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Memorandum

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5/08/2024

Attention:	**Mike Priestly**
CC:	Tarek Badreldien, Karen Frehill, Snyman Van Straaten, Jim Churchill
From:	Rhian Wardley

RE: Mardie Dredge Plume Modelling – Model Results Summary

Background

Baird have been requested by BCI Minerals (BCIM) to assess the impacts from sediment plumes associated with the proposed disposal of dredge spoil at an offshore location in the vicinity of the Mardie site. A specialist marine environmental consultant for the Mardie project will commence benthic studies at the preferred offshore disposal location in early August, and this modelling work has been undertaken to determine the preferred location for the dredged material placement area (DMPA) to be surveyed for benthic species. Investigation has been undertaken for two DMPAs, the first being that identified in previous studies as DMPA1 (see Figure 1), and the second being a location approximately 2.5km to the southwest of this location (see Figure 4 and Figure 5).

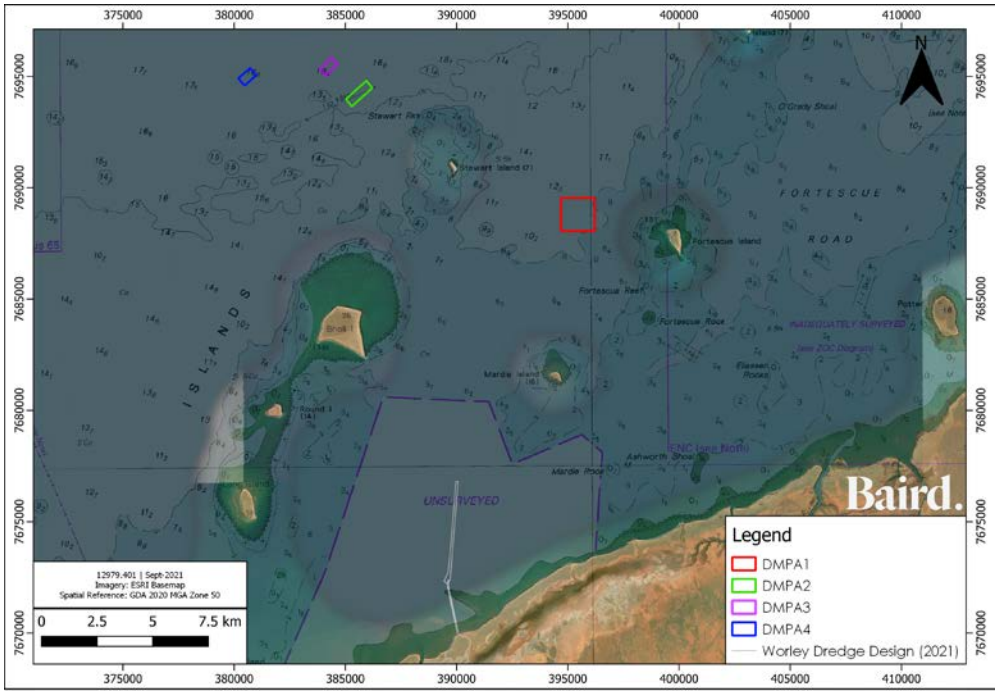

Figure 1: Dredge Material Placement Areas (DMPAs) previously investigated via Baird modelling

Baird have been requested to model a representative period of the full dredging program to maintain the required time efficiency in project delivery alongside the requirement to carry out survey of the benthic habitat at the most favourable DMPA location. For this reason, a representative period of two months has been modelled here, with the opportunity to model the full offshore disposal program if requested in a subsequent scope.

Model inputs – Schedule

Baird have an established and validated 3D hydrodynamic model and dredge plume model that has been updated with the current dredge method and schedule to complete this assessment. This update has included a revision of the model grids as the existing higher resolution grid was designed to focus on the dredge footprint rather than the offshore disposal areas. The model has been reviewed and accepted by the EPA as part of the previous submissions (most recently in Baird, 2022), and was used to model the predicted impacts of plumes generated during the capital dredging works of the channel and basin areas.

Baird have been provided with a dredging schedule by BCIM, with relevant expected duration, quantity of deposited materials, and expected start and finish dates shown in Figure 2. This schedule does not account for the need to dredge deeper than the design depth (i.e., overdredging) and additionally does not capture the potential schedule acceleration should soil conditions allow. In line with this, the assumed volume of sediment to be placed at the DMPA each day is set at 3,600m^3, delivered via 3 hopper loads of 1,200m^3 each.

BCI MINERALS LIMITED- MARDIE SALT AND POTASH PROJECT- PORT - Dredging Schedule

Table Item	Description	Unit Qty (excl overdredge)m3	Average Weekly Production Rate-Hall (m3/week)	Duration (weeks)	Duration (days)	Start Date	End Date
SN	Dredging Works						
1	Separable Portion 12 - by BHD	12264.94	13766.80	0.89	7.00	1/04/2025	8/04/2025
2	Separable Portion 11 - by BHD	121241.14	13766.80	8.81	62.00	8/04/2025	9/06/2025
3	Separable Portion 1- by BHD	15594.84	13766.80	1.13	8.00	9/06/2025	17/06/2025
4	Separable Portion 2- by BHD	15813.52	13766.80	1.15	9.00	17/06/2025	26/06/2025
5	Separable Portion 3-by BHD	24798.97	13766.80	1.80	13.00	26/06/2025	9/07/2025
6	Separable Portion 4- BHD	32248.20	13766.80	2.34	17.00	9/07/2025	26/07/2025
7	Separable Portion 5 - by BHD	29844.22	13766.80	2.17	16.00	26/07/2025	11/08/2025
8	Separable Portion 6 - by BHD	22613.68	13766.80	1.64	12.00	11/08/2025	23/08/2025
9	Separable Portion 7 - by BHD	14639.45	13766.80	1.06	8.00	23/08/2025	31/08/2025
10	Separable Portion 8 - by BHD	14927.15	13766.80	1.08	8.00	31/08/2025	8/09/2025
11	Separable Portion 9 - by BHD	9722.93	13766.80	0.71	5.00	8/09/2025	13/09/2025
12	Separable Portion 10 - by BHD	6565.96	13766.80	0.48	4.00	13/09/2025	17/09/2025
	Total	320275.00		23.26	169.00		

Figure 2: Dredging Schedule Outline

The dredging, and accompanying offshore disposal, program is due to be undertaken across the period April to September (inclusive), over the dry season months at the project location. This period is outside of the cyclone season and is a time of year where metocean conditions are most favourable with generally calm wave conditions. The model has been run using the representative year identified by Baird during previously reported dredge plume modelling campaigns (Baird 2022, Baird 2023) with the following dredging assumptions based on the BCIM dredging schedule:

- Disposal rate at the site by split hull hopper barges of three hopper loads a day, each hopper load holding 1,200 m^3 (3,600m^3 total per day).
- The schedule has been broken into 6 separate sequences, each approximately a month long, starting from April 1st and operating until September 17th. It can be seen in the separable portions (SPs) included in the SEQ column of Table 1 that the sequence of areas nominated in the BCIM dredging schedule (Figure 2) has been maintained in the schedule of sequences used in Baird's dredge plume modelling.
- An overview of the dredge areas (SPs) can be seen in Figure 3, including the entire dredge footprint shown to the left, and the areas closest to the shore to the right (i.e., areas covered by SP 1 to 10).

Table 1:Start and end times of each sequence, for dry season 2019 (as proxy for 2025)

	Areas included in SEQ (BHD)	Start	End	No. Days
SEQ0	SP12 (7 days) 22 days in SP11	1/4/2019	30/4/2019	29
SEQ1	31 days in SP11	30/4/2019	31/5/2019	31
SEQ2	9 days in SP11 SP1 (8 days) SP2 (9 days) 5 days in SP3	31/5/2019	1/7/2019	31
SEQ3	8 days in SP3 SP4 (17 days) 6 days in SP5	1/7/2019	1/8/2019	31
SEQ4	10 days in SP5 SP6 (12 days) SP7 (8 days) 1 day in SP8	1/8/2019	1/9/2020	31
SEQ5	7 days in SP8 SP9 SP10	1/9/2019	16/9/2019	16
			TOTAL	169

The dredge volume to be disposed of at the DMPA has been taken as an estimate from the Hall Contracting Schedule (Figure 2), adding up to 320,000m^3 total (without consideration of overdredging and bulking factors). Following direction given by BCIM, a simplification of the volume to be disposed of at the DMPA each day has been adopted in the modelling program, with 3 loads of 1,200m^3 will be disposed of at DMPA1 each day.

In alignment with the sequencing in Table 1, the proximity of each SP of the dredging to the boreholes with the greatest fines percentage, and the ability to cover 2 months of the dredging schedule in the time allotted to this project, SEQ3 and SEQ4 (covering SP3 through to SP7) have been chosen as the months to cover in this offshore disposal modelling.

Following initial modelling of the DMPA1 location, an alternative location was modelled to determine if the impacts of the dredge spoil plumes could be kept further from the perimeter of the islands that surround the DMPA1 location, with each of these locations shown within the context of the updated model grid setup in Figure 4. Further detail of the model results at DMPA1, and the decision to subsequently model the alternative location, are provided below.

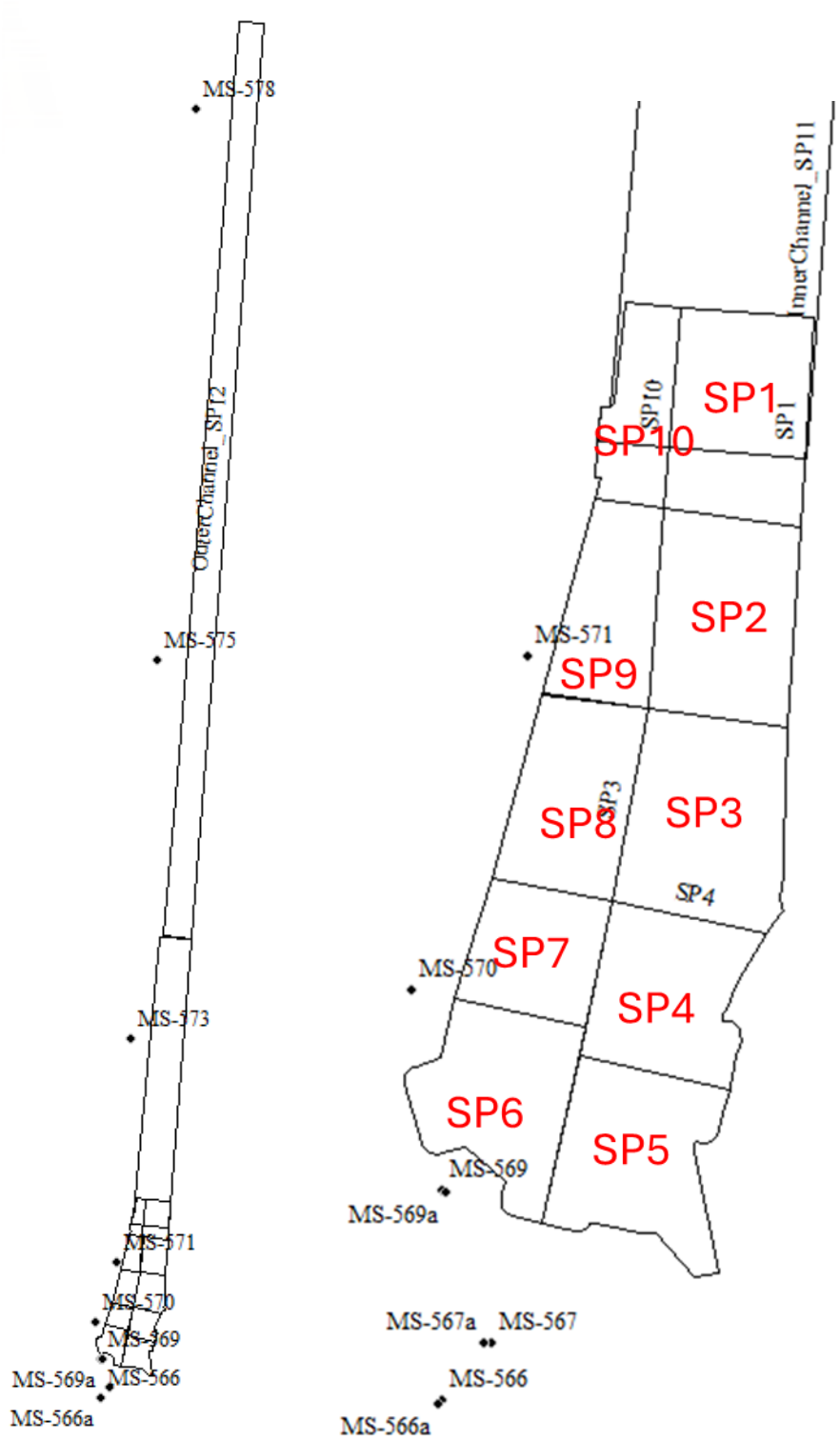

Figure 3: Dredge footprint showing the dredge areas nominated in the offshore disposal schedule (left) with an overview of the areas included in each phase of the offshore disposal program

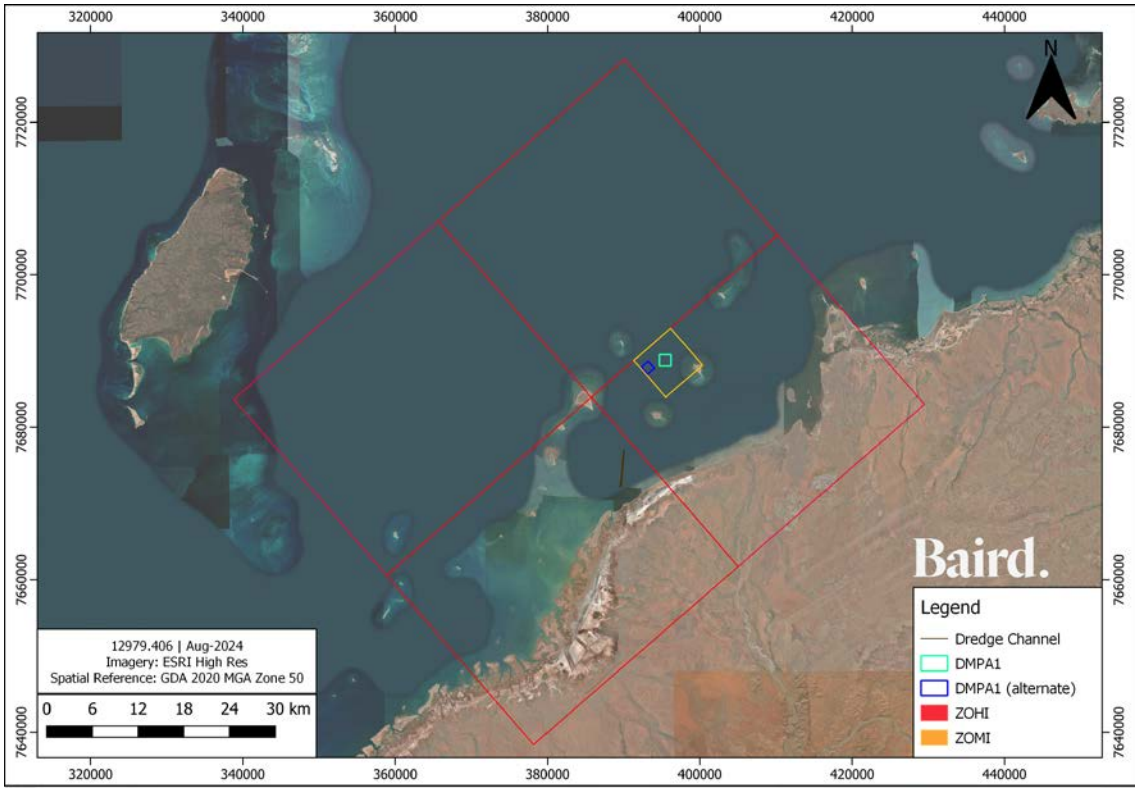

Figure 4: DMPA1 and DMPA1 (alternate) locations within the hydrodynamic modelling grids used in this modelling campaign

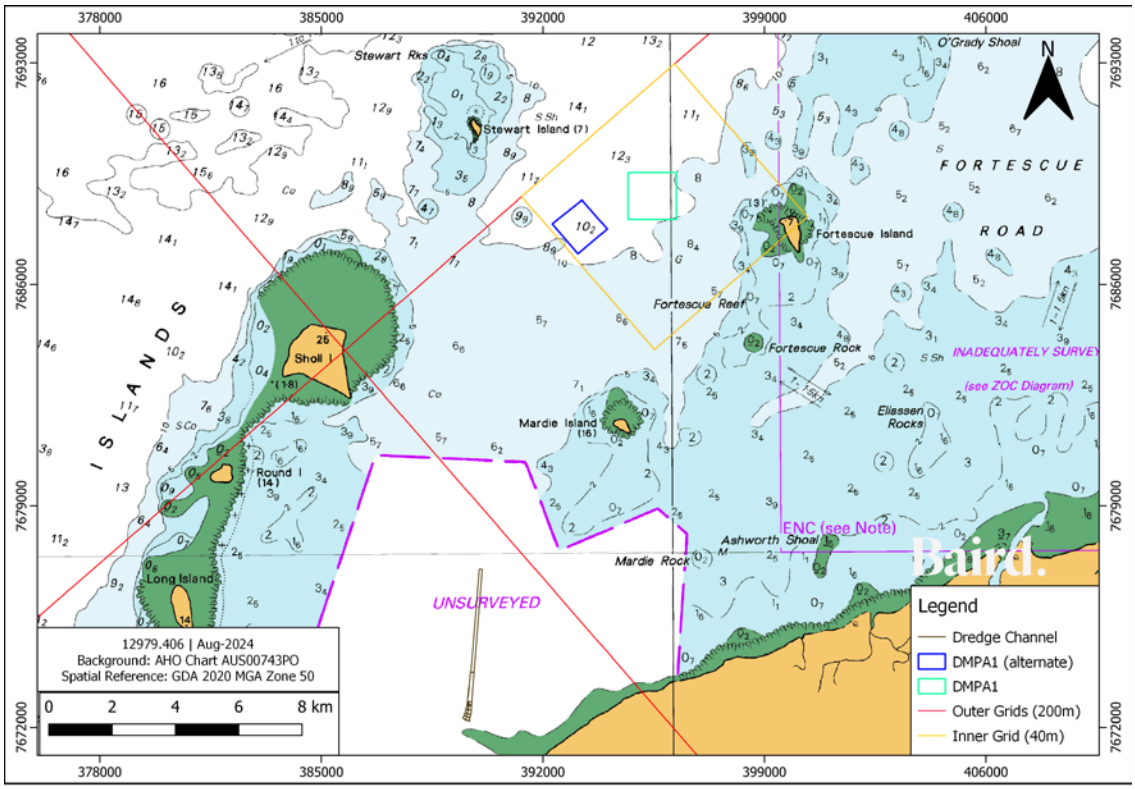

Figure 5: Zoom to DMPA1 and DMPA1 (alternate) locations within the hydrodynamic modelling grids used in this modelling campaign

Source Term Assumptions

The representative model run was based on source terms used in previous modelling campaigns undertaken for BCIM as reported in Baird (2023), based on recommendations from in2Dredging in their Turbidity Source Terms Prediction Technical Note (In2Dredging, 2023):

- 0.94% by mass of total fine sediments lost from the Back Hoe Dredge (BHD) bucket, with
- 2.81% by mass of total fine sediments lost from overflow of the hopper barges input at the surface layer.

These sediment losses at the dredging site were factored into the final volume of each sediment fraction that would be present in the 1,200m^3 hopper load to be released at the DMPA1 site. These assumptions have resulted in the following volumes of the sediment being input to the model per hour (Figure 5), split into sequence 3 and sequence 4 outlined in Table 1.

SEQ3		Sand	Fine Sand	Silt	Clay	Total Fines	
Assumed PSD	SEQ3_SP3	30%	15%	28%	27%	70%	100%
	SEQ3_SP4	27%	14%	30%	29%	72%	100%
	SEQ3_SP5	21%	11%	25%	43%	79%	100%
Volume in Hopper (m^3) out of 1,200m^3 hopper load	SEQ3_SP3	358	177	330	324	830	1200
	SEQ3_SP4	326	161	356	344	861	1200
	SEQ3_SP5	255	126	297	511	934	1200
Final Volume Released at Spoil Ground	SEQ3_SP3	358	177	321	315	812	1170.5
	SEQ3_SP4	326	177	346	335	857	1183.7
	SEQ3_SP5	255	126	289	497	911	1166.0

SEQ4		Sand	Fine Sand	Silt	Clay	Total Fines	
Assumed PSD	SEQ4_SP5	21%	11%	25%	43%	79%	100%
	SEQ4_SP6	24%	12%	28%	36%	76%	100%
	SEQ4_SP7	27%	14%	30%	29%	73%	100%
	SEQ4_SP8	30%	15%	28%	27%	70%	100%
Volume in Hopper (m^3) out of 1,200m^3 hopper load	SEQ4_SP5	255	126	333	327	786	1200
	SEQ4_SP6	291	143	327	428	898	1200
	SEQ4_SP7	327	161	357	345	862	1200
	SEQ4_SP8	358	177	330	324	830	1200
Final Volume Released at Spoil Ground	SEQ4_SP5	255	126	289	497	911	1166.0
	SEQ4_SP6	291	143	318	416	877	1167.6
	SEQ4_SP7	327	161	347	335	842	1169.0
	SEQ4_SP8	358	177	321	315	812	1170.5

Figure 6: Sources of sediment discharged in the model runs based on In2Dredging source term advice, broken down per model sequence.

Spatial Mapping

The overall map of the dredge spoil plume impact area that exceeds the WAMSI thresholds, as defined in Baird (2023), is shown using a 80th percentile (P80) background suspended sediment concentration (SSC) in Figure 7 and Figure 8 for the two locations, DMPA1 and DMPA1 (alternate) respectively. This presents the Zone of High Impact (ZoHI) and Zone of Moderate Impact (ZoMI) for the representative model run period based on the release of dredge spoil from a 1,200m^3 capacity split hull hopper barge.

The results in Figure 7 show that the plume generated by disposal of sediments at the original DMPA1 site result in the ZOMI plume stretching across part of the mapped reef areas of Fortescue Island and Mardie Island shown in the Australian Hydrographic Office (AHO) navigational chart at the Mardie site. For this reason, another set of representative model runs were undertaken for the same time period and conditions but releasing sediment from the DMPA1 (alternate) site approximately 2.5km to the southwest of the original DMPA1 site.

The results in Figure 8 show that the plume generated by disposal of sediments at the DMPA1 (alternate) site result in both the ZOMI and ZOHI plumes staying within the deeper channel inside of the two chains of islands to the east and west of the DMPA1 (alternate) location and do not pass across any of the mapped reef areas shown in the AHO chart.

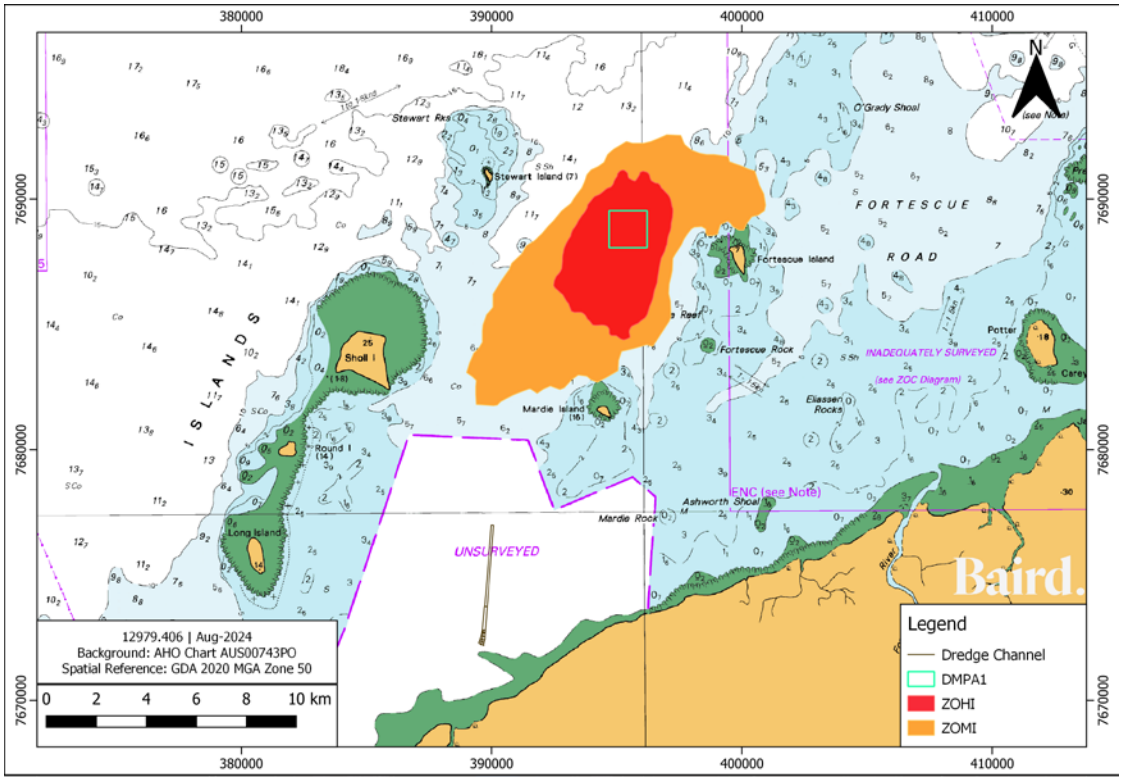

Figure 7: Calculated Zones of Impact (ZoMI and ZoHI) for the two-month representative offshore disposal program based on a background SSC of P80 from the MODIS analysis at DMPA1

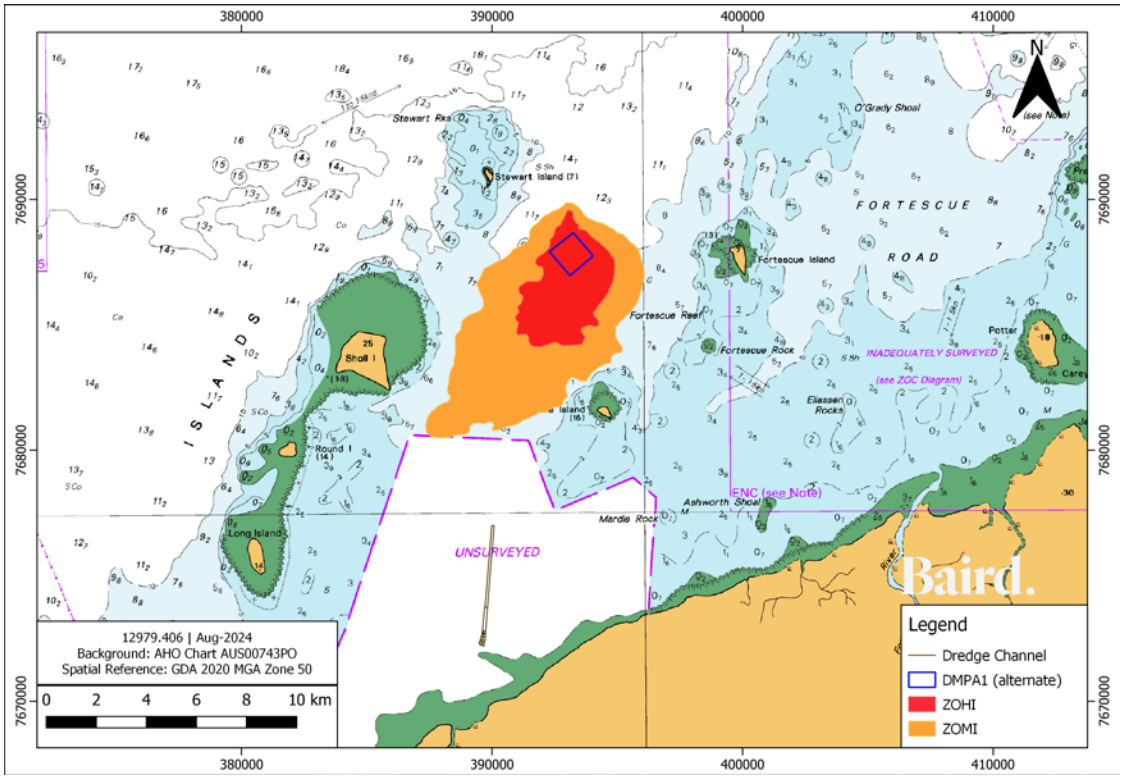

Figure 8: Calculated Zones of Impact (ZoMI and ZoHI) for the two-month representative offshore disposal program based on a background SSC of P80 from the MODIS analysis at DMPA1 (alternate)

Sedimentation Maps

Sedimentation maps taken from the end of the two representative sequences run in this modelling campaign are shown for DMPA1 in Figure 9, and for DMPA1 (alternate) in Figure 10. This sedimentation is solely a representation of the level of sedimentation that would occur under the two-month representative set of model runs, with greater levels and coverage of sedimentation expected when the model scenario is run out in full. This is especially in consideration of the greater level of sand and fine sand present in the unmodelled sequences, with sand falling almost directly to the seabed and causing the majority of sedimentation at the DMPA sites.

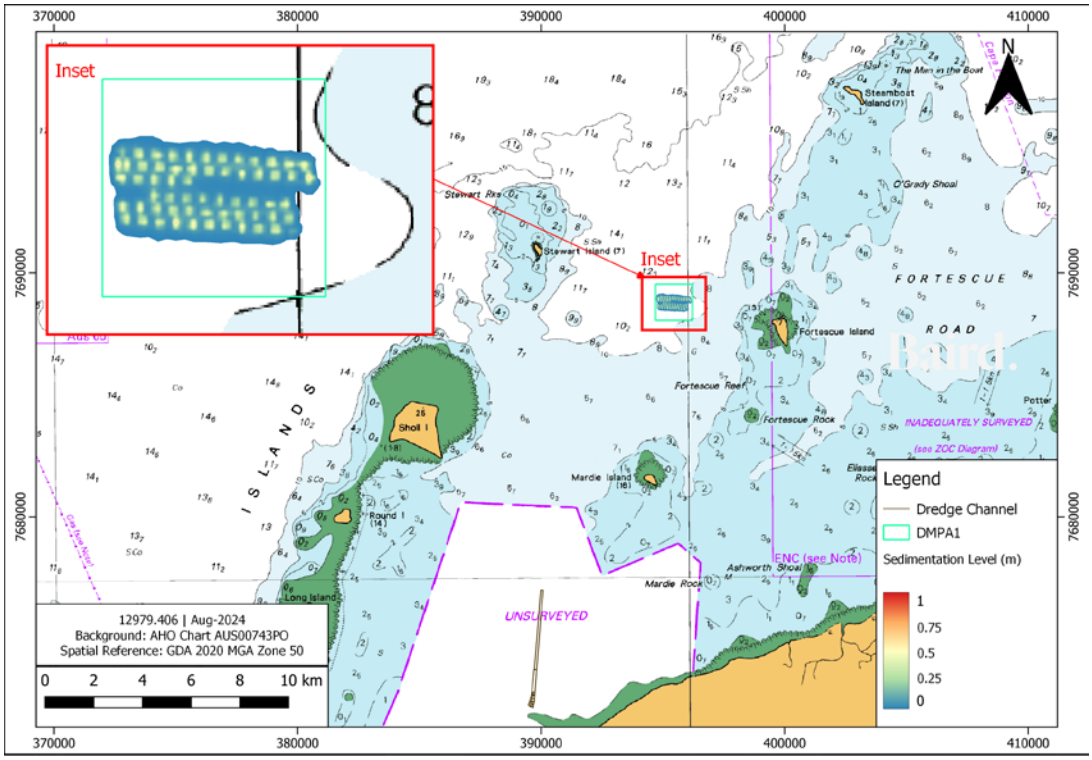

Figure 9: Seabed changes at and around the DMPA at the end of the 2-month representative disposal scenario. Sedimentation depth at DMPA1 has a maximum height 0.71 m after the two-month run.

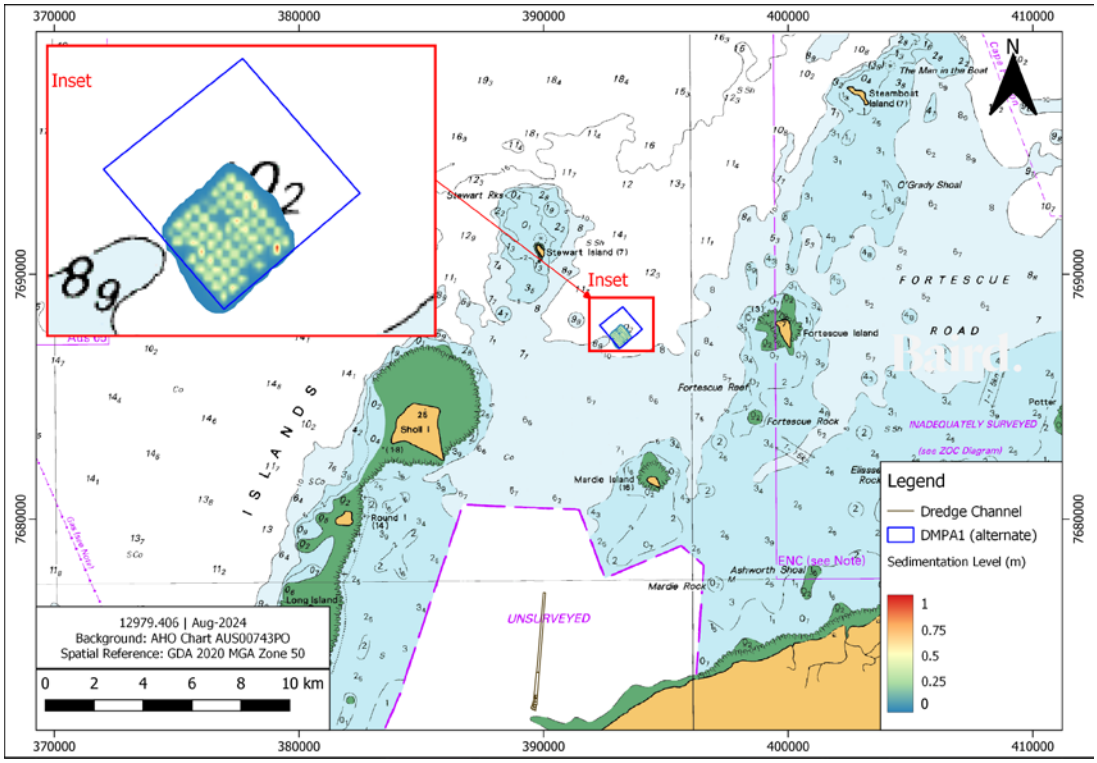

Figure 10: Seabed changes at and around the DMPA at the end of the 2-month representative disposal scenario. Sedimentation depth at DMPA1 (alternate) has a maximum height 1.04 m after the two-month run.