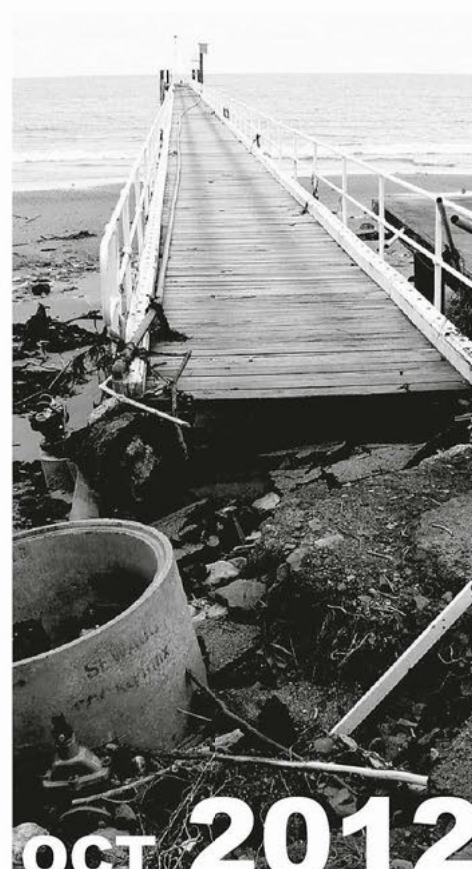


# VULNERABILITY & RISK ASSESSMENT

Coastal Hazard Strategy for Townsville City Council [Pilot Project]



Australian Government  
Department of Climate Change  
and Energy Efficiency



*This report: has been prepared by GHD for Townsville City Council and may only be used and relied on by Townsville City Council for the purpose agreed between GHD and the Townsville City Council .*

*GHD otherwise disclaims responsibility to any person other than Townsville City Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.*

*The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.*

*The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.*

*The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.*

*GHD has prepared this report on the basis of information provided by Townsville City Council and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.*

*Cover images sourced from Townsville City Council, the Queensland Department of Environment and Heritage Protection and B.Harper (2012).*

# Table of contents

1.	Introduction .....	3
2.	Risk Assessment Criteria .....	4
2.1	Risk Types .....	4
2.2	Vulnerability Analysis Thresholds .....	4
3.	Identified Assets to be Included in the Vulnerability Assessment.....	7
4.	Development of Floor Level database.....	8
5.	Risk Analysis Results .....	9

# Table index

Table 1	Risk to Property risk table – storm tide hazard .....	4
Table 2	Risk to Property risk table – permanent inundation hazard.....	5
Table 3	Risk to Infrastructure risk table .....	6
Table 4	Identified assets that will be included in the CHAS vulnerability assessment .....	7



# **1. Introduction**

The Townsville CHAS Study has been undertaken to provide a detailed risk analysis to identify current and future assets at risk in high coastal hazard areas and determine their vulnerability (DERM Invitation to Offer 11-20, 2011). The risk analysis main purpose is to inform the decision process on allocating adaptation options.

## 2. Risk Assessment Criteria

The following details the method that has been adopted to develop the 88 risk maps presented in Appendix A.

### 2.1 Risk Types

The CHAS has considered the following risks:

1. **Risk to Infrastructure** (including transportation assets such as roads – Refer below)
2. **Risk to Property**

The rationale is that the other risk types (e.g. risk of isolation, risk to personal safety) mostly have to do with emergency management and evacuation procedures which are not a focus of CHAS' vulnerability analysis (yet emergency and evacuation procedure considerations are taken into consideration in later parts of the process).

### 2.2 Vulnerability Analysis Thresholds

The vulnerability thresholds developed for the CHAS include:

**Acceptable risk** – individuals and society can live with this risk without feeling the necessity to reduce the risks any further.

**Tolerable risk** – society can live with this risk but believe that as much as is reasonably practical should be done to reduce the risks further. Note that individuals may find this risk unacceptable and choose to take their own steps, within reason, to make this risk acceptable.

**Unacceptable risk** – individuals and society will not accept this risk and measures must be put in place to reduce risks to at least a tolerable level.

The following tables provide with detail on the thresholds agreed with TCC. Hazards are split as '1% AEP storm tide' or 'under tidal influence'. i.e. within the extent of the Highest Astronomical Tide (HAT)".

**Table 1 Risk to Property risk table – storm tide hazard**

Event Range	Residential Buildings - Above floor flooding	Commercial/ Industrial Buildings – Above floor flooding	Open Space/ Rural-Other
100 yr ARI			

**Table 2 Risk to Property risk table – permanent inundation hazard**

Permanent Sea Level	Residential Property	Commercial/ Industrial Property	Open Space/ Rural-Other
>5% of block inundated			
<5% of block inundated			

Table 3 below lists the hazard thresholds considered for the types of infrastructure agreed to be included in the analysis. Infrastructure identified stems from information provided by TCC. Major infrastructure not provided was identified by inspecting Google Maps® and using local knowledge where applicable.

**Table 3 Risk to Infrastructure risk table**

Infrastructure Type	Within infrastructure categorisation					
Water Supply		Trunk mains	Reservoirs/ Towers	Water Treatment Plant processing infrastructure		Source (e.g. weir)
Electricity					Transmission lines	275/110 kV substation
Telecommunications					Telephone exchanges	
Emergency Services				Minor Evacuation Centre	Station (Police/Fire brigade/Ambulance/SES)	Major Evacuation Centre
Cultural Heritage Facilities				Cemetery		Strand
Transport/Freight			Main Roads	Rail Lines	Transport Depots, Highway/Motorway	Evacuation Routes, Sea Ports/Airports/Marinas
Sewage and waste		Scour Pipe		Sewage pump stations, gravity pipes		Sewage Treatment Plant
Health services						Regional Public Hospitals Private Hospitals and aged care facilities Local Public Hospitals
100 year ARI						
Permanent Sea Level (>1% of block inundated)						

### 3. Identified Assets to be Included in the Vulnerability Assessment

The list of identified assets that were included in the vulnerability assessment are listed in the table below.

**Table 4 Identified assets that were included in the CHAS vulnerability assessment**

Feature	Dataset	Note	Source
Sea Port, Marinas	Properties	Verified by Transport Facilities Points of Interest	TCC
Embellished Open Space	Properties		TCC
Emergency Routes & Centres	Infrastructure		GHD/TCC
Airport	Properties	Verified by Transport Facilities Points of Interest	TCC
Deference	Other_Centres	Verified by local GHD's Knowledge and TCC	GHD and TCC
Major Industry (e.g. Nickel and Zinc factories, aquacultures)	Other_Centres	Verified by local GHD's Knowledge and TCC	GHD and TCC
Transport Depots	Properties	Verified by Transport Facilities Points of Interest	TCC
Telephone exchanges	Telecommunication		GoogleMaps®
Rail	Railways		TCC
Waste Water Structure and Mains	Wastewater_Network_Structure ; Wastewater_Gravity_Main Wastewater_Pressure_Main		TCC
Water Structure and Mains	Water_Network_Structure Water_Main		TCC
Evacuation Centres	Major_evac_centres, Community_Recovery_Centres		TCC
Emergency Health Centres	Hospitals, Community Centres, Aged Care		TCC
Emergency Centres	Fire, Police		TCC
Council Buildings	Council facilities		TCC
Other Centres (e.g. cemetery)	Shopping_Centres, Education_Centres, Other_Centres		TCC

## 4. Development of Floor Level database

Floor levels of residential, commercial and industrial properties are fundamental in defining the vulnerability of an asset as well as estimating the damages relating to a storm tide/permanent inundation event. During the CHAS, TCC, GHD and DERM discussed a solution to determine floor levels by correlating existing parameters of the cadastre to recorded floor level surveys. The resulting database was envisaged to be used by TCC as a reliable database that would inform Floodplain Management Studies and similar projects requiring such extensive datasets. Similarly, Geoscience Australia expressed their interest in acquiring such dataset to inform their NEXUS database.

Subsequently, GHD has adopted a methodology to determine floor levels for properties within TCC's Digital Cadastral Database (DCDB) using the readily available recorded floor level datasets:

1. JCU dataset comprising of drive-by observations and Building structure details including Detail of Storeys for more than 14,000 properties. This survey identified Highset, Lowset, Highset built-in-under etc The drive-by survey was undertaken in 1996-97.
2. TCC dataset comprising a kerb side survey defined reference levels for commercial, industrial and selected residential areas for 32 suburbs in the Townsville LGA prior to Council amalgamations. The survey was undertaken in 2005.
3. TCC datasets containing Land parcel and Property details.
4. TCC dataset comprising Digital Elevation Model of the ground elevation.
5. The methodology adopted by GHD to define the floor level elevations for each parcel comprised of:
  6. In the absence of known building locations, a floor level for the centroid of each Property will be calculated.
  7. Calculate a Ground Level for each centroid from the Digital Elevation Model.
  8. Assume a Floor Height of 300mm above Ground level for all Properties where more detailed information is not available.
  9. Override this Floor Height where known reference levels have been determined for selected suburbs in the Maunsell Report.
  10. Override this Floor Height where known reference levels have been determined for selected addresses in the JCU Survey
11. Mask precincts where it is reasonable to assume buildings will not exist (District Open Space, Local Open Space, Regional and City Wide Open Space, Breakwater, Green Space).

## 5. Risk Analysis Results

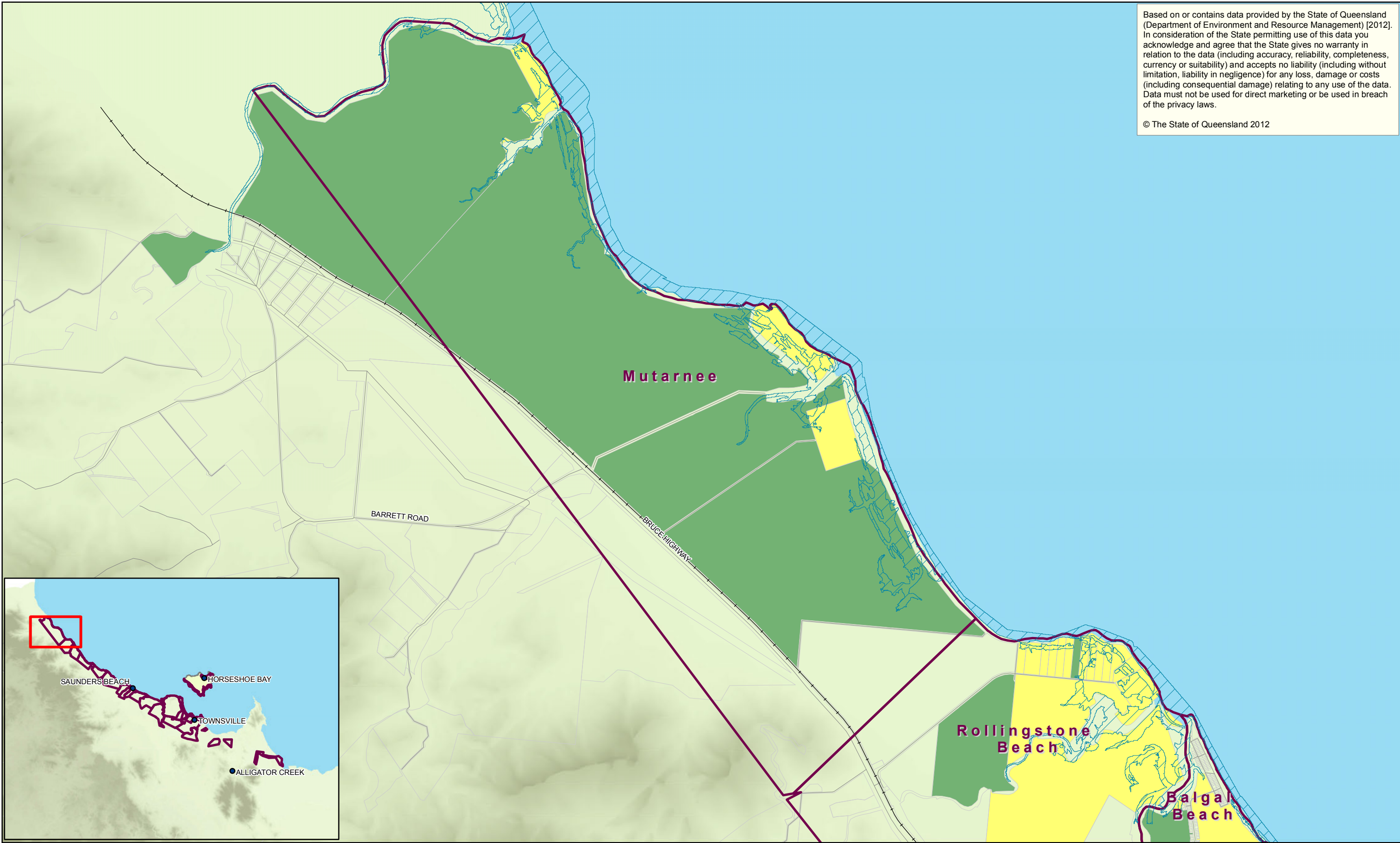
Appendix A presents with the results of the risk analysis mapped across the 11 TCC districts. 88 maps are provided grouped as:

- A1- Tidal Influence - Current Conditions (2012) x Risk to Property
- A2- Tidal Influence - 2100 Conditions (0.8 m SLR) x Risk to Property
- A3- 1% AEP (Annual Exceedance Probability) Storm Tide Event - Current Conditions (2012) x Risk to Property
- A4- 1% AEP Storm Tide Event - 2100 conditions (0.8 m SLR) x Risk to Property
- A5- Tidal Influence - Current Conditions (2012) x Risk to Infrastructure
- A6- Tidal Influence - 2100 Conditions (0.8 m SLR) x Risk to Infrastructure
- A7- 1% AEP Storm Tide Event - Current Conditions (2012) x Risk to Infrastructure
- A8- 1% AEP Storm Tide Event - 2100 conditions (0.8 m SLR) x Risk to Infrastructure

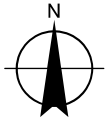


Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



1:45,000 @ A3  
0 500 1,000 1,500 2,000  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- Railway
- HAT (2012)
- Urban Locality
- Properties Boundary

Risk to Property

- Acceptable Risk
- Tolerable Risk
- Unacceptable Risk



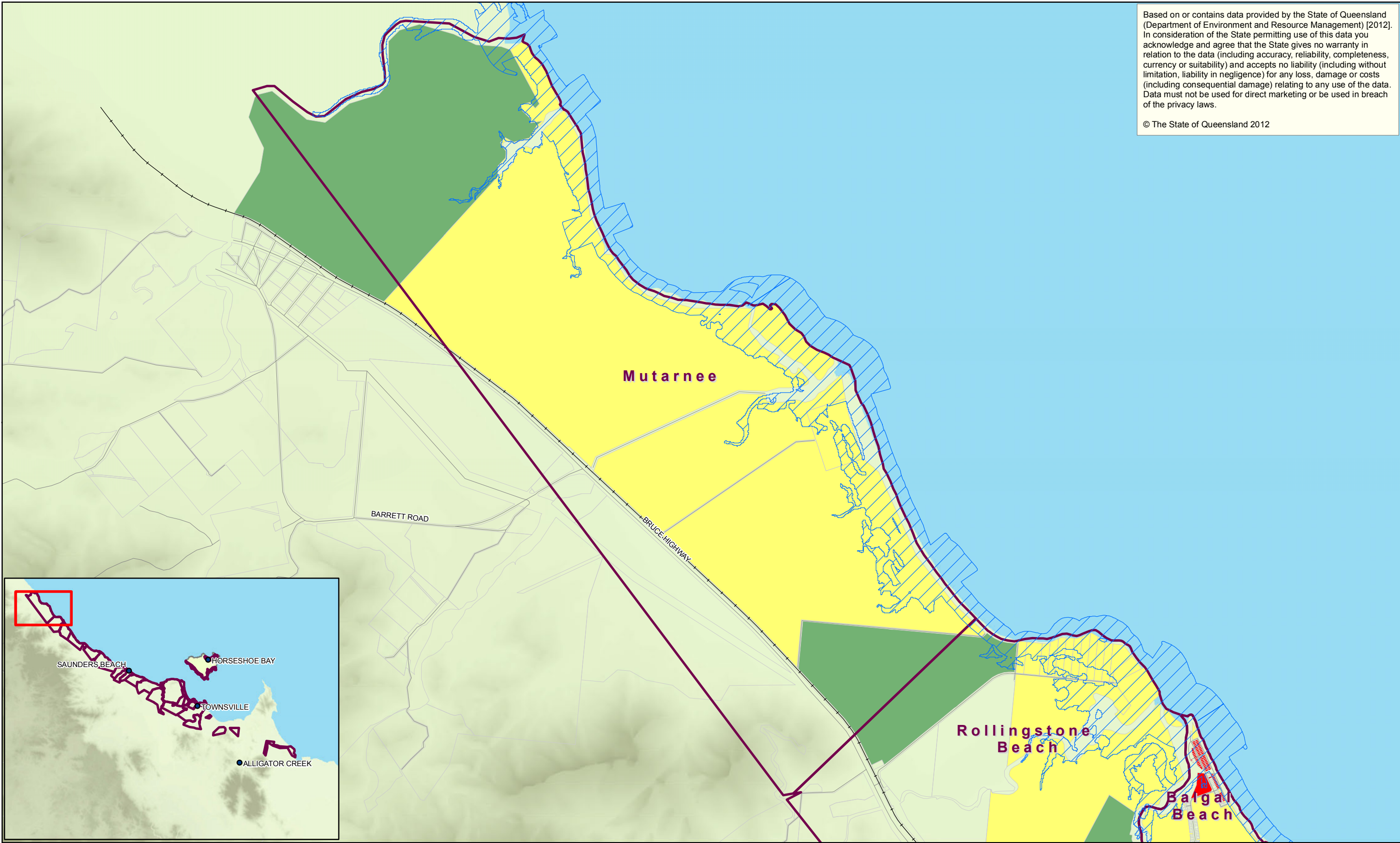
Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
Current Conditions (2012)  
Risk To Property  
District: Rollingsstone

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

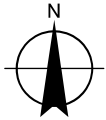
Map Series A1  
Sheet 1 of 11

Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



1:45,000 @ A3  
0 500 1,000 1,500 2,000  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- Railway

- Urban Locality
- Properties Boundary
- HAT 2100 Condition (0.8m SLR)

Risk to Property

- Acceptable Risk
- Tolerable Risk
- Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
2100 Conditions (0.8m SLR)  
Risk To Property  
District: Rollingstone

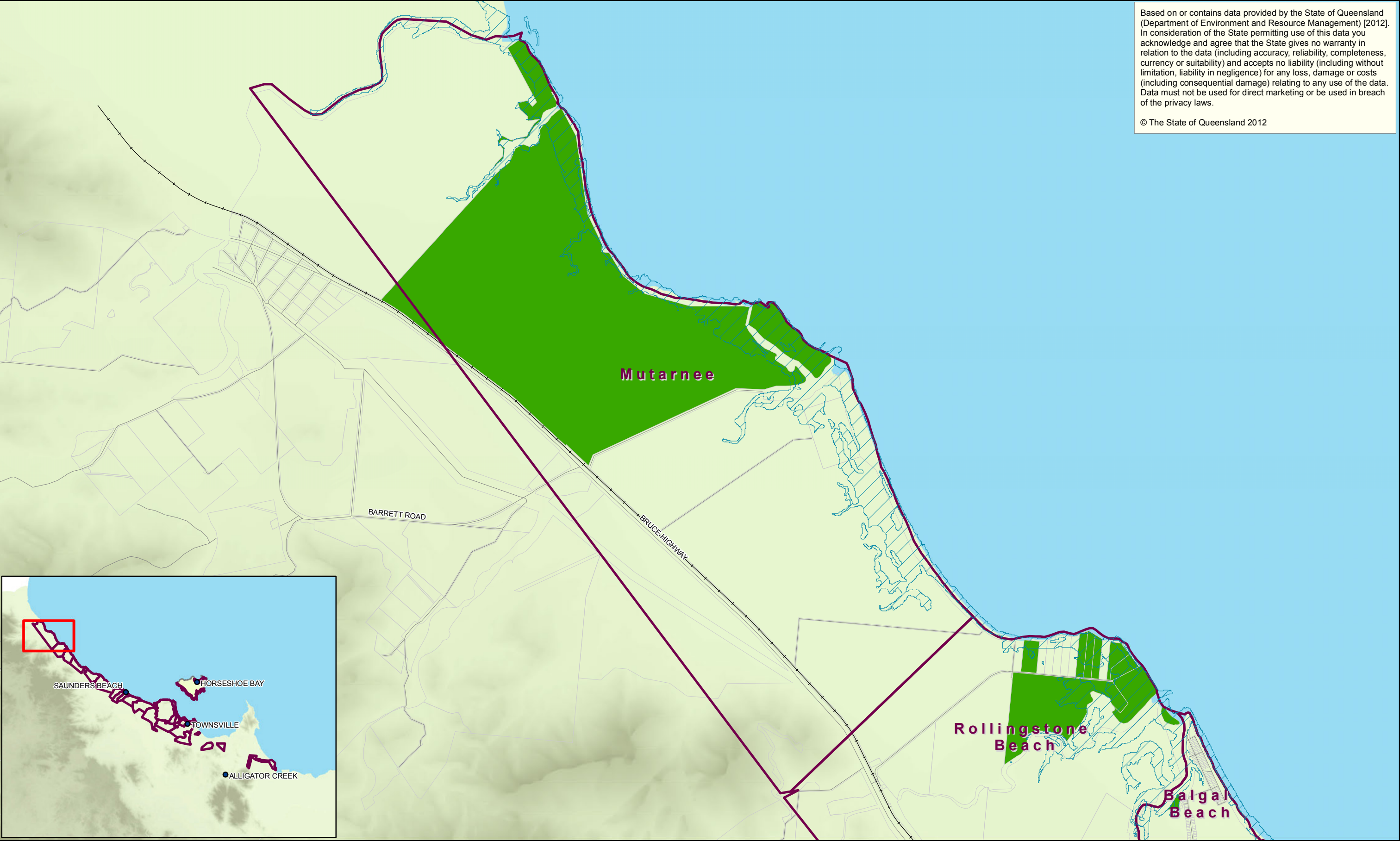
Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A2  
Sheet 1 of 11



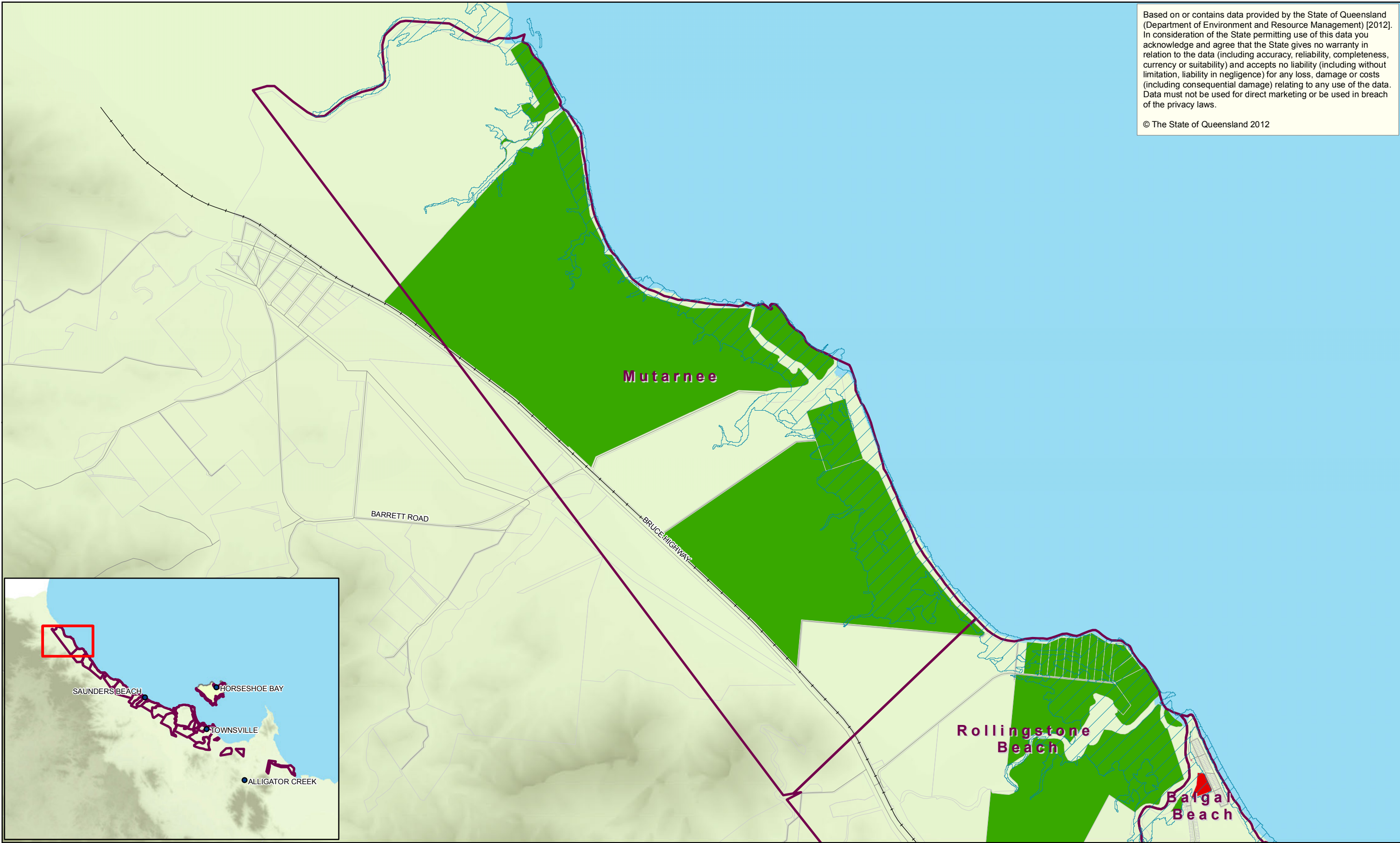
Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012

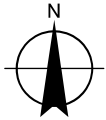


Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



1:45,000 @ A3  
0 500 1,000 1,500 2,000  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- +—+ Railway



District Boundary



Properties Boundary



100 y Return Period Storm Tide Event  
2100 Conditions (0.8m SLR)

Risk to Property

Acceptable Risk

Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
2100 Conditions (0.8m SLR)  
Risk To Property  
District: Rollingstone

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A4  
Sheet 1 of 11

G:\4124609\GIS\Maps\Working\4124609\_Stormtide\_2100Condition\_PropRisk\_RevA\_20121009.mxd

© 2012. Whilst every care has been taken to prepare this map, GHD, TCC, DERM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

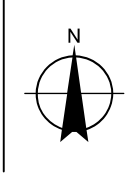
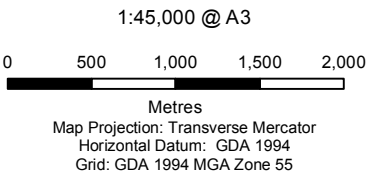
Data source: TCC - Railway, Roads, Properties, Districts (2011). Geoscience Australia - Populated Places (2008). DERM - DEM (2007). Place Names (2010). GHD - Ocean Boundary (2012).

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com



Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



LEGEND

- Town / Locality
- Road
- +— Railway

- HAT (2012)
- Urban Locality
- Properties Boundary

Risk to Infrastructure

- Acceptable Risk
- Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
Current Conditions (2012)  
Risk To Infrastructure  
District: Rollingsstone

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

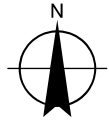
Map Series A5  
Sheet 1 of 11

Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



1:45,000 @ A3  
0 500 1,000 1,500 2,000  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- +—+ Railway
- Urban Locality
- Properties Boundary
- HAT 2100 Condition (0.8m SLR)

Risk to Infrastructure

- Tolerable Risk
- Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
2100 Conditions (0.8m SLR)  
Risk To Infrastructure  
District: Rollingsstone

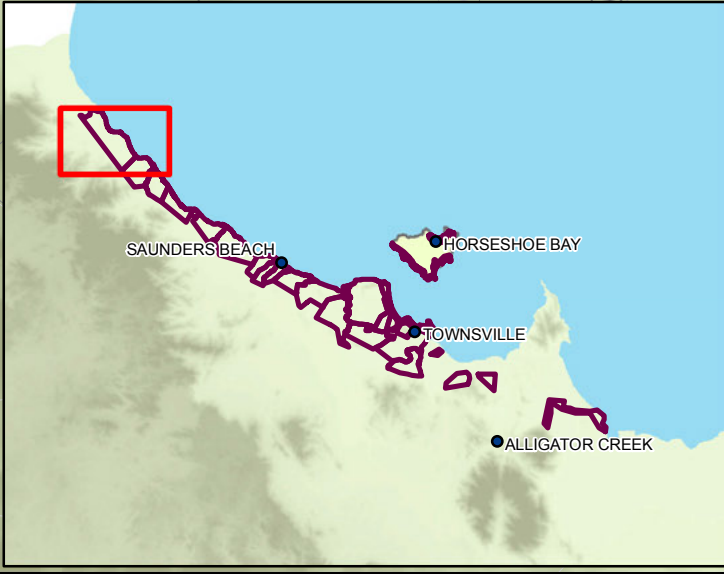
Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A6  
Sheet 1 of 11



Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



1:45,000 @ A3

0 500 1,000 1,500 2,000

Metres

Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55

**LEGEND**

- Town / Locality
- Road
- Railway
- Urban Locality
- Properties Boundary
- Storm Tide Event
- Current Conditions (2012)

**Risk to Infrastructure**

- Acceptable Risk
- Tolerable Risk
- Unacceptable Risk

Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
Current Conditions (2012)  
Risk To Infrastructure  
District: Rollingsstone

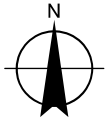
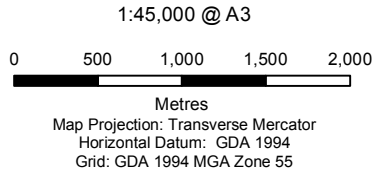
Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A7  
Sheet 1 of 11



Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



LEGEND

- Town / Locality
- Road
- Railway

- Urban Locality
- Properties Boundary
- 100 y Return Period Storm Tide Event  
2100 Condition (0.8m SLR)

Risk to Infrastructure

- Acceptable Risk
- Tolerable Risk
- Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
2100 Conditions (0.8m SLR)  
Risk To Infrastructure  
District: Rollingstone

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A8  
Sheet 1 of 11



Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012

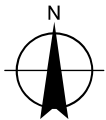




Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012

1:50,000 @ A3  
0 500 1,000 1,500 2,000  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- Railway



Risk to Property

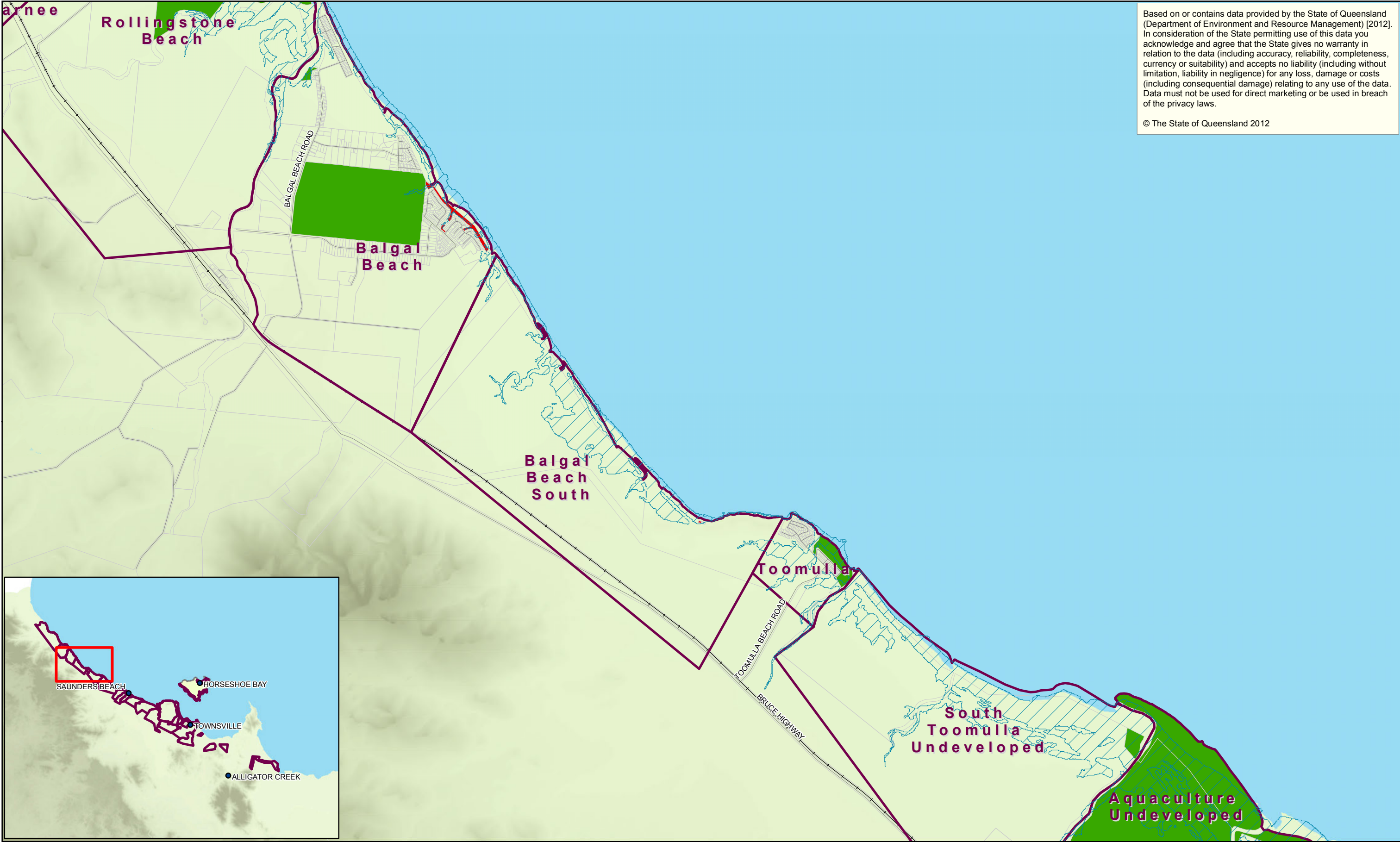
- Acceptable Risk (green)
- Tolerable Risk (yellow)
- Unacceptable Risk (red)



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
2100 Conditions (0.8m SLR)  
Risk To Property  
District: Balgal Beach

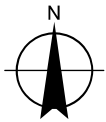
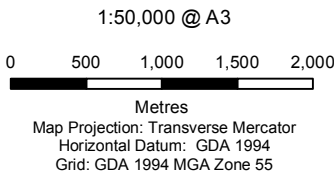
Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A2  
Sheet 2 of 11



Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



LEGEND

- Town / Locality
- Road
- +— Railway

- Urban Locality
- Properties Boundary
- Storm Tide Event
- Current Conditions (2012)

Risk to Property

- Acceptable Risk
- Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
Current Conditions (2012)  
Risk To Property  
District: Balgal Beach

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

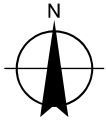
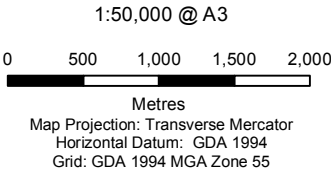
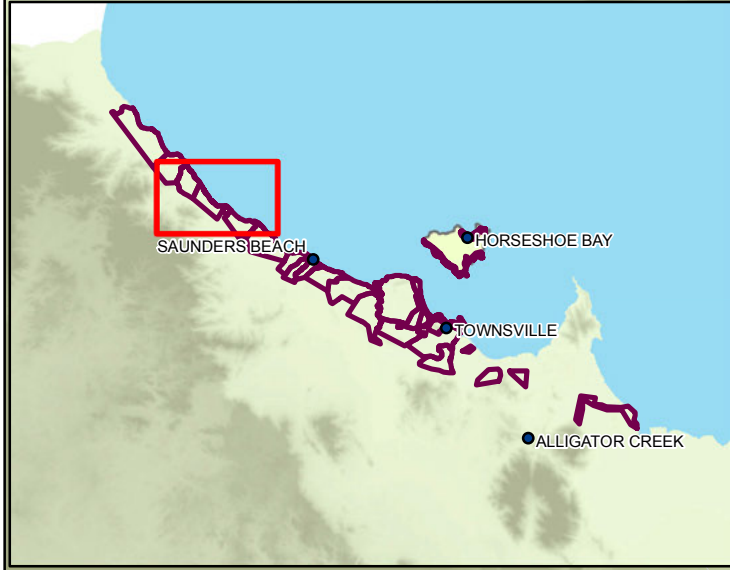
Map Series A3  
Sheet 2 of 11





Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



LEGEND

- Town / Locality
- Road
- +—+ Railway
- ▭ District Boundary
- ▭ Properties Boundary
- ▨ 100 y Return Period Storm Tide Event 2100 Conditions (0.8m SLR)

Risk to Property

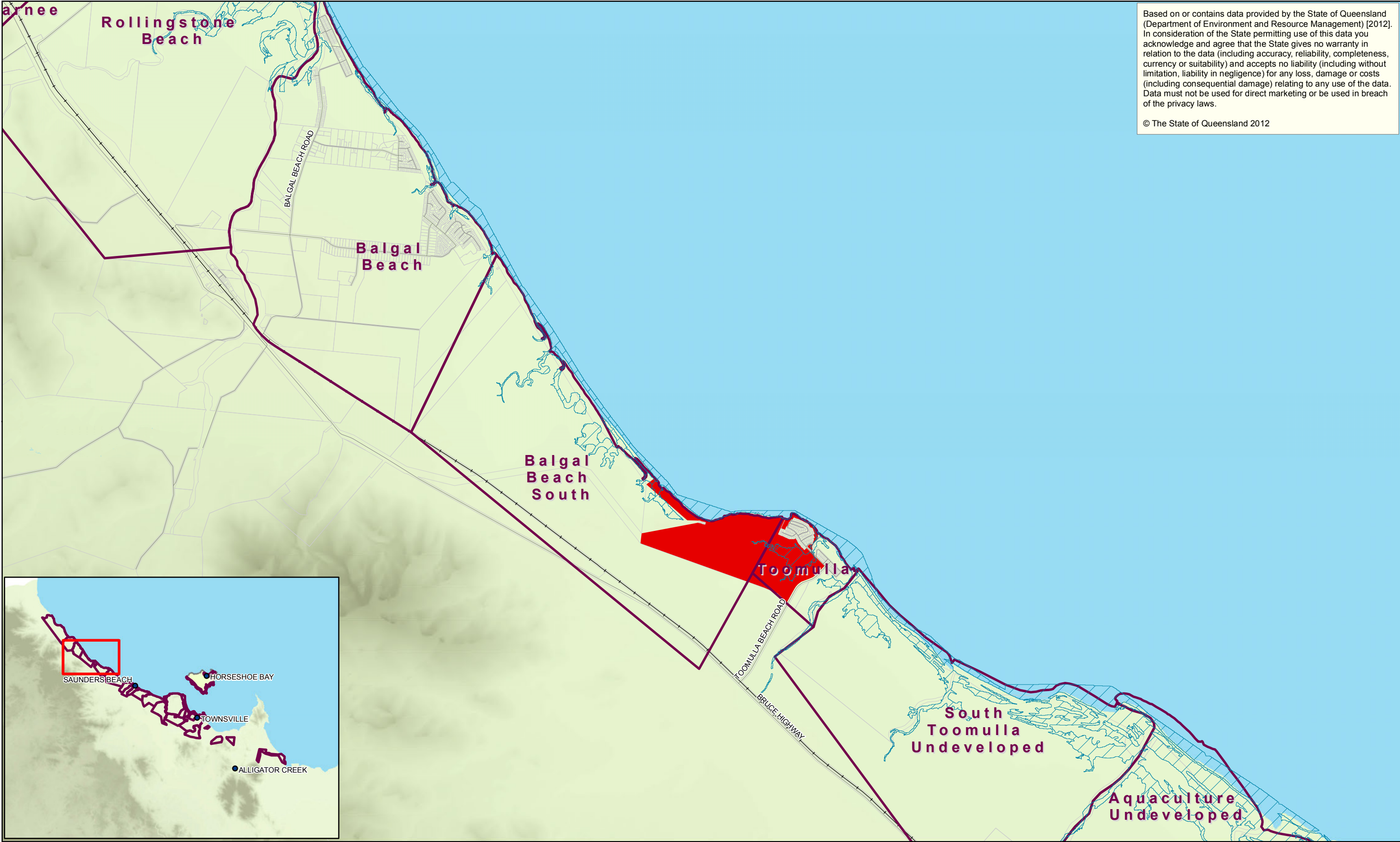
- ▭ Acceptable Risk
- ▭ Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
2100 Conditions (0.8m SLR)  
Risk To Property  
District: Balgal Beach

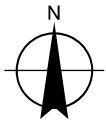
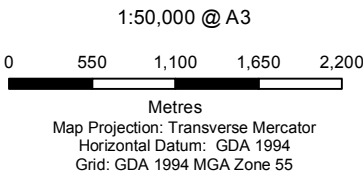
Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A4  
Sheet 2 of 11



Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



LEGEND

- Town / Locality
- Road
- +— Railway

- HAT (2012)
- Urban Locality
- Properties Boundary

Risk to Infrastructure

- Acceptable Risk
- Unacceptable Risk

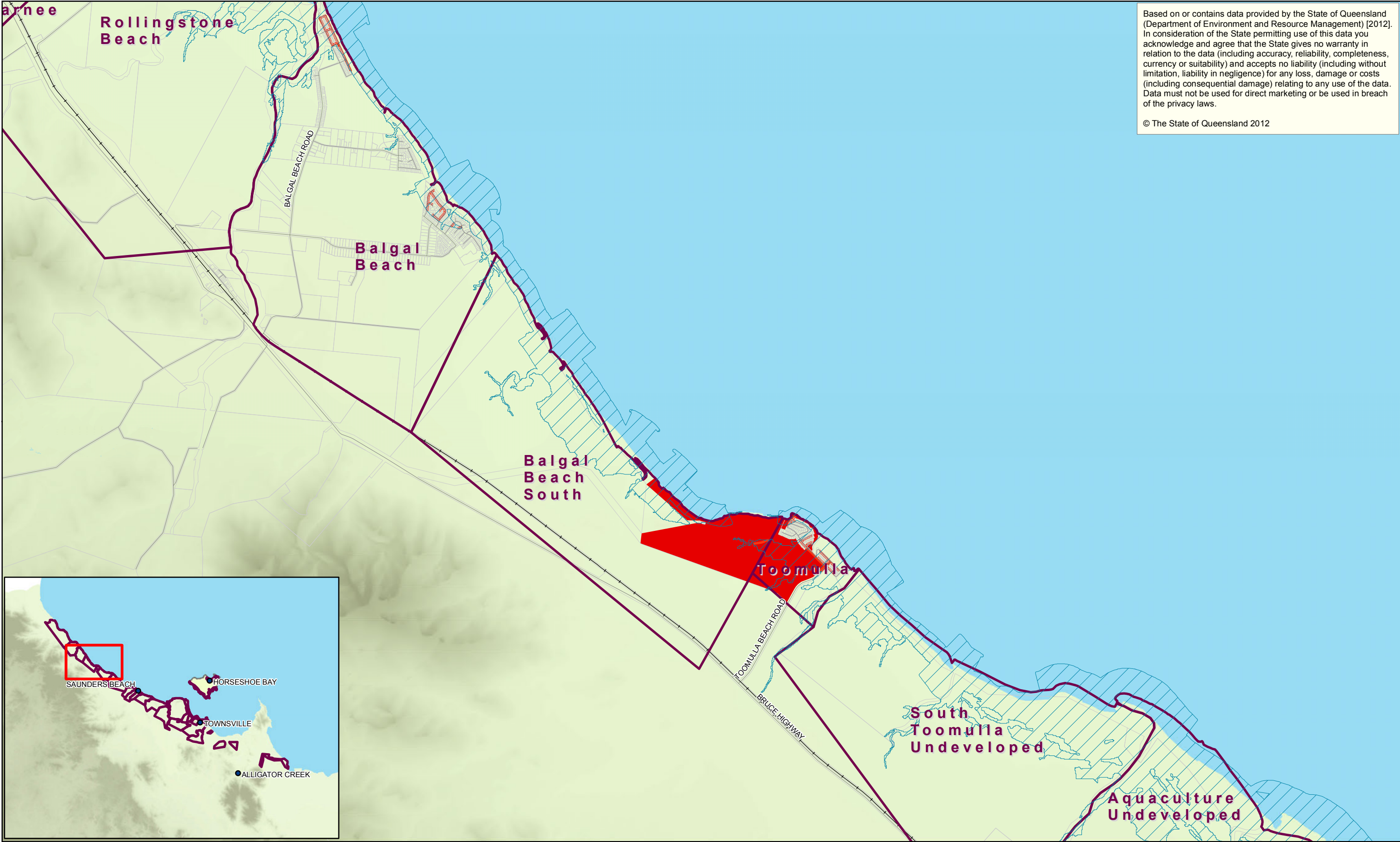


Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
Current Conditions (2012)  
Risk To Infrastructure  
District: Balgal Beach

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A5  
Sheet 2 of 11

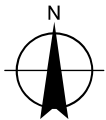




Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012

1:50,000 @ A3  
0 500 1,000 1,500 2,000  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- +—+ Railway
- Urban Locality
- Properties Boundary
- HAT 2100 Condition (0.8m SLR)

Risk to Infrastructure

- Tolerable Risk
- Unacceptable Risk

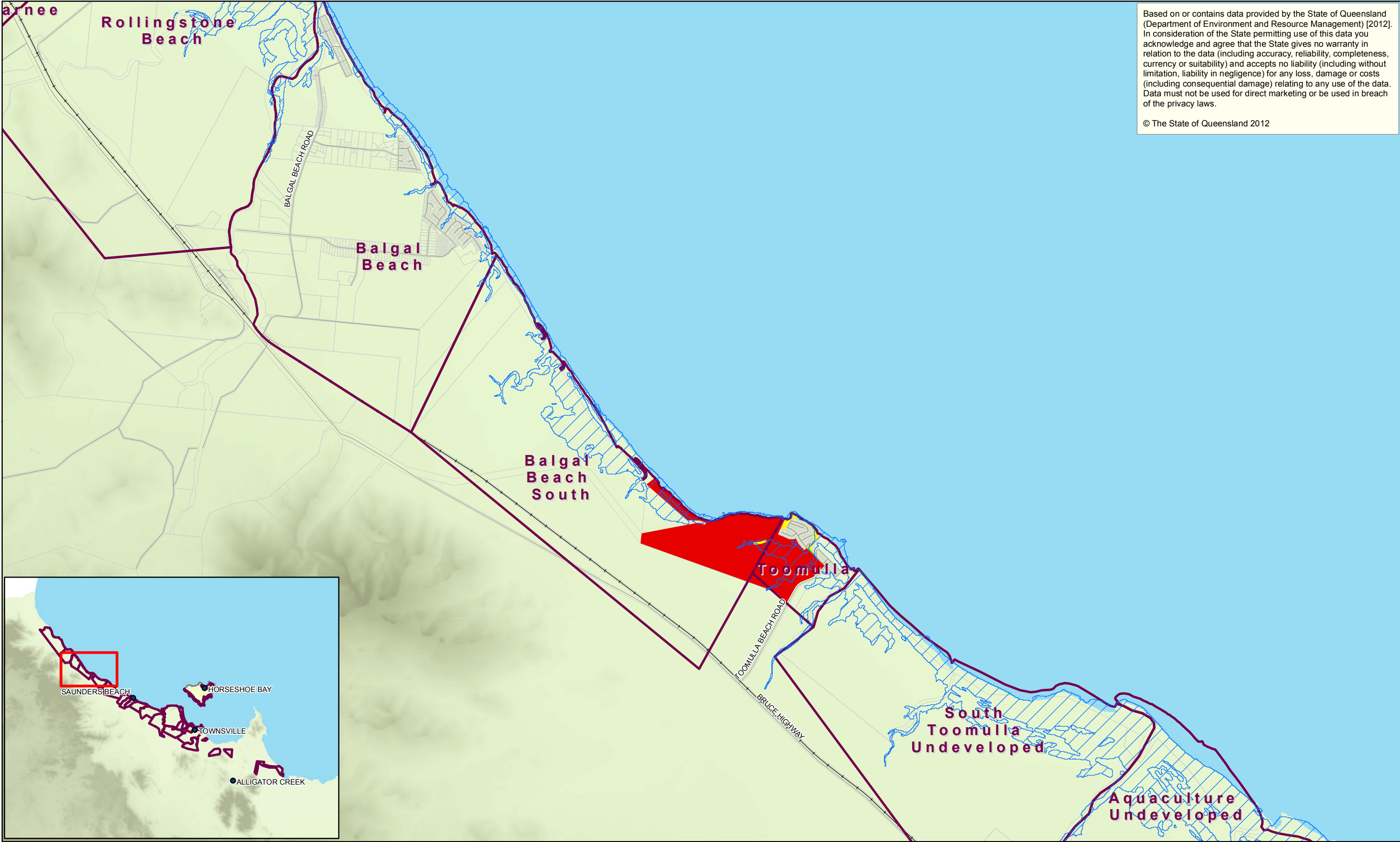


Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
2100 Conditions (0.8m SLR)  
Risk To Infrastructure  
District: Balgal Beach

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A6  
Sheet 2 of 11

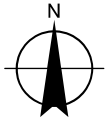




Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012

1:50,000 @ A3  
0 500 1,000 1,500 2,000  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- Railway
- Urban Locality
- Properties Boundary
- Storm Tide Event
- Current Conditions (2012)

Risk to Infrastructure

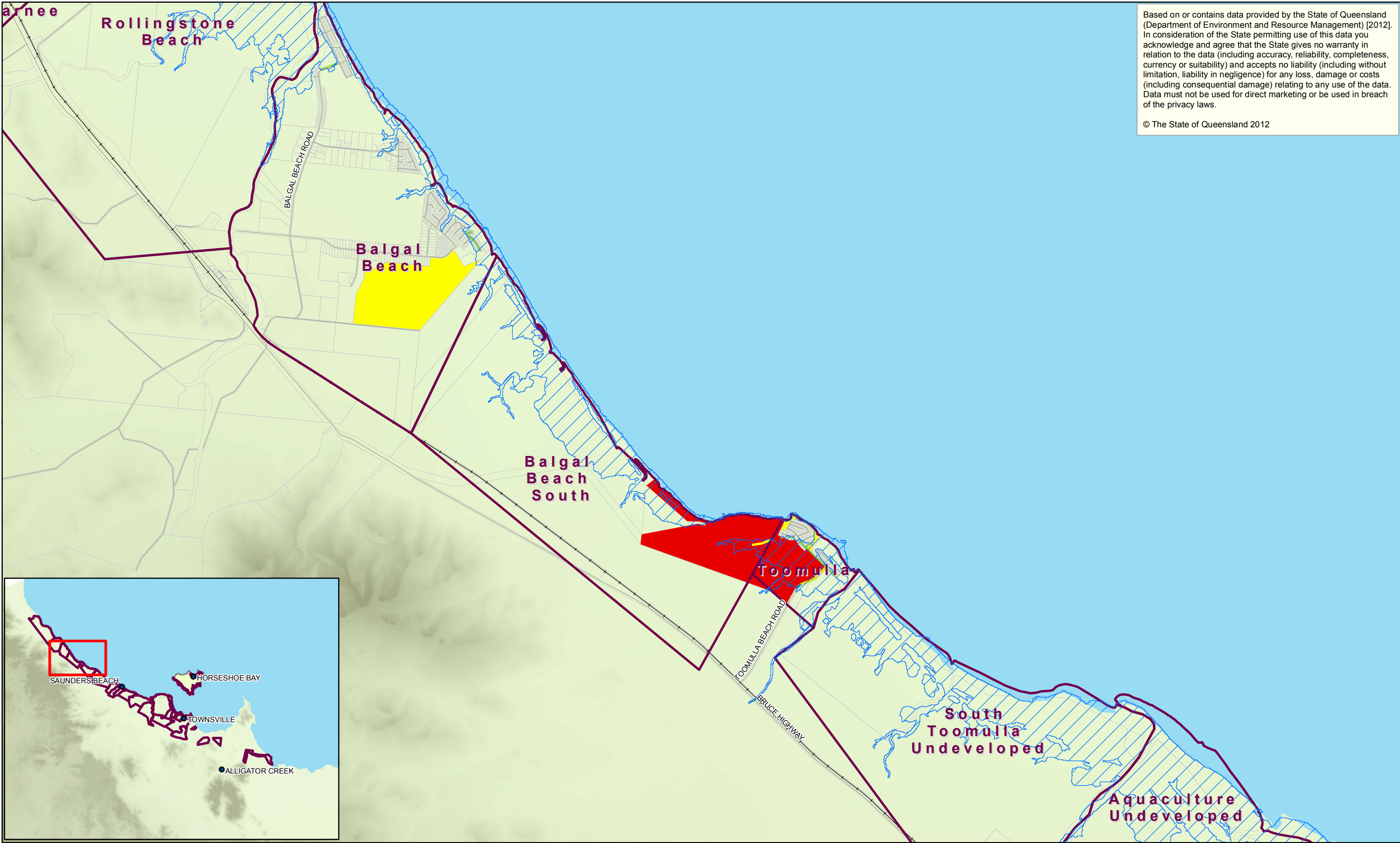
- Acceptable Risk
- Tolerable Risk
- Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
Current Conditions (2012)  
Risk To Infrastructure  
District: Balgal Beach

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

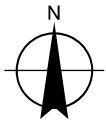
Map Series A7  
Sheet 2 of 11



Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012

1:50,000 @ A3  
0 500 1,000 1,500 2,000  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- +— Railway

Urban Locality

Properties Boundary

100 y Return Period Storm Tide Event  
2100 Condition (0.8m SLR)

Risk to Infrastructure

Acceptable Risk

Tolerable Risk

Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
2100 Conditions (0.8m SLR)  
Risk To Infrastructure  
District: Balgal Beach

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A8  
Sheet 2 of 11

G:\4124609\GIS\Maps\Working\4124609\_Stormtide\_2100Condition\_InfraRisk\_RevA\_20121009.mxd

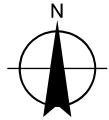
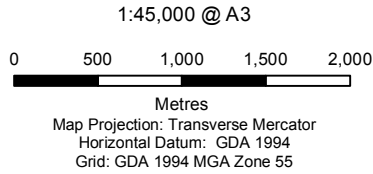
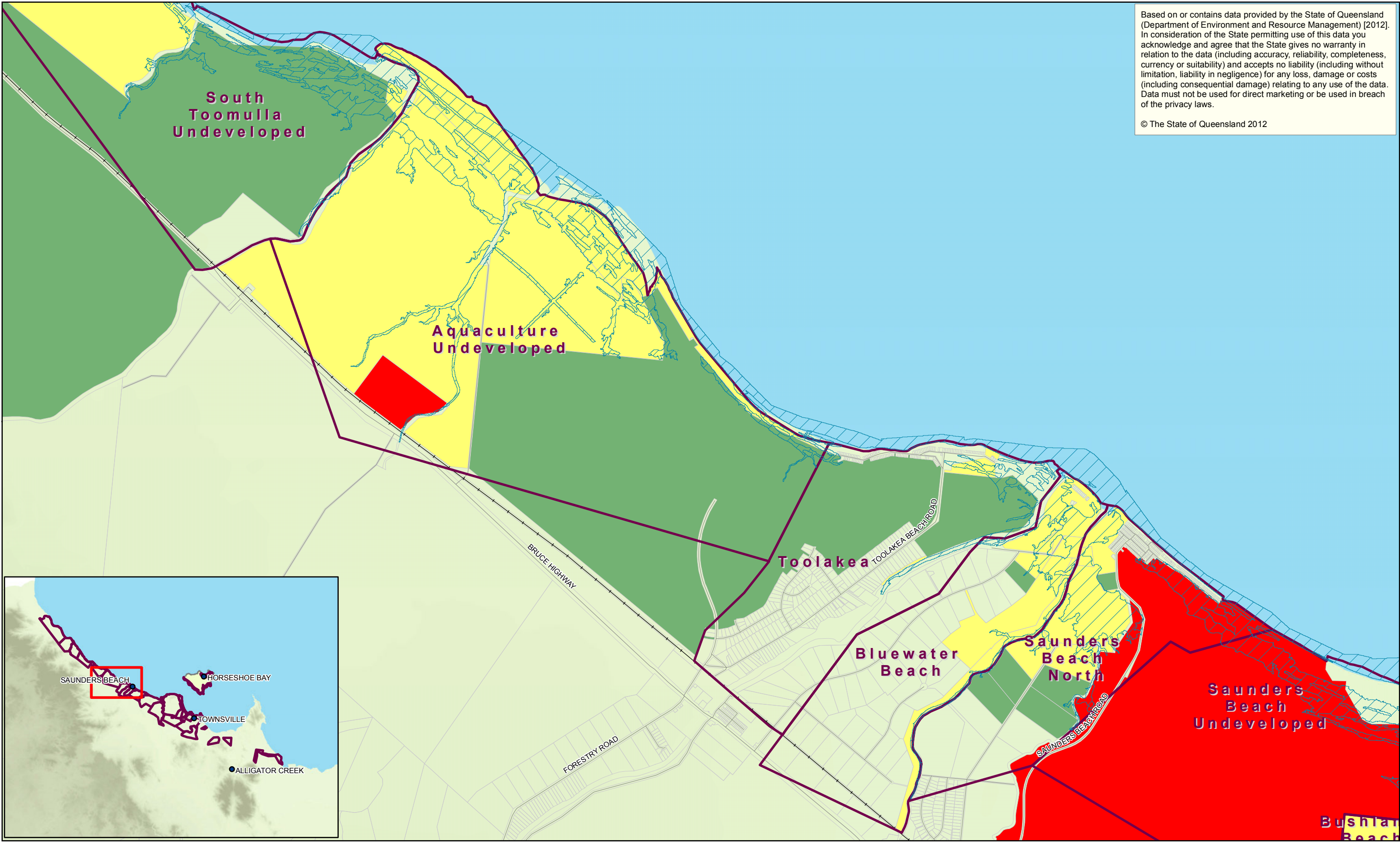
© 2012. Whilst every care has been taken to prepare this map, GHD, TCC, DERM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason. Data source: TCC - Railway, Roads, Properties, Districts (2011). Geoscience Australia - Populated Places (2008). DERM - DEM (2007). Place Names (2010). GHD- Ocean Boundary (2012).

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com



Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



LEGEND

- Town / Locality
- Road
- Railway
- HAT (2012)
- Urban Locality
- Properties Boundary

Risk to Property

- Acceptable Risk
- Tolerable Risk
- Unacceptable Risk



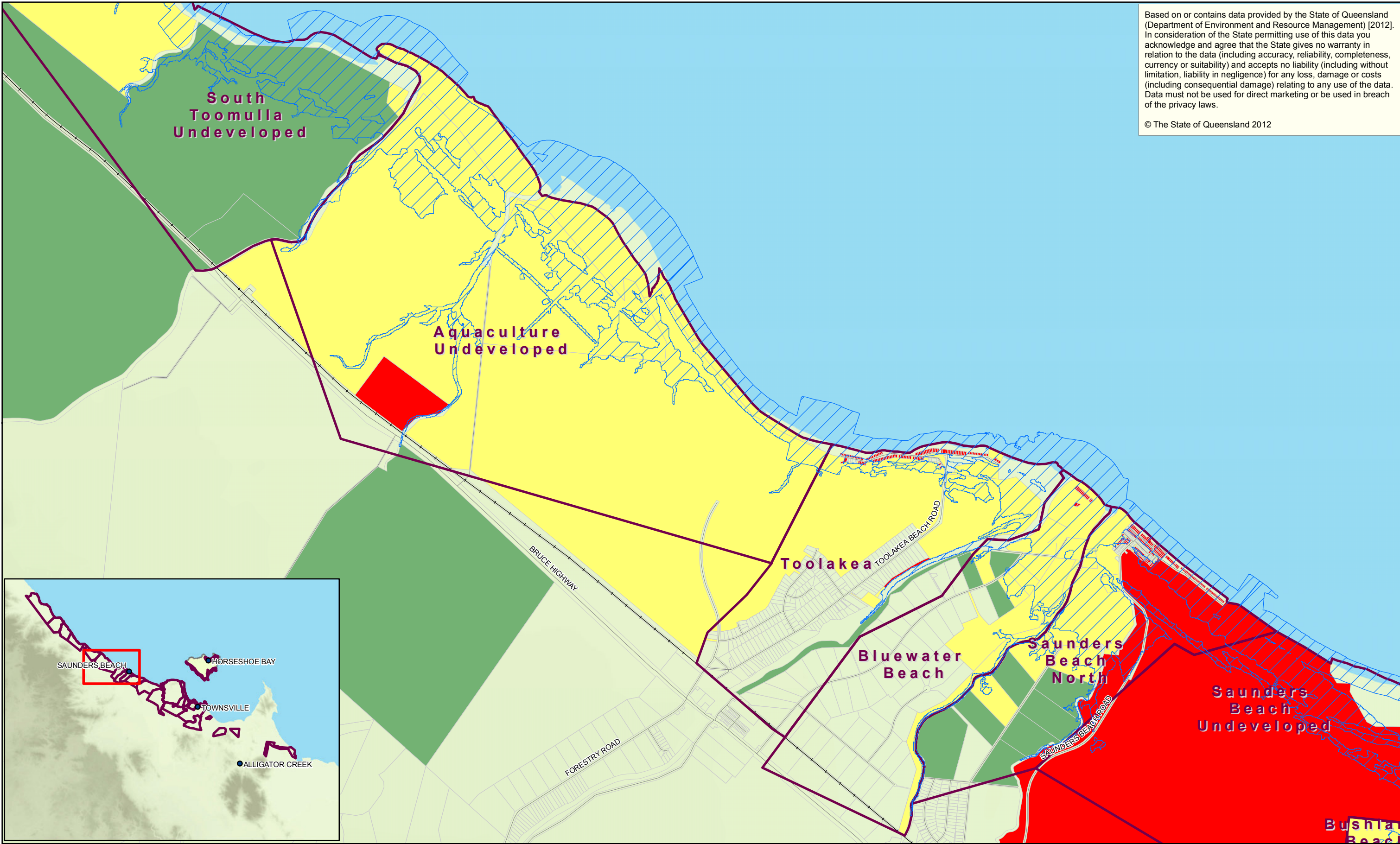
Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
Current Conditions (2012)  
Risk To Property  
District: Toolakea

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

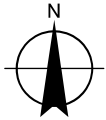
Map Series A1  
Sheet 3 of 11

Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



1:45,000 @ A3  
0 500 1,000 1,500 2,000  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- Railway

Urban Locality

Properties Boundary

HAT  
2100 Condition (0.8m SLR)

Risk to Property

- Acceptable Risk
- Tolerable Risk
- Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
2100 Conditions (0.8m SLR)  
Risk To Property  
District: Toolakea

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A2  
Sheet 3 of 11

G:\4124609\GIS\Maps\Working\4124609\_PermanentHazard\_Condition2100\_PropRisk\_RevA\_20121009.mxd

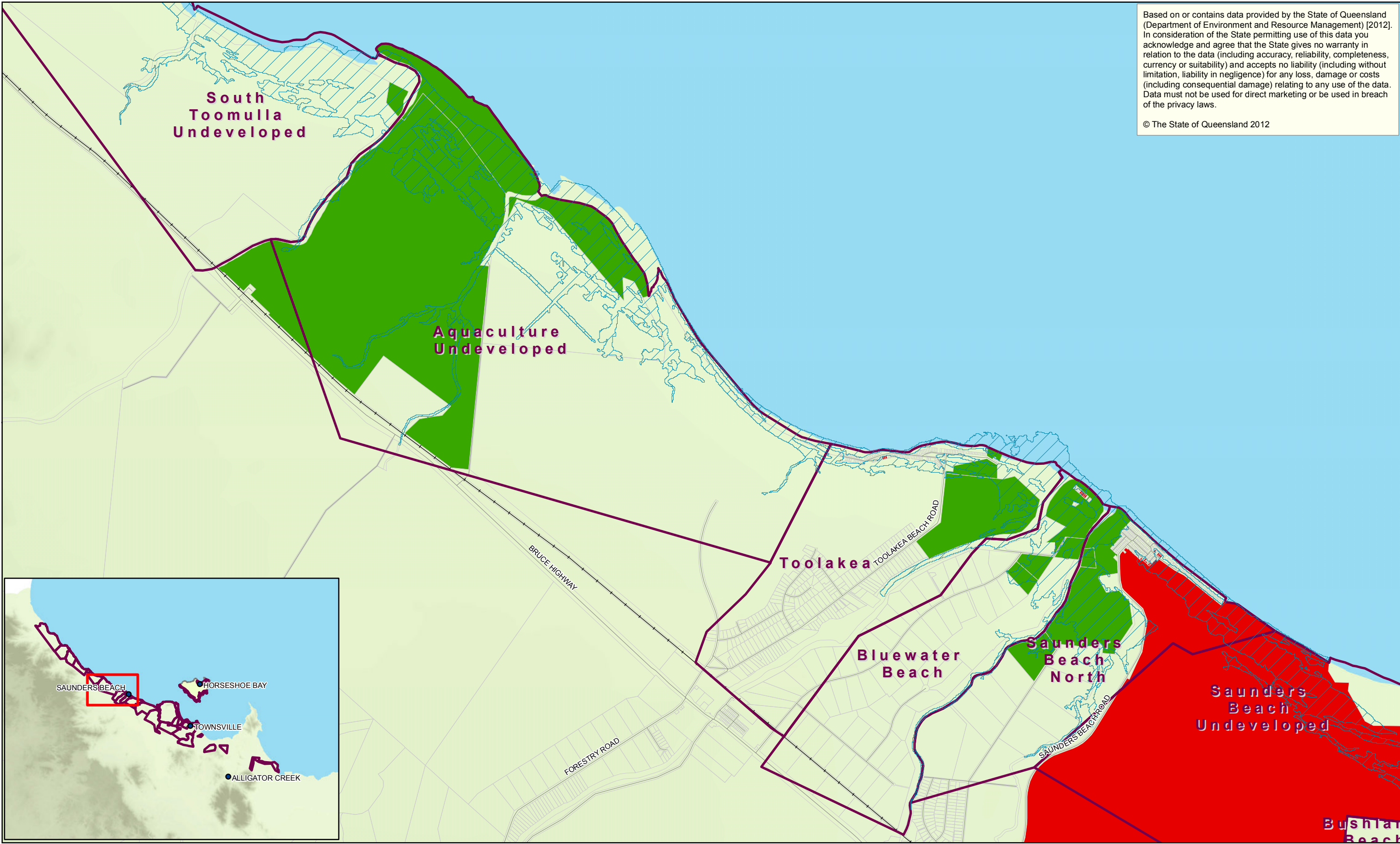
© 2012. Whilst every care has been taken to prepare this map, GHD, TCC, DERM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.  
Data source: TCC - Railway, Roads, Properties, Suburbs, Districts (2011). Geoscience Australia - Populated Places (2008). DERM - DEM (2007), Vulnerable Lands (2011), Place Names (2010). GHD - Ocean Boundary (2012).

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

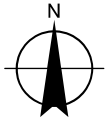


Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



1:45,000 @ A3  
0 500 1,000 1,500 2,000  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- +— Railway
- Urban Locality
- Properties Boundary
- Storm Tide Event Current Conditions (2012)

**Risk to Property**  
Acceptable Risk  
Unacceptable Risk



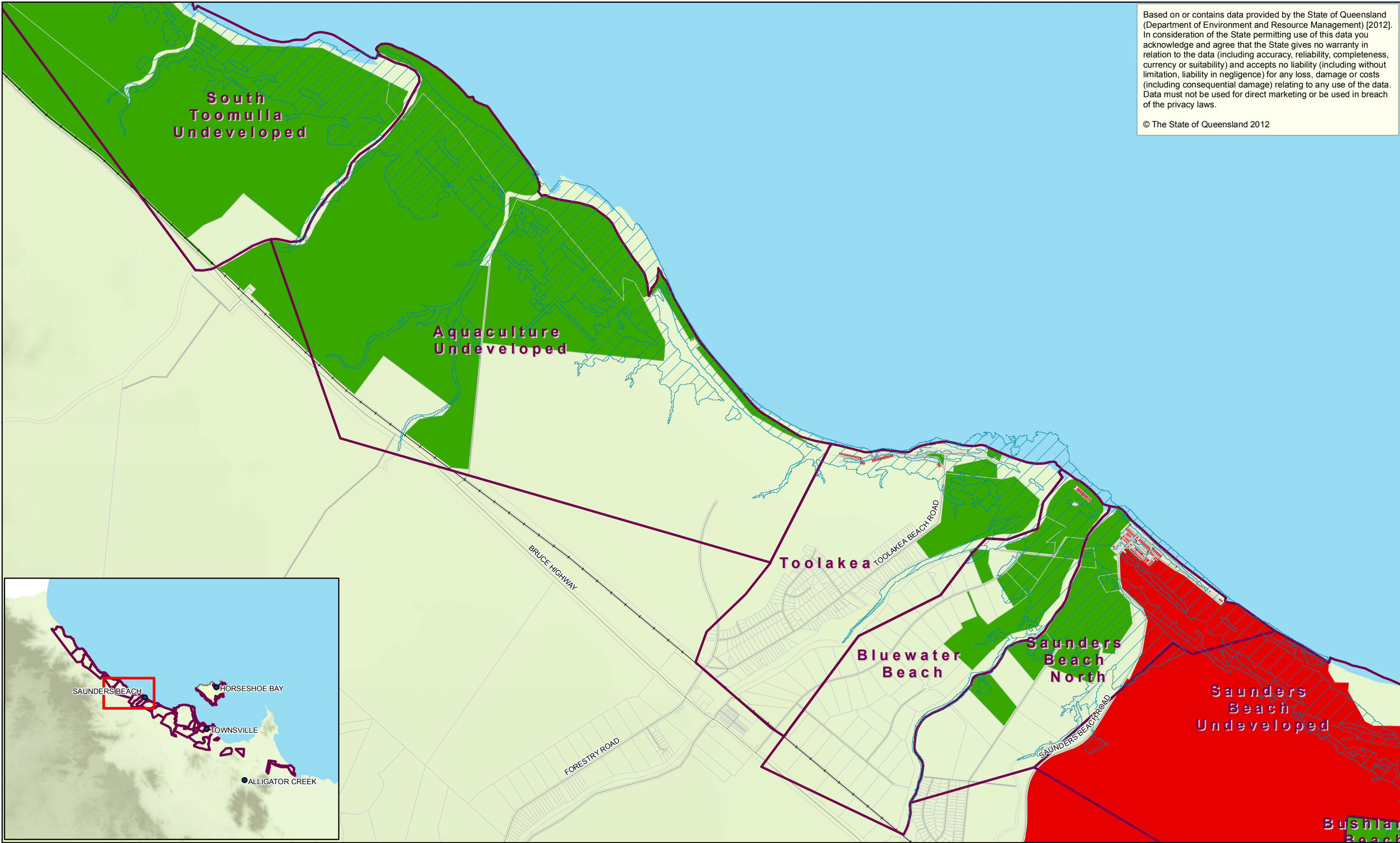
Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
Current Conditions (2012)  
Risk To Property  
District: Toolakea

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

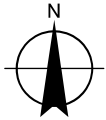
Map Series A3  
Sheet 3 of 11

Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



1:45,000 @ A3  
0 500 1,000 1,500 2,000  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- +— Railway
- District Boundary
- Properties Boundary
- 100 y Return Period Storm Tide Event 2100 Conditions (0.8m SLR)

Risk to Property

- Acceptable Risk
- Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
2100 Conditions (0.8m SLR)  
Risk To Property  
District: Toolakea

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A4  
Sheet 3 of 11

G:\4124609\GIS\Maps\Working\4124609\_Stormtide\_2100Condition\_PropRisk\_RevA\_20121009.mxd

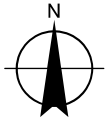
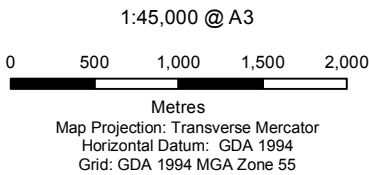
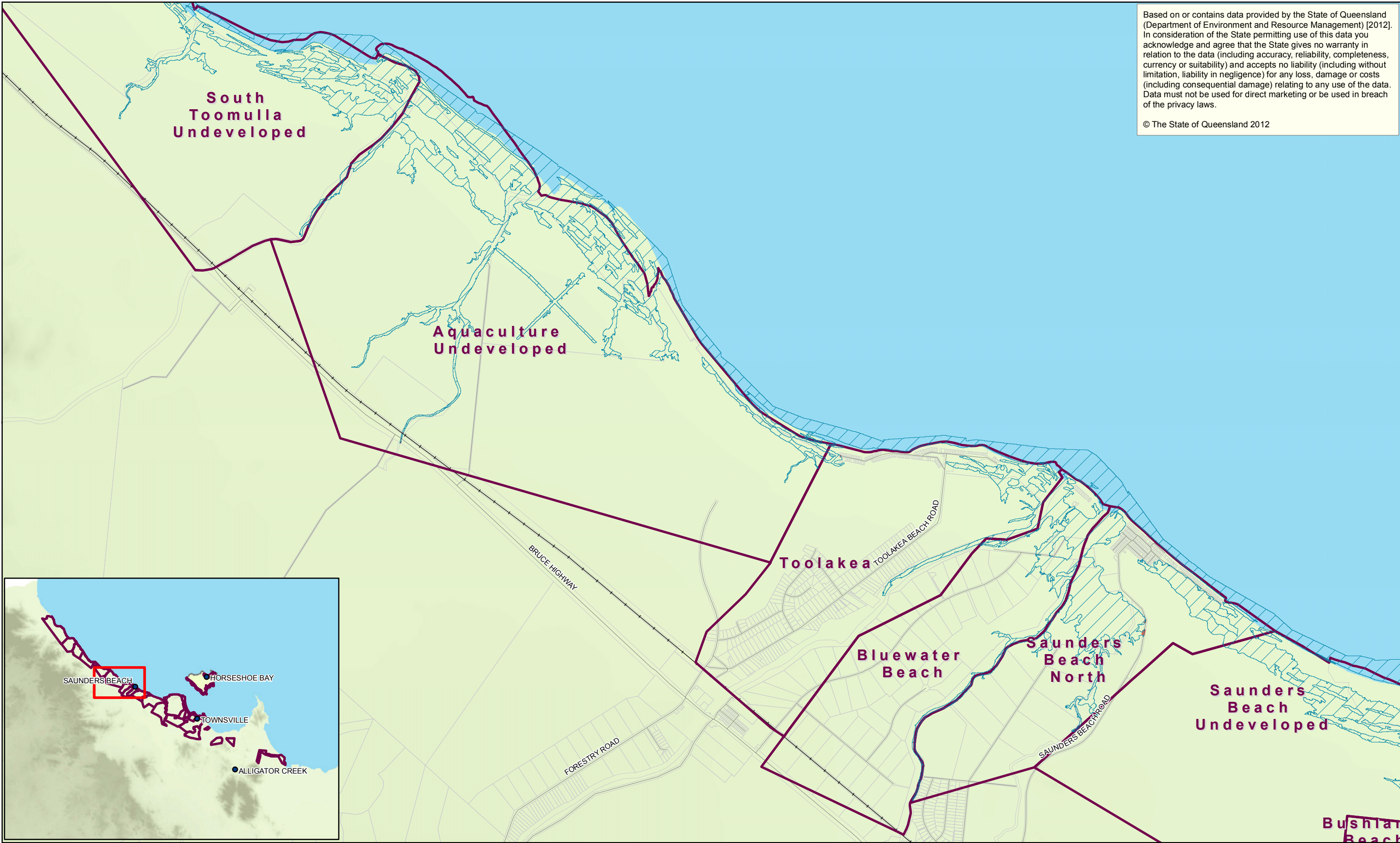
© 2012. Whilst every care has been taken to prepare this map, GHD, TCC, DERM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.  
Data source: TCC - Railway, Roads, Properties, Districts (2011). Geoscience Australia - Populated Places (2008). DERM - DEM (2007). Place Names (2010). GHD - Ocean Boundary (2012).

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com



Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



LEGEND

- Town / Locality
- Road
- +— Railway



HAT (2012)



Urban Locality



Properties Boundary

Risk to Infrastructure

Acceptable Risk

Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
Current Conditions (2012)  
Risk To Infrastructure  
District: Toolakea

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A5

Sheet 3 of 11

G:\4124609\GIS\Maps\Working\4124609\_PermanentHazard\_Current2012\_InfraRisk\_RevA\_20121009.mxd

© 2012. Whilst every care has been taken to prepare this map, GHD, TCC, DERM make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: TCC - Railway, Roads, Properties, Districts (2011). Geoscience Australia - Populated Places (2008). DERM - DEM (2007). Place Names (2010). GHD - Ocean Boundary (2012).

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

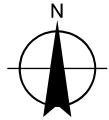


Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



1:45,000 @ A3  
0 500 1,000 1,500 2,000  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- +—+ Railway
- Urban Locality
- Properties Boundary
- HAT 2100 Condition (0.8m SLR)

**Risk to Infrastructure**  
Tolerable Risk  
Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
2100 Conditions (0.8m SLR)  
Risk To Infrastructure  
District: Toolakea

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

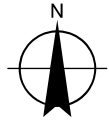
Map Series A6  
Sheet 3 of 11

Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



1:45,000 @ A3  
0 500 1,000 1,500 2,000  
Metres  
Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- Railway

- Urban Locality
- Properties Boundary
- Storm Tide Event
- Current Conditions (2012)

Risk to Infrastructure

- Acceptable Risk
- Tolerable Risk
- Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
Current Conditions (2012)  
Risk To Infrastructure  
District: Toolakea

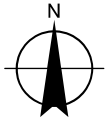
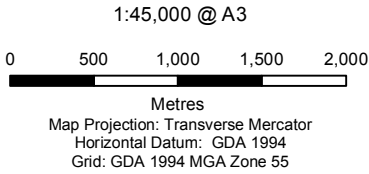
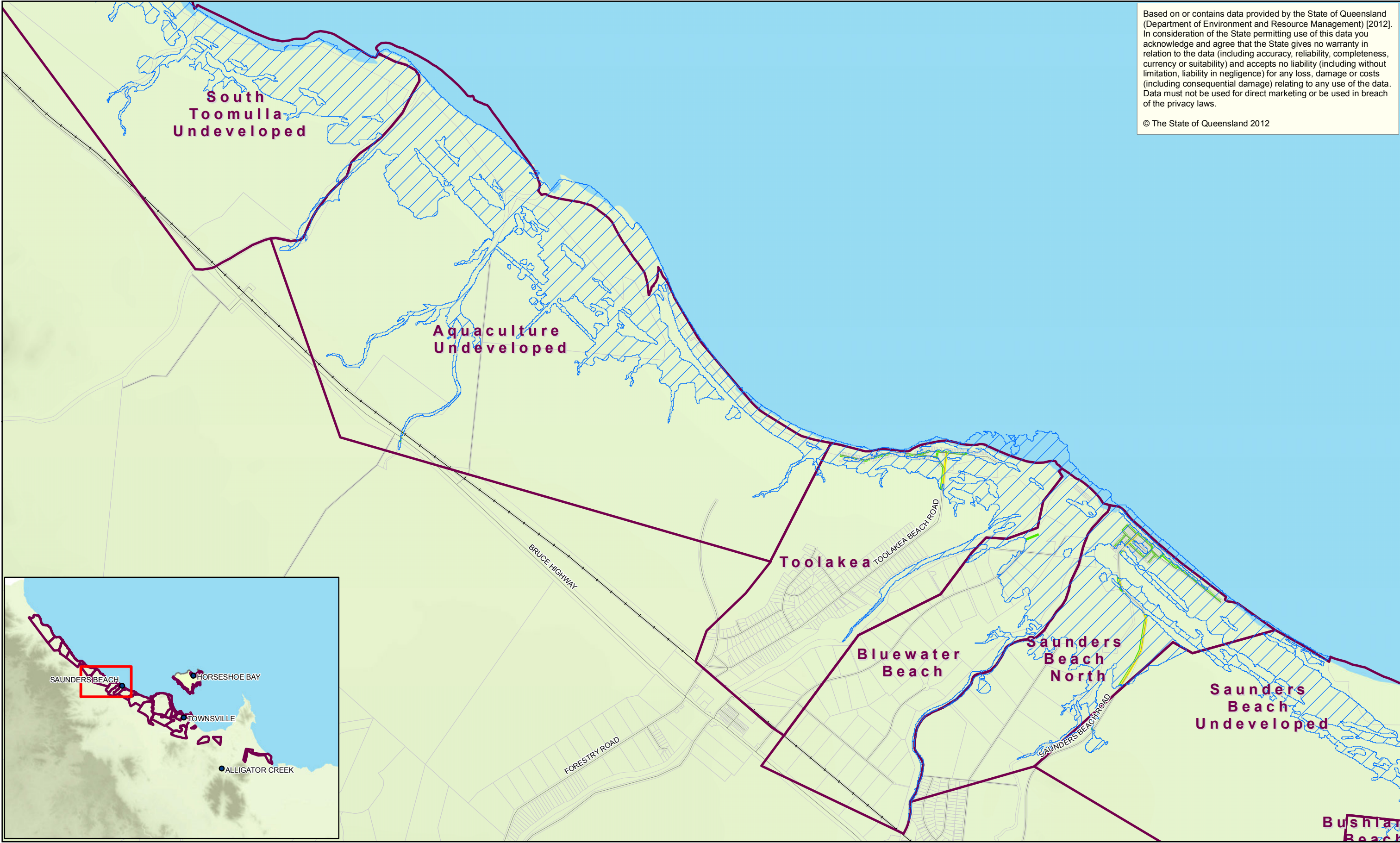
Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A7  
Sheet 3 of 11



Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management) [2012]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.

© The State of Queensland 2012



LEGEND

- Town / Locality
- Road
- Railway
- Urban Locality
- Properties Boundary
- 100 y Return Period Storm Tide Event 2100 Condition (0.8m SLR)

Risk to Infrastructure

- Acceptable Risk
- Tolerable Risk
- Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
2100 Conditions (0.8m SLR)  
Risk To Infrastructure  
District: Toolakea

Job Number 41-24609  
Revision A  
Date 12 Oct 2012

Map Series A8  
Sheet 3 of 11

