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Appendix Q Risk Assessment

Report: East Arm Wharf

Environmental Impact Statement Risk Assessment

29 APRIL 2011

Prepared for

Northern Territory Department of Lands and Planning

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Abbreviations

Abbreviation	Description
<	Less than
DEIS	Draft Environmental Impact Statement
DLP	Department of Lands and Planning (NT)
EAW	East Arm Wharf
EMP	Environmental Management Plan
MSB	Marine Supply Base
NT	Northern Territory
RLO	Rock Load-out Facility
UXO	Unexploded Ordinance

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Introduction

The proposed expansion by the Northern Territory Department of Lands and Planning (DLP) of East Arm Wharf (EAW) broadly comprises four separate developments within the East Arm Wharf (EAW) precinct. The scope of this Draft Environmental Impact Statement (DEIS) includes the five main developments, along with required works associated with these developments. The five main proposed developments within the scope of this DEIS are:

1. Marine Supply Base (MSB)
2. Rock Load-out Facility (RLO)
3. Barge Ramp Facility
4. Tug Berths
5. Rail Loop and future unloading facility.

In addition to the four main developments, dredging is a fundamental component of the project.

The scope of each of the four developments is outlined elsewhere.

The overarching objective of an DEIS is to ensure that all known and potential environmental, social and economic impacts of the Project are identified and assessed and, where possible, to state how any adverse impacts would be avoided. An DEIS needs to provide sufficient information for stakeholders to make an informed decision on the known impacts and potential impacts (also known as risks) of the project, and of the management measures employed to mitigate adverse impacts.

For the EAW Project the RISQUE methodology was adopted for risk assessment, as it allows for the practical documentation and comparison of known and potential impacts across the project, cost-effective mitigation measures to be developed, and for the nature of the risks to be understood in terms of when, where, and to which assets the known impacts and risks will exist.

This report details the process undertaken, and presents the results of the analysis of the risks for the Project.

The key objectives of this report are to:

- Describe the risk assessment process that was undertaken for the EAW Project.
- Present outcomes and findings of the EAW risk assessments that describe the risk events for the overall project. (Note that detailed descriptions of specific risk events are not provided in this report. These are described in the relevant technical chapters in the DEIS);
- Demonstrate whether the EAW Project will pose an acceptable risk to assets including, public health and safety, economy, society, environment, and property and infrastructure; and
- Demonstrate that the EAW risk assessment process meets the regulatory requirements.

2

Approach

2.1 Overview of the Approach

The risk management approach for the EAW risk assessment is based on the RISQUE method which is a widely accepted approach to risk management, often involving the use of a multi-disciplinary "expert panel" for assessing the probabilities and consequences associated with potential risk events.

This approach was selected because it is essentially simple and is able to assess (on a relatively even basis) risks associated with social, environmental, engineering and economic issues and events. It was decided that an alternative, simulation approach sometimes used by the RISQUE method, was not appropriate for the Project.

Highly complex systems involving feedback mechanisms and multi-faceted inter-relationships have been incorporated into the risk assessment through the use of a team of subject matter specialists.

In general terms, the RISQUE method is a cyclical process based on the ISO/Australia and New Zealand Standard for Risk Management (ISO 31000:2009) framework, as described in Figure 2-1 below.

Figure 2-1 Overview of ISO 31000 risk management process

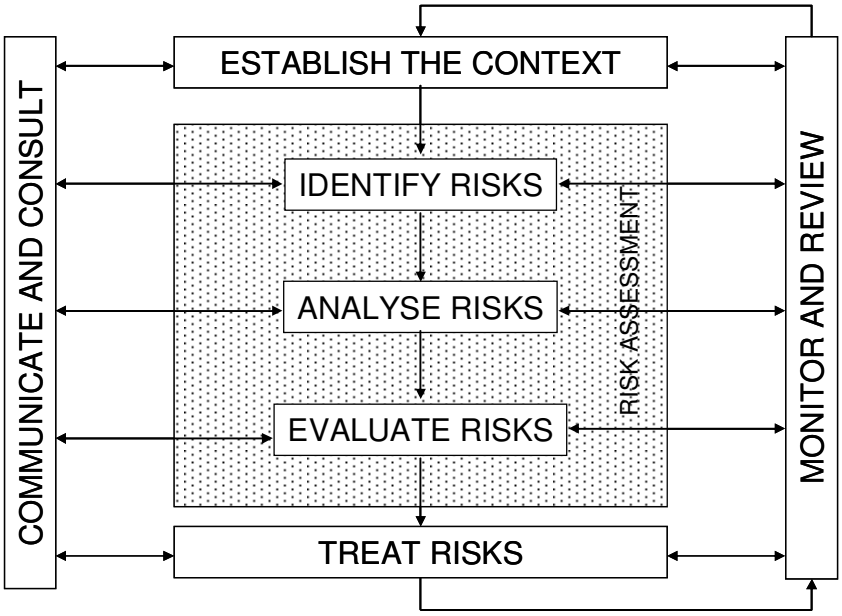


Figure 2-1 shows that the ISO 31000 risk management process is iterative and that the main elements of the process are:

- Communicate and consult – Communicate and consult with stakeholders at each stage of the process.
- Establish the context – Context for the project has been described in the project description. This step provides background to the analysis and structure of the risk assessment.
- Identify risks – Identify when, where, why and how risk events could occur. Information was obtained from DLP personnel and from subject matter specialists. The process was essentially workshop-based with support from other discussions, meetings, and reviews that took place outside of workshops, and was facilitated by URS.

- Analyse risks – Identify existing controls, evaluate likelihoods and consequences to determine levels of risk. The level of analysis was relatively simple (involving calculation of risk quotients and adding risks and likelihoods as appropriate) and was performed by the URS risk analyst.
- Evaluate risks – Compare estimated levels of risk with evaluation criteria, consider benefits versus adverse outcomes. The role of the risk analyst in the risk evaluation process was to generate appropriate outputs from the risk analysis that would be useful for stakeholders (including DLP, community and regulators) to evaluate the risk posed by the Project and to form their views.
- Treat risks – As required, to develop and implement specific strategies for increasing benefits and reducing potential costs and to ensure that all material risk events are addressed in the actions contained with the Environment Management Plan (EMP) of this DEIS.
- Monitor and review – Monitor the effectiveness of all steps of the risk management process. The client, with support from the risk analyst, will assess changing circumstances.

2.2 What is Risk?

Risk is a condition resulting from the prospect of an event occurring and the magnitude of its consequences. Therefore, risk is an intrinsic combination of:

- The likelihood of an event and its associated consequences occurring (this incorporates consideration of the frequency of the event and the probability of the consequences occurring each time the event occurs); and
- The magnitude of potential consequences of the event.

In quantitative terms, “risk” is defined by a risk “quotient”, which is:

Risk Quotient = Likelihood x Consequence

The risk quotient is therefore a numerical value that describes the level of risk posed by an event.

Both likelihood and consequence can be measured in several ways using different techniques, depending on the aims of the risk assessment and the nature of the risk issue. The selected methodologies for assessing likelihoods and consequences in the risk assessments are described in following sections.

2.2.1 Dealing with Uncertainty

As risk is a concept used to describe events that may or may not occur, and for which the scale of potential impacts cannot be accurately predicted, there is always inherent uncertainty associated with the estimation of risk.

Considering the two-dimensional nature of risk (likelihood x consequence), there are two key types of uncertainty in any estimation of risk:

- Uncertainty in the estimated likelihood of an event occurring; and
- Uncertainty in the magnitude of the event consequences.

The underlying cause of the uncertainty itself may be a result of a combination of issues such as lack of historical information for similar situations, uncertainty in scientific knowledge, natural variability, or uncertainty due to assumptions inherent in technical models or calculations used for forecasts and predictions. In assessing and measuring uncertainty, one must take into account each of the assumptions made and the extent of its validity.

3

Risk Identification

A workshop (with subsequent follow-up and validation) process was followed to perform the task of risk identification. The workshop was held on 2nd March 2011 and subject matter specialists in attendance (personal and on teleconference) provided expertise in marine systems modelling, asset management, marine operations, construction engineering, marine ecology, terrestrial ecology, social impact assessment, air emissions, underwater noise emissions, cultural heritage, economics, water quality, terrestrial hydrology, visual impacts and infrastructure.

A list of workshop attendees, their organisation and field of expertise is provided in Appendix A.

The following tasks were performed at the workshop:

- Develop a preliminary list of risk events
- Identify cause-effect relationships (event trees)
- Identify likelihoods of risk events and the severity of their consequences
- Analyse the risk
- Assess the outcomes.

A preliminary list of risk events was developed prior to the risk workshop and was built upon during the initial stage of the workshop.

3.1 Event trees

The preliminary list of risks was developed into event trees by establishing cause and effect relationships. Separate event trees were developed for the Construction, Operation, and De-commissioning (however, no substantive events were identified for the de-commissioning stage). Table 3-1 shows the event tree for dredging operations during the Construction period. An event tree is a diagram that clearly shows the linkages between initiating events and their subsequent impacts and consequences for each risk event.

Table 3-1 Event tree for dredging operations during construction

Activity		Initiating event	Probability of event occuring over the construction period (around 6 months)	Impact	Probability of indicated consequence assuming the initiating event occurs	Consequence
Dredging operations		Seabed removal	1	Removal of flora and fauna	1	Environmental damage
		Use of overseas vessels	0.01	Introduction of marine pests	0.001	Environment and infrastructure da
		Plume sediment production	1	Smothering benthic biota	0.1	Environmental damage
		Plume nutrient mobilisation	1	Development of algal blooms	0.0001	Environmental damage
		Contaminants within plume	1	Toxic to flora, fauna	0.001	Environmental damage
		Reduced light within plume	1	Reduced photosynthesis	0.1	Coral damage, dieback
		Dredge operation noise	1	Disturbance to protected species	0.0001	Interference with feeding
		Barge transit to dredge spoil ground	1	Interference with marine traffic	0.00001	Infrastructure damage, public safe
		Refuelling spill	0.01	Fuel slick	1	Visual, environmental impact
		Spoil disposal	1	Smothering	1	Environmental damage
		Presence of exclusion zone	1	Recreation, access	0.001	Relocation of activities
		Presence of heritage asset	0.0001	Damage to heritage	1	Loss of heritage
		Presence of UXO	0.01	Explosion	0.00025	H&S

Event trees are linear by nature. That is, in order to derive the two components of risk (likelihood and consequence) they indicate a linear cause and effect process that links the likelihoods of an event and its subsequent impacts occurring with the magnitude of the consequences, to provide an estimate of risk for each event.

For example, the second row of Table 3-1 shows that the workshop concluded that it is possible (around a 1 in 100 chance over the Construction period) that an overseas dredge will be used. If an overseas dredge is use, then it is unlikely (approximately a 1 in 1,000 chance) that a new marine pest would be introduced, resulting in environmental damage (and flow-on consequences).

The total frequency for that specific risk event is the product of the above two probabilities (0.01 x 0.001 = 0.00001 or 1 in 100,000). The total risk is the combination of the total frequency and the consequence (consequence levels not shown in Table 3-1),.

3.2 Estimating Likelihoods

For more common events (i.e. those with a likelihood above a 1 in 10 (10%) chance of occurrence over the life of the project, the event likelihood is usually estimated to the nearest few percent (e.g. 5% (0.05), 20% (0.2), 70% (0.7) etc.) based on the subject matter expert's experience or knowledge of similar types of events, and documented information in the industry and literature.

On the other hand, for more novel, untested activities and events with likelihoods below a 1% chance over the life of the project, an individual expert's experience becomes increasingly less direct as the likelihoods become lower. In these cases, project likelihoods are estimated more conceptually and expressed in order of magnitude terms (for example, a 1 in 100 or a 1 in 1,000 chance).

At the workshop, a likelihood guide was supplied to assist participants in estimating likelihoods and to ensure consistency of approach to making this type of conceptual level estimate for events with lower likelihoods. As the name suggests, a likelihood guide serves as a guide only, however the application of a single guide across all of the different disciplines and event types ensures greater consistency of likelihood estimates across the risk assessment. The likelihood guide used in the workshop is included in Appendix B.

3.3 Estimating Consequences

Consequences tables are used in semi-quantitative risk assessments to help the expert team identify and quantify (on an even basis) appropriate levels of impact on a range of asset types, resulting from the occurrence of a potential risk event.

The detailed consequences table that has been applied to the EAW Project is provided in Appendix C. This consequences table is adapted from a previous dredging project for the Port of Melbourne Corporation (Port Phillip Bay Channel Deepening Project)[1] and has been slightly modified to include recent refinements.

The consequences table was developed to achieve a practical level of consistency when estimating consequence levels across different disciplines or environmental assets. The consequences table incorporates qualitative descriptions for different consequence types and levels, and normalises them into a consistent set of quantitative measures.

[1] Port of Melbourne Corporation, 2007, *Port Phillip Bay Channel Deepening Supplementary EES*, Victoria.

3 Risk Identification

Table 3-2 shows the qualitative consequence level (Negligible, Minor, Moderate, Major, and Extreme), a generic qualitative description for each level and the quantitative value assigned to each consequence level. Intermediate values are also indicated.

Table 3-2 Range of consequence levels and generic descriptions

Negligible	Minor	Moderate	Major	Extreme
Minimal, if any impact for some communities. Potentially some impact for a small number (<10) of individuals.	Low level impact for some communities, or high impact for a small number (<10) of individuals.	High level of impact for some communities, or moderate impact for communities area-wide.	High level of impact for communities area-wide.	High level of impact State-wide.
0.1 0.3	1 3	10 30	100 300	1000 Plus

The quantitative values show that each subsequent consequence level represents an order of magnitude (factor of ten) increase in the scale of the consequence, which was a critical factor in ensuring that the levels could be applied consistently across all disciplines. The generic qualitative descriptions describe not only the level of impact but also a description of how widely the impact could be felt (i.e. number of individuals or communities affected), as this is also a key factor in being able to estimate the magnitude of the consequence. For example, the Extreme consequence level refers to impacts that could be felt State-wide.

The other 15 rows of the consequences table in Appendix C provide qualitative descriptions of each level of impact for key categories of impact.

The key categories of impact in the consequence table include:

- Property and Infrastructure;
- Environment;
- Social;
- Economic; and
- Public Health and Safety.

In some situations, it was considered that the event, if it were to occur, would have multiple consequences (for example, excessive noise would have consequences for the local community as well as the environment). In these situations, the consequence values were recorded for each of the categories. These were then summed for each risk issue. For example, a value of 1 for Environment consequences and a value of 10 for Social consequences give a total value of 11 for the total consequence of the risk issue.

3.4 Risk Register

The two key outputs from the workshop risk identification process are:

- Events risk register
- Inputs risk register

3.4.1 Events risk register

The events risk register is a list of events that could result in impacts and potential impacts from implementation of the EAW Project. Workshop participants were shown the preliminary list of risk events that was developed prior to the workshop and were asked to add to the list (without real discussion) to ensure that all of the key impacts and risk events were captured.

A screening process then followed, where the workshop participants efficiently prioritised the issues with respect to criteria such as: likelihood of occurring, scale of impacts, known community interest, relevance to this specific project, and plausibility of pathways. Priority Level 1 issues were identified as high priority, and Priority Level 3 issues were relatively low priority. Some issues were excluded at that point, without assigning a priority level.

The events risk register in Appendix D is a summary showing a list of all of the risk events that were considered at the start of the workshop, whether they were subsequently included in the risk assessment, and an indication of why events were excluded from more detailed assessment.

The events risk register shows that 92 risk events were considered for inclusion in the risk assessment, and that ultimately the assessment considered the 36 Priority 1 events in more detail.

The workshop briefly reviewed the Priority 2 and 3 issues immediately after completion of assessment of the Priority 1 risk profile and concluded that detailed evaluation of the remaining risk issues was not required.

3.4.2 Inputs risk register

The inputs risk register that is provided in Appendix E shows the event pathways, likelihoods and consequences that were provided by the subject matter specialists at the workshop. These values were then input directly into the EIA risk model.

After the workshop the participants were provided with copies of the combined risk register (event risk register and inputs risk register) for review and validation. The outcomes of all corrections additions were entered into the risk registers and input to the final risk model.

3.4.3 Description of risk events

Berth Activity

1. Fire

Fire, as a result of refuelling, during both construction and operations stages would have a property impact due to damage to infrastructure. Possible personnel injury and/or fatality with economic and public health and safety risk. Fuel spillage into harbour could also cause environmental damage.

3 Risk Identification

2. Breakwater Placement

The breakwater placement can smother existing habitats.

3. Pile Driving

Disturbance to protected species, mainly dolphins, turtles and dugongs. Noise may affect their feeding habits.

4. Increased Harbour Traffic

Increased harbour traffic could result in increased collisions during operations, which could result in oil spills and public health and safety concerns. Reduced accessibility of work areas could result in social impacts.

Cutter Suction Dredge (CSD) Activity

5. Dredging Access Channel and Berths

Dredging access would impact on tide velocity, wave speed changes and sediment deposition.

6. Sea Bed Removal

The environmental impact associated with the removal of flora/fauna habitats.

7. Introduction of Marine Pests

The long term environmental implications to the ecosystem function due to introduction of marine pests. Economic factors due to closing the wharf during remediation and possible follow on affects to other industries within the area due to contamination.

8. Plume – Smothering by Sediment

Impacts to corals and mangroves as a result of increased turbidity or sediment accumulation.

9. Release of nutrients into water column

Possible algae growth due to the release of nutrients from dredging activities.

10. Release of contaminants from sediment

The release of contaminants would most likely affect flora and fauna and social impacts due to public concerns with regards to contaminants potentially being toxic to humans.

11. Plume reduced light

Increased turbidity could result in reducing the light available within the plume area resulting in corals inability to photosynthesis, causing damage and potential die-back. Marine fauna would avoid the area due to low light and poor visibility.

12. Underwater Noise

Disturbance to protected species, mainly dolphins, turtles and dugongs, is likely but minimal as fauna would move from noise affected area. The noise may affect breeding habits.

3 Risk Identification

13. Barge transit movement

This event could cause increased water traffic in the area impacting on access and recreational vessels. If incident occurs (collision between the barge and recreational vessel), there would be social and public health and safety concerns.

14. Refuelling and Supply

Fuel spills could occur during refuelling of the dredge which could have social and environmental consequences via direct impacts to the harbour.

15. Spoil Ground Sedimentation

The spoil ground biota would be smothered as a result of dredge material disposal.

16. Exclusion Zone

During dredging, an exclusion zone would be required during the activity that would limit recreational fishing within a proximity to East Arm Wharf.

17. Presence of Heritage Sites

This risk refers to discovery of new, previously unknown heritage sites.

18. Presence of UXO

An exploding Unexploded Ordinance (UXO) could cause impact damage to equipment or injury to personnel operating the dredge.

19. Introduction of Marine Pests

The long term environmental implications to the ecosystem function due to introduction of marine pests. Economic factors due to closing the wharf during remediation and possible follow on affects to other industries within the area due to contamination.

20. Fuel Spillage

Risk and Impacts as per 14.

21. Release of Toxic Material

The material could affect flora and fauna. Social impacts due to public concerns the material potentially could be toxic to humans. Risks would continue throughout maintenance dredging operations.

22. Damage to Sacred Site (Catalina Island)

Risks associated with dredging operations to Catalina Island having a potential loss of heritage and social impact. Erosion, depositional change of wave and current impacts on the island are also considered.

Marine Supply Base Activity

23. Contaminated stormwater release

Risks associated with contaminated run-off from the facility could occur, particularly during the wet season which could include fuel, heavy metals, pesticides and hazardous material.

3 Risk Identification

24. Vehicle accident rock hauling

Risks associated with vehicle accidents associated with increased traffic during construction.

25. Fuel pipeline, tank failure

Risks associated with spills could occur that could have social and environmental consequences via direct impacts to the harbour.

26. Pile Driving

Disturbance to protected species, mainly dolphins, turtles and dugongs. Noise may affect their feeding habits.

27. Introduction of Marine Pests, Weeds

The long term environmental implications to the ecosystem function due to introduction of marine pests. Economic factors due to closing the wharf during remediation and possible follow on affects to other industries within the area due to contamination. Introduction of weeds to the project area.

28. Fuel, Sewerage Spillage

Risks associated with contaminated run-off from the facility could occur which could have social and environmental consequences via direct impacts to the harbour.

Rail Loop

29. Inadequate Compaction, Geotechnical Failure

Risks associated with geotechnical failure could cause impacts such as derailment of train, environmental damage in the event of hazardous product loss into the harbour or waterways, and potential social and public health and safety concerns.

30. Reclamation for Hardstand

Risks associated with the loss of recognised habitat, feeding and resting area for flora and fauna.

31. Train Derailment

Risks associated with train derailment include potential social and public health and safety concerns, or environmental damage or possible hazardous product loss entering the environment.

32. Uncontained Loads

This event could cause material spillage (wind blown or accumulative) to the environment from train carriages.

33. UXO – Explosion

This event could occur during operations and/or construction with risks associated with potential for injury and social or public health and safety risks.

34. Cultural Heritage Site Present

Risks associate with the existence of a known cultural heritage site which contains middens and artefacts.

3 Risk Identification

35. Vehicle Accident

This event is regarding collisions of vehicles that include trains, haul trucks, road trains and public vehicles.

4

Impact Analysis

Risk analysis involved modelling the probabilities and consequences for each substantive risk event for the EAW Project. Risk quotients (see below) were calculated for the Construction and Operations periods. The risk profiles generated by the risk model show all risk events ranked (prioritised) in order of decreasing risk.

The risk for each risk event is stated as a “risk quotient” and is the likelihood of the event occurring (total frequency over the specific period) multiplied by the consequence level if the event were to occur. The contribution by time period refers to the proportion of the risk quotient that occurs during the stated project time period (Construction or Operations). The contribution by Asset refers to the proportion of the risk that is posed to the defined community assets: Public health and safety, Economics, Social, Environmental and Property/Infrastructure.

Establishment of a risk target helps stakeholders to understand what level of risk might be considered acceptable in the context of the scale of the EAW Project. The selected risk target for the major Victorian Port Phillip Bay Channel Deepening Project was set at any event that posed a level of risk greater than 10. Event risk levels greater than 10 were categorized as high risk events.

The risk methodology used for the EAW Project is essentially the same as that applied to the Port Phillip assessment. However, the EAW Project is around an order of magnitude smaller than the CDP and a more appropriate risk target for the EAW Project has been set at a risk level of 1. A risk target of 1 is equivalent to a 10% chance of a Moderate level impact occurring (i.e. consequence value of 10) or a 1% chance of a Major event occurring (i.e. a consequence value of 100). The selected risk target is therefore more conservative than the major project target.

The outcome of the EAW risk analysis (impacts and potential impacts assessment) is a series of graphs showing the highest risks for the project in order of risk quotient, the level of risk considered acceptable for each event, and the consequences and timing of the risks, (i.e. whether the risk was posed to the environment, public health and safety, etc, and whether the issue could occur during Construction, operation, or both).

5

Impact Evaluation

All projects will have positive and negative impacts on the wider environment (impacts on people and their activities, the natural environment, infrastructure, economics). Communities and regulators need to weigh the benefits of the project against the anticipated negative impacts.

Impacts from a project can be separated into two classes:

- Known impacts
- Potential impacts

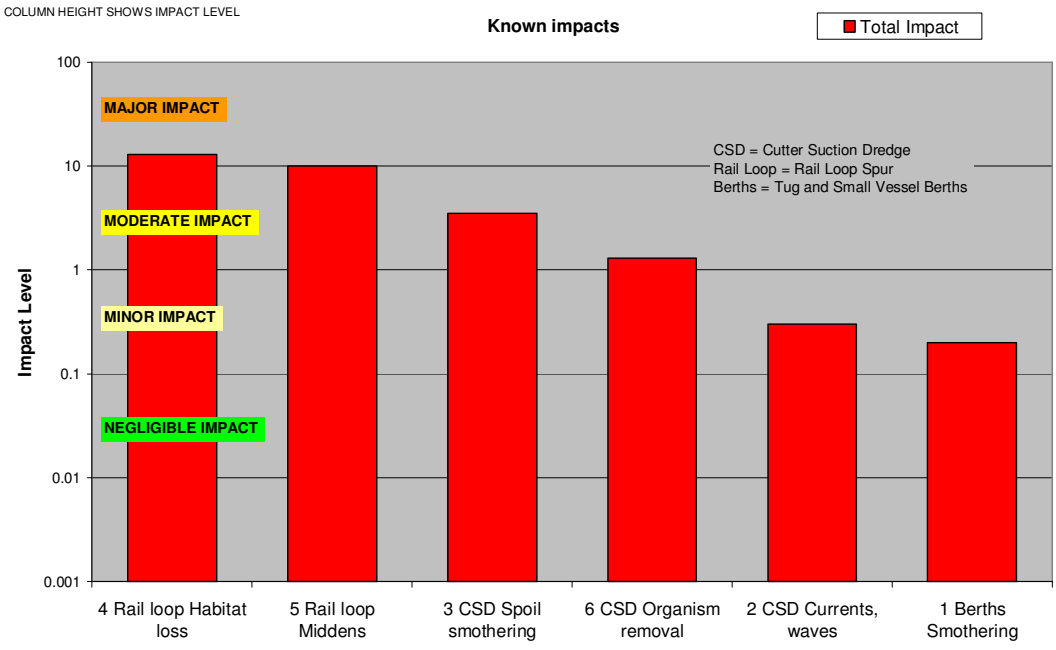
Known impacts are derived from events for which it is practically certain that they will occur (be initiated) at some stage during the life of the project. The chance that these events and their consequential impacts will occur is effectively 100% (or 1). The only real uncertainty lies in the magnitude of impacts when the event occurs. Known impacts on the wider environment from a project need to be identified and reduced to levels that are as low as reasonably practical.

Potential impacts are derived from events that may or may not occur due to project activities. These events are known as risk events. For risk events there is uncertainty as to whether the event will occur in addition to the uncertainty of impact magnitude. The level of risk posed by a project can often be reduced by implementing actions that reduce the likelihood of the risk event occurring and, or actions that reduce the level of impact if the event were to occur.

5.1 Known Impacts

Six events that will have known impacts were identified during the workshop. Figure 5-1 is a profile of the known impacts and shows that it is expected that the project will cause three Moderate level impacts and three Minor level impacts.

Figure 5-1 Profile of known impacts



Based on the current project description, two of the anticipated Moderate impacts will be caused by deposition of the rail loop and its associated lay down area. The remaining Moderate impact will be caused by dredging activities.

5.1.1 Rail loop, habitat loss

A well established bird feeding and resting are (particularly used by migratory species) occurs within the rail loop reclamation are that will form the hardstand. In addition, there will be some loss of mangrove and foreshore habitat.

The magnitude of the impact has been assessed as Moderate, based on the view that a relatively small proportion of such habitat would be affected and the relative ease with which the birds would relocate.

5.1.2 Rail loop, middens

Rail loop construction will take place by deposition of construction and fill material for the bund and lay down area. Deposition may or may not be preceded by removal of the existing mud and soil layers. Cultural heritage articles, mainly in the form of middens and artefacts, are known to be present within the rail loop footprint and this assessment assumes that they will be destroyed.

The magnitude of the impact has been assessed as Moderate, which is equivalent to substantial damage / destruction / removal of a single heritage site.

5.1.3 Dredging spoil, smothering

Marine modelling indicates that the plume that will be generated by the channel and berth dredging operation will cause some smothering of the sea floor by sediment, and that the area affected will be be quite localised with respect to the dredged area. A considerably larger area will be covered by the dredging plume, but the concentration of suspended sediments in that plume will be low and barely distinguishable from natural variation in suspended sediment in the water column.

Following the indicative guidelines of the consequences table, the workshop concluded that within the localised area, smothering by sediments will have a Minor impact on habitat and benthic organisms.

5.1.4 Dredging, organism removal

Dredging will involve removal of seabed areas and therefore physical removal of marine flora and fauna. The area affected will be restricted to the dredged area. Following the indicative guidelines of the consequences table, the workshop concluded that within the dredged area, smothering by sediments will have a Moderate impact on habitat and benthic organisms.

5.1.5 Dredging, currents, waves

Marine modelling shows that some altered water current directions and flow rates, plus wave action will be caused by dredging the access channel and berths. It is expected that the changed tidal flow regime will cause deposition (or additional deposition) and some of the deposition areas will need additional dredging, predominantly during dredge maintenance activities. The assessed Minor impact is based on a financial cost within the approximate range from $0.1 to $1 million.

5 Impact Evaluation

5.1.6 Berths, smothering.

Placement of the rock fill breakwater will cause smothering of habitat and benthic organisms within the breakwater footprint. The impact has been assessed a Minor on the basis of having only a small area affected by the works, but the effect will be permanent.

Table 5-1 shows the estimated impact levels for the six known events.

Table 5-1 Known impacts

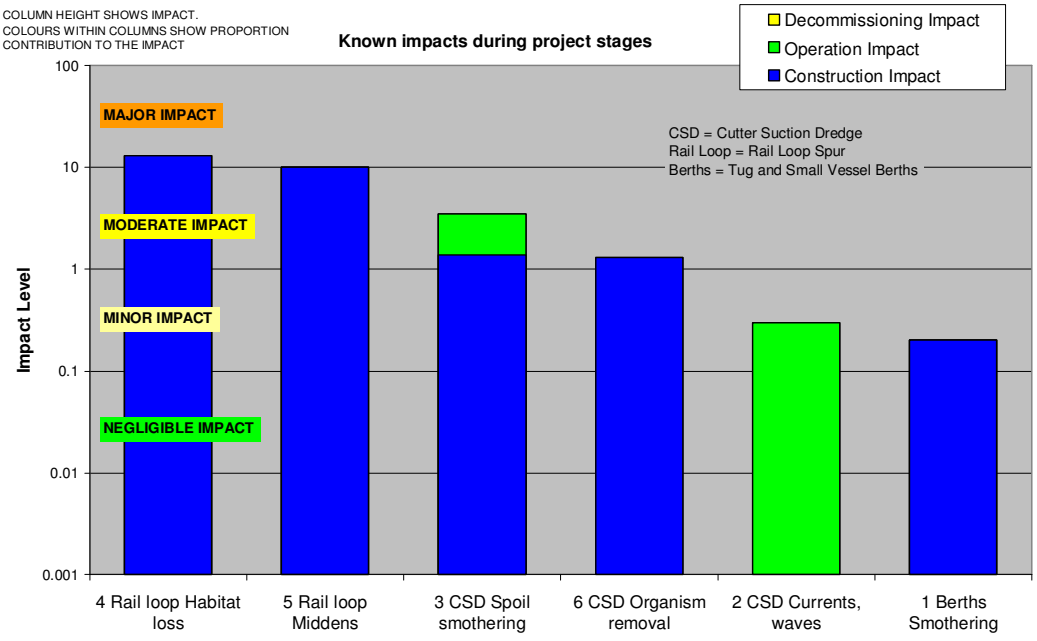
Risk Rank	Event Name	Total Impact	Construction Impact	Operation Impact	Property/Infra Impact Level	Enviro Impact Level	Social Impact Level	Econ Impact Level	Public H&S Impact Level
1	4 Rail loop Habitat loss	13	13			3	10		
2	5 Rail loop Middens	10	10				10		
3	3 CSD Spoil smothering	3.5	3.1	0.4		0.4	3.1		
4	6 CSD Organism removal	1.3	1.3			0.3	1		
5	2 CSD Currents, waves	0.3		0.3	0.3				
6	1 Berths Smothering	0.2	0.2			0.1	0.1		

5.1.7 Timing of known impacts

Figure 5-2 indicates that five of the six known impacts are expected to occur during the construction stage. Construction of the rail loop is expected to have the greatest impact, as three of the four Moderate impacts (loss of habitat, destruction of aboriginal heritage sites, and organism removal) will occur during construction of the rail loop.

Localised, on-going sediment deposition is expected to occur throughout the operations stage.

Figure 5-2 Timing of known impacts



5 Impact Evaluation

5.1.8 Assets impacted upon

Figure 5-3 shows which asset categories are expected to be affected by the known impacts of the project.

The profile shows that although the expected impact on natural environment assets due to smothering, habitat loss and organism removal will be relatively small, the perceived value of those assets by people is relatively high, as reflected in their associated social impact levels. The profile also shows that anticipated damage to middens will most likely have a Moderate social impact.

Figure 5-3 Known impact on assets

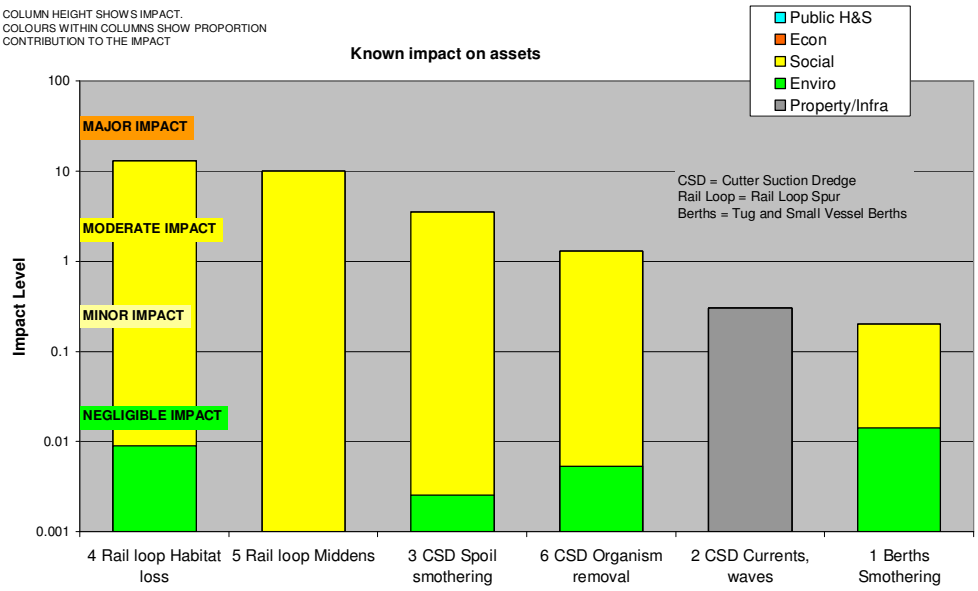
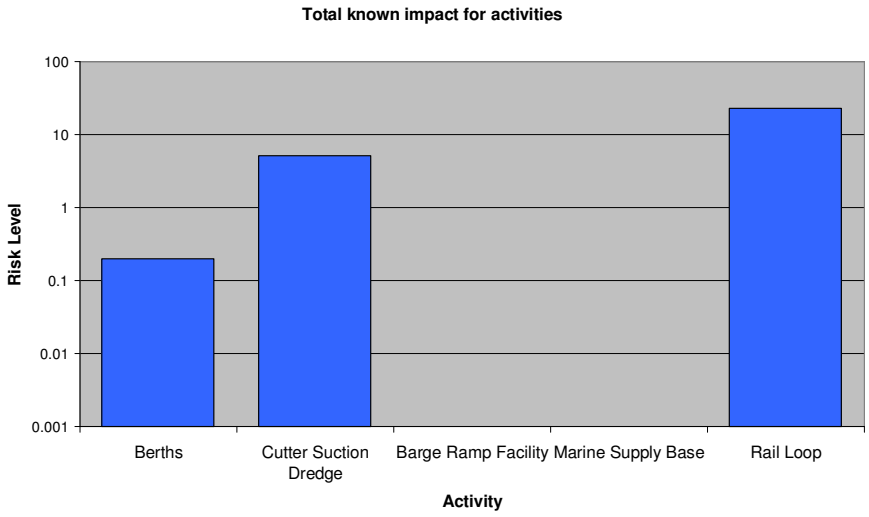


Figure 5-3 also shows that there will most likely be Minor financial costs to dredge sand bars that will form in response to the modified wave and current regime.

The final profile for known events (Figure 5-4) shows which activities will most likely create the greatest known impact.

Figure 5-4 Impact by activity



The profile shows that construction of the rail loop will have the greatest impact (Moderate level). CSD during construction and operations will have a lower (but still Moderate) impact on the wider environment. Berth construction will have a combined Negligible impact on the wider environment. No known impacts were identified for the Barge Ramp Facility Area or the Marine Supply base.

5.2 Potential Impacts (Risks)

A selected range of risk profiles have been generated by the risk model. These profiles are provided and discussed in the following sections.

5.2.1 Overall risk potential impacts (risk) of the project

Figure 5-5 shows the risk events for the EAW Project, listed in order of decreasing risk level. The height of the column represents the risk level (likelihood x consequence) for that risk. Note that there is an order of magnitude (10 times) difference between the horizontal grid lines on the risk profile. This order of magnitude variation reflects the level of "accuracy" of the risk model outputs. As can be seen from the profile, the target risk level is set at 1 and shows what is considered to be an acceptable level of risk for risk events.

Figure 5-5 Overall risk profile

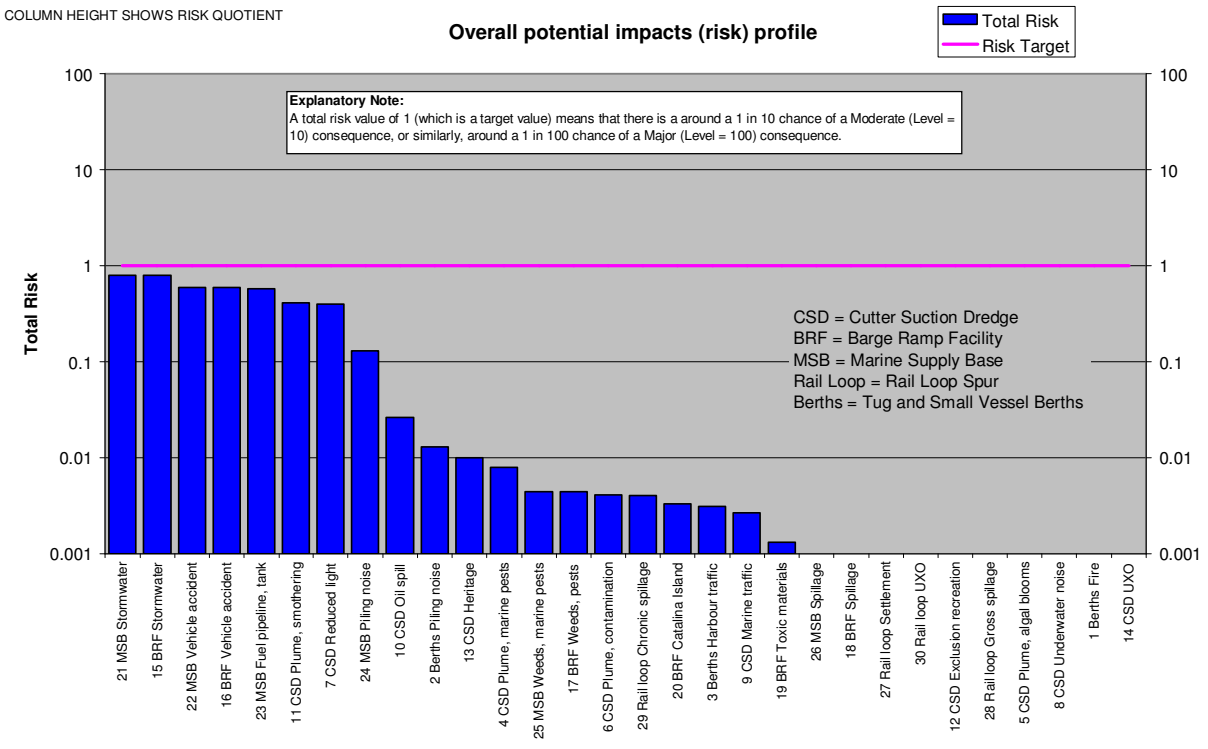


Figure 5-5 shows that all the individual risk events for the Project are below the target risk level.

However, the risk levels posed by seven (7) events lie within one half an order of magnitude of the target risk level for a single event.

The two highest risk events (21 MSB Stormwater and 15 DHA Stormwater) lie just below the target risk level. If possible, strategic actions should be developed to reduce their risk. The actions should be articulated in the Environment Management Plan (EMP) for the EIS.

5 Impact Evaluation

The next five highest risk events (22 MSB Vehicle accident, 16 DHA Vehicle accident, 23 MSB Fuel pipeline, tank, 11 CSD Plume smothering, and 7 CSD Reduced light) pose similar levels of risk. An account of how these risk events are to be managed and monitored should be included within the EMP.

The remaining events pose relatively low risk, but monitoring of the next five risk events (24 MSB Piling noise, 10 CSD Oil spill, 2 Berths Piling noise, 13 CSD Heritage, and 4 CSD Plume, marine pests) should be considered within the EMP.

Table 5-2 provides details on the 30 risk events and for each event shows: the total risk quotient; the risk quotient contributed by the Construction and Operations, and the risk quotient contributed by each of the four consequence categories.

Caution is required when interpreting the numbers in the table below, as the risk assessment is only accurate to around one half an order of magnitude. Representing the risk quotient to several decimal places (as in Table 5-2) does not reflect the accuracy of the risk quotient but can be used to differentiate between risk quotients.

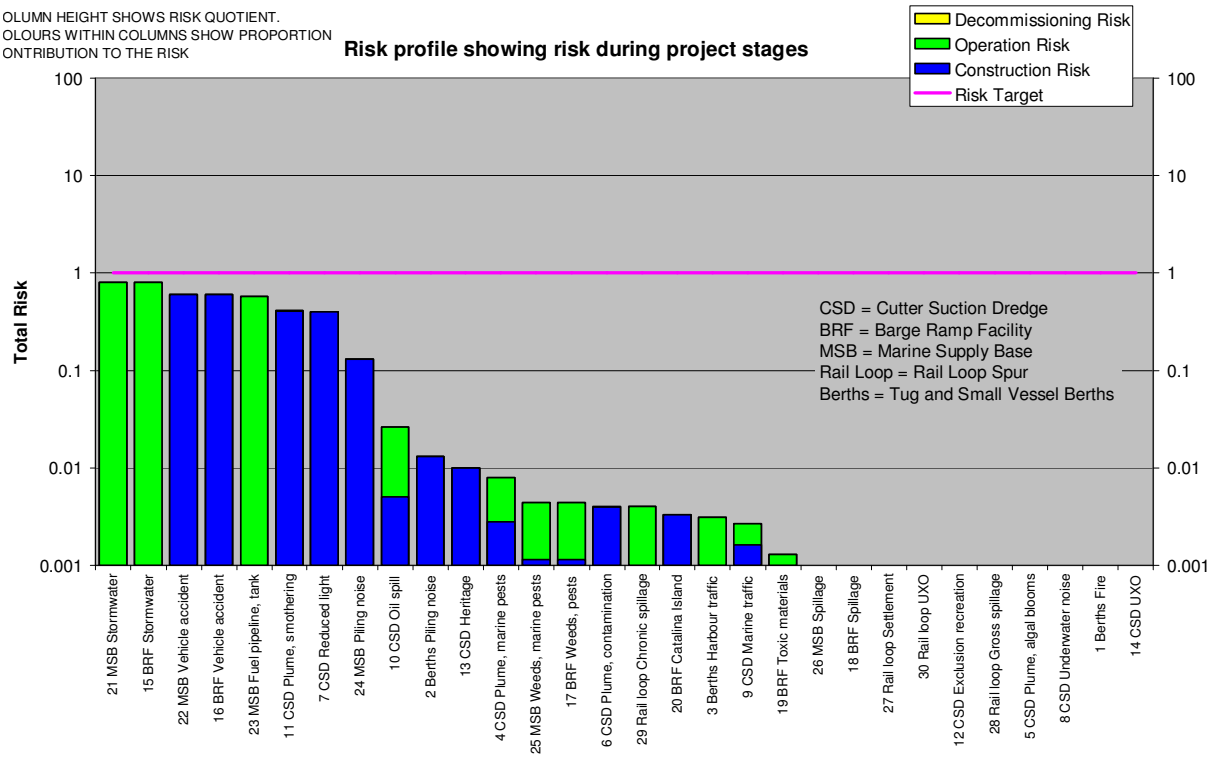
Table 5-2 Risk outputs

Risk Rank	Event Name	Total Risk	Construction Risk	Operation Risk	Property/Infra Risk	Enviro Risk	Social Risk	Econ Risk	Public H&S Risk
1	21 MSB Stormwater	0.8	5E-40	0.8	2E-21	0.2	0.6	2E-21	2E-21
2	15 BRF Stormwater	0.8	5E-40	0.8	2E-21	0.2	0.6	2E-21	2E-21
3	22 MSB Vehicle accident	0.6	0.6	5E-40	3E-22	3E-22	0.3	3E-22	0.3
4	16 BRF Vehicle accident	0.6	0.6	5E-40	3E-22	3E-22	0.3	3E-22	0.3
5	23 MSB Fuel pipeline, tank	0.572	5E-40	0.572	0.039	0.13	0.39	1.3E-22	0.013
6	11 CSD Plume, smothering	0.4105	0.41	0.0005	0.0101	0.1001	0.3003	1.01E-21	1.01E-21
7	7 CSD Reduced light	0.4011	0.4	0.0011	1.01E-21	0.1001	0.301	1.01E-21	1.01E-21
8	24 MSB Piling noise	0.13	0.13	5E-40	1E-21	0.03	0.1	1E-21	1E-21
9	10 CSD Oil spill	0.026	0.013	0.013	2E-22	0.006	0.02	2E-22	2E-22
10	2 Berths Piling noise	0.013	0.013	5E-40	1E-22	0.003	0.01	1E-22	1E-22
11	13 CSD Heritage	0.01	0.01	5E-40	1E-23	1E-23	0.01	1E-23	1E-23
12	4 CSD Plume, marine pests	0.008	0.004	0.004	0.002	0.002	0.002	0.002	2E-25
13	25 MSB Weeds, marine pests	0.0044	0.0004	0.004	0.001	0.0011	0.0013	0.001	1.01E-23
14	17 BRF Weeds, pests	0.0044	0.0004	0.004	0.001	0.0011	0.0013	0.001	1.01E-23
15	6 CSD Plume, contamination	0.00404	0.004	0.00004	1.01E-23	0.00101	0.00303	1.01E-23	1.01E-23
16	29 Rail loop Chronic spillage	0.004	5E-40	0.004	1E-22	0.001	0.003	1E-22	1E-22
17	20 BRF Catalina Island	0.0033	0.0033	5E-40	0.0003	1E-24	0.003	1E-24	1E-24
18	3 Berths Harbour traffic	0.0031	5E-40	0.0031	0.001	0.0001	0.001	1E-24	0.001
19	9 CSD Marine traffic	0.00266	0.00133	0.00133	0.00006	2E-25	0.0006	2E-25	0.002
20	19 BRF Toxic materials	0.0013	5E-40	0.0013	1E-23	0.0003	0.001	1E-23	1E-23
21	26 MSB Spillage	0.00065	5E-40	0.00065	5E-24	0.00015	0.0005	5E-24	5E-24
22	18 BRF Spillage	0.00065	5E-40	0.00065	5E-24	0.00015	0.0005	5E-24	5E-24
23	27 Rail loop Settlement	0.00036	5E-40	0.00036	0.00003	0.00003	0.0001	0.0001	0.0001
24	30 Rail loop UXO	0.000231	0.000231	5E-40	0.00003	0.000001	0.0001	1E-25	0.0001
25	12 CSD Exclusion recreation	0.0002	0.0001	0.0001	2E-23	2E-23	0.0002	2E-23	2E-23
26	28 Rail loop Gross spillage	0.00018	5E-40	0.00018	0.000015	0.000015	0.00005	0.00005	0.00005
27	5 CSD Plume, algal blooms	0.000143	0.00013	0.000013	1.1E-24	0.000033	0.00011	1.1E-24	1.1E-24
28	8 CSD Underwater noise	0.000141	0.00013	0.000011	1.1E-24	0.000031	0.00011	1.1E-24	1.1E-24
29	1 Berths Fire	0.0001006	0.0000503	0.0000503	0.00002	0.0000006	0.00002	2E-26	0.00006
30	14 CSD UXO	0.0001	0.0001	5E-40	1E-25	1E-25	1E-25	1E-25	0.0001

5 Impact Evaluation

In the next risk profile (Figure 5-6), the risk events are shown in the same order, but with the key contributors proportioned within the columns.

Figure 5-6 Risk by project stage



Like Figure 5-5, the height of the columns in Figure 5-6 represent the risk quotient (likelihood x consequence) for that risk event. However, the colours within each column show the proportion that project timing (Construction and/or Operation) contribute to each risk event.

The profile shows that the risk posed by three of the highest eight risk events applies for the construction period only and that the remaining five events pose risk only during operation.

Some risk events apply for both the construction and operation periods. For example, for the ninth highest risk event (10 CSD Oil spill), roughly 50% of the risk is attributable to the construction phase, and roughly 50% of the risk is attributable to the operation phase.

The following risk profile that shows risk in relation to community assets (Figure 5-7) is read exactly like Figure 5-6, except the colours within the columns show the proportion of risk posed to the identified assets (public health and safety, economic, social, environment, and property and infrastructure).

5 Impact Evaluation

Figure 5-7 Overall risk profile showing contribution by assets

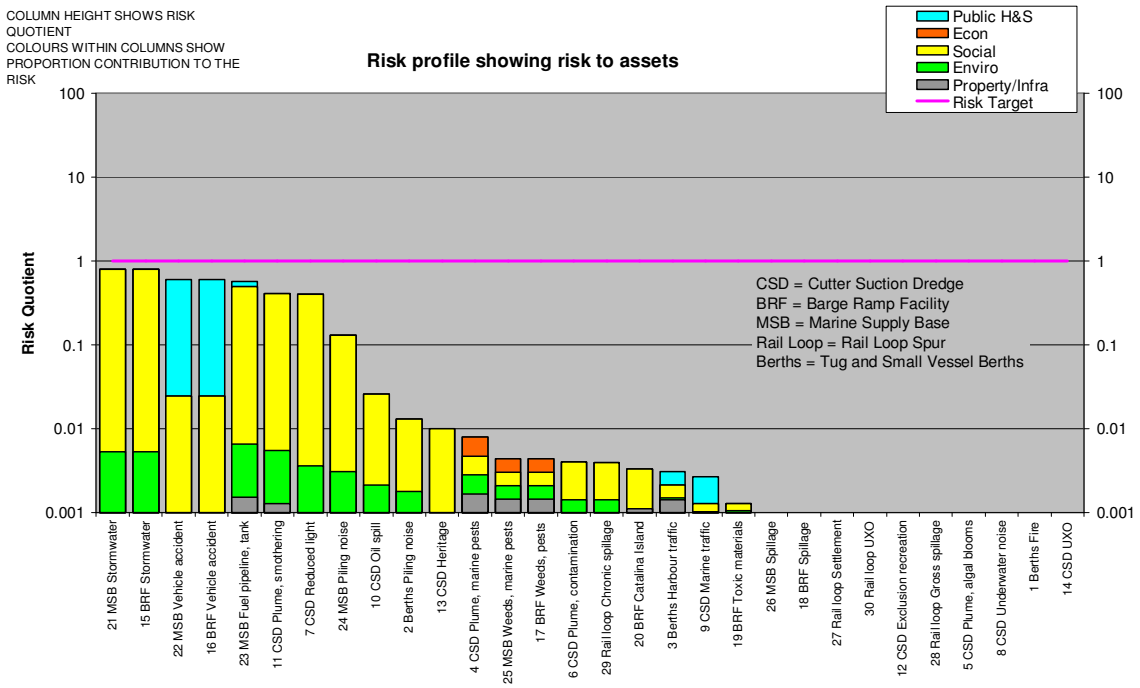


Figure 5-7 shows that most of the risk would be posed to society (mainly potential impact on amenity) and that the risk posed to the natural environment, the economy, infrastructure and public safety is comparatively low.

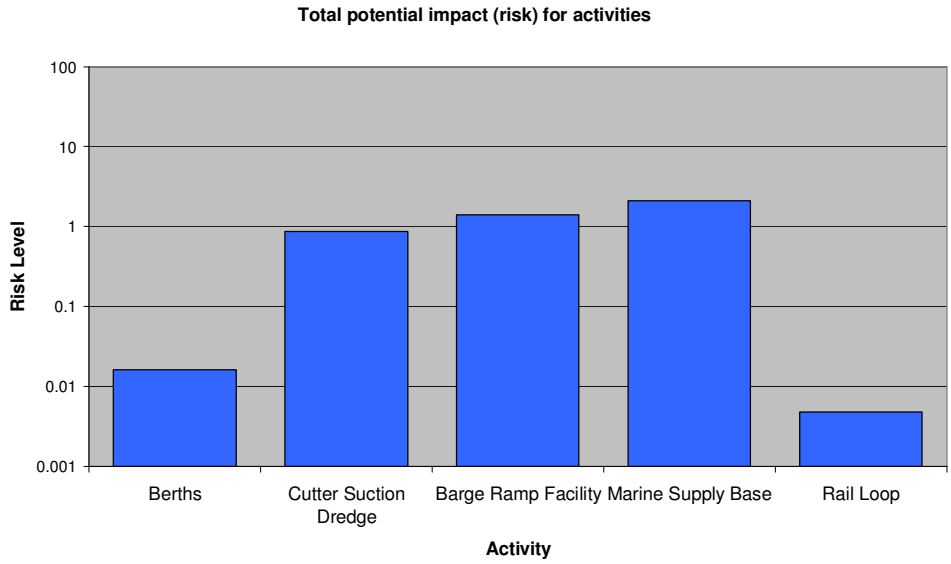
For the two highest risk events (21 MSB Stormwater and 15 DHA Stormwater), roughly 80% of the risk would be posed to society (amenity), and around 20% of the risk would be to the natural environment. By contrast, for example, the 12th highest risk event poses almost equal, but low, risk to infrastructure, the natural environment, society (amenity), and the economy.

The profile also indicates that the 3rd and 4th highest risk events pose approximately equal risk to public safety and society (amenity).

5 Impact Evaluation

Figure 5-8 shows the activities that create the greatest potential impact (risk).

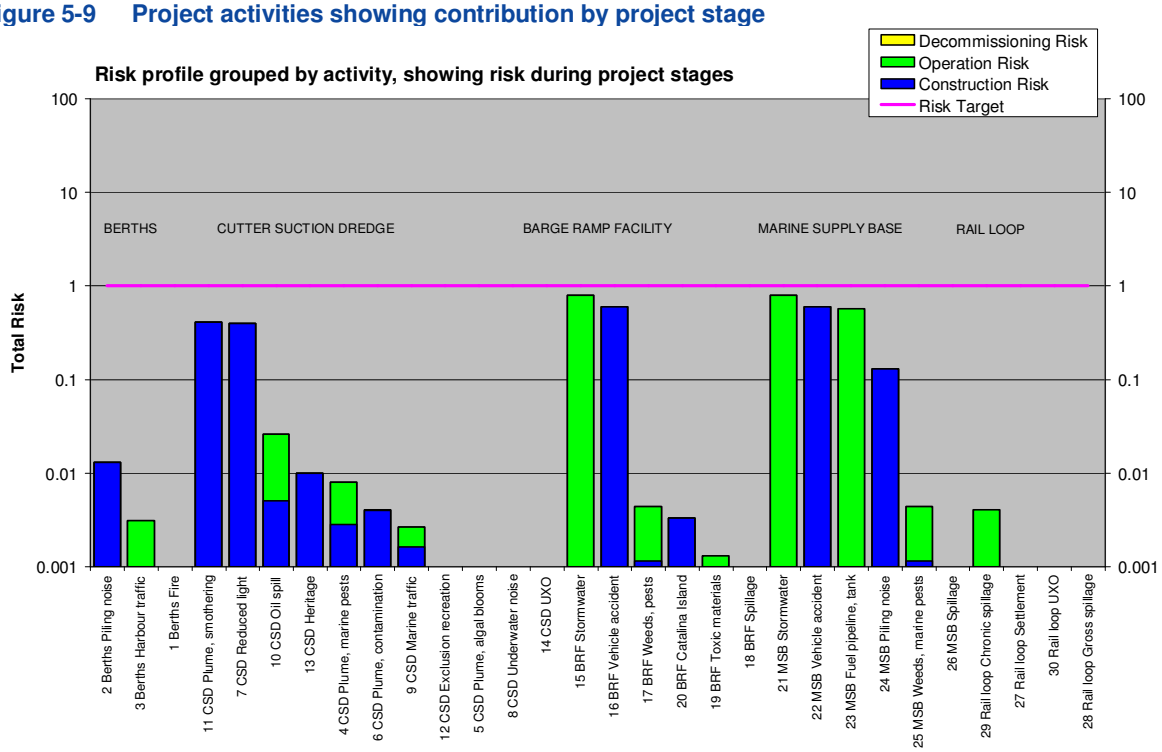
Figure 5-8 Potential impact (risk) by activity



The profile shows that construction and operation of the Marine Supply Base and the Barge Ramp Facility Area will pose the highest risk to the wider environment. Dredging activities will pose less, but similar, risk. In contrast, berth and rail loop construction and operation will pose low risk to the wider environment.

The risk profiles of Figure 5-9 show the same combined levels of risk for each activity, but also provides more information by indicating the key contributors to the total risk for the activity.

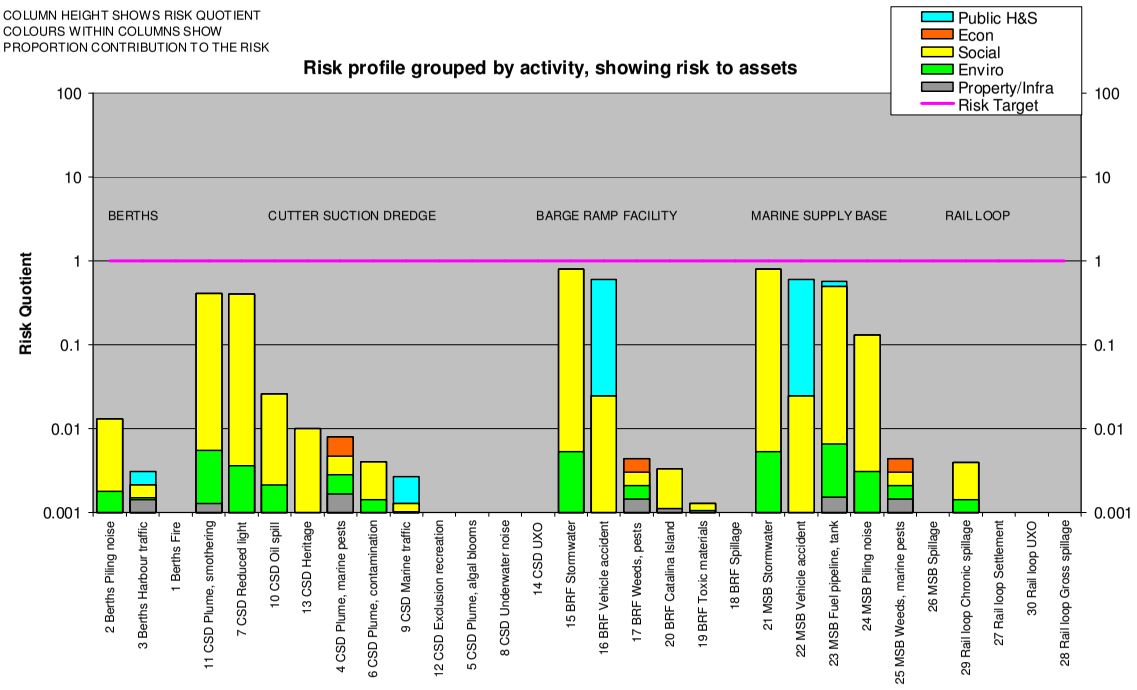
Figure 5-9 Project activities showing contribution by project stage



5 Impact Evaluation

Figure 5-10 shows the proportion of risk posed to the assets by each of the project activities.

Figure 5-10 Project activities showing contribution by asset



6

Conclusions

A preliminary list of 92 events that could potentially lead to negative impacts (financial, environmental and social) on the wider environment was developed. Upon further consideration, six known events and 30 risk events were assessed in some detail.

The following main conclusions have been derived from the EAW DEIS risk assessment:

- Known impacts:
  - Rail loop construction and CSD will cause known impacts on the wider environment.
  - Six events are expected to lead to known negative impacts from the Project. The events will cause three Moderate level impacts and three Minor level impacts.
  - Two of the expected Moderate impacts will be on habitat and middens and will be caused by construction of the rail loop. The remaining Moderate impact will be caused by dredging activities.
  - Most of the known impacts will occur due to construction activities.
  - The expected impact on natural environment assets due to smothering, habitat loss and organism removal will be relatively small, but the perceived value of those assets by people is relatively high, which will lead to elevated social impact (mainly amenity) levels.
- Potential impacts (risks)
  - All the individual risk events for the Project are below the target risk level.
  - However, the risk levels posed by seven events lie within one half an order of magnitude of the target risk level for a single event.
  - The risk posed by three of the highest eight risk events applies for the construction period only and the remaining five events pose risk only during operation.
  - Most of the risk would be posed to society (mainly potential impact on amenity) and the risk posed to the natural environment, the economy, infrastructure and public safety is comparatively low.
  - Construction and operation of the Marine Supply Base and the Barge Ramp Facility Area and to a lesser extent dredging activities, will pose the highest risk to the wider environment.

7

Limitations

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Northern Territory Department of Lands and Planning and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 04 August 2010.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between 4th and 31st March 2011 and is based on the conditions encountered and information obtained at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

A

Appendix A Workshop attendees

Table A-1 List of workshop attendees

Name	Organisation	Discipline/Role	Attendance
Adrian Bowden	URS Melbourne	Risk assessment, facilitator	In person
Arnold Cho	URS Sydney	Terrestrial Noise	Teleconference
Bruce Howard	URS Perth	Economics	Teleconference
Chris MacHunter	URS Darwin	Water - Terrestrial Environment	In person
David MacMaster	Darwin Port Authority	Environmental Officer	In person
Ian Baxter	URS Perth	Marine Ecology	In person
Jacques van Rensburg	URS Darwin	Visual impacts	In person
Jenny Geppert	URS Adelaide	Social Impact Assessment	In person
John Polglaze	URS Perth	Marine Noise	Teleconference
Julie Carpenter	URS Darwin	Terrestrial Ecology	Teleconference
Ken Gardner	NTDLP	Client Project Manager	In person
Leo Noicos	URS Adelaide	Infrastructure	Teleconference
Maria Duchateau	DCM	Senior Project Officer	In person
Mark Nolan	NTDLP	Manager Safety and Environment	In person
Oleg Makarynskyy	URS Brisbane	Oceanic processes and	In person
Peter Collins	URS Perth	Water - Marine	Teleconference
Rhys Watson	URS Sydney	Air Quality	Teleconference
Sarah Anderson	URS Darwin	Scribe	In person
Toby Semler	URS Adelaide	Land-use	Teleconference
Vic Farrington	URS Adelaide	Senior Principal Environmental Scientist	In person

B

Appendix B Likelihood Guide

Source:

Bowden, A.R., Lane, M.R. and Martin, J.H., 2001, Triple Bottom Line Risk Management – Enhancing Profit, Environmental Performance and Community Benefit, Wiley, New York.

Table B-1 Example Alternative Guide to Quantification of Likelihood

Qualitative Description	**Order of Magnitude Annual Probability**	**Basis**
A. Certain	1 (or 0.999, 99.9%)	Certain, or as near to as makes no difference
B. Almost certain	0.2-0.9	One or more incidents of a similar nature has occurred here
C. Highly probable	0.1	A previous incident of a similar nature has occurred here
D. Possible	0.01	Could have occurred already without intervention
E. Unlikely	0.001	Recorded recently elsewhere
F. Very unlikely	1×10^{-4}	It has happened elsewhere
G. Highly improbable	1×10^{-5}	Published information exists, but in a slightly different context
H. Almost impossible	1×10^{-6}	No published information on a similar case

C

Appendix C Consequence Table

CONSEQUENCE LEVEL		Negligible		Minor		Moderate		Major		Extreme
		Minimal, if any impact for some communities. Potentially some impact for a small number (<10) of individuals.		Low level impact for some communities, or high impact for a small number (<10) of individuals.		High level of impact for some communities, or moderate impact for communities area-wide.		High level of impact for communities area-wide.		High level of impact State-wide.
		0.1	0.3	1	3	10	30	100	300	1000
PROPERTY / INFRASTRUCTURE	Cost to repair / replace (and lost revenues)	Approximate range from $0 to $0.1 million.		Approximate range from $0.1 to $1 million.		Approximate range from $1 to $10 million.		Approximate range from $10 to $100 million.		Approximate range $100 million to more than $1 billion.
ENVIRONMENTAL	Ecosystem Function (need to consider resilience and resistance)	Alteration or disturbance to ecosystem within natural variability. Ecosystem interactions may have changed but it is unlikely that there would be any detectable change outside natural variation / occurrence.		Measurable changes to the ecosystem components without a major change in function (no loss of components or introduction of new species that affects ecosystem function). Recovery in less than 1 year.		Measurable changes to the ecosystem components without a major change in function (no loss of components or introduction of new species that affects ecosystem function). Recovery in 1 to 2 years following completion of Project construction.		Measurable changes to the ecosystem components with a major change in function. Recovery (ie within historic natural variability) in 3 to 10 years following completion of Project construction.		Long term and possibly irreversible damage to one or more ecosystem function. Recovery, if at all, greater than 10 years following completion of Project construction.
	Habitat, communities and / or assemblages	Alteration or disturbance to habitat within natural variability. Less than 1% of the area of habitat affected or removed.		1 to 5% of the area of habitat affected in a major way or removed. Reestablishment in less than 1 year (relative to component seasonality) following completion of Project construction.		5 to 30% of the area of habitat affected in a major way or removed. Reestablishment in 1 to 2 years following completion of Project construction.		30 to 90% of the area of habitat affected in a major way or removed. Reestablishment in 3 to 10 years following completion of Project construction.		Greater than 90% of the area of habitat affected in a major way or removed. Reestablishment, if at all, greater than 10 years following completion of Project construction.
	Species and / or groups of species (including protected species)	Population size or behaviour may have changed but it is unlikely that there would be any detectable change outside natural variation / occurrence.		Detectable change to population size and / or behaviour, with no detectable impact on population viability (recruitment, breeding, recovery) or dynamics. Recovery in less than 1 year (relative to species lifecycle) following		Detectable change to population size and / or behaviour, with no impact on population viability (recruitment, breeding, recovery) or dynamics. Recovery in 1 to 2 years following completion of Project construction.		Detectable change to population size and / or behaviour, with an impact on population viability and or dynamics. Recovery (ie within historic natural variability) in 3 to 10 years following completion of Project construction.		Local extinctions are imminent / immediate or population no longer viable. Recovery, if at all, greater than 10 years following completion of Project construction.
SOCIAL	Amenity - Recreation	Short term interruptions in recreational use (say 1 to 2 days).		Activities restricted in a localised area for short-term periods (months).		Restriction on whole or parts of communities to pursue personal recreational pursuits when visiting the area during construction period. No impact post construction period.		Long term inability for whole communities to pursue personal recreational pursuits when visiting the area post construction period (ie. > 2 yrs).		Long-term inability for the general community to pursue personal recreational pursuits when visiting the area post-construction period for more than 10 years.
	Amenity - Sensory / Perception (visual, noise, odour).	Short term impacts that alter perception of area as a high amenity place to live / visit. Region still seen as attractive place to live.		Short term (months) localised impacts that alter perception of area as a high amenity place to live / visit. Region not locally seen as attractive place to live.		Medium term (1-2 years) regional impacts that alter perception of area as a high amenity place to live / visit. Region not widely seen as attractive place to live.		Community perception that the area is significantly damaged. Area loses appeal as residential area. Recovery > 2 years.		Community perception that the area has experienced major damage as a residential location and a recreational area and is a place to be avoided. Recovery, if at all, >10 years.
	Non-Aboriginal Heritage	No measurable alterations to existing natural and human processes already impacting on heritage sites.		Detectable impact to State or Commonwealth significant site with heritage values remaining largely intact.		Partial reduction in heritage value intrinsic to State or Commonwealth signinificant site.		Substantial reduction in heritage value intrinsic to State or Commonwealth significant site.		Complete loss of heritage value intrinsic to State or Commonwealth significant site.
	Aboriginal Heritage	No measureable change in existing natural and human processes impacting on Aboriginal heritage sites		Partial and localised impact on one or more Aboriginal heritage sites.		Substantial damage / destruction / removal of a single site.		Complete destruction / removal of multiple sites in a localised area.		Complete destruction / removal of sites across multiple areas.
ECONOMIC	Commercial fishing and agriculture	Limited and short term reduction in activity. Limited impacts localised and not area wide. No significant impact on regional businesses.		Short term reduction in activity, recovery in less than one year.		Significant reduction (5-30%) in agriculture capacity. Recovery in 2 to 10 years.		Permanent significant reduction (30-90%) in sustainable yield of the fishery and / or agriculture industry. Impact area wide.		Commercial fishing and agriculture completely and permanently prohibited or destroyed across the whole area.
	Tourism	Limited and short term reduction in tourist visitation. Limited impacts localised and not area wide. No significant impact on tourism businesses. Region still seen as attractive place		Short term reduction in tourism use. Recovery in less than 1 year.		Substantial reduction in tourism use. Recovery in 2-10 years.		Permanent reduction in visitation with changes in character of visitors. Impact area wide. Business viability compromised across wide range of sectors with substantial		Permanent loss of icon tourism assets of national significance. Significant flow on affects to supporting businesses.
	Shipping/Mining/Other industries (Port specific)	Shipping disruption is of negligible consequence. Shipping disrupted for 1-2 hours.		Port closed for 24 hours.		Port closed for 2 days, or significant ongoing unexpected interruptions to Port business.		Port closed for 2-6 days.		Closure of shipping channel to all vessels. Infrastructure loss has extreme consequences. Shipping channel is not able to be opened for more than 1 week.
	Delayed project benefits					Project delayed by around 6 months.		Project delayed by 6months - 1 year.		Project delayed by more than 1 year.
PUBLIC HEALTH AND SAFETY	Minor injury / illness	Minor injury or illness to less than 10 individuals.		Minor injury or illness to between 10 and 100 individuals.		Minor injury or illness to between 100 and 1000 individuals.				
	Major injury / illness			Major injury or illness to 1 individual.		Major injury or illness to between 1 and 10 individuals.		Major injury or illness to between 10 and 100 individuals.		Major injury or illness to between 100 and 1000 individuals.
	Fatality / serious injury, disability					1 fatality or serious injury		Between 1 and 10 fatalities or serious injuries		Greater than 10 fatalities / serious injuries

D

Appendix D Events Register

Table D-1 Events that are included in the assessment

Count	Activity	Risk Event (brief, indicative description)	Included or Excluded	Reason
1	Berths	Fire - Public safety	Included	Priority 1
2	Berths	Breakwater placement - Smothering of habitat, species	Included	Priority 1
3	Berths	Pile driving - Underwater noise	Included	Priority 1
4	Berths	Increased harbour traffic - Collision, incident, reduced access	Included	Priority 1
5	Cutter Suction Dredge	Dredging access channel and berths - Change in currents, waves	Included	Priority 1
6	Cutter Suction Dredge	Seabed removal - Physical removal of flora / fauna	Included	Priority 1
7	Cutter Suction Dredge	Introduction of marine pests - Invasion of marine pests	Included	Priority 1
8	Cutter Suction Dredge	Plume - Smothering by sediments	Included	Priority 1
9	Cutter Suction Dredge	Liberation of nutrients into water column - Algal blooms	Included	Priority 1
10	Cutter Suction Dredge	Release of contaminants from sediment - Toxicity affects flora, fauna, humans	Included	Priority 1
11	Cutter Suction Dredge	Plume reduced light - Impacts photosynthesis, visibility	Included	Priority 1
12	Cutter Suction Dredge	Underwater Noise - Affects organisms	Included	Priority 1
13	Cutter Suction Dredge	Barge transit movement - Interference with shipping, boating	Included	Priority 1
14	Cutter Suction Dredge	Refuelling and supply - Fuel, oil spill	Included	Priority 1
15	Cutter Suction Dredge	Spoil ground sedimentation - Smothering biota	Included	Priority 1
16	Cutter Suction Dredge	Exclusion zone - Recreational fishing	Included	Priority 1
17	Cutter Suction Dredge	Presence of heritage sites - Heritage asset damage	Included	Priority 1
18	Cutter Suction Dredge	UXO - Equipment damage, H&S	Included	Priority 1
19	Cutter Suction Dredge	Contaminated stormwater release - Environmental damage	Included	Priority 1
20	Cutter Suction Dredge	Vehicle accident rock hauling - Fatality/serious injury	Included	Priority 1
21	Cutter Suction Dredge	Intro of pests, weeds - Environmental damage	Included	Priority 1
22	Cutter Suction Dredge	Fuel spillage - Environmental damage	Included	Priority 1
23	Cutter Suction Dredge	Release of toxic materials, liquids - Environmental damage	Included	Priority 1
24	Cutter Suction Dredge	Sacred site (Catalina Is) - Damage to sacred site	Included	Priority 1
25	Marine Supply Base	Contaminated stormwater release - Environmental damage	Included	Priority 1
26	Marine Supply Base	Vehicle accident rock hauling - Fatality/serious injury	Included	Priority 1
27	Marine Supply Base	Fuel pipeline, tank failure - Fuel spill	Included	Priority 1
28	Marine Supply Base	Pile driving - Underwater noise	Included	Priority 1
29	Marine Supply Base	Intro of marine pests, weeds, etc - Environmental damage	Included	Priority 1
30	Marine Supply Base	Fuel, sewage spillage - Environmental damage	Included	Priority 1
31	Rail loop	Inadequate compaction, geotech failure - Settlement, derailment	Included	Priority 1
32	Rail loop	Reclamation for hardstand - Loss of habitat, feeding and resting	Included	Priority 1
33	Rail loop	Train derailment - Materials spillage - gross	Included	Priority 1
34	Rail loop	Uncontained loads - Materials spillage - chronic	Included	Priority 1
35	Rail loop	UXO - Explosion	Included	Priority 1
36	Rail loop	Cultural heritage site present - Destruction of middens, artifacts	Included	Priority 1

Appendix D

Table D-2 Priority 2 and 3 risk events (excluded from further consideration)

Count	Activity	Risk Event (brief, indicative description)	Included or Excluded	Reason
37	Berths	Wave action - Bund erosion	Excluded	Priority 2
38	Cutter Suction Dredge	Airborne noise emissions - Affects organisms, humans	Excluded	Priority 2
39	Barge Ramp Facility	Fire -	Excluded	Priority 2
40	Barge Ramp Facility	Adjacent site activities -	Excluded	Priority 2
41	Marine Supply Base	Fire - Public safety	Excluded	Priority 2
42	Marine Supply Base	Release from waste storage bins - Environmental damage	Excluded	Priority 2
43	Marine Supply Base	Lost material, release -	Excluded	Priority 2
44	Marine Supply Base	Loading mishap -	Excluded	Priority 2
45	Marine Supply Base	Hardstand settlement -	Excluded	Priority 2
46	Rail loop	Proximity to Reserve area -	Excluded	Priority 2
47	Rail loop	Groundwater discharge -	Excluded	Priority 2
48	Rail loop	Contaminated stormwater -	Excluded	Priority 2
49	Rail loop	Airborne noise -	Excluded	Priority 2
50	Berths	Unauthorised access - Fatality/serious injury	Excluded	Priority 3
51	Berths	Quarry rock transport road accident - Fatality/serious injury	Excluded	Priority 3
52	Berths	Airborne noise emissions limits exceeded - Affects organisms, humans	Excluded	Priority 3
53	Berths	Air emissions limits exceeded - Public amenity	Excluded	Priority 3
54	Berths	Inadequate compaction - Settlement	Excluded	Priority 3
55	Berths	Ineffective mud removal - Pressure wave, settlement	Excluded	Priority 3
56	Berths	Storms -	Excluded	Priority 3
57	Cutter Suction Dredge	Deepened (and wider) channel - Increased depth of habitat	Excluded	Priority 3
58	Cutter Suction Dredge	Seabed removal - Removal of denitrification layer resulting in reduction in	Excluded	Priority 3
59	Cutter Suction Dredge	Interference with shipping traffic - Shipping delays, accident	Excluded	Priority 3
60	Cutter Suction Dredge	Crew movements to and from dredge -	Excluded	Priority 3
61	Cutter Suction Dredge	Storms -	Excluded	Priority 3
62	Cutter Suction Dredge	Dredging non-target area -	Excluded	Priority 3
63	Cutter Suction Dredge	Dredge sinks -	Excluded	Priority 3
64	Cutter Suction Dredge	Plume visible from shore - Amenity impact	Excluded	Priority 3
65	Cutter Suction Dredge	Direct contact with wildlife -	Excluded	Priority 3
66	Barge Ramp Facility	Munitions accident - Fatality/serious injury	Excluded	Priority 3
67	Barge Ramp Facility	Military attack/terrorism - Fatality/serious injury	Excluded	Priority 3
68	Marine Supply Base	Unauthorised access - Public safety	Excluded	Priority 3
69	Marine Supply Base	Fuel storage tank seepage - Fuel spill	Excluded	Priority 3
70	Marine Supply Base	Contaminated construction material -	Excluded	Priority 3
71	Marine Supply Base	Storms -	Excluded	Priority 3
72	Marine Supply Base	Boat sinks -	Excluded	Priority 4
73	Marine Supply Base	Storm surge -	Excluded	Priority 3
74	Rail loop	Waste management -	Excluded	Priority 3
75	Rail loop	Visible structure -	Excluded	Priority 3
76	Rail loop	Increased rail traffic -	Excluded	Priority 3
77	Rail loop	Acid sulphate soils -	Excluded	Priority 3
78	Rail loop	Biting insects -	Excluded	Priority 3

Table D-3 Other events that were excluded from further consideration

Count	Activity	Risk Event (brief, indicative description)	Included or Excluded	Reason
79	Cutter Suction Dredge	Deepened (and wider) channel - Change in tidal levels	Excluded	Included elsewhere
80	Cutter Suction Dredge	Design - slumping - Shipping interference	Excluded	Included elsewhere
81	Cutter Suction Dredge	Design - slumping - Turbidity causes smothering of organisms	Excluded	Included elsewhere
82	Cutter Suction Dredge	Design - slumping - Increased dissolved (labile) nutrients resulting in	Excluded	Included elsewhere
83	Cutter Suction Dredge	Plume mobilisation of algal cysts - Algal blooms	Excluded	Included elsewhere
84	Cutter Suction Dredge	Terrorist activity -	Excluded	No credible risk
85	Cutter Suction Dredge	Damage to drege -	Excluded	No credible risk
86	Marine Supply Base	Rock dump instability -	Excluded	No credible risk
87	Marine Supply Base	Contamination of potable water supply to vessels -	Excluded	No credible risk
88	Marine Supply Base	Wharf pile corrosion failure -	Excluded	No credible risk
89	Rail loop	Dredge spoil acid leachate release - Environmental damage	Excluded	Included elsewhere
90	Rail loop	Dredge acid spoil release - Environmental damage	Excluded	Included elsewhere
91	Rail loop	Spoil rehab failure - Environmental damage	Excluded	No credible risk
92	Rail loop	Upstream infrastructure -	Excluded	No credible risk

Appendix E Inputs Register

Table E-1 Known Events Inputs Register

	CONSTRUCTION													
							Consequence							
Event Name	Initiating Event	Likelihood During Construction Period	Impact	Prob-ability	Consequence	Total Freq	Property/ Infra	Enviro	Social	Econ	Public H&S	Combined Consequence Level	Risk
1 Berths Smothering	Breakwater placement	1	Smothering benthic biota	1	Environmental damage	1	1E-20	0.1	0.1	1E-20	1E-20	0.2	0.2
2 CSD Currents, waves	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
3 CSD Spoil smothering	Spoil disposal	1	Smothering	1	Environmental damage	1	1E-20	0.1	3	1E-20	1E-20	3.1	3.1
4 Rail loop Habitat loss	Reclamation	1	Habitat loss (resting,	1	Environmental damage	1	1E-20	3	10	1E-20	1E-20	13	13
5 Rail loop Middens	Cultural site	1	Destroy site	1	Heritage loss	1	1E-20	1E-20	10	1E-20	1E-20	10	10
6 CSD Organism removal	Seabed removal	1	Removal of flora and	1	Environmental damage	1	1E-20	0.3	1	1E-20	1E-20	1.3	1.3
0	0	0	0	0	0	0	0	0	0	0	0	0	0

	OPERATION												
							Consequence						
Event Name	Initiating Event	Frequency During Operations Period	Impact	Prob-ability	Consequence	Total Freq	Property/ Infra	Enviro	Social	Econ	Public H&S	Combined Consequence Level	Risk
1 Berths Smothering	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
2 CSD Currents, waves	Bathymetry change	1	Current velocity direction	1	0	1	0.3	1E-20	1E-20	1E-20	1E-20	0.3	0.3
3 CSD Spoil smothering	Maint spoil disposal	1	Smothering	1	Environmental damage	1	1E-20	0.3	0.1	1E-20	1E-20	0.4	0.4
4 Rail loop Habitat loss	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
5 Rail loop Middens	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
6 CSD Organism removal	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix E

Table E-2 Potential Events Inputs Register - Construction

					CONSTRUCTION									
							Consequence							
Event Name	Initiating Event	Likelihood During Construction Period	Impact	Prob-ability	Consequence	Total Freq	Property/ Infra	Enviro	Social	Econ	Public H&S	Combined Consequence Level	Risk
1 Berths Fire	Fuel spill	0.001	Fire	0.001	Fatality, injury	1E-06	10	0.3	10	1E-20	30	50.3	5E-05
2 Berths Piling noise	Pile driving noise	1	Disturbance to protected	0.01	Interference with feeding	0.01	1E-20	0.3	1	1E-20	1E-20	1.3	0.013
3 Berths Harbour traffic	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
4 CSD Plume, marine pests	Overseas vessels	0.01	Introduction of marine	0.001	Environmeat and infrastructure damag	1E-05	100	100	100	100	1E-20	400	0.004
5 CSD Plume, algal blooms	Plume nutrients	1	Development of algal	0.0001	Environmental damage	1E-04	1E-20	0.3	1	1E-20	1E-20	1.3	0.0001
6 CSD Plume, contamination	Plume contaminants	1	Toxic to flora, fauna	0.001	Environmental damage	0.001	1E-20	1	3	1E-20	1E-20	4	0.004
7 CSD Reduced light	Plume reduced light	1	Reduced photosynthesis	0.1	Coral damage, dieback	0.1	1E-20	1	3	1E-20	1E-20	4	0.4
8 CSD Underwater noise	Dredge operation noise	1	Disturbance to protected	0.0001	Interference with feeding	1E-04	1E-20	0.3	1	1E-20	1E-20	1.3	0.0001
9 CSD Marine traffic	Barge transit	1	Interference with marine	0.00001	Infrastructure damage, public safety	1E-05	3	1E-20	30	1E-20	100	133	0.0013
10 CSD Oil spill	Refuelling spill	0.01	Fuel slick	1	Visual, environmental impact	0.01	1E-20	0.3	1	1E-20	1E-20	1.3	0.013
11 CSD Plume, smothering	Plume Sediments	1	Smothering benthic biota	0.1	Environmental damage	0.1	0.1	1	3	1E-20	1E-20	4.1	0.41
12 CSD Exclusion recreation	Exclusion zone	1	Recreation, access	0.001	Relocation of activities	0.001	1E-20	1E-20	0.1	1E-20	1E-20	0.1	0.0001
13 CSD Heritage	Presence of heritage	0.001	Damage to heritage	1	Loss of heritage	0.001	1E-20	1E-20	10	1E-20	1E-20	10	0.01
14 CSD UXO	Presence of UXO	0.00002	Explosion	0.5	H&S	1E-05	1E-20	1E-20	1E-20	1E-20	10	10	0.0001
15 BRF Stormwater	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
16 BRF Vehicle accident	Accident during rock	1	Fatality, serious injury	0.03	Fatality	0.03	1E-20	1E-20	10	1E-20	10	20	0.6
17 BRF Weeds, pests	Construction vehicles	0.1	Introduction of weeds	0.01	Terrestrial environment damage	0.001	1E-20	0.1	0.3	1E-20	1E-20	0.4	0.0004
18 BRF Spillage	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
19 BRF Toxic materials	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
20 BRF Catalina Island	Works operations	1	Erosion or deposition	0.0001	Damage to sacred site	1E-04	3	1E-20	30	1E-20	1E-20	33	0.0033
21 MSB Stormwater	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
22 MSB Vehicle accident	Accident during rock	1	Fatality, serious injury	0.03	Fatality	0.03	1E-20	1E-20	10	1E-20	10	20	0.6
23 MSB Fuel pipeline, tank	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
24 MSB Piling noise	Pile driving noise	1	Disturbance to protected	0.1	Interference with feeding	0.1	1E-20	0.3	1	1E-20	1E-20	1.3	0.13
25 MSB Weeds, marine pests	Construction vehicles	0.1	Introduction of weeds	0.01	Terrestrial environment damage	0.001	1E-20	0.1	0.3	1E-20	1E-20	0.4	0.0004
26 MSB Spillage	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
27 Rail loop Settlement	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
28 Rail loop Gross spillage	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
29 Rail loop Chronic spillage	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
30 Rail loop UXO	UXO	0.00002	Explosion	0.5	Fatality, serious injury	1E-05	3	0.1	10	1E-20	10	23.1	0.0002

Table E-3 Potential Events Inputs Register - Operation

			OPERATION											
							Consequence							
Event Name	Initiating Event	Frequency During Operations Period	Impact	Prob-ability	Consequence	Total Freq	Property/ Infra	Enviro	Social	Econ	Public H&S	Combined Consequence Level	Risk
1 Berths Fire	Fuel spill	0.001	Fire	0.001	Fatality, injury	1E-06	10	0.3	10	1E-20	30	50.3	5E-05
2 Berths Piling noise	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
3 Berths Harbour traffic	Increased harbour	1	Collision, incident	0.0001	Fatality, injury	1E-04	10	1	10	1E-20	10	31	0.0031
4 CSD Plume, marine pests	Overseas vessels	0.01	Introduction of marine	0.001	Environmeat and infrastructure damag	1E-05	100	100	100	100	1E-20	400	0.004
5 CSD Plume, algal blooms	Maint dredging nutrients	1	Development of algal	0.00001	Environmental damage	1E-05	1E-20	0.3	1	1E-20	1E-20	1.3	1E-05
6 CSD Plume, contamination	Maintenance plume	1	Toxic to flora, fauna	0.00001	Environmental damage	1E-05	1E-20	1	3	1E-20	1E-20	4	4E-05
7 CSD Reduced light	Maint plume reduced	1	Reduced photosynthesis	0.001	Coral damage, dieback	0.001	1E-20	0.1	1	1E-20	1E-20	1.1	0.0011
8 CSD Underwater noise	Maint dredge operation	1	Disturbance to protected	0.00001	Interference with feeding	1E-05	1E-20	0.1	1	1E-20	1E-20	1.1	1E-05
9 CSD Marine traffic	Maint barge transit	1	Interference with marine	0.00001	Infrastructure damage, public safety	1E-05	3	1E-20	30	1E-20	100	133	0.0013
10 CSD Oil spill	Maint refuelling spill	0.01	Fuel slick	1	Visual, environmental impact	0.01	1E-20	0.3	1	1E-20	1E-20	1.3	0.013
11 CSD Plume, smothering	Maintenance dredging	1	Smothering benthic biota	0.001	Environmetal damage	0.001	0.1	0.1	0.3	1E-20	1E-20	0.5	0.0005
12 CSD Exclusion recreation	Maint exclusion zone	1	Recreation activities	0.001	Relocation of activities	0.001	1E-20	1E-20	0.1	1E-20	1E-20	0.1	0.0001
13 CSD Heritage	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
14 CSD UXO	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
15 BRF Stormwater	Contaminated	1	Release to harbour	0.2	Environmental damage	0.2	1E-20	1	3	1E-20	1E-20	4	0.8
16 BRF Vehicle accident	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
17 BRF Weeds, pests	Overseas vessels,	0.01	Introduction of pests	0.001	Environment and infrastructure damag	1E-05	100	100	100	100	1E-20	400	0.004
18 BRF Spillage	Transfer spillage	0.001	Contaminant release	0.5	Environmental damage	5E-04	1E-20	0.3	1	1E-20	1E-20	1.3	0.0007
19 BRF Toxic materials	Toxic materials present	1	Contaminant release	0.001	Environmental damage	0.001	1E-20	0.3	1	1E-20	1E-20	1.3	0.0013
20 BRF Catalina Island	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
21 MSB Stormwater	Contaminated	1	Release to harbour	0.2	Environmental damage	0.2	1E-20	1	3	1E-20	1E-20	4	0.8
22 MSB Vehicle accident	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
23 MSB Fuel pipeline, tank	Pipeline, tank failure	0.013	Release of fuel to	1	Environmental damage	0.013	3	10	30	1E-20	1	44	0.572
24 MSB Piling noise	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40
25 MSB Weeds, marine pests	Overseas vessels	0.01	Introduction of marine	0.001	Environment and infrastructure damag	1E-05	100	100	100	100	1E-20	400	0.004
26 MSB Spillage	Transfer spillage	0.001	Contaminant release	0.5	Environmental damage	5E-04	1E-20	0.3	1	1E-20	1E-20	1.3	0.0007
27 Rail loop Settlement	Inadequate compaction,	0.01	Derailment	0.001	Infrastructure, H&S	1E-05	3	3	10	10	10	36	0.0004
28 Rail loop Gross spillage	Derailment	0.00001	Gross spillage	0.5	Environmental damage	5E-06	3	3	10	10	10	36	0.0002
29 Rail loop Chronic spillage	Uncontained loads	1	Chronic spillage	0.01	Environmental damage	0.01	1E-20	0.1	0.3	1E-20	1E-20	0.4	0.004
30 Rail loop UXO	0	1E-20	0	1	0	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	5E-20	5E-40

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