

**Maintenance Dredging at Stirling
Naval Base Garden Island WA**

Addendum to Referral Support
Document

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1 Introduction

This document is an Addendum to the S38 Referral and Referral Support Document (RSD) prepared on behalf of the Department of Defence (DoD – the Proponent) by Aurecon (November 2015) for the Maintenance Dredging Project at Stirling Naval Base Garden Island. The S38 Referral and RSD was submitted to the Office of the Environmental Protection Authority (OEPA) on 18 December 2015. The project involves the dredging and disposal of approximately 7,500 m³ of fine sandy sediments from wharf berthing pockets and turning basins in both Careening Bay and Sulphur Bay. The dredging is required to return the berthing pockets and turning basins to a navigable depth. It is anticipated that the works can be completed within a 10-14 day period and that the dredge spoil can be disposed in deep (>15 m) waters both within the vicinity of the wharves and within Naval waters.

This document has been prepared in response to additional advice received by the OEPA from the Department of Fisheries (DoF) since the mass fish kill event which occurred in Cockburn Sound in late 2015. That advice is presented in Appendix A of this Addendum.

In summary the DoF advised OEPA that the sensitivity of Cockburn Sound had increased following the fish kill and as a result the Department would like the Proponent to provide additional information on:

- Alternatives to the disposal of dredge spoil in the Sound;
- The long term stability of the dredge spoil once disposed;
- The risk posed by dispersion of elevated concentrations of tributyltin (TBT) by plumes generated during the works to the Blue Lagoon Mussel farm located offshore Kwinana; and
- Potential turbid plume dispersion characteristics.

The Department also requested:

- A “stop work” management trigger in the event that dead or dying fish are observed within the vicinity of the dredging and disposal works; and
- Implementation of an integrated monitoring and reporting program to demonstrate to regulators and the broader community that the project has had no adverse effects on the environment of Cockburn Sound.

The OEPA subsequently forwarded the DoF’s correspondence to the Proponent and requested that the DoF comments be addressed.

1.1 Structure of Addendum

Section 2.0 of this Addendum summarises the key aspects of Aurecon’s response to the DoF. Aurecon’s response to the DoF is presented in full in Appendix B of this Addendum.

Section 3.0 of this Addendum summarises the key scope of the Environmental Management and Monitoring Program (EMMP) proposed for the maintenance dredging works. The EMMP is presented in full in Appendix C of this Addendum.

2 Response to Department of Fisheries (DoF)

In summary, Aurecon's response:

- Acknowledges that the sensitivity of Cockburn Sound has increased as a result of the mass fish kill which occurred subsequent to the RSD being submitted to OEPA for evaluation;
- Acknowledges that sediments within two of the berthing pockets in Careening Bay contain elevated levels of TBT;
- Recognises the benefit of being able to predict the Zone of Influence and where turbid plumes can be expected to occur;
- Accepts the need for an integrated monitoring and reporting program; and
- Indicates a willingness to consider (with further advice from DoF) the application of a "stop work" management trigger in the event that dead or dying fish are observed in the vicinity of the dredging and disposal works.

Aurecon's response to the DoF also provides the additional information requested on:

- Alternatives to the disposal of dredge spoil in the Sound;
- The long term stability of the dredge spoil once disposed;
- The risk posed by dispersion of elevated concentrations of tributyltin (TBT) by plumes generated during the works to the Blue Lagoon Mussel farm located offshore Kwinana; and
- Potential turbid plume dispersion characteristics.

The outcome of these additional studies is summarised below.

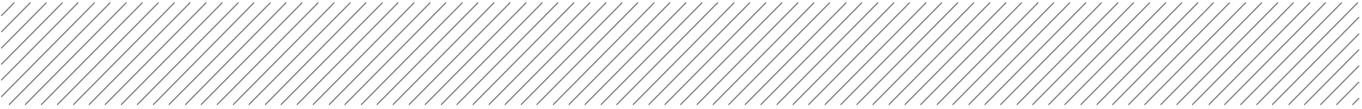
Aurecon has undertaken a desktop evaluation of removing the Careening Bay **sediments to landfill on the mainland** and concluded that this is not a viable alternative to disposal of spoil into the Sound because of:

- The logistical problems involved in storing wet material on land next to the wharves, allowing it to dry, and subsequently loading it onto trucks for transport to a landfill on the mainland;
- The lack of suitable vacant land adjacent the wharves in Careening Bay;
- The double handling costs involved.

Aurecon has also undertaken additional desktop analysis of the size and stability of the spoil ground and modelled the Zone of Influence within which visible turbid plumes arising from the proposed works may occur. Attachment A to the Response to the DoF presented in Appendix B provides these additional engineering analyses.

The key findings of **the spoil stability analyses** were;

- The spoil can be disposed over a small area and managed to ensure that its residual height does not exceed 0.5 m above the seabed;
- The seabed in the location of the spoil grounds is > 15 m deep;
- The sediments on the seabed at the spoil ground locations are much the same particle size as those being dredged and disposed;
- At that depth the spoil will be stable under ambient and strong wind and wave conditions;
- Only under wave conditions generated by a 50 year Average Return Interval Storm from the NE to SE quadrant blowing at 60 knots over a sustained period could the spoil possibly be re-mobilised.



Such events are rare and short lived and would most likely only generate bedforms such as ripples on the seafloor.

Therefore Aurecon remains confident that the spoil grounds will be stable and retentive of the spoil and not be a recurring source of localised water turbidity.

Figures 1 and 2 show the location of the anticipated boundary of the project **Zone of Influence** (Zol) in which turbid plumes might be encountered in both Careening Bay and Sulphur Bay as a result of both dredging and spoil disposal activities. It is important to understand that these diagrams do not represent the predicted scale of the plumes that may be generated. Based on observations during the previous dredging program at the Armaments Wharf, the actual size of the visible plume is anticipated to be small and localised to the close vicinity of the works (Refer Figure 13 in RSD).

As mentioned previously, Aurecon has undertaken preliminary calculations and modelling of the extent of this Zone based on observations from previous dredging works at the Armaments Wharf in 2003 (APASA 2003) and engineering calculations of sediment dispersion and settlement using conservative assumptions to produce a worst case assessment. The assumptions included:

- The occurrence of strong (25 knot) winds for maximum dispersion;
- Disposal of spoil at the water surface via Surface Hopper Barge (SHB); and
- Calculation of the distance required to reduce suspended sediment concentrations to 3 mg/L (near background concentrations).





The modelling indicated that the Zol would extend radially approximately 1200 m from the Careening Bay spoil disposal ground and up to 2 km north and south from the spoil disposal ground in Sulphur Bay.

Regarding the **elevated levels of TBT** in some 1300 m³ of Careening Bay sediments, Aurecon is confident that the proposed works pose minimal risk to the operators of the Blue Lagoon Mussel Farm and to consumers of their product because:

- The TBT is NOT bioavailable as demonstrated by using the recommended elutriate tests. Furthermore the concentrations of TBT recorded by these tests did not exceed Initial Management Triggers established for Careening Bay by the Environmental Quality Criteria Reference Document for Cockburn Sound 2015 (EQCRD, EPA 2015);
- It is proposed to bury the TBT contaminated sediments beneath clean sediments from other wharves in Careening Bay;
- The farm is located some 2 km from the spoil ground in Careening Bay and is outside the modelled Zol;
- There are no TBT screening criteria for maintenance of seafood safe for human consumption provided in EQCRD; and
- TBT does not affect survival of juvenile mussels but only affects growth rate after 12 weeks continuous exposure (Salazar and Salazar, 1996).

[illegible]

- Careening Bay spoil ground coordinates
- Contractor confined spoil ground
- Declared spoil ground size

-  Zol - dredging
-  Zol - disposal
-  Proposed Dredge Areas
-  Little Penguin Rafting Area

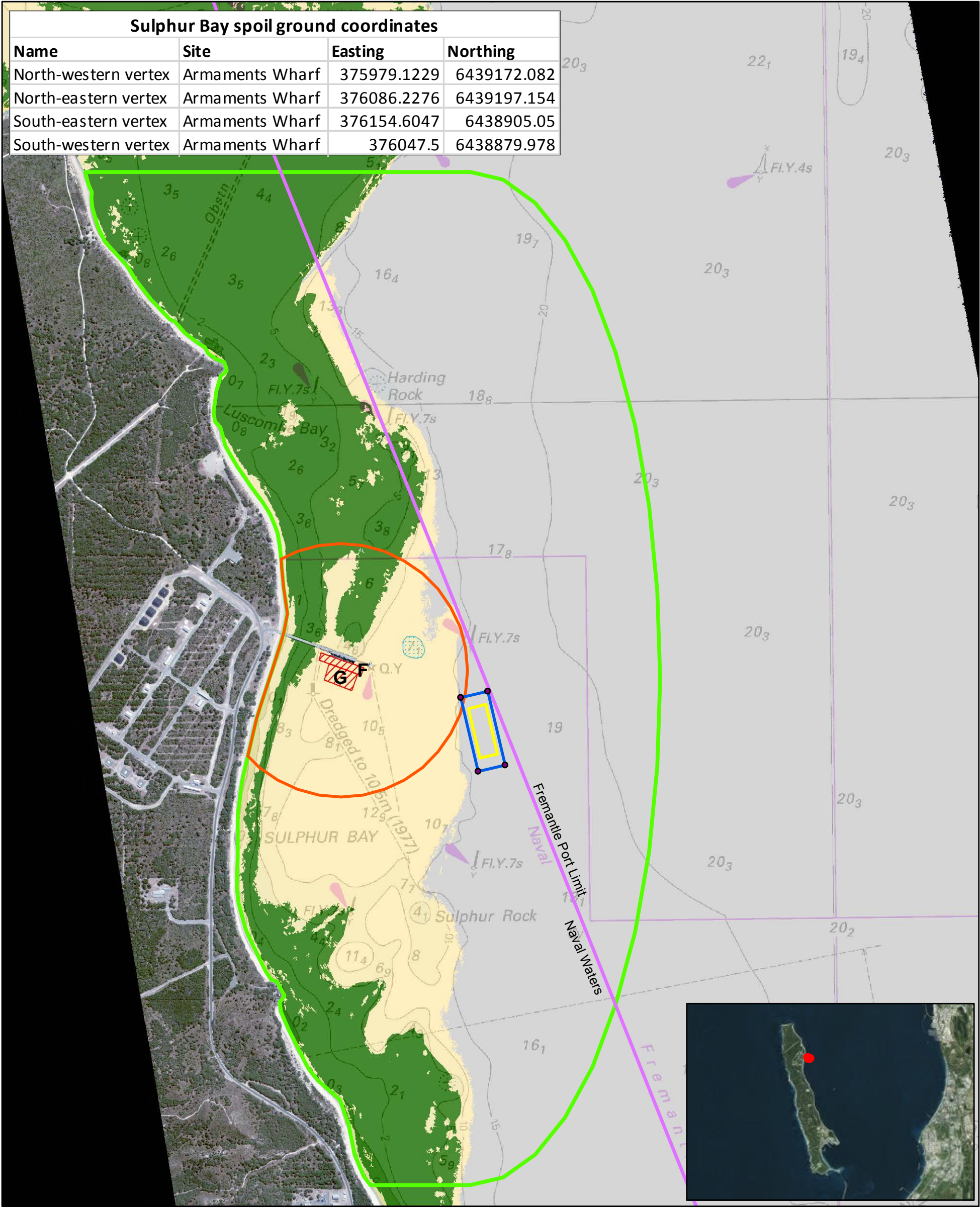
- Seagrass communities
- Sand (<10m)
- Fine Sediment (>10m)
- Coral Bommie

Notes:



Date: 6/04/2016 Version: 1 Job No:
 Coordinate System: GDA 1994 MGA Zone 50

Figure 1: Careening Bay maintenance dredging locations, offshore disposal sites and zones of influence



Legend

- Sulphur Bay spoil ground coordinates
 - Contractor confined spoil ground
 - Declared spoil ground size
 - Fremantle Port Limit
- Zol - dredging
 - Zol – disposal
 - Proposed Dredge Areas
 - Existing Spoil Ground
- BPPH Classes**

 - Seagrass communities
 - Sand (<10m)
 - Fine Sediment (>10m)

Notes:



A3 scale: 1:15,000
0 320 640 Metres

Date: 6/04/2016 Version: 1 Job No:
Coordinate System: GDA 1994 MGA Zone 50

Department of Defence
H.M.A.S Stirling Maintenance Dredging

Figure 2: Armaments Wharf maintenance dredging locations, offshore disposal sites and zones of influence

3 Environmental Management and Monitoring Program

The full text of the EMMP is presented in Appendix C of this Addendum. This section presents a summary of key points only.

The EMMP is presented in two parts:

1. Environmental Protection Measures; and
2. Dredging Monitoring Plan

Under Commonwealth environmental legislation and the Defence Environment Policy, responsibility for appropriately managing environmental values of Garden Island rests with all Defence personnel, contractors and other site users. An Environment Review (ER) document based on the contents of the RSD (Aurecon 2015) assessed the proposal for compliance with the EPBC Act 1999. The ER has been reviewed by the Department of Defence Directorate of Environmental Protection and Assessment (DoD DEPA), who have subsequently set the approval conditions for the proposal specified in Appendix G of the RSD.

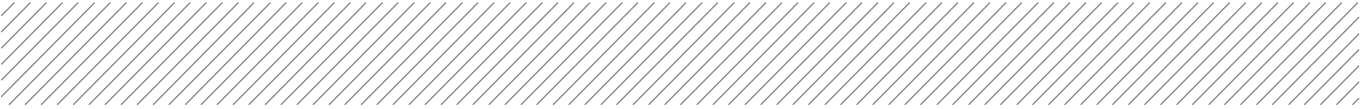
These approval conditions stipulate a number of *Environmental Protection Measures* which must be implemented by the Project Office when this proposal is undertaken. The conditions have been incorporated into the EMMP.

Additional monitoring detail is provided in the *Dredging Monitoring Plan* (DMP) which identifies the potential Zone of Influence of turbid waters arising from the project and the type and location of monitoring activity proposed before, during and after the project. The purpose of the DMP is to collect data that will confirm the reliability of the assessment presented in the RSD and provide regulators and the general public with confidence that the works have not negatively impacted the marine environment of Cockburn Sound.

3.1 Environmental Protection Measures

The key Environmental Protection Measure that has been adopted for this project has been to **restrict the timing of works to the May to August period** to avoid disturbance of the Careening Bay Little Penguin colony during the spring nesting and chick rearing period, and to avoid affecting the success of the peak snapper and crab spawning event in the northern parts of Cockburn Sound (which occurs during September to December). Other key impact avoidance measures include:

- **Maintenance of daylight working hours** and avoidance of evening “rafting area” near Diamantina Wharf in **Careening Bay** – to avoid interfering with the daily penguin migration to and from feeding grounds in Cockburn Sound.
- **Maintenance of night time working hours in Sulphur Bay** if dredging necessary between May – August, to avoid interruption of penguins from both Penguin and Garden islands foraging in the vicinity of Sulphur Bay during daylight hours.
- **Maintenance of a marine fauna watch** – to observe marine fauna abundance and behaviour in the vicinity of the dredging works and temporarily cease works in the unlikely event that protected marine fauna swim into harms way. Works will also temporarily cease in the event that dead fish are observed on the water surface in the vicinity of the dredging and spoil disposal activities and the Department of Fisheries will be immediately notified.
- **Preparation of an Invasive Marine Species Risk Assessment** – for the dredging equipment that is ultimately awarded the contract to undertake the works. Certification will be required from the successful contractor that all vessels from outside WA associated with the dredging activities have



been risk assessed using Department of Fisheries Vessel Check and have completed recommended actions to manage vessels to a Low risk rating.

3.2 Dredging Monitoring Plan

The purpose of this plan is to provide detail of what will be monitored, where and when, and how data collected will be used and reported. In reviewing the DMP it needs to be understood that:

- The volume of material to be dredged is very small (~2000 m³ in Careening Bay and ~ 5500 m³ in Sulphur Bay);
- The duration of dredging works anticipated is very short (4-5 days in Careening Bay and 6-7 days at Sulphur Bay);
- Most of the material to be dredged is uncontaminated clean sediment. Only a very small volume of sediment (~1300 m³) containing elevated concentrations of TBT will be relocated to the spoil disposal site in Careening Bay;
- All works will take place within Naval Waters to which public access for recreational fishing is restricted; and
- No permanent or temporary adverse impacts are anticipated to protected marine fauna populations, recreational fish and crab populations, farmed mussel operations or seagrass beds in Cockburn Sound.

The DMP presents information on:

- Proposed Pre-dredging baseline monitoring program
- Proposed Monitoring during Dredging
- Proposed Post dredging monitoring
- Proposed reporting arrangements
- Monitoring details

3.2.1 Pre-dredging baseline monitoring

Prior to the onset of the works it is proposed to establish the baseline condition of:

- Seagrasses in the vicinity of works in both Sulphur Bay and Careening Bay,
- TBT in surface sediments at the proposed spoil grounds,
- Water quality in the immediate vicinity of both dredging and spoil disposal areas in both Sulphur Bay and Careening Bay, and
- TBT in mussel flesh and water at the NW boundary of the Blue Lagoon mussel farm and within the Zone of Influence.

3.2.2 Monitoring during dredging

During the short dredging campaign it is proposed to undertake monitoring of:

- Water quality in the immediate vicinity of both dredging and spoil disposal areas in both Sulphur Bay and Careening Bay,
- TBT in water at the NW boundary of the Blue Lagoon mussel farm and TBT in mussel flesh and water within the Zone of Influence,
- The direction and extent of dispersal of the turbid plume during daylight hours, and
- Observation of protected and recreational marine fauna in the vicinity of the works.



3.2.3 Post dredging monitoring

Within one month of the maintenance dredging campaign being completed it is proposed to repeat the pre-dredging sampling program; i.e. undertake monitoring of:

- Seagrasses in the vicinity of works in both Sulphur Bay and Careening Bay,
- TBT in surface sediments at the proposed spoil grounds,
- Water quality in the immediate vicinity of both dredging and spoil disposal areas in both Sulphur Bay and Careening Bay, and
- TBT in mussel flesh and water at the NW boundary of the Blue Lagoon mussel farm and within the Zone of Influence.

3.2.4 Reporting

A Project Close Out report will be prepared and anticipated to be submitted to both State and DoD regulators within three months of completion of the proposed works, with the date dependant on receipt of laboratory results. The report will present all data collected by the DMP monitoring program along with an assessment of the reliability of the predictions presented in the RSD.

3.2.5 Monitoring Details

Further detail on the locations, methods and parameters to be sampled in the DMP is provided according to the environmental factor being monitored (i.e., seagrasses, sediments, mussels, water quality, marine fauna). The reader is referred to Appendix C for that detail.



4 References

APASA (2003) Validation of Hydromap/ Mudmap modelling system: prediction of the fate of sediment discharged to Cockburn Sound, Appendix F in DALSE (2003a)

Aurecon (2015) Maintenance Dredging at Stirling Naval Base Garden Island WA Referral Support Document. Produced for the Department of Defence, November 2015

EPA (2015) Environmental Quality Criteria Reference Document for Cockburn Sound (2015). A supporting document to the State Environmental (Cockburn Sound) Policy 2013. Environmental Protection Authority, Perth, WA, March 2015.

Salazar, M.H. and Salazar, S.M. (1996) Mussels as bioindicators: Effects of TBT on survival, bioaccumulation and growth under natural conditions. In: Champ, M.A and Seligman, P.F. (Eds.) Organotin: Environmental Fate and Effects, Chapman and Hall, London, Pp. 305-330.



Appendix A

Fisheries correspondence to OEPA



Our Ref: 2379/14
Your Ref: CMS15182
Enquiries: Carli Telfer 9482 7227

Mr Anthony Sutton
Director - Assessment and Compliance Division
Office of the Environmental Protection Authority
Locked Bag 10
EAST PERTH WA 6892

Dear Mr Sutton

PROPOSAL: MAINTENANCE DREDGING OF GARDEN ISLAND WHARVES
PROPONENT: DEPARTMENT OF DEFENCE

Thank you for the opportunity to provide additional comments on the proposed maintenance dredging of Garden Island Wharves. Due to the high degree of public concern following the recent fish kill and the sensitive receiving environment in Cockburn Sound, the Department of Fisheries (Department) provides the following comments:

Spoil disposal alternatives, and risk of mobilisation

In the Department's view, the proponent has not provided any evaluation of alternatives to the disposal of spoil in Cockburn Sound, including the option of landfill or dumping at an alternative location outside of the Sound. Further, because there is no requirement for a Commonwealth sea dumping permit, this places greater onus on the State, in the absence of another statutory decision making process, to require consideration of these alternatives and consultation with stakeholders.

In addition, the distance between seagrass meadows and spoil disposal locations was described by the proponent as *"remote from sensitive receptors"*¹ however it is later confirmed that *"it is likely that turbid plumes will disperse over the seagrass beds"*². As the Environmental Protection Authority (EPA) is aware, seagrass meadows are important nursery areas for marine organisms, such as blue swimmer crabs which have suffered a collapse in stocks in recent years. In the Department's view, the resilience of the seagrass meadows to further disturbance or additional pressure remains in question given the findings of the State of the Sound Report 2014.

¹ p17, *Maintenance Dredging at Stirling Naval Base, Referral Support Document, Aurecon, 9 November 2015*

² p30, *ibid*

It is also a matter of concern that the proponent has stated that “waves are most unlikely to mobilise sediment during ambient conditions”³ without any apparent consideration of the possible mobilisation of spoil during other weather conditions.

Presence of Organotins (TBT) and risk of dispersion

The Department notes that sediment sampling undertaken by the proponent has demonstrated high Organotin (TBT) concentrations in a number of locations. In Careening Bay, two-thirds of the material to be dredged has elevated levels of TBT and no assessment of the potential for bioavailability appears to have been undertaken.

Notwithstanding some investigations by the proponent, the Department does not have a high level of confidence that there will be no mobilisation of these contaminants through the dredge plume or spoil disposal. This is particularly concerning given the proximity of the Blue Lagoon Mussel farm: “the beds may be exposed to elevated levels of water turbidity for a short period of time during works in Careening Bay”⁴.

Plume dispersion modelling

The Department does not share the proponent’s view that:

*given the very low risk of adverse impact and the fact that the proposal is not a significant dredging project it is considered that the guidance in EAG 7 (EPA 2011) for Marine Dredging Proposals does not apply as it is clear that EAG 7 only applies to significant dredging proposals*⁵.

It is the Department’s view that the sensitivity of the receiving environment and the high degree of public concern about the range of pressures on Cockburn Sound warrants the application of the EPA’s guidance with respect to plume dispersion modelling. Indeed, the modelling – accompanied by an appropriate monitoring regime before, during and after the dredging campaign – may assist the proponent to demonstrate to the community that the visible plume was entirely as predicted and that there were no lasting ecological effects.

Stop work trigger

The Department also requests consideration of a ‘stop work’ management trigger protocol for contractors if dead or dying fish are observed within the predicted plume area or near vicinity during the dredging works. The proponent would be obliged to consult relevant Departments, and take appropriate action, prior to the recommencement of dredging.

³ p31 *ibid*

⁴ p36 *ibid*

⁵ p31 *ibid*

Monitoring regime

The Department is of the view that the dredging campaign should not be undertaken without monitoring of water quality (including dissolved oxygen) and broader sediment sampling before, during and after dredging activities. This should also include shellfish sampling before any dredging commences to establish a baseline.

An integrated monitoring program will allow the proponent to demonstrate to regulators and the broader community that the maintenance dredging has had no adverse effects on marine organisms and the environment in Cockburn Sound. This is particularly important given the elevated levels of TBT in the dredging locations.

All sampling and monitoring results should be made available to the Department, Cockburn Sound Management Council, Department of Environment Regulation and the general public. This will ensure transparency for the proponent, as well as demonstrating due diligence that all potential risks to the marine environment have been effectively managed.

In view of the above concerns, the Department requests that the EPA has particular regard to the following elements of its 'significance test'⁶ in determining whether or not to assess the proposal:

- (a) values, sensitivity and quality of the environment which is likely to be impacted;
- (d) resilience of the environment to cope with the impacts or change;
- (e) cumulative impact with other projects;
- (f) level of confidence in the prediction of impacts and the success of proposed mitigation;
- (i) presence of other statutory decision-making processes which regulate the mitigation of the potential effects on the environment to meet the EPA's objectives and principles for EIA; and
- (j) public concern about the likely effect of the proposal, if implemented, on the environment.

For clarification or further information regarding these issues above, please contact Carli Telfer on 9482 7227.

Yours sincerely



HEATHER BRAYFORD
DIRECTOR GENERAL

29 January 2016

⁶ Environmental Impact Assessment (Part IV) Administrative Procedures 2012, EPA



Appendix B

Aurecon response to DoF correspondence

6 April 2016

Carli Telfer
Department of Fisheries
3rd Floor, The Atrium
168 St Georges Terrace
Perth, WA 6000

RE: 2379/14 CMS15182 RESPONSE TO DEPARTMENT OF FISHERIES
PROPOSAL: MAINTENANCE DREDGING OF GARDEN ISLAND WHARVES
PROPONENT: DEPARTMENT OF DEFENCE

Dear Ms Telfer

I refer to the attached letter dated 29 January 2016 from the Department of Fisheries (DoF) to the Office of the Environmental Protection Authority (OEPA) regarding the proposed maintenance dredging at Garden Island. Aurecon has provided the following response to this letter.

Aurecon acknowledges that the **sensitivity of Cockburn Sound** and the recreational fisheries it contains has increased as a result of the relatively recent mass fish kill experienced late last year since the Department of Defence (DoD) referral and Referral Support Document (RSD) (Aurecon 2015) were prepared and submitted to the OEPA for evaluation.

Aurecon acknowledges that it did not provide an **evaluation of alternatives** to the disposal of spoil in Cockburn Sound because:

- An evaluation of alternatives was undertaken for the previous dredging program at the Armaments Wharf in 2003 (DALSE 2003b) which concluded that disposal in Cockburn Sound was the most environmentally acceptable option. This option was subsequently implemented and a spoil ground developed to the east of the Armaments Wharf with no subsequent adverse environmental impacts recorded;
- The assessment of contaminant status of the material indicated that it was suitable for unconfined disposal in a marine environment; and
- None of the stakeholders consulted raised any concern at the time with disposal of spoil into Cockburn Sound (including DoF, who also indicated a preference for cutter suction dredging and recommended that a downpipe and spreader bar be used to restrict dispersal of turbidity to deeper waters).

Aurecon has since undertaken a **desktop evaluation of removing the Careening Bay sediments to landfill**. Such a task poses significant logistical problems including storing wet material on land adjacent to the wharves, allowing it to drain and dry, and subsequently loading it onto trucks for transport to approved landfill, not to mention large double handling costs. Furthermore, the Navy has indicated that there is no spare vacant cleared land available within the immediate vicinity of the wharves that can be used to temporarily store and dry the sediments. Hence disposing of the material to landfill on the mainland is not considered a viable option.

Given that the sediments are currently in the marine environment of Careening Bay and that their concentration of tributyltin (TBT) is such that they are considered suitable for *unconfined* disposal into the marine environment, the proposal to bury these sediments with uncontaminated sediments from areas C and E at a disposal ground within the Naval Waters of Careening Bay is a logistically much simpler disposal option which poses little risk to the recreational fisheries of Cockburn Sound.

It should be noted that the Navy has already **committed not to undertake works during the peak snapper and crab spawning** and recruitment periods (September to January) as requested by DoF.

Avoidance of this period, together with the fact that the TBT is not in a bioavailable form (Aurecon 2015), we believe substantially reduces the environmental sensitivity of the proposed works.

Aurecon is aware that, according to the recently released State of Cockburn Sound Report 2014 (CSMC 2015), seagrass meadows in shallow waters near the northern end of the Island and adjacent to the naval base settlement north of Colpoys Point are thinning, while meadows in deep water are expanding. The cause of the thinning is not known but does not appear to be linked to nutrient enrichment. Aurecon agrees that it is important to ensure that the proposal does not result in the risk of further loss or thinning of seagrass habitat and is the reason we undertook the Seagrass Risk Assessment (Appendix D of the RSD). That assessment concludes, based on evidence in the literature, that all species (*P. sinuosa*, *P. australis* and *A. antarctica*) growing in the project area will be able to withstand short durations (≤ 3 months) of moderate to heavy shading events, regardless of the timing of the onset of reduced light availability by any plumes generated by dredging and spoil disposal. Thus given the following observations that:

- **The proposed dredging operation will be of very short duration and small volume** (as described in Table 3 of the RSD (**2-3 days and ~ 1900 m³** in Careening Bay and **4-6 days and ~ 5500 m³** in Sulphur Bay));
- **The time of year** proposed for dredging (autumn) is when seagrass carbohydrate levels are known to be high and hence more resilient to disturbance (Gordon et al.1994); and
- No dredging or spoil disposal will take place near the locations where seagrass beds are thinning.

It should be abundantly clear that the risk to seagrass beds from the short term turbidity plumes that may potentially develop from this proposal are minimal.

Aurecon acknowledges that the **stability of the spoil on the seafloor** after disposal could have been addressed better in the report than it is at present, and have undertaken further desktop review to address this shortcoming (refer Attachment A). Aurecon coastal engineers have reviewed the Geoscience Australia Record entitled "The Geomorphology and Sediments of Cockburn Sound" (Skene et al. 2005) and the wave climate of Cockburn Sound and concluded that the deep basin (> 15 m depth) of Cockburn Sound is a sediment trap and that the sandy muds on the seafloor are not mobile. Furthermore, the wave climate is such that wave action generated by a storm of 50 year Average Recurrence Interval (ARI) would be required to mobilise the seafloor at both proposed spoil disposal sites. Therefore our assessment remains that putting fine sands and silts into deep water will result in a stable and retentive spoil ground.

Aurecon acknowledges the DoF's concern regarding the **presence of elevated levels of TBT** in some of the Careening Bay sediments but wishes to reassure DoF that an assessment of the bioavailability of these contaminants has been undertaken using the recommended elutriate tests which have shown that the **TBT present is not readily soluble** (Refer Section 6.4.7 and 6.5 of Appendix A of the RSD). Elutriate test results also did not exceed Initial Management Triggers established for MEPA's by the Environmental Quality Criteria Reference Document for Cockburn Sound (EQCRD) (EPA 2015) (Refer Table 6.5 RSD Appendix A).

Aurecon is aware that the Blue Lagoon Mussel farm operates in the general region of the proposed works in Careening Bay. It should be noted however that the **mussel farm is located some 2 km** to the South East of the proposed works location. Preliminary modelling of the potential Zone of Influence (Zol) of the turbid plume (i.e. the envelope within which a turbid plume may occasionally be observed depending on wind direction and strength at the time) indicates that the mussel farm is outside the boundary of the Zol and unlikely to be affected by turbid waters from the disposal activities.

Even if the farm were within the Zol, short periods of increased turbidity pose little risk to mussels. The risk to mussels posed by short term exposure to TBT is also low. According to Salazar and Salazar (1996), elevated TBT concentrations in seawater **after 12 weeks exposure can reduce growth rate of juvenile mussels but does not affect survival**. It is valuable to note that threshold concentrations causing significant reductions in juvenile mussel growth are estimated at 100 ng l⁻¹ TBT (0.001 ug/L) for seawater and 1.5 µg g⁻¹ TBT for tissue **after 12 weeks exposure**, a considerably longer period than that of the current proposal. It should also be noted that there are no TBT screening criteria for maintenance of seafood safe for human consumption provided in the EQCRD (Table 4) for TBT in Cockburn Sound waters. The operators of the Blue Lagoon mussel farm were also consulted and did not express any concern with the proposal (Refer Section 3 of the RSD). Given the above, Aurecon is confident that the proposed works pose minimal risk to the operators of the Blue Mussel farm and the consumers of their mussels.

However Aurecon acknowledges that there is a screening criterion for TBT provided in the EQCRD (Table 5) (EQG = 0.004 ug/L Sn) for protection of aquaculture which applies at the boundary of the aquaculture lease. We also acknowledge the value of DoD being able to demonstrate to regulators and the broader community that the dredging program has had no adverse effects on sensitive marine organisms and the broader environment of Cockburn Sound. Aurecon therefore accepts the need for an integrated sediment, shellfish and water quality monitoring program and **the monitoring and reporting regime proposed by DoF is acceptable to Aurecon and DoD**.

Aurecon is prepared to also consider the application of a stop work management trigger in the unlikely event that dead or dying fish are observed either within the plume or near the dredging works. Stop work management triggers have already been proposed for selected protected marine fauna in the event that they swim into potentially hazardous activities. However, as this is not a common request or occurrence associated with dredging programs, we would welcome some discussion with, or guidance from, DoF as to how many fish and what type of fish are to be included. It is assumed that DoF would be the first department contacted in the unlikely event of a mass fish “kill”, that they would determine the probable cause of fish death and advise if and when dredging could re-commence.

However **Aurecon questions the need to include plume dispersion modelling** in the RSD for the following reasons:

- The two options under consideration will have markedly different dispersion patterns;
- The risk to primary producers from any turbidity plume arising from either dredging method is exceedingly small given the very short duration of the project;
- It has already been shown (DALSE 2003a) that dredging plumes in shallow waters will be wind driven and hence the plume characteristics will depend on the time of year works are undertaken, as well as method of dredging employed; and
- Neither the time of year nor the dredging method are known at present.

Aurecon also **questions the cost/benefit of applying Environmental Assessment Guideline (EAG7) for Marine Dredging Proposals** (EPA 2011) when it is clear that this project will not result in Zones of High or even Moderate Impact (as defined by EAG7) and that any modelling will only deliver Zones of Influence of a turbid plume, the extent of which will be monitored on a daily basis. Furthermore EAG7 was developed for application to **significant** marine dredging proposals that are subject to formal EIA by the EPA. Aurecon contends that the **proposal is not significant** given its small scale, short duration and low risk to seagrass beds and marine fauna in the vicinity of the proposed works.

However Aurecon recognises the benefit of being able to predict the Zone of Influence and where plumes can be expected to occur in the Notice to Mariners and, as mentioned previously, has

undertaken preliminary calculations and estimations of the extent of this Zone based on observations from previous dredging works and engineering calculations of sediment dispersion and settlement using conservative assumptions to produce a worst case assessment (Refer Attachment A).

As indicated in Section 4.1 of the RSD, mathematical modelling was undertaken for the previous dredging impact assessment in 2003 (DALSE 2003b) to examine the potential extent of the turbid plume and the footprint of sedimentation in the vicinity of the Armaments Wharf. It should be noted that that dredging campaign involved both a much larger and more powerful dredge than is proposed for this project and also required the cutting of some 3,300 m³ of limestone rock which resulted in the release of larger quantities of finer material than is likely to occur during the proposed works.

The actual plume extent was found to be highly dependent on the prevailing wind conditions and during south-easterly winds the plume was predicted to flow parallel to the shore in nearshore waters and possibly extend to the northern tip of Garden Island. However, it should be noted that the suspended solid load would soon reach background levels (~3 mg/L) within Cockburn Sound. Sediment within plumes were also predicted to settle from the water column within 12 to 18 hours after the cessation of discharge. Thus, any particular location on the seabed was not expected to experience continuously elevated turbidity levels and any turbidity would dissipate within hours of the operation ceasing. The above predictions were subsequently confirmed when the model was validated by turbidity and sedimentation monitoring data collected during the dredging works campaign (APASA 2003).

The above report has been reviewed and estimates of the potential plume excursion distance from both dredging and spoil disposal activities have been made using standard engineering calculations based on use of worst case wind strengths (25 knots) and directions, disposal of spoil material at the water surface and the particle size distributions known to occur at the dredging sites (refer Attachment A). It should be noted that the ZoI represents the boundary within which a turbid plume may be visible during the proposed works, not the actual scale of the plume. Based on observations during the previous dredging program at the Armaments Wharf, the actual size of the visible plume is anticipated to be much smaller and localised to the close vicinity of the works (> 1 km).

We hope that the above response adequately addresses the concerns that you raised in your correspondence of 29 January 2016. We would of course be very happy to engage in further discussions with Department of Fisheries if required and would welcome advice regarding the criteria for application of a “stop work” management trigger in the event of dead fish being observed in the vicinity of the works.

Yours sincerely

A handwritten signature in blue ink, appearing to read 'Paul Everson', with a stylized, cursive script.

Paul Everson
Environment Leader – WA | Aurecon

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Attachment A – Aurecon HMAS Stirling plume and spoil site assessment memorandum

Attachment B – Letter dated 29 January 2016 from DoF – Proposal: Maintenance Dredging of Garden Island Wharves Proponent: Department of Defence - located in Appendix A

Memorandum

To	Paul Everson, Mel Petrie	From	Gildas Colleter
Copy	Ian LeProvost, Erik Paling	Reference	243418
Date	4 April 2016	Pages (including this page)	9
Subject	HMAS Stirling plume and spoil site assessment		

1 Introduction

1.1 Background

Maintenance dredging of berth pockets at both Careening Bay and Sulphur Bay is proposed to provide safe berthing for naval vessels at HMAS Stirling on Garden Island in Western Australia. The dredging, consists mostly of fine sand at Careening Bay, while some silt and clay are also anticipated, in particular at the Armament Wharf in Sulphur Bay. Up to 7,500 m³ of dredging of material is proposed and such work is likely to be completed over a short duration (7-9 days in total) (Aurecon 2015).

Disposal of the spoil is proposed to occur in deep water depth, (depth > 15 m), offshore of the wharves.

A number of dredging and disposal options exist and include:

- A backhoe dredge (BHD) with a conventional “Jaden Rose” cutter head (or similar), with disposal via floating pipeline directly onto the seafloor via downpipe and spreader plate; or
- a BHD with conventional bucket head and disposal into a Split Hopper Barge (SHB) for transport to spoil grounds and release at the water surface.

Timing of the proposed dredging works has been restricted to the May – August period of the year to avoid interfering with sensitive receptors in the vicinity of the works (little penguins, snapper and crab fisheries) (Aurecon 2015).

1.2 Objectives

The objectives of this short report are to determine:

- The scale of the zone that may be influenced at some time by a visible turbid plume during the works (Zone of Influence);
- the anticipated dimensions of the proposed spoil disposal grounds; and
- the stability of the disposed sediments at the sites proposed.

1.3 Methods

The principal methods used have included:

- Review of available information on the sediments and wave climate of Cockburn Sound (Skene et al. 2005);
- review of previous plume modelling and validation studies undertaken for previous dredging works at the Armaments Wharf (APASA 2003);
- review of ADCP current monitoring data collected at each dredging area (Appendix E in Aurecon 2015);

- review of PSD characteristics of the sediments to be dredged and disposed (Appendix A in Aurecon 2015); and
- mathematical modelling of sediment dispersion extent and settlement using standard engineering calculations, models and formulae (e.g. Stokes Law, STFATE).

2 Modelling the Zone of Influence (Zol)

2.1 Parameters

The APASA (2003) plume modelling validation study prepared for The Department of Defence on the Armament Wharf deepening and maintenance dredging project provides useful information on plume dispersion at the site. This study undertaken over two days in July 2003 demonstrated that for a similar quantity of finer sediments, visible plumes were contained to an area > 1km radially around the site. Actual data obtained on suspended sediment in water at the time of both dredging and disposal works showed that a visible plume extended parallel to shore in the order of 800 m – 1000 m from the source. Winds at the time of the study ranged between 10 and 12 knots from the north and tides were mid-ebb and near peak flood at the time of the monitoring survey. The validation survey confirmed what had been shown by the pre-dredge modelling, that the direction and extent of plume dispersion would be sensitive to the prevailing wind driven and tidal currents prevailing at time of works.

Table 1 lists the calculation parameters used for this assessment. Note that a conservative ‘worst case’ approach has been adopted for defining the boundary of the Zol by using:

- Strong winds (25 knots = 12.5 m s^{-1}) for maximum dispersion;
- disposal of spoil at the water surface via SHB; and
- calculation of the distance that is required to reduce suspended sediment concentrations to 3 mg L^{-1} (background concentration in Cockburn Sound during Autumn).

25 knot wind speeds are considered a practical limit to dredging operations. Therefore surface wind-driven currents for such wind speeds have been estimated using wind drift surface current approximation to derive the values presented for longshore wind driven surface currents in both Careening Bay and Sulphur Bay (0.18 m s^{-1} and 0.31 m s^{-1} respectively).

As indicated in Table 1, the 2015 ADCP current investigation (Appendix E, Aurecon 2015) at each dredging site measured much smaller 1% exceedance current velocities. Very small current velocities were also indicated in the APASA (2003) hydrodynamic modelling study and subsequent validation study. This suggests that current speeds of 0.18 m s^{-1} and 0.31 m s^{-1} are an over-estimate for depth- and time-averaged velocities used for the plume modelling presented here. These velocities were adopted for the current modelling to provide a conservative assessment of potential Zone of Influence.

2.2 Dredging dispersion Zol

Dispersion of sediment at the dredging site depends greatly on the method used for dredging.

From past experience at this site, the use of even a large Cutter Suction Dredger such as the Wombat (APASA 2003), resulted in relatively small compact plumes near the site. It is likely that the dredge equipment that will be used for the proposed works will be much smaller in terms of ladder size and pumping capacity, thereby reducing turbid plumes locally near the dredge. On the other hand, dredging with a bucket and allowing overflow from the SHB would introduce a wider and persistent surface plume at the dredging location and intermittent short duration plumes at the disposal location.

Considering only the advection of silt particles and their Stokes Law fall velocities, the excursion of the plume is predicted to be 500 m and 700 m for Sulphur Bay (typically 5 m averaged depth near the wharf) and Careening Bay wharves (typically 12 m deep in the bay) respectively.

Natural oceanic turbulence, along with local wind-waves, mix sediment suspension faster and will reduce suspended sediment concentration downstream along the plume trajectory.

A practical guideline on the overflow limit concentration can be estimated from using the VISJET model (2009) which allows the analysis of discharge plumes. VISJET estimates plume dispersion and the extent of the mixing zone under the expected environmental and discharge conditions. Hong-Kong University developed the Lagrangian model supporting VISJET (named JetLag) to predict mixing characteristics of non-interfering buoyant jets in a water current. Each plume element along the plume trajectory increases in mass by shear induced entrainment turbulences and forced entrainment due to the ambient current while resolving the momentum, energy and mass conservation equations.

The mixing zone is defined as the water surface extent of the plume, where mixing reaches a dilution sufficiently high to reach the project water quality objectives (in this case 3 mg L^{-1}).

Figures 1 and 2 present the estimated Zol generated by the dredging works alone (orange line boundary) in both bays based on use of the above models and the input assumptions presented in Table 1.

2.3 Spoil disposal Zol

A quick succession of discrete SHB discharges is likely to lead to the largest visible surface plumes because this will introduce relatively high suspended concentration of sediment near the surface in a short space of time. This scenario has been used to generate a worst case estimate of Zol generated by spoil disposal at the two proposed sites.

The United States Army Corps of Engineer model STFATE (USACE 1998) was employed to study the descent and mixing of such a hopper-generated plume. In this case a small hopper of 400 m^3 capacity (i.e. $20 \text{ m L} \times 6.6 \text{ m W} \times 3 \text{ m D}$) was used for this assessment. Generally the model has been set to its default numerical parameters, with the exception of those local parameters outlined in Table 1.

The SHB was filled with the mix of sediment particle size distributions detailed in Appendix A (Aurecon 2015) and released into a depth of -15 m at both sites with current velocities respective of 0.18 m s^{-1} and 0.31 m s^{-1} and a discharge duration of 60 seconds.

The model indicated that the hopper release will very rapidly generate, immediately below the barge, a “collapsed” conical mound of sediment on the ocean floor with a peak height 0.3 m and a 50 m wide. Suspended sediment concentrations will then spread along with the down current as coarser material settles along on the seafloor.

In Careening Bay, where current velocities are low, the plume is predicted to travel approximately 1200 m before the suspended concentration reduces to background (3 mg L^{-1}). Due to the near circular shape of the bay, an area with a radius of 1200 m has been considered to be the effective Zol for this spoil ground.

At the Armament Wharf, the current is generally longitudinal to the shore and the Zol was predicted by the STFATE model to move to a distance of 2000 m. The sediment concentrations across the plume are typically Gaussian and STFATE provides an estimate of 750 m for the width. These estimates were adopted to define the Zol as an ellipsoid of 2000 m by 750 m centred on the spoil dump site.

Figures 1 and 2 present the estimated Zol generated by the disposal works alone (green line boundary) in both bays, based on use of the above models and the input assumptions presented in Table 1. Although waves generated by 25 knots are small, these would be sufficient to keep the sediments in suspension in shallow water, therefore the Zol boundary has been extended towards the closest nearshore points in both bays.

2.4 Spoil site dimension

STFATE indicated that a single hopper discharge of 400 m² in 15 m water depth would create a “collapsed” conical mound of peak height 0.3 m, 50 m wide. Outside of this area, siltation would be in the order of 10 mm at the most. Considering that many releases will be required to carry on the dredging at each site and that the SHB is likely to be approximately 30 m long, it is therefore prudent to provide a 50 m radius for the works to contain the spoil in a relative confined area.

Bed levelling following the works is proposed to be such that the residual height of the spoil does not exceed 0.5 m. The spoil ground size for Careening Bay has therefore been increased to a 100 m radius to allow for spillages. Thus a 100 m radius for the declared spoil site, with the contractor confined to a 50 m radius would provide a buffer of approximately 1 barge length. The Sulphur Bay spoil ground has been designed to fit between the 15 m depth contour and the Naval Waters boundary and hence an elongate rectangular form has been adopted. The dimensions of the maximum spoil ground boundary (declared spoil ground size) are 300 m x 110 m.

A pipeline discharge would need to be moved to achieve these tolerances, particularly to reduce the bed levelling effort. On the other hand, an SHB may be positioned accurately on a “grid” and surveyed/monitored as the work progresses to achieve these objectives with minimal bed levelling.

The yellow line boundary on Figures 1 and 2 present the boundary of the spoil ground to which the dredging contractor will be confined. The blue line boundary presents the anticipated boundary location of the possible edge of the spoil ground allowing for spillages.

2.5 Spoil Ground Stability

A common concern associated with spoil disposal is that the spoil ground does not become a recurring source of local water turbidity as a result of sediment resuspension via ambient wave action and current shear. As indicated in the preceding section, the height of the spoil ground will be restricted to > 0.5 m above seafloor and levelled off to ensure that it does not extend above -15 m depth.

Additionally, a review of ‘The Geomorphology and Sediments of Cockburn Sound’ (Skene et al. 2005) indicates that:

- Cockburn Sound is a large elongate low-energy coastal waterway protected from moderate oceanic swell by the Pleistocene limestone Garden Island Ridge to the west and carbonate sand banks to the south (Southern Flats) and north (Parmelia Bank). The Garden Island causeway provides further protection to Careening Bay from oceanic swell.
- Wind waves and tidal currents are therefore the only source of potential bed shear stress.
- The wind regime for the area varies seasonally with moderate to strong morning offshore (easterly) and afternoon onshore winds from the SW during summer; and more variable and lighter winds during winter with the occasional storm from the NW. Storms can also occur during Autumn and Spring but these seasons also experience periods of light winds.
- Wind waves in the Sound consist primarily of low amplitude “wind chop” in the order of 1 m maximum wave height.

- Tides are micro-tidal, diurnal with a maximum spring tide range in the order of 1 m.
- Cockburn Sound is considered to be a sediment trap and that below 15 m, the seabed sediments, composed of sandy muds, are not mobile and generally accumulate coastal erosive soils.
- The sediments which currently occur on the seabed at the proposed spoil disposal locations are of similar grain size to those that will be dredged and disposed at that location.

Both proposed spoil grounds are well protected from winds and wind waves emanating from the NW to SW quadrant.

However, both sites are exposed to rare multi-directional storm winds, where waves could be generated from the North to East quadrant which have sensibly equivalent fetch of 15 km at both sites.

The Soulsby diagram (Soulsby 1997) indicates that a sand grain of median size of 0.2 mm would be mobilised if the seabed shear stress increases above 0.15 N.m^2 on the seabed. This bed shear stress is therefore likely to initiate the mobilisation of some of the spoil material. To generate such shear stress by a wave event in -15 m depth, a 1.8 m significant wave height is necessary according to wave bed shear stress formula (Shore Protection Manual 1984).

Such large wave conditions would only occur coincidentally with a storm of 50 year Average Return Interval (ARI) wind, according to the Australian Standards (AS/NZS 1170.2:2011), where the sustained wind speeds across the fetch would reach approximately 60 knots.

Under ambient wave conditions and lesser storms, the seabed sediments are not re-mobilised. This finding correlates well with observations suggesting that the Cockburn Sound seabed, located below -15 m is very stable.

Therefore, an approximately 50 year ARI wind-wave action is the limiting wave conditions for seabed spoil resuspension. Only beyond such extreme winds is there a risk of seabed movement, and even if grain motion is initiated on the seabed, the actual displacement of sand is likely to consist mostly of seabed forms such as small sand ripples considering that the seabed is nearly flat at such depth and wave bed shear stresses are oscillatory on a flat seabed. Also, because storm duration is usually brief, the seafloor is typically very stable and therefore spoil resuspension is considered most unlikely.

2.6 Limitations

This preliminary assessment relies on an empirical model to estimate turbulent mixing and assumed current velocities which have been used as depth-averaged and time-averaged approximations for a 25 knot wind. The assessment also does not include for the effect of the bathymetry, seabed slope and the shoreline or tidal fluctuations. Such a quasi-static approach is inherently limited in accuracy.

Therefore significant variation may occur in the field and parameters have therefore been assessed in a conservative manner, with a view to provide a “worst case” assessment of the ZOI and spoil ground stability. Such an empirical approach is considered adequate given the low risk that the proposed works present to the marine environment of Cockburn Sound.

It is acknowledged that a 3D hydrodynamic numerical model, couple with a particle tracking model (such as Delft3D or other) would be better suited to estimate sediment concentrations generated by this dredging project, but would require more accurate description of the dredging configuration and time of year which is currently not available.

3 References

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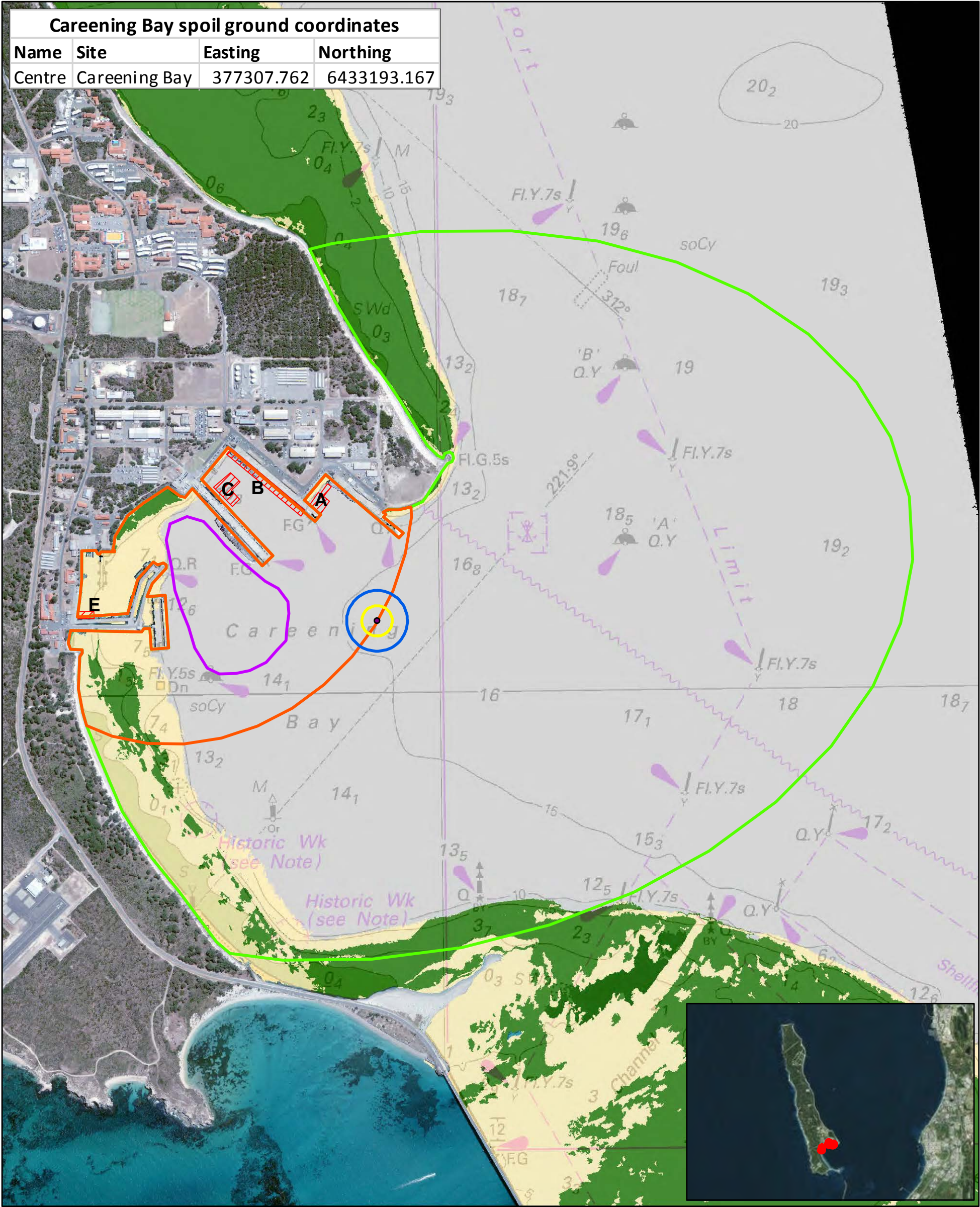
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Table 1 – Calculation Parameters

	Careening Bay	Sulphur Bay	Note
Approximate dredged volume, m ³	4,000	4,000	Estimate
Tidal range, m	1.2	1.2	
Median tidal current, m/s	0.025	0.05	ADCP, 2015
1% exceedance current velocity, m/s	0.10	0.23	ADCP, 2015
Dredge disposal limiting conditions			
Wind speed, gust, m/s	12.5	12.5	ADCP, 2015
Longshore surface current (wind-driven), m/s	0.18	0.31	
Dredge disposal site water depth, m	15	15	
Spoil site design storm conditions (50 year ARI wind)			
Fetch, km	15	15	N-NW
Wind speed, m/s	31.2	31.2	AS 1170.2
Wave significant height, m	1.8	1.8	Hasselman
Wave peak period, s	5	5	Hasselman
Soil Particle Size Distribution	% Passing	% Passing	Median PSD from 2015 samples
Gravel 2-60mm	1.5%	9.6%	
Sand 0.06-2mm	89.8%	66.8%	
Silt 2-60 µm	3.1%	10.2%	
Clay < 2µm	5.6%	13.4%	
D50mm	0.17	0.17	



Legend

- Careening Bay spoil ground coordinates

Contractor confined spoil ground

Declared spoil ground size

Zol - dredging

Zol - disposal

Proposed Dredge Areas

Little Penguin Rafting Area

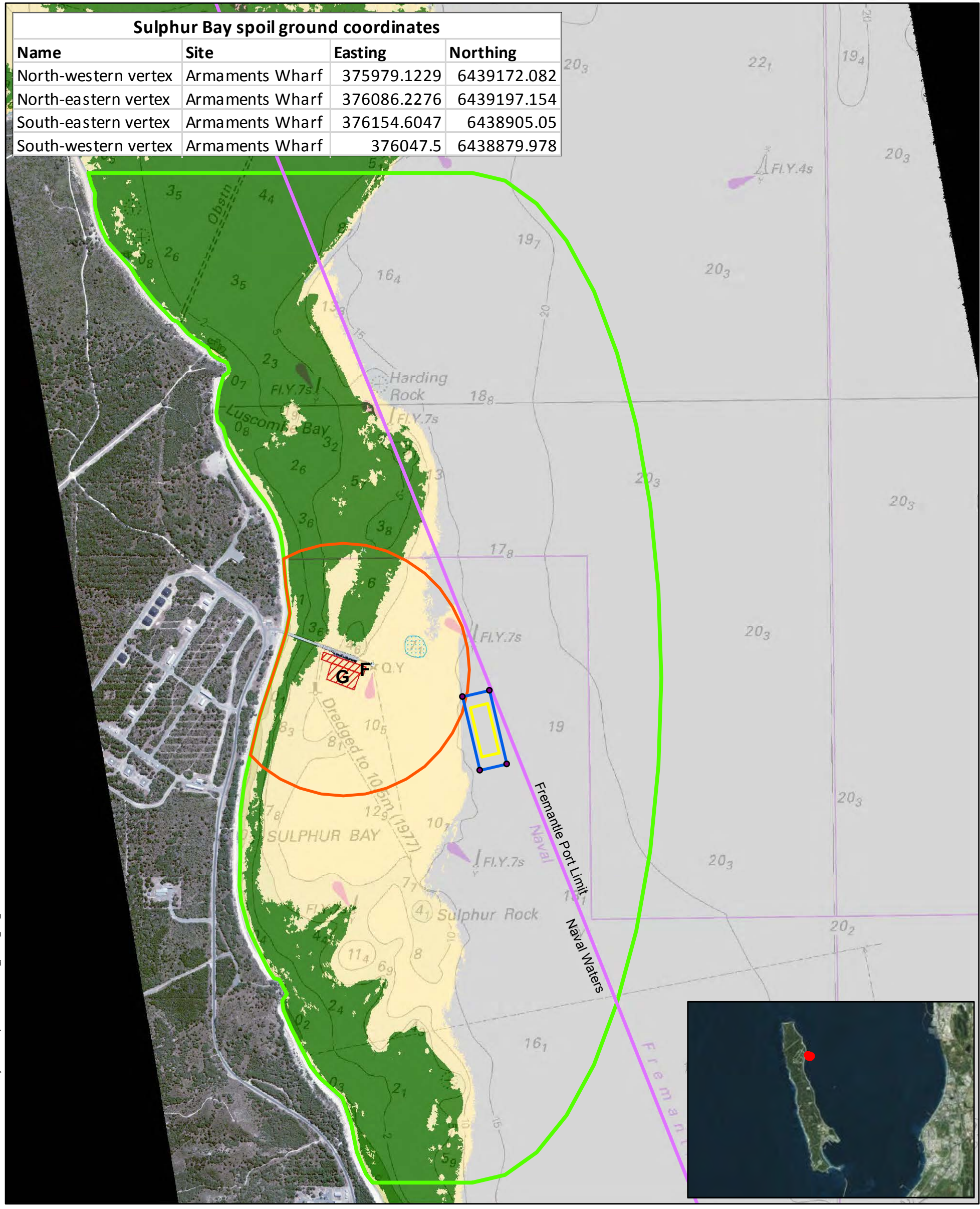
BPPH Classes

Seagrass communities

Sand (<10m)

Fine Sediment (>10m)

Coral Bommie
- Notes:
-
- A3 scale: 1:12,500
0 265 530 Metres
- Date: 6/04/2016 Version: 1 Job No:
Coordinate System: GDA 1994 MGA Zone 50
- Department of Defence
H.M.A.S Stirling Maintenance Dredging
Figure 1: Careening Bay maintenance dredging locations, offshore disposal sites and zones of influence

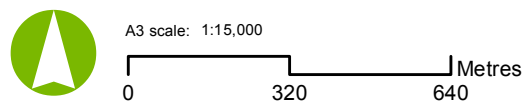


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Legend

- Sulphur Bay spoil ground coordinates
- Contractor confined spoil ground
- Declared spoil ground size
- Fremantle Port Limit
- ZoI - dredging
- ZoI - disposal
- Proposed Dredge Areas
- Existing Spoil Ground
- BPPH Classes**
 - Seagrass communities
 - Sand (<10m)
 - Fine Sediment (>10m)

Notes:



Date: 6/04/2016 Version: 1 Job No:
Coordinate System: GDA 1994 MGA Zone 50

Department of Defence
H.M.A.S Stirling Maintenance Dredging
Figure 2: Armaments Wharf maintenance dredging locations, offshore disposal sites and zones of influence



Appendix C

Environmental Management and Monitoring Programme

1 Environmental Management & Monitoring Plan

A Heritage Management Plan (HMP) was prepared for Garden Island in 2013 (GML 2013). The HMP sits under the Defence Heritage Strategy and is the key document used by the Department of Defence to determine and implement controls for specific uses of HMAS Stirling and Garden Island. The HMP identifies Natural Heritage Values on the island and provides recommendations for their management and conservation, while guiding ongoing Defence operations.

Under Commonwealth environmental legislation and the Defence Environment Policy, responsibility for appropriately managing the heritage and environmental values of Garden Island rests with all Defence personnel, contractors and other site users. An Environment Review (ER) document (based on the contents of the Section 38 Referral Support Document (RSD) (Aurecon 2015) assessed the proposal for compliance with the EPBC Act 1999. The ER has been reviewed by the Department of Defence (DoD) Directorate of Environmental Protection and Assessment (DoD DEPA), who have subsequently set the approval conditions for the proposal specified in Appendix G of the RSD. These conditions stipulate a number of *Environmental Protection Measures* which must be implemented by the Project Office when this proposal is undertaken. The conditions have been incorporated into this Environmental Management and Monitoring Plan (EMMP) below, which also presents all proposed management and monitoring commitments. Additional monitoring detail is provided in the Dredging Monitoring Plan (DMP) which identifies the potential Zone of Influence of turbid waters arising from the project and the type and location of monitoring activity proposed before, during and after the project. The purpose of the DMP is to collect data that will confirm the reliability of the assessment presented in the RSD and provide regulators and the general public with confidence that the works have not negatively impacted the marine environment of Cockburn Sound.

The **Environmental Protection Measures** proposed for this project include:

A General

- Prepare and implement a **Project Management Plan** that includes induction, monitoring and reporting responsibilities.
- **Prepare an Oil Spill Contingency Plan** – for dealing with refuelling or hydraulic fluid spills in the unlikely event that they occur.

B Benthic Communities and Habitat

- **Use identified spoil ground locations** – which have been selected for their depth (>15 m) and distance from nearest seagrass beds (>250 m).
- **Maintain a daily record of turbid plume dispersal direction and extent** – to confirm which habitats are exposed to water turbidity from works and determine if CSMC seagrass and water quality monitoring sites in the vicinity of the works have been influenced by turbid plumes.
- **Opportunistic aerial photography of plumes during works to confirm that the Zone of Influence affected by turbid plumes is as predicted.**
- **Pre and post dredging monitoring of condition of nearest seagrass meadows** – to confirm that no loss of habitat or significant change of seagrass cover has occurred due to dredging.

C Marine Environmental Quality

- **Burial of sediments containing below Guideline trigger tributyltin (TBT) concentrations** from Area A and B by **clean sediments from Area C and E in Careening Bay.**

- **Disposal of spoil material direct to seafloor** via downpipe linked to floating pipeline (in the event that a Cutter Suction Dredge (CSD) is used) to minimise the vertical distribution of the plume in the water column.
- **Collect water samples** immediately downstream of the spoil discharge at the onset of works in each bay to confirm criteria detailed in the Environmental Quality Criteria Reference Document for Cockburn Sound (EQCRD) (EPA 2015) are not being exceeded.
- **Collect sediment samples** from Careening and Sulphur Bay spoil disposal sites prior to spoil disposal. Post dredging, surface sediment samples to be gathered from both spoil grounds.

D Marine Fauna

- **Maintenance of a marine fauna watch** – to observe marine fauna abundance and behaviour in the vicinity of the dredging works and **temporarily cease works in the unlikely event that protected marine fauna** swim into harm's way. Works will also temporarily cease in the event that **dead fish** are observed on the water surface in the vicinity of the dredging and spoil disposal activities and the Department of Fisheries will be immediately notified.
- **Restriction of timing of works to May – August period** – to avoid disturbance of the Careening Bay Little Penguin colony during the nesting and chick rearing period, and to avoid affecting the success of the peak snapper and crab spawning event in the northern parts of Cockburn Sound.
- **Maintenance of daylight working hours and avoidance of evening “rafting area” near Diamantina Wharf in Careening Bay** – to avoid interfering with the daily penguin migration to and from feeding grounds in Cockburn Sound.
- **Maintenance of night time working hours in Sulphur Bay if dredging necessary between April – August** – to avoid interruption of penguins from both Penguin and Garden islands foraging in the vicinity of Sulphur Bay during daylight hours.

E Invasive Marine Species

- **Preparation of an Invasive Marine Species Risk Assessment** – for the dredging equipment that is ultimately awarded the contract to undertake the works. Certification will be required from the successful contractor that all vessels from outside WA associated with the dredging activities have been risk assessed using Department of Fisheries Vessel Check and have completed recommended actions to manage vessels to a Low risk rating. A system for ensuring these vessels remain at a low risk after arrival in WA waters must also be developed (for example follow-up vessel inspections for marine pests for vessels staying longer than a few days).
- Any associated equipment coming from outside WA should also be either new, or thoroughly cleaned, then dried for at least 24 hours. In general equipment should be inspected for marine pests before use in WA waters, but advice on the need for this can be sought from the Department of Fisheries.
- **Floating pipeline** – if a floating pipeline is used it must be clean of fouling (either a new pipeline or pipeline that has been out of the water in a yard for at least two months) to ensure it is free of Invasive Marine Species.
- **Decontamination of dredge vessel at end of dredging program** – the dredge vessel must undergo decontamination process at the end of the proposed works to ensure Invasive Marine Species in the area are not transported elsewhere.
- The Department of Fisheries requests that the presence of any suspected marine pest or disease be reported within 24 hours by telephone (FishWatch tel. 1800 815 507) or email (biosecurity@fish.wa.gov.au). This includes any organism listed in the Western Australian Prevention List for Introduced Marine Pests (http://www.fish.wa.gov.au/Documents/biosecurity/epa_introduced_marine_pests.pdf), and any other non-endemic organism that demonstrates invasive characteristics.

Clauses in the dredge contract will include as many of the above management requirements as appropriate.

F DREDGING MONITORING PLAN

The **purpose of this plan** is to provide detail of what will be monitored, where and when, and how data collected will be used and reported. In reviewing this DMP it needs to be understood that:

- The volume of material to be dredged is very small (~2000 m³ in Careening Bay and ~ 5500 m³ in Sulphur Bay).
- The duration of dredging works anticipated is very short (2-3 days in Careening Bay and 6-7 days at Sulphur Bay).
- The time of year that dredging will occur (May – August) has been selected to avoid interfering with penguin breeding, and snapper and crab spawning seasons. It is also the time of year when seagrasses are most resilient to reduced light availability.
- Most of the material to be dredged is uncontaminated clean sediment. Only a very small volume of sediment (~1300 m³) containing elevated concentrations of TBT will be relocated to the spoil disposal site in Careening Bay. This TBT most likely occurs as paint flakes and is not bioavailable (RSD Appendix A). Once these disposal works are completed, the concentrations of TBT in the surface sediments of the Careening Bay Wharf will be reduced.
- All works will take place within Naval Waters to which public access for recreational fishing is restricted.
- No permanent or temporary adverse impacts are anticipated to protected marine fauna populations, recreational fish and crab populations, farmed mussel operations or seagrass beds in Cockburn Sound.

Given the above, the **objective of the DMP** is to collect data that will confirm:

- The reliability of the assessment presented in the RSD,
- Provide regulators and the general public with confidence that the works have not harmed the marine environment of Cockburn Sound (as predicted in the RSD), and
- That the Environmental Protection Measures implemented have indeed been successful.

It is recognised that Environmental Assessment Guideline (EAG7) for Marine Dredging Proposals (EPA 2011) suggests that Dredging EMMP's should be designed to provide early warning of potential impacts to trigger pre-emptive management aimed at ensuring required environmental protection outcomes. However given the very short duration of the proposed maintenance dredging works; the time taken to have samples collected and analysed; plus the variety of locations under consideration and the very low risk of adverse impact occurring in their vicinity, it is difficult to implement such an approach and in reality it is not warranted given the small scale of the project. Hence the focus in this monitoring plan on confirming the reliability of the assessment.

The DMP presents information on:

- The Anticipated boundary of the Zone of Influence
- Proposed Pre-dredging baseline monitoring program
- Proposed Monitoring during Dredging
- Proposed Post dredging monitoring
- Proposed reporting arrangements

F1 Anticipated Zone of Influence

EAG7 puts forward a spatially-based Impact Zonation Scheme which includes:

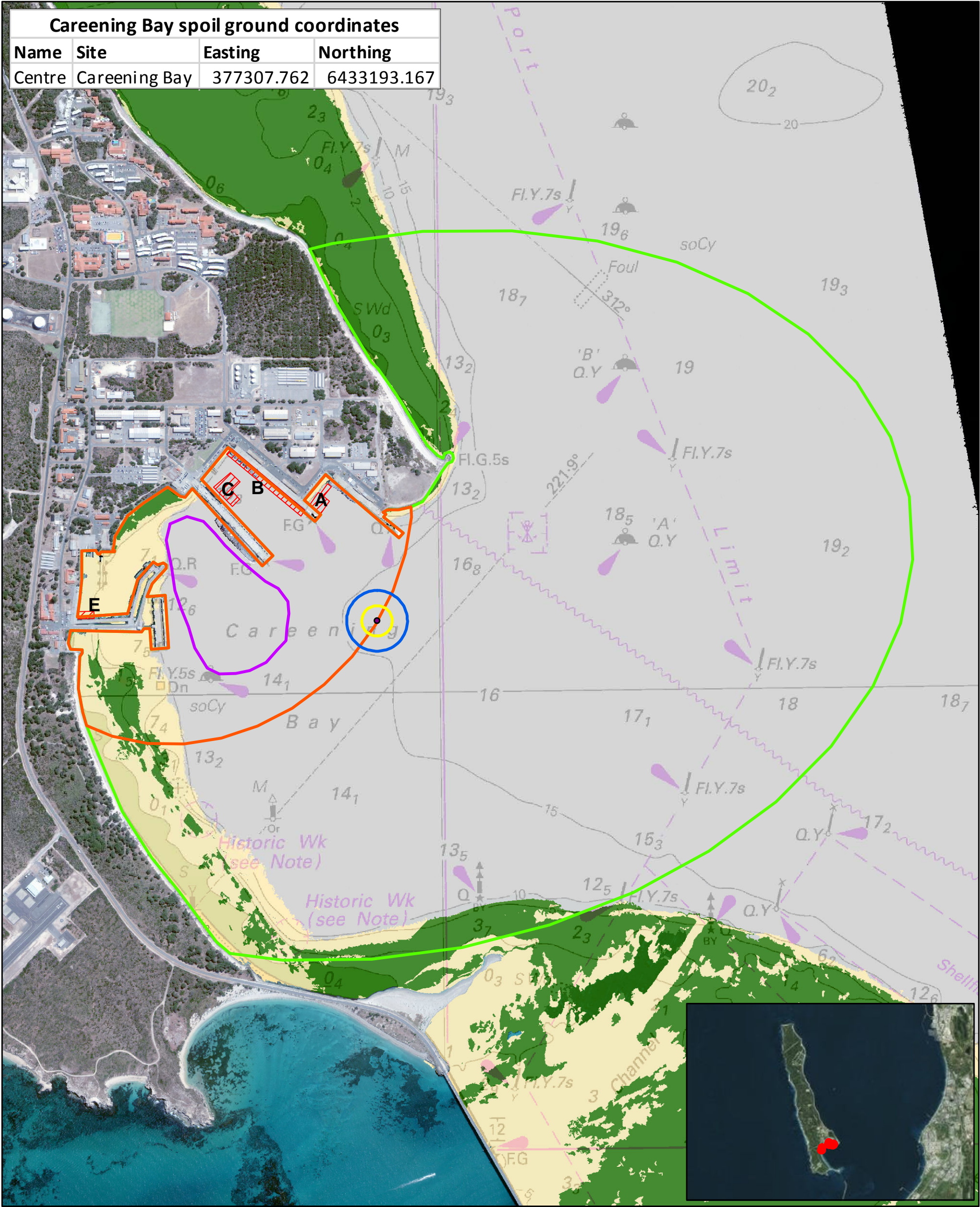
- A Zone of High Impact (ZoHI) which is the area immediately adjacent to the works and where some permanent adverse impact or loss of habitat is expected;
- A Zone of Moderate Impact (ZoMI) which is the area immediately outside the ZoHI in which predicted impacts on benthic communities are sub-lethal and affected communities are likely to recover within five years of cessation of dredging; and
- A Zone of Influence (Zol), a larger area around the dredging and disposal works where turbidity plumes are predicted to potentially occur but where no detectable impact on benthic biota is anticipated.

As previously indicated in Section 4.1 of the RSD (Aurecon 2015), no ZoHI or ZoMI is predicted as a result of the proposed works. However there will be a short term Zol.

Also indicated in Section 4.1 of the RSD, mathematical modelling was undertaken for the previous dredging impact assessment in 2003 (DALSE 2003a) to examine the potential extent of the turbid plume and the footprint of sedimentation in the vicinity of the Armaments Wharf. It should be noted that that dredging campaign involved a much larger and more powerful dredge than is proposed for this project, and also required the cutting of some 3,300 m³ of limestone rock which results in the release of larger quantities of finer material than is likely to occur during the proposed works.

The actual plume extent was found to be highly dependent on the prevailing wind conditions and during south-easterly winds, the plume was predicted to flow parallel to the shore in nearshore waters and extend to the northern tip of Garden Island. However, it should be noted that the suspended solid load would soon reach background levels within Cockburn Sound of approximately 3 mg/L. Plumes were predicted to sink from the water column within 12 to 18 hours after the cessation of discharge. Thus, any location on the seabed was not expected to experience continuously elevated turbidity levels and turbidity would dissipate within hours of cessation of the operation. These predictions were subsequently confirmed when the model was validated by turbidity and sedimentation monitoring data collected during the actual dredging works campaign (APASA 2003).

The above reports have been reviewed and worst case estimates of the potential plume excursion distance from both dredging and spoil disposal activities have been made using standard engineering calculations based on use of strong wind strengths (25 knots), disposal of spoil material at the water surface via SHB and the particle size distributions known to occur at the dredging sites (refer Attachment A). **Figure 1** and **Figure 2** present the location of the dredging and spoil disposal areas and anticipated Zones of Influence of turbid plumes emanating from both dredging and spoil disposal activities in Careening Bay and Sulphur Bay respectively. It should be noted that the Zol represents the boundary within which a turbid plume may be visible during the proposed works, not the actual scale of the plume. Based on observations during the previous dredging program at the Armaments Wharf, the actual size of the visible plume is anticipated to be much smaller and localised to the close vicinity of the works (<1 km).



Legend

- Careening Bay spoil ground coordinates

Contractor confined spoil ground

Declared spoil ground size

Zol - dredging

Zol - disposal

Proposed Dredge Areas

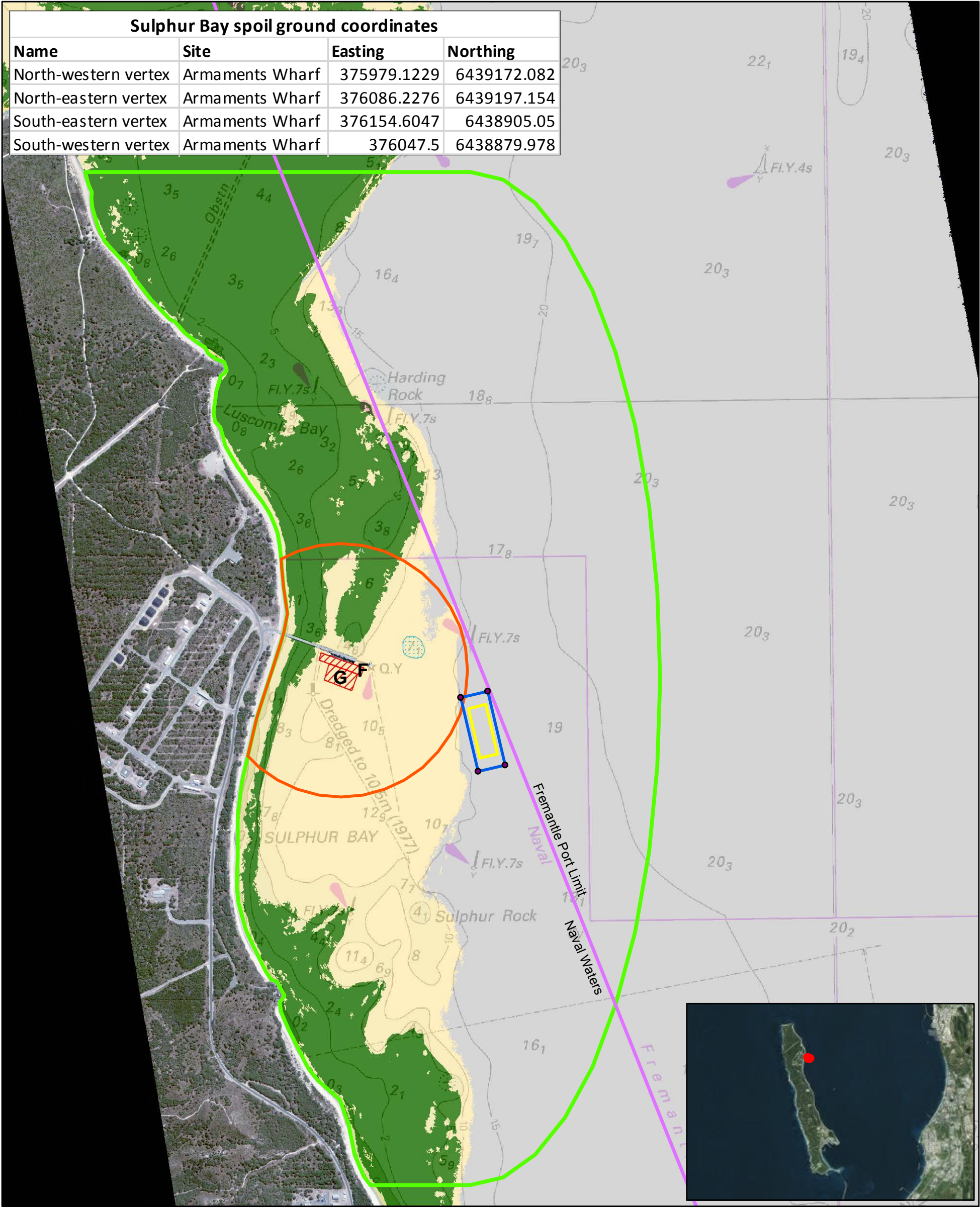
Little Penguin Rafting Area

Seagrass communities

Sand (<10m)

Fine Sediment (>10m)

Coral Bommie
- Notes:
-
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- Date: 6/04/2016 Version: 1 Job No:
Coordinate System: GDA 1994 MGA Zone 50
- Department of Defence
H.M.A.S Stirling Maintenance Dredging
Figure 1: Careening Bay maintenance dredging locations, offshore disposal sites and zones of influence



Legend

- Sulphur Bay spoil ground coordinates
 - Contractor confined spoil ground
 - Declared spoil ground size
 - Fremantle Port Limit
- Zol - dredging
 - Zol - disposal
 - Proposed Dredge Areas
 - Existing Spoil Ground
- BPPH Classes**

 - Seagrass communities
 - Sand (<10m)
 - Fine Sediment (>10m)

Notes:



A3 scale: 1:15,000
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Date: 6/04/2016 Version: 1 Job No:
Coordinate System: GDA 1994 MGA Zone 50

Department of Defence
H.M.A.S Stirling Maintenance Dredging
Figure 2: Armaments Wharf maintenance dredging locations,
offshore disposal sites and zones of influence



F2 Pre-dredging baseline monitoring

Prior to the onset of the proposed works it is proposed to establish the baseline condition of:

- Seagrasses in the vicinity of works in both Sulphur Bay and Careening Bay,
- TBT in surface sediments at the proposed spoil grounds,
- Water quality in the immediate vicinity of both dredging and spoil disposal areas in both Sulphur Bay and Careening Bay, and
- TBT in mussel flesh and water at the NW boundary of the Blue Lagoon mussel farm and within the Zone of Influence.

F3 Monitoring during Dredging

During the short dredging campaign it is proposed to undertake monitoring of:

- Water quality in the immediate vicinity of both dredging and spoil disposal areas in both Sulphur Bay and Careening Bay,
- TBT in water at the NW boundary of the Blue Lagoon mussel farm and TBT in mussel flesh and water within the Zone of Influence,
- The direction and extent of dispersal of the turbid plume during daylight hours, and
- Observation of protected and recreational marine fauna in the vicinity of the works.

F4 Post dredging monitoring

Within one month of the maintenance dredging campaign being completed it is proposed to repeat the pre-dredging sampling program; i.e. undertake monitoring of:

- Seagrasses in the vicinity of works in both Sulphur Bay and Careening Bay,
- TBT in surface sediments at the proposed spoil grounds,
- Water quality in the immediate vicinity of both dredging and spoil disposal areas in both Sulphur Bay and Careening Bay, and
- TBT in mussel flesh and water at the NW boundary of the Blue Lagoon mussel farm and within the Zone of Influence.

F5 Reporting

A Project Close Out report will be prepared and anticipated to be submitted to both State and DoD regulators within three months of completion of the proposed works, with the date dependant on receipt of laboratory results. The report will present all data collected by the DMP monitoring program along with an assessment of the reliability of the predictions presented in the RSD.

F6 Monitoring details

Further detail on the locations, methods and parameters to be sampled in the DMP is provided below according to the environmental factor being monitored.

F.6.1 Water quality

Water quality monitoring will take place on a single occasion before, during and immediately after dredging at four sites; Careening Bay dredge area, Careening Bay spoil disposal site (**Figure 1**); Sulphur Bay dredge area and the Sulphur Bay spoil disposal site (**Figure 2**). The sampling during dredging will take place within the turbid plume immediately downstream from the dredging and disposal area within 12 hrs of works at that area commencing.

The parameters measured will include (*sensu* CSMC 2015):

- Dissolved oxygen concentration, temperature, salinity, pH, Secchi depth
- Chlorophyll a, total suspended solids, Total Nitrogen, nitrate, ammonium, Total Phosphorus, Filterable Reactive Phosphorus (FRP) and Dissolved Organic Carbon.

Three samples will be collected at each site and the data combined to form an average.

F.6.2 Seagrasses

Seagrass monitoring will be carried out before dredging and within one month of it ceasing at the following sites:

Careening Bay (Figure 3)

- Five potential impact sites adjacent the works in Careening Bay (Transects 1-5),
- One CSMC monitoring site north of Colpoy's Point (Garden Island Settlement), and
- One CSMC monitoring site south of Careening Bay (Southern Flats).

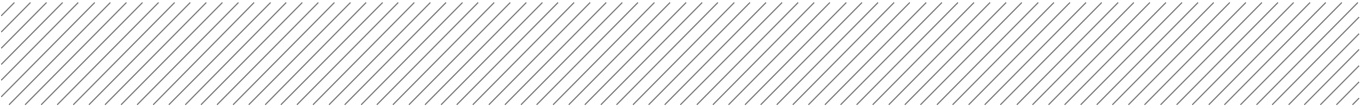
Sulphur Bay (Figure 4)

- Three potential 'impact' sites immediately adjacent to the proposed works (Transects 9-11),
- Two reference sites near the north end of the island (CSMC Garden Island North Shallow and deep),
- One CSMC seagrass monitoring site to the north of the wharf (Luscombe Bay),
- Two potential impact sites to the south of the Wharf (Transects 7,8),
- One reference site to south of the Wharf and outside Zol (Transect 6), and
- One CSMC seagrass monitoring site to the south of the wharf (Garden Island South).

Seagrasses will be monitored in the vicinity of the transects shown on Figures 3 and 4 using video camera equipment. Collaboration and discussion of sampling design will be undertaken with the WA Department of Parks and Wildlife (DPaW) Marine Group who undertake regular seagrass monitoring for the Cockburn Sound Management Council (CSMC). Finalisation of the video analysis method is to be confirmed and finalised.

F.6.3 Sediment

Pre-dredge (baseline) sediment sampling has already taken place at the wharf locations in Careening and Sulphur Bay (i.e. three samples each from Areas A, B, C, F and G) but not at the spoil grounds (RSD Appendix A). Three samples will be collected at each spoil ground at both Careening and Sulphur Bays (**Figure 3** and **Figure 4** respectively) to determine a baseline condition before dredging. Sampling will not be undertaken during dredging due to access and safety considerations, the short duration of the dredging (less than five days) and the identified low risk of the activity (i.e. there are very few contaminants in the sediments (RSD Appendix A). Post dredge sediment sampling will take place at



both spoil grounds (**Figures 3 and 4**). Parameters measured will include: TOC, Antimony, Arsenic, Cadmium, Chromium, Lead, Mercury, Nickel, Silver, TPH and TRH, TBT, moisture and PSD.

F.6.4 TBT monitoring in Mussels

As identified in Section 2.2 of the Referral Support Document the only sedimentary contaminant of concern that has any potential for mobilisation during dredging and/or spoil disposal is TBT at Careening Bay (RSD Appendix A). However it should be noted that the TBT is not bioavailable and that there are no TBT screening criteria for maintenance of seafood safe for human consumption provided in the Environmental Quality Criteria Reference Document for Cockburn Sound (EQCRD) (EPA 2015 Table 4). There is however a screening criterion for TBT provided in EPA 2015 (Table 5) (EQG = 0.004 ug/L Sn) for protection of aquaculture which applies at the boundary of the aquaculture lease.

Therefore, pre-dredge (baseline/reference) monitoring of TBT in mussel flesh will be undertaken at two sites within the existing mussel farm lease closest to Careening Bay (i.e. the north-western border of the lease, **Figure 3**) and also at two sites within the Zone of Influence. Sampling of TBT in mussel flesh will also be undertaken at two sites within the Zone of Influence during dredging operations.

However given that there is a screening criterion for TBT provided in EPA 2015 (Table 5) (EQG = 0.004 ug/L for Sn) for protection of aquaculture which applies at the boundary of the aquaculture lease it is proposed to undertake water quality sampling at the NW boundary of the farm lease and also within the Zone of Influence within 24 hrs of works commencement, once during dredging operations and again within 24 hours after completion of works to confirm that the above criterion has not been exceeded.

Post dredge monitoring of TBT concentrations in mussel flesh will take place at the two potential impact sites at the NW boundary of the farm lease, two impact sites within the Zone of Influence and at a reference site located on the southern extremity of the farm lease boundary (**Figure 3**).

Stakeholder Consultation

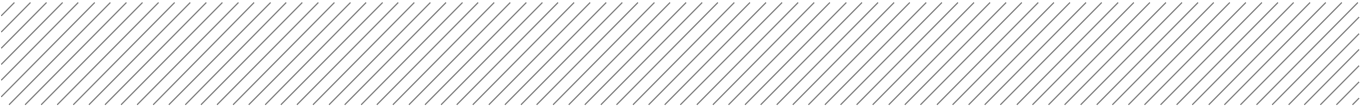
Blue Lagoon Mussels (Glenn Dibben) were consulted in July 2015 as part of the original stakeholder engagement process. At this time Glenn raised no issues with the proposed works.

Glenn was again contacted on 3 March 2016 in response to advice received by the OEPA from the DoF since the mass fish kill event which occurred in Cockburn Sound in late 2015. This advice requested additional information on the perceived risk posed by potential dispersion of TBT by sediment plumes generated during dredging works to the Blue Lagoon Mussel farm. In response to this correspondence the monitoring of TBT detailed above was devised. Glenn has been further advised on 25 May 2016 of the additional monitoring of TBT in mussels and water on the boundary of his farm and within the Zone of Influence. Glen assisted in determining appropriate mussel monitoring sites and will also be providing the mussels used for monitoring.

F.6.5 Plume monitoring

In order to determine the direction and furthest extent of dispersal of the turbid plume generated by the proposed works during daylight hours, visual observations and turbidity measurements (both Secchi disc and metered NTU) will be made from a vessel along with opportunistic photographs and GPS fixes will be obtained from the air via helicopter or fixed wing aircraft. It is anticipated that a naval work boat will be on standby throughout the works to ensure that recreational vessels do not enter Naval Waters in the vicinity of the works. An environmental scientist will be located on a separate vessel which will be able to track the plume under prevailing wind and tide conditions, and obtain appropriate data to confirm its dispersal pattern and Zone of Influence.

This strategy, based upon the short duration of the works, the various locations being dredged and the influence of wind strength and direction on plume dispersal, and the predicted ZoI extent, is deemed to be the most appropriate for this dredging campaign. Note that works at Sulphur Bay, if undertaken during



the April to August period, will be carried out at night and it is not proposed to monitor the plume during night works due to safety considerations.

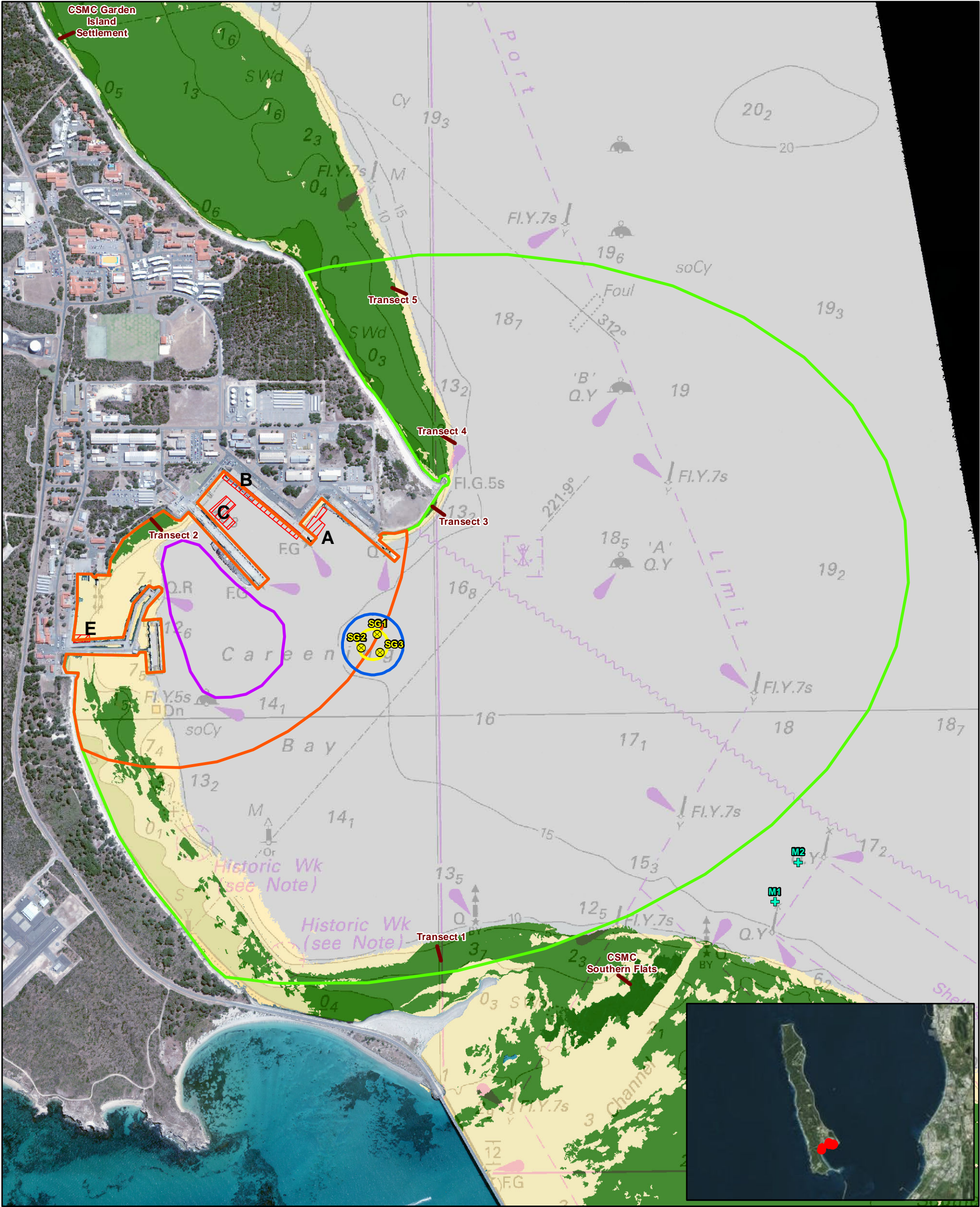
F.6.6 Fauna watch

A *Marine Fauna Observer* (MFO) will be stationed on the dredge during daylight operating hours to monitor marine protected fauna and dead snapper floating on the water surface. The purpose of the MFO will be to record abundance, distribution and behaviour of protected marine fauna in the vicinity of the works and to decide if dredging needs to temporarily cease in the event that either protected species swim into harm's way. The following protocol will be carried out by the MFO:

1. Should protected species (cetaceans, pinnipeds or Little Penguins) swim within 50 m of the operating dredgehead, operations will cease temporarily until the animal has been observed to move out of that exclusion zone and has not been seen within that zone for 15 minutes, at which time operations will recommence.
2. Should dead or injured protected species be observed within 100m of the dredging works, DPaW will be immediately notified and operations will cease temporarily pending advice from DPaW.

In the event that dead or dying fish are observed in the water within the Zone of Influence, the following protocol will be followed by the MFO:

1. In the event that dead or dying fish are observed in the water within the Zone of Influence of the dredging and disposal works, the Department of Defence must immediately report the sighting to the Department of Fisheries (Fishwatch 1800 815 507).
2. The Department of Fisheries (fish health unit) will investigate the sighting and advise the Director General (or approved delegate) of the Department of Fisheries.
3. The Director General (or approved delegate) will form a view, on balance, as to whether the dredging and/or disposal works may be directly or indirectly impacting fish or their environment, and will notify the Department of Defence.
4. The Director General (or approved delegate) may direct the Department of Defence to suspend the dredging and disposal works pending further investigation. If this investigation reasonably concludes that the dredging campaign poses an acceptable level of risk to fish and their environment, the Director General (or approved delegate) will advise the Department of Defence that it may recommence dredging and/or disposal.
5. If dead or dying fish are observed within the vicinity of the dredging and disposal works, but outside the predicted Zone of Influence, the Department of Fisheries will notify the Department of Defence.



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Legend

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| Mussel sampling sites | Zol - dredging | BPPH Classes
Seagrass communities
Sand (<10m)
Fine Sediment (>10m)
Coral Bommie |
| Sediment sampling sites | Zol - disposal | |
| Seagrass transects (50m) | Proposed Dredge Areas | |
| Contractor confined spoil ground | Little Penguin Rafting Area | |
| Declared spoil ground size | | |

Notes:

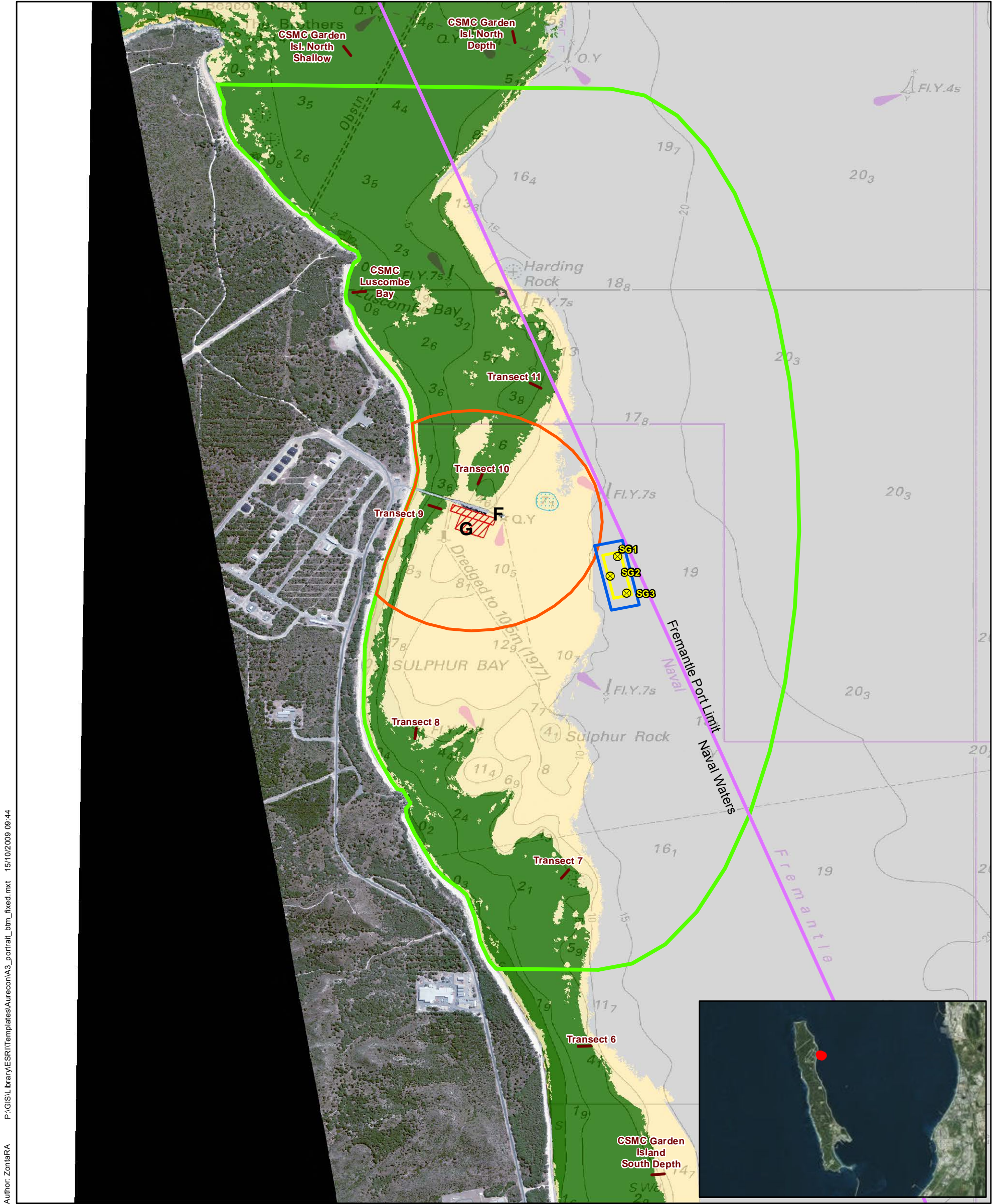


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Figure 3: Potential Zones of Influence from turbid plumes arising from dredging and spoil disposal activities in Careening Bay and locations of proposed seagrass, sediment and mussel sampling sites



Legend

- | | | |
|----------------------------------|-----------------------|--|
| Sediment sampling sites | ZOI - dredging | BPPH Classes
Seagrass communities
Sand (<10m)
Fine Sediment (>10m) |
| Seagrass transects | ZOI - disposal | |
| Contractor confined spoil ground | Proposed Dredge Areas | |
| Declared spoil ground size | Existing Spoil Ground | |
| Fremantle Port Limit | | |

Notes:



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Date: 22/04/2016

Version: 1

Job No:

Coordinate System: GCS GDA 1994

Department of Defence
H.M.A.S Stirling Maintenance Dredging

Figure 4: Potential Zones of Influence from turbid plumes arising from dredging and spoil disposal activities in Sulphur Bay and locations of proposed seagrass, and sediment sampling sites



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Attachment A – Aurecon HMAS Stirling plume and spoil site assessment memorandum - located in Appendix B



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