Independent peer review of AGL Gas Import Jetty Marine Environment Considerations

Technical Report A - Annexure L

AECOM Australia Pty Ltd

Independent Peer Review of AGL Gas Import Jetty Marine Environment Considerations

March 2020

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1. Introduction

1.1 Gas Import Jetty and pipeline Project

AGL Wholesale Gas Limited and APA Transmission Pty Limited propose to establish a gas import jetty and pipeline respectively, consisting of a:

- Floating storage and regasification unit (FSRU) at Crib Point Jetty (Gas Import Jetty Works)
- Gas pipeline between Crib Point and Pakenham to connect to the Victorian Transmission System east of Pakenham (Pipeline Works).

The Project will supply imported natural gas into the south-eastern Australian gas market for industrial, commercial and residential gas customers meeting a projected domestic gas shortfall and improving gas supply certainty. The imported natural gas will be imported as Liquefied Natural Gas (LNG) before being regasified on the FRSU.

1.2 Marine Environment Impact Assessment

A range of studies have been undertaken of the potential marine impacts of the proposed Gas Import Jetty which form part of the Environmental Effects Statement (EES) prepared for the Project.

1.3 Purpose of this report

The purpose of this report is to provide an independent peer review of the Marine Environment Impact Assessment and whether it adequately addresses the EES scoping requirements.

1.3.1 EES scoping requirements

The Scoping Requirements for the EES included the following draft evaluation objectives:

- To avoid, minimise or offset potential adverse effects on native flora and fauna and their habitats, especially listed threatened or migratory species and listed threatened communities.
- To minimise adverse effects on water (including groundwater, waterway, wetland, estuarine, intertidal and marine) quality and movement particularly as they might affect the ecological character of the Western Port Ramsar site.

Key issues:

- Direct loss of native vegetation and any associated listed threatened flora and fauna species and communities known or likely to occur in or adjacent to the project works.
- Direct loss of, or degradation to, habitat for flora and fauna species listed as threatened or migratory under the EPBC Act, FFG Act and/or DELWP advisory lists, including but not limited to the following species:
  - Southern Right Whale (*Eubalaena australis*)
  - Humpback Whale (*Megaptera novaeangliae*)
  - Southern Brown Bandicoot (*Isoodon obseulus obesulus*)
  - Loggerhead Turtle (*Caretta caretta*)
  - Green Turtle (*Chelonia mydas*)
  - Leatherback Turtle (*Dermochelys coriacea*)
  - Australian Grayling (*Prototroctes maraena*)

  - Australian Fairy Tern (*Sternula nereis nereis*)
  - (Far) Eastern Curlew (*Numenius madagascariensis*)
  - Curlew Sandpiper (*Calidris ferruginea*)
  - Sharp-tailed Sandpiper (*Calidris acuminata*)
  - Red Knot (*Calidris canutus*)
  - Great Knot (*Calidris tenuirostris*)
  - Greater Sand Plover (*Charadrius leschenaultia*)
  - Lesser Sand Plover (*Charadrius mongolus*)
  - Bar-tailed Godwit (*Limosa lapponica*)
  - Bar-tailed Godwit (Baueri) (*Limosa lapponica baueri*)
  - Northern Siberian Black-tailed Godwit (*Limosa limosa menzbieri*)
  - Red-necked Stint (*Calidris ruficollis*)
  - Double-banded Plover (*Charadrius bicinctus*)
  - Short-tailed Shearwater (*Ardenna tenuirostris*)
- Indirect loss of vegetation or habitat quality, that may support any listed species or other protected fauna, resulting from hydrological or hydrogeological change, edge effects, habitat fragmentation, loss of connectivity, or other disturbance impacts arising from construction or operation, including noise, vibration and lights.
- Potential for adverse effects on the ecological character and biodiversity values of the Western Port Ramsar site including, but not limited to, the species mentioned above and terrestrial and marine conservation reserves.
- Potential for indirect effects on biodiversity values including but not limited to those effects associated with changes in hydrology (including surface and groundwater changes), water quality (i.e. on water dependent ecosystems), contaminants and pollutants, environmental weeds, pathogens and pest animals including, but not limited to declared weeds, pathogens and pest animals under the C&LP Act.
- Potential for significant short and long-term impacts on marine biota due to entrainment of organisms in seawater for regasification or due to discharge of cooled seawater after use for regasification, including impacts resulting from reduced availability of food for other species, resultant hydrodynamic changes and other impacts such as long-term changes to populations and distribution.
- Potential for impacts resulting from increased shipping activity on cetaceans and other large marine animals, including acoustic impacts and potential collisions.
- Potential for significant impacts on the marine environment resulting from accidental or unintended leaks or spills arising from construction works or operational activities, including unintended introduction of exotic species (e.g. through ballast water).

Priorities for characterising the existing environment:

- Characterise the distribution and quality of native vegetation and terrestrial, aquatic, intertidal and marine habitat and any wildlife movement in the area that could be impacted by the project or associated works. This must include the quality and type of habitat impacted and quantification of the total impact area and areas indirectly impacted from the proposed action and must be informed as appropriate by targeted surveys undertaken in accordance with the appropriate Commonwealth or DELWP survey guidelines, as well as identify the existing or likely presence of any protected species, and especially species listed under the FFG Act and DELWP advisory lists, as well as environmental weeds, pathogens and pest animals.
- Characterise the listed threatened and migratory species, other protected species, ecological communities and potentially threatening processes that are likely to be present, in the Western Port Ramsar site or in other wetlands nearby. This characterisation is to be informed by the literature and suitable available data (especially, where relevant, data <5 years old) and supported by seasonal or targeted surveys where necessary. Details of the scope, timing and method for studies or surveys used to provide information on the ecological values at the site (and in other areas that may be impacted by the project) should be outlined. Records and other data from local sources should also be gathered and considered as appropriate.
- As appropriate, identify the different uses which significant species may make of different habitat areas that could be affected by the project at different times or life-cycle stages.
- Identify and characterise any groundwater dependant ecosystems that may be affected by the project works. This characterisation is to be informed by data, literature and appropriate surveys.
- Identify the marine or intertidal fauna and flora that could be affected directly or indirectly by the FSRU, including but not limited to entrainment through pumping system, susceptibility to changed water temperature or susceptibility to discharges containing chlorine or other pollutants.
- Identify exotic marine organisms that are already present or established near the project.
- Identify flora and fauna that could be affected by the project's potential effects on air quality, noise or vibration, or could be disoriented or otherwise impacted by project lighting.
- Describe the biodiversity values that could be affected by the project, including: native vegetation and any ecological communities listed under the EPBC Act or FFG Act; presence of, or suitable habitats for, native flora and fauna species, especially those listed under the EPBC Act, FFG Act, and DELWP advisory lists; and use of the site and its environs for movement by EPBC Act, FFG Act, and DELWP advisory list listed fauna species, including migratory species, and other protected species.
- Describe the biodiversity values that could be affected by the project, including: native vegetation and any ecological communities listed under the EPBC Act or FFG Act; presence of, or suitable habitats for, native flora and fauna species, especially those listed under the EPBC Act, FFG Act, and DELWP advisory lists; and use of the site and its environs for movement by EPBC Act, FFG Act, and DELWP advisory list listed fauna species, including migratory species, and other protected species.

- Describe the biodiversity values that could be affected by the project, including:
  - Native vegetation and any ecological communities listed under the EPBC Act or FFG Act
  - Presence of, or suitable habitats for, native flora and fauna species, especially those listed under the EPBC Act, FFG Act, and DELWP advisory lists
  - Use of the site and its environs for movement by EPBC Act, FFG Act, and DELWP advisory list listed fauna species, including migratory species, and other protected species
- Describe the existing threats present to biodiversity values, including:
  - Direct removal of individuals or destruction of habitat
  - Disturbance or alteration of habitat conditions (e.g. habitat fragmentation, changes to water quantity or quality, fire hazards, etc.)
  - Threats of mortality of listed threatened fauna
  - Presence of or risk of introduction of any declared weeds, pathogens and pest animals within and near the project area
  - Initiating or exacerbating potentially threatening processes under the EPBC Act or FFG Act

Design and mitigation measures:

- Identify potential and proposed design options and measures that could avoid, minimise, mitigate or manage significant direct and indirect effects on native vegetation and any listed ecological communities or flora and fauna species and their habitat including the ecological character of the Western Port Ramsar site and habitat values within or adjacent to the pipeline alignment.
- Best practice guidelines and standards must be considered when designing mitigations.

Assessment of likely effects:

- Assess likely direct and indirect effects of the project and alternatives on native vegetation, ecological communities and habitats for protected fauna and flora species, in particular any species listed under the EPBC Act, FFG Act or DELWP advisory lists.
- Assess likely direct and indirect effects of the project on the ecological character and habitat values of the Western Port Ramsar wetland site, including but not limited to effects of entrainment, potential introduction of exotic organisms, wastewater discharges, other waste streams, noise, vibration and light.
- Assess likely direct and indirect effects of the project and alternatives on protected fauna and their habitat, including threatened or migratory species listed under the EPBC Act, FFG Act or DELWP advisory lists, relative to existing hazards and risks and with regard to conservation or listing advices, action statements, recovery plans and threat abatement plans.
- Assess likely cumulative effects on biodiversity-related values that might result from the project in combination with other projects or actions taking place or proposed nearby.

Approach to manage performance:

- Describe and evaluate proposed measures to manage the residual effects of the project on biodiversity values, including an outline of an offset strategy that sets out and includes evidence of the offsets that can be secured or are proposed to satisfy Commonwealth and Victorian offset policy or guideline requirements.
- Describe and evaluate the approach to monitoring and the proposed contingency measures to be implemented in the event of adverse residual effects on flora, fauna and ecological community values requiring further management.
- Identify any further methods proposed to manage risks and effects on other biodiversity values and native vegetation, to form part of the Environmental Management Framework.

1.4 Scope

The scope of this peer review includes:

- A review of the Marine Environment Impact Assessment and associated reports prepared for and by AECOM and the scoping requirements of the EES. The following documents were provided for review:
  - Crib Point Gas Import Jetty EES – Marine Environment Introduction and Methodology (CEE 31 Jan 2020)
  - Crib Point Gas Import Jetty EES – Marine Environment Existing Conditions (CEE 31 Jan 2020)
  - Crib Point Gas Import Jetty EES – Marine Environment Hydrodynamic Modelling (CEE 31 Jan 2020)
  - Crib Point Gas Import Jetty EES – Marine Environment Risk and Impact Assessment Crib Point Gas Import Jetty EES – Marine Environment Conclusions (CEE 31 Jan 2020)
  - Westernport Modelling Review (eCoast 15 Nov 2019)
  - Appendix A – Underwater Noise Impact Assessment (AECOM, undated)
- A review of the process, methodology and assessment undertaken in preparation of the marine environment impact assessment including:
  - Legislation, policy and guidelines criteria
  - Assessment of existing conditions
  - Construction impact assessment method
  - Operational impact assessment method
- Identify any additional matters which should be considered in order to address the EES scoping requirements

Following the initial review and comment, revised documents were provided and these were:

- Crib Point Gas Import Jetty EES – Marine Environment Introduction and Methodology (CEE March 2020)
- Crib Point Gas Import Jetty EES – Marine Environment Existing Conditions (CEE March 2020)
- Crib Point Gas Import Jetty EES – Marine Environment Hydrodynamic Modelling (CEE March 2020)
- Crib Point Gas Import Jetty EES – Marine Environment Risk and Impact Assessment (CEE March 2020)

- Marine Environment Conclusions (CEE March 2020)
- Crib Point Gas Import Jetty EES – Underwater Noise Impact Assessment (AECOM March 2020)
- JASCO Applied Science Gas Import Jetty Facility Underwater Acoustic Modelling - M.W. Koessler, C.R. McPherson, and K. Lucke. 2019. *AGL Gas Import Jetty Facility: Underwater Acoustic Modelling*. Document 01816, Version 1.1 DRAFT. Technical report by JASCO Applied Sciences for AECOM

1.5 Limitations

This report has been prepared by GHD for AECOM Australia Pty Ltd and may only be used and relied on by AECOM Australia Pty Ltd for the purpose agreed between GHD and the AECOM Australia Pty Ltd as set out in section 1.3 of this report.

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The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

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GHD has not been involved in the preparation of the Marine Environment Impact Assessment and has had no contribution to, or review of the Marine Environment Impact Assessment other than in the role as peer reviewer. GHD shall not be liable to any person for any error in, omission from, or false or misleading statement in, any other part of the Marine Environment Impact Assessment.

1.6 Peer reviewer

The peer review was led by [redacted] of GHD. David has 30 years' experience in marine environmental consulting and research throughout Australasia, Asia and North America. He has provided a wide range of technical inputs into the environmental management of ports and dredging projects, development of marine infrastructure, coastal management planning and other developments that impact upon marine or estuarine environments. David has a long history of working in Western Port including extensive recent experience with the Port of Hastings proposed redevelopment, the second container port for Victoria. David also has experience with environmental issues at LNG terminals including being a scientific advisor to the Port of Ashburton in Western Australia and audit work on the environmental performance of the Darwin LNG terminal. David has the experience of a number of high profile Environmental Effects Statements in Victoria including the Victorian Desalination Project and Channel Deepening (as an auditor). He has undertaken many technical reviews of approvals documentation for both government and industry.

David was assisted in the review of hydrodynamic modelling by [redacted] of GHD. José has over 25 years of research and consultancy experience in water quality, marine and aquatic ecology, hydrodynamics, numerical modelling and management of large aquatic and marine monitoring programs. José has also prepared numerous environmental impact assessment technical reports for State and Federal/Commonwealth approvals submissions, management plans for a range of operational and construction activities, and regulatory compliance reports. He has facilitated numerous risk assessment workshops and prepared ENVIDs for proposals potentially affecting inland and marine waters. José has particular technical knowledge and experience related to hydrodynamics, management of water quality and restoration in aquatic environments inclusive of lakes, reservoirs, estuaries, rivers and coastal settings. Jose has previously held academic and research positions at the Centre for Water Research at the University of Western Australia, Department of Biology at the University of Michigan and the Department of Biological Sciences at the University of California at Santa Barbara.

Also assisting David with the review of the Underwater Noise Assessment was [redacted] who is an Environmental Scientist and the Service Line Leader for the Air & Noise and Meteorology Team in GHD's Melbourne office. He has 11 years' experience in environmental monitoring and regulatory approvals including impact assessments and audit works for industrial sites such as rendering plants, fellmongeries, meat works, WWTP's, engineering workshops, pump stations, mines, quarries, asphalt and bitumen plants, waste transfer stations, landfills, power stations, road and industry, Milk drying/cheese/coffee/bread production, fertiliser factories, fibre-glassing, abrasive blasting, spray painting, piggeries, broiler and free range chicken farms, and composting facilities. Craig has first-hand experience in the application of air quality, noise and vibration legislation and policy, guidelines, and standards for a variety of locations including NT, QLD, NSW, VIC and TAS as well as, working on international projects in New Zealand, Qatar, Philippines, and the UAE. Craig has experience in air dispersion and noise modelling using TAPM/CALMET, AERMOD, AUSPLUME, CadnaA and experience in air, noise and vibration monitoring and meteorological systems, their deployment, site placement and operation, attended field measurements, data quality assurance, site and sampling logistics, and detailed analysis

2. Findings

An independent peer review of the Marine Environment Impact Assessment and associated reports prepared for and by AECOM and the scoping requirements of the EES. Legislation, policy and guidelines

The Marine Environment Impact Assessment considers a variety of legislation and policy applicable to the Project. The applicable legislation and policy described within the assessment reviewed includes:

Commonwealth

- Environment and Protection Biodiversity Conservation Act 1999
- Biosecurity Act 2015

State

- Environment Effects Act 1978
- Flora and Fauna Guarantee Act 1988
- Marine and Coastal Act 2018
- Fisheries Act 1995
- Environment Protection Act 1970 and Environment Protection Amendment Act 2018
- State Environment Protection Policy (Waters) 2018
- Port Management Act 1995
- National Parks Act 1975
- Crown Land (Reserves) Act 1978

The legislation and policy listed above is considered generally appropriate and has been applied correctly in performing the Marine Environment Impact Assessment.

2.1 Existing conditions assessment

The existing conditions assessment provides a description of the environmental values consistent with the requirements of the scoping study of the EES. A desktop review of identified sources of information about the marine environment was then supplemented with field investigations to validate and supplement the information obtained from existing sources.

The approach taken is appropriate and provides a good basis upon which the description of the existing environment was based such that an assessment of the potential impacts of the construction and operation of the facility can be made.

The only area where there was not a description of the existing environment was the underwater noise assessment. This was explained in the report and a conservative approach was taken to estimate the current ambient noise.

2.2 Impact assessment method

The Marine Environment Impact Assessment method used a systematic risk-based approach to determine the likely impacts of the proposed project on the marine environment. This method was appropriate to the assessment required as it provides an objective framework against which different potential impacts can be assessed. A conceptual model of the ecological pathways in Western Port was used as a basis for the risk assessment. The risk assessment used both qualitative and quantitative approaches. A clear description of the impact pathways would be useful and although these pathways are described through the report, consolidating them in one locations would be helpful.

The outcomes of the risk assessment are plausible and the risks for each item examined is explained in the text.

2.2.1 Construction impact assessment method

The potential risks of the construction of the proposed facility are identified and considered in the risk and impact assessment. The construction risks to the marine environment are largely related to vessel operations and include chemical and fuel spills. These are adequately dealt with in the risk and impacts assessment. The conclusions of the construction risk assessment appear sound.

2.2.2 Operational impact assessment method

The potential operational risks are greater in number and duration than the construction risks. The systematic risk assessment process allows the risks to be identified and assessed. The assessment included the impacts determined through the use of hydrodynamic modelling to establish the potential risks of the warm / cool water discharge, the chlorine discharge and the potential for entrainment of organisms into the FSRU. The assessment was conservative, for example, it assumed that all entrained organisms would be killed though it is likely that some will survive entrainment. The conclusions of the operational risk assessment appear sound. There are some inconsistencies though. The section on Pelagic and Demersal Fish (Section 7.6.13) describes the potential impact of entrainment of fish eggs and larvae in spring as summer as of moderate consequence. This rating does not appear in the summary of Entrainment Risks (Section 7.6.16, Table 7-11). Some additional discussion is required.

2.3 Additional matters which should be considered in order to address the EES scoping requirements.

No additional matters need to be considered in order to address the EES scoping requirements.

3. Conclusions

3.1 Initial Conclusions on Draft Reports

An independent peer review of the Marine Environment Impact Assessment and associated documents was performed. The review found that the EES scoping requirements have been adequately addressed although noise, which is listed as a key issue, still needs to be addressed with a complete report. Several recommendations were made during the initial peer review. These are listed below and they have all been closed out in the updated versions of the documents provided to the peer review. These recommendations were:

Recommendation 1: Update the underwater noise report with a description of the ambient soundscape currently present at the location of the proposed facility such that an assessment of the likely increase in sound resulting from the facility can be made. The underwater noise assessment also needs to describe the impact assessment method that was used.

Recommendation 1

Closed Out: An updated underwater noise report was provided as well as the Underwater Acoustic Modelling Report. The updated report fully addresses the comments in the recommendation.

Recommendation 2

Further discussion is required regarding the assessment that the risk of entrainment of fish eggs and larvae during full operation in spring and summer (Section 7.6.13, p 30) as moderate and then the rating of entrainment risk to Pelagic and Demersal Fish as Low in Table 7-11 (Section 7.6.16, p 38).

Closed out: Additional text has been added to Sections 7.6.2, 7.7.2 and 7.8.2 which now reflects the view that the risk of entrainment of fish eggs and larvae is low.

Recommendation 3

A clear description of the impact pathways would be useful and although these pathways are described through the report, consolidating them in one location would be helpful.

Closed out: This recommendation was aimed at improving the readability of the reports, however the information is present within different sections of the documents.

3.2 Underwater Noise Report

The findings from the review of these reports, which were provided following the initial review, are as follows:

- The JASCO report uses its own in-house boutique noise model for the assessment (Marine Operations Noise Model (MONM)).
- This model uses what looks like a RAMGEO type algorithm that they call MONM (wide-angle parabolic equation) for the low to mid-range frequencies (10 (hertz) Hz to 1.25 kilohertz (kHz)) and then BELLHOP for higher Frequencies from 2.5 kHz up to 25 KHz, these types of algorithms are industry standard so they are appropriate for use in this situation.
- Modelling criteria is based largely on the recent research done by [NMFS] National Marine Fisheries Service (U.S.) in 2018 and are reasonable.

- No Specific local assessment of marine species or population density is undertaken, hence this is generic assessment based on generalised animal populations, but includes a number of types of mammalian taxa and fish.
- Outputs from the model seem reasonable and provide information on distances as a radius from source in kilometres for Behavioural Response, Temporary Threshold Shift and Permanent Threshold Shift criteria for both Sound Pressure Levels and Sound Exposure Levels.
- The noise source used was a surrogate taken from an average of two Floating Production Storage and Offload (FPSO) vessels. Although it this is not the exact output from the FSRU as discussed in the report it is likely to be similar to the FSRU, and be a reasonable estimate.
- The model resolution is good with radials being modelled for one degree increments at 10 m grid point (quite reasonable resolution)
- Physical parameters are included in the model such as bathymetry, temp, salinity, seabed geology and are appropriate.
- The results are presented in two formats: i) as noise contour maps (also referred to as sound level isopleth maps), and ii) as distances to broadband noise thresholds for both mammal and fish criteria and SPL and SEL's of interest.
- Interestingly the resulting contours are plotted based on maximum-over-depth levels calculated at each radial grid point. These are then resampled through triangulation to produce a flat Cartesian projection. It could be argued this is overly conservative and a Log-Average could be used instead. The conservative approach however presents no problems
- Further conservatism is added through the Rmax and R95% values used where the conservative estimates of the threshold radii are obtained by shifting the best fit line upward by 3.0 dB to exceed 90% of all SPL values.
- The methods used in the study are appropriate and the conclusions can reasonably be drawn from the methods applied.

3.3 Overall Conclusions

Following the review of initial material and the subsequent review of additional material provided we make the following conclusions.

- The marine ecology assessment methodology is appropriate for the assessment required and the conclusions presented can be reasonably drawn from the methods used.
- The underwater noise assessment methodology is appropriate for the assessment required and the conclusions presented can be reasonably drawn from the methods used.
- The hydrodynamic modelling methodology adequately assesses the cool (from heat exchangers) and warm (from FW cooler) water discharges on the seabed habitat over a number of scenarios. In particular, the assessment sensibly identified the optimal solution for the discharge of open loop (cool water) from the FSRU as reconfiguring the design for port (west) side discharge. The methodology provides reasonable estimates of the areal extent in which the seabed criterion of ±0.5°C is exceeded (i.e. Table 6-6).
- The modelling methodology adequately assesses the chlorine discharges on the seabed habitat over a number of scenarios. The methodology provides reasonable estimates of the areal extent in which the seabed criterion of 6 µg/L is exceeded (i.e. Table 6-7).

- The modelling methodology adequately assesses the entrainment predictions of planktonic organisms in the water column into the FSRU sea chest over a number of scenarios with the caveat of further clarification of withdrawal envelope volumes provided in Table 6-8 (see below). The methodology appears to provide reasonable estimates of the expected percentage of entrainment of planktonic organisms within North Arm (i.e. Table 6-10).

There is only one follow-up comment that requires clarification in the final form of the document, which is in regards our comment on Section 6.7.1.

The comment and CEE response is as below.

Section	Reviewer Comment	CEE Response
Section 6.7.1	Dot point 4 says that "entrainment" occurs when a tracked particle enter a small zone" what is the definition of a small zone? Also why is entrainment in inverted commas here but not anywhere else?	The entrainment zone depends on the current speed as defined in Table 6-8.

It is suggested that in the final version of the document that this comment is addressed.

4. Addendum

During the independent peer review of the Marine Environment Impact Assessment and associated documents, several errors or suggested areas for improvements were noted. These were detailed below and these comments were addressed in the subsequent revisions of the reports. The CEE responses to the comments below follow this section.

Marine Environment Existing Conditions

The report does not contain a References section even though there are many documents and sources of information referred to in the text.

Marine Environment - Introduction and Methodology

No comments

Marine Environment Hydrodynamic Modelling

General

A References section is absent.

A schematic of the system is not provided in Section 6. A simple schematic would be useful of the systems modelled (e.g. port locations, separations distances, vertical distances, etc.).

The ultimate objective of the modelling is meeting the temperature (or chlorine) guideline/criteria to define the mixing zone during operations. Hence, the temperature criteria/guideline of 0.5 C (Section 6.4.4) should be mentioned at the beginning to establish context.

Section 6.1

This section seems to pre-empt the results. Rather than just confining itself to “the Purpose” the section also briefly describes the operation and pre-empts some of the outcomes of the modelling. The first paragraph would have sufficed to describe the purpose.

Section 6.2.4

The application of the near-field model for the ‘FRSU Only’ (Figure 6-6) and ‘FSRU with LNG Carrier’ (Figure 6-7) is more aptly evaluated with the 3D model. Hence, near-field modelling focus ought to be on near-field dilution. Discussion on Richardson Number and ‘pool of cool water during slack tide’ should be limited to simplify understanding of analysis.

Section 6.2.6

Is the discharge water always 7° C cooler than ambient? If so that means that in winter, it may be around 5° C and in summer around 18° C.

Section 6.3

One model requirement not well defined is the ability to configure complex bathymetry (e.g. tidal channels that may have scales of 10 m) and complex shapes. AEM3D is an excellent model that simulates stratification problems very well (indeed it was developed as a lake stratification model, whereby conservation of potential energy very important). However, AEM3D is a rectilinear model so discussion on the potential weaknesses relative to a finite element model (e.g. DHI Mike 3, Delft3D) ought to be evaluated. In fact, because of the tidal dynamics the strength of the AEM3D model (e.g. stratification) diminishes relative to the flexibility of a finite element model. A discussion on this element of the modelling would be useful.

Section 6.3.6

The calibration of the bottom drag coefficient over the three seabed types is understandable (e.g. sand, seagrass, mangrove fringe). However, why is calibration of the two mixing parameters needed, rather than adopting industry (or past AEM3D) tidal modelling values? Good calibration of water levels is expected in this tidally driven system. Further, the calibration plots of the currents are very good. What is the confidence in the 'optimised' values of Ce=0.018 and Ct=50 across the model domain to produce these results? Was there a validation period? Generally agree that the regional model is well configured and reproduces observed measurements well.

Section 6.4.2

The mapping of heat inputs from the near-field model dilution predictions into the regional model cells to maintain conservation of heat is understood (i.e. Table 6-1). Why weren't the atmospheric fluxes modelled to more accurately model heat losses and gains from this source to provide a more realistic assessment of the changes to temperature on the marine environment from the discharges? AEM3D is a very good model to capture these atmospheric exchanges. Further, given the initial dilution and relative small temperature increases introduced into each of the model cells after initial dilution via near-field modelling (20:1 to 10:1 with a 0.3 to 0.7 C max reduction in temperature into the model cells for the cooling water case), these atmospheric exchanges are likely to be important.

Section 6.4.3

Inclusion of number of ports, separation distances between ports and range vertical locations relative to seabed/surface in Table 6-2 would be useful.

Section 6.4.14

Good summary of area exceeding temperature criteria of 0.5°C for open loop case. Clearly presence of LNG carrier is the predominant driver to establish the greatest spatial extent of the mixing zone.

Section 6.5.2

Good that chlorine guideline value provided prior to chlorine mixing zone analysis. Do same for temperature.

Section 6.5.10

Good summary of mixing zone predictions for chlorine impacts. Much smaller area of impact than temperature with presence of LNG carrier.

Section 6.7.1

Dot point 4 says that "entrainment" occurs when a tracked particle enter a small zone" what is the definition of a small zone? Also why is entrainment in inverted commas here but not anywhere else?

Section 7.6.3

Using the data from Table 4-4, the entrainment rates in Sector 2 are either of moderate or high consequence. Where is this is discussed in the document?

Appendix A - Underwater Noise Assessment

Section 1.0 Methodology

There are no methods presented in this section. Without a detailed description of the methods the process for obtaining conclusions cannot be verified.

Section 1.1 Existing conditions assessment

This section is blank.

Section 1.2 Risk assessment method

This section comprises nothing but a single table that makes little sense without some narrative as to what the table intends to convey.

Section 1.3 Impact Assessment method

This section is blank.

Section 1.5 Assumptions and limitations

The report states, "The existing underwater ambient sound field at the Gas Import Jetty has not been measured and cannot be approximated from measurements at other locations. In this assessment, it is assumed that the existing harbour operations create a noise field that already alters the natural sound field and impacts the marine receptors in the surrounding area" What does this actually mean? Why were field measurements not made? There was sufficient time to get field data on water quality and the biota of the area. Existing harbour operations only have about 2 to 3 ships per month. More information on this assumption is required.

Section 2.0 Existing Conditions

There is no description of existing conditions in this section. Despite the existing sound levels being referred to in the assumptions section, this section merely describes what underwater sound is.

Section 2.2 and 2.3

These sections entitled "Ambient Soundscape" and "Estimated Sound Fields at the Gas Import Jetty" do not provide any information about the likely levels of sound at the proposed facility. They are general descriptions of underwater sound with some sound sources that appear to be not relevant to the scope of the report. For example, discussion of seismic sound appears irrelevant to the report.

Section 3.1.1.1

The report states "The predicted range of audibility for sound emitted by the activities at the Gas Import Jetty is expected to exceed the range of onset of behavioural responses for all cetaceans and pinnipeds." The report then concludes that "The consequence of being able to hear the noise emitted from the vessels and operations at the Gas Import Jetty for individual marine mammals is considered to be minor and negligible on a population level." How was this conclusion reached? Particularly since the report states that “The exceedance of this range, however, cannot be assessed quantitatively due to the lack of information on the ambient noise level".

Section 3.1.1.2

The report states, "This impact cannot be quantified without prior knowledge of the absolute hearing sensitivity and related auditory parameters for each marine mammal species of concern." but then goes on to claim that the "The consequence of acoustic masking for individual marine mammals is considered to be minor and negligible on a population level." How can the risk be assessed if there is no knowledge to support the claim.

Section 3.1.1.3

Mention is made of Scenario 4. What is Scenario 4? Later in the document, Scenario 4 is partially discussed. However, this does not help the reader at this stage of the document. Scenarios 1 to 4 are also not discussed as such in the other documents considered in this review.

Section 5.0

Table 5.1 lists recommended mitigation measures. No guidance is given as to when or why these measures may need to be implemented.

Section 6.1

The conclusions states that "The noise emission will not cause significant changes to the soundscape in a pre-existing harbour area". However, one of the assumptions is that "The existing underwater ambient sound field at the Gas Import Jetty has not been measured and cannot be approximated from measurements other locations". How is the conclusion made that there will be no change if the existing conditions are not known?

Section 6.3

Why is only the FFG Act mentioned? What about other legislation or policy?

Marine Environment Risk and Impact Assessment

Section 7.0 Risk and Impact Assessment

The report should provide a description of the proposed action that may put the environment at risk. There is no detail provided as to features such as the nature of the intakes or discharge ports (except for a picture of the Victorian Desalination Project discharge, which does not fit the description of the screening provided in the text).

7.5.1 Mitigation measures for Seawater Intake

The report states that "As shown in Figure 7-5. many biota are commonly found at the surface of the seabed". Figure 7-5 does not actually show this. It shows where the intake is to be located and provides no information on where the biota are occurring.

7.6.13 Pelagic and Demersal Fish

First sentence: would older larger larvae really be able to avoid the intake by swimming? They may be able to swim slightly faster than the intake current for short periods but it would require them to perceive the current as a threat which wold appear to be unlikely.

7.6.2 Initial Entrainment Risk Ranking

Some addition description as to the initial risk ranking would be useful. It is difficult to see how ME 6 comes out as Medium without this context.

Section 7.7.3

Figure 7-13 has an incomplete legend as only the red line is defined.

7.8.24 Bioaccumulation and Chlorine

There is no risk rating provided for this threat.

Marine Environment Conclusions

Section 8.3

A monitoring program is proposed, however this is not linked back to the risk assessment and conclusion. That is, why is the monitoring being conducted?

The following responses to the above were provided by CEE to the above comments.

Section 6. Hydrodynamic Modelling

Section	Reviewer Comment	CEE Response
General	A References section is absent.	All references will be provided in separate section
General	A schematic of the system is not provided in Section 6. A simple schematic would be useful of the systems modelled (e.g. port locations, separations distances, vertical distances, etc.)	The geometry of the FSRU is very complex, and the various discharges would actually combine in practice, as has been used in the modelling. The diagram should be in the project description section of the EES.
General	The ultimate objective of the modelling is meeting the temperature (or chlorine) guideline/criteria to define the mixing zone during operations. Hence, the temperature criteria/guideline of 0.5 C (Section 6.4.4) should be mentioned at the beginning to establish context	Done in Sect 6.4.1
Section 6.1	This section seems to pre-empt the results. Rather than just confining itself to “the Purpose” the section also briefly describes the operation and pre-empts some of the outcomes of the modelling. The first paragraph would have sufficed to describe the purpose.	Done. Purpose and flow description retained. Outcomes moved to later in Section.
Section 6.2.4	The application of the near-field model for the ‘FRSU Only’ (Figure 6-6) and ‘FSRU with LNG Carrier’ (Figure 6-7) is more aptly evaluated with the 3D model. Hence, near-field modelling focus ought to be on near-field dilution. Discussion on Richardson Number and ‘pool of cool water during slack tide’ should be limited to simplify understanding of analysis.	Done. Discussion on Richardson No reduced.
Section 6.2.6	Is the discharge water always 7° C cooler than ambient? If so that means that in winter, it may be around 5° C and in summer around 18° C.	Yes, always 7 °C cooler during open loop operation.
Section 6.3	One model requirement not well defined is the ability to configure complex bathymetry (e.g. tidal channels that may have scales of 10 m) and complex shapes. AEM3D is an excellent model that simulates stratification problems very well (indeed it was developed as a lake stratification model, whereby conservation of potential energy very important). However, AEM3D is a rectilinear model so discussion on the potential weaknesses relative to a finite element model (e.g. DHI Mike 3, Delft3D) ought to be evaluated. In fact, because of the tidal dynamics the strength of the AEM3D model (e.g. stratification) diminishes relative to the flexibility of a finite element model. A discussion on this element of the modelling would be useful.	A sensitivity analysis is included in the HydroNumerics report that shows the model performs well. We doubt that a finite element model would be any better.

Section	Reviewer Comment	CEE Response
Section 6.3.6	The calibration of the bottom drag coefficient over the three seabed types is understandable (e.g. sand, seagrass, mangrove fringe). However, why is calibration of the two mixing parameters needed, rather than adopting industry (or past AEM3D) tidal modelling values? Good calibration of water levels is expected in this tidally driven system. Further, the calibration plots of the currents are very good. What is the confidence in the 'optimised' values of Ce=0.018 and Ct=50 across the model domain to produce these results? Was there a validation period? Generally, agree that the regional model is well configured and reproduces observed measurements well.	The calibration exercise was carried out to make the model perform best at matching measured currents at C rib Point. We agree that the model reproduces the measured currents well.
Section 6.4.2	The mapping of heat inputs from the near-field model dilution predictions into the regional model cells to maintain conservation of heat is understood (i.e. Table 6-1). Why weren't the atmospheric fluxes modelled to more accurately model heat losses and gains from this source to provide a more realistic assessment of the changes to temperature on the marine environment from the discharges? AEM3D is a very good model to capture these atmospheric exchanges. Further, given the initial dilution and relative small temperature increases introduced into each of the model cells after initial dilution via near-field modelling (20:1 to 10:1 with a 0.3 to 0.7 C max reduction in temperature into the model cells for the cooling water case), these atmospheric exchanges are likely to be important.	We agree that atmospheric heat exchange is important at a 1 km scale. However we were using the model to determine the size of the mixing zone in a 100 m scale, where atmospheric exchange is blocked by the vessels. Also, cold water is on the seabed, mixing up. So a conservative assumption of no surface loss was used.
Section 6.4.3	Inclusion of number of ports, separation distances between ports and range vertical locations relative to seabed/surface in Table 6-2 would be useful.	The six open loop ports are 10 m apart on the east side of the vessel, and a minimum of 1.5 m below the water surface. The actual arrangement is still to be designed.
Section 6.4.14	Good summary of area exceeding temperature criteria of 0.5°C for open loop case. Clearly presence of LNG carrier is the predominant driver to establish the greatest spatial extent of the mixing zone.	Yes, we agree.
Section 6.5.2	Good that chlorine guideline value provided prior to chlorine mixing zone analysis. Do same for temperature.	A Guideline Value for temperature of 0.5 deg C is derived in Sect 5.6.
Section 6.5.10	Good summary of mixing zone predictions for chlorine impacts. Much smaller area of impact than temperature with presence of LNG carrier.	Yes, we agree.
Section 6.7.1	Dot point 4 says that "entrainment" occurs when a tracked particle enter a small zone" what is the definition of a small zone? Also why is entrainment in inverted commas here but not anywhere else?	The entrainment zone depends on the current speed as defined in Table 6-8.

Section 7 – Risk and Impact Assessment

Section	Reviewer Comment	CEE Response
Section 7.5.1	The report states that "As shown in Figure 7-5. many biota are commonly found at the surface of the seabed". Figure 7-5 does not actually show this. It shows where the intake is to be located and provides no information on where the biota occur.	Fixed
Section 7.6.13	First sentence: would older larger larvae really be able to avoid the intake by swimming? They may be able to swim slightly faster than the intake current for short periods but it would require them to perceive the current as a threat which wold appear to be unlikely.	At some age and size they will be able to swim away from a dark noisy 'cave' on the side of a ship.
Section 7.6.2	Some addition description as to the initial risk ranking would be useful. It is difficult to see how ME 6 comes out as Medium without this context.	Text added to sections 7.6.2, 7.7.2 and 7.8.2
Section 7.7.3	Figure 7-13 has an incomplete legend as only the red line is defined.	Full; legend provided in figure
Section 7.8.24	There is no risk rating provided for this threat	Protected Species: risk rating is LOW
General	The report should provide a description of the proposed action that may put the environment at risk. There is no detail provided as to features such as the nature of the intakes or discharge ports (except for a picture of the Victorian Desalination Project discharge, which does not fit the description of the screening provided in the text).	Details provided in previous chapters

Section 8 – Conclusions

Section	Reviewer Comment	CEE Response
Section 8.3	A monitoring program is proposed, however this is not linked back to the risk assessment and conclusion. That is, why is the monitoring being conducted?	An explanation has been added after each task on the purpose of that task

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