AS#4 Assessment Notes – Response to OMR#2 – Protected Matters

Deliberative / contemporaneous notes made during assessment of AS#4 for Protected Matters assessment scope, December 2025 – January 2026.

Key findings for discussion with team – Findings meeting, 20/01/2026

SRWs:

- All things considered, detection, SSV and controls are reasonable.
- Potentially condition start-up in event that SRWs detected in reproduction BIA during Sept/Oct to firm up.
- SSV – discuss '3-minute L75, L90, L95 distributions ≥95% of the time'? What purpose do the ambient measurements serve now based on detection of impulsive >120dB SPL. Set conditions around SSV programme?

Modelling:

- Large differences in the modelling not adequately explained/rationalised in the EP – How are we to consider this?
- Differences in source/activity and NMFS (2024) weightings and thresholds unlikely to account for such reductions in some results.
- Reductions in predicted effects range due to Animat seem unusually large and not explained.
- Latest modelling informs all impact assessments, flow on to acceptability, EPOs, EPSs, etc.
- Some controls based on smaller predicted ranges (5 km for PBWs).
- Have undertaken further review of modelling methods and inputs against NOPSEMA Underwater Acoustic Impact Evaluation and Management Info Paper and DOC 2016 referenced therein to try to understand possible reasons – See Summary of Findings – There are number of areas that warrant either clarification or addressing, and differences in rigour/accuracy of models that may be influencing results as well as simply the activity parameters and NMFS (2024).

Acceptable levels/EPOs/demonstration of an acceptable level:

- Stronger justification for demonstration of acceptable levels of impact to SRWs and linked to recovery plan.
- Still some issues in EP generally (e.g. thread, defined acceptable levels, EPOs)
- [redacted] – Fish and inverts?

- EPOs - Inconsistencies and ambiguities in EPOs linked to defined acceptable levels and the SRW recovery plan! Those included in G1 potentially not appropriate and incomplete. Which is the EP adopting?

Note other to discuss / be aware of:

- Status of consultation and external correspondence (EJA/GMTOAC, Carli Reeve, FFTB, etc) – Discuss with [redacted]
- Seismic impacts to whiting and flathead research now published (since resubmission of EP) – [redacted]
- Defined acceptable levels of impacts for fish and invertebrates – [redacted]

………

Letter Point 1.1 – Scope and bounds of the activity

The scope and bounds of the activity need to be more clearly defined

Issue: The EP should include a suitable description of the activity and how it may affect the environment, including the scope and bounds of the activity (GL1721: Section 6.3). The Activity Description in Appendix A2 provides definitions of the Operational Area (OA), Active Source Area (ASA), Survey Acquisition Area (SAA), and a newly defined Mitigation Source Area (MSA). However, the description of activities in Appendix A2 create uncertainty about where the sound source will be operated.

Reasons: The EP (Appendix A2, Section 3.2.1) states that 'If the survey vessel leaves the Active Source Area (ASA), the sound source must not be activated, tested or in any way discharged'; however, the EP now includes a "Mitigation Source Area" (MSA), which extends outside the ASA, in which a small source will be active. Similarly, section 3.4 of Appendix A2 provides the definitions of the OA, ASA, SAA and MSA, however, the definition of the OA states that 'The sound source cannot be active in the Operational Area outside of the Active Source Area', despite the definition of the MSA stating that a source will be active outside of the ASA.

Titleholder response: Changes have been made to address the matters raised in the letter. In addition, numerous changes have been made throughout the EP to remove the April to June operational window and delay the start of the activity to mid-September.

NOPSEMA review and findings:

The activity description in A2 has been updated to clarify that '*If the survey vessel leaves the Active Source Area the sound source must not be activated, tested, or in any way discharged <u>at full power</u>*.'

The definition of the Operational Area has also been updated to clarify that '*The sound source cannot be active in the Operational Area, outside of the Active Source Area* *and Mitigation Source Area*.'

Activity description now also incudes USBL which will emit "ancillary" sound. No issue, noting vessel and seismic source noise will dominate.

Activity description and activity limitations updated to reflect new reduced source volume (2,820 down to 2,650 cui) and updated survey timing.

Issue resolved. No issues.

………

Letter point 2.1 – Acoustic modelling

Areas of uncertainty in underwater sound model predictions of impacts to marine mammals have not been adequately addressed

Issue: The EP does not demonstrate, with relevant supporting evidence, that all impacts and risks (including those relevant to protected matters) will be managed to acceptable levels, and areas of uncertainty in predictions of impact and risk are identified, acknowledged and addressed (**GL1721, Section 8.3**). The evaluation and prediction of impacts from acoustic emissions should be supported by the best available science (i.e. relevant, applicable, contemporary, peer-reviewed and published by reputable sources) and appropriate impact threshold criteria (**IP1765, Sections 3.3 and 3.4**).

Reasons: CGG has not adequately considered the NMFS (2024) technical guidance updates and, therefore, the EP does not demonstrate with sufficient confidence for NOPSEMA to be reasonably satisfied, that impacts and risks to protected matters will be managed to acceptable levels.

OMR#1 letter item 3.4 outlined key updates made in NMFS (2024) and NOPSEMA provided CGG with further advice (12 March 2025) on specific issues to be addressed. However, the EP has not accounted for updates to marine mammal weighting functions and, therefore, overlooks the most relevant metric for the assessment of TTS in low-frequency cetaceans (SEL_{24h}), including blue whales and southern right whales. The EP's impact assessment and control measures (e.g. shut down zones) for blue whales and southern right whales are also based on animat modelling predictions for TTS. As advised (12 March 2025), it is unclear to NOPSEMA whether an analysis of propagation differences between NMFS (2018) and NMFS (2024) can be reliably applied to the animat model results.

Titleholder response:

CGG has now completed the full STLM to reflect the updated NMFS 2024 criteria. There were several other changes to the activity design that were also considered in the remodel that reduce impacts (e.g. the reduced sound source) and reduce uncertainty (e.g. full model considering the NMFS 2024 criteria and Animat remodel).

CGG notes that any model is insufficient to rely on and cannot eliminate uncertainty. CGG has added further discussion about the sources of uncertainty, including modelling uncertainty, and how CGG has proposed to address each source of uncertainty (**Appendix F3, s3.1.5 [*SRW - Mitigation effectiveness*]**). Further, CGG has made the case that uncertainty is also addressed through precautionary measures, which the EP has implemented for SRW.

<u>Appendix 2 – Change register:</u>

- EP – 'Reviewed and updated to address all changes since last submission'
- B7a – No change
- B7b – No change
- B7c – New document

No other specific changes in the EP are identified.

Additional context:

- Previous two rounds of acoustic and animat modelling were undertaken by JASCO
- Issue raised in OMR#1 re NMFS (2024) technical guidance updates, specifically new weightings and thresholds for PTS and TTS based on latest science.
- OMR#1 asked CGG to account for these changes. It was noted in meetings that the weighting and exposure functions were important for LFC, despite minor/no changes to LFC thresholds. Options discussed included JASCO technical addendum to modelling, if re-modelling not feasible.
- CGG response to OMR#1 contracted SLR and used the NMFS 2024 vs 2018 spreadsheet tool. However, the simplistic tool does not account for full frequency distribution of the weighting and exposure functions, only a single frequency reference point. This does not adequately account for the range of frequencies from seismic where they overlap with the range of frequencies under the LFC hearing curve. The NMFS spreadsheet tool also uses simple transmission loss calculations which are not reliable or comparable to more sophisticated models such as those that had been utilised.
- Therefore, OMR#2 raised issues with the approach. Subsequent meetings with the titleholder again identified a technical memo from JASCO or revised modelling as possible options.

- CGG chose to undertake new modelling. CGG contracted SLR for new modelling instead of JASCO due to incompatible timelines with CGG schedule (at the time).
- Meetings with titleholder discussed risk in this approach, noting that the EP would need to demonstrate that new modelling (both propagation and animat) was robust and representative. SLR animat not previously assessed by NOPSEMA, while JASCO Animat previously subjected to scrutiny re methods and behavioural parameters (North West Australia 4D, Scarborough 4D).
- EP AS#4 notes that SLR modelling was commissioned by CGG to account for:
    - NMFS (2024) technical guidance
    - Reduced conventional source volume (2820 cui to 2630 cui) and alternative source option (Sercel Bluepulse)
    - Adjustment to SEL24h scenarios

NOPSEMA review findings:

<u>Documents reviewed:</u>

- EP Section 7.3 (Underpinning studies of the Environmental assessments)
- Appendix B7 Cover sheet
- Appendix B7 Modelling explanation (*SLR's Underwater Sound Transmission Loss Modelling and Animat Study*
- B7a – JASCO (2023), Document 03076, Version 1.0.
- B7b – JASCO (2024), Document 03301, Version 2.0.
- B7c – SLR (2025), SLR Project No.: 675.073227.00001, December 1, 2025, Revision: 1.
- Appendix E2 – E8 (underwater sound) and F3 further impact assessments

EP, Section 7.3

Section 7.3 (Underpinning studies of the Environmental assessments) of the up-front EP document includes information rationalising the different studies. No subheadings in the contents indicate that this sort of information is present.

- '*Collectively, these studies establish a robust, multi-stage technical foundation for understanding how sound from the activity is expected to propagate within the Otway Basin and how it may interact with ecological and human receptors*.'
- Study 1 (JASCO) – Prospective area
- Study 2 (JASCO) – Amended spatial survey layout (ASA >50m depth, new survey plans)
- Representativeness of first two studies – '*The first two studies together remain relevant because…*'
    - *Source configuration, discharge parameters and operational characteristics exceed those now proposed making them conservative and precautionary in*

most dimensions. What discharge parameters and operational characteristics have changed? Not specified here - check.

- *The first two studies therefore continue to provide a strong foundation for understanding spatial patterns of propagation and received sound levels at modelled coastal sites of high public interest and environmental significance.*
- Study 3 (SLR):
  - Updated NMFS (2024) Technical Guidance. Thresholds and weighting functions.
  - Updated source signature (2630 cui) plus Bluepulse evaluation.
  - New source modelling, propagation modelling, SELcum and animat modelling.
  - *To reflect the most up-to-date activity design, this study considered three representative source locations, and two long-range propagation transects.*
  - *Slightly extended cumulative TTS and behavioural disturbance distances for low-frequency cetaceans, consistent with previous studies and reflective of precautionary assumptions used in animat modelling.* Slightly extended compared to what? Check, results actually appear to show substantial reduction in LFC TTS compared to previous modelling.
  - *Cumulative exposure thresholds increase predicted ranges for high- and very-high frequency cetaceans; however, these increases remain within established mitigation boundaries (including the 500 m exclusion zone).* Check
  - *Updated threshold distances remain aligned with, or more conservative than, those used to inform the EP's mitigation framework.* Check.
  - *As with the first two modelling studies, the third modelling study applied precautionary assumptions and thresholds to ensure conservative predictions. The updated modelling* (To check):
    - *Used the seasonal sound-speed profile most favourable to long-range propagation.*
    - *Assumed a reflective seabed driven by coarse sand overlying semi-cemented calcarenite, explaining larger offshore isopleths at some sites.*
    - *Did not incorporate avoidance directional movement or biologically informed horizontal travel paths in the Animat model.* Appears to be reframing of a statement that was previously written in relation to JASCO modelling. This is not evident from the MAI Animat modelling, as MAI discusses aversion parameters, but does not state what assumptions were made re aversion.
    - *Treated Animat movement as purely stochastic, and undirected producing precautionary over-estimates of exposure likelihood.*
    - *Recognised that variable sand-layer thickness could reduce propagation compared to the model's uniform layer.*

These assumptions place the results at the protective end of the realistic range of outcomes.

- *Across all three studies…Propagation predictions are conservative and reflect worst-case environmental and seabed conditions. The patterns of sound distribution predicted in the first two studies remain relevant to stakeholder-requested sites and coastal receptors.*

B7 - Cover Sheet

- Cover sheet also explains high level process during the EP and purpose of the three modelling studies
- '*While the revised NMFS criteria result in some changes to predicted behavioural and cumulative exposure ranges, these remain….*' – The NMFS (2024) Technical Guidance on Auditory doesn't revise any behavioural criteria. Possibly referring to NMFS's general summaries of acoustic thresholds, not the technical guidance. **Immaterial.**

B7 - SLR's Underwater Sound Transmission Loss Modelling and Animat Study (after cover sheet)

- Acknowledges variability due to different models used across a range of input parameters - '*Such variation reflects differences in modelling assumptions and computational approaches, rather than discrepancies in technical quality or robustness*' – OK, but only provided the modelling assumptions are reasonable. Is new modelling approach as robust/defensible? This highlights the need for conservatism where predictions are used to inform the effectiveness of controls and demonstrate acceptable impact.
- CGG has used the latest SLR modelling as the primary acoustic modelling reference. Consistent with what was proposed in titleholder meetings, JASCO reports included by CGG for transparency.
- CGG considers that application of these outputs for SRWs warrants an additional layer of precaution re reproduction. Also integrate pre-survey ambient noise baseline and continuous real-time sound monitoring.
- Animat discussion and justification (To check):
  - Movement parameters and dive profiles for PBW foraging from peer-reviewed sources. See Appendix E of Appendix B7c.
  - Movement parameters for SRW migration, resting and foraging from peer-reviewed sources. See Appendix E of Appendix B7c. Behavioural state (foraging) parameters appropriate for calving/nursing?
  - Section 3 of Appendix B7: '*To investigate potential effects on SRW migration, resting, and foraging, movement parameters were drawn from tagged North Atlantic Right Whales and SRWs, supported by an equivalent body of peer -reviewed literature (Appendix E, Appendix B7c). Because no published studies exist describing detailed parameter sequences for SRWs engaging in*

"aggregation" behaviours, right whale foraging behaviour was used as a scientifically credible surrogate. This approach is consistent with established practice, particularly given evidence that SRWs undertake resting and foraging behaviour in the study region.'

- Neither JASCO or SLR provide specific parameters so difficult to understand specific differences.
- MAI animat report describes only "foraging" behaviour profile - Is foraging appropriate and representative of reproduction?
- JASCO report acknowledges
  - The behaviour of southern right whale mother/calf pairs can be dramatically different from other demographics, particularly in regards to the amount of time spent resting at the surface (Cusano et al. 2019, Nielsen et al. 2019). MAI report and EP have considered Nielsen, but not Cusano.
  - Reproduction behavioural states comprise resting, travelling, and surface active - NARW studies + behavioural probabilities available from studies of southern right whales in South America (Thomas et al. 1984 and Lundquist et al. 2008). MAI report and EP do not appear to have considered these studies. Do these additional studies offer any important insights? May or may not be material.

- 2 animats per km^2 – Over-seeding compared to real-world densities is ok (note less than 6 animats as pers JASCO).
- Monte carlo approach – randomised.

B7c – SLR modelling report

- Animat modelling undertaken separately by Marine Acoustics Inc for SLR. Not undertaken by SLR. Check how the two modelling studies are integrated. SLR single impulse isopleths provided to MAI, but then not clear how SEL24hr fields generated/integrated. May need further info.

Key modelling results (max Rmax km)

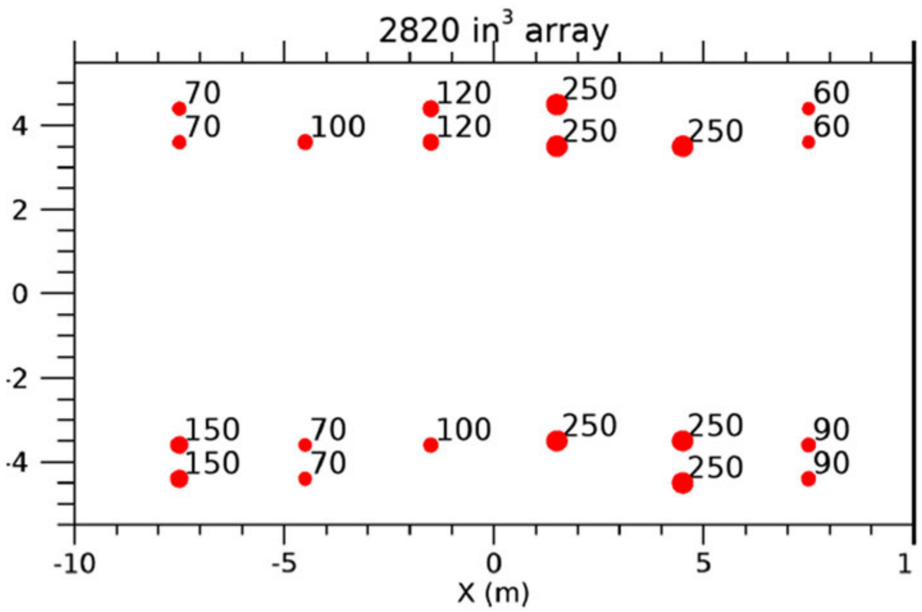
Max Rmax (km)	JASCO 2024 (NMFS 2018)		SLR/MAI 2025 (NMFS 2024)	
	PK	SEL_{24h}	PK	SEL_{24h}
LFC				
PTS	0.03	**5.07**	0.073	**8.53**
TTS	0.09	**41.9**	0.086	**27.92 ?**
HFC				
PTS	-	-	0.055	**0.080**
TTS	-	**0.05**	0.068	**0.600**
VHFC				
PTS	**0.41**	0.07	**0.397**	0.090

TTS	**0.82**	0.35	**1.100**	0.840
OW/Penguins				
PTS	-	-	0.055	0.055
TTS	0.03	**0.06**	0.068	**1.020**
120 dB$_{weighted}$	77.0		10.62	
Turtles				
PTS	0.04	**0.07**	0.051	**1.060**
TTS	0.08	**3.35**	0.064	**6.250**
175 dB SPL disturbance	2.62 km		1.64	
166 dB SPL response	6.3km		Not assessed in modelling. (note E6, s2.2 now refers to 6.25km TTS range for turtles instead of response)	
Fish (swim bladder connection)				
Injury	**0.23**	0.12	0.21	**2.010**
TTS	-	**8.35**	-	**10.95**
Behavioural	N/A - Popper et al (2014) qualitative, relative risk (high risk tens – hundreds of metres; moderate risk thousands of metres) previously applied in EP.		13.81 km (NMFS 150 dB criteria) (note E3, s2.2 now refers to 10.95km TTS range for turtles instead of larger behavioural). Now more conservative, but potential implications for matters raised in socio-economic assessment.	
SPL isopleths				
160	11.8		6.96	
140	58.8		24.18	
120	Not presented		160.62	
SEL isopleths				
160	5.85		Not presented	
140	35.3		Not presented	
120	Not presented		Not presented	
ANIMAT (ER95%)				
PBW foraging				
PTS	1.98		0.127	
TTS	22.5		4.322	
160 SPL	9.83		4.669	
140 SPL	Not presented		18.227	
120 SPL	Not presented		51.773	
SRW migration				
PTS	1.4		0.077	
TTS	13.2		3.642	
160 SPL	9.38		4.606	
140 SPL	Not presented		18.434	
120 SPL	Not presented		50.027	
SRW reproduction				

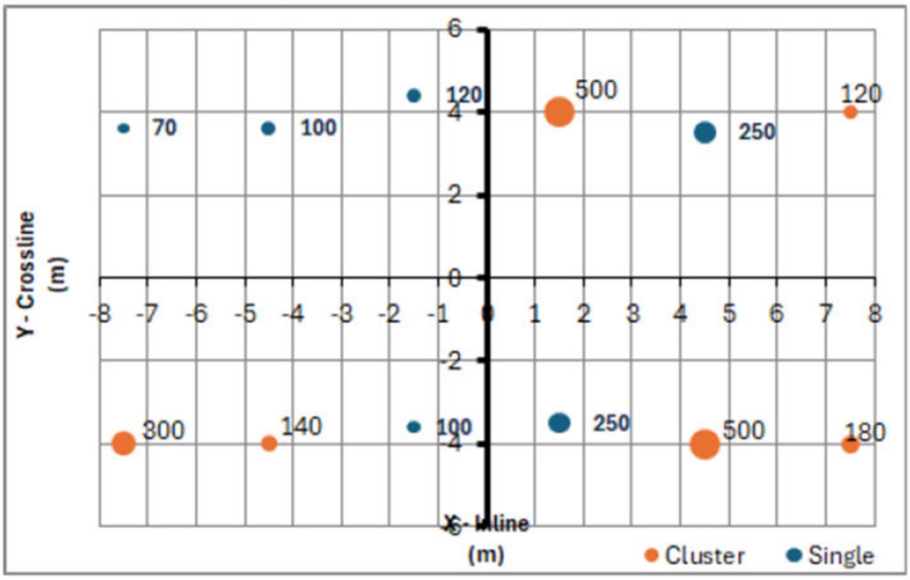
PTS	Nil exposures when seeding restricted to HCTS (**1.26** unrestricted seeding)	0.069
TTS	14.2 when seeding restricted to HCTS (13.2 unrestricted seeding)	3.754
160 SPL	Nil exposures when seeding restricted to HCTS (**9.38** unrestricted seeding)	3.355
140 SPL	Not presented	12.838
120 SPL	Not presented	32.364

Comparison of source characteristics

- Note, Bluepulse option not adopted, assessment focus is on the conventional source differences.
- Total volume reduced from 2820 cui to 2630 cui (190 cui less).
- Array geometry and airgun configuration also relevant.
- Source model for 2630cui source appears to use 500 cui guns in place of 2x 250cui, 300cui instead of 2x 150cui, 140cui instead of 2x 70 cui, 120cui instead of 2x 60cui guns, etc compared with the 2820cui source. The difference in source array is the removal of 1x 70cui at the front and 1x 120 cui in the middle of one string.



2630 CUI)



- SLR source model (Gundalf) provides only vertical ghost source levels.
- SLR PK and source level of reduced 2630 cui conventional source are the same as or higher than JASCO 2,820 cui source (in the vertical plane with ghost reflection)
- PK 256 dB SLR compared with 255.1 dB JASCO
- However, note that SEL source level in vertical plane is 228 dB (<1 kHz) compared with JASCO 230 dB (<2 kHz), so unable to make direct comparison due to not being presented for exact same frequency ranges, but noting additional energy above 1kHZ these values are comparable. SLR do not present SEL for higher frequency category.
- It is noted that in the free-field over distance, there can be some reduction in sound levels not evident from source specifications, however, even sources with a couple of dB different source levels, do not usually result in such significant differences in propagation results as are presented in the new modelling.

<u>JASCO 2024</u>

Table 11. Far-field source level specifications for 2820 in^3 source, for 7 m tow depth. Source levels are for a point-like acoustic source with equivalent far-field acoustic output in the specified direction. Sound level metrics are per-pulse and unweighted.

Direction	Peak source pressure level ($L_{S,pk}$; dB re 1 μPa m)	Per-pulse source SEL ($L_{S,E}$; dB 1 μPa^{2}m^{2}s)	
		10–2000 Hz	2000–25000 Hz
Broadside	249.0	224.3	185.8
Endfire	244.9	222.6	186.4
Vertical	255.1	228.0	194.0
Vertical (surface affected source level)	255.1	230.8	197.0

SLR 2025

Table 15: Noise source levels (Conventional and Bluepulse 2630 CUI)

Acoustic Metric	Conventional	Bluepulse
zero-to-peak sound pressure level, PK ($L_{p,pk}$, dB re 1 µPa @ 1 m)	256	249
root-mean-square sound pressure level, SPL ($L_{p,rms}$, dB re 1 µPa @ 1 m) with a 90%-energy pulse duration	243	237
Unweighted sound exposure level SEL (L_E, dB re µPa^2·s @ 1 m)	228	224

Comparison of modelling locations and scenarios

JASCO (2024)

Table 5. Key parameters of the four accumulated sound exposure level (SEL) scenarios.

Scenario	Array	Impulse interval (m)	Tow direction (°)	Total impulses	Acquisition period (h)
A	Triple 2820 in^3 seismic source	12.5	113/293	8000	11.9
B				8116	12.46
C				13508	20.26
D				13248	20.16

Table 6. Location details for the single-impulse modelled sites. Each site was modelled for both tow directions applicable to the modelling of the scenarios of 24 hour operation.

Site	Scenario(s)	Tow directions (°)	Latitude (°S)	Longitude (°E)	MGA[1] Zone 54		Water depth (m)
					X (m)	Y (m)	
1	A, B	113/293	38° 32' 14.47"	142° 13' 18.17"	606478	5733855	49.1
2			38° 34' 46.30"	142° 18' 36.24"	614112	5729068	54.8
3			38° 37' 42.81"	142° 25' 11.06"	623581	5723485	63.9
4	C, D		38° 47' 44.74"	142° 29' 15.08"	629180	5704837	81.0
5	B, C, D		38° 39' 09.22"	142° 03' 04.80"	591481	5721254	61.9
6			38° 42' 40.30"	142° 13' 44.82"	606865	5714555	71.1
7	C, D		38° 54' 13.43"	142° 24' 11.18"	621664	5692971	124.9
8	D		38° 50' 31.49"	142° 12' 53.35"	605428	5700047	173.6
9			38° 46' 28.15"	142° 00' 39.98"	587832	5707763	166.5
10	C		38° 50' 59.78"	142° 52' 42.94"	663020	5698199	67.4
11			38° 46' 49.37"	142° 39' 47.20"	644460	5706281	72.0
12	C, D		38° 53' 08.30"	142° 39' 59.06"	644533	5694594	84.0
13			38° 58' 41.40"	142° 37' 18.31"	640477	5684395	99.0
14	A, B, C		38° 41' 11.94"	142° 26' 08.44"	624867	5717017	69.2
15			38° 34' 10.45"	142° 01' 12.89"	588879	5730494	51.6

[1] Map grid of Australia (MGA)

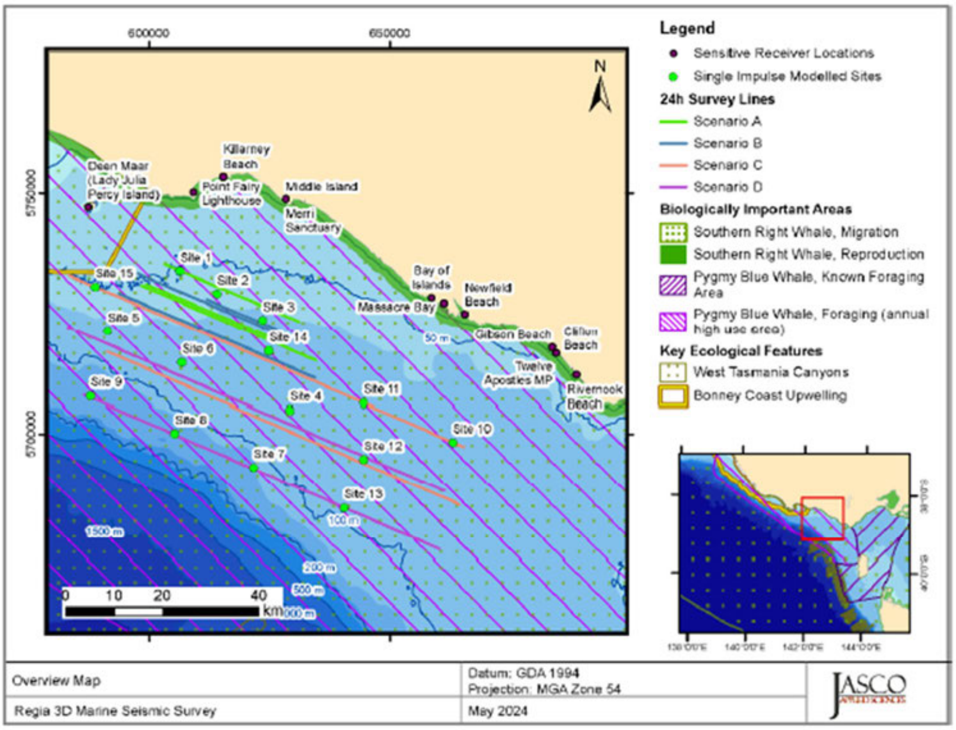


Figure 1. Overview of the single-impulse modelled sites, acquisition lines in the modelled scenarios, and features relevant to the Regia Marine Seismic Survey.

<u>SLR (2025)</u>

Table 13: Details of the selected transect survey lines for the cumulative SEL modelling for scenario C

Scenario C Survey Lines	UTM Coordinates Zone 54H		Distance (m)	Time (hours)	Estimated number of pulses
	Start (m)	End (m)			
1 (sites 15 and 10)	588879 E 5730494 S	668617 E 5695483 S	87,086	10.45	6,967
2	667270 E 5692245 S	610840 E 5716943 S	61,598	7.39	4,928
		Total	148,684	17.84	11,895

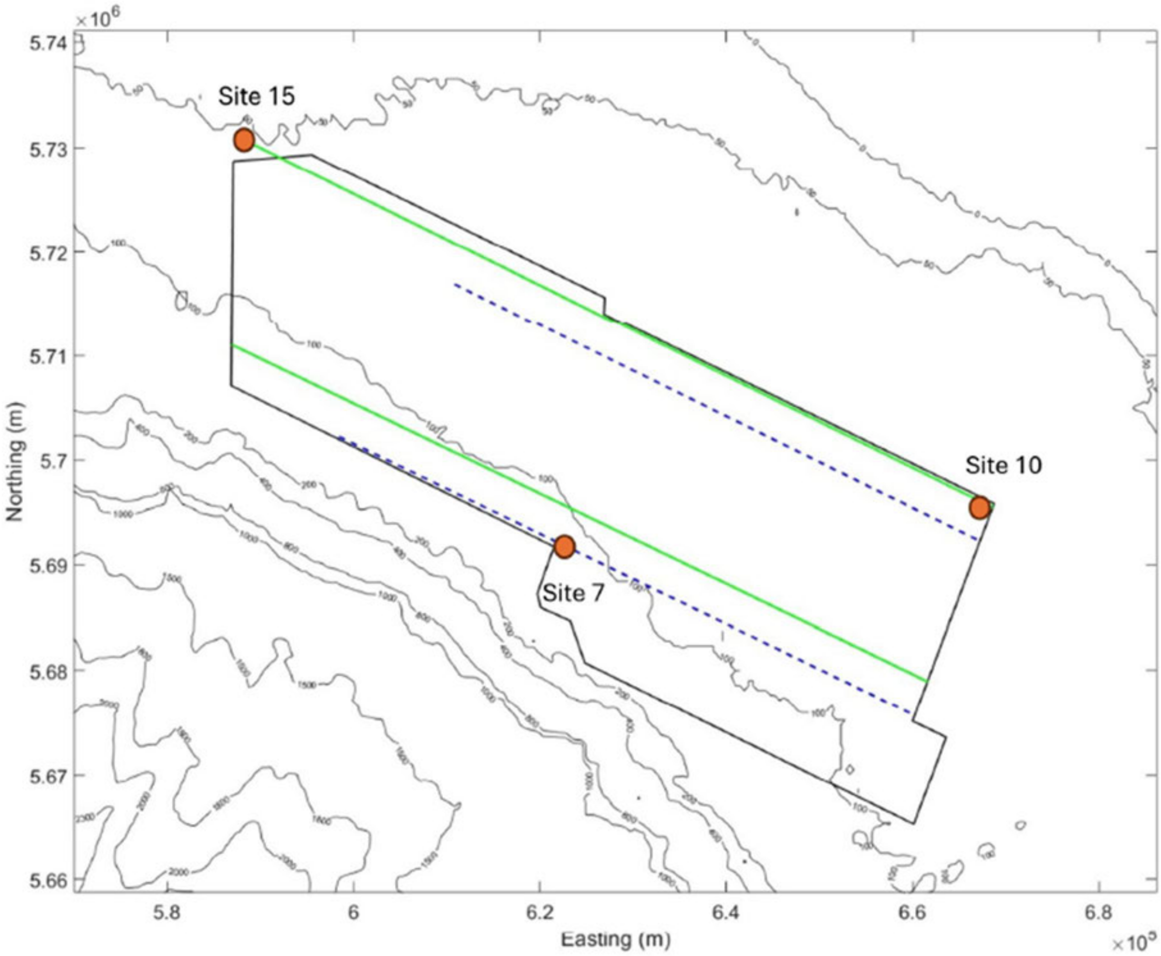
Table 14: Details of the selected transect survey lines for the cumulative SEL modelling for scenario D

Scenario D Survey Lines	UTM Coordinates Zone 54H		Distance (m)	Time (hours)	Estimated number of pulses
	Start (m)	End (m)			
3 (site 7)	586898 E 5711026 S	661636 E 5678916 S	81,340	9.76	6,507
4	660275 E 5675671 S	598431 E 5702221 S	67,300	8.08	5,384
		Total	148,640	17.84	11,891

Table 12: Details of the three selected source locations for the long-range modelling

Source Location	Water Depth, m	UTM Coordinates Zone 54H (m)	Locality
Site 15	51.6	588878 E 5730493 S	Northwest extent of the survey area towards shallow water environments and near Biologically Important Areas (BIAs).
Site 10	67.4	663020 E 5698199 S	Eastern extent of the survey area near Biologically Important Areas (BIAs).
Site 7	124.9	621664 E 5692971 S	Southern extent of the survey area towards deep-water and further from the coast.

Figure 11: Representation of the selected source locations (orange) over the survey area



Map details: WGS 84 / UTM Zone 54 H

- SLR (2025) model locations 7, 10 and 15 correspond with the same locations and water depths as in JASCO (2024).
- SLR (2025) scenarios C and D are broadly similar to JASCO (2024) scenarios C and D.
- Overlay / comparison of the ASA and survey layout from the previous EP revision and the latest shows this has not materially changed and the modelling sites and scenarios align.

- The SLR SEL24h scenarios are informed by fewer standalone sites than the JASCO scenarios. Mid depths not as represented. Not a major concern given limited depth variation represented but could account for some variability between the two studies.
- SLR (2025) scenarios have fewer total impulses in the 24hr assessment period than JASCO (2024) e.g. 11,895 pulses vs 13,508 pulses. Survey area and lines appear to be the same when overlaid. 12.5 SPI is the same. No explanation in EP of why number of impulses has reduced and if this is appropriate. Potentially a longer line turn duration or change in vessel speed (?), noting vessel speed range changed in activity description (Appendix A2).
- Fewer total pulses may result in some reduced SEL accumulation overall, but note that SPI of 12.5 m would remain the same. SEL24hr ranges would still therefore largely be driven by accumulation of SELss in the eastern sections of the line scenarios where two lines lie in parallel and where the greatest accumulation contributions occur.

Consideration of NMFS 2024 vs NMFS 2018

- For low frequency sound source like seismic and LFC, expect this could potentially result in some small relative increase in PTS and TTS ranges for SEL_{24h}, given that NMFS (2024) weighting and exposure function parameters have adjusted to account for slightly more energy under the weighting curve around the lower frequency roll-off (although less at the higher frequency end of the curve).
- E.g. a simple comparison of decidicade (1/3 octave bands) source spectra for a range of airgun arrays adjusted as per NMFS 2018 and NMFS 2024 weightings, demonstrates how broadband levels from weighted spectra are greater in the frequency range <1KHz for NMFS 2024 vs 2018 LFC. If then translated into effect ranges the differences could be in the order of 10-20% greater for NMFS 2024 (for full range of simplistic spreading, which aren't true representations or comparable to modelling, but demonstarte that due to increased energy under the curves some increase in ranges is anticipated from the modelling rather than any reduction).
- Exact ranges would be more accurately predicted using modelling, but proportionately, we'd expect NMFS (2024) to result in some increase in SEL24h TTS ranges for LFC, not a decrease. Therefore, some trade-off between reductions from source/activity and increase from NMFS weightings.

Initial findings for discussion with team, 6 January 2026

- Small reduction in source volume (noting comparable source levels) expected to result in negligible change to predicted effect ranges
- Change in SEL24h scenario and shot points could result in small change to predicted effect ranges, but SPI and adjacent lines are the same and would influence these results

- NMFS 2024 weightings would likely result in some increase in predicted PTS and TTS ranges.
- Overall, these changes would not explain such substantial differences between JASCO and SLR model predictions.
- Note that SLR PTS and TTS range predictions are generally greater then JASCO results, which could be ok as the more conservative of the two sets of results.
- Unusually, the SLR LFC TTS effect range is substantially smaller (28km, previously 42km) – Not clear why this one should be so different
- SLR behavioural response (SPL) ranges are generally ~half of what JASCO predicted – Not explained why
- SLR/MAI Animat results are approx. half of what JASCO predicted for 160 dB SPL – Not clear why from methods/parameters, explanation provided.
- SLR/MAI Animat results show a marked reduction from the SLR propagation modelling predictions
  - SLR Animat ranges are 1/6 to 1/8 of the propagation ranges
  - JASCO Animat ranges were 1/2 to 1/4 of the propagation ranges
  - SLR Animat ranges 1/5 to 1/6 of JASCO Animat ranges (and an entire order of magnitude smaller if considering PTS in foraging PBWs).
  - Not explained in EP.
  - Don't have behaviour profile parameters from either study so can't compare.
- **EP provides some general insights into modelling approach and acknowledges variability in models, but EP has not adequately explained these**
- **Happy to accept some differences due to model differences, but the EP does not provide information that gives us comfort that the marked reduction in some ranges from the SLR/MAI model predictions should be relied upon.**
- **Implications for our decision if not explained and controls based on least conservative results? Are management measures commensurate with the level of risk and uncertainty put in front of us?**
- **SRW management framework likely ok due to SSV and adaptive/corrective measures, but modelling and controls for other species need further consideration.**

NOPSEMA Acoustic impact evaluation and management information paper

Check of modelling against considerations/principles highlighted in NOPSEMA Acoustic impact evaluation and management information paper and DOC 2016 referenced therein.

Note these are not strict requirements, but considerations

NOPSEMA Information Paper Considerations

- *The level of accuracy and rigour required in the prediction of received sound levels will be informed by the intensity and duration of acoustic emissions in combination with the complexity and sensitivity of the receiving environment.* Regia intensity, complexity/sensitivity require modelling to provide a high level of accuracy and rigour.

- *In all cases, there should be a clearly described justification as to why a particular approach has been taken to predict received sound levels including why this approach is appropriate in the context of: • biological sound receptors in the receiving environment • the spatial and temporal scale of the activity and the nature/intensity of the sound source • the complexity of the operating environment and its potential to influence sound propagation.* Modelling approach justified, but justification of differences between the two methods is not clearly described.
- *It is important that the personnel undertaking the sound prediction exercise have sufficient knowledge and experience with underwater sound modelling and the physics of underwater acoustic propagation to ensure a) they are using the right models/methods, and b) that input parameters are appropriate and results are accurate and make physical sense for the particular activity circumstances.* SLR experienced (although limited recent experience with Seismic in Australia and not aware of previous experience with Animat predictions for this purpose). Marine Acoustics Inc - Dr. William Ellison, Founder / Chief Scientist, 60yrs experience in ocean acoustics, Fellow of Acoustical Society, impact of anthropogenic activities on wildlife. Clients have included US Navy, BOEM, JIP OGP, and others. Very technically capable company with relevant experience in acoustics. Not aware of any experience under Australian policy requirements.
- *The outputs (measures and units) from the received sound level prediction exercise should be appropriate to inform the evaluation of impacts. In particular, the outputs should be comparable with appropriate thresholds for predicting the biological effects identified through an activity specific detailing of impacts.* Applies NMFS, 2024 criteria. But have weightings been adequately accounted for if propagation models only account for up to 1kHz? See review against DOC 2016 below.
- *The outputs should be at an appropriate spatial scale for estimating sound exposure and associated impacts to all relevant biota and their habitats. For example, consideration for the minimum distance between the sound source and sensitive fauna habitats and the position of relevant fauna/habitats relative to the sound source (e.g. seabed below the source and shoals adjacent to the source).* OK
- *The relevant area for modelling should be determined based on the spatial extent of the activity; the spatial extent of potential impacts; and the importance of biological habitats and socio-economic areas.* OK
- *Regardless of modelling approach, predictions of received sound level that directly inform conclusions regarding the likely effectiveness of controls or the demonstration of acceptable impacts should be supported by a desktop evaluation of the validity (i.e. accuracy and precision) of the predictions, e.g. sensitivity analysis of assumed environmental parameters and benchmarking against actual measured data.* This is an issue. Informs conclusions regarding the effectiveness of controls, particularly

controls such as shut down range for blue whales based on the animat modelling predictions. No clear evaluation of validity of SLR report vs JASCO and no sensitivity analysis or parameters, although this is difficult to relate to animat parameters.

- *Sites / areas selected for modelling should be representative of the environmental parameters for which modelling results may be applied (e.g. bathymetry, salinity, seabed composition and temperature) and for many activities more than one modelling site may be required.* OK
- *Limitations and caveats with the chosen modelling/prediction approach should be clearly described* Variability acknowledged but not adequately explained. Model limitations have not been considered.
- *Point-source models with simple acoustic spreading laws are unlikely to be appropriate models for predicting received sound levels from seismic airgun arrays in complex marine environments (see Table 3)* *N/A.*
- Table 3: Underwater acoustic modelling
    - *Accurate and comprehensive model inputs are critically important for successful prediction of sound levels. The nature of the environment, in particular the bathymetry, composition of the seabed, and the sound speed profile of the water column, strongly affect the propagation and attenuation of sound (Farcas et al. 2016).*
        - Bathy:
            - SLR use GEBCO (2022) 4 arc second grid (approx. 120m), JASCO used 9-arc second (Whiteway 2009) bathy extracted and re-gridded to a 200m x 200m resolution.
            - Comparable.
        - SSP:
            - JASCO derived SSP from temperature and salinity profiles from the US Naval Oceanographic Office's Generalized Digital Environmental Model (GDEM) and selected June SSP (winter) - The June sound speed profile is expected to be most favourable to longer-range sound propagation due its upward refracting profile.
            - SLR use World Ocean Atlas 2009 – Winter profile selected as most conservative (unclear if June or another month).
            - Similar/comparable profiles selected by both providers
        - Geoacoustics:
            - JASCO considered several seabed types at different water depths.
                a. <65m water depth – sand layer underlain by variably cemented calcarenite

b. 65m – 120m water depth - sand layer absent, only variably cemented calcarenite at seafloor interface.
c. >120m water depth - Upper slope/shelf break – Silty carbonate sand to semi cemented carbonate.
d. Sites located above the calcarenite seabed generally displayed higher rates of loss at distance away from the source as compared to sites where a layer of sand overlies calcarenite.
e. Based on Australian Government's Marine Sediment Survey (MARS) database (Heap 2009), and McCauley et al. (2016), AIMS 2018

- SLR report to be similar to JASCO, using MARS database (Heap 2009) and McCauley et al. (2016).
- SLR Site 10 and 15 comparable to JASCO <65m water depth.
- Site 7 (>120 m water depth) uses geoacoustics with slightly higher density than JASCO.
- Note that SLR does not appear to consider the same geoacoustic characteristics used by JASCO for 65 – 120 m water depth (calcarenite), which is actually more conservative as calceranite would typically impede sound propagation.
- Despite these differences, the Rmax taken from the JASCO modelling reports are derived from the model locations which aren't dominated by calceranite.
- Results generally based on very similar geoacoustic profiles (speed and attenuation).

- Overall, both providers' model results used for impact predictions appear to be have been based on very similar bathy, SSP, and geoacoustic parameters. No indication these would have caused substantial differences.

○ *Model inputs should be robustly measured or estimated, contain sufficient spatial coverage and resolution throughout the area being modelled, and should be accompanied by explicitly stated measures of certainty and variability.* No issues

○ *Sufficient characterisation of sound source is required for an accurate output and poorly justified or incorrect assumptions regarding the source level, spectrum, and directionality of a sound source are to be avoided.* See further evaluation of sound source characterisation below under DOC 2016.

- *Numerical models are likely to be appropriate for predicting received sound levels in units of biological relevance to receptors* OK

- *There are many numerical models that have been developed to predict sound propagation in the marine environment. The selection of the most suitable method will be influenced by factors such as the sound frequency of the emitting source, the complexity of bathymetry, seabed properties and water depth. More detailed context on numerical model selection is available in a New Zealand Department of Conservation report (DoC, 2016):* https://www.doc.govt.nz/Documents/conservation/marine-and-coastal/seismic-surveys-code-ofconduct/twg-reports-2016/05-scr-sound-mod.pdf See below
- *In circumstances where there is considerable uncertainty in relation to model inputs, model outputs, and the model's limitations, some form of model verification and / or a conservative mitigation approach is likely to be warranted, particularly where the effectiveness of controls relies on accurate sound level predictions.* Uncertainty presented to us highlights need for conservative mitigation and/or model verification.
- Table 3: Model validation:
    - *Comparison of predictions with measured sound levels provides a direct and holistic means of assessing the validity of a model and should be considered when modeling exercises are likely to underestimate received levels due to information gaps and assumptions. Validation data may come from previous recordings of the sound source in the modelled area or from in-situ measurements.*
    - *In cases where environments are highly sensitivity to sound, verification of model outputs may be necessary in order to provide feedback to sound propagation models in order to improve their accuracy and inform adaptations to control measures to ensure they remain effective.*
    - *For successful validation, ideally measurements would be sampled at sufficient resolution over the full range of environmental conditions covered by the model using appropriately calibrated sound monitoring equipment.*
    - SLR modelling reports includes some validation study references which may provide clarity. **Further assessed under DOC (2016) below.**
- *Sufficient information on the methods, inputs, assumptions, limitations and uncertainties of predictions of received sound levels should be clearly presented in EPs and is important for transparency and accurate interpretation.* Information presented in EP and modelling reports describes inputs and assumptions but still does not provide sufficient information to explain deviation in results.
- *It is generally not appropriate to assume that the results of a sound prediction model from one activity scenario can be sensibly applied or extrapolated to provide accurate predictions for another. The availability and suitability of previous modelling and/or sound field verification exercises should be considered when choosing both source and environmental models, however these historic modelling exercises should only be utilized in appropriate circumstances which will be informed by the similarities in the*

acoustic source, bathymetry and geo-acoustic properties of the receiving environment. Noted. NOPSEMA assessment considers the parameters of the SLR modelling as the most current (source volume, scenarios, etc), but also considering similarities in attempt to rationalise the significant differences in predictions presented to us.

- *Predictions of received sound levels should be presented in such a way that it is clear what levels may be received at the seabed directly below a source as well as laterally (endfire and broadside) at the seabed and in the water column.* OK

Detailed review against DOC 2016

Report of the Sound Propagation and Cumulative Exposure Models Technical Working Group Part of the 2015–2016 Seismic Code of Conduct Review process

Having appropriate regard for recommendations that are relevant to Australia/Regia, and not to recommendations that are unique/specific to NZ setting and species.

Section 2.3 - Source and transmission-loss models – choosing, using and applying them

- *The choice of model should be biologically relevant. Models must be able to handle the wide range of frequencies that are biologically relevant.*
    - *While airguns are commonly referred to as only including components below 1 kHz, studies have shown that **considerable energy is also present beyond 10 kHz for ranges beyond 1,300 m, even for only a single airgun (Hermannsen et al. 2015)…***
    - Note, Section 2.3.2.1 also states that source models should be able to model the source to frequencies above 20 kHz.
    - *Higher frequencies attenuate rapidly, and therefore are likely only to be relevant for the consideration of the PTS and TTS thresholds, with the longer-range behavioural response thresholds primarily requiring consideration of low frequencies. This will guide the models and techniques used.*
- *Model selection should be paired to frequency range - While the frequency range of biological interest was defined above, selection of acoustic models must be based on the physical properties of sound waves at the different frequencies. The only truly reliable definition would therefore be that 'high frequencies' are those for which wave effects are unimportant. In practice, you would find this out by running both model types at successively higher frequencies until they agree; then you can reasonably assume the high frequency model will be accurate at frequencies above this. As a rough guide, a ray model should be fine in water depths from a few tens of metres to a few hundred metres, for frequencies of 10 kHz and above, and that you'd need to use a wave model for frequencies of 1 kHz or less. Between 1 kHz and 10 kHz the answer would be 'it depends'. In deeper water, you may or may not be able to push the lower frequency limit of the ray model down, depending on the sound speed profile.*

- SLR Scooter short range model from 1Hz to 1 kHz, RAMGeo long range modelling 8 Hz to 1 kHz.
- How does SLR propagation modelling only to 1kHz adequately account for biologically relevant frequencies and auditory weightings for NMFS (2024) criteria? E.g.:
    - LFC $f1$ = 0.168 kHz, $f2$ = 26.6 kHz
    - HFC $f1$ = 1.73 kHz, $f2$ = 129 kHz
    - VHFC $f1$ = 5.93 kHz, $f2$ = 186 kHz
    - OW $f1$ = 2.53 kHz, $f2$ = 43.8 kHz
- Section 4.3.5 of the SLR modelling report states '*For weighted SEL for individual marine mammal hearing groups, the source spectra are adjusted, accounting for the frequency weighting functions for individual hearing groups (as in Appendix B), and the weighted SEL for individual hearing groups to be obtained by repeating the first two steps as above; <u>For the high-frequency energy component, which is important for marine mammals with high-frequency hearing range, the source spectra and propagation modelling are extended up to 10 kHz</u>, with the source spectra being close to $1/ff$ attenuation for frequencies above 1 kHz (LandrØ et al. 2011), so that the high-frequency energy component to be included for the weighted SEL predictions.*' **This isn't clear if this is limited to high frequency cetaceans, or if LFC has also accounted for up to 10 kHz or just the dominant <1kHz.**
- **If they have accounted for up to 10kHz, it is also unclear if appropriate models have been used for the higher frequencies.**
- **DOC (2016) note "considerable energy beyond 10kHz", so the SLR models potentially account for less of the source frequencies that may be relevant to auditory weighting of the seismic source spectra and reliable model predictions.**
- **This could affect weighted SEL24h predictions for PTS and TTS for all fauna groups (and potentially weighted SPL for penguins). It may not make a substantial difference for LFC. **NEEDS CLARIFICATION****
- Note JASCO modelling (source and propagation model to 25kHz for seismic, and to higher frequencies if required by propagation models), with JASCO noting that '*while airgun signatures are highly repeatable at the low frequencies, which are used for seismic imaging, their sound emissions have a large random component at higher frequencies that cannot be predicted using a deterministic model. Therefore,* [JASCO] *AASM uses a stochastic simulation to predict the high-frequency (800–25,000 Hz) sound emissions of individual airguns, using a data-driven multiple regression model*'. JASCO propagation models also account for propagation at all source frequencies.
- **So, if comparing the two modelling methods, there may be limitations to reliability of SLR propagation model compared with JASCO.**
- **SLR modelling approach may be ok to provide reasonable predictions to use in many applications, but in such a complex and sensitive situation as this one, the**

difference between the two methods (and predictions) is a relevant consideration for why there may be such a big difference in model predictions and whether one approach is more or less accurate/reliable over the other. Not an issue with SLR's modelling services *per se*, but not appropriate or thought through in this case.
- **Fundamentally, it seems that the SLR approach may not account for the frequency ranges required to fully assess against NMFS (2024) criteria.**

Section 2.3.2.1 – Airgun (source) models

- *Source models should be able to model the source to frequencies above 20 kHz*. Ok for SLR (Gundalf) and JASCO (AASM).
- *For environmental assessment, the source models must characterise the source in a biologically relevant way – which relates particularly to the horizontal plane. As a minimum the models should characterise the: • Vertical pressure signature and specifications (both with and without surface reflection) • Horizontal pressure specifications in endfire and broadside directions without surface reflection • Overpressure signature and power spectrum • Azimuthal directivity pattern of source level, for both broadband and one-third octave-bands*.
- Gundalf industrial source model only characterises the vertical pressure signature with surface (ghost) reflection. Does not account for highly anisotropic horizontal components.
- Gundalf has been calibrated/verified against various datasets of near-field recorded signatures and has been verified against other source array sound signature models (Ainslie et al. 2016), as noted in the SLR modelling report, but these are also industrial source models that have the same limitations, not based on field validation measurements.
- Limitations of source models such as Gundalf also more widely recognised, E.g. Jimenez Arranz (2023):
    - Gundalf prediction consists of a far-field signature in the vertical direction with ghost reflection and two frequency-dependent directivity graphs for the crossfire and endfire directions. Obtaining the free-field (i.e., ghost-free) acoustic signature of the array in the direction of interest using this information is simply not possible. The Gundalf output is then a vertical, ghost-affected far-field signature, roughly corrected in amplitude to account for the vertical directivity of the array. This output is not a fair representation of the true free-field acoustic signature of an air gun array at a given direction.
    - While some industry source models have been updated to provide environmental impact modelling capabilities, their accuracy and transparency often still have considerable room for improvement. Benchmarking and comparison of different source models highlighted differences in the spectrum at frequencies above 1 kHz. The mismatch was attributed to

differences in the initial rise time of the primary pulse between different source models.

- **GUNDALF source model limitations, set a starting point that may not be accurate in terms of free-field horizontal components that may affect horizontal sound propagation predictions for environmental assessment purposes.**
- **SLR approach and use of Gundalf may be ok to provide reasonable predictions to use in many applications, but in such a complex and sensitive situation as this one, the difference between the two methods (and predictions) is a relevant consideration for why there may be such a big difference in model predictions and whether one approach is more or less reliable over the other. This is not an issue with SLR's modelling *per se*, more due diligence on CGG/Klarite's part as to which approach would provide accurate and reliable results.**

Section 2.3.3 – Acoustic propagation models

- See potential issues identified above with propagation model frequencies.
- Scooter short range model is a range-independent, wavenumber integration model – DoC (2016) Table 3 suggests that this approach is both physically applicable and computationally practical for low frequencies in a shallow water (shelf) environment.
- RAMGeo long range model is a range dependent parabolic equation model – DoC (2016) Table 3 suggests that this approach is both physically applicable and computationally practical for low frequencies in a shallow water (shelf) environment.
- Scooter and RamGeo are considered appropriate range independent and range independent models for low frequencies only.
- **Note point above re models only modelling to 1kHz (to 10kHz for higher frequency cetaceans), which does not capture all relevant source frequencies or frequency ranges applicable to NMFS (2024) weighting and exposure functions.**
- **DOC (2016) (section 2.3.1.3) also discusses how model selection should be paired with frequency range; noting already that Scooter and RamGeo are modelled to 1 kHz, it is unclear if any models or what models are paired with these to crossover to the higher frequencies (~2 kHz and above) and if these approaches are appropriate, as per Table 3 in DOC (2016).**

2.1 Metrics (characterisation of PK and rms SPL)

- SLR modelling approach uses empirical conversion factors to convert modelled SEL to PK and SPL.
  - SLR notes that the conversion is regarded as conservative for estimating relevant near-field acoustic parameters based on SEL predictions, which may be appropriate for near field ranges such as PK criteria for PTS and TTS (tens of metres).

    - For SPL, differences can vary depending upon distance. Although a range of conversion factors are applied depending on distance, it may not be particularly accurate.
- DOC (2016) highlights how characterisation of rms SPL can be problematic for impulsive sources such as airguns, because the results depend heavily on the integration time chosen. Accurate modelling of the temporal distribution of acoustic energy within a pulse is complex, and results can depend on local environmental parameters – many of which are poorly understood.
- If rms SPL is to be modelled accurately, full waveform modelling must be performed, either using 90% pulse duration or a fast time weighted (t= 0.125s).
    - 90%-rms SPL magnitudes may not reflect how these very short impulses would be perceived by mammalian auditory systems.
    - Fast-time-weighted rms SPLs, computed over a fixed time window of 125 ms, better represent perceived sound levels than the 90%-rms SPL.
- JASCO modelling modelled differences between SEL and SPL with distance using the 125ms fixed time window approach, which is more accurate and reflective of
- Time domain weighting is particularly relevant when applying auditory weighting to SPL, which becomes very complex.
- **SLR conversion factors for SPL may not be accurate for determining SPL (less reliable than JASCO time domain approach).**
- **This has implications for the prediction of SPL (which are noted as being one of the areas of results where significant differences in results are observed).**
- **Significant implications for weighted SPL (such as the OW-weighted SPL for penguins, which has a very unusual and different result. Also, if source model and frequencies captured by propagation models are already limited (above), these predictions will not be reliable.**

Part 3: General guidelines for in-field verification

- Has the sound propagation model ever been properly ground-truthed/validated?
    - Yes, Section 4.3.6 of the SLR report:
        - *The source modelling software Gundalf has been calibrated against various datasets of near-field recorded signatures and has been verified against other source array sound signature models (Ainslie et al. 2016); and*
        - *The short-range and long-range models have been validated against various underwater acoustic measurement programs undertaken by independent third parties, with good agreements between modelled and measured results being reported (e.g., Simon et al. 2018; Li et al. 2021).*
- *Only through a comprehensive G-T exercise it is possible to validate model results, understand and quantify differences, and ultimately identify and refine the parameters that account for the discrepancy.*

- *Model results must therefore consider the depths and locations that could be sampled to facilitate direct comparison with measurements. This might mean providing a separate set of modelling results specifically for G-T, in addition to those results incorporated into the EIA. Modelling studies often focus on maximum exposures of marine mammals or fish, and consequently the results are often presented as 'maximum-over-depth' of sound level on the seabed. G-T studies are typically made with a small number of receivers at fixed depths.*
- *GT metrics should include: Per pulse peak SPL • Per pulse rms SPL (with a specified integration time window) • Per pulse 1 s SEL • Accumulated SEL as appropriate.*
- *To enhance the usefulness of these standardised metrics, G-T studies should: • Clarify the location and depth of both the recorder and the source • Clearly define ranges as slant or horizontal • Display the metrics as a function of source location and known receiver location, in the reporting. The immediate ground-truthing would be limited to single-shot SEL and received pressure levels (with third octave bands and spectra). Sound speed profile measurements are also very important.*
- *Analysis requirements – Standardised integration time – time domain pulse spreading - Integration times need to be consistent across modelling and ground-truthing.*
- Source model verification - Ainslie et al. (2016) – Verification workshop involving JASCO, Schlumberger and Delft. Doesn't specifically mention Gundalf, not clear. Refers to AASM and Agora. Not field validation, just comparison of different industry source models which have the same limitations as Gundalf.
- Propagation model verification – 2 studies referenced:
  - Simon et al. (2018) – Reports found do not appear to be a field verification. Query if correct report referenced.
  - Li et al. (2021) – Not included in references, cannot find.
- Unable to review model verification studies to understand the extent and rigour applied.
- Not possible to determine if relevant metrics all relevant metrics have been validated. However, noting that the SLR model does not use time-domain modelling for SPL, it seems unlikely this has been validated.
- Note numerous validation studies for JASCO models, for seismic and other sources, in Australia and elsewhere globally, and often consistent with the standards described in DOC (2016).
- Overall:
  - Source model only validated against other source models with potentially same limitations. Not in-field validation.
  - Cannot determine if models have been appropriately validated.
  - Apparently not validated as comprehensively as JASCO model.

Animal exposure assessment – Animat modelling

Element/factor	JASCO	SLR / Marine Acoustics Inc.	Notes
Model	JASCO JASMINE JASMINE uses same animal movement parameters and algorithms as 3MB (Houser 2006) https://doi.org/10.1109/JOE.2006.872204	Marine Acoustics Inc (MAI) Acoustic Integration Model (AIM) (Frankel et al., 2002) https://marineacoustics.com/wp-content/uploads/2020/07/Frankel-et-al.-2002_AIM_IEEE.pdf	
Model prediction methods	Stochastic, Monte Carlo-based, randomisation approach	Monte Carlo-based, statistical model	Similar concepts/approach
Integration of SEL_{24h} exposure	Yes, with JASCO MONM and FRAWM model predictions	*MAI report states that SLR provided:* *- track lines* *- weighted single pulse SEL field* *- unweighted SPL field* *- unweighted PK SPL field* *for a single model site along each track line.* s.4.1.1: *These simulated marine mammal movements were integrated with the broadband acoustic received level fields produced by SLR to predict the exposure range for each simulated animal… the predicted sound received level was estimated every 30 seconds (sec) for each animat, which resulted in a sound exposure*	**Based on the methodology described in the MAI report, it is not clear how MAI have modelled exposure range. Areas that would need clarification include:** • **Seems that only single impulse sound fields provided, bot accumulated SEL sound field.** • **Exposure of animals to received sound levels at 30s intervals - how does that accumulate in a manner comparable to SEL accumulated from 5.4s SPI? Could grossly underestimate exposure ranges.**

		history over the modelled duration of the seismic activity. *At each 30-sec time step, every animat was moved according to the programmed rules describing each marine mammal species' behavior, and the received sound level for each animat is recorded (in the same units that were used to specify the source level, e.g., dB rms, SEL or peak). At the end of each time step, the environment of each animat was evaluated, including its three dimensional (3D) location.* *AIM simulates realistic 4D animal movements (3D space and time) and records each animats received level at each time step to create the animats' exposure history. The output of an AIM simulation is the time history of acoustic exposure for each animat. For this modeling effort, the exposure history provides the received level for each modeled animat every 30 sec for the duration of the seismic survey. Animat exposure histories for metrics of maximum sound*	

		pressure level, maximum peak sound pressure level, and sound exposure level were generated and used to estimate the exposure ranges of each species for each modeled scenario. S.4.1.3: *Exposure ranges to acoustic thresholds are calculated using the results of the animat movement modeling. As each animat moves through the acoustic sound field during an AIM simulation, the predicted received sound level is recorded, along with the distance of the animat from the sound source. The cumulative SEL, maximum peak SPL and maximum SPL for each animat is calculated over the duration of the seismic survey. The modeled animats that have predicted sound levels that exceed the regulatory thresholds for the modeled taxa are identified, and the range to those animats' closest point of approach (CPA) (i.e., minimum distance between each animat and the acoustic source) is determined, producing a distribution*	

		of ranges. The 95th percentile of these distances is defined as the exposure range. Concept of ER95 based on CPA is the same for JASCO JASMINE and MAI AIM.	
Seeding density and scaling - PBW	4 animats/km2	2 animats/km2	Higher densities provide a finer probability distribution function (PDF) estimate resolution but require more computational resources. **2/km2 is less conservative but still higher than real-world densities.**
Seeding density and scaling - SRW	4 animats/km2 Reproduction BIA - 6 animats/km2	2 animats/km2	
Sub-models (movement parameters) considered	Travel rate, direction, Dive ascent rate, descent rate, depth, reversals, surface interval	Diving patterns - time limits, depth limits, heading variance, and speed. Aversions Heading variance Residency	Different breakdown of movement parameters, but nothing to suggest one is more appropriate than other. Note Aversions are included in MAI model, but not clear what parameters or assumptions have been applied.
PBW behaviour profiles and parameters	Not specified in JASCO Regia report but the following consistently applied in other recent JASCO animat studies. Feeding PBW: • Moller et al. (2020) (EIO PBW) - Travel rate • Davenport et al. (2022) (EIO PBW) – Surface interval. • Double et al. (2014), Gill (2015) – Shore following, depth limit on seeding.	Movement parameters and dive profiles for PBW foraging from peer-reviewed sources. See Appendix E of Appendix B7c. Appears based on EP species profile, with fewer specifics, but MAI report isn't clear. • Owen et al. 2016 – Feeding depth, dive duration • Davenport et al. (2022) • Irvine et al. (2019) • Goldbogen et al. (2011)	Species-specific studies (e.g., tagging studies) where available, or reasonably extrapolated from related species? Not clear from reports exactly what parameters each provider has used exactly. Previous examples accepted from JASCO have included this additional detail and the approach, parameters

	• Goldbogen et al. (2011) (blue whale) – Ascent/descent rates, bottom following, reversals, probability of reversals, reversal ascent dive rate, reversal descent dive rate, time in reversal • Irvine et al. (2019) (blue whale) – Average depth, surface interval Migrating BWs included Owen et al 2016 and others.	• Möller et al. (2020) Consequently, two animats were created for pygmy blue whales: Male and Female. Mean surface time between dives is approximately 2.5 min (range: 10 s to 6.7 min).	and assumptions have been acceptable. **Neither the JASCO report or the MAI report provided for Regia EP set out the specific values applied to each individual parameter, however, both reference similar/some of the same peer-reviewed sources when describing their behaviour profiles.**
SRW behaviour profiles and parameters	The behaviour of southern right whale mother/calf pairs can be dramatically different from other demographics, particularly in regard to the amount of time spent resting at the surface (Cusano et al. 2019, Nielsen et al. 2019). Therefore, separate behavioural profiles were modelled for mother/calf pairs and for all other demographics. Accordingly, a total of four behavioural profiles were considered for southern right whales: migrating mother with calf, migrating adult with no calf, reproducing adult with calf, reproducing adult with no calf.	Movement parameters for SRW migration, resting and foraging from peer-reviewed sources. See Appendix E of Appendix B7c. Include animats representative of southern right whales (migrating and foraging animats representing mother & calf pair and an adult with no calf). **Foraging behavioural state profile appropriate for reproducing/ calving/nursing?** The **four southern right whale animats** were created using data from tagged North Atlantic (NARW) and Southern right whales	**JASCO developed behaviour profiles for migrating and reproduction (with and without calf). MAI have developed behaviour profiles for migrating and foraging (with and without calf). It is not clear how a foraging behaviour profile would be fully representative of reproduction behaviours, where resting, nursing and time spent at surface are likely to be very different from migrating and foraging behaviours. Potentially, it might not matter in relation to SRWs if the sound transmission modelling does not predict TTS in the reproduction BIA, and depending on how CGG are using the information / managing sound in the reproduction BIA.**

	Migrating SRW: • Mackay et al. 2020 (SRW) - Travel rate • Baumgartner and Mate 2003 and Dombroski et al. 2021 (NARW) – All other parameters Reproducing behavioural profile: • Behavioural states comprise resting, travelling, and surface active. • NARW studies + behavioural probabilities, which were available from studies of southern right whales in South America (Thomas et al. 1984 and Lundquist et al. 2008).	• Baumgartner and Mate (2003) • Dombroski et al. (2021) • Barendse and Best, 2014 • Nielsen et al., 2019 • Mackay et al., 2020 Generally, very consistent references used. Note, no mention of Thomas et al. 1984 and Lundquist et al. 2008 for reproduction behavioural probabilities, which could lead to differences. Neither report presents a comprehensive list of exactly what parameters / values have been used so cannot compare exactly.	JASCO report acknowledges • The behaviour of southern right whale mother/calf pairs can be dramatically different from other demographics, particularly in regards to the amount of time spent resting at the surface (Cusano et al. 2019, Nielsen et al. 2019). MAI report has considered Nielsen, but not Cusano. • Reproduction behavioural states comprise resting, travelling, and surface active - NARW studies + behavioural probabilities available from studies of southern right whales in South America (Thomas et al. 1984 and Lundquist et al. 2008). MAI report and EP do not appear to have considered these studies. Impossible to know if interpretation of these additional studies and application into behaviour profiles would offer any insight into the differences in Animat modelling results.

Parameter distribution	Gaussian/normal	All parameters except speed use a uniform distribution between the minimum and maximum values. Speed parameters include the minimum and maximum as well as the statistical distribution used to select speed values. Options include a normal distribution and a gamma distribution. When gamma distributions are specified, they are typically the result of fitting to an existing dataset. The mean of the normal distribution is also the mean of the minimum and maximum speed. The minimum and maximum values are four standard deviations below or above the distribution mean.	No particular concerns.
Aversion or directional bias applied?	Appendix D of the JASCO report clearly states that aversion was not considered. Directional (e.g. migration) bias not specified in Regia JASCO report. Previously not applied migration bias for conservatism (foraging/ aggregating).	Not specified in MAI report. Section 7.3 of the EP states that modelling did not incorporate avoidance directional movement or biologically informed horizontal travel paths in the Animat model.	**Not clear. Would require clarification.** This was flagged during meetings. The text in Section 7.3 of the EP appears to be residual / reframing of a statement that was previously written in relation to JASCO modelling. Not clear from MAI report if this is accurate. MAI report discusses

	Previously, established precautionary approach in Australia means animal aversion is not assumed to occur.		aversion parameters, but does not state what assumptions were made re aversion. Common practice in the US to apply aversion assumptions. **This could significantly alter results.**

Summary of Findings – Modelling

- Significant / unusual differences noted in modelling results between JASCO and SLR, in particular:
    - LFC TTS (potentially)
    - All SPLs results (unweighted and weighted)
    - Reduction in exposure ranges predicted using Animat modelling
- Differences in the modelling are acknowledged in the EP: "*variation reflects differences in modelling assumptions and computational approaches, rather than discrepancies in technical quality or robustness*".
- However, reasons for differences are not adequately explained or addressed in the EP.
- NOPSEMA review of JASCO and SLR modelling methods indicate:
    - Environmental parameters (bathymetry, SSP, geoacsoutics) reasonably comparable and unlikely to have contributed to such material differences.
    - Small reduction in seismic source would not account for such large changes (noting that modelled source levels also demonstrate negligible difference).
    - Differences in total number of shot points in SEL24h scenarios are unlikely to not account for such large changes (noting that the SLR scenarios align with JASCO scenarios, SPI remains 12.5 m and lines remain parallel/adjacent to one another where sound energy would primarily accumulate).
- Proper incorporation of NMFS (2024) weightings are expected to increase TTS effects ranges for LFC, not reduce ranges.
- So potential for small reduction from change in source/activity parameters, but potential for small increase from incorporation of NMFS (2024) weightings.
- Reviewed against NOPSEMA's information paper and DOC (2016) referenced therein, identifies a number of potential limitations with the SLR modelling approach when compared with the JASCO modelling report, which reduces confidence in the SLR approach:
    - Limitations of SLR source model (Gundalf) - Does not account for highly anisotropic horizontal components - not a fair representation of the true free-field acoustic signature of an air gun array at a given direction.
    - Acoustic propagation models:
        - Appear to model only to 1kHz (or to 10 kHz for HFC), which would not account for full frequency range of seismic source or the biologically relevant frequencies required to properly assess against NMFS (2024) weighting and exposure criteria.
        - Are suitable only for low frequency components, but no information is provided that demonstrates that the models used are suitable for modelling higher frequency components (above ~2 kHz).

    - Use of conversion factors to obtain PK and SPL from modelled SEL is not as accurate/site-specific, noting that SLR models do not use time domain (time integration) approach to predict SPLs (JASCO approach is more robust).
    - Noting possible limitations identified above in relation to frequency weightings and lack of time domain modelling, the accuracy and reliability of weighted SPL results is questionable. E.g. weighted 120 dB SPL for penguins reduced to 10.6km, noting negligible difference in source levels, and accounting for NMFS (2024) weightings.
- Differences in Animat results between JASCO and SLR are significant. The reduction evident from the Animat modelling from predicted effects ranges using SLRs propagation models is also significant and highly unusual, and not explained. Potentially areas that would require clarification/improvement are:
    - Integration of modelling and exposure – MAI report suggests that single impulse isopleths have been incorporated and there is a 30s time-step. This does not align with the SPI of the survey and could significantly underestimate.
    - Unclear from MAI report if aversion or directional bias has been included.
    - SRW behaviour profiles – not clear if foraging profile is appropriate for reproduction.
    - Lack of transparency of parameters from JASCO and SLR, difficult to make meaningful comparison. Do not need to be same, but clearer that they are reasonable.

Would need these potential issues to be clarified and addressed.

DISCUSS HOW WE CONSIDER THESE ISSUES AND OPTIONS AVAILABLE

Note:

- NOPSEMA communicated to CGG that if they are doing different modelling, the EP will need to justify the modelling approach, why it is representative and account for differences, apply conservatism for uncertainty
- Initial SLR model results for PBW were reduced, but plausible and CGG had presented controls, e.g. shut down for PBWs, seemingly applying conservatism.
- Final meeting with CGG revealed significantly reduced model ranges and we noted this was unusual and how important it is to account for the reasons and apply conservatism.
- Controls (e.g. 5km shut down for PBWs) lean on the least conservative predictions.
- SSV is included.
- Corrective/adaptive measures only provided for SRWs, not for BWs or other fauna if measured propagation ranges turn out to be greater than predicted. And does the EP demonstrate that control measures can be effective if the actual distances are uncertain?

………

Letter point 2.2 – SRW

The EP does not demonstrate that potential impacts and risks of underwater sound emissions will be of an acceptable level – Southern Right Whales

Issue: The EP does not demonstrate that the activity can be undertaken in a manner that is consistent with the National Recovery Plan for the Southern Right Whale. In particular, the EP does not demonstrate that the Regia MSS will not prevent any southern right whale (SRW) from utilising the reproduction BIA (habitat critical to survival), or that the risk of behavioural disturbance is minimised.

Reasons: The EP does not adequately demonstrate that the activity will be undertaken in a manner that is not inconsistent with the National Recovery Plan for the Southern Right Whale.

Southern right whales are particularly vulnerable during breeding, calving and nursing, and there is significant scientific uncertainty associated with behavioural responses of southern right whales to seismic or other similar sound disturbance during these critical life stages. The thresholds used in the EP to predict acoustic impacts to southern right whale reproduction behaviours are not sufficiently low enough, to ensure that all impacts and risks are adequately evaluated or managed to meet the requirements of the recovery plan.

The Regia MSS is proposed to avoid the period of peak SRW abundance (July and August). However, avoidance of July and August does not demonstrate that it will prevent any southern right whale from utilising the reproduction BIA and HCTS. This is because female SRWs accompanied by a calf generally occupy the calving grounds for 2 to 3 months, with the majority of first sightings in coastal waters occurring in May or June, with last sightings occurring in September or into October. There remains the potential for some females and calves to experience several weeks of repeated or sustained exposures to elevated levels of underwater sound during either of the proposed Regia MSS survey windows. Consequently, the EP does not demonstrate that the Regia MSS will not prevent any SRW from utilising the reproduction BIA or that the risk of behavioural disturbance is minimised.

Titleholder response: Further discussion has been added to Appendix A2, Appendix E7, and Appendix F3 to adopt a series of measures to reduce impacts and manage uncertainty to SRW. These include:

• Eliminated April to June window, eliminated the early September period (1st - 15th).

• Extended season exclusion of northerly lines (from 1-20 to 1-30), so we’re no closer than 42 km away from the SRW reproduction BIA during September and October.

• Reduced the source size, remodelled, with distances to behavioural effects <5 km @ 160 dB SPL, and <13 km @ 140 SPL.

• Committed to expanding and updating the ambient sound baseline in the region.

• Included a comprehensive sound source verification procedure (new Appendix G6).

• Expanded our coastal detection program to include multiple drone-enabled MFO teams (new Appendix G5).

• Committed to shutdowns for any SRW detection within a new shutdown zone of ~ 10,500 km2.

• Committed to a 'live' ambient monitoring program, which can detect impulsive sound signals at the extremities of the survey, proximate to the SRW reproduction BIA.

– Detection approach directly aligned with recommendations from relevant experts (Marotte et al 2022).

– Shut down for detection of any impulsive sound signal above the ultra-conservative level of 120 dB SPL in September, and 140 dB SPL in October.

This extensive set of commitments is clearly a significant reduction in impacts, well beyond ALARP levels, to ensure impacts to SRW will be of an acceptable level. This has been further demonstrated in Appendix F3 in the s3.1.5 where specific consideration of uncertainty occurs. Further, there is a new section in Appendix F4 on compliance with the EPBC Act policies and plans, specifically the SRW National Recovery Plan.

NOPSEMA review and findings:

Appendix A2 – Activity Description

Activity description and limitations now include following key details relevant to SRWs:

- Source volume reduced from 2820 to 2630 cui
- In September, October, November or December, the acquisition lines will be acquired working from the deepest lines first. Need to consider what is meant by deepest – From the furthest out (67?), of simply anywhere in the lines 31-67?
- No petroleum activity to be carried out between 1 January and 15 September – This avoids most of the SRW migration and reproduction periods, with tail end of reproduction (i.e. late Sept/October) and migration (October) remaining with potential for exposure.
- Only commence lines 1 -30 after 1 November and if SRW are confirmed to have been absent from the reproduction BIA (between and inclusive of Cape Bridgewater and Cape Otway) for 24-hours. Reasonable given it is very likely that SRWs will have departed long before November so low level of risk.

- No longer ADM - PAM buoys repurposed from primary use for detection to ambient noise monitoring and sound verification

Appendix B8 – Seismic Studies Summary

EDITORIAL: Section 8 Marine mammals updated to reference Accomando et al 2025, but not NMFS 2024. Still advocates for NMFS (2018) incorporating the best available science and criteria to inform assessment of PTS and TTS. Appendix B appears to put forward NMFS 2018 and Accomando et al (2025) as the appropriate criteria, don't mention NMFS (2024).

Note: Section 8 includes reference to Wood et al. (2012), but has not but has not been updated to reflect the correct levels and probabilities relevant to mysticetes, or to acknowledge that these levels refer to migrating mysticetes (i.e. no acknowledgement of 120dB), or apply appropriate conservatism that may be appropriate for sensitive reproduction life stage or considering effects to 'any whale' (individual) whales.

Section 8 includes an update to include Darias-O'Hara et al. (2025), acknowledging the median 139 dB level for seismic, but lack of consensus and considerable uncertainty. The report fairly highlights how Darias-O'Hara et al. (2025) states that the elicitation process revealed "*significant uncertainty – driven by a lack of data – on how marine mammal species respond to these sound sources," particularly when attempting to apply results from different species, sound sources, or regions to Antarctic EIAs. The authors reinforce this point, stating that "the distributions clearly highlight the uncertainty associated with these thresholds. Critically, these behavioural response thresholds are restricted to the scenarios and assumptions in this elicitation. Specifically, these thresholds are appropriate for use in applications in Antarctic waters where the definition of response is the same as applied here*."

Section 8 also notes (in relation to Darias-O'Hara et al. (2025)) that 'whether these responses result in meaningful biological impacts depends on several external factors, including activity duration, individual health, prey availability, and recovery capacity. While the thresholds reflect expert judgement certainty, the accompanying dose–response functions capture variability and uncertainty within and between species.'

Note: While the EP reasonably point out that Darias-O'Hara et al. (2025) may not be appropriate for scenarios outside the Antarctic, and question whether some responses would result in meaningful biological impacts, the following appear to be missed:

- Section 8 recognises Darias-O'Hara et al. (2025) presents median levels (50th percentile), but does not acknowledge lower probability levels.
- Section 8 does not acknowledge other points made clear by Darias-O'Hara et al. (2025):
  - that the distributions on response curves clearly highlight the uncertainty associated with thresholds.

  - that mother-calf pairs are more likely to elicit more adverse, and quicker responses to sound sources than their conspecifics, and the paper's elicited thresholds may not consider the most vulnerable individuals (e.g. calves).
  - that the scenarios considered were based on short term exposure of individuals and are not to be utilised in the assessment of long term or repeated exposures. NOPSEMA has highlighted the uncertainty about sustained or repeated exposure over the duration of the Regia MSS to CGG on several occasions.
- Section 8 notes that some responses might not result in biologically significant impacts. The Darias-O'Hara et al. (2025) methodology defined significant response as any level of behavioural response which has the possibility to impact an individual's fitness (i.e. response score of 4 or above from Southall et al. 2021) so the definition of response in Darias-O'Hara et al. (2025) considers that response may affect an individual's fitness – this is important in the context of recovery plans that require consideration of individuals ("any whale").

Appendix E7 – Underwater sound impact assessment - Marine mammals

Section 4.3.6 - Desc of Env:

  - SRW description appropriate re presence, life stage history, behaviours, BIAs, timing, population and recovery.

Section 6 - Defined acceptable level of impact:

  - **ISSUE/EDITORIAL:** errors confusing NMFS 2016, 2018, 2024 and Accomando et al. 2025. **Does not even mention NMFS (2024) for PTS/TTS**
  - **Mentions NMFS (2024) in relation to behavioural disturbance criterion**
  - Defined acceptable levels applicable to SRW:
    - REMOVED 160 dB for behavioural. OK.
    - Actions within and adjacent to southern right whale BIAs and HCTS should demonstrate that they do not prevent any southern right whale from utilising the area or cause auditory impairment. OK, consistent with RP. Does the EP demonstrate that this is achieved?
    - Actions within and adjacent to southern right whale BIAs and HCTS should demonstrate that they minimise behavioural disturbance. OK, consistent with RP. Does the EP demonstrate that this is achieved?
    - Sound exposure levels to southern right whales must be below a TTS per pulse and TTS 24 hr SEL thresholds of 216 dB and 168 dB respectively. The intent of this is ok, noting that they would shut down (or apply other mitigation) if a SRW was detected within ranges corresponding with these thresholds in order to reduce potential for TTS.

    - Exposure of marine mammals to impulsive sound will not result in population-level effects. Ok intent, but potentially superfluous given need to be consistent with recovery plan which gives consideration to individuals, on the basis that impacts to individuals could impact the recovery of the population.

Section 8 - Elimination and substitution:

- No activity 1 Jan to 15 Sept – Reasonable explanation provided re SRWs and BWs
- Reduced source volume
- Only commence lines 1 -30 after 1 November and if SRW are confirmed to have been absent from the reproduction BIA (between and inclusive of Cape Bridgewater and Cape Otway) for 24-hours since last observation.
- The acquisition lines will be acquired working from the deepest lines first.

Section 9 – Predicted impacts

- References new modelling. **ISSUE:** Animat distances – See modelling review above.
- 4km shut down for TTS, 5 km shutdown for behavioural (160 dB) – Based on animat SRW cow-calf pairs in reproduction BIA
- Precautionary shutdown measure of 13km for any SRW based on 140 dB – To any SRW anywhere? Subsequent text contradicts by referring again to the 5km shut down zone so unclear. FMP does not refer to 13 km but now includes SRW shutdown area, though seaward boundary appears to correspond with 13km.
- No mention in Section 9 of lower levels for reproduction.
- **Section 9.3 Measures adopted:**
    - Approach to SRW not reliant on modelling as is about SSV and measured received levels.
    - SEA, EA, MFO, PAM, relief PAM/MFO, Whale Expert panel
    - Spotter vessel
    - Spotter vessel procedure:
        - May to October (SRW):
            - Spotter vessel 20 km shoreward
            - Scouting mode – reconnaissance 20 km ahead of the survey vessel before commencement of the survey and each line turn
            - Sentry mode – 20 km shoreward
            - When/what determines sentry/scouting modes?
        - Nov – Dec (BW):
            - Sentry mode – 20 km west of seismic vessel

    - Scouting – 10 km ahead of survey vessel before commencement of the survey and each line turn (10 km footnote justification missing)
  - *20 km separation distance is informed by the performance of the PAM systems installed on both the seismic and spotter vessels, each capable of detecting whales at ranges of ~10 km. By positioning the spotter vessel 20 km away from the seismic vessel, CGG maximises combined detection coverage and enhances the likelihood of detecting Southern Right Whales and Blue Whales.*
- Pre-survey and aerial surveillance procedures – See FMP
- Pre-start up procedure – See FMP
- Start-up procedure – See FMP
- Start-up delay procedure – See FMP
- Operating and shutdown procedures – See FMP
- Night time/low vis – See FMP
- Marine fauna detection and observation zone of 40+ km horizontal radius from the seismic source
  - *By deploying PAM systems on both the seismic vessel and spotter vessel, each capable of detecting whales out to 10 km, the project achieves 40 km of continuous linear monitoring coverage. When the vessels are positioned approximately 20 km apart along the survey line, each PAM system contributes 20 km of linear detection capability (10 km port and 10 km starboard). Together, these form a seamless 40 km detection corridor, significantly enhancing early-warning potential for whales moving toward the survey area.*
- 30 min soft start
- Seismic on paper, FMP, sail line plan, compliance assurance procedures

Section 9.3 Fauna Detection:

- **Issue/Editorial:** Sections 9.3.1 and 9.3.3 still include some references to ADM. Section 9.33 still discusses ADM, '*subject to a successful test deployment prior to commencement of the survey*'.
- Some parts of the EP (E7) still reference ADM for whale detection subject to trial – Passage of time and focus only on F3?
- 9.3.3.1 MFOs
  - In optimal weather conditions, visual observations are effective up to ~5 km from the survey vessel.
  - Officers of the watch trained in identifying whales.

- 9.3.3.2 PAM
    - Detection range of ~10 km from the survey vessel
    - Primary detection method during night and low visibility.
- 9.3.4 Aerial surveillance
    - UAVs/drones – SRW reproduction BIA and PBW in/out Otway – Whale presence and distribution in the broader region.
    - Complements vessel obs, PAM and land-based visual monitoring.
    - Cape Bridgewater to Cape Otway – Whale Monitoring Teams – PICs and MFOs. Nearshore and mid-shelf up to 40 km offshore.
    - Whale coastal monitoring programme and FMP set out the various observation and detection methods, generally good.
- 9.3.5 Adaptive approach to monitoring
    - Additional and adaptive approaches may be deployed subject to the advice of the Whale Expert Panel, namely, deployment of additional aerial surveys during the Regia MSS (in addition to a minimum of one (1) aerial survey prior to commencement of the Regia MSS).

Section 10 – Demonstration of acceptable impacts

- No material changes. Potential issues identified below, although not raised previously.
- Defined acceptable level: *Actions within and adjacent to southern right whale BIAs and HCTS should demonstrate that it does not prevent any southern right whale from utilising the area or cause auditory impairment.*
- Defined acceptable level: *Actions within and adjacent to southern right whale BIAs and HCTS should demonstrate that it minimises behaviour disturbance*.
- ‘*the impact assessment sets out reasoned and supported rational for why it is not feasible for very high frequency and low frequency cetaceans to remain in close enough proximity to the seismic source for cumulative exposure to practically occur over 24 hours*.’
- Temporary and reversible
- Small scale
    - VHF / HF justification talks about they can move to other parts of their BIA, but there are no BIAs
    - Re BW and SRW, it talks about 160 dB as percentage of foraging and migration BIAs (i.e. rest of the BIA is available), though this is not relevant in the context of the RPs which talk about displacement / utilisation by individual. Also, only true based on instantaneous levels >160dB.

    - Natural variation – Discusses areas and periods important for foraging and reproduction will be avoided (injury). Behaviour only considers instantaneous levels, strong unsupported statements.

Section 11 - EPOs

- Still inconsistencies and ambiguity in wording of EPOs.
    - 'If sighted, shutdown' *vs* 'if sighted in reproduction BIA, shut down' and '13 km shutdown zone' (based on new animat modelling?).
    - SSV for exceeding 120 dB – Purpose of monitoring ambient??
    - EPO in F3 impact assessment, justified which consistent with RP actions (prevent utilise, minimise): *No behavioural disturbance will occur to any SRW within the reproduction BIA as a result of the Regia MSS.*
        - EPO at end of F3: *As a result of the implementation of real-time monitoring and activity limitations, SRW are not exposed to sound levels that cause behavioural disturbance within or adjacent to BIAs or HCTS.*
        - EPO in G1: *As a result of the implementation of real-time monitoring and activity limitations, SRW are not exposed to sound levels that cause substantial behavioural disturbance within or adjacent to BIAs or HCTS.*
    - EPO: *As a result of the implementation of real-time monitoring and activity limitations, SRW are not exposed to sound levels that cause sustained behavioural disturbance within or adjacent to BIAs or HCTS*.
        - EPO not clearly linked to acceptable levels. How does "sustained behavioural disturbance" relate to "minimised"?

Appendix F2 – ALARP

- A lot appears outdated, Not followed their process.
- Still includes ADM – Does not align with selected controls. Not updated to explain why rejected (e.g. not proven, challenges detecting SRW calls)
- Still includes aerial surveys
- Not all controls assessed or scored in Table F2-14. Not clear if controls are adopted or not
- 6.5.3 Alternative, additional, improved control measures. Not scored like those in Table F2-14.
    - Bluepulse, Vibroseis ruled out
    - UAVs (onshore) adopted
    - Gliders rejected – on basis of already achieving coverage with network of static PAM buoys.
    - PAM adopted on spotter vessel. Nov/Dec all vessels PAM readiness assessment – preferential selection. *Where full PAM deployment is not*

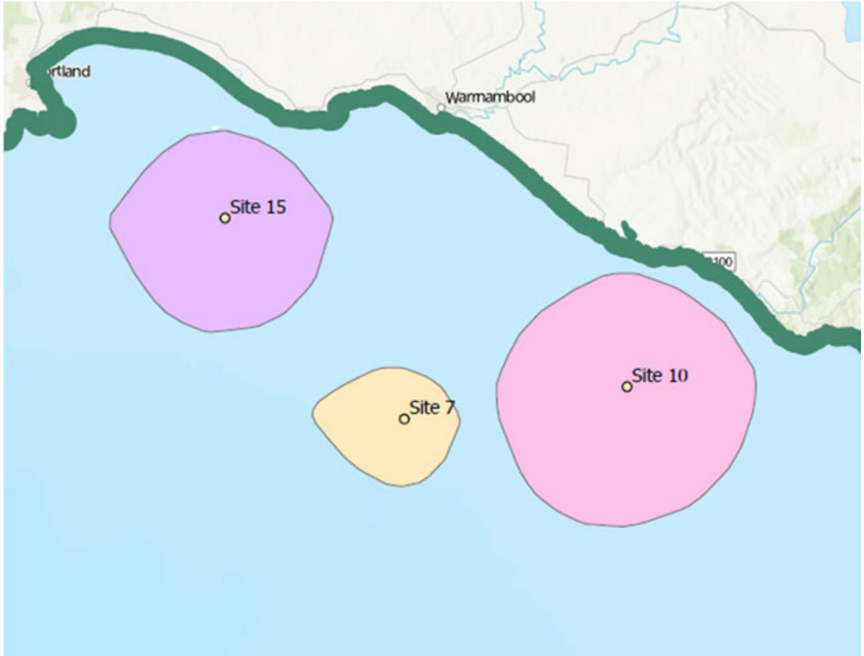
possible, CGG will implement alternative monitoring arrangements to ensure environmental performance outcomes are met.

- Figure F2-7 ALARP Assessment Results is out of date

Appendix F3 – Further assessment

Section 3.1 – SRW

- Reference Darias-O'Hara et al (2025) median (50%ile) 139 dB - Considering that the thresholds apply only under the assumptions and Antarctic scenarios assessed. While the values provide a conservative indication of where behavioural responses may begin, their biological significance depends on multiple external factors, and the study is positioned as an early step requiring further research to strengthen regulatory assessment. While reasonable to point out the caveat that the study is intended for Antarctic scenarios, the distribution of response is based on a body of relevant available literature and demonstrates the uncertainty. What about less than 50th percentile or consideration of sensitive reproduction/calves.
- Timing of residence in BIA (Charlton et al. 2025) mean residency for CC pairs 3.5 months; site fidelity 57.6% of females sighted multiple years (1984-2019).
- Klarite 2025 SRW Monitoring programme (July-October) – Provides 2025 montioring data in potential absence/delay in availability of WhaleFace data. 4 cow calf pairs July - Sept.
- Tested onshore MFOs and local citizen science.
- Behavioural effects from other stressors – Notable, but not comparable contexts/activities
- **Section 3.1.2.1 Behavioural effects**
    - References Richardson et al. (1999) studies with levels down to 120 dB.
    - References Wood et al. (2012), but no updates to correct the levels, or acknowledge for 120, 140, 160 dB for migrating mysticetes.
- **Section 3.1.2.4 – Behavioural Disturbance Within and Adjacent to the SRW Reproduction BIA**
    - Engages with the relevant recovery actions
    - Acknowledge that behavioural responses can still occur at levels less than 140 dB, but low severity.
    - Ambient 90 -158 dB, with mean of ~110 dB – Distinguish between natural variability and activity.



- EPO ***– No behavioural disturbance will occur to any SRW within the reproduction BIA as a result of the Regia MSS.***
  - Characterise the ambient baseline sound levels in the reproduction BIA recognising variation
  - SSV as close as possible to Reproduction BIA – activity sound does not elevate above defined ambient ranges during sampling periods.
  - Real-time decision making.

CHECK

Shoreline observations, offshore monitoring platforms, aerial surveys, and acoustic detection systems.

Controls

- Removes reliance on modelled behavioural effect distances
- **If any SRW is detected within the reproduction BIA, the seismic source will be shutdown. Restart of the seismic source will only occur once monitoring confirms that SRWs have departed the reproduction BIA, ensuring actions must not prevent whales from utilising the area.**
- May 2025 – Oct 2025
    - SRW monitoring – validate observation locations and citizen science, 2025 season
- Oct 2025 – April 2026
    - Extended ambient sound recording – Jan-Apr relevant to the time of year?
    - Aerial surveillance prep – See Appendix G5)
- May – July 2026
    - SRW monitoring
    - Pre-survey aerial surveillance of nearshore/reproduction BIA
    - Ongoing ambient sound logging.
- 1 Aug to 15 Sept
    - All detection programs and platforms
    - Deploy and calibrate SSV
    - Seismic on paper
    - Pre-survey aerial surveillance (likely onshore drones)
- 16 Sept – 31 Oct
    - Shut down the sound source if impulsive noise levels exceeding 120 dB SPL are repeatedly detected by the SSV buoys.
    - In October, if there have been 14 consecutive days without a confirmed SRW detection, the shutdown trigger for repeated impulsive-noise exceedances increases to 140 dB SPL.
    - Shutdown the sound source upon “confirmed detection” of any SRW from any detection platform. Soft restart of the survey can only commence when there have been no confirmed detections of a SRW across all the platforms for a period of 24 hours. Anywhere or reproduction BIA?
    - Investigate all “unconfirmed detections” of SRW from any information platform or program within 12 hours.
    - Gather ambient and received sound levels throughout the survey from locations just outside the reproduction BIA via SSV buoys. What is the

purpose of the ambient noise data collection, if controls now relate to 120dB – is this now redundant/superfluous? Set condition for having independent expertise involved in SSV?

- Investigate potential causes for pre-defined exceedances of ambient sound levels as detected by any SSV buoy.
- Soft (re)start of the survey can only commence if the sound source detected by SSV buoys is confirmed not to be from the Regia MSS. and it is during daylight hours.
- The spotter vessel will travel parallel to the seismic vessel, 20km away and on the northerly side, while it is acquiring lines 31-67.

- Reasonable rationale as to why meets RP requirements and acceptable level

EPO

As a result of the implementation of real-time monitoring and activity limitations, SRW are not exposed to sound levels that cause behavioural disturbance within or adjacent to BIAs or HCTS.

Appendix F4 – Acceptable levels assessment

- Very high level and generic "tick box" type statements.
- F3 Further impact assessment actually explains it better for SRW and puts it into the context of the recovery plan actions (as now referenced the updated defined acceptable levels).
- F3 impact assessment makes reference to a new EPO (effectively "no behavioural disturbance" in it's justification for being acceptable, but this EPO is not included in G1 Environmental performance; a different EPO is instead included which introduces "substantial behavioural disturbance" without defining what this is or explain why this is consistent with the recovery plan actions for 'not preventing utilisation' or enuring 'noise is minimised'.
  - *As a result of the implementation of real-time monitoring and activity limitations, SRW are not exposed to sound levels that cause substantial behavioural disturbance within or adjacent to BIAs or HCTS.*
    - Substantial is ambiguous
    - within or *adjacent to* BIAs or HCTS - no longer spatially defined
    - RP – Activities in or adjacent to, not the disturbance.
- Refer to review in spreadsheet Register in RMS

Appendix G1 – Environmental Performance (p.3634) - UWN

EPOs

- Some EPOs for SRW are incomplete
- Some are not clearly defined / aligned with RP
- EPO in F3 is not included

Appendix G2 – FMP

Steps out controls. See G5 and G6 for specifics of monitoring and SSV.

Appendix G5 – Whale Coastal Monitoring Programme Implementation Plan

Demonstrates coastal, vessel, drone and spotter vessel coverage

Appendix G6 - Sound source verification procedure

- Given control for shutting down if 120 dB exceeded, what is the purpose of the ambient noise monitoring? Potentially just superfluous, so not necessarily a reason to refuse.

Additional notes re Blue Whales

E7 – Section 9:

- Timing – Nov/December - Early PBW and upwelling season – Relatively low numbers based on historical data
- 5 km shut down for TTS and behavioural (Animat) – Query remaining re modelling results and conservatism. 9km for LFC? What distance is appropriate?
- 2km shutdown zone for "whales" (based on PS2.1)
- 9km shutdown zone for LFC (based on SLR modelling of SEL24h for PTS). This distance is actually longer than the JASCO prediction.
- Drifter boys are proposed to validate the modelled sound field. This is important, noting the potential large uncertainty presented by the two modelling reports. However, there is no mention of the corrective or adaptive measures that would be implemented depending on the drifter and moored SSV, except in relation to SRWs (i.e. shutdown). This doesn't address the uncertainty for controls for PBWs (e.g. 5km shutdown) and potentially other marine fauna where model predictions for PTS or other effects form the basis for those mitigation distances.

……….

Letter point 2.3 – Fauna Detection

The EP does not demonstrate that the integration of the different fauna detection methods will be effective, such that impacts and risks to blue whales and southern right whales will be managed to acceptable levels.

Issue: As outlined in OMR#1, letter point 3.5, it is not evident from the EP whether the proposed combination of methods for detecting blue whales and southern right whales will be effective to inform decision making for timely implementation of control measures to prevent the activity from having an unacceptable impact or an impact that is inconsistent with the recovery plans.

Reasons: CGG has proposed a combination of visual and acoustic detection methods. The EP acknowledges the limitations associated with the various detection methods and notes the importance of a multifaceted approach to whale detection. However, it is currently unclear that the combination of detection methods proposed will have sufficient spatial coverage and detection rates to ensure the suite of control measures can be effectively implemented.

1. In relation to acoustic detection:
    a. The ADM is a necessary component of the detection strategy. However, the EP (including EPSs in Appendix G1) still states that deployment of the ADM array is subject to a successful trial. The EP needs to include a clear commitment to the implementation of ADM as part of the overall suite of detection measures.
    b. The particular ADM system being trialled by CGG is not yet demonstrated to be effective in detecting low-frequency cetaceans like blue whales and southern right whales. The EP does not set out measures the level of performance to be implemented in order to have effective spatial coverage and the ability to detect low-frequency cetaceans in the presence of sound produced from the activity. Measure requirements include:
        i. Minimum detection range and the effective vocalisation detection rate (e.g. >50% detection of vocalisations at 10 km range) when accounting for the signal-to-noise ratio under a range of representative background noise levels that may occur during an activity.
        ii. Commitment to hydrophone/receiver operating frequencies (and sensitivity) that cover the frequency range of the marine mammal species of interest; use of species-specific detection software; and data relay rates that are appropriate to inform a timely mitigation response.
    c. The EP needs to identify the relevant factors and decision-making criteria that will be considered to determine the final number, locations and configuration of the ADMs needed to detect and localise blue whales and southern right whales, and achieve the required spatial coverage.
2. In relation to the overall integration of visual and acoustic methods:
    a. The EP does not currently demonstrate that visual detection methods and acoustic detection methods will be effective independently of each other over the required detection ranges so that the activity can be managed in a manner that is not inconsistent with the recovery plans. In particular, recognising the limitations of acoustic detection, the EP does not demonstrate that visual detection methods will have sufficient coverage over the required detection area.

Titleholder response: NOPSEMA found that “the ADM is a necessary component of the detection strategy”. This was not a claim made by CGG. NOPSEMA made findings about the ADM that included advice from the Australian Antarctic Division (AAD).

Following meetings with NOPSEMA, CGG has decided to abandon the ADM strategy and deploy the acoustic monitoring buoys in a different function. Rather than relying on the

ADM buoys for SRW detections, CGG has replaced this function with a comprehensive visual and aerial detection strategy. This strategy is outlined in Appendix G5.

The buoys have been retained in an additional and more traditional function of detecting impulsive sound near the boundary of the SRW reproduction BIA. This activity, along with other pre-survey baseline work, and in-field sound source verification work, is required to be able to adopt a critical shutdown measure to manage uncertainty of behavioural disturbance to SRW within the reproduction BIA.

This change renders the AAD advice irrelevant as the buoys are performing a function that is a well-accepted practice for the technology. It is possible that the buoys will adequately detect SRW calls, and if they do, this will result in a shutdown of the sound source.

NOPSEMA review and findings:

- No longer ADM so no longer issue of unproven ADM systems and detection rates/ranges.
- Disregard issues raised in AAD advice re detection of vocalisation, moorings now primarily focussed on SSV.
- ALARP Assessment (F2) includes some updates, but still inconsistencies, not followed process (e.g. ADM still included and written in light of whale detection, not SSV)
- EP presents reasonable case for coverage by various visual and acoustic detection platforms (offshore and coastal).
- Assessment focus instead on elements in FMP, Whale Coastal Monitoring Programme and Sound Source Verification Programme.

……

Letter point 2.4 – Little Penguins

The EP does not demonstrate that potential impacts and risks of underwater sound emissions will be of an acceptable level – Little penguins

Issue: The assessment of underwater sound impacts does not demonstrate that impacts and risks to foraging little penguins during the chick rearing and provisioning stage will be managed to acceptable levels.

Reasons: In response to OMR#1, letter item 3.3, CGG has made revisions to the impact assessments for little penguins. However, while it is noted from the revisions that little penguins have some foraging flexibility to compensate for variability in food availability, the EP does not demonstrate with clear and supported evidence that the level of flexibility in their foraging will be sufficient for foraging little penguins to tolerate potential disturbance and avoidance, noting that there remains uncertainty regarding the distances and sound levels that may result in behavioural avoidance.

Titleholder response: CGG has reviewed all available literature regarding the effects of seismic sound on little penguins and provided a comprehensive analysis of this in the EP. CGG has reviewed and broadened the defined acceptable levels as suggested by NOPSEMA, justified these new levels, and amended the effect distances to reflect the latest modelling. CGG notes the existing text in the EP that "In Australia, the species occurs from Western Australia (Carnac Island) to New South Wales (Broughton Island) and Tasmania. Their distribution is not continuous, with sections of the southern coast of Australia without occurrence of breeding colonies (CoA 2020a)."

NOPSEMA review and findings:

Note, Little Penguin not a listed Threatened or Migratory species, but listed 'Marine' – Give less weight to this than Threatened/Migratory species but still relevant to consider in context of population level impacts (e.g. consistent with EPBC Act Significant Impact Guidelines for listed Marine species as part of the Commonwealth Marine Area: '*An action is likely to have a significant impact on the environment in a Commonwealth marine area if there is a real chance or possibility that the action will have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution*').

Understood from pre-submission meetings that EP updates and response would provide clarity on what constitutes population and clearer conclusions re population level impacts.

Text in EP "*In Australia, the species occurs from Western Australia (Carnac Island) to New South Wales (Broughton Island) and Tasmania. Their distribution is not continuous, with sections of the southern coast of Australia without occurrence of breeding colonies (CoA 2020a)*" describes species distribution but does not provide further clarity on whether this is assessed as a single population or collection of local populations.

Various lines of evidence presented in E5 and F3 in relation to behavioural impacts to penguins and prey species, including:

- Extent of <u>aspect</u> in s2.2 reduced from 77 km to 10.6 km due to new modelling.
  - Derived from Sørensen et al. (2020) 120 dB SPL behavioural response study on captive penguins – Noted in B8 "difficult to reconcile (captive) exposures to sudden sound stimuli at close range (metres) in the absence of natural ocean background noise with a real-life exposure".
  - OW-weighting used as proxy for assessment, given "similar hearing sensitivity in the frequency band of underwater hearing for diving birds and otariid pinnipeds, which are included in the group. This provides a conservative approach, as otariids are considered more sensitive to underwater sound at higher frequencies than penguins".
  - Reasons for such marked reduction to only 10.6 km not clear, but note questions re modelling under item 2.1 above.

  - No established sound effect criteria for birds.
- Pichegru et al. (2017) – Study in South Africa found change in foraging direction and area increasing their distance between their feeding area and the location of the seismic vessel from 77 km, compared to ca 65 km on average in the absence of seismic activity.
  - Reverted to normal foraging behaviour after cessation of seismic activities.
  - No significant changes in distribution and/or abundance of small pelagic fish in the region compared to a few months prior to or after the seismic operations.
  - Note that in previous EP revisions, the modelled extent of aspect was (coincidentally) comparable to findings of Pichegru et al. and made sense), but revised modelling of 10.6km is very different and would be difficult to reconcile.
- Examples of studies of seismic effects on prey, e.g. Clupeiformes – disturbance, distribution.
- Examples of foraging distances from little penguin colonies in Victoria, including Middle Island (Berlincourt and Arnould, 2014), noting foraging limited to shorter daily ranges during egg laying, chick guard/provisioning stages (typically August to February, though some variability noted from relevant persons).
  - forays out to 30+ km, but majority of feeding during this period is occurring within 15-20 km of nesting sites.
- Evaluation that considers the issue of increased foraging effort and sufficient food to sustain developing chicks, e.g.
  - Semi-quantitative spatial-temporal overlap analysis in response to relevant person queries (F3), however, this assesses the amount of time and proportion of core foraging only where/when seismic vessel intersects with core foraging ranges from colonies, but does not evaluate extent of potential disturbance.
  - Flexibility of foraging (e.g. Berlincourt and Arnould, 2014; Camprasse et al. 2017).

EP presents relatively comprehensive assessment given the limited studies on effects to penguins, however, still not clear in terms of magnitude of impacts due to inconclusive lines of evidence presented in the EP, e.g.:

- Latest modelling potentially introduces potential further uncertainty in terms of actual extent of aspect. Noted that extent of aspect does not equate to impact.
- How transferable are some aspects of the in terms of tolerance to Regia noting that penguin colonies are located ~17 – 30 km from the survey, which is notably closer than 65-77 km in Pichegru et al. (2017), what level of foraging flexibility studies like Berlincourt and Arnould, 2014, Camprasse et al. 2017 are inferring can occur without

impacts to fitness/provisioning, noting potential extent of disturbance could be extensive for some of the colonies' available core foraging areas.

- No clarity on what is being assessed in terms of a 'population' for a reasonable conclusion about population viability to be made.

Uncertainties and limitations reasonably acknowledged in the EP.

Defined acceptable levels updated to:

- Diving birds, including little penguins are not exposed to sound levels that cause permanent auditory injury or mortality at any life stage.
- Any temporary hearing effects to diving birds including penguins remain brief, recoverable, and do not impair essential functions such as foraging, navigation, chick provisioning, or juvenile development.
- Any behavioural responses to diving birds including little penguins are minor, short-lived and do not reduce survival, reproductive success, access to nesting sites, or overall population viability.

Note that EPO linked to these defined acceptable levels is limited to 'No death or injury to fauna, including listed threatened or migratory species, from the activity'.

REVIEW AND DISCUSS AS TEAM

………

Letter point 2.5 – Defined acceptable levels

Some defined acceptable levels of impact are not appropriate because evaluations of impact do not demonstrate that the defined acceptable levels have been met.

Issue: To demonstrate that an acceptable level of impact or risk has been met, the evaluation needs to demonstrate that the defined acceptable level has been met and that the EPO can be achieved (GN1344, Section 3.5). It is not clear demonstrated whether some defined acceptable levels of impact in Appendix E have been or can be met.

Reasons: Some of the defined acceptable levels of impact outlined in the EP (Appendix E) cannot be demonstrated that they won't be exceeded, as the evaluation of impacts indicates that they won't be met (i.e. exposure of the receptor to levels exceeding the referenced threshold will or may occur).
For example:

1. *Plankton communities should not be exposed to peak sound levels of >210dB SELcum24hr* (Appendix E2) – Predictive modelling indicates that plankton communities will be exposed to levels that exceed the selected threshold. Please also note that it is unclear whether the SEL24h threshold is the correct threshold to be referenced in this instance given that the text refer to

'peak sound level' and it is the peak pressure criterion that CGG has used to determine the extent of the aspect and references in the evaluation of impacts to zooplankton.

2. *No fish should be exposed to sound at or exceeding threshold levels for greater than 24 hrs for a TTS set at 186 dB SEL24hr* (Appendix E3) – Predictive modelling and the impact evaluation in Appendix E3 indicates that fish may be exposed to levels that exceed the selected threshold (particularly demersal and benthic fish species). The intent or appropriateness of referencing exposure to a SEL24h threshold for greater than 24 hours is not explained.
3. *Sound exposure to invertebrates must be below mortality/ mortal injury at thresholds in exceedance of 202 dB PK-PK* (Appendix E4) – Predictive modelling and the impact evaluation in Appendix E4 indicates that invertebrates will be exposed to levels that exceed the selected threshold.
4. *Sound exposure to any blue whale / southern right whale must be below the behavioural effect threshold of 160 dB SPL* (Appendix E7) – The intent of this defined acceptable level seems to be about having control measures in place to prevent a level of behavioural disturbance that may constitute displacement / utilisation within a BIA. However, by referencing the threshold, when a blue whale / southern right whale is detected within the predicted effects range, exposure will have already exceeded this (single impulse) threshold. Please also note letter item 3.2 above in relation to the application of the 160 dB threshold for southern right whale reproduction behaviours.

Titleholder response: CGG notes that there is no requirement in the Regulations to "demonstrate that the defined acceptable levels have been met" as suggested in NOPSEMA's letter. The requirement is to demonstrate environmental impacts and risks are of an acceptable level. Following discussion with NOPSEMA, CGG has reviewed all defined acceptable levels and made changes as follows:

<u>Plankton:</u> The previous defined acceptable level (Plankton communities should not be exposed to peak sound levels of >210dB SELcum24hr) has been amended to "Plankton communities should not be exposed to sound exposure levels of >210dB SELcum24hr over a spatial or temporal scale likely to result in significant disruption to population dynamics." CGG notes that there are multiple defined acceptable levels for most receptors sensitive

to sound and that they should be considered holistically. CGG notes that the previous revision contained the following additional defined acceptable level "Sound exposure to plankton communities does not compromise ecological integrity of the pelagic food web" which performs a similar function to the amended text.

<u>Fish:</u> The previous defined acceptable level (No fish should be exposed to sound at or exceeding threshold levels for greater than 24 hrs for a TTS set at 186 dB SEL24hr.) has been amended to "No fish should be exposed to sound at or exceeding threshold levels for TTS set at 186 dB SEL24hr." CGG notes that there are other defined acceptable levels that should be interpreted as cumulative in understanding when latterly demonstrating that acceptable levels of impact to fish have been met.

<u>Invertebrates:</u> The previous defined acceptable level (Sound exposure to invertebrates must be below mortality/mortal injury at thresholds in exceedance of 202 dB PK-PK.) has been replaced with "Exposure of individual invertebrates to sound levels exceeding 202 dB PK-PK may occur but is acceptable provided that the affected species or functional groups have sufficient abundance, distribution, or reproductive capacity to maintain population viability and ecological function."

<u>Southern Right Whales:</u> The defined acceptable level (Sound exposure to any southern right whale must be below the behavioural effect threshold of 160 dB SPL.) has been removed. CGG notes that there are multiple defined acceptable levels related to this species, including the actions from the SRW National Recovery Plan related to BIA utilisation and minimising behavioural disturbance, and these have all been retained. CGG believes that these were and remain sufficient for comparison against our predicted impact levels and subsequent demonstration that sound impacts to SRW will be of an acceptable level.

With these changes in place, the comprehensive set of multiple defined acceptable levels are clearer and provide a suitable and appropriate basis for comparing predicted impacts against.

NOPSEMA review and findings:

- Some still based on exceedance of thresholds that can't be achieved (fish, inverts) and not clear why – [redacted] reviewing.

Letter point 3.1 – EPOs

The EP does not provide appropriate environmental performance outcomes (EPOs)

Issue: The EP contains EPOs that are not demonstrated to be achievable or cannot be easily monitored for compliance (**GL1721: Section 9.2**). The EP also contains EPOs that are inconsistent or not clearly linked to acceptable levels (**GL1721: Section 9.2**).

Reasons:

1. There are EPOs in Section 11 of the various impact assessments in Appendix E that are not included or contain different wording from those presented Appendix G1. While it is noted that differences between the appendices may be the artefact of the process that CGG has used to develop the EP, it is also noted that some EPOs in Appendix E have been revised since to previous submission in order to be consistent, but others haven't. It is also noted that the wording of some of the EPOs in Appendix E may be more appropriate and for monitoring compliance than EPOs in Appendix G1. For example:
    a. Appendix E2, Section 11 includes EPOs "As a result of complying with the sound source volume and activity limitations, sound emissions will not disrupt the ecological integrity of plankton communities" and "As a result of comply[ing] with the sound

source volume and activity limitations, no impacts to plankton communities beyond 230 metres from the sound source", which are not included in Appendix G1.

b. Appendix E9, Section 11 includes EPO "Light emissions are managed to avoid displacing turtles or disrupting nesting, foraging, or migratory behaviours within or near biologically important areas", which is not included in Appendix G1.

2. A number of EPOs relevant to managing the impacts of underwater sound are either not clearly linked to CGGs defined acceptable levels, do not demonstrate that they will be achievable or easily monitored for compliance, are ambiguous, or contain errors. For example:

   a. "The sound source will not remain stationary at full power at any time"

   b. "As a result of the implementation of real-time monitoring and activity limitations, SRW are not exposed to sound levels that cause sustained behavioural disturbance within or adjacent to BIAs or HCTS."

   c. "As a result of the implementing the suite of mitigation measures, marine mammals experience **[sic]** auditory injury or sustained behavioural disturbance affecting survival, reproduction, or population distribution" appears to include an editorial error which sets a level of performance that marine mammals will be injured and/or disturbed by the activity.

   d. "As a result of implementing shutdown or relocation procedures when a blue whale remains within the 23 km ensonified area for more than 12 hours, blue whales will not be exposed to physical injury from sound exposure"

   e. "As a result of implementing shutdown or relocation procedures when a SRW remains resident in the 15 km ensonified area for more than 12 hours, SRW will not be exposed to auditory impairment"

Titleholder response: CGG has reviewed all documents that create EPOs from the defined acceptable levels and made the changes necessary to align them across Appendix G1 – Environmental Performance.

NOPSEMA review and findings:

- Still ambiguity and inconsistency in the SRW EPOs and not clearly aligned with the recovery plan (e.g. sustained, significant, displaced, etc.)
- EPO in F3 re no behavioural disturbance is not included as EPO in G1 – How do we treat this [redacted] want to consider this?
- Incomplete EPO in G1 re 13 km so also unclear how we should treat this.

Letter point 3.2 – EPSs

Some EPSs cannot be easily monitored for compliance

Issue: The EP does not demonstrate that it provides clear EPSs and measurement criteria that can be easily monitored for compliance and demonstrate that the desired environmental performance is being met (**GL1721: Section 9.3**).

Reason: The EP includes EPSs and/or measurement criteria that cannot be easily monitored for compliance or demonstrate that the desired environmental performance is being met. For example:

a. Shutdown procedures include EPSs with shutdown criteria such as '*Shutdown the sound source if a [Blue Whale / Southern Right Whale] remains resident in the [23 km / 15 km] ensonified area for more than 12 hours'.* It is not clear how this demonstrates that the desired environmental performance (i.e. no TTS) is being met, or how these EPSs can be monitored for compliance; specifically, how will CGG ascertain that an individual whale is tracked and remains resident within the ensonified area for 12 hours. It is also possible that an individual whale could experience TTS within shorter timescales than 12 hours, depending upon its proximity to the seismic source.

b. '*The seismic source will only be discharged in the Pygmy Blue Whale foraging BIA off Otway when the presence and distribution of Pygmy Blue Whales and other foraging whales have been assessed by CGG and confirmed to be compatible with the activity proceeding without causing unacceptable disturbance*.' It is also unclear what information will be available to CGG to enable the determination of presence and distribution of pygmy blue whales and other foraging whales off Otway prior to commencement of the survey.

c. The EPS related to the Otway Adjustment Protocol control measure states that, "*A claim can be lodged up to 180 days after the completion of the activity*". This is inconsistent with the claim period stated in Appendix G4 (i.e., 183 days). Additionally, the Implementation Strategy interchangeably refers to this claim period as 6 months and 183 days.

Titleholder response: The EPS's have all been reviewed and can now easily be monitored for compliance.

NOPSEMA review and findings:

EPSs revised and issues addressed.

EPSs and MC present for all controls, are appropriate and linked.

…….

Key 3rd party correspondence received since submission

Shared with CGG for procedural fairness.

Discuss with team and review consultation again.

Key examples below.

Warrnambool Coastcare Landcare Network

Little penguin monitoring – Middle Island

'The evidence collected over this time shows that the colony's breeding success varies with food availability, predation by foxes, human activities including anthropogenic climate heating, the success variability year to year of the internationally significant Middle Island Little Penguin-Maremma Project and potentially other factors.'

Concerns re vulnerability and additional pressures from seismic.

'The plan notes accurately that the peak breeding season for Little Penguins on Middle Island is September to February. The plan's support of seismic testing from September to December coincides with peak breeding and is likely to impact Little Penguins feeding and breeding at the most important time in their life cycle.'

Other concerns re uncertainty and impact levels, as well as behavioural disturbance in Appendix E5 are also noted.

Note that WCLN say that Sep-Feb peak breeding season is accurate.

[redacted]

'In their most recent response to my work that I sent them (and you) in 3 parts on 7/5/25, 16/5/25 & 8/6/25, they didn't acknowledge a significant portion of the specifics about my concerns and the reasons for them, brushing me off with broad statements saying that everything in their EP regarding the penguins was "acceptable" and that they had already addressed what I was concerned about in previous communications. Even though they haven't. Not properly. Their email cover letter implied that my concerns were not backed sufficiently by scientific data and research and were therefore not valid. I don't believe this to be true.'

Is this example reflective of a more general challenge that we have experienced assessing CGG consultation report? – everything said to have merit, specific issues are sometimes responded to in more general terms rather than individually.

Review and confirm with team re consultation.

On balance, the EP considers extensive info provided by relevant persons as well as from published sources, but these are info sources not always going to be in agreement with one another.

Fight for the Bight

Further detailed and in-depth correspondence re specifics of modelling impacts to plankton based on McCauley et al (2017) and Richardson et al. (2017).

This aside, generally satisfied that the EP has presented evidence that addresses the experimental design limitations of McCauley et al. (2017) and body of evidence points to more localised impacts.