



Environmental Assessment Guidelines

Environmental Assessment Guideline for Marine Dredging Proposals

September 2011

Environmental Protection Authority

Western Australia

FOREWORD

Western Australia has an exceptionally rich marine biodiversity, including globally-recognised hotspots of species richness and endemism.

This marine biological diversity reflects the diversity of habitats contained within WA's coastal waters, which extend from the tropical Kimberley to the temperate south coast, covering an area of approximately 118,000 square kilometres and including 3,747 islands.

The Environmental Protection Authority is charged with the important task of protecting this environment and its associated values. In practical terms, this means using every endeavour to avoid and mitigate the major threats to that environment.

We do this by producing strategic guidance materials for proponents and by continually seeking a better understanding of the marine environment to inform decision making by proponents and Government.

Marine dredging is one of the contemporary pressures on our environment. In Western Australia, there are a number of marine dredging proposals that are large by global standards and can attract considerable public scrutiny.

With a marine environment as large and diverse as ours, it is not surprising that we are still learning about how marine ecosystems function and the tolerance of those ecosystems to external pressures, including dredging.

In spite of these knowledge gaps, the EPA has the responsibility to assess the environmental impact of significant proposals and make recommendations to the Minister about whether a project is environmentally acceptable and if so, under what conditions.

In an ideal world, it would be possible to generate marine impact predictions with 100 percent accuracy and this would facilitate more straightforward assessments. However, the reality is there is a far lower level of accuracy and confidence associated with predictions made during EIA, and the EPA recognises that this uncertainty can lead to monitoring and management regimes that proponents find onerous and costly.

Recognising this, the EPA has adopted a pragmatic approach in establishing its position on the presentation of predicted impacts to benthic habitats associated with significant dredging proposals. It aims to

ensure predictions presented to the EPA have a sound scientific basis and consider the range of *likely* impacts.

Specifically, this guideline sets out an approach by which predictive uncertainty can be taken into account by reflecting a target that the proponent *aims* to achieve using best practice approaches to dredging and its management. It also recommends proponents identify an outcome that they are *confident* of achieving using best practice even if things do not go well.

This framework also guides the development of efficient and cost-effective monitoring and management programs that are linked to the predictions and that aim to keep impacts as low as practicable and ensure the environmental protection outcomes are achieved.

The framework, of itself, will not close our knowledge gaps. However, in having a common and transparent basis for the assessment of impacts, and if there is corporate commitment to sharing information, we can learn from the actual environmental outcomes of individual projects to improve impact predictions.

The EPA also strongly supports the dredging science node of the WA Marine Science Institution. It is expected that the science outputs of that node will contribute significantly to the ability of proponents and Government to understand the likely impacts of marine dredging campaigns and contribute to timely, rigorous and cost-effective assessment, management and monitoring.

It should be noted that this EAG constitutes guidance only. It has been designed to assist proponents with providing adequate information for efficient and effective EIA.

This document has the status of “Final” which means it has been subject to a process of review by stakeholders and the public during its development.

I am pleased to release this document.

A handwritten signature in blue ink, appearing to read 'P. Vogel', with a long horizontal line extending to the right.

Dr Paul Vogel
CHAIRMAN
ENVIRONMENTAL PROTECTION AUTHORITY

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1.0 INTRODUCTION AND BACKGROUND

1.1 Purpose

Environmental Assessment Guidelines (EAGs) are developed by the Environmental Protection Authority (EPA) under s16(k) of the *Environmental Protection Act 1986* (EP Act). Environmental Assessment Guidelines are used to provide advice to proponents, consultants and the public about specific procedures, methodologies, frameworks and the minimum requirements which the EPA expects to be addressed by proponents of proposals or schemes which are subject to environmental impact assessment (EIA). By imparting clarity and consistency to the mechanics of EIA, these EAGs serve to deliver more effective and timely approvals.

This EAG is designed to ensure that the predicted extent, severity and duration of impacts to benthic habitats associated with significant dredging activities, which are subject to formal environmental impact assessment by the EPA, are presented in a clear and consistent manner.

1.2 Background

Australia is an island nation and major aspects of our social systems and economy are strongly linked to our coasts and coastal oceans. Western Australia (WA) in particular has an export-orientated economy, which is heavily dependent on maintaining safe and efficient trade through ports. Most coastal towns and cities have developed around natural safe anchorages, which are relatively rare on our coast. At these locations, the combination of shallow and deep water and varying degrees of shelter from wind and waves has allowed the development of diverse habitats and associated biological communities with important ecological values. The marine environments within ports also support a range of community uses that rely on healthy ecosystems. Furthermore, WA port authorities are required to protect the environment of the port and minimise impacts of port activities on that environment¹.

Dredging is an activity carried out at existing and new ports and the associated sediment plumes have the potential to influence large areas beyond port boundaries. The scale and number of significant dredging projects in WA is large by world standards and this places the EPA at the forefront of dealing with the environmental issues associated with this type of development. In addition to the large scale of dredging and the potential spatial extent of its influence, dredging projects often occur in sensitive

¹ Section 30(1)(f), *Port Authorities Act 1999*

environments with unique and/or generally poorly-understood biodiversity and ecology (e.g. understanding of the natural tolerances and susceptibilities of key biota) presenting additional and significant challenges for environmental impact assessment and management. The EPA therefore takes an interest in dredging proposals and often decides that they will be subject to formal assessment.

1.3 Rationale

Environmental impact assessment is based on *predictions* of environmental impacts as well as the degree to which these impacts have been minimised and will be managed during project implementation. Together, prediction and associated environmental management programs form the basis for EPA judgements about environmental acceptability of proposals and their impacts. In WA, outcomes of the EIA process inform approval decisions and set the regulatory scene for the construction and operation of approved projects.

Legislation, regulations, management frameworks and guidance already exist for a number of key environmental issues relevant to the assessment, management and regulation of dredging proposals. These environmental issues include sea dumping, contaminated site assessments and protection of wildlife. Proponents are responsible for addressing the requirements of all relevant legislative and regulatory frameworks and guidance issued by other agencies. The EPA draws upon information presented by proponents in the context of these (and other) relevant regulatory frameworks and the advice of relevant regulators during its assessment of dredging proposals.

Until recently there has been a lack of guidance for the clear and consistent presentation of predicted impacts of dredging and dredge-generated sediment on benthic habitats that is appropriate for WA's environmental impact assessment and associated approvals systems. This gap was first filled by the EPA's draft EAG No7, which is now superseded by the advice and guidance contained in this document.

The EPA recognises that, at the time of publication, the typical accuracy limitations of modelling (especially ecological) applied to impact prediction is high and there is scope for significant improvement. Nonetheless, dredging proposals still come before the EPA for formal assessment and hence the need for this EAG.

This is generic guidance that applies State-wide and as such, it does not differentiate between types of dredging proposals or regional environmental differences nor does it provide specific technical/scientific guidance on impact prediction methodology for developing or using pressure-response thresholds for predicting environmental impacts.

It should be noted that the guidance provided in this EAG is not new, nor does it signal a fundamental shift in the way the EPA assesses dredging proposals.

This EAG sets out the contemporary expectations of the EPA and is designed to promote a more certain and consistent approach to assessments and subsequent approval outcomes for all dredging proposals subject to formal EIA. Nonetheless, if proponents have an alternative methodology for presenting the extent, severity and duration of predicted dredging-related impacts that they believe is superior to that contained in this guidance, then impacts based on the alternative approach may be presented for the EPA's consideration.

2.0 CONTEXT

2.1 What is dredging?

Dredging and dredge spoil disposal are key elements of many significant marine infrastructure proposals in WA. These proposals generally involve plans to develop new facilities or maintain existing ones. Most dredging proposals are carried out to provide navigable water depths for shipping at ports and harbours. Dredging of trenches for the placement of subsea pipelines is another relatively common practice. Dredging for marine mining operations that target diamonds, shell sand and other resources is also proposed from time to time.

Dredging involves excavation of the seabed, typically underwater, but may also occur above the water surface, either in intertidal areas during low tide or behind constructed bunds designed to maintain a 'dry' dredge site.

Once material is excavated from the seabed by a dredge, it can be handled in a number of different ways. Often dredged material is loaded into a hopper (part of the dredge itself or on a separate vessel) and transported to a disposal site where the contents of the hopper are emptied directly in the open ocean (i.e. *sea dumping*) or via a pipeline that allows the dredge material to be pumped to location where it is used for engineering purposes (e.g. *land reclamation*). Depending on the type of equipment being used and the substrates involved, dredged material is sometimes pumped directly from the dredge site to a disposal location either at sea or on land. Material dredged for pipeline trenches is often placed temporarily on the seabed adjacent to the trench before being placed back into the trench after pipe has been laid to aid in pipeline stabilisation and protection. Similarly, some dredging operations for shipping channels involve dredged material being placed temporarily on the seabed near the dredge site before it is picked up by another dredge and transported to the disposal site.

For the purpose of this document, dredging refers to seabed excavation and dredge material placement activities that introduce sediments to the water column.

A number of different types of dredges are typically used for significant dredging proposals in WA. These include hydraulic dredges such as cutter suction dredges and trailing suction hopper dredges and mechanical dredges including bucket or grab dredges. Further information regarding the operation of different types of dredges and the factors that influence their selection can be found in PIANC (2010) or at web sites including:

<http://www.iadc-dredging.com/>

<http://www.boskalis.com/>

<http://www.jandenui.com/>

<http://www.vanoord.com/>

2.2 Environmental considerations

All dredging causes an environmental impact at dredge and disposal sites (Victoria EPA 2001) and, potentially, also further afield (PIANC 2010). Some examples of the types of potential impacts associated with dredging proposals include:

Impacts to benthic habitats

- direct loss of benthic communities and habitats by removal or burial;
- indirect impacts on benthic communities and habitats from the effects of sediments introduced to the water column by the dredging and disposal;

Other types of impacts

- changes to shorelines, bathymetry and habitats through modified ecological and physical processes;
- introduction of invasive pest species translocated in dredging (or ancillary) equipment that can have both ecological as well as economic consequences;
- adverse effects of contaminant release and dispersion (including impacts associated with reclamation or onshore disposal of acid sulphate soils) on marine environmental quality;
- conflict with fisheries and impacts on fish, their habitats and fisheries production;

- changes to coastal processes and water circulation that impact on the community's use of the coast and coastal waters; and
- impacts on the behaviour and survival of marine wildlife, including specially protected species.

This EAG is solely concerned with providing guidance for the presentation of predicted impacts of dredging activities on benthic communities and habitats.

Although the other types of impacts listed above are not addressed further in this document, this should not be taken to imply that they are not relevant or important. In some locations, dredging may have implications for marine conservation reserves, commercial and/or recreational fishing, public uses of the environment, or contaminated sites. In all cases, the EPA expects proponents to give the appropriate level of attention to each of the significant environmental issues associated with their dredging proposals. Appendix 1 provides high-level advice relevant to dredging proposals but which lies outside the scope of this EAG.

2.2.1 Dredge-generated sediments and their effects

Dredging and spoil disposal introduces sediment to the water column to varying degrees from three principal sources:

1. from the mechanical interaction of the dredging equipment with the seabed substrates;
2. from overflow associated with loading² of dredged material and land reclamation; and
3. from the disposal of dredge spoil.

The mechanical interaction of dredging equipment with the seabed causes sediment particles, in a range of particle sizes, to be introduced to the surrounding water column at the dredge site (e.g. loss from the cutting head of a cutter suction dredge or spillage from grab/bucket dredges). Limited under-keel clearance and turbulence from propellers can also disturb and lift sediments into the water column.

Hydraulic dredges produce slurries that comprise a fine sediment-water mixture and dredged solids. When the fine sediment-water mixture is allowed to escape during loading at dredging site or from land reclamation area, it can introduce significant loads of fine sediment to the water column. This sediment-laden discharge is the second principal source of sediment introduced to the water column by dredging and is commonly referred to as

² As defined in the *National Assessment Guidelines for Dredging*, Commonwealth of Australia, Canberra, 2009

overflow or *spill* when discharged from vessels or *return water* when discharged from reclamation areas.

Some sediment is also introduced to the water column during disposal of dredged material at sea, although the proportion of fines retained in spoil is relatively low when overflow practices are used during loading. Accordingly, in many cases only a relatively modest proportion of all fine sediments produced by dredging is introduced to the water column during dumping at sea. Exceptions to this will arise where overflow at the dredge site is eliminated or highly controlled to manage release of contaminants or when dredging up-current of particularly important areas.

The characteristics of sediment introduced to the water column by dredging can be very different to the characteristics of native substrates at a dredge site. The characteristics of sediments generated and released by dredging is influenced by a range of factors including the geotechnical characteristics of the substrates to be dredged, the type of dredge and its mode of operation, and the nature of the interaction between the dredge and seabed substrate.

Predicting impacts of dredge-generated sediments relies on understanding the key factors that influence the generation, sources, physical characteristics and release rates of fine sediments.

2.3 Policy and legislative context

2.3.1 Area of application

The EP Act applies to all WA lands, inland waters and marine coastal waters within three nautical miles from the territorial sea baseline.

The EPA expects proponents of formally assessed dredging proposals in WA coastal waters to give proper attention to this guidance when preparing EIA documentation. This means that the work required to underpin predictions and proposed monitoring and management strategies may be scalable, considering the magnitude of the proposal and its environmental setting, the details of which should be addressed at the scoping stage of the EIA process.

The EPA will consider this EAG when providing environmental advice to other regulators or decision-makers in respect of proposals that are located outside of State coastal waters but where risks to areas under WA jurisdiction are identified.

Not all dredging proposals in WA are subject to formal assessment by the EPA and some proposals will only be considered under approvals

processes administered by other authorities. Other authorities are not legally bound to implement this guidance or require that it be implemented by proponents. Nevertheless, other authorities may consider the principles and assessment framework set out here at their discretion.

This EAG applies to significant marine dredging proposals that are subject to formal environmental impact assessment by the EPA.

2.3.2 Other policy matters

Proposals to undertake dredging and spoil disposal present a range of environmental issues, only one of which is dealt with by this EAG. The scoping stage of EIA is designed to be used to identify the range of relevant environmental issues to be addressed by proponents in their assessment documentation.

Proponents are expected to address the issues identified during scoping in accordance with relevant guidance, policies, regulations and legislative requirements. The EPA will seek the advice of the appropriate authorities and technical experts when considering information presented by proponents.

The EPA strongly supports greater public availability of environmental data collected for EIA and post-approval monitoring and management programs. As a key step towards achieving this outcome, the EPA now routinely recommends conditions to the Minister for Environment to facilitate public availability of environmental assessment and monitoring data. Other initiatives are also being implemented to deliver new information relevant to dredging assessments into the public domain (e.g. the Dredging Science Node of the Western Australian Marine Science Institution).

2.4 Overarching environmental protection principles

The following principles are aimed at protecting benthic communities and habitats from the effects of dredging proposals. Assessment documentation should detail how the hierarchy of the principles below have been considered in advance of presenting predictions of environmental impact.

1. There should be demonstrable consideration of options to avoid impacts on benthic communities due to dredging, for example, by providing the rationale for selection of the preferred site and the proposed dredging methods.
2. Where impacts cannot be avoided, then proposed project design should aim to minimise impacts (e.g. through iterative design and demonstrable application of Principle 3 below) and the proposed design

should be justified in terms of operational needs and environmental constraints of the site.

3. Best efforts should be made to demonstrate in EIA documentation the application of 'best practice'³ in all aspects of proposals, including design, selection of construction methods and environmental management aimed at minimising predictive uncertainty and environmental impacts.

The EPA's judgement on the environmental acceptability of dredging proposals will take into account the level to which proponents demonstrate the principles of impact avoidance and minimisation and application of best practice in all aspects of their proposals.

Other principles

In the context of ports, dredge and disposal sites and other port facilities tend to occupy only a small portion of the total gazetted area of the port. Assessments should consider this in the context that outside of the areas occupied by the operational port facilities, large areas of ports support a wide range of environmental values (both social and ecological) that rely on maintaining healthy marine ecosystems.

The waste hierarchy (i.e. Avoid, Re-Use, Recycle, Recover and Dispose) will guide EPA judgements concerning the acceptability of proposals to dispose of dredged material. For example, unconfined ocean disposal of clean dredge spoil in WA waters should only be considered after the environmental costs and benefits of alternatives have been evaluated.

3.0 METHODOLOGY

3.1 General approach

The assessment framework described in this EAG is designed to impart clarity and consistency to the way predicted impacts are presented for assessment by the EPA. It establishes an approach for generating and presenting predictions of *the likely range* of environmental impacts, which in turn, provide the basis for facilitating the transfer of these predictions into recommended conditions and environmental monitoring and management strategies.

³ Some examples of 'best practice' are outlined in Section 3.7.

In simple terms, the predictions are made by superimposing the dredging pressures (i.e. excavation, burial, sediment deposition and elevated turbidity) on the biological communities and determining the likely responses of communities to those pressures.

While it is not the intention of the EPA to mandate a specific methodology, in order to generate realistic impact predictions, proponents are encouraged to consider and apply guidance provided in the following sections:

- Describing benthic habitats (Section 3.1.1);
- Background environmental data (Section 3.1.2);
- Describing impacts (Section 3.2);
- Generating and representing predictions (Sections 3.3 and 3.4);
- Integrating predictions with monitoring and management (Section 3.5).

3.1.1 Describing benthic habitats

An adequately detailed benthic habitat map is a critical piece of information for assessing the impacts associated with dredging.

The benthic habitat map (or series of maps) supplied by proponents must be at a sufficiently fine scale to provide confidence in the habitat boundaries which in turn reduces uncertainty in relation to the predictions of the areas of impact. Mapping should be undertaken as finely and accurately as possible considering the primary purpose and end use of the maps (e.g. to evaluate habitat loss and inform location of monitoring and reference sites) and factors such as expected intensity of pressure and the types and uniformity (or heterogeneity) of biological communities present. For example, the main benthic habitat types might be defined on the basis of the abundance of dominant and sub-dominant functional groups.

Spatial coverage of benthic habitat surveys and mapping is an important consideration. As general rule, mapping coverage should extend across the predicted Zones of High and Moderate Impact and the area of the Zone of Influence⁴ immediately outside of the Zone of Moderate Impact. High quality benthic habitat extent and distribution data in the Zone of Moderate Impact and adjacent Zone of Influence will be necessary for identifying suitable monitoring sites to manage environmental performance and assess compliance during project implementation. Knowledge developed through the survey work will also inform the selection of local biota that may be suitable surrogates or indicators for impact prediction and monitoring.

⁴ The terms Zone of High Impact, Zone of Moderate Impact and Zone of Influence are described in Section 3.4.

Technical reports that describe how benthic habitat surveys and mapping were conducted and how maps were produced must be supplied as part of the EIA documentation. Reports should clearly state any assumptions and consider their implications, and describe methodologies including those employed in the field for surveys and in the laboratory to interpret data and prepare spatial products. Spatial data associated with the benthic habitat map and infrastructure outlines should be supplied to the EPA in a suitable GIS compatible format. Early advice should be sought from the OEPA regarding the preferred data format of spatial data and associated metadata statements.

An understanding of the extent and distribution of benthic habitats is an integral requirement for EIA. Descriptions and maps of the different benthic habitats should be fit for purpose and accompanied by clear descriptions of methods used to generate them.

3.1.2 Background environmental data

Acquisition and analysis of background data is an integral part of any environmental impact assessment. In the context of this EAG, for example, long-term background data sets for a suite of dredging-relevant environmental variables (e.g. light climate, total suspended sediment concentration, sediment deposition rate, correlations between these factors) can be used to develop knowledge about natural tolerances and susceptibilities of local benthic organisms. Furthermore, independent baseline data sets are critically important for calibration and validation of numerical models.

Proponents are strongly encouraged to seek specialist professional advice regarding the types of baseline data that should be collected to inform and maximise the confidence in predictions of the extent, severity and duration of dredge-related environmental impacts.

Relevant background environmental data should be used to inform, validate and enhance confidence in predictions of environmental impacts.

3.2 Describing impacts

Environmental impact assessment is based on predictions of the extent, severity and duration of environmental impacts, taking into account confidence around the predictions and the likely effectiveness of proposed monitoring and management strategies.

The EPA expects that both direct and indirect impacts are considered explicitly.

Direct impacts occur predominantly within and immediately adjacent to infrastructure footprints where dredges excavate the seabed and where rock armour and spoil is dumped. Direct impacts typically involve irreversible loss of benthic habitats and communities, where *irreversible* is defined as 'lacking a capacity to return or recover to a state resembling that prior to being impacted within a timeframe of five years or less' (EPA, 2009).

Indirect impacts arise from effects of dredge-generated sediments and generally extend over areas surrounding infrastructure footprints and dredging sites and occur when sediment deposition rates and/or elevated turbidity exceed the natural tolerance levels of benthic organisms exposed to those pressures. These indirect effects of dredge-generated sediments may restrict or inhibit key ecological processes and cause impacts that range in severity and duration from irreversible to readily-reversible.

Both direct and indirect impacts, along with an assessment of the reversibility of those impacts, are to be included in predictions of impacts associated with dredging proposals.

3.3 Generating predictions

3.3.1 General

Predicting direct impacts of dredging is relatively straightforward as these impacts are generally tightly linked to the dredge area and/or disposal sites and immediately surrounding these areas.

Numerical modelling is most commonly used to inform predictions of the extent, intensity and persistence of dredge-generated sediment plumes, and the extent, severity and duration of resultant indirect impacts in benthic habitats, which can range in severity and duration from irreversible to readily reversible. Modelling techniques are particularly valuable predictive tools for proposals where suitable empirical data from previous dredging campaigns are either not available or unsuitable for informing accurate predictions of environmental impacts.

In very simple terms the approach commonly applied to predict indirect impacts from dredge-generated sediments involves implementing three key types of predictive modelling in a logical sequence:

- hydrodynamic modelling;
- sediment transport modelling; and
- ecological response modelling.

The EPA recognises the application of physical and ecological modelling to predict potential indirect impacts of dredge-generated sediments is

challenging, but they provide important and useful information on sediment plumes and as long as proposals continue to be presented for EIA approvals, numerical modelling will continue to be an integral component of impact assessments (PIANC 2010).

Direct impacts are generally predicted based on a combination of information about the dredge and disposal areas. The extent, severity and duration of indirect impacts are generally predicted with the use of simulation models, sometimes supplemented with empirical data collected during previous dredging projects.

Proponents are strongly encouraged to seek early advice from suitably qualified specialists and the OEPA regarding the application of this guidance, including the use of predictive numerical simulation models, in the context of their proposal.

3.3.2 EIA and modelling

Clearly presented information regarding calibration and validation of numerical models, assumptions and sources of uncertainty and their associated implications for predictions will assist the EPA in forming judgements about reasonableness and the confidence it can place in predictions of environmental impacts.

The level of agreement between model outputs and data measured in the field will vary from application to application and be dependent on many factors. It is therefore not appropriate for the EPA to set a requirement that specifies the level of agreement between model outputs and observations to be achieved. Instead, the EPA expects proponents to set out the process and outcomes of calibration and validation exercises and relevant assumptions on a project-to-project basis.

To improve confidence in dredging EIA, numerical models should be calibrated and validated and any associated assumptions and implications of those assumptions should be clearly stated and evaluated.

In cases where all relevant proponent documentation is not provided, is ambiguous or includes unsubstantiated conclusions, the level of confidence in the prediction would generally be lower than if high quality, peer reviewed information is provided.

3.3.3 Peer review

While the EPA does not mandate that proponents commission peer reviews of all studies underpinning EIA, peer review by a suitably qualified expert can, in some situations, assist the EPA in achieving timely assessments. If proponents either choose to commission a peer review or are requested to do so by the EPA, it is beneficial to seek agreement with the EPA on the terms of reference and scope before commencing the review.

To maximize the effectiveness and transparency of the peer review process, the EPA expects to receive the peer reviewer's reports, including their 'close out' comments based on the document that is ultimately submitted for EIA.

Proponents should expect that information relating to the peer review, including the terms of reference and the peer reviewer's reports will be made publicly available as part of the EIA process.

3.4 Describing impact predictions

3.4.1 Impact zonation scheme

The EPA has developed a spatially-based zonation scheme for proponents to use as a common basis to describe the predicted extent, severity and duration of impacts associated with their dredging proposals. The scheme consists of three zones that represent different levels of impact:

- **Zone of High Impact (ZoHI)** is the area where impacts on benthic organisms are predicted to be *irreversible*. The term *irreversible* is defined in accordance with EPA (2009) as 'lacking a capacity to return or recover to a state resembling that prior to being impacted within a timeframe of five years or less'. Areas within and immediately adjacent to proposed dredge and disposal sites are typically within zones of high impact. The irreversible loss of the benthic primary producer habitats within these zones should be considered in the context of Environmental Assessment Guideline No.3 (EPA, 2009), unless a defensible case for recovery of the impacted BPPH can be presented.
- **Zone of Moderate Impact (ZoMI)** is the area within which predicted impacts on benthic organisms are sub-lethal, and/or the impacts are recoverable within a period of five years following completion of the dredging activities. This zone abuts, and lies immediately outside of, the zone of high impact. Proponents should clearly explain what would be protected and would be impacted within this zone, and present an appraisal of the potential implications for ecological integrity of the impacts over the timeframe from impact to recovery (e.g. through loss of productivity, food resources, shelter). Where recovery from the

impact predicted in this zone is likely to result in an 'alternate state' compared with that present prior to development, then this outcome should be clearly stated in environmental assessment documents, along with justification as to why the predicted impacts should be included within this zone (rather than the Zone of High Impact) and an appraisal of the potential consequences for ecological integrity. The outer boundary of this zone is coincident with the inner boundary of the next zone, the Zone of Influence.

- **Zone of Influence (Zoi)** is the area within which changes in environmental quality associated with dredge plumes are predicted and anticipated during the dredging operations, but where these changes would not result in a detectable impact on benthic biota. These areas can be large, but at any point in time the dredge plumes are likely to be restricted to a relatively small portion of the Zone of Influence. The outer boundary of the Zone of Influence bounds the composite of all of the predicted maximum extents of dredge plumes and represents the point beyond which dredge-generated plumes should not be discernable from background conditions at any stage during the dredging campaign. Furthermore, this provides transparency for the public regarding where visible plumes may be present, albeit only occasionally, if the proposal receives approval. Reference sites for monitoring natural variability would ideally be located outside of the Zone of Influence of the dredging activities.

3.4.2 Presenting the zonation scheme

The system of zones is designed to be presented in a spatially-based map form. Figure 1 shows a zoomed out view of how the zonation scheme would be represented. It shows the relative sizes of the zones that are likely to be generated based on recent experiences and also shows that all effects of dredging should be captured by the outer boundary of the Zone of Influence.

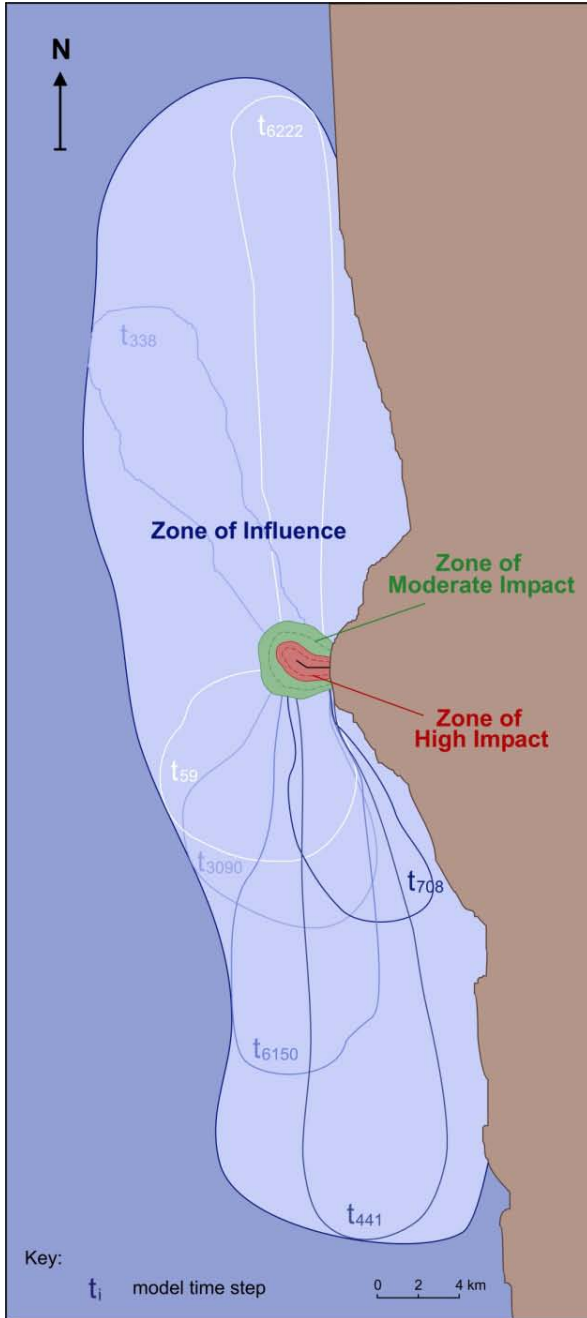


Figure 1: A schematic representation of the spatially based zonation scheme for representing dredging related impacts where red represents the Zone of High Impact, green represents the Zone of Moderate Impact and pale blue represents the Zone of Influence. Individual dredge plumes are shown as blue shaded lines within the Zone of Influence at different time steps (t_n) during a simulated dredging campaign.

In simple terms, the level of cumulative pressure on biota from dredge-generated sediments will generally decrease with distance from the dredging site. As a result, the degree of impact would similarly be expected to decrease with distance from the dredge site. Figure 2 shows how the pressure and resultant degree of impact on benthic communities would change with distance from dredging, and how these changes can be represented by the zonation scheme described above.

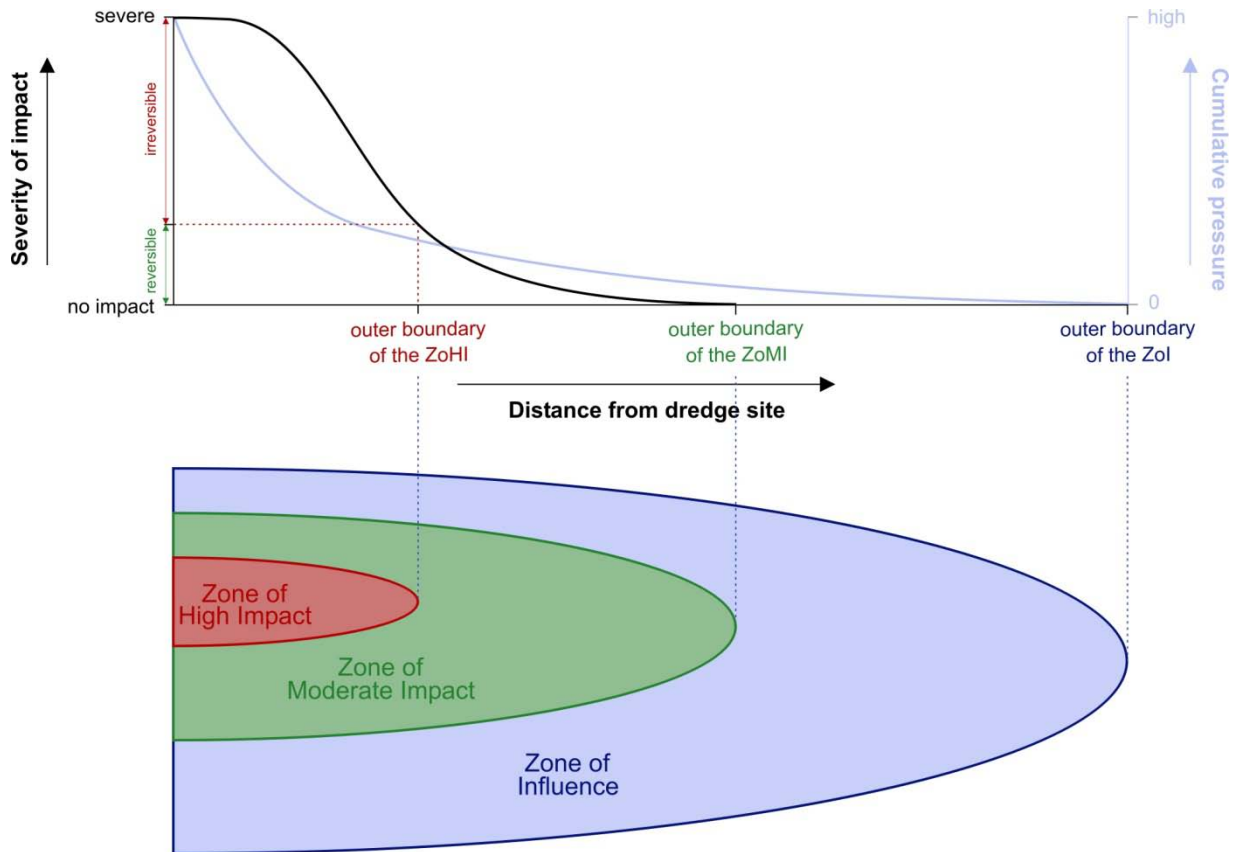


Figure 2: A schematic representation of the degree of change in environmental quality associated with dredging (grey line) and level of resultant impact (black line) along a transect extending away from the dredging site to the outer extremity of the Zone of Influence. The location of the outer boundaries of the Zone of High Impact (ZoHI), Zone of Moderate Impact (ZoMI) and Zone of Influence (ZoI) are shown relative to these predicted changes in environmental quality and impacts on biota.

The level of ecological impact associated with dredging would generally be expected to attenuate with distance from the dredge site as represented by the black line in Figure 2. This figure also shows the position of the outer boundaries of the Zones of High and Moderate Impact relative to the level of impact expressed as 'reversibility'. A key point to note is that all impacts relevant to a particular zone are attenuated within that zone before transition into the next zone further from the source of sediments. For the Zone of High Impact, this means that no irreversible impacts should be predicted to occur outside of this zone and the corollary is that not all impacts on all biota within this zone are predicted to be irreversible. Near to the boundary with the Zone of Moderate Impact, but still within the Zone of High Impact, the level of impact can logically be expected to be lower than closer to the dredge site and approaching the point where there are no

irreversible impacts. Most importantly there should be no irreversible impacts on benthic communities in the Zone of Moderate Impact or beyond.

Similarly, moving further along the transect away from the dredging site a point would be reached near the Zone of Influence but still within the Zone of Moderate Impact where there would be practically no detectible impact on biota.

The spatially-based zonation scheme provides a clear and consistent way of describing and presenting the extent, severity and duration of predicted impacts of dredging for environmental impact assessment.

3.4.3 Accounting for predictive uncertainty

Uncertainty is a factor inherent in all predictions and there is an array of sources of uncertainty associated with dredging impact predictions. In order to take account of this uncertainty in the EIA process, the final set of predictions may describe the lower and upper ends of the *likely range* of impacts associated with the proposal (i.e. the likely best case and the likely worst case). This range should be realistic and based on understanding of probable scenarios and their associated environmental outcomes. For the majority of proposals, the range of predictions to be considered should be conservative but not include unrealistic best or worst case (or other improbable) predictions.

This is illustrated conceptually in Figure 3, which shows the likely location of the outer boundaries of the high and moderate impact zones along a transect extending away from the dredging site. The transect line at the top of the figure has two sections marked 'likely range', which represent the range of possible positions of the boundary of each zone. The distances from the dredging site that correspond to the two ends of each marked section represent the likely 'best case' and likely 'worst case' positions of that boundary.

In order to take account of this uncertainty in the EIA process, the final set of predictions may describe the lower (*likely best case*) and upper (*likely worst case*) ends of the *likely range* of positions of the boundaries that could reasonably be expected based on understanding of probable scenarios and their associated environmental outcomes.

In practice, the pair of boundaries might be generated by implementing a number of different approaches. Approaches might include modelling scenarios that capture variation in physical forcings (e.g. typical and atypical wind conditions, neap and spring tidal regimes), sediment release rates (e.g. more fines, less fines), and dredge operation and management scenarios (e.g. different dredge types and operating modes). Testing the

sensitivity of ecological impact predictions to different pressure thresholds or considering seasonal effects may also be undertaken to understand the likely range of prediction outcomes. Furthermore, in recognition that different biota may display very different degrees of tolerance and susceptibility to the same level of sediment-related pressure, in many cases it may be appropriate to generate different predictions for the location of boundaries for different groups of benthic organisms or community/habitat types. In all cases there will need to be a degree of ‘professional judgement’ employed to establish the likely best case and likely worst case locations of the boundary for a zone.

The range of likely impact predictions should be based on best practice approaches being applied to dredging and its management.

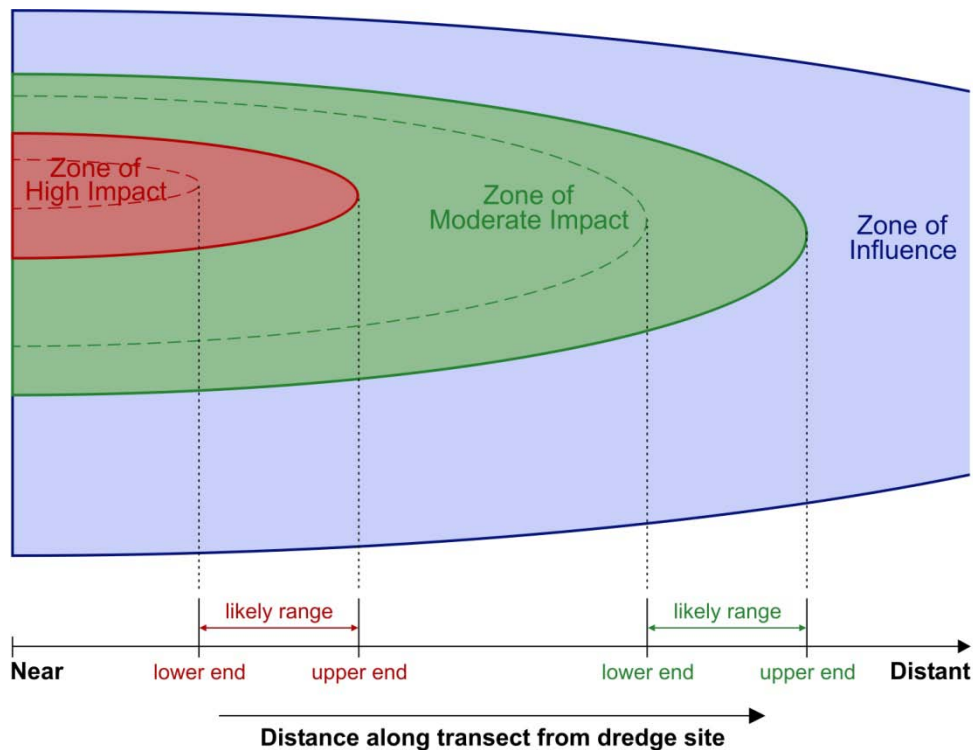


Figure 3: A conceptual representation of the ‘likely’ range of realistic locations for boundaries of the Zone of High Impact and Zone of Moderate Impact associated with a dredging proposal and how this is translated into the spatial zonation scheme for presenting impacts for environmental impact assessment.

3.4.4 Presenting realistic and likely predicted impacts

Boundaries that represent the range of likely environmental impacts should be presented in map form as shown in Figure 4. Figure 4 a) shows the full extent of the predicted Zone of Influence and the Zones of High and

Moderate Impact within it. Figure 4 b) shows boundaries associated with the Zone of High Impact and Zone of Moderate Impact, where the broken and solid lines represent the likely best case and likely worst case respectively.

In making and presenting predictions in the manner shown in Figure 4, proponents should consider the likely best case as reflecting an outcome they are *hopeful* of achieving if all goes well and best practice approaches are applied to dredging and its management. The likely worst case on the other hand would reflect an outcome that the proponent is *confident* of achieving using best practice even if things do not go as well as hoped.

These maps serve a number of key purposes. Firstly, they present fundamental information for effective environmental impact assessment, including information about the extent, severity and duration of predicted impacts, and the full extent of the predicted Zone of Influence, which ensures there is a common basis for understanding the potential extent of sediment plumes anticipated during the dredging operations. These maps explain predictive uncertainty and clearly differentiate between the targets which the proponent will aim for and the outcomes that they are confident in achieving, through management of the project.

For the purpose of assessments, the EPA will consider the likely range of impacts associated with the proposal when making judgements about environmental acceptability of impacts and when formulating advice and any recommended conditions of approval. Proponents can expect the EPA to recommend conditions that, as a minimum, require the impacts of the proposal to be kept below those predicted to be the 'likely worst case'. Proponents will be expected to consider the range of likely impacts when developing their proposed environmental monitoring and management strategies.

The lower end of the range of likely impacts should reflect a likely best case that would become a target for management. The upper end of the range should reflect a likely worst case outcome that the proponent is both confident of achieving and prepared to be conditioned to.

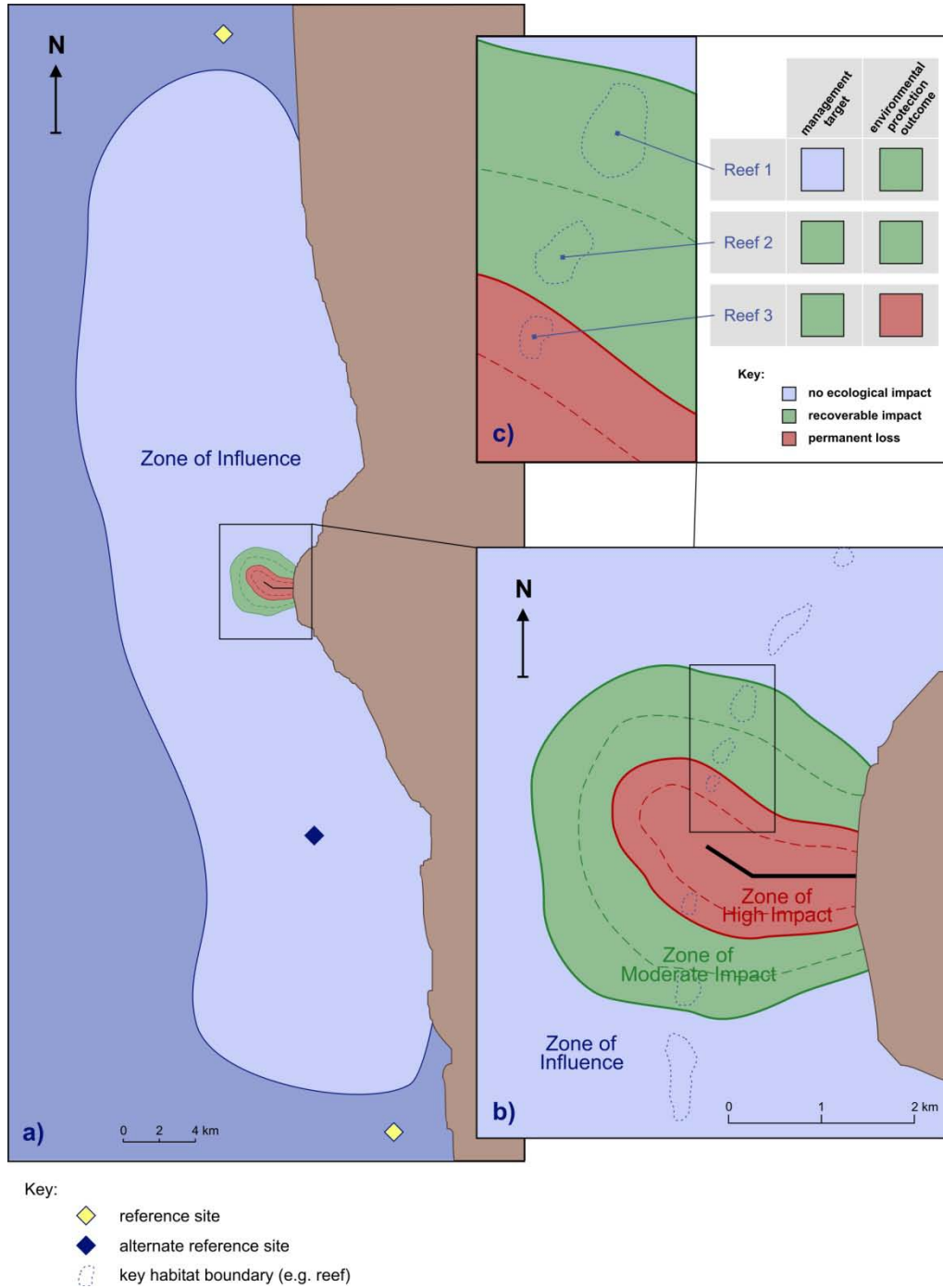


Figure 4: An example map-form presentation of: a) the predicted Zone of Influence and the predicted zones of High Impact and Moderate Impact associated with channel dredging (represented by the black line), b) closer view of the predicted Zones of High Impact and Moderate Impact, noting that the area between the broken lines (inner) and solid lines (outer) represents the uncertainty associated with the location of the zone boundary, and c) zoomed in section showing the management targets and expected environmental outcomes for the zones and the area of uncertainty within the zones.

3.5 Integrating predictions with monitoring and management

In an ideal world predictions would be 100% accurate, and this would facilitate straightforward EIA and reduce or negate the need for monitoring and reactive management. The reality, however, is different and a range of environmental monitoring and management strategies are employed to ensure that impacts are minimised during project implementation and compliance with conditions relating to limits can be demonstrated.

By presenting predictions that represent the lower and upper ends of the range of likely impacts, the framework establishes a logical and consistent basis for translating those predictions into monitoring and management strategies and conditions of approval. The likely best case predictions will be used in setting appropriate 'management' objectives (i.e. targets) whilst the likely worst case predictions would be more aligned with environmental protection outcomes (i.e. regulatory limits). Importantly this allows a distinction to be made between monitoring requirements for informing management of dredge operations and monitoring requirements for demonstrating compliance. This should allow a more efficient allocation of resources between the various monitoring and management tasks.

In simple terms, proponents can expect that the frequency and extent of compliance monitoring during the dredging programs will be inversely proportional to the overall confidence in the predictions of environmental impact, the environmental significance of the impacts and the effectiveness and responsiveness of the proposed environmental monitoring and management strategies.

Developing the detail around proposed monitoring to inform adaptive management and determine if management targets are being achieved would ideally be a task for proponents, however there may be cases where, based on its consideration of information provided for assessment, the EPA will make prescriptive recommendations in this regard. When developing proposed environmental monitoring programs, proponents should consider monitoring required for adaptive management purposes and that necessary to demonstrate compliance and any efficiencies that could be realised.

An overarching objective of the assessment framework, outlined in the preceding sections, is to enhance the linkage between the environmental impact predictions made for EIA and the data generated through monitoring and management programs implemented post-approval. This should generate validation data which will further increase confidence over the prediction – management continuum.

Furthermore, targeted scientific research, such as that being conducted by the Western Australian Marine Science Institution dredging science node,

will help improve certainty. As outcomes of this body of research become available the EPA may prepare supplementary and more technical guidance to assist proponents in specific aspects of dredging impact prediction. As contemporary understanding from these initiatives and from the results of more targeted monitoring of dredging pressures and impacts are applied in EIA, confidence in dredging-related impact predictions should increase resulting in reduced monitoring requirements over time.

Monitoring and adaptive management in the various zones will have differing objectives. The environmental significance of the area and the level of predictive uncertainty exposed during EIA will drive how much monitoring is required.

Proponents could expect the highest monitoring and management burden in situations where environmental values are high and where there are high levels of predictive uncertainty.

3.5.1. Environmental monitoring and management plans

The fundamental purpose of an environmental monitoring and management plan (EMMP) is to provide the proponent with a way to ensure that the environmental protection outcomes established for a project are not compromised. It must also establish the framework for monitoring in a way that informs adaptive management of dredging to minimise the impact on the environment with an aim to achieve the relevant management targets. As such, the EMMP needs to focus on the key threats posed by the project and the pathways by which those threats could cause the environmental protection outcomes to be compromised. The primary threats to the surrounding marine environment from dredge-generated sediment are shading caused by sediments suspended in the water column and smothering of benthic habitats and organisms caused by the deposition of these sediments. These pressures, if unchecked, could cause flow-on effects to critical habitats such as coral reefs and seagrass meadows.

The EMMP should be geared towards achieving management targets that indicate a level of impact that is lower than the limits established as environmental protection outcomes. As such, the EMMP is designed to provide early warning of potential impacts to trigger pre-emptive management before the environmental protection outcomes are compromised. The proposed monitoring set out in the EMMP also has another element designed to demonstrate that the environmental protection outcomes have been met.

Environmental monitoring and management plans should be developed such that focus on achieving the management targets would provide a high degree of confidence that the environmental protection outcomes are not compromised.

An EMMP should be clear and unambiguous and contain the following key elements:

- clearly stated objectives;
- a monitoring/management feedback loop to achieve those objectives;
- management triggers along pressure-response pathways;
- monitoring regime including site locations and methods to provide data to allow assessment against the management triggers;
- clearly set out data evaluation procedures to identify where and when management triggers have been reached;
- contingency management strategies to be employed if triggers are reached; and
- a reporting process.

The EPA expects proponents to provide the EMMP for dredging as part of the documentation submitted for assessment. These plans should contain sufficient information to allow the monitoring methods, data interpretation and the efficacy of proposed management to be assessed.

Environmental Monitoring and Management Plans should be an integral part of the documentation submitted for EIA of dredging proposals.

3.5.2. Environmental monitoring locations and their purposes

Selection of locations for establishing monitoring and reference sites should be based on factors including the locations of predicted zone boundaries (including the area of uncertainty), the level of acceptable impact for each zone and the types and locations of benthic communities in those zones.

For example, because the Zone of High Impact is based on the extent of irreversible impacts and any approval that might be granted would recognise that, it would not be necessary to monitor the health of benthic communities in that zone for 'compliance' purposes. There would however, be significant benefit from monitoring both dredge-related 'pressure' and 'ecological response' along a gradient from near the dredging location through to the edge of this zone (and beyond). In the short term, the results of pressure and response monitoring would help to appraise and refine some of the early warning trigger criteria used for 'management' of impacts in the Zones of Moderate Impact and Influence during the course of the dredging campaign (i.e. adaptive management). In the longer term,

benefits would be realised through improved understanding to inform assessments of future proposals for new capital or maintenance dredging.

The Zone of Moderate Impact is a key focus for monitoring and management as this is the transition zone between where permanent loss and no effects are predicted. Monitoring and management in the Zone of Moderate Impact serves dual purposes to 1) minimise impacts through informed adaptive management designed to at least achieve a management target, and 2) ensure that those impacts which do occur are reversible and not greater than approved (i.e. the environmental protection outcomes). In this zone it would be expected that monitoring would include both dredge-related 'pressure' and 'ecological response'.

The overarching objective of monitoring and management in the Zone of Influence is to ensure there are no detectible effects of dredging on benthic communities in that zone.

As a rule, monitoring locations for a zone should be as close as possible to the inner boundary for that zone. This is particularly important for the Zone of Influence, given its size, and so these monitoring locations should be established in suitable habitats as close to the Zone of Influence/Zone of Moderate Impact boundary as possible.

Reference sites should be located outside of the predicted Zone of Influence (Figure 4). However, given the potential scale of the Zone of Influence, it may prove to be logistically very difficult to establish and regularly monitor sites that are very distant from the central area of activity. Furthermore, the environmental settings outside of the Zone of Influence may be such that there are few appropriate areas that have the necessary degree of similarity to the monitoring sites to be appropriate as reference sites. In acknowledgement of these issues, the EPA is prepared to consider arguments for reference sites within the Zone of Influence, if well justified and where it can be demonstrated that the frequency and intensity of exposure to dredging plumes is low. Notwithstanding the above, the EPA would still expect reference sites to be established outside of the Zone of Influence as a safety measure, but would accept a lower monitoring frequency than at the operational reference sites.

Reference sites should ideally be established outside the Zone of Influence but proposals for sites within this zone may be considered if well justified.

3.5.3. A risk-based environmental monitoring and management framework

The framework around which to design environmental monitoring programs should be risk-based using understanding of pressure-response pathways for key biota in the benthic communities to be monitored. Essentially this means that monitoring would be designed around the application of indicators that signify progressively greater risk of unacceptable impact. For example monitoring may take the following general risk-based form and apply suitable techniques to measure the responses in primary, secondary and tertiary indicators. Further explanation and guidance is provided below.

1. **Primary indicators** signify a very early warning of potential threat and low level of risk to the biota of interest. A primary indicator could be a water quality measure linked to pressure from dredging such as turbidity, light attenuation coefficient, sediment deposition rate. Exceeding a criteria linked to a primary indicator would trigger tier 1 management, which could include **investigating the cause of the exceedance** and **increasing monitoring** to include a secondary indicator.
2. **Secondary indicators** signify a moderate risk to the biota of interest and might include measures of biotic stress such as change in the colour of coral tissues or a reduction in the shoot density of seagrass. Exceeding a criterion linked to a secondary indicator would trigger tier 2 adaptive management, which could include implementation of measures to **reduce dredge-related pressure** and monitoring of a tertiary indicator.
3. **Tertiary indicators** signify a high and unacceptable level of risk to the biota of interest. A tertiary indicator would be a measure or measures that are immediate pre-cursors to an unacceptable impact. Exceeding criteria linked to a tertiary indicator would trigger strong management action to **alleviate pressure**.

An objective of the integrated EIA and environmental monitoring and management approach is to provide for a more explicit description of environmental impact of dredging than has necessarily occurred in the past. Proponents should therefore expect that the EPA will incorporate the predicted zone boundaries into conditions it may recommend to the Minister for Environment.

The clear definition of project impacts (in terms of extent, severity and duration) and areas to be protected allows for unambiguous audit of project performance against approval conditions, which in turn reduces uncertainty around compliance or enforcement issues.

The strong links between predictions and approvals highlight the importance of robust model calibration and validation, and high-quality science - all targeted towards reducing predictive uncertainty. The EPA recognises that development of knowledge of pressure-response relationships in particular can not occur immediately, but considers this is an important goal that should be strived towards collectively.

Environmental Monitoring and management plans should reflect contemporary best practice and ideally be risk-based, using readily measureable indicators along the pressure-response pathway, to trigger management to prevent unacceptable impacts.

3.6 Critical windows of environmental sensitivity

When designing dredging proposals and making predictions of environmental impacts, proponents should consider *critical windows of environmental sensitivity*. Critical windows of environmental sensitivity include times of the year or particular sites where key species or ecological communities or critical processes may be particularly vulnerable to pressures from dredging.

There are numerous examples of known critical windows of marine environmental sensitivity and it is likely that with further scientific research others will be identified. Some examples which the EPA has either considered previously in relation to dredging proposals or is aware of supporting scientific data include spawning and larval settlement periods for corals, habitat for spawning aggregations and juveniles of fish (e.g. pink snapper) and invertebrates (e.g. blue swimmer crabs), critical habitat for breeding of marine wildlife (e.g. turtles, dugong), the timing and routes for migration of specially-protected migratory species (e.g. JAMBA/CAMBA listed migratory birds, whales) and habitat that supports primary food resources for marine mammals (e.g. seagrass areas in Shark Bay and Exmouth Gulf grazed by dugong).

Critical windows of environmental sensitivity should be addressed in the context of the overarching environmental protection principles set out in Section 3.4.

3.7 Best practice

The EPA's general view on the concept of best practice is outlined in Guidance for the Assessment of Environmental Factors No. 55: *Implementing Best Practice in proposals submitted to Environmental Impact Assessment process* and is based on the principle that WA's high level of environmental quality should be maintained.

While best practice tends to be highly site and project specific, some examples considered to represent best practice in the context of dredging proposals include:

- up-front design to minimise the need for dredging, considering the environmental setting and operational safety requirements;
- dredge area design that aims to minimise direct and indirect impacts on key benthic habitats (e.g. design and locate marine infrastructure to avoid or reduce impacts on coral or algal reefs, seagrass habitat or mangroves);
- using site-specific geotechnical data and understanding of dredge equipment-substrate interactions to help select *fit for purpose* dredging equipment and operating modes to minimise the environmental impacts;
- using this knowledge of geotechnical conditions, and dredge equipment-substrate interactions to establish the likely physical characteristics and generation rates of fines produced by dredging at the site;
- using validated hydrodynamic and sediment transport models to assess the dynamics and likely fate of sediment plumes;
- the use of silt curtains where they are operable and likely to be effective in controlling turbidity release and dispersion;
- contracting dredges equipped with sediment management devices where these are found to minimise sediment generation and dispersion;
- a commitment to manage dredging in ways that minimise the release of sediments into the water column as much as practicable, particularly in situations where dredging-related sediments have the potential to impact sediment-sensitive benthic communities. Methodologies such as planned commencement of overflow, piping dredge spoil direct to disposal sites or to transfer vessels stationed sufficient distances from sensitive receptors to eliminate or minimise risk pathways to those receptors may need to be considered; and
- the application of near real-time data collection and interpretation methods (particularly for turbidity) to support environmental management of dredging. This should be determined on a hierarchical basis grading from small maintenance dredging campaigns in low sensitivity environments where real-time monitoring is not warranted

through to major capital dredging projects where substantial commitments to monitoring and adaptive management, including the use of telemetered turbidity meters, are required. In addition to the scale and environmental settings of proposals, in all cases the degree of uncertainty in impact prediction will be considered when determining the appropriate level of near real-time data collection and interpretation required to manage project implementation.

4.0 DEFINITIONS

Word or phrase	Definition for the purpose of this EAG
Dredge spoil	Seabed substrate material after it has been excavated from the seabed.
Dredging	Involves excavation of the seabed from the upper intertidal zone to the subtidal zone. Dredging in the sense of this EAG means both dredging and dredge spoil disposal activities.
Extent	The area over which an impact extends.
Functional groups	Groups of species (which are not necessarily related generically) that share similar important ecological characteristics and play equivalent roles in the functioning of the biological community.
Infrastructure	Shipping channels, turning basins, berth pockets, pipeline trenches, spoil disposal sites, sub-sea mine areas and land reclamations are some examples of infrastructure.
Irreversible	Lacking a capacity to return or recover to a state resembling that prior to being impacted within a timeframe of five years or less (also see reversible).
Near real-time	Refers to a system for monitoring and interpreting data where the time lag between collecting monitoring data and responding is sufficiently short to be considered as immediate as practicable.
Persistence	The period of time that an impact continues.
Prediction	A forecast of future outcomes.
Pressure threshold	Pressure thresholds signify a level of pressure (generally expressed in terms of intensity, frequency and duration) that equates to a pre-defined level of effect or impact to an organism or group of organisms of interest.
Recoverable	See reversible.
Reversible	A capacity to return or recover to a state resembling that prior to being impacted within a timeframe of five years or less.
Severity	The degree of harm caused. For example, the degree of harm or severity of impact to biota could range from sublethal effects to mortality or loss.
State coastal waters	The State coastal waters extend three nautical miles seaward from the territorial sea baseline.
Uncertainty	In relation to prediction is doubt or concern about the reliability of achieving predicted outcomes.

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Status	Final
Citation	This document can be cited as: Environmental Protection Authority (2011). <i>Environmental Assessment Guideline for Marine Dredging Proposals</i> . Environmental Protection Authority, Perth, Western Australia, September 2011
Contact Officer	The EPA undertakes periodic review of guidance documents, if you have any comments on the content of this Guideline please provide feedback to: Marine Ecosystems Branch, Strategic Policy and Planning Division, Office of the EPA, marine@epa.wa.gov.au

Appendix 1

High-level advice for considering some key issues that may be relevant to dredging proposals.

For those issues that are not a primary focus of this EAG, proponents are advised to contact responsible agencies directly at an early (preferably pre-scoping) stage for advice on information requirements for EIA.

Marine biodiversity conservation

The principal state legislation for marine biodiversity conservation is the *Conservation and Land Management Act 1984* (CALM Act) and the *Wildlife Conservation Act 1950*. Both of these acts are administered by the Department of Environment and Conservation.

Proponents of dredging proposals that are likely to impact a specially protected marine species or an identified value of a CALM Act marine conservation reserve are strongly encouraged to seek advice from DEC in the first instance.

The advice of the Department of Fisheries should be sought at an early stage where there is potential for dredge-related effects and/or impacts in areas reserved under the *Fish Resources Management Act 1994*.

Matters of national environmental significance listed in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) may be relevant to dredging proposals in WA waters. Australian Government Department of Sustainability, Environment, Water, Population and Communities (SEWPaC), the same agency that administers the *Environment Protection (Sea Dumping) Act 1981* (Sea Dumping Act), also administers the EPBC Act. As it is not normally appropriate for the EPA to advise proponents on the Australian Government's requirements, proponents should ensure they make their own representations to SEWPaC as appropriate in relation to the EPBC Act, the Sea Dumping Act or any other federal legislative or policy requirements.

Contaminated sites

The *Contaminated Sites Act 2003* and associated Contaminated Sites Regulations 2006 are used to regulate contaminated sites in WA. The *Contaminated Sites Act 2003* defines 'contaminated' as:

"having a substance present in or on that land, water or site at above background concentrations that presents, or has the potential to present, a risk of harm to human health, the environment or any environmental value."

Land owners, occupiers and polluters are required to report known or suspected contaminated sites to DEC. Reported sites are then classified, in consultation with the Department of Health, based on the risks posed to the

community and the environment. The site classification will guide decisions about management and allowable current and future use of the site.

For dredging proposals that involve land reclamation with dredge spoil, there may be a requirement to consider the *WA Contaminated Sites Act* and associated Regulations and guidelines. Depending on the source of fill and its quality in terms of toxicants and acid sulphate soil potential, areas reclaimed with dredge spoil may require assessment, classification and/or specific management.

It is recommended that proponents consult at an early stage with the Contaminated Site Branch of DEC for advice on matters including sampling and analysis requirements. In order to maximise the utility of sampling and analysis efforts, it is suggested that consultation with DEC on contaminated sites matters occur at around the same time as discussion takes place with the Australian Government about requirements under the Sea Dumping Act, where that act also applies.

Fisheries and bio-security

It is not uncommon for dredging proposals and associated zones of impact and influence to interact with commercial and recreational fisheries.

In view of their purpose and operating mode dredging vessels present a unique set of issues in relation to marine biosecurity risk. Indeed, are examples in WA where dredging-related vessels have presented marine biosecurity risks that have required decisive management intervention.

The Department of Fisheries is the agency responsible for management of fisheries and marine biosecurity in WA. That department should be contacted to discuss management of potential conflicts and management in relation to marine fisheries and biosecurity matters.

Community uses

The community values coastal marine waters for many reasons. It must be recognised that the community may raise legitimate concerns regarding the potential effects of dredging on those values. Proponents are encouraged to liaise with the relevant agencies, committees and councils that have statutory roles and responsibilities that relate to the community's use of the marine environment. Some examples include the Cockburn Sound Management Council, Swan River Trust and local governments. Proponents should also be mindful of the roles and responsibilities of the Department of Health (DoH) in relation to protecting human health. Some examples of issues that may be of interest to the DoH include potential dredging-related mobilisation of contaminants, harmful algal species and bacteria. In some cases it will be appropriate to consult the Department for Planning and the Department of Transport regarding advice potential impacts of maritime and coastal infrastructure on beaches and land-side coastal environments.