion.

The flood of 1864, though it brought considerable destruction in life and property, was of service to settlers in various ways. It showed that much of the lower portion of the town was subject to inundation., though not to an equal extent.

The same experience was gained in the country districts, however the country being very sparsely populated it was not till 1875 that the lesson of where to build with safety was thoroughly learned.

1865
1866
1867

1868
12th to 15th February: Rockhampton: Fresh in river during last three days. At Yaamba on 12th the river was 1.2 metres higher than 1867 and higher on the 14th Eighteen—mile Island submerged; Alligator, Lion, Ten-mile and Deep Creeks all in flood. At high tide on 14th Queen's wharf was 1 metre under water.

14th February – Rockhampton. The Fitzroy rose 2.7 metres and still rising with the Dawson bank high.

24th February - Mails between Rockhampton and Clermont detained by floods.

1869
10th April: Rockhampton: Fitzroy rising steadily; wharves almost under water. Dawson and Mackenzie Rivers bankers and country traffic stopped.

1870
31st January Rockhampton: Floods at Cawarral with humpies near the crushing machine carried away and the store completely flooded. The claims considerably damaged. 2nd February Diggers leaving the field found Moore's Creek impassable.

2nd February - Rockhampton: Heavy rains; greater portion of the country along the river flooded; wharves submerged; steam punt unable to ply between the north and south banks of the river; railway line damaged at Stanwell.

2nd to 4th February - Country all about Rockhampton under water for miles; Alligator Creek 3km wide and 800 metres of railway line under water.Most of Yaamba and the country around it under water. Bonnie Doon and other creeks impassable. Fitzroy River still rising and communication with the north suspended.

4th February - Rockhampton: 250 metres of Wiseman's Bridge carried away by flood waters; railway bank gave way in several places. Fitzroy River within 1.2 metres of the highest flood mark and still rising. In one direction only the tops of telegraph posts visible for the distance of 2km. Rainfall from the 29th January to the 3rd February amounted to 570mm.

1871
28th February Rockhampton: Lagoons in the neighbourhood 0.5 metre higher than during the flood last summer.

1872
24th February: Rain abundant in Springsure district; Nogoa and Comet Rivers, also all creeks, flooded.

13th December Rockhampton: Strong fresh in Fitzroy River; Dawson also flooded.

1873
1874

1875 - The end of January and the beginning of February were marked by showery weather, the rain early in February being heavier in the western country than in town putting a strong fresh in the Fitzroy River.

20th February: Heavy rains produced serious floods and extensive losses. All coach and railway traffic stopped.

On the 21st of February rain fell heavily in Rockhampton with a strong south-easterly gale blowing. That night and the following day the rain increased as did also the violence of the wind doing damage to many houses by blowing away sheets of iron. 200mm of rain fell in the twenty-four hours which ended at 9 a.m. on the 23rd of February.

After that the rain continued to fall in deluging showers. The low-lying portions of the town were flooded and the creeks and rivers in the country districts began to rise. On the morning of the 25th the rain gauge was overflowing at 8 a.m., the rain pouring down in torrents. It was estimated that 380mm had fallen in the preceding twenty-four hours.

By the evening of that day the river had risen to within 600mm of the 1864 level and the highest point it had reached since that memorable occasion. The whole country was by this time flooded and boats were out in all directions rescuing people from their houses.

It was estimated that 860mm of rain fell in four days and by the 26th the river had risen to within 450mm of the 1864 flood. On the outskirts of the town it was estimated the waters had risen 250mm higher than in 1864 as a result of the greater local fall. The rain ceased on the 26th of February.

It will be understood that this flood in the river and in the environs of Rockhampton was entirely due to local rain, probably swollen by the creeks pouring into the river in the vicinity of Yaamba. Water from the up-country water not having yet come down.

4th March - The water on the Dawson River rose 4.8 metres above the 1864 flood. The railway was submerged for miles and loss of life in all parts of the colony.

On the 5th of March the river at Rockhampton attained its highest mark being about 76mm below that of 1864. The velocity of the current was eight and a-half knots an hour. Meanwhile the flood at the Dawson had disappeared and a pair of yoked bullocks were found entangled in the branches of a tree 15 metres above the river bank showing the height of the waters. The stench arising from the dead animals and the mud was almost unbearable and an immense amount of sickness followed.

When the people at the Dawson saw the immense body of water—supposed to be so much greater than had ever been known before—it was thought that great danger existed of Rockhampton being swept away. Messages were sent to town to prepare people for the worst, and advising the people to take to the hills in time. Fortunately, a narrow gorge exists in the river above Yaamba, known as "The Gap" where the hills are so close together that the volume of water going through is restricted, unless it rises to a. great height. The flood waters at the entrance to this gorge are so dammed back that the water at that end is said to be 3.4 metres higher than it is at the lower end of The Gap. As already mentioned, this gorge, to a considerable extent, has been the salvation of Rockhampton so far as floods are concerned.

1876
1877

1878 26th March - Great floods in the Comet River district

1879

Note: * indicates information was extracted from Queensland Flood History(by decade) available at http://www.bom.gov.au/qld/flood/fld_history/index.shtml

***1884** 7th February - Fitzroy River in flood with water 0.6 metres above the wharves at Rockhampton

1885 was the driest year on record

1888 - 17th and 18th February [*18th January Floods at Rockhampton. 540mm of rain fell in three days] 530mm fell in forty-eight hours causing the low-lying places about Rockhampton

and the wharves to be covered to a depth of a 1 metre. The heavy rain appeared to be confined to a narrow strip in a north-westerly direction, Marlborough reporting 440mm in the two days. Mount Morgan coach washed away, mails lost, and a passenger drowned.

In 1890 and 1893 extensive flooding occurred throughout Queensland.

1890 - nearly 1,400mm falling during the first three months of the year. January was wet almost throughout with considerable rain falling in the country districts. The rivers and creeks ran freely and put a small flood in the Fitzroy, the water frequently rising over the wharves. The rain was so distributed, however, that nowhere was there particularly heavy flooding, except about Marlborough, where the downpour was excessive. The low-lying portions of the town and suburbs were covered with water at intervals, particularly towards the end of the month, but no great inconvenience to traffic occurred. On the 2nd of February the flood waters from the neighbourhood of Marlborough came down in sufficient volume to cover the Railway Wharf. At the end of February heavy rains occurred in the west, flooding the rivers and damaging the railway. This flood water came down at the beginning of March and covered the wharves again, but the water all got away in a few days and normal conditions existed once more, though showery weather continued. About the middle of March rain fell heavily, and increased in volume towards the end of the month, particularly in the western districts. The river rose again, and on the 26th of March, the water was 0.6 metres over the Railway Wharf. The previous night 230mm of rain fell at Emu Park and everything was flooded there. Wonderfully heavy rains had fallen at the head of the Dawson and at the railway crossing that river was 11.5 metres deep, which looked like a big flood. The rivers throughout the division continued to rise, and by the 28th of March the Dawson valley was covered with water to a width of 11 km with the river at Rockhampton meanwhile rising steadily. The Comet River rose 4.7 metres over the rails. On the 3rd of April the flood on the Dawson River reached the high water mark of 1875, but it rose no higher, and soon after it began to recede.

The flood at Rockhampton attained its greatest height on the 7th of April, when it was found by the Town Surveyor (Mr. T. Parker) to be 580mm higher than the flood of 1875. Captain Haynes, of the Saurian, who was here during all the floods, made out that the flood of 1864 was 100mm higher than the flood of 1875, and that of 1890 50mm higher than 1875. When at its height the flood was 2.8 metres below the decking of the Fitzroy Bridge at its highest arch. At 7.45 a.m. on the 9th of April one of the cylinders of the Fitzroy Bridge gave way to the pressure of the flood waters and canted over. No one was hurt, fortunately, but traffic was suspended for many months while Messrs. Burns and Twigg repaired the damage. The bridge gave way after the flood had attained its, highest point.

*2nd February: Floods in Fitzroy River

*1891 10th June - Floods in Fitzroy River

1893 - February 15th the Fitzroy rose 2.4 metres twelve hours from local rain, the wharves being covered to a depth of 1 metre. The river continued ro rise till the 17th, when the flood was 2 metres below that of 1890. The waters then receded, and though the river rose again when the waters from the Dawson and Isaacs came down the flood was of little importance.

1896 - Towards the end of January very heavy rain fell in Rockhampton, the last week of that month showing about 610mm. The low-lying ground was quickly flooded and the Fitzroy rose rapidly. By the 5th of February all marks except those of 1864, 1875 and 1890 had been covered and the water continued to rise. News from the country showed that the rains had been general and in some places unprecedented. The Dawson attained its greatest height on the 5th of February, when the water was 1.7 metres higher than the floods of 1875 and 1890.

[*1896 1st February: Heavy floods at Clermont and 6th February heavy floods at Rockhampton]

On the 10th of February 1896, the flood reached its height in Rockhampton when it was about 150mm over the flood of 1890 and about 100mm higher than the inundation of 1864 breaking all known records. It was stated by residents at the back of the Range that the flood there attained a height of at least a 250mm greater than that of 1890. At Yaamba the water reached 350mm above all previous known floods.

Though some people hold the opinion that the flood of 1864 was the highest on record, the evidence is clear and convincing that the flood of 1896 exceeded in height and volume all previously known floods in the Fitzroy. This was proved not only at Rockhampton, but at Yaamba and the Dawson. Of course a considerably enlarged area was flooded in 1896, but fortunately the fatal casualties were not numerous.

1898-1903 - This five-year drought was one of the most severe ever experienced. It affected practically the whole of Australia but most persistently the coast of Queensland and inland areas of New South Wales and South Australia and extended to central Australia. The drought consisted of a series of very dry years with only some areas receiving good rains. In 1901-02 dry conditions throughout Queensland resulted in a severe drought that had a devastating effect on stock, crops, and pastures which had survived the dry conditions of previous years. Sheep numbers were reduced by about half, and cattle numbers by more than 40%. Average wheat yields per hectare were reduced to a quarter of their usual levels and sugar production was significantly reduced.

***1908** 15th March - Flood in the Fitzroy River. 19th March, Rockhampton wharfs submerged. 25th March, Fitzroy River in flood at Yaamba
April – Yaamba, Fitzroy River in flood. More rain than is usual in April

***1917** 1st to 9th January - Flood in the Fitzroy River at Rockhampton within 1 metre of highest on record. 1st to 13th March Mackenzie and Fitzroy Rivers and adjacent streams, including Theresa Creek (Clermont) flooded

On 21 January 1918, an unnamed Tropical Cyclone crossed the coast just north of Mackay. It was very large in size and the destructive winds extended down to Rockhampton resulting in structural damage to some buildings and two deaths when two men were drowned in

Rockhampton. The cyclone brought widespread flooding to the region and caused Rockhampton's record flood of 1918. . (https://en.wikipedia.org/wiki/Rockhampton)

***1918** January - Minor flood at Rockhampton on the 17th followed by 19th to 22nd January - unprecedented flooding in the Fitzroy River with severe flooding at Rockhampton (9.7 metres[1]) with two or three lives lost. 20th to 26th April - Minor flooding in parts of the central -west. Damage to railway lines and bridges
Note: [1] the first time reports are in river height rather than height above the wharves. Later reported as the highest recorded flood reaching 10.11 metres on the Rockhampton gauge

***1921** January - From 13th to 16th local floods occurred between Townsville and Rockhampton, and between Rockhampton and Clermont

***1922** February 1st to 10th - Flood in the Fitzroy River with parts of Rockhampton submerged

1922 March/April - Flooding in central Queensland from cyclone Charles

1925-1926 - One of the harshest droughts in Queensland occurred in 1925-1926. In some areas this drought was more severe than that of 1898-1903. It began with the failure of the 1925-26 summer rains. Most of Queensland had heavy stock and crop losses. Some temporary relief rains fell in September 1926, but drought conditions quickly returned until substantial rain fell in December 1926.

***1928** April 20th to 24th more serious inundations in the Lower Fitzroy and Dawson rivers and streams in the Dawson Valley. Floods in the latter were of a disastrous and probably unprecedented nature. A house was washed away at Walmul in the Dee River area and the seven occupants drowned. One or two other drowning fatalities were reported. The railway bridge over the Dee River at Mt Morgan was swept away and property damage was extensive.

At Rockhampton several houses were evacuated and 1,000 bales of wool were submerged. Rail traffic north from Gladstone and west from Rockhampton was completely dislocated and mail trains delayed for several days. Extensive damage occurred to railway property at Rannes and the State Coal Mine at Baralaba collapsed. There was heavy damage to crops and loss of stock. At one station alone 3,000 head of cattle were washed away.

1927-1936 - This was a period of almost continuous rain deficiency in the central and southern interior with short breaks occurring in 1930, 1931, 1932 and 1933

***1929** February 20th to 24th - floods in the Lower Fitzroy River. Rockhampton recorded a record rainfall of 775mm in 3 days. All traffic was dislocated for several days and low lying parts of Rockhampton were inundated. Considerable damage to roads and bridges at Rockhampton and Mt Morgan. Two men were drowned, one at Rockhampton and one at Gracemere.

***1933** July 10th to 12th - minor flooding in many localities in coastal districts from Bowen to Gladstone, over a greater part of the Central division. At Rockhampton 290mm fell in 24 hours to 0900 on 11th and low lying areas were submerged. Road damage was extensive. Rail traffic between Rockhampton and Gladstone and from the Rockhampton to Longreach, Clermont, Blackall and the Dawson Valley was interrupted.

***1937** February 12th - flooding in the Rockhampton-Mt. Larcom-Mt. Morgan districts and between Emerald and Clermont. 15th, local flooding between Emerald and Clermont.

***1940** March – along with the far north, the Fitzroy River system was most affected. Peaks were at Riverslea on 23rd, (second highest on record), at Yaamba on 26th , and at Rockhampton on 27th. Saltbush Park, on the headwaters of the Connors River and Funnel Creek, reported waters 8 kilometres wide and levels above the February flood height. Apart from cyclonic activity, periods of strong south-easterly weather prevailed along most of the coast and over waters eastward.

***1941** January - In central and southern interior districts of the State there was much flooding in low lying areas along streams and creek branches. Rivers at high to flood levels included the Fitzroy

***1946** March - under cyclonic influences extensive heavy to record flooding occurred during the first part of the month in all tropical coast streams between Cooktown and Rockhampton back to the adjacent highlands and eastern Carpentaria. Widespread damage, soil erosion and protracted traffic disabilities were reported

On 2 March 1949, an unnamed Tropical Cyclone crossed the Capricorn Coast, just south of Keppel Sands, and followed the Fitzroy River into Rockhampton. The cyclone caused significant damage, and resulted in the deaths of two Rockhampton men who were both blown from their rooftops while attempting repairs. Widespread damage and destruction was recorded in the city of Rockhampton, and surrounding towns. (https://en.wikipedia.org/wiki/Rockhampton)

***1950** December - Due to the heavy flood rains of November all streams in the central , southern and south-west interior were carrying heavy flood run-off early in December. By the end of the first week all these streams had reached their peak heights and were falling.
Peak heights were recorded on 6th at Boolburra on the Dawson River and at Riverslea on the Fitzroy River. Near record to record floods caused extensive stock losses particularly in the central interior parts of the State

***1951** January - Heavy rains from the end of the 1st week to the end of the 3rd week caused the first flood period. Record or near record flood levels were reported in all tropical coast streams and in the Burdekin and Fitzroy river systems. Traffic dislocation was extensive. All rail routes and major traffic arteries were cut. In the Fitzroy River system torrential rains of over 1,000mm on the headwaters of the Isaac River were mainly responsible for the extensive flooding in Rockhampton.

At Riverslea on the Fitzroy River a record height was recorded on 18th, the previous record being in April 1928. In the second heavy rain period in the final week of the month further rises were reported in the central interior, Burdekin and Fitzroy systems.

1951-1954 - After record heavy rains over most of the state in 1950, a severe dry spell set in from February 1951. Low rainfall, grass fires and bushfires over an area of about 6 million ha and cold winters caused one of the worst droughts in Queensland. Heavy losses occurred in the pastoral and dairying industries, with some of the worst affected parts being the southern coast to Port Curtis and the tropical interior. Crop and dairy production were the lowest since 1926. These conditions continued until April 1952. Another short period of dry weather followed in some areas in 1953. By January 1954 the drought extended from the Gulf of Carpentaria to the Darling Downs and west to the border with South Australia.

***1954** February - Sustained and extensive widespread flooding in all main river systems reached record or near record levels in the Burdekin , Fitzroy and southern interior streams. Dislocation of traffic routes was fairly general. At least 10 people lost their lives and hundreds of families had to be evacuated , particularly in the Rockhampton and Mackay areas. The flood rains of 8th to 13th caused very high floods in the Fitzroy River system. The second highest heights on record occurred at Boolburra on 15th, Riversleigh on 15th and Rockhampton on 19th. Following the heavy cyclonic rains in the south eastern quarter of the State from 19th to 22nd, the Dawson River at Theodore rose to a record height on 19th.

***1955** January - Rockhampton experienced local flooding on 23rd when storm rains entered some houses and business premises. Washaways of the railway line delayed trains for some hours

***1956** February - Floods were practically state-wide during the month. High flood levels were reached in the lower Fitzroy River at Riverslea on 20th and Rockhampton on 23rd , following serious floods in the Dawson and Nogoa catchments. On the Dawson River, Theodore reached a record height on 14th and Taroom recorded the highest level since 1890 on 11th.

***1958** April - Heavy flooding was reported in the Mackenzie River and lower reaches of the Fitzroy River as a result of near record river heights in the northern tributaries , notably Funnel Creek and the Connors and Isaacs rivers. On 3rd, Funnel Creek at Saltbush Park reached the highest reading for 40 years, whilst Royles on the Mackenzie River reported a record height at 11.00 on 6th. Near record levels were recorded at other stations in the northern catchments of the Fitzroy basin. Peak heights in the lower reaches occurred at Riverslea on 10th, at Yaamba on 12th and at Rockhampton on 13th. Some low lying yards in Rockhampton were I metre under water and traffic around the city was disrupted.

***1959** February - The whole of the Fitzroy catchment experienced moderate flooding which commenced on 17th and moved to the lower reaches by the end of the month. Peaks on the Fitzroy River were at Riverslea on 24th and Rockhampton on 27th

Two hundred sheep were lost in the severe flood on Capella Creek, and many Clermont families were evacuated when Sandy Creek became a 500 metre wide torrent after 275mm of rain within 12 hours in the surrounding area. Clermont was isolated with flooding described as the worst since the 1916 disaster. Water entered low lying yards in parts of Rockhampton at the peak of the flood

***1960** May - Flash flooding, causing damage to crops and communications, resulted from very heavy rain on 25th at Cawarral, 40 kilometres north of Rockhampton

1964-1966 - Drought conditions prevailed mainly in the south-west and south of Queensland from late 1964 to late 1965. In 1965 areas around the central coast, central highlands, and the Curtis districts were also affected. Good rains in December 1965 and January 1966 brought some relief, but dry conditions persisted in the far south-west and certain coastal areas as late as August 1966.

***1966** September - As a result of some heavy thunderstorms local flash flooding occurred at Mt. Morgan and Rockhampton

1969-1970 - Drought was widespread throughout Queensland, and was harshest in the western border districts and on the central coast.

***1971** February - During the month moderate to major flooding occurred in most rivers in the south-east quarter of Queensland. Inundations in varying degrees Rockhampton.

***1973** December - Heavy flood rains during the latter part of the month from Cyclone Una, caused major flooding and extensive traffic disabilities in coastal streams between Gladstone and Rockhampton. Moderate to major flooding occurred inland throughout the central and northern reaches of the Fitzroy River catchment

***1977** November - Very isolated local flash flooding occurred along the Central Coast just north of Rockhampton for a short period about the middle of the month

***1978** February - Heavy flood rains in late January and early February brought moderate to major flooding to many streams within the Burdekin and Fitzroy river basins. The major flood which occurred on the Fitzroy River brought extensive flooding to Rockhampton where the Fitzroy peaked at 8.15 m on Sunday 12th , causing some property damage

1979-1983 - This extensive drought affected nearly all of eastern Australia. Drought had been severe through the south-west of Queensland from 1979 and some areas of Queensland recorded their record lowest rainfall.

***1981** May - Local flooding occurred to most streams from Rockhampton to Proserpine during 21st and 22nd. Two boys drowned near Rockhampton when motor vehicles were washed off flooded creek crossings. Taffic delays along coastal routes till streams subsided after about 24 hours

***1983** May - Widespread rain during the last week of April and the first few days of May caused extensive flooding in the southern and southeast districts. Minor to moderate continued in the Burnett River till 5th. The Fitzroy River had major flooding at Rockhampton from 11th to 13th and a final flood warning was issued on 16th. On the 21st flood warnings were issued for the Mackenzie River with major flooding expected at Taroom on 23rd. Major to moderate flooding continued in the Fitzroy River basin till 31st

***1988** March - Major flooding extended along the lower Mackenzie and Fitzroy rivers early in the month as a result of heavy rainfalls associated with Cyclone Charlie. The Fitzroy at Rockhampton peaked at 8.4m on the 11th with extensive inundation of low lying areas of the city. Only two floods have been higher this century (February 1918 and February 1954). The Bureau provided accurate river level predictions for Rockhampton about 8 days in advance

***1989** April - Cyclone Aivu brought heavy to flood rains to the Burdekin coast. Major flood levels were reached in the northern headwaters of the Fitzroy River basin in the Connors River and Funnel Creek on the 5th causing a subsequent flood peak of 6.0m at Rockhampton on the 15th with minor to moderate flooding

***1991** January - Extensive flooding occurred in coastal and inland areas during January. The Fitzroy River at Rockhampton peaked at 9.15 metres on Monday 7th then fell slightly before rising to a second peak of 9.30 metres on Saturday 12th, the third highest flood on record since readings began in about 1860. Extensive damage was associated with the flooding with approximately 300 houses flooded above ground level, and about 50 houses above floor level. Road and rail links were completely cut and the airport closed to fixed wing aircraft. Four deaths were attributed to the flooding. Extensive losses and damage was incurred by the rural sector. The total damage bill for the Rockhampton flood has been estimated at more than $10 million. Continued heavy rainfalls caused by ex-Cyclone Joy along coastal areas caused minor to moderate flooding to develop in all coastal streams between Cairns and Gladstone during January

1990-1996 - The drought that gripped most of Queensland in 1991 was quite severe. The initial onset of dry conditions commenced in mid-1990, and the partial failure of the 1990-91 summer rains in the south of the state resulted in serious deficiencies in a number of areas. From March 1991 rain declined across the state and by November 1991 the area from Bundaberg to the New South Wales border and west to Charleville was in the grip of drought. Although the tropical

areas had received above average rainfall during the summer of 1990-91, by October 1991 this area had suffered eight consecutive months of below average rainfall. The first area to receive drought relief was the Proserpine-Sarina district. This drought continued to affect many areas of Queensland into 1996.

***1998** September - Flood warnings were current at the beginning of the month for the Dawson, Mackenzie and Isaac Rivers and tributaries. The Isaac River at Connors Junction peaked at major flood level on the 1st. Moderate flood levels peaked in the Mackenzie River at Coolmaringa on the 4th and the Dawson River at Newlands on the 6th. Because of the timing of the peaks, the Fitzroy River peaked at minor flood levels at Riverslea on the 6th and Yaamba on the 8th

***2000** November - Very intense rainfall was recorded along the coast between Mackay and Rockhampton on 17 November. This caused moderate flooding in the Connors and lower Isaac Rivers during the following week. Some rises were also recorded along the Mackenzie River but flood levels along the Fitzroy River remained below minor flood levels

***2003** February - Heavy rains of 100 to 200 mm were recorded in the 24 hours to 9am 6th February in the Rockhampton area and southwest. This resulted in rapid river rises and moderate to major flooding in the lower Dawson River downstream from Baralaba and the Don River. Local flash flooding was reported in a number of small creeks and tributaries. Major flooding continued in the Dawson River for several days with only minor to moderate flooding occurring in the Fitzroy River with the minor flood peak had passing through Rockhampton on the 13th

***2008** January - Very heavy rainfall occurred along the Queensland coast between Townsville and Mackay and inland over the coalfields and central interior between the 10th and 20th January. The most pronounced and intensive rainfall occurred over the Nogoa River and Theresa Creek (Fitzroy Basin) and the Belyando River (Burdekin Basin). Bogantungun recorded a 4-day rainfall total of nearly 700mm. The Fairbairn Dam near Emerald was filled and Emergency Services evacuated many houses in and around the city of Emerald about the 20th of January as floodwaters from the Nogoa River surrounded and isolated the city. Some evacuations also occurred a week later on the Fitzroy River around Rockhampton about the 28th. In February a monsoon low originating in the Gulf of Carpentaria traced a path southeast across southern Cape York Peninsula on the 11th of February to intensify (996 hPa) over land just southwest of Mackay on the 12th of February. The system brought very heavy rainfall to areas between Townsville and Rockhampton between the 11th and 15th and produced widespread 24-hour rainfall totals of between 100mm to 200mm, including isolated heavier rainfalls in excess of 300mm. Rainfall from the low pressure system extended further southward to the Fitzroy River where 24-hour rainfalls of between 50mm to 150mm were recorded, resulting in major flooding that peaked at Rockhampton a week later on the 25th of February.

***2010** February - Rainfall associated with the monsoon trough produced moderate flooding in the Connors and Isaac Rivers during the final days of January. Moderate flood levels continued

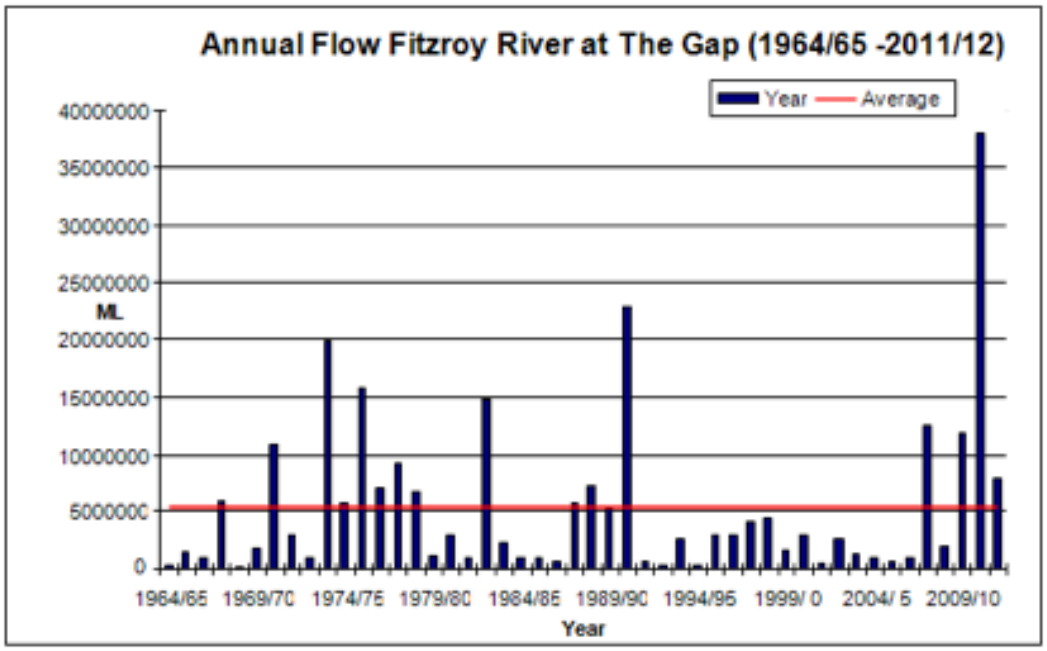
downstream causing minor flooding in the Tartrus area on the Mackenzie River. Flood levels at Rockhampton remained well below the minor flood level

***2010** December - An exceptional rain event occurred over eastern Queensland during the week of the 23 to 29 of December 2010 causing river flooding along the Tropical Queensland coast before producing record breaking flood levels particularly through the Central Highlands, Wide Bay and Burnett and the Darling Downs and Maranoa. An active monsoon trough intensified to be named Tropical Cyclone Tasha early on the morning of the 25th. Tasha was short lived crossing the coast south of Cairns around 5am on the 25th and then continued southwest movement through the interior as a tropical low. The system is most notable for the intense rainfall it then produced over Queensland's central and southern interior and about the southeast coast. It was this heavy rainfall that brought about record breaking floods in the Fitzroy River catchment and other parts of Queensland. Record flood heights were recorded in a number of towns in the affected areas including Emerald on the Nogoa River, Rolleston on the Comet River and Theodore on the Dawson River while high levels were recorded at Taroom, Moura and Baralaba (Dawson River) and (9.20 metres)

***2013** January - Ex-Tropical Cyclone Oswald causes record flood levels along the east coast with 3 day rainfall totals in excess of 1,200mm. Record major flooding is recorded in the Burnett, Baffle, Boyne, Kolan and Calliope Rivers and at Laidley on Laidley Creek. Major flood levels were recorded throughout the Fitzroy catchment including at Rockhampton. February, major flooding is recorded in the Fitzroy River

***2015** February - Tropical Cyclone Marcia and a preceding trough brought significant rainfall to coastal catchments south of Rockhampton, with major flood levels recorded in the Don River catchment (Fitzroy Basin), upper Burnett, Mary and Sunshine Coast catchments.

On 20 February 2015, Tropical Cyclone Marcia hit Rockhampton as a Category 3 system after crossing the Capricorn Coast at Shoalwater Bay as a Category 5 cyclone. While Yeppoon and the rural communities to the north of Yeppoon such as Byfield and Woodbury were hardest hit, the eye of the cyclone travelled directly across the city of Rockhampton as it moved southwest. A vast number of trees and power lines were brought down, and many properties in Rockhampton were damaged by the strong wind gusts. (https://en.wikipedia.org/wiki/Rockhampton)



Note: Source is https://www.fitzroyriver.qld.gov.au/improving-water-quality/practices.

Assessing the regional economic impacts of flood interruption to transport corridors in Rockhampton

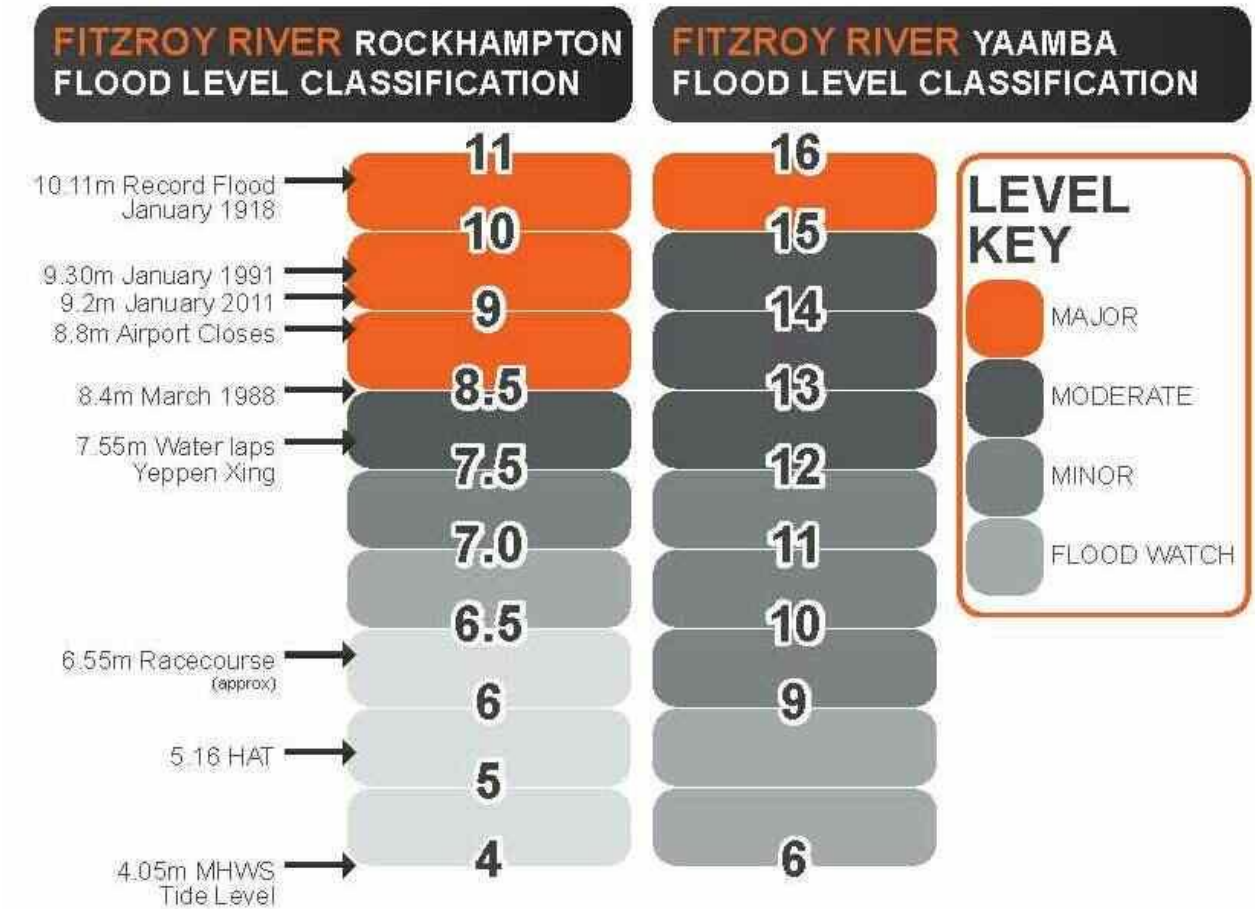
This study examined the economic costs of transport corridor closures at Rockhampton, Central Queensland, as a consequence of peak flooding in the Fitzroy River during January 2011.

This project was supported by research funds from CQUniversity Vice Chancellor's Flood Initiative and Capricorn Tourism & Economic Development Ltd (trading as Capricorn Enterprise).

Data for the project has been supplied by Capricorn Enterprise, the Queensland Department of Transport and Main Roads (QTMR), and the Rockhampton Regional Council (RRC).

Particular thanks go to Mary Carroll (Capricorn Enterprise), Evan Pardon and Peter Priem (RRC) and Vincent Garty (QTMR) for helping to supply information and data for the project. Additional thanks go to the local business representatives who participated in the business survey.

http://www.rockhamptonregion.qld.gov.au/Your_Community/Regional_Profile_and_Statistics



Note: Source is http://www.rockhamptonregion.qld.gov.au/Our_Region/Disaster_Management/Disasters/Flood_ Season

Climate Change Reports – Fitzroy region

1

EAST COAST NORTH

The East Coast North sub-cluster comprises NRM regions in the central part of the eastern seaboard of Australia. The area encompasses important headwater catchments for a high proportion of Australia's population i.e. South East Queensland (SEQ).

The sub-cluster area has a predominantly sub-tropical climate, with regional variations such as some tropical influences in the north.

Key messages

- Average temperatures will continue to increase in all seasons (*very high confidence*);
- More hot days and warm spells are projected with *very high confidence*. Fewer frosts are projected with *high confidence*;

- Rainfall changes are possible but unclear;
- Increased intensity of extreme rainfall events is projected, with *high confidence*;
- Mean sea level will continue to rise and height of extreme sea-level events will also increase (*very high confidence*);
- A harsher fire-weather climate in the future (*high confidence*);
- On annual and decadal basis, natural variability in the climate system can act to either mask or enhance any long-term human induced trend, particularly in the next 20 years and for rainfall.

Exploring climate change projections

Rainfall
Rainfall changes are possible but unclear. On annual and decadal basis, natural variability in the climate system can act to either mask or enhance any long-term human induced trend, particularly in the next 20 years.

Past rainfall trends
Observed trends in rainfall are not as significant as is the case for temperature. There is no long-term trend in annual rainfall for the sub-cluster during the available record. Year to year variability is strongly influenced by the El Niño-Southern Oscillation.

Rainfall projections
Natural climate variability is projected to remain the major driver of rainfall changes in the next few decades. Models show a range of results, with little change or decrease being more common particularly in winter and spring.

Impact assessment in this region should consider the risk of both a drier and wetter climate.

Temperature
Average temperatures will continue to increase in all seasons (*very high confidence*).

Past temperature trends
Temperatures have increased over the past century, with the rate of warming higher since 1960. Mean temperature increased between 1910 and 2013 by around 1.0°C. The recent decades have been the warmest on record for both daily minimum and daily maximum temperatures in the sub-cluster.

Temperature projections
There is *very high confidence* in continued substantial increases in projected mean, maximum and minimum temperatures in line with our understanding of the effect of further increases in greenhouse gas concentrations.

For the near future (2030), the annually averaged warming across all emission scenarios is projected to be around 0.4 to 1.3°C above the climate of 1986–2005.

By late in the century (2090), for a high emission scenario (RCP8.5) the projected range of warming is 2.5 to 4.7°C. Under an intermediate scenario (RCP4.5) the projected warming is 1.2 to 2.6°C.

Extreme temperature
More hot days and warm spells are projected with *very high confidence*. Fewer frosts are projected with *high confidence*.

Extreme temperatures are projected to increase at a similar rate to mean temperature, with a substantial increase in the temperature reached on hot days, the frequency of hot days, and the duration of warm spells (*very high confidence*).

Frost risk days (minimum temperatures under 2°C) are expected to decrease across the cluster (*high confidence*).

Some parts of the sub-cluster could experience around two to three times the average number of days above 35°C under intermediate emission scenarios by late in the century.

Extreme rainfall and drought
Increased intensity of extreme rainfall events is projected, with *high confidence*.

Understanding of the physical processes that cause extreme rainfall, coupled with modelled projections, indicate with *high confidence* a future increase in the intensity of extreme rainfall events, although the magnitude of the increases cannot be confidently projected.

Time spent in drought is projected, with *medium confidence*, to increase over the course of the century.

Marine and coast
Mean sea level will continue to rise and height of extreme sea-level events will also increase (*very high confidence*).

For 1966 to 2009, the average rate of relative sea-level rise for Australia, from observations along the coast, was 1.4 mm/year.

There is *very high confidence* in future sea-level rise. By 2030 the projected range of sea-level rise for the cluster coastline is 0.08 to 0.18 m above the 1986–2005 level, with only minor differences between emission scenarios. As the century progresses, projections are sensitive to concentration pathways. By 2090, the intermediate emissions case (RCP4.5) is associated with a rise of 0.30 to 0.65 m and the high emissions case (RCP8.5) a rise of 0.44 to 0.87 m. Under certain circumstances, sea-level rises higher than these may occur.

Late in the century warming of the East Coast coastal waters poses a significant threat to the marine environment through biological changes in marine species, including local abundance, community structure, and enhanced coral bleaching risk. Sea surface temperature is projected to increase in the range of 2.1 to 3.6°C by 2090 under a high scenario (RCP8.5). The sea will also become more acidic, with acidification proportional to emissions growth.

Other
A harsher fire-weather climate in the future.

Fire weather: There is *high confidence* that climate change will result in a harsher fire-weather climate in the future. However, there is *low confidence* in the magnitude of that change because of the significant uncertainties in the rainfall projection.

Evaporation: Potential evapotranspiration is projected to increase in all seasons as warming progresses (*high confidence*).

Humidity: There is little change in relative humidity for the near future, but *medium confidence* in a decrease later in the century.

(http://www.climatechangeinaustralia.gov.au/en/impacts-and-adaptation/east-coast/)

1a

Climate Change and Agriculture: a study for the Fitzroy Basin Association

Detailed Summary

In this study we developed potential 'best' and 'worst' case climate change impact distribution models for future cropping and grazing using species distribution modelling software. MaxEnt predicts the probability that an area will be suitable for agricultural production based on changes in the climate variables most appropriate for each commodity.

We chose the most appropriate climatic variables based on consultations with farmers, industry, NRM representatives and published literature.

We considered two Global Climate Models (GCM) under the current (baseline) climate and the A1FI emission scenario for 2025 and 2035 representing: 1) a 'worst' warmer and drier future (CSIRO Mk3.5) and 2) a 'best' cooler and wetter future (CSIRO MIROC-M).

This study found that Agriculture in the Fitzroy Basin will be impacted by climate change.

- Cropping suitability is predicted to shift and contract from the west to the east.
- Cropping will be less affected under the cooler-wetter GCM.
- Grazing suitability is predicted to shift and contract south and east.
- Enterprises in the west are likely to experience stronger climate change impacts.
- Rainfall (May-October) was the most important predictor of cropping.
- Average annual temperature was the most important predictor for grazing.

Understanding the spatial changes to agriculture under future climates can inform land management decisions at various scales.

https://terranova.org.au/repository/east-coast-nrm-collection/climate-change-and-agriculture-a-study-for-the-fitzroy-basin-association

2a

Practical Adaptation to Climate Change in Regional Natural Resource Management: Queensland Case Studies – Fitzroy Basin Report - Part A – Production and natural resource indicators in beef systems under climate change conditions.

Published by: Department of Natural Resources and Water, Queensland Climate Change Centre of
Excellence, Toowoomba, 2007.

Australian Greenhouse Office, Sinclair Knight Merz, Queensland Murray Darling Basin Committee, Desert Channels Queensland, Fitzroy Basin Association and South East Queensland Western Catchments August 2007

Project overview

The project involved seven regional natural resource management (NRM) organisations - including the Fitzroy Basin Association (FBA), Queensland Murray-Darling Basin Committee (QMDC) – and the Queensland Department of Natural Resources and Water. It was coordinated by Sinclair Knight Merz.

The project has two main objectives, as follows:

1. Improve understanding of the implications of climate change for regional NRM;
2. Develop tools and processes that help regional NRM organisations incorporate climate change impacts, adaptations and vulnerability into their planning processes.

The project was divided into three main stages:

Stage A. This stage identified components of participating region's natural resource system that were more vulnerable to climate change. The key steps were to develop the 'conceptual mapping' workshop process, conduct a literature review to document climate change projections, impacts and adaptive mechanisms for each participating region and then to run 'conceptual mapping' workshops in each of these regions.

Stage B. This stage completed a series of regional case studies which explored climate change impacts on one or a small number of components of the natural resource system that were more vulnerable to climate change. The case studies were designed to provide more objective information on climate change impacts and vulnerability and will be used to support analysis of how regional NRM processes can incorporate climate change considerations.

Results of the case study for FBA are reported here and will be used by each of the participating NRM regions to complete Stage C.

Stage C. The final stage, in which lessons from the case study will be used to help develop tools and processes (e.g. thinking models, numerical models, workshop processes, modifications to risk assessment processes) that enable regional NRM organisations to incorporate climate change into their planning, priority setting and implementation. A series of workshops will be held in each state to receive feedback on the tools and processes developed or identified through the project.

Objectives of the case study

Earlier work in this project (Stage A) completed a review of literature and assessment of the likely impacts of climate change in the Fitzroy Basin (Miles *et al*. 2005), and is available from the Fitzroy Basin Association or Queensland Murray Darling Committee in Toowoomba. A meeting was held in Rockhampton (September 2005) to help the community better understand the drivers, pressures and impacts of climate change, and to plan the responses that maybe useful to prepare for climate change (Stage A). During this process a number of key issues were identified related to climate change (Clifton and Turner 2005).

This report provides a scientific assessment (Stage B) of one key issue in the region, namely; under climate change conditions for 2030 identify changes in:

1. Regional rainfall, temperature and evaporation; and
2. Production and natural resource indicators in beef systems. (p.3)

3a

ClimateQ: toward a greener Queensland: Climate change in the Central Queensland Region

This regional summary describes the projected climate change for the Central Queensland (CQ) region. Projected average temperature, rainfall and evaporation for 2030, 2050 and 2070 under low, medium and high greenhouse gas emissions scenarios are compared with historical climate records. (p.1)

Climate change projections

Queensland climate change projections were produced by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM) based on the results from 23 Global Climate Models. Projections were provided for 2030, 2050 and 2070. However, as the climate can vary significantly from one year to the next, these projections show changes in average climate for three future 30-year periods centered on 2030, 2050 and 2070. Sea-level rise is also considered. (p.3)

Key findings

Temperature

- Average annual temperature in CQ has increased 0.5°C over the last decade (from 21.6 °C to 22.1 °C).
- Projections indicate an increase of up to 4.5 °C by 2070, leading to annual temperatures well beyond those experienced over the last 50 years.
- By 2070, Rockhampton may have four times the number of days over 35 °C (increasing from an average of 16 per year to an average of 64 per year by 2070), while Barcaldine may have nearly twice the number of hot days (increasing from an average of 87 per year to an average of 163 per year by 2070).

Rainfall

- Average annual rainfall in the last decade fell by nearly 14 per cent compared with the previous 30 years. This is generally consistent with natural variability experienced over the last 110 years, which makes it difficult to detect any influence of climate change at this stage.
- Models have projected a range of rainfall changes from an annual increase of 17 per cent to a decrease of 35 per cent by 2070. The 'best estimate' of projected rainfall change show a decrease under all emissions scenarios.

Evaporation

- Projections indicate annual potential evaporation could increase 7–15 per cent by 2070.

Extreme events

- The 1-in-100-year storm tide event is projected to increase by 51 cm in Gladstone and 32 cm at Cape Clinton if certain conditions eventuate. These conditions are a 30 cm sea-level rise, a 10 per cent increase in cyclone intensity and frequency, as well as a 130km shift southwards in cyclone tracks.

(p.2)

Impacts of climate change on the Central Queensland region

Projections for the Central Queensland region include a decline in rainfall, with increasing temperature and evaporation, in conjunction with more extreme climate events and sea-level rise. The temperature projections for inaction on climate change suggest a temperature increase well outside the range of temperatures ever experienced over the last 50 years. The projections for temperature and number of hot days are all in the same direction i.e. increasing.

The CQ region has significant areas of land under irrigation for agricultural/horticultural production and therefore a high rural water demand. As its regional population increases, coastal developments and the expansion in mining and industrial activity all add to the pressure on the water resources. Any further reductions in water availability as a result of climate change will place great pressure on consumptive uses and exacerbate competition with environmental water uses.

In addition to the impacts on the water resource, climate change is expected to have long-term impacts on agriculture, human health, infrastructure, economic activity and coastal and marine ecosystems. For example:

- In the winter of 2050, under the high emissions scenario, the predicted decline in rainfall (-9 per cent), increasing high temperatures (+2.0 °C) and an increase in evaporation (+8 per cent) could result in challenges in supplying sufficient water to meet demand.
- The projected higher temperatures and more hot days above 35 °C can result in significant health impacts such as heat exhaustion and increased mortality among vulnerable sectors of the community such as the very young or old. These conditions could also result in the spread of vector-borne disease south, with Dengue Fever possibly reaching Rockhampton by 2050.
- Furthermore, increased temperatures are likely to cause more regular coral bleaching in the Great Barrier Reef. These bleaching events are very likely to become more severe as temperatures increase and such events could occur annually by 2050. As a consequence of this, the Great Barrier Reef is very unlikely to survive in its present form. The degradation of the reef will not only be a loss of great intrinsic value, it will also come at a great cost to the tourism industry (NRM, 2004). (p.9)
- In addition, the increasing concentration of carbon dioxide is causing increased acidification of the sea water which, in turn, impacts the coral formation (De'ath et al, 2009). This adds a further dimension to the Great Barrier Reef's vulnerability to climate change.
- As a high proportion of the population of central Queensland reside in close proximity to the coast, there is a significant risk from cyclones. Increases in extreme storm events are expected to cause more flash flooding, affecting industry and infrastructure, including water, sewerage and stormwater, transport and communications. The riskiest areas are those closest to the coast, which can incur flash flooding, wind damage and considerable structural damage from falling trees, affecting industry, infrastructure and roads.

All of these potential impacts combine to multiply the challenges that the people of Central Queensland face in planning for a productive and sustainable future for the region. Successfully addressing these challenges will require knowledge of the changes that are likely, including an understanding of which changes can be mitigated and which will need to be addressed by adaptation. (p.10)

4

Responding to Climate Change in the Fitzroy Basin (Routley, R. 2009, QPI and F, Toowoomba)

Our country, Our future.

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