



Environmental Factor Guideline

Coastal Processes

The objective of the factor *Coastal Processes* is:

To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.

Purpose

The purpose of this guideline is to communicate how the factor *Coastal Processes* is considered by the Environmental Protection Authority (EPA) in the environmental impact assessment (EIA) process.

Specifically, the guideline:

- defines the factor *Coastal Processes* and explains the associated objective
- describes EIA considerations for this factor
- discusses the environmental values supported by coastal processes, and their significance
- describes issues commonly encountered by the EPA during EIA of this factor
- identifies activities that can impact on coastal processes
- provides a summary of the type of information required by the EPA to undertake EIA related to this factor.

What are coastal processes?

For the purpose of EIA, the EPA defines coastal processes as:

Any action of natural forces on the coastal environment.

The coastal environment is naturally dynamic, and its morphology at any point in time is determined by the interaction between its structure (e.g. rocky cliffs or unconsolidated sand), and the intensity and degree of exposure to key geophysical processes (e.g. wind strength and wave height, current speed and direction).

These processes occur everywhere along the coastline, moving sand laterally along the coast as well as on- and off-shore, and they vary in intensity and relative importance. The processes can be cyclic and occur on a daily or seasonal basis, or episodic, and these processes change the shape of the seabed and beach profiles at varying rates and degrees. The physical action of water and wind can alter beach profiles over short timescales, while cliffs and rocky platforms will erode and change over longer timescales.

Coastal processes also influence the type and distribution of benthic communities and habitats in sub-tidal and inter-tidal zones. For example, seagrass meadows thrive in bays and lagoons that are sheltered from wave energy by offshore reefs or islands. The types

and distribution of benthic communities can influence coastal morphology by moderating the effects of coastal processes; for example, mangroves can protect coastlines from storm damage.

The placement of hard structures on the coast or offshore can alter the effect of coastal processes and hence impact the coastline and near shore zone, and the environmental values they support.

For the purpose of EIA, the primary focus will be on the environmental values most likely to be affected by the predicted changes in coastal processes as a result of development. This is generally restricted to the coastal strip from the near shore sub tidal area to the coastal dune systems.

How this factor links with other environmental factors

The EPA recognises that there are inherent links between the factor *Coastal Processes* and other environmental factors. For example, impacts to coastal processes can result in changes to the factors *Marine Environmental Quality, Benthic Communities and Habitats, Marine Fauna, Landforms, Inland Waters Environmental Quality, Terrestrial Flora and Vegetation, Terrestrial Fauna* and *Social Surroundings*. While impacts to these values will be addressed under the relevant environmental factor, the EPA will consider the impacts to *Coastal Processes* in concert with these other factors in order to assess impacts on environmental values and an ecosystem's integrity as a whole.

The environmental objective for the *Coastal Processes* factor

The EPA's environmental objectives for the factor *Coastal Processes* is "To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected".

This objective recognises the fundamental link between the geophysical processes which shape the coastal environment and the environmental values they support. These uses include the maintenance of ecosystem values, landforms, amenity, recreation, tourism, commercial, urban and industrial use.

Therefore, the focus of this factor and its associated objective is on how alteration of geophysical processes might significantly impact on natural coastal dynamics and the significant coastal ecosystems and other values the coastal environment supports.

Considerations for environmental impact assessment

Considerations for EIA for the factor *Coastal Processes* include, but are not necessarily limited to:

- application of the mitigation hierarchy to avoid or minimise impacts on coastal processes, where possible
- the predicted changes to coastal processes based on modelling and analyses to a standard consistent with recognised published guidance
- the significance of the likely change to coastal processes as well as the environmental values affected by those changes
- impacts to coastal processes in the context of the latest climate change science and projections
- the likely change to coastal processes and consequent risks to coastal morphology and associated environmental values
- the technical and practical feasibility of proposed management measures and approaches.

Environmental values of coastal processes and their significance

The coastline of Western Australia is over 20,781 kilometres (km) long, made up of 12,889 km along the mainland and 7,892 km on the State's islands. This coastline has a wide variety of physical characteristics ranging from sandy coasts, rocky coastlines, fringing reefs or rocky platforms, to tidal sand and mud flats. These can occur singly or in various combinations.

The coastal zone is highly valued for its aesthetic, cultural, social and recreational values including fishing, boating, beach going and swimming. The coastal area is densely populated in the Perth metropolitan region and the south-west of the State. Approximately 80 per cent of the state's population lives within 10 km of the coast. In addition to recreational and social values, the coastal environment is also important to commercial tourism and fisheries, and in siting infrastructure such as harbours and ports to facilitate the State's industrial and shipping needs.

The coastal environment is a naturally dynamic system. Coastal processes shape the physical environment, providing habitat such as turtle or seabird nesting beaches, reefs, and mangrove forests or seagrass beds. It also influences the hydrodynamics of an area which, in turn, determine the ecological communities which are able to establish in the coastal zone as well as critical life-cycle processes such as coral or fish spawning and recruitment.

For the purposes of EIA the EPA is focused on the effects of the changes to coastal processes on environmentally significant coastal values including, but not necessarily limited to:

- benthic communities and habitats such as coral reefs, mangroves, salt marshes, seagrass meadows and sponge gardens
- conservation significant marine fauna and critical habitat such as nesting, breeding or foraging habitat
- conservation significant low lying areas including tidal creeks, deltas and river mouths
- conservation significant flora and vegetation and terrestrial fauna species
- unique landforms
- significant cultural and aesthetic values
- active or passive recreation.

The EPA recognises that changes to coastal processes resulting from a proposal may not cause impacts at that location, but impacts may occur further along the coastline or offshore. In addition, changes to coastal processes when left unmanaged can threaten ecological integrity and/or the integrity of man-made structures.

Issues

The following issues are matters that are commonly encountered by the EPA due to the nature of proposals that are referred to it. Background on these issues is provided here to help proponents and the community engage with EIA. This issues section will be updated from time to time to reflect new issues as they arise in referrals and EIA.

Coastal development pressures

With continued population growth in Western Australia there will be ongoing demands for coastal living and mixed use developments, such as marinas with urban and commercial development incorporated within the design. Perth has one of the highest boat ownership rates per capita compared to other Australian cities, creating continuing demand for coastal marinas and boat launching facilities.

For the purpose of EIA the EPA is focused on ensuring that coastal processes and the ecological and social values of the coastal environment they support are able to be maintained despite these growing development pressures.

Changing climate

Coastal processes are vulnerable to a changing climate. Global mean sea levels have risen over the course of the 20th century and are predicted to continue to rise due to thermal expansion of the world's oceans and the melting of polar ice sheets. In addition, sea level is also affected by short term fluctuations and regional variations which occur as a result of tides, storm surge events, the Leeuwin and other ocean currents, and the El Nino – Southern Oscillation.

The EPA will consider impacts to coastal processes in the context of the latest science and while this is still a developing area and there are a range of predictions, the EPA recognises that a rise of 0.9 metre (m) in mean sea level by 2110 is currently considered the best prediction for decision making.

Sea level rise may affect the structure, integrity and biodiversity of coastal ecosystems, including wetlands, estuaries and waterways which are connected to the marine environment. Effects include an increased risk of inundation in low-lying areas and accelerated coastal erosion in vulnerable locations. The EPA recognises that there is potential for significant habitat changes to coastal terrestrial ecosystems as well as aquatic ecosystems from rising sea levels. However, the impacts to, and responses of, individual ecosystems will vary.

The consequences of other effects of a changing climate such as increasing storms and wave energy are likely to significantly affect coastal processes and associated environmental values in the coastal zone.

For the purposes of EIA, the EPA is concerned with proposal specific impacts that, when considered in combination with climate change, are likely to exacerbate changes to coastal processes and significant environmental values in the coastal zone. The EPA is also concerned with protecting ecosystems from the impacts that damaged infrastructure may cause as a result of sea level rise and to ensure that infrastructure does not prevent ecosystems from adapting to higher sea levels.

State of the science and/or knowledge

The EPA recognises that the current state of scientific knowledge for coastal processes and the environmental values they support is highly variable. The range of coastal types, exposure, and climatic regimes in Western Australia presents challenges for predicting and assessing the impacts of development proposals on coastal processes.

Mathematical models for simulating the effects of coastal development proposals on hydrodynamic and most coastal processes are reasonably well developed for 'normal' or 'average' conditions. However, the ability to predict the impacts under extreme weather events such as cyclones is less well developed.

Information that may be used to inform modelling and predictions is variable across the state. Aerial photography which enables consideration of historic shoreline movement trends is available for the majority of the coastline from the 1950s onwards, while sediment cell mapping, which can be used in defining the extent of impacts, has only been undertaken for some areas of Western Australia.

Reliable bathymetric data is fundamental for predictive modelling of water currents and circulation patterns. While coarse scale bathymetry is available for all of the State's waters, fine scale bathymetry that is required for detailed modelling is variable in quality and availability. Where suitable information to inform modelling and predictions is not available, the EPA may require proponents to undertake this work.

The effects of modifying coastal processes on the existing environmental values is difficult to predict and not well documented. The collection of coastal process data before and after development, and over time, will provide insight and provide calibration and validation data to tune model outputs and assess model performance and predictions in the future.

For all proposals which significantly modify coastal processes, the EPA will take into account the level of knowledge and confidence underpinning the predicted environmental impacts and risks. While region-wide studies are likely to be beyond the capacity of any individual proponent, the EPA will encourage cooperative efforts to build information about poorly known systems which may be targeted for future development.

Impacts

Development activities that have the potential to impact coastal processes include, but are not necessarily limited to:

- infrastructure that alters wave energy and current patterns such as:
 - breakwaters, rock armour or revetment walls
 - jetties, boat launching facilities or marinas
 - reclamation areas

the associated impacts may include:

- changes in the structure of marine communities
 - interruption of longshore sediment transport
 - changes in erosion/deposition patterns
- infrastructure or activities that interrupt tidal flows or cause a reduction in water exchange such as:
 - marina or harbour water bodies
 - canal developments
 - groynes, boat launching facilities or marinas
 - alteration of river mouths or deltas

the associated impacts may include:

- changed water quality
 - accumulation of wrack
 - retention of nutrients and other contaminants
 - saltwater intrusion or coastal inundation
- activities that directly alter the morphology of the coastal zone resulting in changes to sediment sources or sinks such as:
 - reclamation/excavation of the coastline
 - capital and maintenance dredging
 - creation of shipping channels
 - disposal of dredge spoil
 - sand bypassing

the associated impacts may include:

- interruption of longshore sediment transport
- changes in erosion/deposition patterns

- activities that remove natural communities and habitats that protect the coastline and increase exposure to the action of coastal processes such as:
 - removal of benthic communities, e.g. mangroves
 - habitats, e.g. reef structures
 - terrestrial vegetation, e.g. foreshore or dune vegetation

the associated impacts may include:

- increased erosion.

Information required for EIA

Where *Coastal Processes* has been identified as an environmental factor, the EPA may require the proponent to:

- demonstrate how the proposal has been located and designed to avoid, minimise and mitigate impacts to coastal processes
- characterise the coastal type and current coastal processes. This may include: modelling of the local current and wave climate; analysis of long-shore sediment movement and erosion and deposition patterns; beach profiling, and determination of tidal flow and exchange
- predict the changes to coastal processes as a result of the proposal, taking into account the appropriate spatial and temporal scales
- describe the impacts resulting from the changes to coastal processes
- consider cumulative impacts from and to other existing and approved developments in order to determine whether the proposal, in combination with other developments, will significantly impact coastal processes and any consequential impacts to environmental values in the coastal zone
- determine coastal vulnerability and the potential impacts as a result of climate change
- identify monitoring strategies, and management and mitigation measures
- identify governance arrangements for the ongoing management of impacts
- commission peer review of coastal process modelling and predicted impacts.

Environmental Protection Authority 2016, *Environmental Factor Guideline: Coastal Processes*, EPA, Western Australia.

This document is available in alternative formats upon request.

National Relay Service

TTY: 133 677

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More information

Office of the Environmental Protection Authority

Level 8, The Atrium

168 St Georges Terrace

Perth WA 6000

Locked Bag 10,

East Perth WA 6872

p: 08 6145 0800

e: info@epa.wa.gov.au

w: www.epa.wa.gov.au