

2 STUDY APPROACH

2.1 Overarching Approach

The former Hervey Bay City Council had, for a number of reasons, difficulty in implementing the shoreline erosion management options identified in the *Hervey Bay Coastal Protection Strategy* (WBM, 2004) (see discussion in Lawson *et al.*, 2007). When scoping the methodology for the development of an SEMP for the new Fraser Coast LGA in 2009, FCRC sought to adopt an approach that would minimise the risk of these issues arising again. FCRC determined that it was necessary to adopt an approach that went beyond the SEMP guidelines outlined in the old QCP and incorporated more rigorous consultation and participation by the key stakeholders involved in management of the coastal zone. After reviewing the literature, FCRC prepared the initial scope of works for this project based on the methodology presented in the United Kingdom's Department of Environment, Food and Rural Affairs (DEFRA) *Shoreline Management Plan Guidance* manual (DEFRA, 2006).

In March 2011, and subsequent to commencement of the project, the Queensland Government released the updated QCP and companion documents, including the *State Planning Policy for Coastal Protection Guideline* (DERM, 2011c) which provides updated guidance on the approach to preparing SEMPs. A review of the new SEMP guidelines conducted by Cardno confirmed that the Fraser Coast SEMP project was largely compliant with the new SEMP guidelines, but that some modification of the project methodology would be required to ensure compliance with the new guidelines prepared under the updated QCP. The Fraser Coast SEMP will need to comply with the QCP guidelines in the event FCRC wishes to seek endorsement of the Plan by the Minister.

Consequently, an effort has been made to adopt a methodology for preparing the Fraser Coast SEMP that meets the requirements of the QCP, but also incorporates those elements of the DEFRA guidelines that add value to the SEMP process. This section outlines the methodology adopted, and concludes with a table that cross references the tasks undertaken to prepare this report with the corresponding activities listed in both the QCP and the DEFRA guideline documents (Table 2.5).

2.2 Consultation

Development and activities within the coastal zone involves a complex interplay between a broad range of stakeholders including State and local governments, the local community, environment and commercial interests.

To inform the development of an SEMP that has broad acceptance there is a need to consult with key stakeholders and the community at least initially to raise awareness about shoreline erosion issues. In order to address this requirement, a *Stakeholder Consultation Plan* (CPR Group, 2011) was developed to guide the consultation process.

The stated objectives of the consultation process are:

- To ensure that the community is made aware of the SEMP process;

- To deliver information and key messages on the SEMP to stakeholders and collect feedback; and
- To ensure the SEMP is developed with formal input from the community, to achieve transparent and acceptable outcomes.

A range of consultation mechanisms were used to obtain input to the SEMP, including the establishment of formal steering committees to direct consultation with key stakeholders and community representatives. Input from the community and key stakeholders has been considered in the development of this *Erosion Management Options Assessment Report*.

2.2.1 Stakeholder Consultation

In order to guide the development of the Fraser Coast SEMP a steering committee was established by FCRC. The committee consists of a core group known as the Client Steering Group (CSG), while a larger consultative body including a wide range of stakeholders known as the Extended Steering Group (ESG) was also convened.

Client Steering Group

The function of the CSG is to assist FCRC with technical direction and overall project management of the development of the SEMP. It includes technical experts and representatives of State and Local Government, as well as the technical specialists comprising the project team, including:

- FCRC's project manager and project director from the Environment, Sustainability and Open Space team (which is responsible for coastal management);
- Representatives from DERM's Coastal Unit, who assist FCRC with technical oversight and direction;
- Representatives from various State Government agencies with a concurrence or approvals role in coastal development, including DERM's Cultural Heritage Coordination Unit and Queensland Parks and Wildlife Service, DEEDI, Maritime Safety Queensland (DTMR), and the Burnett Mary Regional Group;
- Independent technical experts in coastal management; and
- Members of the consultant project team, including Cardno and CPR Group.

Extended Steering Group

As outlined above, the ESG has a wider consultative function. A number of invitations were issued to seek expressions of interest in sitting on the Committee, and the final ESG consists of:

- All members of the CSG;
- Fraser Coast Councillors;
- Additional FCRC staff with a role in strategic management of the coastal zone, including staff from Strategic Planning and Engineering Services; and
- Representatives of local Progress Associations.

The ESG facilitates information sharing between FCRC, its technical specialists and key stakeholders in the management of the Fraser Coast coastline and wider community. It facilitates ongoing dialogue and is the main forum to communicate FCRC's objectives, present relevant reports or documents, and discuss issues. In addition, communication was undertaken as required with a number of the committee members on specific issues outside of the formal meetings.

Invitations to every ESG meeting are sent to all the Progress Associations within the LGA, and to the Queensland South Native Title Representative Body. Introductory telephone calls were also made to invite participation in SEMP consultation by Traditional Owners, however, no expressions of interest in sitting on the ESG were received. A meeting was held with Dr Eve Fesl as she was referred to the project team as a Native Title Party for part of the area. Dr Fesl recommended that FCRC peruse previous Cultural Heritage studies for the coastline and that a Cultural Heritage assessment be completed to identify at a high level where there are likely to be Cultural Heritage implications.

Meetings

Meetings of the CSG and ESG were held on the following occasions:

- *Inception meeting, 10 February 2010* – An inception meeting was held with FCRC and the project team in order to confirm the proposed scope of works and discuss the proposed composition of the Steering Committees. Subsequent to this meeting, invitations were issued to various organisations and the CSG and ESG were formed. One of the key outcomes of this meeting was advice from DERM that they were currently in the process of updating the EPAs for the Fraser Coast as part of the review of the QCP, and that (when available) this information could be provided for use in this SEMP (as per Section 2.2).
- *First Meeting of the CSG and ESG, 13 April 2010* – The purpose of the first meeting of the committees was to present the proposed scope of works, confirm the committee members' interest in the study, and seek feedback on the methodology. FCRC gave a presentation on the need for the study, and Cardno and CPR Group presented on the proposed methodology. FCRC identified that one of the key challenges for the project was the need for early input from consent/concurrence authorities on the compatibility of proposed coastal protection works with the regulatory framework. The relevant authorities indicated that they would be happy to provide comment on the SEMP but were unable to provide 'in principle' approval until such time as a detailed development proposal was prepared.
- *Second Meeting of the CSG and ESG, 7 July 2010* – A second meeting was held in order to present the findings of the first stage of the larger SEMP project, the draft *Gap Analysis Report*. The key finding was that there was likely to be a need to demonstrate a 'Net Benefit to the State' in implementing the SEMP in order to obtain endorsement of the Plan, but that the regulatory environment remained challenging. It was also suggested that the study should await the release of the updated EPAs for the Fraser Coast LGA.
- *Project on hold pending release of updated QCP and EPAs, January 2011* - Further informal discussion was held between FCRC, Cardno and DERM on the updated QCP and EPAs, and the implications for the Fraser Coast SEMP. A decision was made to place the

project on hold until such time as this information became available. The new QCP and Fraser Coast EPAs were released in March 2011.

- *Third Meeting of the CSG and ESG, 31 May 2011* – The purpose of the third meeting with the Committees was to present the new 2100 EPAs for the Fraser Coast, including those developed by DERM for the Hervey Bay area, and those developed by Cardno for the Great Sandy Strait area. A *Risk Assessment Discussion Paper* outlining the proposed risk assessment methodology was presented and endorsed by the committee (see Appendix B).
- *Fourth Meeting of the CSG, 14 October 2011* - The first draft of this report (*Shoreline Erosion Management Options Report Version 2*) was distributed to the Committee members for review. The comments provided were then discussed with the CSG at the meeting, and an approach for preparing the second draft report (Version 3, i.e. current version) was agreed.

2.2.2 Community Consultation

Direct consultation with the community has been facilitated by CPR Group on behalf of FCRC. The engagement with the community undertaken to date has focussed on:

- Identifying community usage and values associated with the Fraser Coast coastline;
- Understanding the communities awareness of risk from erosion and obtaining information on historical erosion issues; and
- Assessing what types of erosion management approaches were considered suitable.

The key mechanisms used to provide information about the project and to seek input from the community were:

- Establishment of a free call telephone number (1800 100 204), email address (SEMP@cprgroup.com.au) and website update regarding the project (<http://www.frasercoast.qld.gov.au/web/guest/sempr>);
- Advertisement of project commencement in the Fraser Coast Chronicle (3 and 10 April 2010);
- Publication of a series of articles in the Fraser Coast Chronicle and Fraser Coast Living to advertise the project and provide updates;
- Councillor briefings (21-22 April 2010);
- Direct consultation with neighbourhood Progress Associations; and
- Distribution of a questionnaire to the Progress Associations, a range of community groups, a Neighbourhood Centre and any other interested parties.

Briefing notes were prepared to support the consultation activities undertaken, and a number of informal discussions with community members were also conducted throughout the course of the project.

Community input to the project has been voluntarily sought, with responses received from around 400 people who discussed the SEMP with the project team and provided a large number of photographs documenting historic erosion issues. A summary of the matters raised during the community consultation program is provided in Appendix A.

The feedback received thus far from stakeholders and the community has been considered in assessing the values and uses of the coastal zone (Section 5), consequences of erosion for the community (Section 6), formulation of management objectives (Section 7.1), and in developing and assessing the management policies and options (Sections 7.2-7.3).

2.3 Public Exhibition

The *Draft Erosion Management Options Assessment Report* was presented to the FCRC and the CSG for further comment prior to finalisation.

The Draft Report was also placed on Public Exhibition from 22 December 2011 to 3 February 2012. A copy of the report was placed at each of Council's Customer Service Centres in Tiaro, Maryborough and Hervey Bay, and additionally at Council's libraries in Hervey Bay, Maryborough and Burrum Heads. The report was also available to view on Council's website.

Flyers advertising the *Draft Erosion Management Options Assessment Report* were distributed through The Maryborough Herald, the Hervey Bay Independent and the Fraser Coast Chronicle. Advertisements and articles on the report also appeared in the Fraser Coast Chronicle.

The submissions received during the public exhibition period were collated and summarised by Council. Council and Cardno prepared a response to each submission, which answered the respondents question, provided further information as required, and identified necessary changes to the draft Report. The outcome of this process was the preparation of this final Options Assessment Report.

2.4 Planning Horizons

Proactive planning to minimise the impacts of predicted shoreline erosion in the coastal zone requires developing responses and activities to implement prior to the predicted impacts occurring. In general, these plans seek to look to a future planning horizon.

The key difference between the UK and Queensland shoreline management approaches relates to the chosen planning horizons. The QCP requires consideration of both existing and potential future shoreline erosion based on the 2100 planning horizon. The SEMP is then required to adopt an implementation timeframe of 20 years. A different approach is adopted in the UK, for which the DEFRA guidance requires consideration of potential hazards from shoreline erosion for 2030, 2050, 2070 and 2100 horizons. Management policies and options are then developed for each of these four planning horizons. As a result, the SEMP effectively provides for an implementation timeframe of 90 years.

Planning horizons to be adopted for the Fraser Coast SEMP were agreed in consultation with the CSG, noting that there was a degree of uncertainty surrounding the longer term (2050, 2070 and 2100) planning horizons due to:

- Uncertainty relating to the projected impacts of climate change on rates of shoreline erosion;
- Uncertainty surrounding the other potential impacts of climate change hazards (i.e. including storm tide, SLR inundation and catchment flooding) on existing and future development in the Fraser Coast LGA; and

- Acknowledgement that the patterns of development and land use within the study could change significantly over the coming years.

For these reasons, it was agreed that this project would:

- Develop EPA extents for the 2030 (nominal 20-year) planning horizon to assess the short term (or existing) risk to development and assist FCRC with operational planning for the next 20 years;
- Present the EPA extents for the 2100 planning horizon to provide context on the potential long term impacts of shoreline erosion; and
- Develop EPA extents for the 2050 and 2070 planning horizons, and consider in a qualitative sense the potential medium term impacts of shoreline erosion.

In adopting this approach, it is intended that the Fraser Coast SEMP focus on reducing existing risk by including management options that are based on consideration of the likelihood and consequences of shoreline erosion up to 2030. The SEMP will also include guidance on management options that seek to minimise the longer term risk of shoreline erosion (i.e. to 2100) by controlling or limiting future development within the 2100 EPAs.

2.5 Derivation of Erosion Prone Areas

2.5.1 Background to EPAs

In Queensland the vulnerability of land adjacent to the shoreline from erosion is characterised by the Erosion prone area (EPA). The EPA concept was developed by DEHP as a coastal planning tool to assist in planning development free buffer zones adjacent to the coastline. EPA widths describe the vulnerability of a coastline to encroachment from erosion associated with the following processes (DERM, 2011b):

- Short-term storm erosion (otherwise referred to as storm bite), due to storm induced waves acting on the shoreline for the storm duration;
- Dune scarping (collapse of a near-vertical post-storm erosion scarp to a more stable slope);
- Historic long term erosion trends (shoreline recession);
- Shoreline recession due to projected SLR (that is, SLR inundation and shoreline adjustment to SLR); and
- A safety factor that increases the EPA width by 40%.

The EPA is a concept that acts as a tool to assist in broad scale, long term planning in the coastal zone and any estimates of EPAs need to be considered in this context. EPAs were initially introduced in 1984 as a statutory planning tool under the *Beach Protection Act 1968*. They were intended to trigger a requirement for concurrence from DEHP on the approval of proposed development in the coastal zone, whereby the EPAs were used to guide decisions on land surrender for the reconfiguration of established lots.

Incorporating as it does a safety factor of 40% the EPA methodology likely overestimates the net long term trend in shoreline erosion. On the other hand, the EPA width shows the change in the average shoreline position, and there may be significant fluctuations around this average due to seasonal and/or inter-annual changes in wave climate and storm activity. For example, if two storms occur in close succession, the amount of observed erosion would be greater than for a single isolated storm event (of the same intensity) because there has been limited beach recovery between storms. Nonetheless, the EPA methodology developed by DEHP is considered to be sufficiently conservative for use in the current study.

As outlined in Section 1.1, the State Government has recently updated the framework for coastal management through the preparation of a new QCP (DERM, 2011a), released in March 2011. DEHP has also updated the EPA mapping originally prepared by the Beach Protection Authority and has published new mapping for the Hervey Bay area showing the extent of EPAs for 2100 (i.e. incorporating 0.8m sea level rise) (<http://www.derm.qld.gov.au/coastalplan/>). These maps show:

- Indicative EPAs comprising areas at risk from erosion and permanent inundation under projected 0.8 m (nominally 2100) SLR; and
- Default storm tide inundation extents for the 100-year average recurrence interval (ARI) storm event under projected 0.8 m SLR, divided into areas subject to medium hazard areas (inundation depths <1 m) and areas subject to high hazard (inundation depths >1m).

The mapping prepared by DEHP highlights that there are significant areas of both developed and undeveloped land at risk from erosion under a 0.8m SLR (2100) scenario.

2.5.2 Derivation of EPAs for the Study Area

EPAs have been estimated for the Fraser Coast LGA using the current methodology presented in the *Queensland Coastal Hazards Guidelines* (DERM, 2011b). Cardno was provided with the 2100 EPAs developed by DEHP for the Hervey Bay area in spreadsheet format. Cardno then modified the 2100 EPAs for Hervey Bay provided by DEHP to develop the 2030, 2050 and 2070 SLR planning horizons also requested by FCRC.

Advice provided by DEHP (DERM, 2011d) identifies that the EPA estimation methodology was developed for coastlines that experience moderate to high wave energy, which applies only to the Hervey Bay area. For the tidally dominated Great Sandy Strait area, DEHP advised that the study should adopt a default EPA width taken as the line which is 40 m landward of the line formed by the intersection of the Highest Astronomical Tide (HAT) surface and the coastal topography (DERM, 2011d). The HAT value for each planning horizon is increased equivalent to the projected SLR estimate for that planning horizon (e.g. $HAT_{2100} = HAT_{2010} + 0.8m$ SLR). EPAs were adopted for the Great Sandy Strait area for the 2030, 2050, 2070 and 2100 planning horizons in accordance with this advice.

The EPA calculations are considered conservative estimates of the risk of erosion that may potentially occur in a particular coastal location – that is, they are likely to overestimate erosion. The intent of the EPA formula is primarily to adopt a precautionary approach to land use (or site) planning, and in this regard the EPA calculation methodology prescribed by DEHP (DERM, 2011b) is appropriate.

Whilst there are some limitations associated with applying the EPAs to develop shoreline erosion management options, it is considered that the EPAs are sufficient to develop an understanding of erosion risk and for prioritising locations requiring management within the larger Fraser Coast study area.

Further detail on the EPA methodology, the components of the formula and its application to the calculation of EPAs along the Fraser Coast coastline can be found in Appendix B.

2.6 Derivation of Management Zones

To assist management, the study area was divided into five smaller management zones on the basis of:

- Sediment transport processes (after BPA, 1989; Helman,2010);
- Substrate type (e.g. rock, sand);
- Topography;
- EPA boundaries; and
- Development intensity in the landward portion of the coastal zone (as interpreted from aerial photography).

Each of these factors make some contribution to the level of risk associated with shoreline erosion (see Section 2.7).

2.7 Analysis of Constraints and Opportunities

It is important to consider the constraints and opportunities for management of shoreline erosion for a number of reasons, including:

- To inform the risk assessment process;
- To assist in translating the principles and policies outlined in the QCP (DERM, 2011a) into management objectives for the Fraser Coast SEMP; and
- To develop and assess different erosion management options.

One of the key constraints on the implementation of shoreline erosion management initiatives under the SEMP is the statutory and non-statutory framework. Prior to implementation, many of the erosion management options available will require permits or approvals from at least one authority, as required under the statutory framework. This relates primarily to those options requiring on the ground works. While policies and plans do not have the same statutory weight, they do identify preferred types of management options, and have therefore been considered. The statutory and non-statutory constraints are discussed in relation to the SEMP in Section 4, and the outcomes incorporated into the options assessment.

There are also a number of values or uses associated with the study area. These values or uses will influence the level of risk from shoreline erosion (see Section 2.7) that may influence the type of management policy or option adopted in the SEMP. An overview of the values and uses of the study area was undertaken for the following broad value categories:

- Land use and land tenure;

- Critical infrastructure;
- Environmental values; and
- Socio-economic values.

The different attributes or features considered under each of these value categories was determined by the availability of information to guide the analysis of constraints and opportunities. The *Gap Analysis Report* (Cardno, 2011) presents a summary of the information collated for the purposes of this study. Values have also been informed by community input obtained from the completed surveys (Section 2.2.2). The data considered in relation to each of the value categories is identified in Table 2.1. A range of qualitative and quantitative data sources was used. It is noted that the data sources used in the analysis are not intended to represent an exhaustive catalogue of all attributes of the study area under that value category. Notes on the coverage and/or quality of the data are provided in Table 2.1.

The spatial distribution of values and uses of the study area are discussed in Section 5, including a summary of the significance of these values and uses on the local, regional, national and international scales, as well as a discussion on the relative allocation of the benefits associated with these values and uses.

Table 2.1: Data Sources for Analysis of Constraints and Opportunities

Attribute	Data Type	Data Used	Source	Notes
<i>Land Use and Land Tenure</i>				
Land use type & land parcels	GIS layer	DCDB.tab	FCRC	
<i>Critical Infrastructure</i>				
Stormwater drainage	GIS layers	DrainagePipes.tab; PipeBeachOutlets.tab	FCRC	The accuracy of the available mapping of each of these assets is variable, but is considered adequate for the purposes of this study. There may also be some areas that are not covered by some of these data sets.
Potable water mains		WaterMains.tab		
Sewage network		SewerEffluentMain.tab; SewerEffluentPumpStation.tab; SewerTreatmentPlant.TAB SewerPumpStations.TAB SewerRisingMains.TAB SewerGravityMains.TAB SewerHouseConnections.TAB		
Gas mains		GasMains.tab		
Roads & footpaths		Road_Cline.tab; RoadFootpath.tab		
<i>Environmental Values</i>				
Important wetlands	GIS layer	ramsar.shp; doi_wetlands.shp	DEHP	
Creeks	GIS layer	DrainageCreek.TAB	FCRC	
Conservation areas / important habitat	GIS layers	vma_erhab_v3_polys_extract.shp; STATE_MARINE_PARKS.shp; WHA.shp	DEHP	
		fish habitat areas.shp	DAFF	
Habitat	Qualitative	Observational records (notes & geo-referenced photographs)	Cardno	Can be subjective in nature.
		Community feedback	CPR	
		Aerial photographs	FCRC	
<i>Socio-economic Values</i>				
Cultural heritage sites	GIS layers	CulturalHeitage.TAB; TiaroCulturalHeritage_updateNov02.TAB	FCRC	Does not account for traditional practices, resource uses or other activities. May not account for culturally significant sites or landscape features. GIS layers may not show all listed heritage items.
		IOATLAS_QLD_HERITAGEREGISTER_DCDB_A.tab	QGIS	
		Fraser_Coast_Cultural_Heritage_places.TAB; QLD_ESTATES_EXT.TAB; WHA.shp	DEHP	
		rne_poly_public.TAB	SEWPAC	
Recreational access & amenity	Qualitative	Observational records (notes & geo-referenced photographs)	Cardno	Can be subjective in nature.
		Community feedback	CPR	
	GIS layers	FC_PublicParks.TAB; PARKS.tab; CoastalJetty.MAP;	FCRC	GIS layers for features may not show all items or cover the entire

Attribute	Data Type	Data Used	Source	Notes
		CoastalBoatramp.TAB; FC_BoatRamps.TAB; BeachAccess.TAB		study area. Not intended as a comprehensive list.
Visual amenity	Qualitative	Observational records (notes & geo-referenced photographs)	Cardno	Can be subjective in nature.
		Community feedback	CPR	
Categories & value of foreshore parks	GIS layer	Foreshore Parks.tab	FCRC	Some categories of foreshore park are un-costed in some locations.
Community values	Qualitative	Community feedback	CPR	Can be subjective in nature.
Commercial activities	GIS layer	DCDB.tab	FCRC	Shows leased land and port areas.
	Qualitative	Observational records (notes & geo-referenced photographs)	Cardno	

1. See Glossary for acronyms

2.8 Risk Assessment

Risk is assessed by considering both the *likelihood* and *consequences* of an event occurring. Likelihood is used as a general description of probability or frequency, that is, how likely it is that something will occur. A consequence is the outcome or impact of an event (AS/NZS 4360:2004). Using erosion risk as an example, the likelihood of an erosion event occurring at a particular location within a specified time frame (the planning horizon) depends on a number of physical characteristics. These include the erodibility of the beach material, the magnitude of the 'design' storm event (e.g. a 100 year ARI storm, which is itself a probabilistic term), the sea level at the time of the event, and surface runoff. The consequences associated with a particular erosion event depend on the values and uses associated with the area that has potential to be eroded. Therefore, for any given erosion event, the level of risk will be higher if there is a valued feature or use associated with the subject site (e.g. if there is a risk to life and assets) and/or if there is a high likelihood the receptor (e.g. the value or use of the site in question) will be impacted by the erosion event.

Two types of risk assessment were conducted: a qualitative assessment (Section 2.7.1) and a quantitative assessment (Section 2.7.2). The outcomes of the risk assessment were then used to inform the development of erosion management policies (Section 2.8.2).

2.8.1 Qualitative Risk Assessment

In establishing the risk assessment framework, it was recognised that there were two different types of erosion that were likely to occur (see Section 3.1), and these should be considered separately due to disparities in likelihood and consequences:

- Recurrent risk from short term erosion events (i.e. storms); and
- Risk from gradually occurring long term shoreline erosion (including SLR inundation).

The frequency of these two types of processes was considered qualitatively in the risk assessment.

The key values of uses of the study area that could be impacted by short or long term erosion are known as 'receptors'. The values and uses considered in this qualitative risk assessment include all those items listed in Table 2.1. Some additional items were also considered in the qualitative risk assessment to ensure that it adequately captured the public health and safety impacts of shoreline erosion, including:

- Evacuation routes;
- Public safety;
- Public health/lifestyle; and
- Social disruption.

The likelihood of an impact on each of the values and uses was assigned based on the qualitative measures of likelihood listed in Table 2.2.

Table 2.2: Qualitative Measures of Likelihood

Level	Descriptor	Recurrent Risk / Storm Event	Long Term Risk / Shoreline Recession & SLR Inundation
1	Almost Certain	Could occur several times per year. More likely to occur in a given year than not.	Likelihood of change in rate/extent very high.
2	Likely	May occur about once per year. As likely to occur in a given year as not.	Likelihood of change in rate/extent high.
3	Possible	May arise once in 10 years. Less likely to occur than not, but still appreciable.	Likelihood of change in rate/extent possible.
4	Unlikely	May arise once in 10 to 25 years. Unlikely but not negligible.	Likelihood of change in rate/extent low.
5	Rare	Unlikely during the next 25 years. Negligible likelihood of occurrence.	Likelihood of change in rate/extent very low.

The potential consequence of both short and long term erosion on each of the aspects was assessed based on the qualitative measures of consequence listed in Table 2.3.

Table 2.3: Qualitative Measures of Consequence

Level	Descriptor	Environmental Values	Critical Infrastructure	Social Values – Recreational Access & Amenity	Social Values – Public Health & Safety	Commercial Values
1	Insignificant	No/negligible environmental change or damage.	No damage. No disruption to service.	No decrease in extent of open space. No decline in recreational amenity.	No/negligible social impacts.	No/negligible loss or damage of private assets.
2	Minor	Minor environmental change. Minor environmental degradation or deterioration in environmental values. Good potential for restoration / relocation.	Localised short term service disruption. No permanent damage. Some minor restoration work required.	Localised short term loss &/or closure of open space. Some minor restoration work required to recreational facilities.	Person suffers an injury. Short-term disruption to some community members. Some negative reports or complaints.	Minor property damage (e.g. to ancillary structures). Minor restoration works required.
3	Moderate	Isolated but significant instances of environmental change. Isolated but significant instance of environmental degradation. Potential for restoration / relocation. Significant environmental feature subject to minor impacts.	Widespread damage & loss of service. Damage recoverable by maintenance & minor repair. Short term disruption to service. Partial loss of local infrastructure.	Widespread short term or localised permanent loss of public open space. Damage to a range of recreational facilities recoverable by maintenance and minor repair. Loss of some minor recreational facilities.	Person suffers serious injury or several people with minor injuries. Short-term disruption to a number of community members. Isolated but noticeable decline in social cohesion (conflict over resources). Negative reports or complaints.	Property damage. Damage to property recoverable by maintenance & minor repair.

Level	Descriptor	Environmental Values	Critical Infrastructure	Social Values – Recreational Access & Amenity	Social Values – Public Health & Safety	Commercial Values
4	Major	<p>Significant environmental change over a large area.</p> <p>Significant environmental degradation or deterioration in environmental values over a large area.</p> <p>Significant environmental feature subject to significant impacts.</p> <p>Limited potential for restoration, some potential for relocation.</p> <p>Some clean-up & remediation required.</p>	<p>Extensive damage requiring extensive repair.</p> <p>Major disruption of service until infrastructure is repaired.</p> <p>Permanent loss of infrastructure services for a sub-region.</p>	<p>Extensive &/or significant public open space areas are permanently lost.</p> <p>Extensive damage to recreational facilities across a number of sites requiring extensive repair.</p>	<p>A number of serious or irreversible injuries occur.</p> <p>Fatality may occur from an individual event.</p> <p>Temporary disruption to essential activities undertaken by the community.</p> <p>Significant decline in services or quality of life for large sector of the community.</p> <p>Significant public debate about the issue, constrained resources and services.</p> <p>Negative reports in national media; complaints.</p>	<p>Extensive property damage.</p> <p>Long term loss of part of property or access way.</p> <p>Extensive repair to property.</p>
5	Catastrophic	<p>Irreversible environmental change or damage over a large area.</p> <p>Irreversible impacts on significant environmental feature.</p> <p>No potential for restoration.</p> <p>Potential for relocation very limited.</p> <p>Considerable clean-up & remediation required.</p>	<p>Permanent damage &/or loss of infrastructure service across the region.</p> <p>Service completely stopped until infrastructure is replaced.</p> <p>Retreat of infrastructure support.</p>	<p>Regional public open space areas & associated facilities are permanently lost.</p>	<p>A number of serious or irreversible injuries occur.</p> <p>Chance of death from an event.</p> <p>Disruption to a large sector of the community.</p> <p>Public outrage; community divided over the issue.</p> <p>Regional community resources unable to support/inadequate for the population.</p> <p>Negative reports in international media; complaints.</p>	<p>Widespread permanent loss of property.</p>

Each risk event was assigned an overall level of risk determined as a factor of the probability (or likelihood) of the event occurring and the consequence if the event occurred (Table 2.4).

Table 2.4: Qualitative Measures of Risk

		Consequence				
		Catastrophic 1	Major 2	Moderate 3	Minor 4	Insignificant 5
Likelihood	Almost Certain (1)	1	2	3	4	5
	Likely (2)	2	4	6	8	10
	Possible (3)	3	6	9	12	15
	Unlikely (4)	4	8	12	16	20
	Rare (5)	5	10	15	20	25
Risk Severity		Low		Medium		High/Extreme

This qualitative risk assessment process was undertaken for each of the Management Zones to gain an indication of the spatial variation in risk from shoreline erosion. In addition, the risk assessment was undertaken for the four planning horizons (2030, 2050, 2070 and 2100) in order to gain an appreciation of how the risk from shoreline erosion will change over time.

2.8.2 Quantitative Risk Assessment

The objective of the quantitative risk assessment was to quantify some of the impacts of shoreline erosion by considering the number of cadastral lots (land parcels) at risk from shoreline erosion, and to translate this information into an approximate economic value.

The assessment also considers the amount/linear extent of critical infrastructure (services and utilities, see Table 2.1) that are at risk from shoreline erosion, noting that the loss of any critical infrastructure would result in a significant cost of repair/replacement and also social disruption. It is noted that the assessment quantifies the infrastructure that falls within the EPAs only, however, the impact of losing that infrastructure may have wider implications (e.g. loss of functionality of infrastructure located outside of the EPA).

These findings of the quantitative risk assessment must be viewed in the long term planning context as a number of assumptions have been made in the application of the method. The analyses are intended to provide a means of identifying where the greatest risks to land tenure occur and also as a basis for assessing the cost of implementation of potential management options.

The discussion on quantitative risk can be found in Section 6.2.

Land at Risk from Erosion

To determine the land at risk from erosion, the number of cadastral lots falling within each EPA, within each Management Zone, was assessed. Statistics are provided on the number of cadastral lots falling partly or

wholly within the EPAs, broken down on the basis of the land tenure categories included in the digital cadastral database layer (see Table 2.1). The tenure categories encoded into the digital cadastral database that fall within the EPAs are:

- Freehold;
- Lands Lease;
- State Land;
- National Park;
- Reserve; and
- State Forest.

It is noted that the GIS also recognises strata titles within the digital cadastral database such that where a single cadastral lot includes multiple residences (such as for apartment buildings), each strata title has been counted within the number of freehold cadastral lots.

A preliminary indicative assessment of the value of the cadastral lots identified as falling within the EPAs was undertaken using the median residential property sales values obtained for each coastal suburb from RPData (<http://www.rpdata.net.au>) in late-2010/early-2011. The EPAs were overlaid on the digital cadastral database and suburb boundaries in the GIS. The GIS software package was then queried to derive the total number of cadastral lots (of any land tenure category) per suburb within each EPA. The present day (2011) total value of cadastral lots within the EPA of each of the Management Zones is estimated by applying current median house prices for each suburb to the number of lots within the EPA and suburb, and then summing the results.

The analysis counted all cadastral boundaries intersecting the EPA, including partial lots. The existence and location of dwellings within each cadastral lot is not known, and therefore, the median land value was applied to all full and partial lots, both improved and unimproved within the EPA.

The assessment relies on median residential property sales values (at roughly December 2010), and hence provides an indicative estimate only. Within the context of the large size of the study area, it is considered adequate for the purposes of comparing the potential economic value associated with direct loss of land within the EPAs.

Foreshore Parks

The foreshore parks GIS layer provided by FCRC (see Table 2.1) was used to gain an appreciation of the areal extent and value of foreshore parks at risk from erosion. The dataset was queried in the GIS software package to generate areas of foreshore parks (ha) and land values calculated based on information provided by FCRC.

Critical Infrastructure at Risk from Erosion

Critical infrastructure at risk from erosion was assessed through the application of GIS analyses to quantify the extent of infrastructure falling within the EPAs. The analysis was undertaken using a similar methodology to that applied for the counts of cadastral lots, although in the case of infrastructure, some of the data was

linear in nature (e.g. sewer trunk mains) which permitted calculation of the length of that asset falling within the EPAs.

The definition of 'critical infrastructure' is provided in the Glossary and in Section 5.3.

2.9 Management Framework

The management framework established in this report consists of:

- *Management objectives* formulated to guide the development of the SEMP;
- *Management policies* that describe the strategic approach for management of shoreline erosion; and
- *Management options* that represent the various types of activities that may be implemented under the SEMP to achieve the management policies.

2.9.1 Management Objectives

The management objectives seek to maintain the values and uses of the study area (Section 5), consistent with the guiding principles for coastal management outlined in the QCP (DERM, 2011a). They represent 'desired outcomes' from the SEMP.

The management objectives are also used as assessment criteria in the options assessment (see Section 2.8.3).

2.9.2 Management Policies and Options

There are a range of different policies available for management of shoreline erosion, including:

- No Active Intervention;
- Planning;
- Managed Retreat;
- Hold the Line; and
- Managed Realignment.

There is typically more than one management option that may be implemented to achieve the management policy. The range of management policies and options available are discussed in Section 3.4.

The allocation of preferred management policies for different Management Zones (or part thereof) is based on review of a range of factors, including:

- The values and uses of the Management Zone;
- The level of risk from shoreline erosion at the 2030 and 2100 planning horizons, noting that 2030 has been adopted as an operational planning horizon, whereas 2100 has been adopted as a strategic planning horizon; and

- The compatibility of the management policies with the management objectives.

The management policies and options effectively seek to reduce the level of risk from shoreline erosion adopting a risk management hierarchy. In the first instance, an effort should be made to avoid the hazard. This is not possible due to the nature of shoreline erosion and the presence of existing development in the EPAs. The next step would be to identify policies and options that reduce the level of risk, both in the present day and in the future. This process was followed for the study area using the outcomes of the risk assessment, whereby the general level of risk within each Management Zone is used to identify a preferred management policy. Alternative management policies are also considered. Relevant management options were then identified based on the management policy.

The management options for implementation of the preferred policy were developed by the Cardno study team taking into consideration both the existing coastal protection works along the Fraser Coast shoreline, and the options presented in the *Hervey Bay Coastal Protection Strategy* (WBM, 2004) and CLT (2006).

The following information was provided for each management option:

- A unique option ID number. The first digit of the ID number corresponds to the relevant Management Zone;
- An Option Type based on the generic management options presented in Table 3.1;
- A brief description of the option;
- Location of implementation; and
- Primary and secondary responsibilities for implementation.

2.9.3 Options Assessment Methodology

As outlined in Section 1.1, one of FCRC's requirements for this project was to identify cost-effective and sustainable erosion management strategies that maintain natural coastal processes and resources, and consider community needs in both the short and long term. In addition, FCRC also requires assistance in prioritising preferred management options for implementation at the scale of the entire LGA.

In order to address these requirements, a triple bottom line multi-criteria options assessment framework was developed that permits comparison of all the management options on a common basis. The output of the options assessment is a ranked list of management options for consideration by FCRC.

Once the full list of management policies and options was collated for this study, an options assessment was conducted to assist FCRC in identifying the preferred options for inclusion as management actions in the Fraser Coast SEMP.

The multi-criteria options assessment framework incorporates:

- Cost of implementation;
- Two knock out factors:
 - Technical feasibility, and

- Compatibility with the statutory framework;
- A benefit index;
- Stakeholder and community feedback;
- Cost:benefit index; and
- Options ranking.

For each management option some brief notes are also provided to indicate the allocation of costs and benefits associated with implementation of that option.

The approach adopted is not intended to represent a comprehensive assessment of the options. Further assessment of impacts and technical and economic feasibility would be required prior to implementation.

The components of the cost:benefit index are explained below.

Cost of Implementation

The cost of implementation is calculated as a net present value (a function of the capital and recurrent costs) over a 20 year period of implementation adopting a discount rate of 7%.

The costs were developed based on professional engineering experience and a review of the literature in accordance with the unit rates presented in Appendix C. Table C.1 includes a review of cost estimates from the literature. Table C.2 provides the cost estimates that were adopted for the purposes of this study. Each element of the cost shown in Table C.2 has an individual Item Number. The management options spreadsheet contains notes on the costings as required, including reference to the Item Numbers that were used to calculate the costings.

Costings for seawall options falling under the Managed Realignment Policy (Options 1.21, 2.02, 3.20, 4.03 and 5.11) were based on the number of freehold lots falling within the 2030 EPA. The total length of the seawall represents the sum of the length of the foreshore frontage of all freehold properties within the 2030 EPA.

The capital and recurrent costs of implementation represent a preliminary estimate of the cost of any investigations, cost of obtaining any necessary approvals, and of constructing and maintaining the option (where relevant). It is noted that these cost estimates are indicative only and further detailed costings would be required in the event an option is considered for implementation.

For the purposes of this assessment the costings assume a local source of sand and rock, which in reality may not be feasible (see Cardno, 2011). In the event a local source of materials is not available, the cost of implementation of the relevant options may increase substantially.

Knock-Out Factors

Two knock-out factors were incorporated into the options assessment:

- Technical feasibility (as assessed by Cardno's coastal engineers and environmental planners); and

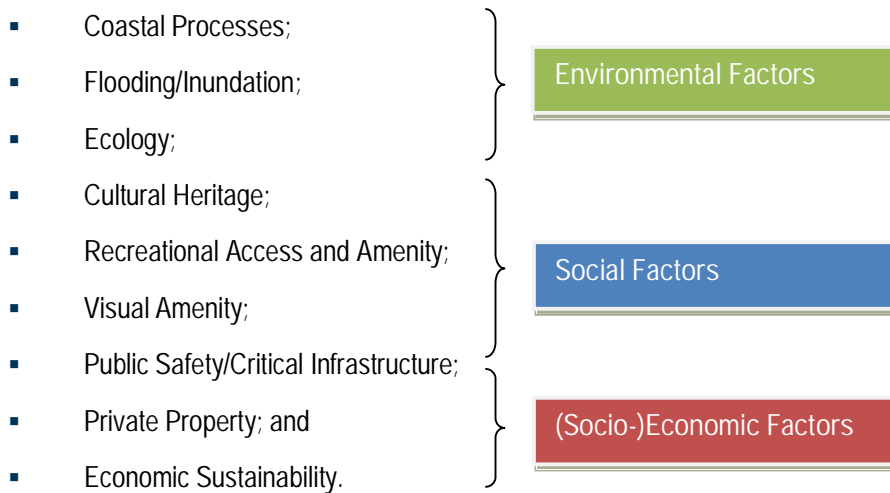
- Compatibility with the statutory framework, which in this case considers whether the proposed option is permissible.

Where an option did not meet either of these requirements, it was not subject to further consideration and was knocked-out of the options assessment process.

Benefit Index

A benefit index was calculated based on an assessment against the ability of the option to meet the management objectives developed for the SEMP. The benefit index is also an indicator of the potential net spatiotemporal impacts of the option considering both the construction and operational phase of implementation.

The benefit index involved consideration of a range of criteria:



A positive or negative score is allocated to each of these nine factors based on the criteria outlined in Appendix D.

The scores for each assessment criteria are then summed together to calculate a raw benefit index. Once the agency and community feedback has been incorporated into the multi-criteria matrix assessment framework (see below), the raw benefit index is translated into an adjusted benefit index.

Committee/Community Feedback

There is capacity within the scoring framework to incorporate scores based on feedback from CSG and the community.

The CSG includes some independent experts, as well as representatives from a range of agencies who would have an approvals or referral role at the implementation stage (see Section 2.2.1). Their scores would represent the overall compatibility of the proposed option with the policy and regulatory framework. Even where an option is permissible under the statutory framework, the consent/referral authorities are also required to consider a range of supporting policies (and zone objectives in the case of the Marine Park), which may result in a certain type of option being preferred over another. The members of the CSG were asked to score the options, and their scores were averaged and entered into the assessment framework. The following organisations provided input on scoring:

- DEEDI; and
- FCRC.

The community scores would represent the wider community's preference with respect to proposed options, and are pending consultation.

Scores are allocated as follows:

- Score of +/-2 = Strong support for/opposition to the option;
- Score of +/-1 = Some support for/opposition to the option; and
- Score of 0 = no preference/opinion.

The raw benefit index is modified based on the agency and community feedback to calculate an adjusted benefit index.

The Cost:Benefit Index and Options Ranking

Once each option has been assessed using the methodology described above, a cost:benefit index can be calculated, which is a function of the (adjusted) benefit index and the net present value. Each of the options is then ranked against each other on the basis of the cost:benefit index. In general, those options that have a lower cost of implementation and for a greater net benefit will rank highest.

2.10 Summary

In order to clarify the manner in which this options report addresses the requirements of both the QCP and the DEFRA guidelines, an audit has been presented in Table 2.5 that relates the findings presented in each section of this report to the relevant task or activity listed under both the QCP and DEFRA guidelines.

The DEFRA guidance allocates numbers to each task; the corresponding DEFRA task number is provided in the fourth column of Table 2.5. The SEMP guidelines provided in the QCP do not include task numbers and so the text describing the required tasks has been summarised in the third column of Table 2.5 instead.

Table 2.5: Cross-Reference to QCP and DEFRA Guidelines

Section Reference	Section Title	Corresponding Task(s) Under:	
		QCP	DEFRA*
2.2	Consultation	Seek stakeholder input on the proposed options...to: <ul style="list-style-type: none"> - Gather information and improve estimates of the economic and social values of various coastal localities [see also Cardno, 2011] - Obtain feedback from stakeholders on the various options and associated costs, benefits and impacts - Seek advice from the relevant state agencies with regards to compliance with the relevant legislation and policies. ...[seek] relevant stakeholder input, determining a priority list of recommended actions and estimated costs.	Task 1.3
3	Erosion Prone Areas	Map the EPAs...Identify and describe the coastal processes at work in each locality (see also Cardno, 2011).	-
3.1	Overview of Coastal Processes		Task 2.1
3.2	Erosion Prone Areas		
3.3	Management Zones	If the SEMP is to address more than one EPA, divide the coastal section into logical units for investigation.	Task 2.5
3.4	Existing Coastal Defences	..a review of the effectiveness and suitability of existing erosion responses and strategies being implemented (including an analysis of the structural integrity and effectiveness of existing protection works) to determine if these are consistent with government policy.	Task 2.1
3.5	Generic Erosion Management Policies/Options		Task 3.1
4	Statutory & Non-Statutory Framework	...gain a clear understanding of the constraints and opportunities for shoreline management prior to embarking on development application processes.	Not conducted under DEFRA
4.2	Key Relevant Legislation		
4.3	Policy Framework		
5	Values & Uses of the Study Area	Identify or map existing coastal resources (such as wetlands, inshore and wildlife habitats)... In addition, the benefits of coastal areas to the community should be outlined.... Show the various land uses with particular emphasis on property, infrastructure (including roads and access points), existing coastal protection works and areas of high ecological significance....[provide a] description of the environmental economic and social values of the developed and undeveloped areas.	Task 2.3
5.2	Land Use & Land Tenure		
5.3	Critical Infrastructure		
5.4	Environmental Values		
5.5	Socio-Economic Values		

Section Reference	Section Title	Corresponding Task(s) Under:	
		QCP	DEFRA*
5.6	Discussion on Values & Uses		
6	Risk Assessment	Determine the threats within each locality and describe the present and emerging risk to people, property and the environment from shoreline erosion.... [Assess] erosion risks for various localities and determine an approximate ranking of importance.	Tasks 2.2 & 3.2
6.1	Qualitative		
6.2	Quantitative Risk Assessment Findings		
6.3	Discussion on Risk	Identify zones of present and emerging threats to existing and planned development within the EPAs. Identify the present and emerging pressures for preserving and enhancing public access to foreshore areas and providing additional recreational infrastructure.	
7	Management Recommendations	-	-
7.1	Objectives for Management	[refer to QCP requirements listed with reference to Section 7.3]	Task 2.4
7.2	Preferred Management Policies	Identify a priority listing for rehabilitating areas to create coastal buffer zones... Outline the appropriate long term uses of erosion prone land, and long term management goals as agreed upon by governments and the community.	Task 3.3
7.3	Management Options Assessment	For each coastal locality, determine options for risk treatment...[conduct] an assessment of each risk management option taking into account all environmental, economic and social factors. Rank management options with regard to environmental, social and economic cost:benefits, prioritising options having regard to: <ul style="list-style-type: none"> - minimising adverse impacts on coastal processes and biodiversity - preserving areas of high conservation or ecological values - maintaining or enhancing buffer zones - maintaining foreshore access and recreational amenity - minimising threat to development - minimising risk within storm tide within storm tide coastal hazard areas. 	Not conducted under DEFRA

* Task 2.6 omitted after discussion with the CSG. Other DEFRA tasks addressed through preparation of the Gap Analysis Report (Cardno, 2011) and SEMP document (forthcoming).