Waratah-Wynyard Council

Stormwater System Management Plan

For urban defined municipal areas

Version	Date issued	Author
A – Initial Adoption	02/12/2019	JPW

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1. PREFACE

1.1. INTRODUCTION

Stormwater management has become an increasingly critical subject for local Councils. Compounded by effects of climate change, expanding towns, historical issues and recent flood events, stormwater has continuously been pulled into the spotlight.

In 2013 the *Urban Drainage Act* was created to supersede the Drains Act 1954.The objective was to ensure Councils have strategies and plans to protect property and human life from the effects of urban flooding. *The Act* legislated a timeline of six years for local Councils to develop a *Stormwater System Management Plan.*

1.2. OBJECTIVE

The objectives of this *Stormwater System Management Plan* are to:

- Define the urban area within the municipality.
- Contextualise the stormwater system with this urban area, and its asset management framework.
- Define catchments and sub-catchments hosting the urban area and existing mechanisms to convey stormwater.
- Discuss historical flooding and options to mitigate the risk of future flooding.
- Review over-capacity network branches.
- Review future networks and corresponding issues.
- Derive projects and strategies to minimise flooding within the urban area.
- Provide a framework to monitor and review this plan and its deliverables.

1.3. SCOPE OF PLAN

In accordance with the *Urban Drainage Act*, this document will include:

> *1. Plans for the management of any assets used for the delivery of a stormwater service.*
>
> *2. The level of risk from flooding for each urban stormwater catchment in the public stormwater system.*

In this endeavour, the scope will exclude flooding that does not affect the urban area.

1.4. DEFINITIONS

1.4.1. Meanings and Default Units

The following references will be used throughout this plan:

Reference	Meaning
ARI	Average recurrence interval. A metric to reference intensity of rainfall.
AEP	Average Exceedance Probability. This is the probability of a specific rainfall intensity to occur and will be reference mostly in this plan.
Catchment	An area that encapsulates rainfall and run-off. Usually defined by topography.
Sub-Catchment	An area within a catchment that is or will be serviced by a stormwater network generally resulting in a single main discharge point.
SSMP	Stormwater System Management Plan.
BOM	Bureau of Meteorology
ARR	Australian Rainfall & Runoff guide
Urban Area	As defined in 1.4.2
Minor Rainfall Event	As defined in 1.4.3.
Major Rainfall Event	As defined in 1.4.4.
Stormwater Infrastructure	Refer to 1.5.
The Act	The Urban Drainage Act 2013
Council	Waratah-Wynyard Council
IFD	Intensity-Frequency-Duration (charts or tables for rainfall intensities and durations)
Unsafe	This term refers to stormwater levels in channels that exceed the known depth of the channel
Unreasonable	Unreasonable stormwater levels constituent an unsafe water flow depth and speed through any overflow route. This term may be used to aggregate the state of multiple overflow routes.
HGL	Hydraulic Grade Line. This is the surface level of water (or water profile), in a channel or pipe. The value may be greater than the free-flowing water surface level as it includes additional energies – water pressures.

Table 1 - Reference-Meanings

Reference	Default Units (UNO)
Width/Breadth	mm
Depth/Height	m
Length	m
Diameter	mm
Area	Ha
Flowrate	m^3/s
Probability	AEP
Intensity	mm/hr

Table 2 - Unit References

1.4.2. Urban Area

Subject to Council approval, the following criteria will be used to define the Urban Area boundaries:

All parcels of land within the town boundary of Wynyard, Somerset, Sisters Beach and Boat Harbour Beach (which will be referred to as Boat Harbour herein) that contains some, or all, of the following planning zones from the current planning scheme:

- 10.0 General Residential
- 11.0 Inner Residential
- 12.0 Low Density Residential
- 15.0 Urban Mixed Use
- 20.0 Local Business
- 21.0 General Business
- 22.0 Central Business
- 23.0 Commercial
- 24.0 Light Industrial
- 25.0 General Industrial

We acknowledge the following zones require specific design given their purpose. Design of drainage would be considered on a case by case basis.

- 17.0 Community Purpose
- 18.0 Recreation
- 19.0 Open Space
- 31.0 Port And Marine
- 32.0 Particular Purpose

A visual definition may be found in *Appendix A* based on the approved 2013 planning scheme.

1.4.3. Minor rain event

In accordance with current Council and industry standards this plan defines a minor rainfall event to be an IFD not exceeding a 5% AEP (a 1 in 20 year event). This event, to current standards, is expected to be carried by the stormwater network without substantial overland flow or detention.

Data for this event intensity will be sought from the BOM and ARR data hub.

1.4.4. Major rain event

This event is defined by an IFD not exceeding a 1% AEP (a 1 in 100 year event) and includes events with an intensity greater than a 5% AEP. Stormwater flows generated by this rainfall event is expected to be maintained by underground networks and overland flow paths such as open channels, grassed swales/reserves or public roadways.

1.5. CONVEYANCE OF STORMWATER

Stormwater in general can be transported through a diverse means. However, *The Act* formally defines stormwater as:

> *"stormwater means run-off water that has been concentrated by means of a drain, surface channel, subsoil drain or formed surface"*

For the Waratah-Wynyard municipal area, natural or man-made stormwater infrastructure that conveys stormwater includes:

- Piped network
- Kerb and channel
- Natural, blockwork or concrete lined creeks and tributaries with the primary function of conveying stormwater flows
- Open channels/swale drains

2. BACKGROUND

2.1. DEFINITION OF CATCHMENTS

2.1.1. Sisters Beach

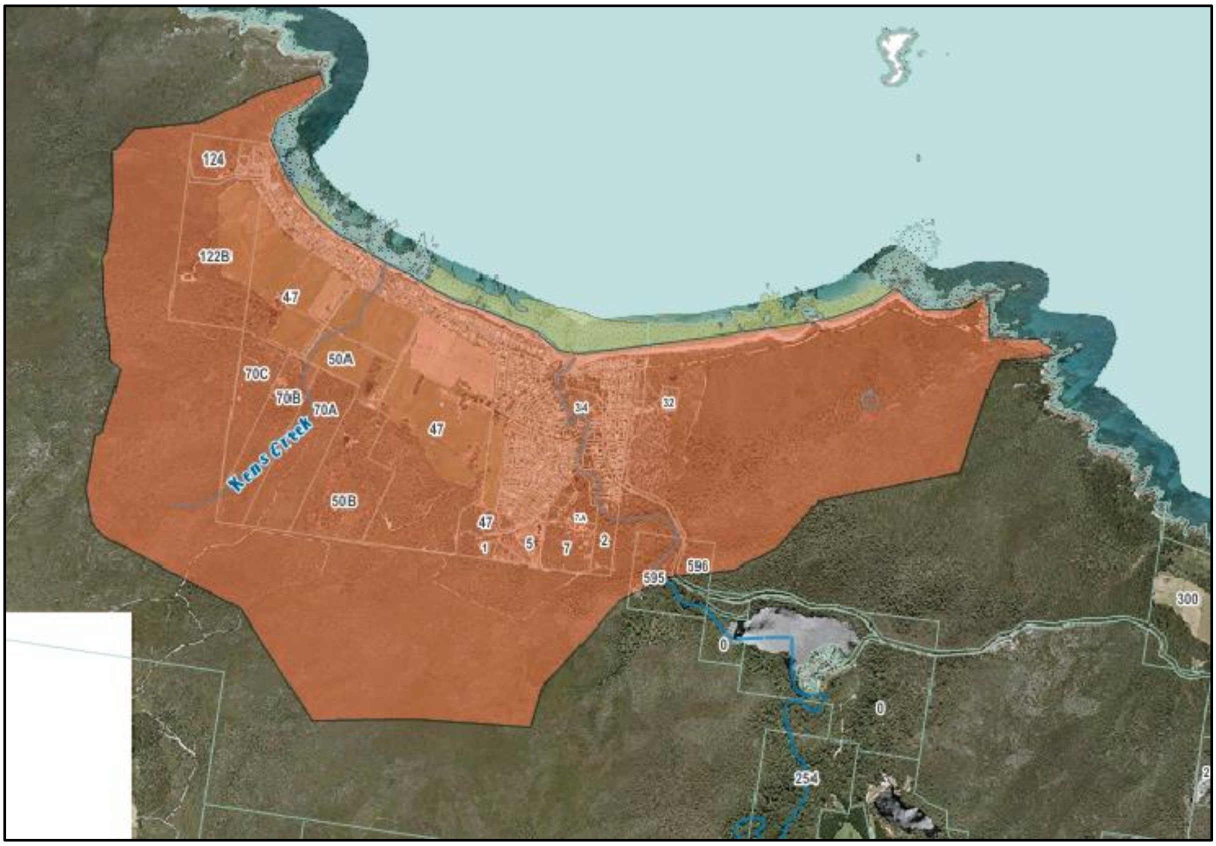

Figure 1 - Sisters Beach Catchment Highlighted Orange

The Sisters Beach catchment encapsulates the ridge line to the East, South and West and is bounded by the coast. We note the South-East area eventually bisects a natural valley which hosts *Sisters Creek.* The catchment does include *Ken's Creek* in its entirety.

The settlement along the coastline in Sisters Beach is generally flat, including the farmland to the South, steepening as Sisters Hills is reached.

The cleared area of Sisters Beach is founded on quaternary sandy marine deposits indicating good drainage. Vegetation in this area varies from dense scrub to cleared farmland and sparse trees.

Existing stormwater is serviced by 11 outlets, one of which vents to Ken's Creek and five to Sisters Creek. The last five discharge to sea.

Appendix A below may be used to contrast the Urban Area with this 658 Ha catchment with future development expected to occur on numbers 32, 47, 50A, 122B.

2.1.2. Boat Harbour

Figure 2 - Boat Harbour Catchment Highlighted Purple

We note the Boat Harbour catchment encompasses the urban area (see *Appendix A)* and is defined by topography until the South where it meets the road. The catchment is generally flat to the South, being mostly agricultural land, and steepens greatly as it approaches the coast. Previous geology and soil investigations have found a mix of tertiary basalt bedrock with Precambrian quartzites to the North of the settlement.

These qualities suggest the settlement isn't particularly free draining but generally has excellent qualities for overland flow paths.

The catchment is approximately 128 Ha in size and hosts 16 formal outlets draining to the sea.

2.1.3. Somerset

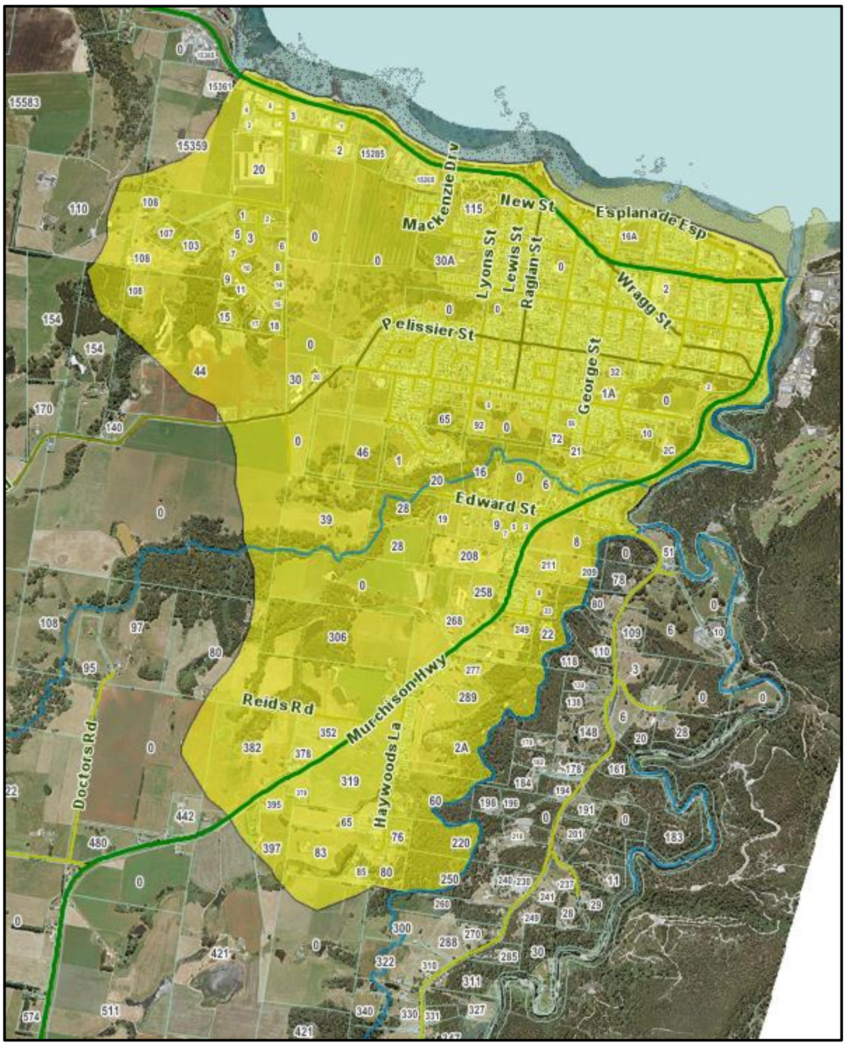

Figure 3 - Somerset Catchment Highlighted Yellow

From *figure 3* above, highlighted yellow, we can see the Somerset catchment. This catchment is the single largest in the municipality canvassing some 815 Ha and may be divided further in the future through Distillery Creek.

It's generally bounded by topography from the West to the South, with the Cam River and Maldon Creek to its East. The farm land has a gentle grade from South to North with it becoming flatter through the settlement. Vegetation is sparse and mostly lines watercourses.

Soil geology suggests tertiary quartz to the South as a patch of quaternary sandy marine deposits form to the North with a quaternary alluvium band across the coast. The expectation being mediocre drainage and some overland sheet flow.

Most of the stormwater network is concentrated to the North, near the sea. Catering for 12 headwall outlets to its North and 10 to its East into the Cam River. There are an additional 3 informal outlets into this river as well.

2.1.4. Wynyard

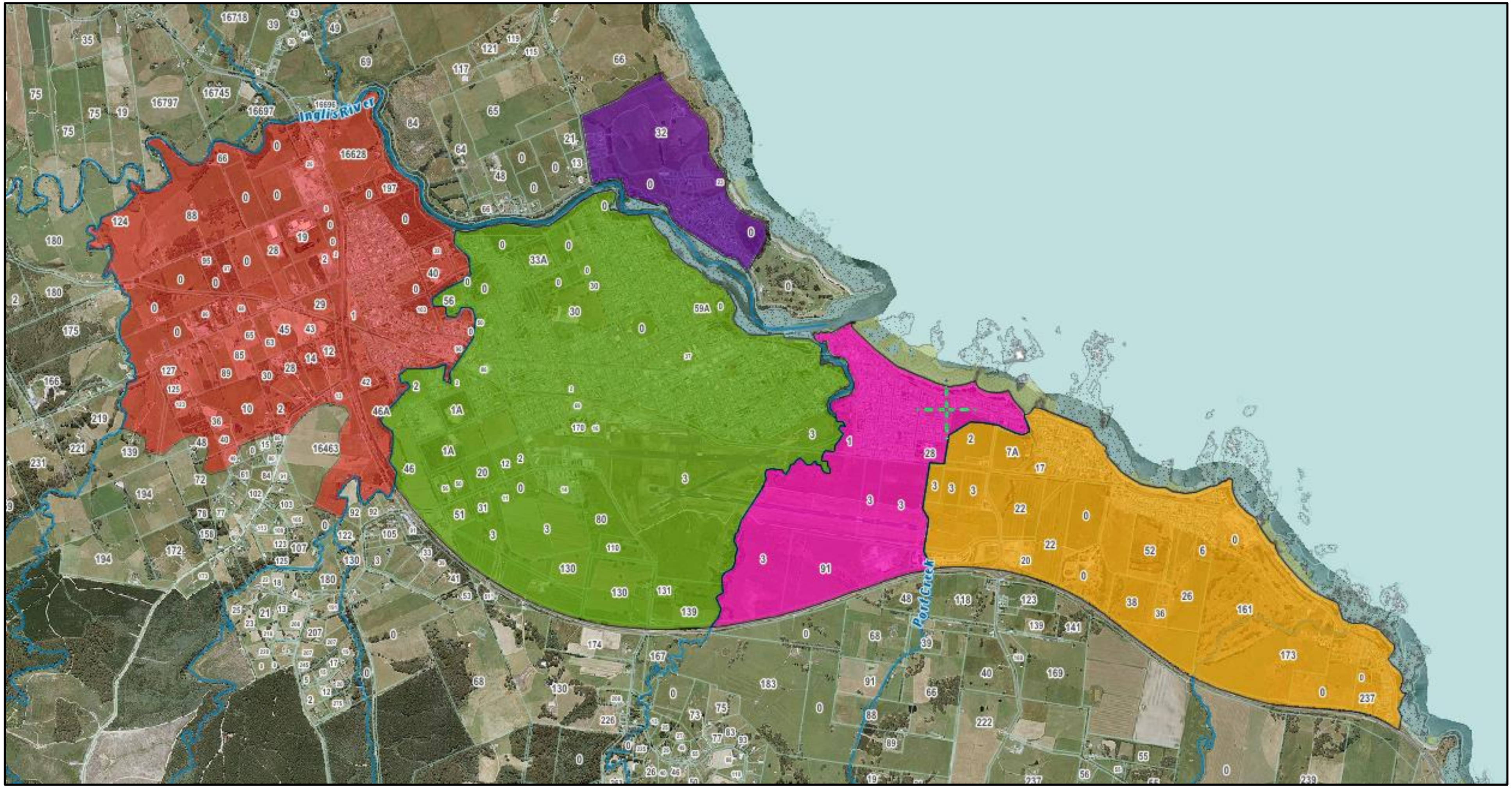

Figure 4 - Wynyard Catchments Highlighted

2.1.4.1. Big Creek West

The Big Creek West catchment is bounded by several creeks and topography. With reference to *figure 4* above (shaded red), to the West this catchment is bounded by Blackfish Creek and the Inglis River heading to the North.

Looking to the South, the 414 Ha catchment is eventually bounded by the topography of Oldina Road, and Big Creek to its East. Topography is generally undulating but not particularly steep with vegetation in clusters. The catchment is mostly developed with some areas used for farming.

Soil geology is reported to be of quaternary sandy estuarine deposits suggesting reasonable drainage.

There are three headwall outlets that discharge indirectly to the Inglis River and 11 that discharge into Big Creek with some cases discharging onto vacant land adjacent to a watercourse. We note most stormwater assets exist to the East of the Bass Highway within this catchment.

2.1.4.2. Big Creek East

Big Creek East (coloured green) is well defined by Big Creek to its West, the Inglis River to the North, Bass Highway to the South and Camp Creek to the West forming a size of approximately 550 Ha.

This catchment maintains 13 stormwater outlets into Big Creek, 25 into the Inglis River, 2 open channels into the Inglis River, 8 into Camp Creek and 1 open channel into Camp Creek.

Soil geology, vegetation and gradients are generally the same as Big Creek West. We note this being a mostly urbanised area except for the airport – not so much farmland as per the counterpart catchment.

2.1.4.3. Table Cape

The Table Cape catchment bound by topography surrounding the South of the area as shown in purple. The Western side of this catchment is constrained by Table Cape Road. We note also, the golf course to the East is not included within the catchment albeit the topography slopes to the sea.

Soil geology in this area is a slightly different to the surrounding catchments. The hill behind the golf course and surrounding settlement is a tertiary basalt bedrock with colluvium deposits. Quite similar to the Boat Harbour catchment.

Drainage under these conditions would be mediocre with overland flows expected on steeper sections. Previous landslip action is visible on these steeper sections.

Table Cape is the smallest catchment for this analysis comprising of only 72 Ha and contains 13 outlet headwalls to the Inglis River.

2.1.4.4. Port Creek West

In a similar manner to Big Creek East, the Port Creek West (pink shade) is bounded by Big Creek to the West and Port Creek to its East, with Bass Highway bounding it South.

Port Creek West is approximately 170 Ha in size and has 7 stormwater outlets discharging into Camp Creek, 10 directly into the sea and a further 3 into Port Creek. We note Port Creek in some sections has been cultivated into a channel and with instances of residents discharging directly into the creek.

Both Port Creek catchments share a different soil geology than the others, having quaternary alluvium on a gentle slope. We note there is a clear divide in the settlement being a third developed land and two thirds farmland.

The expectation here is free drainage being somewhat hard to achieve with overland flows most likely ponding.

2.1.4.5. Port Creek East

The orange shaded section is the last catchment in Wynyard. It's clearly defined by Port Creek, the Bass Highway and the intersection of the Bass Highway and coast at Doctors Rocks to its East. This catchment covers some 302 Ha.

This sub-catchment discharges two outlets into Port Creek with a further two into an unlabelled water course and 14 directly to the sea.

Geology and topography of this catchment is similar to its counterpart as discussed above.

2.2. SUB-CATCHMENTS AND EXISTING ASSETS

2.2.1. Foreword

To define a serviceable lot, we will compare the mapped network of pipework and apply a 30m buffer as per the *Act* to review any intersection with the lot. This needs to be reviewed further to include other connections points such as kerb and channel or open channels.

For the management of all stormwater infrastructure assets, refer to:

Urban Stormwater Infrastructure Asset Management Plan 2019;

Strategic Asset Management Plan 2019;

2.2.2. Sisters Beach

The figure below shows the urban area of Sisters Beach where the white overlay being unable to connect to the stormwater network as per the *Act* and blue being able to connect. That is to say, they are reasonably serviceable by stormwater infrastructure within 30m.

The Sisters Beach catchment is unique for the municipality as it contains a substantial amount of informal swale drains. In summary, Sisters Beach has:

Item	Amount	Evaluated Cost
Reticulation Main	5.1 km	$1,457,082
Culvert Cells	36.1 m	$163,519
Open Channel	Nil formalised	Nil
Subsoil Drainage	354 m	$23,596
Access Chambers	41	$130,408
Grated Pit	102	$88,197
Headwalls	34	$18,414
Side Entry Pits	8	$34,266
	Total	**$1,915,482**

Table 3 - Sisters Beach Asset Summary

As shown by a blue background in the figure below, some 130 lots (28.8 Ha) are yet to be serviced by infrastructure.

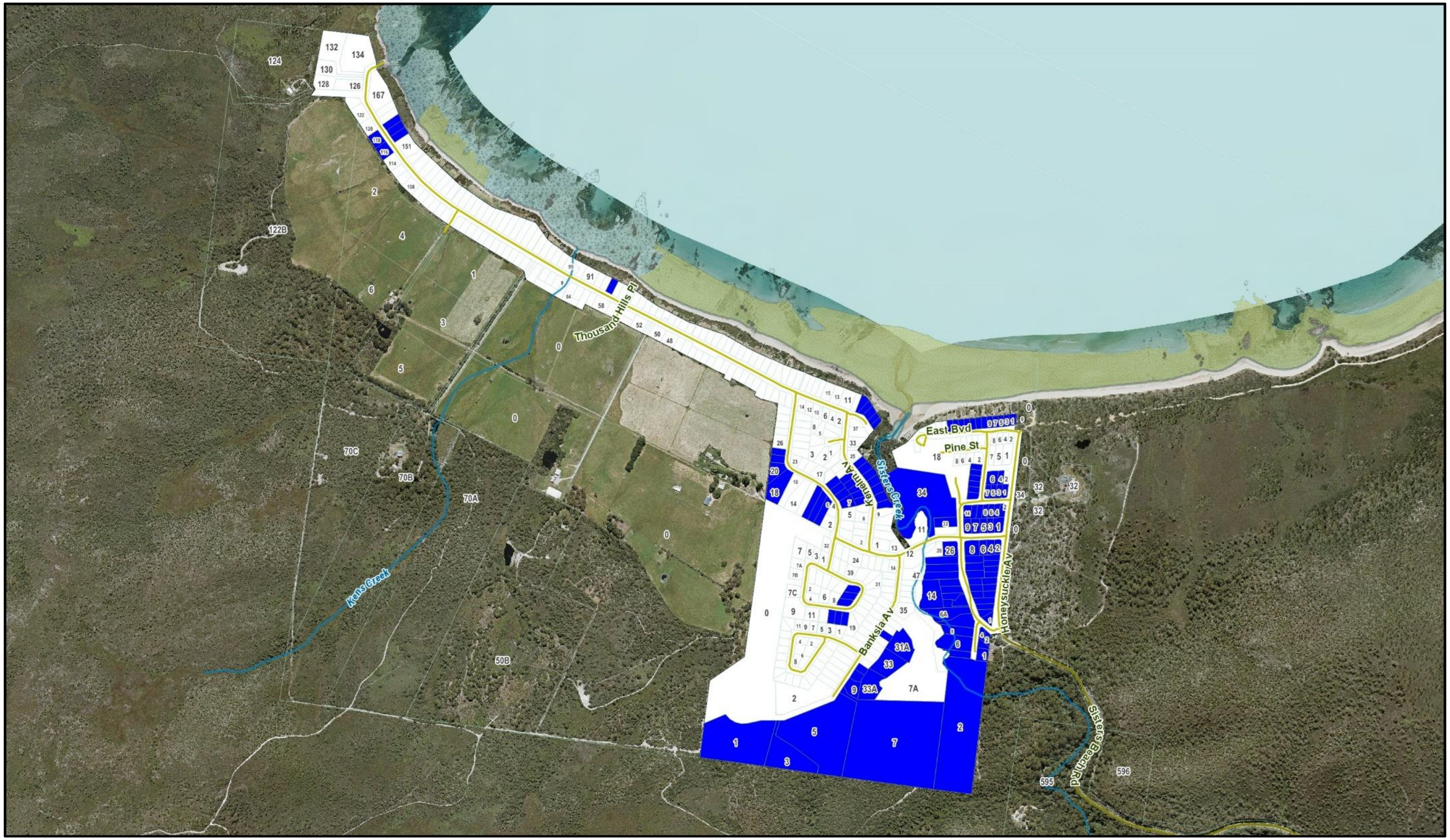

Figure 5 - Sisters Beach Urban Area: White able to connect, blue requires investigation

2.2.3. Boat Harbour

Boat Harbour has a mix of new and old stormwater infrastructure that captures most of the settlement. Overland flow paths have not been formalised however some kerb and channel exists.

Proximity to the sea and steep topography suggests overland flow paths would be ideal to transport stormwater.

Some 26 lots require further investigation to determine connectability to the stormwater network as found in *figure 6* below.

Item	**Amount**	**Evaluated Cost**
Reticulation Main	818 m	$136,586
Culvert Cells	Nil	Nil
Open Channel	Nil	Nil
Subsoil Drainage	Nil	Nil
Access Chambers	21	$33,101
Grated Pit	26	$15,983
Headwalls	3	$1,674
Side Entry Pits	Nil	Nil
	Total	**$187,344**

Table 4 - Boat Harbour Asset Summary

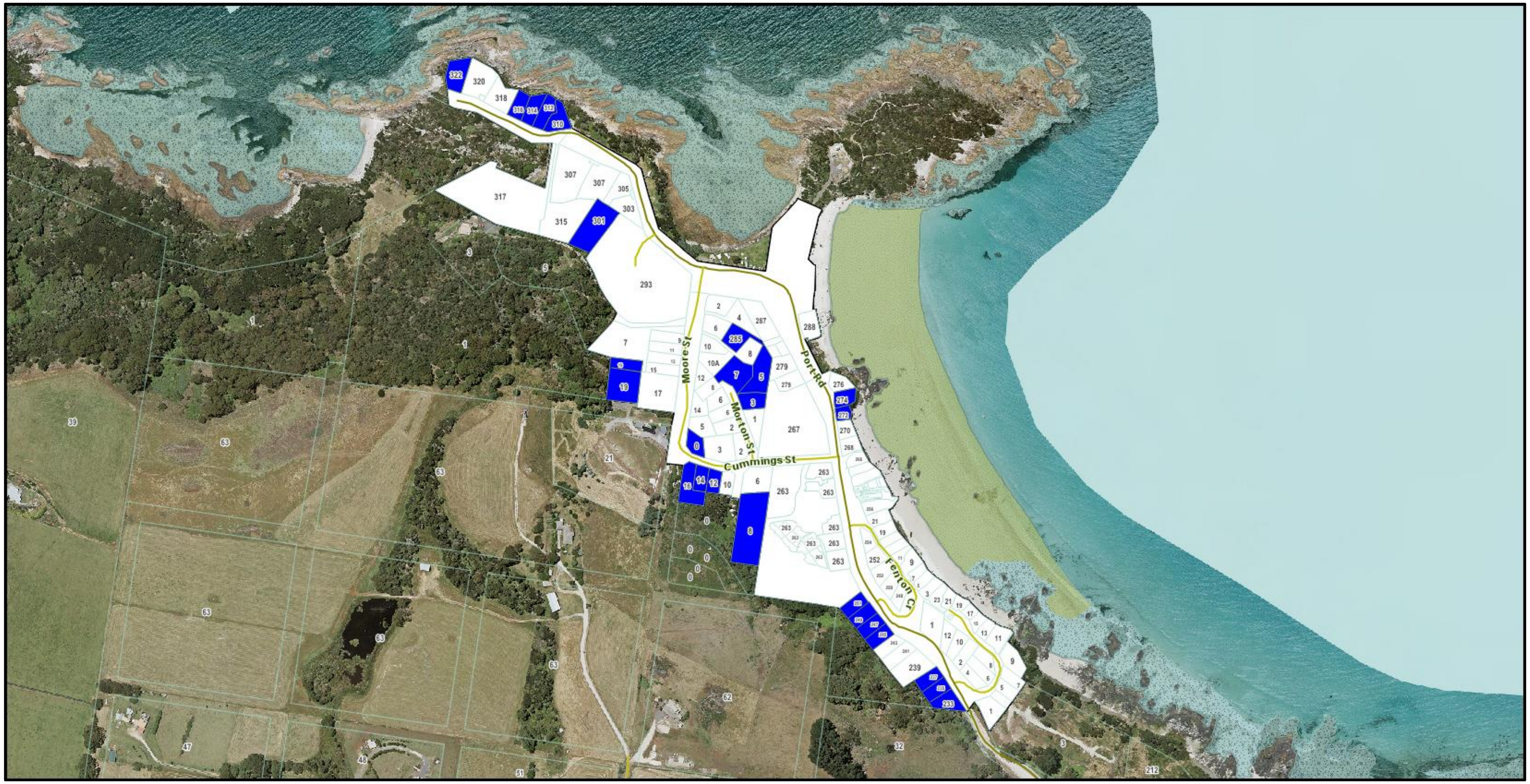

Figure 6 - Boat Harbour Urban Area: White connectable, blue requires investigation

2.2.4. Somerset

The Somerset catchment has good coverage of stormwater infrastructure (see *table 5* below).

Being a relatively flat settlement, generating reasonable fall in the stormwater network is difficult and would be greatly impacted by tidal action.

We note from *figure 7* below some 104 lots require further investigation for the ability to connect to the stormwater network. These are grouped to the South where traditionally stormwater may have discharged into Maldon Creek.

Item	**Amount**	**Evaluated Cost**
Reticulation Main	33.59 km	$8,474,622
Culvert Cells	Nil	Nil
Open Channel	Nil	Nil
Subsoil Drainage	675	$44,962
Access Chambers	577	$2,344,929
Grated Pit	443	$402,478
Headwalls	32	$31,856
Side Entry Pits	47	$197,144
	Total	**$11,495,991**

Table 5 - Somerset Asset Summary

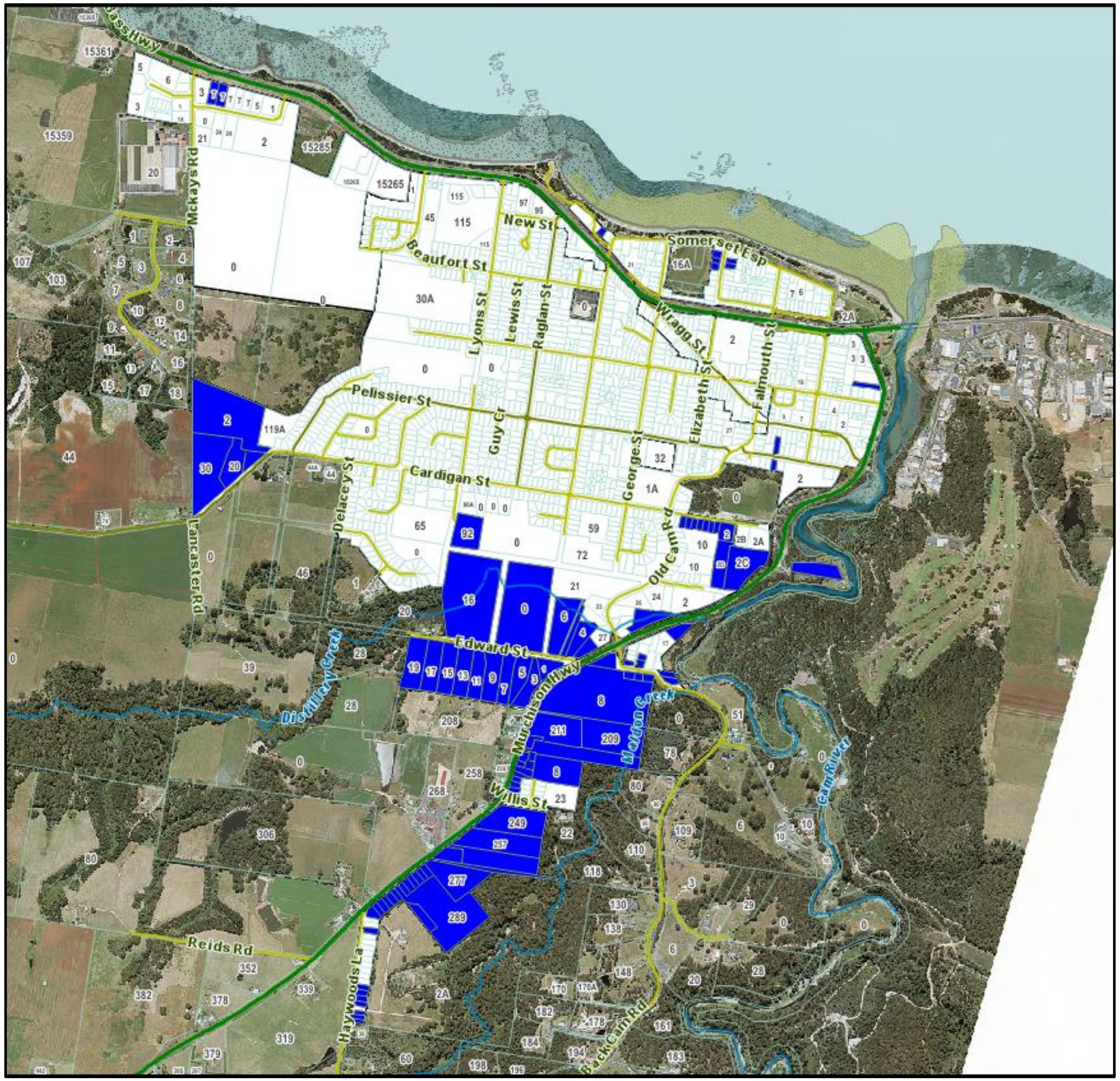

Figure 7 - Somerset Urban Area: White connectable, blue requires investigation

2.2.5. Wynyard

The main settlement of the municipality has a diverse range of infrastructure. This existing infrastructure coverage may almost service the urban area with a few exceptions:

Some 18 lots in Big Creek West, 8 in Big Creek East, 4 in Port Creek West and 24 to Port creek East require further investigation.

Item	Amount	Evaluated Cost
Reticulation Main	54.1 km	$14,982,717
Culvert Cells	47.3 m	$78,824
Open Channel	268 m	$49,739
Subsoil Drainage	510 m	$33,980
Access Chambers	831	$3,810,446
Grated Pit	604	$554,779
Headwalls	83	$46,314
Side Entry Pits	211	$878,839
	Total	**$20,435,638**

Table 6 - Wynyard Asset Summary

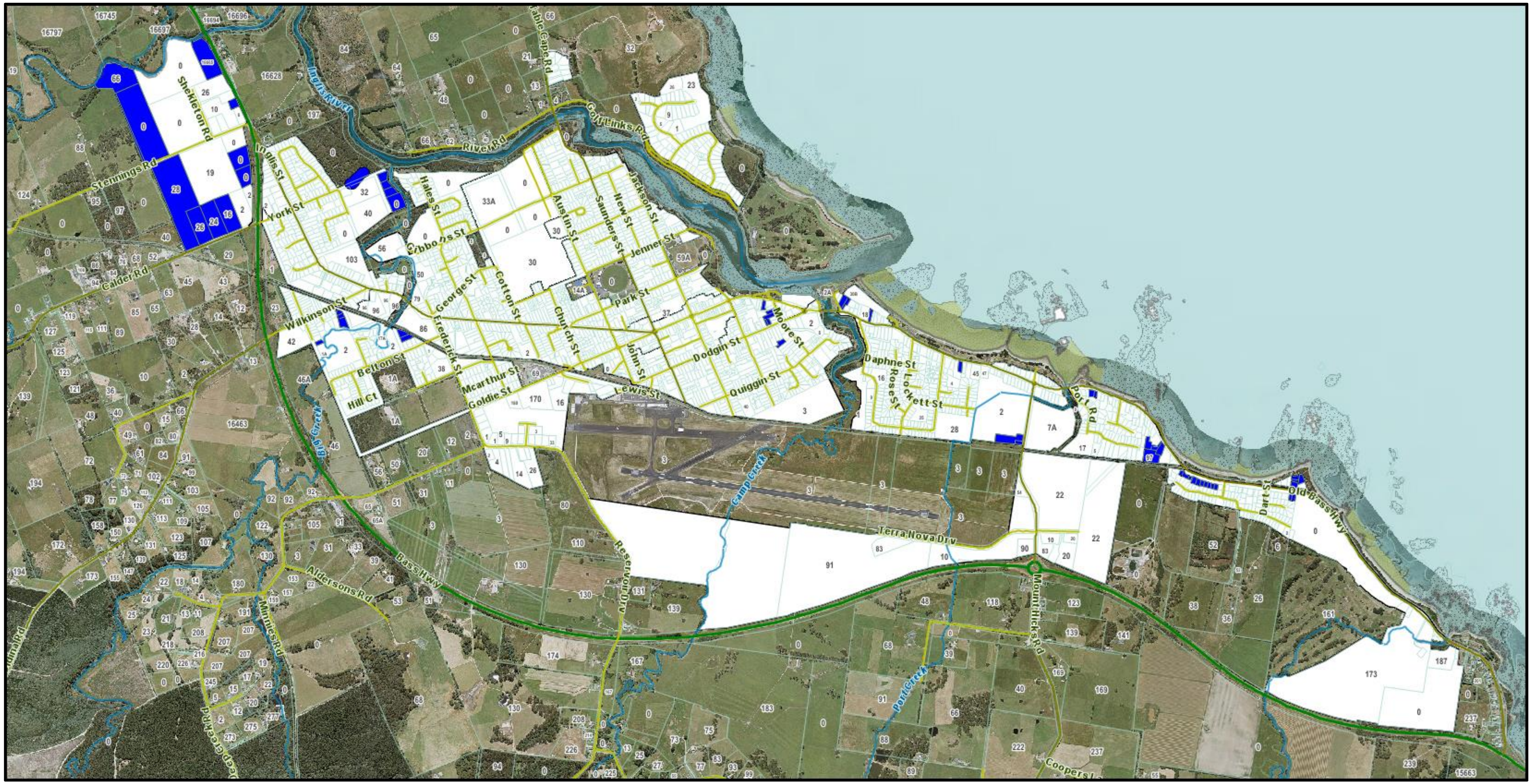

Figure 8 - Wynyard Urban Area: White connectable, blue requires investigation

2.3. HISTORICAL FLOODING

This section will review known areas that have been subject to historical flooding and are within the defined urban area.

A broad range of avenues to identify historical flooding continue to be explored including the review of historical claims, analysing current infrastructure capacities and discussing first-hand accounts from employees.

Three flooding issues will be analysed according to the issues found.

2.3.1. Big Creek

Stanwyn Court was subdivided from a now obsolete section of Shekleton Street in the later 70’s to early 80’s, to form a fully developed 16-lot portfolio.

In the June 2016 floods some 13 properties were significantly inundated when the nearby Big Creek was overwhelmed with water. Prior to this some reports of minor flooding occurred in-line with heavy rainfall events.

The Council proceeded to engage a hydraulic consultant to report on the magnitude of the 2016 event, and effectiveness of proposed solutions to mitigate inundation occurring in the future.

The report by Water Technology indicated the event was near a 1% AEP – this being an upper bound of flooding considered by this report. Discussion of solutions for this flood plain will be considered in *section 3.4* below.

2.3.2. Cotton Street

In a similar manner to the Stanwyn Court subdivision, several units and houses in Cotton Street (the area South of Inglis Street) were subject to inundation under heavy rainfall.

The issue is primarily due to the underground stormwater main being over capacity and having a choke point directly below the area flooded.

During the 2016 floods this issue was highlighted as houses along Cotton street to the South of Inglis Street were inundated.

Catchment analysis was performed by CSE Tasmania at the direction of Council to determine the impact to the area. CSE also investigated high-level solutions future occurrences. These are outlined and refined in *section 3.4*. below.

2.3.3. Port Creek

Port Creek is a relatively small catchment of approximately 700 Ha. Naturally flowing from Mount Hicks, the creek was then purposefully channelled using a swale drain from Shires Lane to its outlet near Port Road.

During the June 2016 floods, several properties along Old Bass Highway were inundated. Reports of the creek breaking its banks at lower intensity rainfall events were also noted.

Water Technology were engaged to assess mitigation options to prevent flooding in the future. The report will be reviewed in *section 3.4* below.

3. ANALYSIS

Stormwater network analysis was modelled using DRAINS software and a Horton/ILSAX routing method. Ensembles, losses and preburst data were sought from the ARR data hub with the Bureau of Meteorology supplying IFD data.

3.1. SUB-CATCHMENT REVIEW

This section defines stormwater networks within the catchments outlined above. Further refinement through analysis of the stormwater capacity within each catchment is reviewed. After which, areas to be added due to the formalisation of the urban area are then considered for future works packages.

3.1.1. Sisters Beach

As outlined in *section 2.2.2* above, the underground stormwater network is serviced in combination with overland swale drains. This atypical network was a result of historical design that considered the low-lying area with little to no fall would assume frequent overland flow. Being of course unable to generate required falls in the piped network.

The direct result of this is continual and informal swale drains along road sides with a piped network directly below. Grated pits, acting more as surcharge pits, are frequently placed along the piped network to equalise the overflow and underflow.

Historically, this urban area was not generally considered for stormwater infrastructure and as such we would expect little to no design of local infrastructure. This catchment will need to be modelled further to confirm flood risk, however ponding of water in heavy rainfall has been noted in some areas.

3.1.2. Boat Harbour

A report of the watercourse to the West of Boat Harbour Beach near Port Road inundating a resident was found. This will be investigated further.

Overall, we expect reasonable drainage with possibly some overland flow issues depending on rainfall events. This will catchment will be modelled later to confirm flood events.

3.1.3. Somerset

Several local areas have been reported to pool with water, these will be investigated.

This catchment will also be analysed in detail later.

3.1.4. Wynyard

Similar to Somerset and with the exception of the three known flooding scenarios, some localised areas were reported and will be analysed in the future, along with the catchment as a whole.

3.2. SUSTAINABILITY

3.2.1. Climate Change

The Australian Rainfall and Runoff (2019) guide considers climate change factors within stormwater design.

From Book 1 Chapter 6, the ARR outlines the likely impacts of climate change including IFD's, ensembles and antecedent conditions.

The ARR uses the Climate Futures tool developed by the CSIRO from the IPCC's fifth assessment report. In conjunction with the Bureau of Meteorology a Global Climate Model was generated based on greenhouse gas concentration pathways (RCP's). These RCP's can dictate temperature variances by considering levels of concentration.

The guide suggests using 'low' (4.5) and 'high' (8.5) concentration RCP's in contrast with risk associated with the infrastructure to determine if climate change impacts should be considered in the long-term redevelopment of the stormwater infrastructure.

To determine the projected rainfall intensity increase, the ARR guide defines the following formula:

$$I_P = I_{ARR} \times 1.05^{T_m}$$

Where:

I_P = is the projected intensity

I_{ARR} = is the current rainfall intensity

T_m = is the projected temperature increase

For the SSMP we will expect all future development to consider the current maximum forecast (year 2090) climate change factors as we expect an 80-year design life for the piped network.

The online ARR data hub can be used to determine these factors. Currently, these are between a low of 7.6% increase to a high of 16.3% for rainfall intensity for Wynyard and its surrounds.

3.2.2. Future Development

Customers of the municipality are rated for stormwater to account for the asset depreciation costs (i.e. replacement). However, as the urban area expands (being intimately linked to the planning scheme), consideration will need to be given for the expansion of networks as they accept a larger catchment area.

3.3. FLOOD PREVENTION

Within the municipality there exists three known consistent flooding issues. All of which are within the Wynyard catchment, and are detailed below.

3.3.1. Big Creek

Initially discussed in *section 2.3.1* above, flooding occurs downstream of Big Creek periodically inundating several houses in Stanwyn Court.

WWC engaged Water Technology following the June 2016 floods to provide a report into the hydrology around this flooding issue.

The subsequent analysis confirmed the previous event as having the effects of 1% AEP.

Water Technology was then later engaged around January 2018 to review this further and provide an assessment of two solutions found the most viable from the previous investigation.

The first option, a levee wall some 375m long and approximately 2m high was found to be a valid solution by the consultant.

The second option, a detention basin upstream (dam) was also found to be a generally viable solution but required further investigation.

The second option was pursued for several reasons;

1. A detention basin upstream would ensure future development may occur in the surrounding land at Stanwyn Court.
2. Protecting against a 0.5% AEP, or greater floods, would be relatively cheap.
3. The dam would not interfere with visual amenity or require claiming of residential land.

The volume of water required to withhold during the flood was found by Water Technology to be approximately 1,363,000 m^3.

An assessment by Geoton found local soil conditions to be generally in favour of dam construction with a report by CSE suggesting estimated costs would be in the region of $610,000.

Total costs for the project were estimated to be approximately $850,000.

Prior to commencing detailed hydrological assessment and dam design this flood mitigation option will be compared for prioritisation in section 5.

3.3.2. Cotton Street

An unnamed watercourse accepting flow from paddocks, and the Burnie airport, is piped near the waste transfer station along Goldie street.

Historical incremental development in low lying areas in combination with heavy rainfall events cause the watercourse to periodically flood the houses along Cotton Street.

At the request of WWC, CSE Tasmania undertook a hydraulic analysis of the network under Cotton Street.

The results confirmed the historical extent of the flooding. With further analysis providing a multitude of solutions including;

- Providing a detention basis further upstream.

- Providing an automated sluice gate to limit pipe flows and using nearby areas as a natural detention pond.
- Install the correct stormwater network.

Costs were approximated in the region of $265,000. However, these need to be investigated in detail.

3.3.3. Port Creek

The Port Creek waterway floods periodically and most notably during the 2016 flood event when approximately 11 residents along Old Bass Highway were inundated.

This watercourse encapsulates significant tracts of farm land to the South, the airport and some residential developments further to the North. It has also been modified multiple times in the past to redirect the natural flow around developments.

WWC engaged Water Technology to provide a hydrological and hydraulic analysis of this June 2016 flood event. They also reviewed several options to mitigate flooding during their analysis, which are:

1. Widening of the creek and construction of a levee
2. Cause new developments to build to a higher RL and purchase old developments.
3. Investigate flow restrictors upstream.

In conclusion, the report suggests a levee wall and widening of the creek would be the most appropriate option for the current and future protection of developments. This levee could be designed to protection against a 0.5% AEP and be between 1-2m high depending on the chosen channel width.

Further investigation will be required, with initial costs suggesting the project would be in the region of $1,285,000.

4. SUMMARY OF OPTIONS

In this section a summary of works derived above will be tabulated below. As modelling of the catchments evolve further, costs may be derived for solutions to existing and future problems.

Approximate costs for the known flood prevention capital works projects are outlined in *table 7* below:

Case	**Approximately Cost**	**Lots Affected**	**Cost per Lot**
Big creek	$850,000	12 (future development as well)	$70,833
Cotton Street	$265,000	13	$20,385
Port Creek	$1,285,000	7 (future development as well)	$183,571

Table 7 - Existing Issue Remediation Summary

5. DERIVING PROJECT PACKAGES

5.1. STRATEGIES AND PROJECTS TO MEET OPTIONS

We may divide all noted issues into several strategies

1. A strategy to remediate issues with existing networks.
2. A strategy to solve future issues with the network, or lack thereof.
3. Capital works packages to deliver the three flood prevention strategies.

For each strategy or package lies multiple projects to deliver the overall intent. These will be discussed below.

5.1.1. Remediate existing network

This strategy deals with issues that cause the existing network to be dysfunctional.

Legacy issues are prominent with historical stormwater infrastructure with their cause varying substantially. For example, during the development of the new Bass Highway, stormwater infrastructure was reconnected improperly causing multiple bottlenecks. Other examples can include different design standards at the time, informal overland drainage (swale drains) that were not upkept or quite simply an increase in catchment area for the network that is unable to accept it.

Expanding on issues arising from informal drainage systems above; an inconsistent issue with the stormwater network in each catchment are informal systems. These are items like swale drains that are not currently considered assets but are required to successfully drain the urban area of stormwater. While it may not be considered a dysfunctional part of the system, without it the system would be dysfunctional and so recognition, development and maintenance of these items is key to minimising flood risk in the urban area.

Tidal action is another frequent problem with low lying catchments such as Wynyard, Sisters Beach and Somerset.

With high tide increasing the HGL through the piped network, we would expect upwelling to occur in some instances. Further modelling and design would be required to consider how to remediate the affects of this, and in conjunction with climate change.

5.1.2. Solving Future Network Issues

With the creation of an urban area to comply with the *Act* also comes the expectation to supply a network to cover this area. Customers are now able to request a connection to the stormwater network if they are within 30m of stormwater infrastructure.

To provide this right to customers and given the extent of works, we must consider future projects to deliver infrastructure to protect against future inundation issues.

Stormwater infrastructure generally has a long life of up to some 80 years with recent reviews of the in-situ network state suggesting over 100 years to be acceptable. This requires design to consider future issues.

One issue which was explored in *section 3.2* above by reviewing climate change in relation to industry and governmental guidance. As expected, we generally find an increase in rainfall intensity which must be considered with current and future infrastructure. Industry guidance suggests reviewing associated risk with infrastructure that may fail with increased rainfall to determine the necessity to remediate affected areas.

In a similar vein to the above, storm ensembles with increasing intensity and volume can generate peak flows and quite easily overwhelm networks. The immediate effects of this are a greater pressure on overland flow paths, which as climate change progresses, will highlight the importance of their capability. On the other hand, we must also consider larger volume of flow through the network due to the same event.

Consideration should also be given to the concept of urban area. In this case, the SSMP utilises the planning scheme to define this area. This implies future development and re-zoning will increase the catchment area thus increasing the volume of flow carried by the network.

5.1.3. Flood prevention capital works

The three capital works packages below are solutions to alleviate known cases of inundation due to stormwater. The risk is apparent, and work has already commenced to resolve the issues.

Big Creek (Stanwyn Court) and Port Creek are a combination of low-lying developments and overcapacity watercourses. These are a somewhat naturally occurring phenomena that need to be moderated to minimise the risk to life and property.

The last, Cotton Street, appears to be a historical issue due to bottlenecks within the system.

5.2. INTANGIBLE BENEFITS OF PROJECTS

The analysis of projects doesn’t take into consideration multiples benefits including;

- The allowance of future development with surety of flood mitigation.
- Customers able to secure insurances.
- Decreased risk of landslip opportunities and failure of structures (whether public or private).
- Formalisation of assets to include correct maintenance regimes and intervention levels.

5.3. ASSOCIATED RISK AND PRIORITISATION OF PACKAGES

To align with Councils risk management framework, this report will utilise the Councils standard risk matrix framework and descriptions as found in *Appendix C* to compare issues within the catchments. However, this review into risk will require input from additional plans and as such this section will be completed at a later date

6. INTEGRATION OF PROJECTS

6.1. PRELIMINARY TIMEFRAME OF PROJECTS

Based on future modelling and direction from Council, projects may be reviewed in the future to include timeframes, funding sources and responsible officers.

6.2. COMMUNICATION PLAN AND STRATEGY

Broadly, there are several key items that need to be communicated to the public and various stakeholders resulting from this SSMP:

Subject	Issue	Communication Strategy	Timeframe
The definition of Urban Area	What it will mean to the public	Website/social media/workshop	Short term
	What will change (fees, service levels, asset loading etc.)	Website/brochure/social media	Short term
	Legacy issues caused by the definition	Website/brochures	Short term
Existing network	Notifying public of known issues	Letters	Medium term
	Notifying public of plans to investigate issues	Social media/website	Medium-Long term
	Expectations of the municipality in light of the Urban Drainage Act	Letters/workshop	Medium term
Future network	Changing requirements of developers	Website	Short term
	Adding customers to the network	Letters/workshop	Long term

Flood plains	Updating the public on flooding issues	Letters	Short – medium term
	Notifying affected public of flood plains	Letters	Short - medium

Table 8 - Communication Strategy Summary

A refined strategy will be developed by the communications and media personnel as outcomes from Council meetings are realised.

6.3. MONITORING AND REVIEW OF THE ABOVE

This Stormwater System Management Plan is expected to be reviewed every four years post adoption.

A service champion may be assigned to overwatch the progression of each action, project or package as whole. However, at the least, each responsible directorate should have a manager or director briefed and capable of delivering the actions, strategies and the like.

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APPENDIX A – URBAN AREA COLOURISED

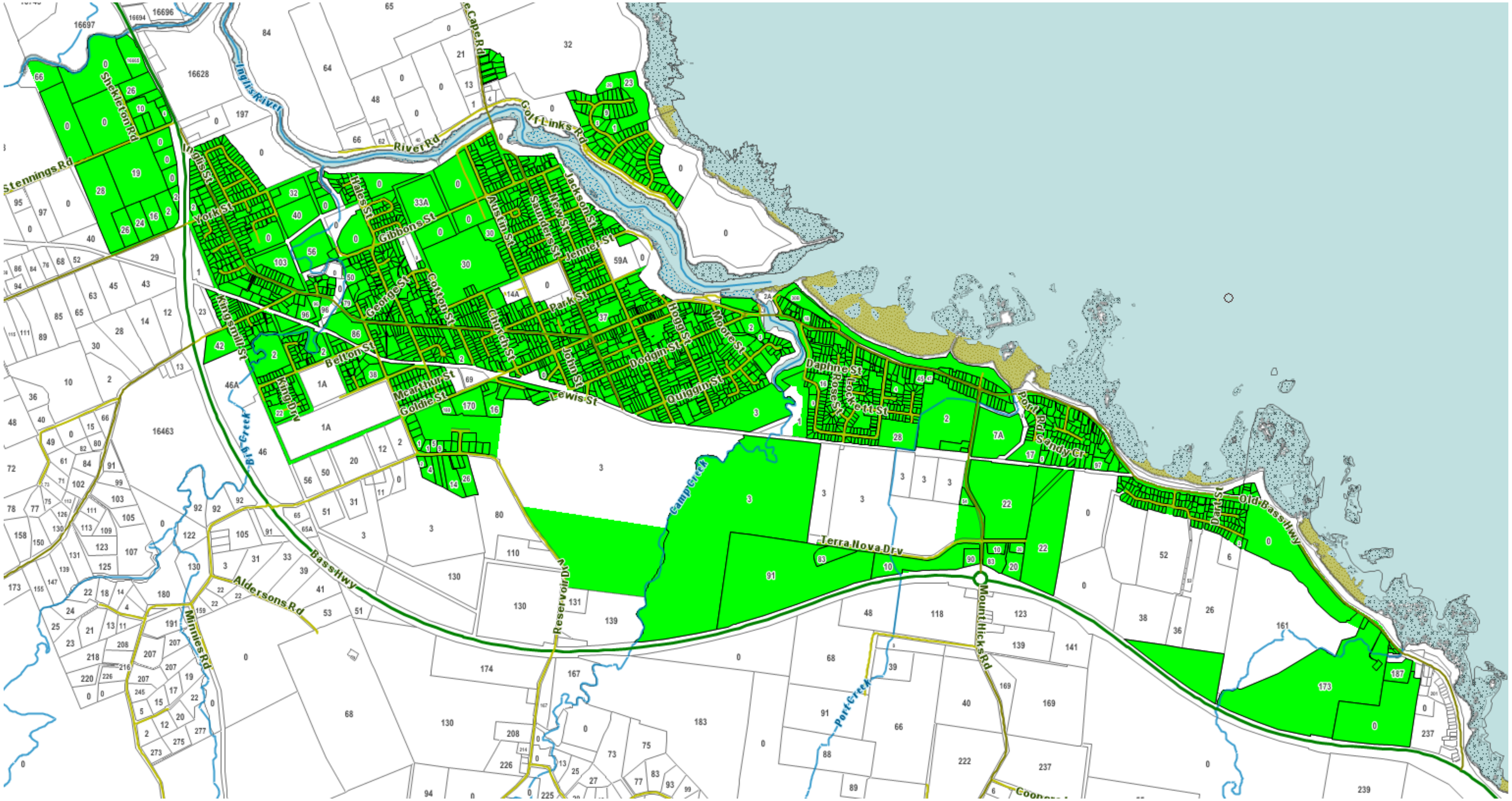

Figure 9 - Wynyard Urban Area shaded green

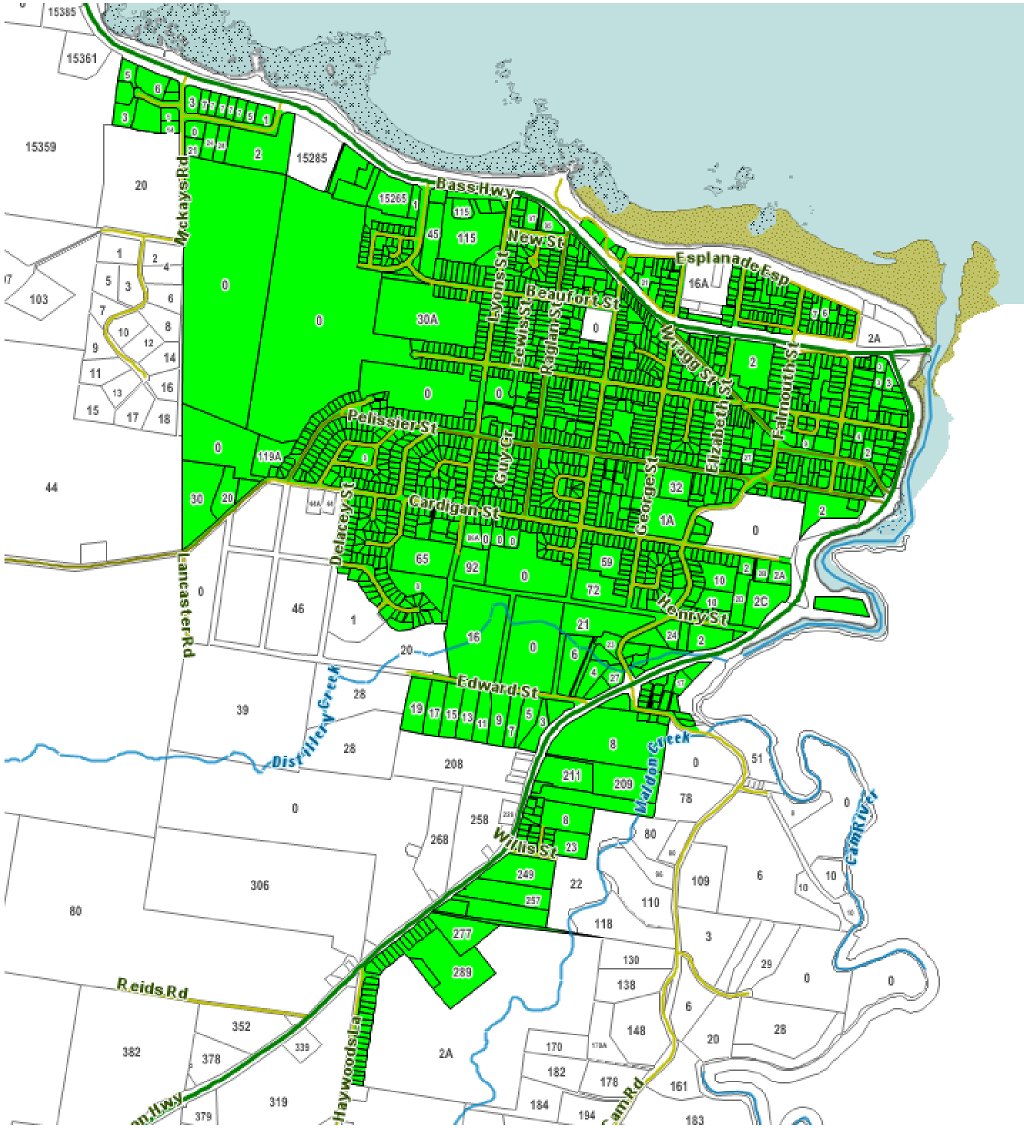

Figure 10 - Somerset Urban Area shaded green

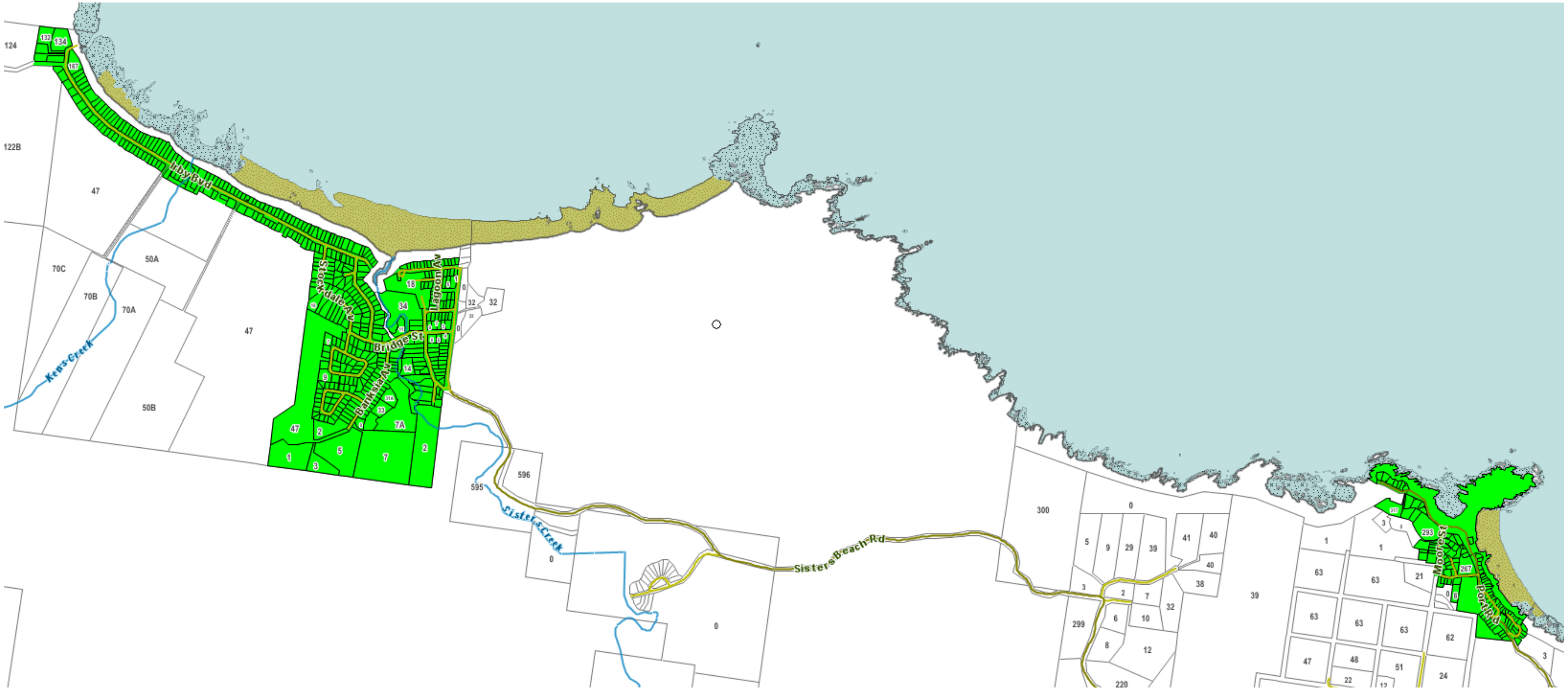

Figure 11 - Boat Harbour and Sisters Beach Urban Area shaded green

APPENDIX B – RISK ASSESSMENT FRAMEWORK

	Operational	Public	Business	Financial	Environmental
Critical	Critical failure of Council to operate in accordance with legislative and operational needs. Failure impacts on Council's ability to operate.	Loss of life or inundation of >50 residents	Critical business failure preventing core activities from being performed. The impact threatens not only Council's core activities but Council itself.	Critical impact on Council's budget resulting in Council being unable to fulfil all of its financial obligations / or > 25% of budget	Sustained adverse public, political and stakeholder scrutiny
Major	Significant components of Council's business operations are not met or completed	Permanent injury or physiological trauma or inundation of > 25 residents	Breakdown of key activities leading to reduction in business performance.	Major impact on Council's budget / or > 10% of budget	Public, political and stakeholder scrutiny
Moderate	Components of Council's business operations are not met	Broken bones or open flesh wounds or inundation of > 5 residents	An impact on business resulting in reduced performance such that targets are not met.	Moderate impact on Council's budget / or 5% of budget	Scrutiny required by external consultants or audit
Minor	Some impact resulting from the lack of core business not being carried out	Cuts and bruises, likely no inundation but water levels breached overland flow paths	Some impact on business areas in terms of delays, systems quality but able to be dealt with at operational level	Some impact on Council's budget / or between 2 -5% of budget	Scrutiny by Executive or internal committees to prevent escalation
Insignificant	Minimal impact resulting from the lack of establishment of non-essential business functions	Wet clothes or mild scare trauma, no inundation, water levels maintained by overland flow paths	Minimal impact on non- core business operations. The impact can be dealt with by routine operations	Minimal impact on Council's budget / or <2% of budget	Self-improvement review required

LIKELIHOOD CRITERIA				
Rare	**Unlikely**	**Possible**	**Likely**	**Almost Certain**
This event has not known to have occurred. Approaching PMP scenario.	1% AEP – event may have occurred in one generation or may have occurred in another area.	2% AEP – this event has a probability suggesting it will occur once every 50 years.	5-10% AEP – this event may have occurred several times in one generation	Event occurs annually

RISK MATRIX						
CONSEQUENCE		LIKLIHOOD				
		Rare (1)	Unlikely (2)	Possible (3)	Likely (4)	Almost Certain (5)
	Insignificant (1)	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
	Minor (2)	Low risk	Low Risk	Low Risk	Medium risk	Medium risk
	Moderate (3)	Low risk	Medium risk	Medium risk	High risk	High risk
	Major (4)	Medium risk	Medium risk	High risk	Extreme risk	Extreme risk
	Critical (5)	Medium risk	Medium risk	High risk	Extreme risk	Extreme risk

Residual Risk	Mitigation and Reporting
Extreme	GM attention required. Develop risk minimisation and mitigation strategies. Each identified risk to be included for reporting and monitoring to each council meeting or on an occurrence basis
High	Significant Senior Management control is required. Develop risk minimisation and mitigation strategies. Each identified risk to be included for reporting and monitoring to the Council and Senior Management semi-annually, or on an occurrence basis.
Medium	Senior Management intervention and control is required. Develop risk minimisation and mitigation strategies. Each identified risk to be included
Low	Manage by routine procedures. Allocate and monitor responsibilities to each risk. Each identified risk to be included for reporting and monitoring in annual reports to the Senior Management Team.