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JUDICIAL REVIEW – ENVIRONMENTAL AUTHORISATION FOR THREE PROPOSED GAS TO POWER POWERSHIP PROJECTS LED BY KARPOWERSHIP SA (PTY) LTD – MARINE ACOUSTIC ECOLOGY EXPERT INPUT

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OVERVIEW: This report contains an expert opinion assessing the scientific soundness of activities relating to three Gas to Power - Powership Projects led by Karpowership SA (PTY) Ltd. The proposed project locations include: (1) Port of Ngqura (on the Southeastern side of South Africa), (2) Richards Bay (near Durban), and (3) in Saldanha Bay (near Cape Town on the West Coast of South Africa). The projects involve the generation of electricity by means of mobile Powerships to be berthed in the marine environment. Additional components of the projects include Floating Storage Regasification Units (FSRU), gas pipelines, and a Liquid Natural GasCarrier (LNGC), which will all interact with marine ecosystems. Specifically, this report is concerned with whether the marine ecology assessments and noise impact assessments (hereafter 'the studies') and the associated environmental impact assessment reports (EIAs) adequately assessed the environmental impact of anthropogenic noise and vibrations associated with the proposed projects and associated activities. Noise and vibrations will be broadly addressed, with specific emphasis on suitability of the EIAs to address impacts to the marine environment.

These projects collectively rely on a single technical study to predict possible noise levels emanating from the powership, repeat language and mitigation strategies, and rely on the same scientific and technical references. As such, this report will address the three independent EIAs and the associated studies collectively, noting differences in the ecology of the three regions as needed, since site specific assessments of marine noise impacts were omitted from all three EIAs and associated studies.

This report comments specifically on the following documents and appendices:

1. FINAL ENVIRONMENTAL IMPACT ASSESSMENT REPORT: Proposed Gas to Power via Powership Project at Port of Richards Bay, uMhlathuze Local Municipality, KwaZulu-Natal DEFF REF NO: 14/12/16/3/3/2/2007 A Project of Karpowership SA (PTY) Ltd
    a. Appendix I
    b. Appendix J

2. FINAL ENVIRONMENTAL IMPACT ASSESSMENT REPORT: The Proposed Gas to Power Powership Project at the Port of Ngqura within the Coega SEZ, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape DEFF REF NO: 14/12/16/3/3/2/2005 A Project of Karpowership SA (PTY) Ltd)
    a. Appendix I
    b. Appendix J

3. FINAL ENVIRONMENTAL IMPACT ASSESSMENT REPORT: The Proposed Gas to Power Powership Project at the Port of Saldanha Bay, Saldanha Local Municipality,

Western Cape DEFF REF NO: 14/12/16/3/3/2/2006 A Project of Karpowership SA (PTY) Ltd

a. Appendix I
b. Appendix J

Abbreviations will be used when referencing sites, studies, and EIAs. References to the project at Port of Richards Bay, uMhlathuze Local Municipality, KwaZulu-Natal will be indicated with RB, the project at Port of Ngqura within the Coega SEZ, Nelson Mandela Bay Metropolitan Municipality, Eastern Cape will be indicated with PN, and the project at the Port of Saldanha Bay, Saldanha Local Municipality, Western Cape will be indicated with PS.

SUMMARY OF OPINION: It is my opinion that the findings of the three EIAs on the impacts of anthropogenic noise on the marine environments have not been adequately assessed. As noted in the each of relevant EIAs and each of the associated specialist studies, a dedicated investigation into the impacts of noise on the marine environment at each site is needed to determine project viability. This work, however, was not included in the EIA or in the appendices. The studies on anthropogenic noise located in Appendix I of each EIA focused specifically on **terrestrial noise** values in each study; these values do not apply to the marine environment. Despite this, the EIAs came to the conclusions that anthropogenic noise would have minimal or no environmental impact; this is not supported by relevant science or by the studies included in the Appendices of each EIA. In my opinion, the Applicant:

(1) failed to complete the necessary research (desk or field) to conduct a reasonable environmental assessment of noise impacts in the marine environment

(2) failed to propose adequate long term marine noise mitigation

The following is a specific list of topics pertaining to acoustic ecology and underwater noise assessments that the Applicant failed to address. This list is not comprehensive, but does highlight some of the primary failures of the EIA's and associated studies

1. Failed to address the impacts of anthropogenic noise on commercially important species. This is significant because a reduction in commercial fish may have economic or cultural consequences.

2. Failed to address the impact of anthropogenic noise on important prey species. This is significant because the proposed sites are in the near proximity or directly adjacent to Marine Protected Areas (MPAs), National Park, and Critical Biodiversity Areas. Noise may endanger prey species in or *en route* to these areas. This could disrupt the base of the food web and may be ecologically significant throughout trophic levels.

3. Failed to adequately describe likely potential sound sources and amplitudes (e.g. vessels, pile driving noise, suction noise, etc.). This is significant because, without this information, the studies were unable to understand noise impacts on important species or ecosystems including how far sound will travel.

4. Failed to adequately quantify baseline ambient sound levels at any of the three proposed sites. This is significant because marine organisms use sound for navigation, prey detection, and foraging, so alterations made to the baseline natural soundscape will have ecological consequences that may be severe.

5. Failed to adequately quantify naturally occurring contributions to the marine soundscape. This is significant because in the absence of known natural ambient noise levels, it is not possible to assess how much the proposed activities will increase ambient noise levels in the soundscape. The naturally occurring baseline is therefore necessary for assessing impacts of proposed noise.

6. Failed to adequately model/measure sound propagation in these regions. This is significant because sound propagation may impact protected areas. Quiet biological sounds are used as a cue for foraging megafauna such as odontocetes. Anthropogenic noise at even low levels in these regions may mask biologically relevant sounds associated with predator foraging or larval settlement.

7. Failed to assess the risk associated with permanent soundscape alterations due to permanent changes on the seafloor due to construction activities. This is significant because animals use the soundscape as a cue to inform migration, habitat suitability and settlement (i.e., where juvenile animals select to grow and populate).

8. Failed to consider the impact of noise on marine areas outside of the immediate construction range including coastal areas and along vessel routes. This is significant because vessel noise outside of and adjacent to the powership may permeant and potentially overwhelm protected areas. Vessel noise has a wide range of negative impacts on marine fauna throughout the food web. These impacts may be ecologically substantial.

9. Failed to consider the physiological effects of anthropogenic noise on sound sensitive species including marine mammals, invertebrates, and fish. This is significant because the studies failed to consider how biologically critical behaviors that are important both for the fitness of the individual and overall population may be impacted.

10. Failed to adequately consider the impact of noise on the behavior protected or sound sensitive species- including marine mammals. Noise can have significant impacts such as separating cetacean calves from mothers. This is particularly relevant given the recent decline in Southern right whale abundance (including cows and calves) and given that humpback cow-calf pairs utilize this area and may be disturbed by noise.

11. Failed to incorporate International Whaling Commission's (IWC) Resolution 2018-4, Resolution on Anthropogenic and Underwater Noise, which requires effective remediation of noise impacts when cost effective solutions are available and states a lack of information is not grounds for ignoring the potential threats of anthropogenic noise.

12. Failed to consider impact of noise on the ecosystem holistically, including a failure to consider the links between trophic levels (e.g., predator and prey), and links between

ecosystems and economics (e.g., commercial fish and fisheries). This is significant because it omits some of the largest, though not immediately obvious, potential and cumulative impacts of noise on this ecosystem and the users who rely on it.

13. Failed to incorporate best science into assessment of underwater noise impacts. This is significant because the results of the EIA mitigation efforts are not based on reliable scientific information, and therefore may not adequately protect sensitive ecosystems.

In order to assess the impact of anthropogenic noise and efficacy of proposed mitigation efforts pertaining to the projects, several considerations must be included:

a. Ecologically/economically important species and trophic interactions

b. Sources of anthropogenic noise

c. Alterations anthropogenic noise will make to the natural soundscape

d. Sound propagation within the region

e. Physiological responses of organisms to anthropogenic noise

f. Behavioral responses of organisms to anthropogenic noise

g. Uncertainty and noise mitigation

h. Relationships between affected marine species and natural resource economics of the region.

GENERAL INTRODUCTION: Anthropogenic noise is sound produced by human activities, including infrasonic (below the range of human hearing) vibrations, and ultrasonic (above the range of human hearing) vibrations, and sound audible to the human ear. It poses a well-established threat to organisms across many types of organisms[1] that rely on sound for vital life functions including foraging, breeding, travelling, and socializing [2–8]. This threat is particularly pronounced in marine ecosystems where sound can travel great distances with little loss of energy and where - in the absence of human activities - many if not most marine species evolved to rely on sound as their most important sense [9,10]. Among others, anthropogenic noise has been documented to limit acoustic communication, elicit changes in foraging behavior, alter predator-prey dynamics, induce physiological stress, and/or result in physical damage or death [2–4,10–16].

Assessing the impacts of anthropogenic noise is a complex field of study requiring the integration of ecology, resource management, and physics. Compared to marine biology, oceanography, or fisheries ecology, acoustics is a relatively new field of study that is not regularly incorporated into traditional academic coursework, and therefore a comprehensive impact assessment that includes an investigation into the impacts of noise should include an

acoustician on the assessment team. Because the properties of sound underwater vary significantly from the properties of sound in air or through land, a specialist is needed to assess underwater noise impacts on both the environment and ecology. Because regions and ecosystems are site specific and unique, assessments must be made relevant to a specific location.

For most marine organisms, sound is critical to life function. Social cetaceans including whales and dolphins rely on sound for communication and pod cohesion) [17]. Bottom-dwelling animals,, fishes, and invertebrates also rely on or respond to sound in their environment (e.g. larval invertebrates and fishes use sound to know when/where to leave their open water life stage and settle into adulthood) [18,19]. Science literature on how marine organisms respond to anthropogenic noise includes behavioral responses, changes in organism presence or absence, physical responses including hearing loss, physiological responses including stress, mortality, and demographic shifts including reduced reproductive success or larval development[1]. As such, any proposed activity that is believed to be sound producing may have significant consequences throughout the ecosystem. The studies and technical reports associated with the EIAs did not directly address the impacts of noise to marine organisms found within each region.

A. ECOLOGICALLY/ECONOMICALLY IMPORTANT SPECIES AND TROPHIC INTERACTIONS

While attention was paid in the studies to the impact of noise terrestrial systems, no analyses were conducted on the impact of underwater noise on other ecologically or economically important species in this region (See Appendix I, section on Noise Impacts for evidence of this omission in each project). As an example, in the RB Noise Impact Assessment (Appendix I16) the study states that "A marine specialist should be consulted to determine the effects of underwater noise on marine animals in the vicinity." This recommendation was not heeded in the EIA.

Anthropogenic noise from various sources (powerships, vessels, construction, plant operation) has the potential to negatively impact both commercially important fish species as well as important prey species for birds, marine mammals, turtles and pelagic fishes [20]. Responses of fishes to anthropogenic noise include reduction of anti-predator response, which leave individuals at higher risk of being eaten, acoustic masking of breeding sounds which may impact species at the population level, reduced breeding success [8,21,22], temporary or permanent hearing loss, stress [23], and direct or indirect death in fishes and invertabrates[24]. Given the proximity of the proposed site to protected areas, aquaculture sites, national parks, and Critical Biodiversity Areas - *West Coast National Park Marine Protected Area (MPA) Network* which is within 5 km of the PS project site, *Addo National Park Marine Protected Area* which is less than 5 km from the PN site, and multiple *Critical Biodiversity Areas* which overlap (i.e. 0 km distance) with the proposed project site in RB – the risks to pelagic fishes, lower trophic level bait fish, and invertebrate prey species may be both ecologically substantial as well as economically significant. A reduction in prey may have fitness consequences for predators (including marine mammals). A reduction in commercial fish may have economic consequences for communities.

This impacts of noise on prey species and/or commercially important fish species were not included in the studies, despite the acknowledgement that in at least one region (Richards Bay) contains "*nursery areas, refuge areas and food sources for numerous marine biota, some of which are commercially important*" (Marine Ecology Specialist Study, RB EIA 2.1), and all regions contain multiple sound sensitive marine animals (including but not limited to pacific humpback dolphins (*Sousa plumbea*) in RB; humpback whales (*Megaptera novaeangliae*) in PS, juvenile fish in PN (see Appendix I of each EIA)). Dedicated investigation of the impact of noise on sound sensitive marine species and marine mammals in particular (similar to those conducted on avifauna), did not occur. Further, the studies failed to quantify the presence of important invertebrate species, including prey species.

The Port of Ngqura EIA (Pg. 204) states that *"The sensitive receptors to underwater noise within the Port of Ngqura are fish and marine mammals. To a certain extent, benthic invertebrates may also be impacted by underwater noise and vibration, however evidence is limited."*

This statement is not supported by the scientific literature. Research demonstrates that anthropogenic noise can have acute effects on invertebrates including immobilization, cessation of eating,mating, or egg laying, and changes in swimming behavior [26]. Broadly, invertebrates are critical food sources for marine mammals in South African waters [25], and any negative impacts to this food source would have implications for megafauna, much of which have a year round presence near the proposed activities.

Moreover, many larval invertebrates and fishes including corals, shellfish, and crustacean species rely on sound to facilitate settlement (the act by which larval animals transition from their pelagic 'drifting' phase, to permanent locations[27,29-30]). Acoustic masking of habitat sounds may prevent important structure-building organisms from locating suitable habitat. One Marine Protected Area is within 15 km of proposed activity- which may be close enough to be inundated with noise associated with construction and project operation, and may experience high noise levels associated with vessels. As the marine environment is a boundaryless medium, anthropogenic noise in coastal areas associated with vessel transits may impact noise-sensitive organisms outside of the immediate operations site. Anthropogenic noise produced within of the operations site may inhibit settlement (habitat selection) and recruitment of fishes and invertebrates in nearby protected or sensitive areas, and thus impact their predators. Broadly, the region adjacent to the proposed activities (including MPAs, National Parks, Critical Biodiversity Areas and aquaculture sites) may experience long duration and loud noise from vessels, powership operations, and/or construction that cause physiological or behavioral responses. Moreover, many migratory organisms that seek refuge in protected areas will also have to transit through the operation site in order to reach these protected regions. In general, the studies failed to investigate potential impacts on trophic interactions and marine organisms broadly, and failed to relate noise impacts to each ecosystem specifically.

B. SOURCES OF ANTHROPOGENIC NOISE

Consideration of the different types of sound sources were not included in the studies that accompanied the EIAs.

The Port Ngqura (pg. 284) and Port Saldanha Bay (pg. 184) EIAs state that:

> *"The underwater noise that could be generated in this project includes, but is not limited to, the following: - An increase in marine traffic during LNG deliveries. The main noise sources will be propeller noise, sonar ranging devices and engine noise transmitted through the hull. - Pile driving when constructing and installing the LNG offloading infrastructure. - Noise that is radiated through the ship's hull during power generation. - Noise from the suction and discharge of cooling water used on the ship into the harbour environment."*

With the exception of the technical report on the powerships, noise levels associated with sound sources were omitted entirely from the noise studies and EIAs. Appendix J does address the source levels (loudness) of an existing powership in Ghana with a very thorough technical report. However, the report failed to quantify noise sources other than powership operations, source levels (loudness), and failed to include the impact of the duration of noise likely to occur in this region. The Applicant also failed to commit to using the same noise cancelling technologies on the measured powership and failed to consider long term noise impacts, mitigation and monitoring of noise sources as the structure ages beyond 12 months. In the absence of these quantitative variables (loudness of other noise sources, commitment to noise cancelling technologies), it is not possible to adequately assess environmental impacts or long-term threats associated anthropogenic noise from this project.

In addition to sound loudness, sound *duration* is a critical component to consider whether a sound will cause physiological stress in an organism. Biological responses to elevated noise are not linked exclusively to amplitude but also to the amount of time sound is experienced. Studies have demonstrated that cumulative sound exposure level (SEL)- a unit of loudness that incorporates duration – can be used to predict the risk for hearing loss in marine mammals [2]. This demonstrates that sounds received at lower levels for a longer duration may have similar effects as sounds received at higher levels for a shorter duration. This is particularly relevant given that the powerships are expected to operate for 16-hours per day (PN EIA, pg. 173) for 20 years (PN EIA, pg. 300).

In reference to the marine noise technical report, the EIAs state that "In a short-term study on the underwater noise produced by powership operations, measurements were obtained over 13- to 30-minute time periods from 14 locations surrounding an operating powership near Takoradi in Ghana." While valuable as a baseline, this is not analogous with noise impacts over the total duration of the project. The studies and EIAs failed to address the impact of 16 hours a day of continuous noise production on the marine environment over the total length of the powerships' industrial life, made no suggestions to mitigate the total duration of noise output from other industrial sources, and failed to commit to monitoring beyond 12 months. This is significant given the potential and likelihood of increased noise that accompanies aging equipment. The technical report coupled with the studies and EIAs are insufficient to make an impact assessment on noise and noise duration in the marine environment.

Pile driving may occur during the powership and pipeline construction phase. Given the potential loudness of pile driving, these sounds may propagate long distances and/or have intense

localized effects. While portions of the EIAs and studies claim that no pile driving will take place, this is later contradicted. In section 8.3.2 (Port Ngqura EIA) the following is stated: *"During the construction phase no blasting is envisaged and piling, if required, will be minor. TNPA has an approved "Blasting and Noise Reduction Management Plan" to manage underwater noise due to construction activities"*. No effort was made to include the potential detection range of this or other non-powership sound sources for this study, nor to quantify the potential impact to sound-sensitive species that may fall within acoustic range, nor to mitigate impacts of pile driving or construction noise on nearby protected areas. (See SOUND PROPAGATION below).

C. ALTERATIONS ANTHROPOGENIC NOISE WILL MAKE TO THE NATURAL SOUNDSCAPE

While the studies considered many baseline ecological and geophysical features of each of the proposed project regions, no baseline soundscape assessments were made for the three proposed regions.

No effort was made to quantify what naturally occurring sound levels were for these regions, what naturally occurring sources of sounds were present in this region, or what seasonal and temporal cycles in ambient sound levels exist that may be ecologically important cues. In the absence of known natural ambient noise levels, it is not possible to assess how much the proposed activities will increase ambient noise levels in the soundscape- and therefore to assess underwater noise impacts.

Given that marine organisms use sound for navigation, prey detection, and foraging, alterations made to the natural soundscape may have severe ecological consequences. An adequate baseline assessment of the acoustic properties of the soundscape including biological sources of ambient sound, environmental sources of ambient sound, and ambient sound levels is needed to complete an assessment of underwater noise impacts. The Applicant did not assess this in the studies or the EIAs.

D. SOUND PROPAGATION

Sound attenuation is site specific and is linked to bathymetry (water depth), water temperature, seasonality, bottom substrate, and bottom density, among other variables. Thus, propagation modeling from one area is not applicable to a different one. Differences in the depths of the powerships in the three proposed studies may exceed 10m depth, and thus would not be analogous to the aforementioned study in Ghana. Local sound propagation modeling is essential to determine underwater noise impacts, and equivalent equipment needs to be measured or committed to in order to ensure the values in the technical report are emulated.

Each of the EIAs contains the following text in the sections on noise impacts:

> *"No site-specific modelling studies have been undertaken for underwater noise from the proposed FPP operations. Therefore, this is a high-level, nonquantitative assessment*

> *based on estimations of underwater noise from commercial ships and powerships moored in other locations."* (PN EIA at 205; RB EIA at 210; PS EIA at 172).

This statement confirms that the Applicant failed to conduct a quantitative assessment of underwater noise, and has not modeled noise impacts for the proposed regions. In Section 1.1 of the technical report commissioned by the Applicant, experts acknowledge that the sound generated by the proposed activities overlaps with the hearing of marine fauna. The actual range that the sound from this project is capable of travelling before falling below a biologically meaningful threshold can only be determined through either *in situ* sound propagation experiments or through propagation modeling for each of the three regions.

The following text is taken from the Port Ngqura EIA (pg. 205) in reference to the technical report (Appendix J in each EIA):

> *"In a short-term study on the underwater noise produced by powership operations, measurements were obtained over 13- to 30-minute time periods from 14 locations surrounding an operating powership near Takoradi in Ghana. The gas engine powership (Khan class) has an electrical output capacity of 470 MW from 24 operating engines and was operating at 100% capacity during the time of measurement. The vessel is moored in water approximately 10 m deep."*

Unless the depth, bottom profile, and ecological conditions of the three proposed regions are identical to those in Ghana, then these figures are best served as input variables to be included in noise modeling efforts. They are not analogous to exact noise values that would be found in the project locations. This was acknowledged within the EIA. On page 206 of the PN EIA it states:

> *"a better understanding of the underwater noise climate in the Port of Ngqura is required to place the noise generated by the powership in context."*

This phrase is also reiterated for both RB and PS.

Depending on the bathymetry of the area, sound paths from a source near the surface (like vessels or generators) can come together, creating regions of higher sound pressure at about the same depth as the source at 50-60 km intervals away from the source[47]. Given the proximity between the proposed powership regions and protected areas (as little as 1 km; PN EIA pg. 43) noise is likely to inundate important ecological habitats.

Understanding how far sound travels beyond the project sites is essential for assessing impact; an omission of this may have significant ecological conditions including population declines, behavioral shifts, physiological shifts and/or death. Larval bivalves rely on reef sounds to determine where to settle; disturbance to reefs and associated soundscapes negatively impacts coral settlement, and thus continued reef building [28,35,36]. Moreover, quiet biological sounds associated with important prey species appear to be used as a cue for foraging megafauna[48]. Thus, anthropogenic noise at even low levels in these regions may mask biologically relevant sounds associated with predator foraging. The general risk associated with anthropogenic noise in biologically sensitive or protected areas cannot be effectively assessed in the absence of robust

sound propagation models that estimate how far sound travels in this region and what impact generators, vessel, and construction noise may have on the underwater soundscape.

Alterations to the seafloor may permanently change how sound travels in this region. Alterations to the sea floor result in changed bathymetry and subsea substrate density, which impacts how sound travels[47]. Alterations to the substrate may result in a change in the quality of sound and distance sound is capable of traveling, and thus alter how natural sounds are perceived by marine organisms in this region. Animals use sound as a cue to inform migration [16,37], habitat suitability and settlement (i.e. where juvenile animals select to grow and populate) [35,36,38]. Sound propagation modeling should be used to assess the risk associated with permanent soundscape alteration.

Noise produced from industrial activities cannot be physically contained underwater and may inundate critical biodiversity locations proximate to proposed operations and associated vessel activities. This requires careful consideration given the known impact of noise on marine mammals (stress, behavioral responses, reduction in foraging[15]), fish (behavioral responses, physiological responses, antipredator responses, death[8,24]), larval invertebrates (reduction in settlement, larval deformation [19,26,39]), and pelagic zooplankton (death[40]). The potential for anthropogenic noise to impact ecologically important areas may harm, alter, or lead to death or population decline across a wide range of organisms and life stages that make up both ends of the trophic web. Because noise cannot be contained to the project site due, the impacts of noise are further reaching than the directing region of interest and must include coastal and adjacent pelagic areas as well.

SITE SPECIFIC COMMENTS ON SOUND PROPAGATION:

- In the section on underwater noise impacts the PN EIA states that "*The entrance to the Port of Ngqura faces south, away from the St Croix Island group. The Eastern Breakwater, the end of which is 2.3km from the powerships, shields the islands from the direct impact of sound waves.*" (PN EIA at 173-74).

  Much of the noise associated with the powerships is likely to be tonal (e.g. like a whistle) while the noise of crashing waves is broadband and widely dispersed (like the sound of static (see GSD-report in Appendix J). Noise from powerships and associated vessels/construction activity will not attenuate and travel in the same manner as the sound of breaking waves. Similarly, the energetic content (and thus loudness) of powership and associated industrial noise far exceeds wave noise and thus will not impact behavior analogously. Lastly, that the St. Croix Island group (a marine protected area) is protected from noise shielded by the breakwater is speculative in the absence of propagation modeling.

- Section 8.3.10 of the PS EIA states that *"Sound propagation from the FPP operations in Small and Big Bay will be affected by the topography of the Port. Sound waves will be absorbed and/or reflected by port structures. It is assumed that the Powership proposed for the Port of Saldanha Bay is equivalent in sound generation to that moored in Ghana, then effects on the surrounding marine ecology would be unlikely"*

Sound Propagation in this region hasn't been measured, nor have sound levels from ancillary project sources been measured or quantified. Additionally, the impacts of noise on the specific marine ecology of this area have not been measured quantified. The assumption therefore that this location is equivalent to the site in Ghana and would have minimal impact is unsubstantiated. A dedicated desk study on sound propagation in this area, noise impacts on the culturally, ecologically, and commercially important species in this area, as well as *in situ* noise measurements, monitoring, and mitigation, is required for adequate assessment.

E. PHYSIOLOGICAL RESPONSES

Anthropogenic noise has the ability to cause physiological stress, alter metabolic rates, induce embolisms, alter life history traits, and cause permanent or temporary loss of hearing[6,12,21,23,41,42]. The studies for the powerships acknowledge that noise may cause direct physical damage to hearing. Beyond this acknowledgement, no mention is made of the physiological impacts of noise in organisms either within or near the proposed sight, or along the transit path for vessels, and potential impacts on marine organisms are erroneously dismissed.

On page 172, the section *Disturbance to Marine Avifauna and Habitat by Underwater Noise* in the Port Ngqura EIA states:

> *"While many taxa, especially Cetaceans, are known to be affected by or to avoid high intensity underwater noise (Pichegru et al. 2017), there is little evidence to date that pelagic prey fish and seabirds avoid or are affected by low intensity underwater noise such as that associated with marine traffic and onshore anthropogenic activities. Noise levels to avoid physical injury to fish and cetaceans and to avoid fish behaviour changes are in excess of 200dB."*

This statement is misleading in the context of the proposed activities at this site because it disregards the sub-lethal and cumulative impacts associated with anthropogenic noise (i.e. cessation of foraging, impact to parental care) that occur at much lower noise values (less than 110 dB r 1 μ $Pa_{RMS\ 50\text{-}1500\ HZ}$). A lack of avoidance is not an indication of a lack of disturbance-particularly in ecologically important areas.

Similarly, this statement, and the studies more broadly, disregard the role that *duration* plays in direct injury (hearing loss) in marine species. As noted above, longer duration exposure to lower amplitude noise can result in temporary hearing loss in marine mammals [2]. Consideration was not paid to stress and other physiological responses in fishes (commercially and ecologically important), invertebrates (essential for trophic transfer, reef building, economics), nor was uncertainty accounted for. Moreover, in the absence of propagation modeling and the incorporation of duration into ecological modeling, whether animals experience hearing loss or other physiological shifts cannot be determined.

Animals that experience a physiological response to noise when in close range to anthropogenic noise sources may continue to experience that physiological response when they exit the region

and travel to nearby protected areas. Therefore, animals subjected to elevated noise levels within the project regions, may experience duress en route to marine protected areas or Critical Biodiversity Areas. It is thus essential to consider noise levels both within the project regions, and nearby the project regions to minimize physiological responses. Physiological responses including and exceeding hearing loss and in combination with behavioral responses may result in population level cumulative effects that have not been analyzed in this study.

SITE SPECIFIC COMMENTS ON PHISIOLOGICAL RESPONSES:

- On Pg. 200 of the RB EIA it states that *"Given that this level of noise is less than the indicated injury sound levels, levels, i.e. does not breach threshold levels for estuarine and marine aquatic fauna, these fauna in the vicinity of the powerships are unlikely to be significantly affected (Lwandle, 2021)."*

  This statement assumes that the only potential impact to marine/estuarine organisms are hearing threshold shifts and does not account for additional threats to the trophic web (e.g. stress, or behavioral responses (see below). Moreover, this does not account for noise from additional industrial sources expected within the bounds of the project (construction, vessels) which may impact physiological responses. Nor does this study include the impact of noise duration – which in this study will be substantial – on hearing loss. Importantly, no direct effort was made to investigate physiological impacts of noise to marine organisms <u>in this location</u>, and therefore the assessment is not sufficient for decision-making.

F. BEHAVIORAL RESPONSES

The study broadly refers to behavioral responses in the description of potential impacts, but fails to considers the effects of masking of sounds and displacement, and offers no mitigation to avoid acoustic masking. There are several additional behavioral responses that were not considered that have important impacts for marine mammals, economically and ecologically important fish species, pelagic plankton, and invertebrates. Among these groups, ambient noise results in the cessation of feeding in multiple cetacean species [14,43], the cessation of foraging activity in invertebrates and fishes [8,22,26], and the cessation of egg laying and reproduction in invertebrate and fish species[26,16]. These biologically critical behaviors are as important to the fitness of the individual and health of the populations and have not been assessed in the study.

G. UNCERTAINTY AND NOISE MITIGATION

The EIAs failed to account for reasonable uncertainty or to propose effective long term mitigation. On page 200 of the RB EIA it states that "*The impact of underwater noise on marine/estuarine fauna is specifically addressed in the Marine Ecology Specialist Report and all mitigation measures and conditions provided must be adopted.*" However, the marine ecology

specialists report indicates that *"Data on underwater noise are not supplied, and so the spatial extent of the impact is unknown."* (Marine Ecology Study- RB, 1.2.1). As such, science-based recommendations and mitigation measures cannot be made. While the EIA's all support 12-month monitoring programs, no concrete mitigation or monitoring was suggested beyond the 12-month mark, despite the projected 20-year life of the powership projects.

The lack of concrete data on noise impacts, does not justify a failure to propose mitigation measures. Many significant risks to marine fauna associated with anthropogenic noise likely exist, but have not yet been thoroughly described. Section 2 of the International Whaling Commission's (IWC) Resolution 2018-4, Resolution on Anthropogenic and Underwater Noise states that the Commission

> *2. Further agree that, in line with the precautionary approach, the lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to address the effects of underwater noise (or other potential threats).*

Spoken plainly, a lack of information is not grounds for ignoring the potential threats of anthropogenic noise when cost effective solutions are available. In the case of the proposed projects there is evidence from the literature that anthropogenic noise causes a significant biological threat to marine organisms throughout trophic levels (benthic fauna, fish, marine mammals, sea turtles). The lack of research resulting from this exact region on these specific faunal communities is not grounds for ignoring potential noise impacts, rather it is a greater indication of the need for baseline research in this region prior to development, and a need for careful mitigation measures.

Without proposing science-based mitigation methods, the studies acknowledge that sufficient research was not done in association with the proposed projects. On pages 206-207 of the PN EIA it states that: *"A quantitative underwater noise assessment is recommended to comprehensively assess the impact on the marine ecology"*

The follow up statement: *"However, it was noted that the effects of underwater noise from FPP operations on marine ecology are unlikely."* is unsupported by the provided documentation.

Noise mitigation measures should include those proposed by the International Maritime Organization and in the peer reviewed literature, but were not included in the EIA, or the associated noise impact studies (Appendices I) or the noise technical report (Appendices J). Currently there are no proposed long-term noise mitigation strategies, and no mitigation strategies in association with vessel activities or pipeline operations. Vessel noise mitigation should include a minimum of hull cleaning, reductions in ship speed in protected or ecologically important areas – as recommended by the International Maritime Organization's "Guidelines for the reduction of underwater noise from commercial shipping to address adverse impacts on marine life." – and/or convoying ships to reduce ambient noise [46]. The Applicant should commit to reducing or ceasing noise producing activities in the presence of sound-sensitive species, and during months when marine mammal, fish, and turtle migration is likely to be impacted. Monitoring and mitigation should be done year-round to identify noise-sensitive species if/when they arrive so that construction activities and associated project operations can be paused. A firm

commitment to noise mitigation throughout the 20-year life of the project is essential. This includes establishing maximum noise thresholds that incorporate duration, and concrete mitigation strategies for how the Applicant will respond when noise thresholds are approached and met.

SITE SPECIFIC COMMENTS ABOUT UNCERTAINTY AND MITIGATION:

- The following statement can be found in the PN EIA:

  "Impact 4: effects of increased noise and vibration levels on the marine ecology: The cumulative impact of increased anthropogenic noise levels in oceans has been recognised as an ongoing and widespread issue of concern (Koper and Plon 2012). The operation of the powerships will contribute to the cumulative noise within the Port of Ngqura and will likely result in an impact of increased significance on the surrounding marine ecology. A noise modelling study should be undertaken to gain a more quantitative understanding of the noise produced from powership operations in the Port of Ngqura." (PN EIA at 293).

  Despite the above acknowledgment that operations will "likely result in an impact of increased significance", Table 8.8 of the PN EIA claims that noise is of 'low impact'. The conclusion in the table appears to have been made in the absence of the study's own evidence and without mitigation recommendations.

H. INTERRELATEDNESS OF NON-HUMAN ORGANISMS WITHIN AN ECOSYSTEM AND HUMAN USERS WHO RELY UPON THEM

To best understand and mitigate the potential adverse effects of vessel noise on marine organisms requires a collaborative and integrated effort on the part of stakeholders, industry professionals, and scientists. Such efforts, known as an eco-centric approach, or an ecosystem-based approach, should seek to address environmental concerns *in context to and in connection with* both the ecological and social needs of targeted ecosystems. The applicant failed to do this throughout the study by instead isolating species and taxa with no reference to their interrelatedness. This is most obvious in the case of noise impacts on fish, which are both a prey species and commercially important, and invertebrates, which make up the base of the food web in some cases and are ecosystem engineers in others.

A primary tenet of an eco-centric approach is that the scope of mitigation and prevention should address ecosystems in their entirety- including the role of humans. This includes the acknowledgment that human well-being is intrinsically connected through the delivery of ecosystem services across a range of scales to ecosystems themselves. In this regard the threat of pervasive anthropogenic noise in the region of interest is not only a hazard for marine organisms, but also a potential threat to the human stakeholders associated with the coastal ecosystem in which these marine organisms reside. There is ample need for continued investigation on the impact of anthropogenic noise associated with the proposed project in the eco-centric context. The resilience of the marine organisms in these regions has not yet been quantified, and the

potential ecological and social trade-offs of damaging or displacing organisms from this ecosystem are unassessed.

EXPERTISE:

I am a postdoctoral research associate at the Cornell University K. Lisa Yang Center for Conservation Bioacoustics where I use bioacoustics to study human impacts on marine organisms. I have a PhD in Wildlife Sciences from the department of Fisheries, Wildlife, and Conservation at Oregon State University with a specialization in marine bioacoustics and underwater noise. I have a MS in Marine Resource Management from the College of Earth Ocean and Atmospheric Sciences at Oregon State University. My MS thesis focused on marine mammal bioacoustics and communication; my dissertation research investigated the impact of vessel noise on marine mammals. I am an author on over a dozen peer reviewed bioacoustic research articles on taxa ranging from humpback whales and harbor seals to toadfish and barnacles. I have a decade of experience conducting marine bioacoustics research.

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