Referral Report No. 4

IMPACT ASSESSMENTS

OF KEY ENVIRONMENTAL FACTORS

Boskalis Cambridge Gulf Marine Sand Proposal
Western Australia

Prepared for Boskalis Australia Pty Ltd by EcoStrategic Consultants

For submission to:
- Western Australia Department of Water & Environmental Regulation
- Western Australia Environmental Protection Authority

In support of Project Referral under Section 38 of the Western Australia *Environmental Protection Act*

AUGUST 2024

Boskalis

ecostrategic
CONSULTANTS

CONTENTS

ACRONYMS

ACH	Aboriginal Cultural Heritage.
ACHMP	Aboriginal Cultural Heritage Management Plan
ACHIS	Aboriginal Cultural Heritage Inquiry System
AIMS	Australian Institute of Marine Science
BAC	Balanggarra Aboriginal Corporation
BCH	Benthic communities & habitats
BIA	Biologically Important Area (for various marine species as defined by DCCEEW)
BKA	Boskalis Australia Pty Ltd
CG	Cambridge Gulf
CSIRO	Commonwealth Scientific & Industrial Research Organization
DBCA	WA Department of Biodiversity, Conservation & Attractions
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment & Water
DEM	Digital Elevation Model
DES	Digital Earth Australia (Geoscience Australia)
DEMIRS	WA Department of Energy, Mines, Industry Regulation & Safety
DHI	Danish Hydraulics Institute
DPLH	WA Department of Planning, Lands & Heritage
DSM	Digital Surface Model
EGS	Environmental Group Site Details (required by DEMIRS under WA Mining Act)
EMP	Environmental Management Plan
EMS	Environmental Management System (required by DEMIRS under Mining Act)
EOPCMP	Environmental Outcomes, Performance Criteria & Monitoring Plan (required by DEMIRS under Mining Act)
EPA	WA Environmental Protection Authority
EP Act	WA Environmental Protection Act
EPBC Act	Commonwealth *Environment Protection & Biodiversity Conservation Act*
EQMF	Environmental Quality Management Framework (in relation to marine environmental quality)
EQO	Environmental Quality Objective (in relation to marine environmental quality)
ERA	Environmental Risk Assessment (required by DEMIRS under Mining Act)
GHG	Greenhouse gas
HAT	Highest Astronomical Tide
HD	Hydrodynamics
IMP-MDRP	Introduced Marine Pests - Monitoring, Detection & Response Plan
IPA	Indigenous Protected Area
JBG	Joseph Bonaparte Gulf
KS	King Shoals
LAT	Lowest Astronomical Tide
LAU	Local Assessment Unit (for the impact assessments presented in this report)
LiDAR	Light Detection & Ranging
LPM	Littoral Processes Mode
MAFRL	Marine & Freshwater Research Laboratory (Murdoch University)
MCP	Mijing Conservation Park
MEQ	Marine environmental quality
MG Corporation	Yawoorroong Miriuwung Gajerrong Yirrgeb Noong Dawang Aboriginal Corporation
MMF	Marine mega-fauna (large marine animals such as cetaceans, dugong, turtles, crocodiles, sharks etc)
MNES	Matters of National Environmental Significance (under Commonwealth EPBC Act)
MoU	Memorandum of Understanding
MSL	Mean Sea Level

NWQMS	National Water Quality Management Strategy
PCS	Port & Coastal Solutions (www.portandcoastalsolutions.com)
PSD	Particle Size Distribution (of sediments)
REF	Relevant Environmental Factor
SEM	Scanning Electron Microscope
STM	Sediment Transport Model
SWM	Spectral Wave Model
TO	Traditional Owner
WA	Western Australia (State of)

REFERAL DOCUMENTS

Report Citation: Boskalis Australia (BKA) (2024d), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 - Referral Report No. 4: *Impact Assessments of Key Environmental Factors.*

This report is part of a larger set of documents submitted as part of Boskalis Australia's project Referral under section 38 of the Western Australia (WA) *Environmental Protection Act* (EP Act), as listed below.

Documents submitted as part of this Referral package (August 2024):	
Short Title	**Full citation**
Referral Report No. 1: *Regulatory Framework.*	Boskalis Australia (BKA) (2024a), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 1: *Environmental Regulatory Framework.*
Referral Report No. 2: *Setting & Existing Environment Descriptions.*	Boskalis Australia (BKA) (2024b), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 2: *Proposal Setting & Existing Environment Descriptions.* Annexes include: – Sand resource assessment report - Boskalis. – BCH mapping methods statement - MScience – Coastal LiDAR report - Sensorem. – Sediment contamination assessment report. – eDNA report - University of Canberra. – Turtle nesting report - EcoStrategic / DBCA.
Referral Report No. 3: *Traditional Owner Matters.*	Boskalis Australia (BKA) (2024c), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 3: *Traditional Owners, Native Title & Aboriginal Cultural Heritage*. Annexes include: – Letters of support from the two TO groups.
Referral Report No. 4: *Impact Assessments.*	Boskalis Australia (BKA) (2024d), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 *Referral Report No. 4: Impact Assessments of Key Environmental Factors.*
Referral Report No. 5: *Metcocean & Sediment Dynamics.*	Port & Coastal Solutions (PCS) (2024a), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 5: *Metcocean & Sediment Dynamics - System Understanding, Conceptual Model & Initial Modelling.* – Annex 1: PCS (2024b) Supplementary Technical Note. – Annex 2: PCS (2024c) Factual Data Report.
Referral Report No. 6: *Consultation Report.*	Boskalis Australia (BKA) (2024e), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 6: *Stakeholder Engagement & Consultation.*
Referral Report No. 7: *Commonwealth Matters.*	Boskalis Australia (BKA) (2024f), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 7: *Commonwealth Protected Matters.*
Documents still being developed (to be submitted later).	
Referral Report No. 8: *Metcocean & Sediment Dynamics Full Modelling.*	Port & Coastal Solutions (PCS) (2024d), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 8: *Hydrodynamic, Coastal Processes & Sediment Plume Modelling.*
Referral Report No. 9: *IMSA Package.*	Boskalis Australia (BKA) (2024g), Cambridge Gulf Marine Sand Proposal - WA EP Act s38 Referral Report No. 9: *IMSA Metadata Package Statement.*

FURTHER INFORMATION

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PROJECT LOCATION

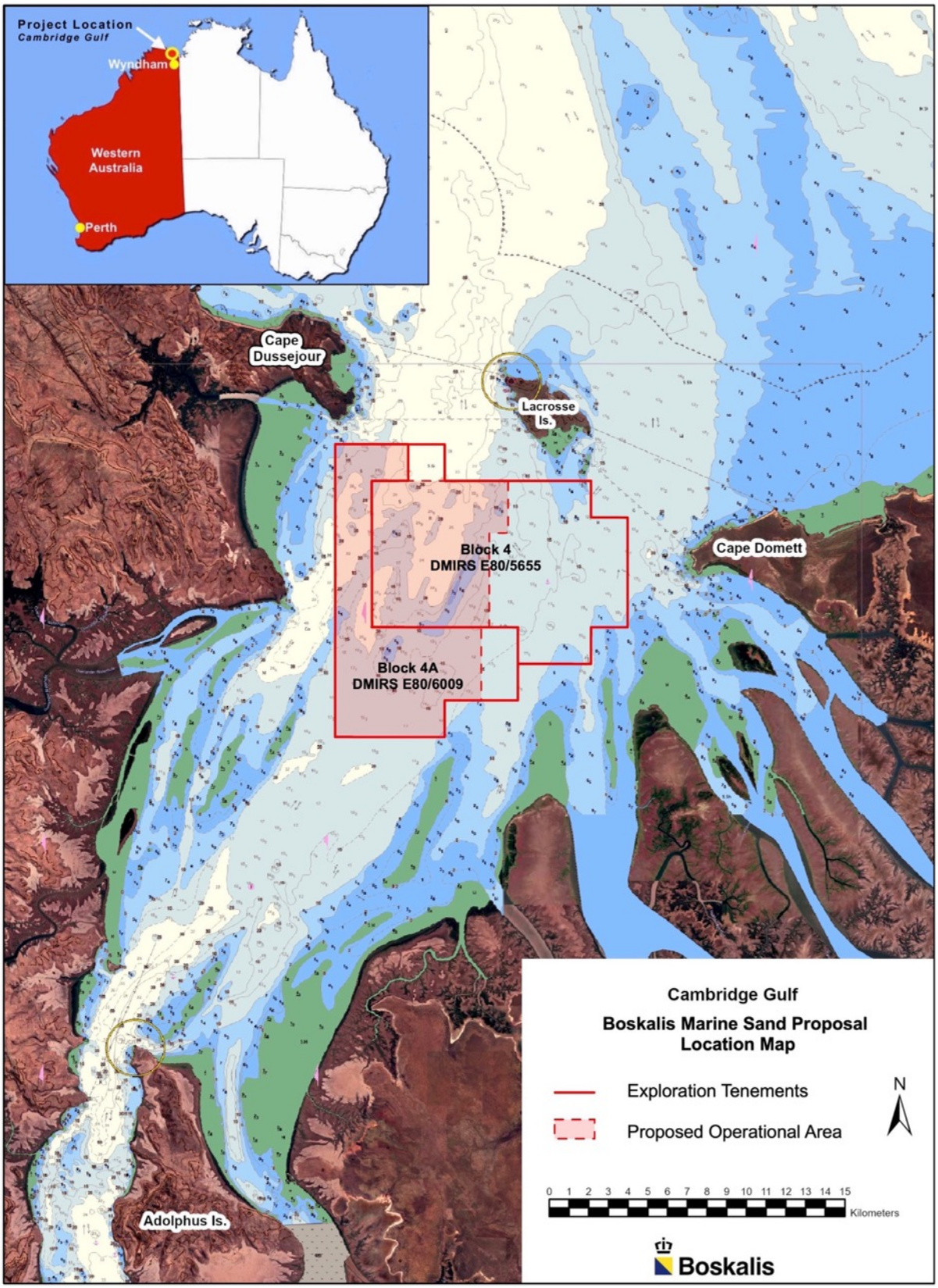


FIGURE 1: *Location of the proposal in Cambridge Gulf near Wyndham in the northeast of Western Australia.*

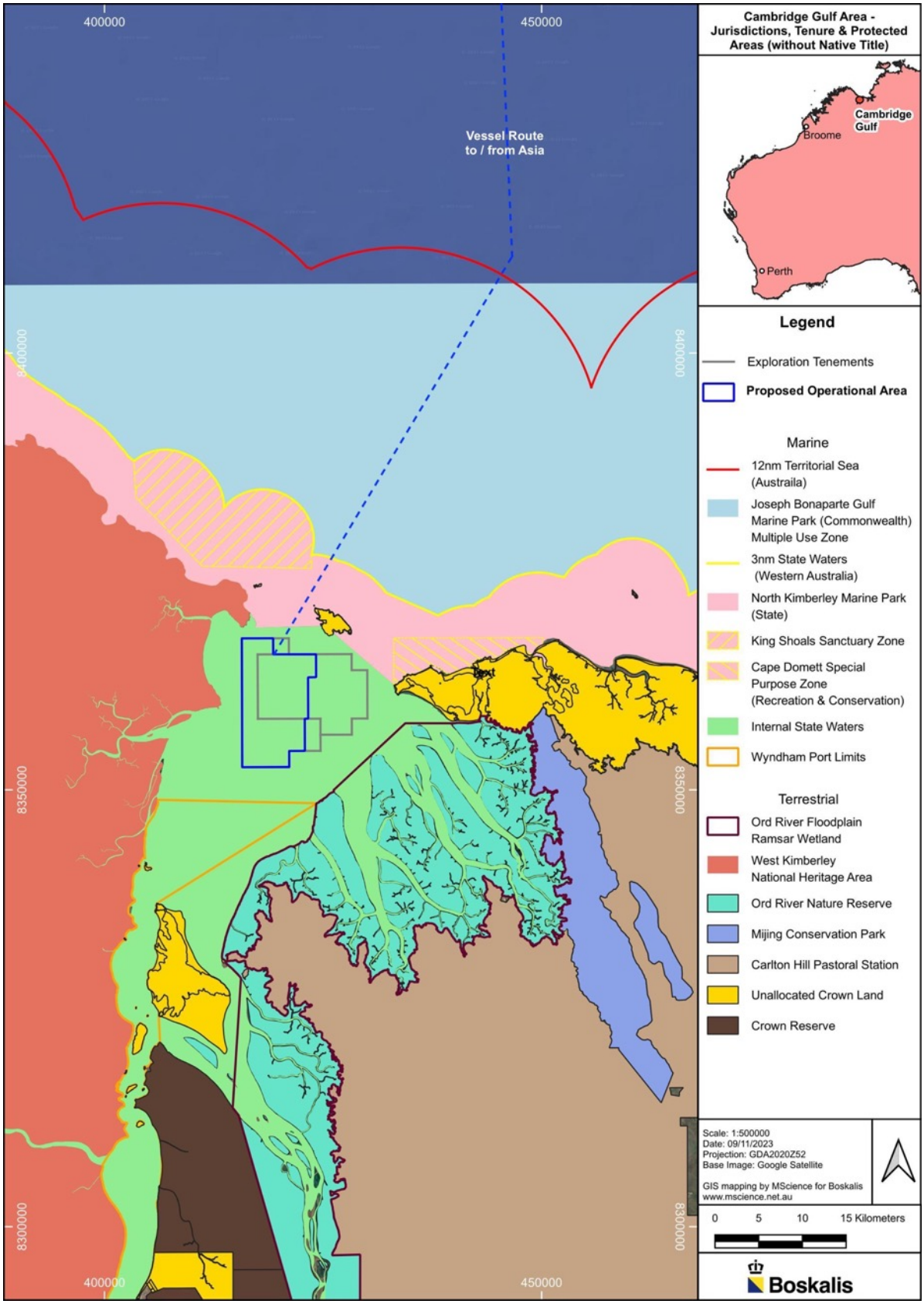


FIGURE 2: *Jurisdictions & tenure in the vicinity of the proposed operational area and the indicative route for the Sand Production Vessel (SPV) to/from Asia*

EXECUTIVE SUMMARY

1. Boskalis Australia Pty Ltd (BKA) is currently assessing the feasibility of developing a marine sand production operation in Cambridge Gulf (CG) near the Port of Wyndham in the northeast of Western Australia (WA) (Figure 1).

2. Despite the low likelihood of significant environmental impacts, as a responsible company with stringent environmental and social policies, BKA has committed to self-referring the proposal to the WA Environmental Protection Authority (WA EPA) under section 38 of the WA Environmental Protection Act (EP Act), and to the Commonwealth Department of Climate Change, Energy, the Environment & Water (DCCEW) under Part 7 of the Commonwealth Environment Protection & Biodiversity Conservation Act (EPBC Act), for their determination of what further environmental assessments might be required, if any.

3. As part of this process, BKA has undertaken a wide range of studies in order to assess potential impacts of the proposal on the following Key Environmental Factors (KEFs):

    a) Benthic communities & habitats (BCH).
    b) Coastal processes.
    c) Marine environmental quality (MEQ).
    d) Marine fauna.
    e) Air quality.
    f) Greenhouse gas (GHG) emissions.
    g) Social surroundings.

4. Overall, it is assessed that the proposal does not present a risk of significant or irreversible negative impacts on any of the KEFs, either directly or indirectly, and will directly provide substantial positive economic, social and cultural benefits, including to the TOs of the area. Summary assessments are presented in Table ES.1.

TABLE ES1: *Summary assessment of the BKA proposal against each KEF*

Key Environmental Factor (KEF)	Summary assessment of the BKA proposal
Benthic Communities & Habitats (BCH):	Refer section 7 for detailed assessment. Due to the extreme environmental conditions including permanent lack of light at the seabed, general lack of hard, stable substrate, strong tidal currents and constantly moving seabed sediments, the LAU does not host benthic primary producer communities or sensitive benthic communities in the form of coral reefs, seagrass beds, sponge beds, macroalgae communities etc, so there is no potential for impacts on such communities (this is one of the key factors why BKA selected CG in the alternatives screening process – see section 18). The main intertidal BCH in the LAU comprise: – a relatively thin band of mangroves along most of the coastline within CG, backed by extensive salt- and mud-flats, – rocky shores and rock platforms, with very little biota although some areas have turf algae, – intertidal cobble and boulder substrate, with very little biota; and – intertidal sand substrate, with very little biota. The main subtidal BCH in the LAU comprise: – some small areas of rocky seabed, with some small biota, – seabed sand substrate, with very little biota; and – seabed mixed clay, silt, sand and gravel substrate, with very little biota. The seabed benthic habitat within the proposed operational area, which will be directly affected by the proposed sand extraction, comprises dynamic sand waves formed and constantly moved by the prevailing tidal currents, and contains very little biota. The likely environmental outcomes with regard to BCH, at the end of the 15-year project timeframe, are assessed as follows: – There will be no impacts on benthic primary producer communities / sensitive benthic ecological communities in the form of coral reefs, seagrass beds, sponge beds, macroalgae communities etc, as they are not present in or near CG. – There will be no irreversible loss of benthic communities and habitats. – There will be no significant or measurable physical changes to benthic habitats. – There will be no significant or measurable changes to biological diversity and ecological integrity of benthic communities in or near CG.

Key Environmental Factor (KEF)	Summary assessment of the BKA proposal
	– There will be no significant or measurable changes in composition, structure, function and processes of benthic communities in or near CG. – The proposed operational area will be on average <1m deeper than the pre-project seabed. It will still comprise sand with similar seabed morphology and thus the same habitat features as pre-project (dynamic sand waves formed and constantly moved by tidal currents).
Coastal Processes:	Refer section 8 for detailed assessment. The coastal areas of CG that comprise rocky cliffs, rocky shores and intertidal rock platforms are fixed, stable substrates and therefore will not be potentially affected by the proposal. Of most relevance to this assessment are the coastal, intertidal and subtidal areas that are comprised of more mobile substrates, and which may therefore be potentially affected by any changes to sediment dynamics that might be caused by the extraction of up to 70 million m^3 of sand from the proposed operational area over 15 years. In assessing potential impacts of the proposal on coastal processes, BKA focused on whether the proposal will alter the natural coastal dynamics and in turn, the coastal ecosystems and values that the coastal environment supports, in particular: – the mangroves around the coast of CG, and especially the eastern coastline and False Mouths of the Ord (which appear to be naturally highly dynamic with numerous areas of significant natural erosion and undercutting of mangroves); and – the turtle nesting beaches on the seaward sides of Cape Domett and Cape Dussejour, and at Turtle Bay on Lacrosse Island. BKA's studies, including calibrated and verified modelling indicate that the proposed operation is unlikely to cause significant changes to coastal processes and there are unlikely to be any significant measurable changes to coastal processes in or near CG, including in relation to inter-tidal sand banks, sand beaches and mangrove areas (see Referral Report No. 5 - PCS 2024a).
Marine Environmental Quality (MEQ):	Refer section 9 for detailed assessment. Overall, the receiving environment in CG in terms of MEQ can be summarized as being free of contaminants and pollutants, with no significant sources of potential contamination along the immediate coastline or in the broader catchment. CG has normal sea temperature, salinity and pH values, relatively low chlorophyll *a* concentrations, and extremely high TSS and turbidity levels and very low (generally zero) light levels at the seabed, throughout the year. There are three possible (but unlikely) mechanisms whereby the proposed operation could potentially affect MEQ and the supported environmental values in CG: – Potential mobilisation of any existing (pre-project) contaminants that might be present in the sand as it is dredged. This has been assessed and the sand is free of contaminants. – Potential alteration of the suspended sediment and turbidity values in CG. BKA engaged PCS (2024a) (Referral Report No. 5) and it is assessed that the proposed operation is unlikely to significantly alter the natural suspended sediment and turbidity values in CG, which are naturally extremely high and dynamic. Further modelling is ongoing and will be reported in subsequent report to be submitted to EPA. – Potential marine pollution from the Sand Production Vessel (SPV). The risk is very low and will be reduced further through best practice prevention and mitigation measures (refer Annex 2). The likely environmental outcomes with regard to MEQ at the end of the 15-year project timeframe are assessed as follows: – the proposed operation is unlikely to cause any changes in the level of contaminants in water, sediments or biota or any changes in the physical or chemical properties of waters and sediments relative to the natural state in CG; and – the proposed operation is therefore unlikely to cause any significantly impact on MEQ and the supported environmental values in CG.
Marine Fauna:	Refer section 10 for detailed assessment.

Key Environmental Factor (KEF)	Summary assessment of the BKA proposal
	CG provides habitat for several significant and protected marine fauna species, including: – Snubfin Dolphin (*Oracella heinshoni*). CG is within the overall boundary of the Commonwealth-defined breeding, calving, foraging and resting Biologically Important Area (BIA) for this species. Surveys observed a few sightings (4 in Feb 2024 and 11 in July 2023), with different sightings possibly being the same individual(s). – Humpback Dolphin (*Sousa sahulensis*). – Flat Back Turtles *(Natator depressus).* CG is within inter-nesting BIA 60 km radius around a globally important nesting beach on the seaward side of Cape Domett outside of CG. There are also turtle nesting beaches with lesser numbers on the seaward coast west of Cape Dussejour, at Turtle Bay on the NW side of Lacrosse Island and at East Bank Point (Barnett Point) within CG. – Green Turtles (*Chelonia mydas*). There is a foraging BIA offshore from CG but no food sources within CG and surveys did not sight any in CG. – Olive Ridley Turtles (*Lepidochelys olivacea*). There is a foraging BIA offshore from CG but no food sources in CG and there are no recorded observations. – Saltwater Crocodiles *(Crocodylus porosus).* – Sawfish (*Pristis spp* and *Anoxypristis cuspidae).* – River Sharks *(Glyphis spp).* CG and especially the mangrove-lined coast and inlets provide habitat for a range of fish species that are typically found in such areas, including Barramundi (*Lates calcarifer*) and Threadfin Salmon (*Eleutheronema tetradactylum*), that are targeted by both commercial and recreational fishermen. The mangrove-lined coast and inlets around CG provide habitat for Mud Crabs (*Scylla spp*) and nursery areas for Red Legged Banana Prawns (*Penaeus indicus*) and White Banana Prawns (*P. merguiensis*). Potential impacts on marine fauna will be avoided and minimized through the following factors and measures: – None of the marine fauna species of concern are likely to be present in the proposed operational area in significant numbers, if at all. Their primary habitats in the CG area are either offshore (turtles) or along the mangrove-lined coast and up the inlets and rivers around CG, and not in or near the proposed operational area. The proposed operation will not impact on their primary habitats. – The SPV will enter and depart CG via West Entrance in order to maintain maximum distance (17 km) from the most important turtle nesting beach at Cape Domett. – The SPV will only be present in CG for one to two days every two weeks, and there will be zero operational activity in CG for 86% of the time during the project's lifespan. – The SPV will operate in CG at very low speeds (~2 knots) and will implement MMF observation and avoidance systems and procedures. – The SPV will be fitted with turtle-safe lighting and marine fauna deflector chains on the drag-head. – The SPV will be a 'new-build' vessel and thus able to incorporate relevant best practice noise reduction measures from the design-phase, as per the IMO 2023 Underwater Noise Guidelines (IMO 2023). As the design parameters for the SPV mature (it is still in conceptual phase), modelling of likely noise emissions will be undertaken in accordance with the IMO Guidelines, and used to inform optimum design and incorporation of noise reduction measures. While even with such measures there is always a possibility that a vessel at sea can have an interaction with marine fauna, such an interaction would not constitute significant impact as per criteria under the WA EP Act and Commonwealth EPBC Act. The likely environmental outcomes with regard to marine fauna at the end of the 15-year project timeframe, are assessed as follows: – There are unlikely to be any significant impacts on marine fauna in or near CG, including protected species and species of conservation significance. – The protection, conservation and management of key marine fauna species in the CG area will be substantially strengthened and improved through BKA's support for research and monitoring of the biology, ecology and behaviour of these species, in close consultation and cooperation with TO and other relevant stakeholders.

Key Environmental Factor (KEF)	Summary assessment of the BKA proposal
Air Quality:	Refer section 11 for detailed assessment. There is no urban, industrial or other development on the coast or in the immediate catchment of CG that could be potential sources of air pollution. The proposal does not involve the construction and operation of any shore-based facilities or infrastructure that could be sources of air pollution. The Sand Production Vessel (SPV) will generate routine air emissions from its engines and on-board machinery. The SPV will comply with Annex VI (Air Pollution) of the *International Convention for the Prevention of Pollution form Ships* (MARPOL) and the implementing Australian regulations (AMSA Marine Order 97). These regulations set strict standards and limits on emissions of nitrous oxides (NOx), sulphur oxides (SOx) (including setting sulphur content limits for marine fuels), volatile organic compounds (VOCs), particulate matter, ozone depleting substances and greenhouse gases from ships. As part of BKA's fleet decarbonisation program, the SPV will be designed for dual-fuel use, allowing adoption of alternative cleaner fuels such as methanol as they become viable in future. The vessel could also potentially be fitted with Rotor Sails which can cut fuel consumption and this emissions on large ships by up to 30%. Through these measures the SPV will not cause negative impacts on human health and amenity or the broader environment through impacts on air quality in the CG area.
Greenhouse Gas Emissions:	Refer section 12 for detailed assessment. The proposal does not involve the construction and operation of any shore-based facilities or infrastructure that could be sources of greenhouse gas emissions. The GHG emissions while the Sand Production Vessel (SPV) is operating in WA waters are calculated to be in the order of 13,000 metric tonnes/year of CO2-e, or 13% of the EPA trigger value of 100,000 tonnes per year. This Environmental Factor is therefore not triggered for the proposal in terms of the EP Act referral. The SPV will comply with Annex VI (Air Pollution) of the *International Convention for the Prevention of Pollution form Ships* (MARPOL) and the implementing Australian regulations (AMSA Marine Order 97). These regulations set strict standards and limits on emissions of GHG from ships, and require ships to implement a range of on-board energy efficiency and emissions reduction strategies and plans, including having an IMO-compliant ship-specific Energy Efficiency Design Index (EEDI) and Shipboard Energy Efficiency Management Plan (SEEMP). As outlined under air- quality above, as part of BKA's fleet decarbonisation program, the SPV will be designed for dual-fuel use, allowing adoption of alternative cleaner fuels such as methanol as they become viable in future. The vessel could also potentially be fitted with Rotor Sails which can cut fuel consumption and thus emissions on large ships by up to 30%.
Social Surroundings:	Refer section 13 for detailed assessment. The potential for significant impacts on social surroundings in CG is limited by the fact that the area is completely uninhabited, with no road access and no built facilities or infrastructure. Wyndham is too distant from the proposed operational area for social surroundings there to be affected. The proposal does not include any facilities or activities in Wyndham that could impact on social surroundings. The SPV will not enter the Port of Wyndham as it will be too large to do so. A small vessel might be based in the Port of Wyndham to support environmental monitoring in CG and for occasional transfers to and from the SPV in CG if needed. The aesthetic values of CG will not be affected by the proposal as there will not be any alteration of the coastline or construction of any onshore or marine facilities or infrastructure, except perhaps a small, 10 m high meteorological mast on the coast. This would be painted to blend with the environment. The SPV will only be present in CG for one to two days every two weeks, so there will be zero visual activity in CG for 86% of the time during the project's lifespan. The Aboriginal cultural heritage sites on Lacrosse Island and on the adjacent mainland will not be impacted by the proposal, as there will not be any construction of onshore facilities or any

Key Environmental Factor (KEF)	Summary assessment of the BKA proposal
	land-based operations, except perhaps the small meteorological mast mentioned above, which would have TO approval and cultural heritage clearance. The commercial vessels that transit to and from the Port of Wyndham will not be impacted by the proposal as normal navigational safety laws and procedures will apply to the SPV, and BKA is consulting closely with relevant maritime authorities on this. Recreational and commercial fishing will not be affected by the proposal as neither are active in the proposed operational area and the proposed operation will not affect fish stocks in CG. The outcomes with regard to social surroundings are positive, including: – Payment of royalties to the State of WA – Payment of royalties to the two TO groups in the area (BAC and MG Corp). – Job and career development opportunities for local TOs and other Australians (initially 40 jobs on the SPV and more in the Boskalis global fleet). – Long-term contracts for TOs and others for project support and environmental monitoring. – Improved knowledge, understanding, protection and conservation of the environment, biodiversity and fisheries of the CG area through funding of scientific research on these issues in consultation and cooperation with relevant partners. – Sponsorship of important community groups and initiatives.

1. BACKGROUND & PURPOSE OF THIS REPORT

1.1 Brief Description of the Proposal

Brief summary only - pls refer Proposal Content Document for details.

1. Boskalis Australia Pty Ltd (BKA) is assessing the feasibility of developing a marine sand sourcing operation in Cambridge Gulf (CG) near Wyndham in the northeast of Western Australia (WA) (Figure 1). The sand in CG is derived from natural terrestrial sources via river inputs. The sand would be exported to Asian markets for use in construction projects. In proposing CG, BKA has screened alternatives as outlined in Referral Report No. 4 - *Impact Assessments* (BKA 2024d).

2. The proposal is subject to the WA *Mining Act* including the comprehensive environmental assessment and management framework under that Act. BKA currently holds two exploration tenements in CG, E80/5655 (Block 4) and E80/6009 (Block 4A) (Figures 1 to 3). Based on sand distribution, the proposed operational area where BKA proposes to apply for a mining tenement is the western part of Block 4 and all of Block 4A (Figure 1 & 2). Key facts relating to the proposal include:

    a) Project lifespan: Up to 15 years from commencement of operations.

    b) Zero coastal or land-based development: The proposal does not involve the construction and operation of any shore-based facilities and does not involve the alteration of the coastline in any way. It will be a 100% vessel-based operation.

    c) Marine area: The proposed operational area is located in the central part of the main body of CG where there is a significant seabed sand resource, covering an area of ~100 km^2 as shown on Figures 1 and 2. Water depths within the area average -25 m MSL. The seabed within and around the proposed operational area comprises highly-dynamic sand-waves with very little biota and no significant benthic communities, due to the constantly moving substrate, strong tidal currents (>2 m/s), constantly high suspended sediments and permanent lack of benthic light.

    d) Single vessel: The proposed operation will involve a Sand Production Vessel (SPV) based generally on the design of a large Trailer Suction Hopper Dredger (TSHD) (Figure 4). It will be an internationally-registered vessel subject to all relevant regulatory requirements of the International Maritime Organization (IMO) and the Australian Maritime Safety Authority (AMSA). While design is conceptual, indicative specifications are Length Overall (LoA) of ~350 m, draft of ~19 m, sand capacity 75K m^3 to 125K m^3 and crew of ~25. There will be no refuelling or waste discharges in CG.

    e) Zero activity in CG for 86% of time: The SPV will self-load sand in CG for one to two days every two weeks. It will then sail to the sand delivery port in Asia and return to CG two weeks later to repeat the cycle. This means that the SPV will only operate in CG for 52 days per year, or 14% of the time. There will be zero operational activity in CG for 86% of the time during the project's lifespan of up to 15 years.

    f) Sand volumes: Exploration surveys indicate that there is a minimum of 300 million m^3 of sand in the proposed operational area and likely several times more. There are several orders of magnitude higher volumes of sand throughout CG overall. It is proposed to export up to 70 million m^3 of sand. This is a maximum of only 23% of the minimum volume of 300 million m^3 of sand estimated to occur in the proposed operational area, and a much smaller % of the volume of sand that occurs throughout CG overall.

    g) Low footprint each loading cycle: During each one- to two-day sand loading cycle, the SPV will work over an area of ~0.5 km^2 within the proposed operational area, with a drag-head width of ~6 m. The SPV will remove a layer of approximately 40 cm of sand from the seabed during each loading cycle.

    h) End of project seabed condition: At the end of the 15-year project timeframe, if the proposed 70 million m^3 of sand is exported, the area within the proposed operational area will be on average <1m deeper than the pre-project seabed. It will still comprise sand with similar seabed morphology, dynamics and habitat features as before sand sourcing.

    i) No significant environmental impacts: Overall, due to the above factors and other factors as assessed in Referral Report No. 4 - *Impact Assessments* (BKA 2024d) and Referral Report No. 5 - *Metocean & Sediment Dynamics* (PCS 2024a), and with the implementation of best-practice impact avoidance, prevention, minimization, mitigation, management and monitoring measures, the proposal is unlikely to cause significant environmental impacts. If the proposal proceeds, BKA will seek to support research and monitoring initiatives to improve environmental protection and biodiversity conservation in the area, in cooperation with relevant stakeholders including TOs (see BKA 2024d).

    j) Economic benefits & TO support: The proposal will generate a range of economic benefits, including payment of State royalties, payment of voluntary royalties to TO groups, up to 40-50 local jobs, service contracts and business opportunities with priority focus on TOs, and support for local Indigenous Ranger groups and community development. Both TO groups in the area, Balanggarra and Miriuwung-Gajerrong, have issued letters of support for the proposal (see Referral Report No. 3 - *Traditional Owner Matters*, BKA 2024c).

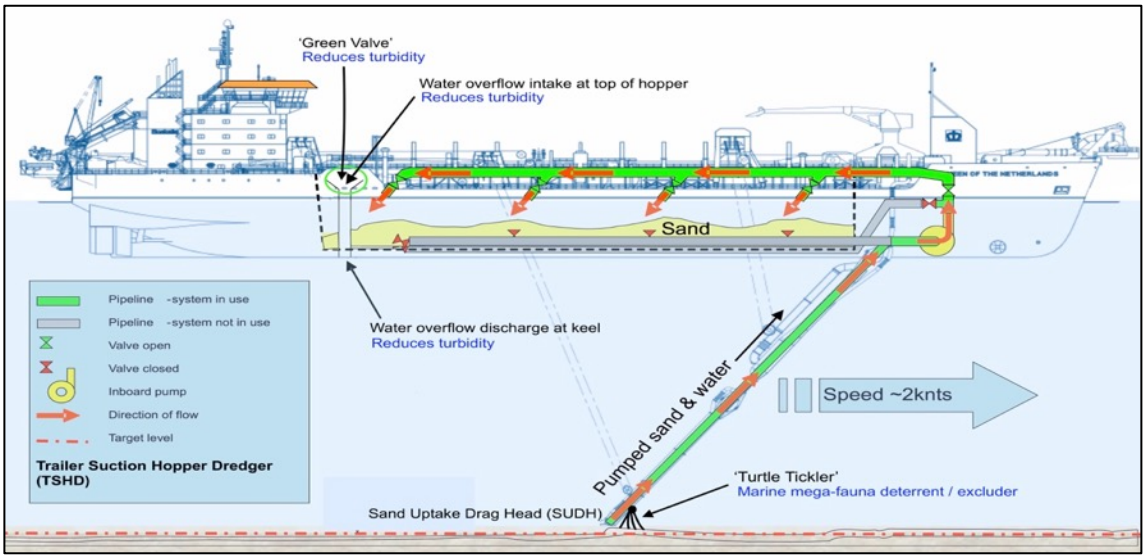


FIGURE 3: *The proposed operation will involve a single Sand Production Vessel (SPV) based generally on the design principles of a large Trailer Suction Hopper Dredger (TSHD) shown here – but designed and built specifically for the proposal.*

1.2 Purpose of this Report

1. To support its feasibility assessment BKA has undertaken a wide range of environmental, engineering, economic and other studies since 2018. These studies find that the proposal is feasible and viable and unlikely to cause significant environmental impacts, as defined under the WA *Environmental Protection Act* (EP Act), the WA *Mining Act*, the Commonwealth *Environmental Protection & Biodiversity Conservation Act* (EPBC Act) and other relevant State and Commonwealth legislation. The findings of these studies in terms of State (WA) impact assessments are presented in this report.

2. Despite the low likelihood of significant environmental impacts, as a responsible company with stringent environmental and social policies, BKA has committed to self-referring the proposal to the WA Environmental Protection Authority (EPA) under section 38 of the EP Act, and to the Commonwealth Department of Climate Change, Energy, the Environment & Water (DCCEW) under Part 7 of the EPBC Act, for their determination of what further environmental assessments might be required, if any. If it is determined that assessment is required under both Acts, BKA will seek a joint process under the WA environmental assessment system, which is accredited by the Commonwealth.

3. As outlined in section 1.1 the proposal is subject to the comprehensive environmental assessment and management framework under the WA *Mining Act*, as outlined in section 17.1, and relevant applications are also being made to the WA Department of Energy, Mines, Industry Regulation & Safety (DEMIRS).

4. The purpose of this report is to support BKA's self-referral under the section 38 of the EP Act, by identifying and describing potential direct and indirect impacts of the proposal on environmental resources and values in the CG area. The impact assessments have been carried out in accordance with the EP Act and the various EPA principles, factors, objectives, standards and guidelines as described in sections 2 and 3.

5. In undertaking these assessments BKA has applied the EPA criteria relating to 'significant impact' as described in section 2 and has also applied the EPA environmental management hierarchy which has the following order of priority:

    a) Avoid (prevent) impacts.
    b) Minimise (mitigate) impacts.
    c) Rehabilitate impacts.
    d) Offset impacts.

6. Cumulative and holistic impacts are assessed in section 16, consistent with EPA requirements. Because the proposal is also subject to the comprehensive environmental assessment and management framework under the WA Mining Act, BKA is developing an Environmental Risk Assessment (ERA) and an Environmental Outcomes, Performance Criteria & Monitoring Plan (EOPCMP) as required under that Act. These are being submitted separately to DEMIRS along with the other required documents as outlined in section 19.1.

7. This report is supported by several other technical reports, as listed under Referral Documents above and indicated where relevant in each section. A version of this report will also be submitted to DCCEW in support of BKA's self-referral under the Commonwealth EPBC Act, aligned with Commonwealth requirements.

2. ENVIRONMENTAL PRINCIPLES, FACTORS & OBJECTIVES

1. The WA EPA's *Statement of Environmental Principles, Factors & Objectives* (EPA 2018) provides clear guidance on how, for the purposes of environmental impact assessment, the EPA:

    a) considers the object and principles of the EP Act,
    b) uses environmental factors and objectives to organise and systemise environmental impact assessment and reporting,
    c) takes a holistic view of the environment and a proposal's potential impact on the environment; and
    d) considers significance when determining whether or not to assess a proposal and recommend whether or not an assessed proposal may be implemented.

2.1 Definition of Environment

1. The EPA's *Statement of Environmental Principles, Factors & Objectives* reiterates the definition of environment from section 3(1) the EP Act, as follows:

    - *Environment, subject to subsection (2), means living things, their physical, biological and social surroundings, and interactions between all of these.*

    - Subsection (2) states: *For the purposes of the definition of environment in subsection (1), the social surroundings of man are his aesthetic, cultural, economic and social surroundings to the extent that those surroundings directly affect or are affected by his physical or biological surroundings.*

2. This definition of 'environment' establishes the scope of environmental impact assessment conducted by the EPA. It clarifies what matters are relevant during environmental impact assessment, and what matters are beyond the scope of environmental impact assessment.

2.2 Environmental Principles

1. The EPA's *Statement of Environmental Principles, Factors & Objectives* lists five principles that support the objective of the EP Act, which is to *protect the environment of the State. T*he EPA is required to have regard to these principles when assessing proposals and exercising it's powers under the Act. The five principles are:

    a) The precautionary principle: *Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.*

    In the application of the precautionary principle, decision should be guided by:
    - careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and
    - an assessment of the risk-weighted consequences of various options.

    b) The principle of intergenerational equity: *The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.*

    c) The principle of the conservation of biological diversity and ecological integrity: *Conservation of biological diversity and ecological integrity should be a fundamental consideration.*

    d) Principles relating to improved valuation, pricing and incentive mechanisms:
    - *Environmental factors should be included in the valuation of assets and services.*
    - *The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement.*
    - *The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any wastes.*
    - *Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.*

    e) The principle of waste minimisation: *All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.*

2. In undertaking its assessments BKA has applied these principles as relevant to various environmental factors, and section 6 presents a summary assessment of the proposal against each of the five principles.

2.3 Environmental Factors & Objectives

1. The EPA's *Statement of Environmental Principles, Factors & Objectives* identifies Environmental Factors as parts of the environment that may be impacted by a proposal. The Factors provide a systematic approach to organising environmental information for the purpose of environmental impact assessment and a structure for the assessment report.

2. The EPA has 14 Environmental Factors, organised into five themes, Sea, Land, Water, Air and People, as listed in Table 1. The EPA has identified an environmental Objective for each Environmental Factor. The EPA considers these Objectives when assessing whether the environmental impact of a proposal is deemed to be significant.

3. The EPA has published guidelines on every Environmental Factor and supporting technical guidance for several of the Factors, as listed in Table 1.

4. While the EPA's use of Environmental Factors and Objectives provides an important structure for the organisation of information, the EPA also takes a holistic approach to assessing environmental acceptability, by having regard to whether the proposal meets the principles outlined in section 2.2 above and considering the interconnected nature of the environment.

5. The EPA's Environmental Factors and associated Objectives are presented in Table 1, including identification of those that are relevant to the BKA proposal – referred to hereafter as Key Environmental Factors (KEFs). There are seven KEFs as follows:

    a) Benthic communities & habitats (BCH).
    b) Coastal processes.
    c) Marine environmental quality (MEQ).
    d) Marine fauna.
    e) Air quality.
    f) Greenhouse gas (GHG) emissions (although emissions will be well below the EPA's trigger of 100,00 tonnes CO_2-e/year, an assessment is included).
    g) Social surroundings.

6. The Environmental Factors relating to land and inland waters are not relevant as the proposal is a 100% vessel-based marine operation with no land-based components.

7. In undertaking its assessments BKA has addressed each KEF and its associated Objective. Section 6 presents a summary assessment of the proposal against the seven KEFs overall, and sections 7 to 13 present specific assessments of the proposal against each KEF.

8. The relevant supporting EPA guidelines as listed in Table 1 have been used when assessing potential impacts on each KEF, and the assessments in sections 7 to 12 are structured to address the requirements of each relevant guideline. Two additional factors - Protected Areas and Commonwealth Matters, have been added as summarised in sections 14 and 15 respectively.

TABLE 1: *The EPA's 14 Environmental Factors and associated Objectives and their relevance to the BKA proposal*

Theme	Environmental Factor	Objective	EPA Guidance	Relevant to BKA Proposal?
Sea	Benthic Communities & Habitats (BCH).	To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.	2016, Environmental Factor Guideline - Benthic Communities & Habitats. 2016, Technical Guidance - Protection of Benthic Communities & Habitats. 2021, Technical Guidance - Environmental Impact Assessment of Marine Dredging Proposals.	Yes - assessed in section 7.
	Coastal Processes.	To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.	2016, Environmental Factor Guideline - Coastal Processes.	Yes - assessed in section 8.
	Marine Environmental Quality (MEQ).	To maintain the quality of water, sediment and biota so that environmental values are protected.	2016, Environmental Factor Guideline - Marine Environmental Quality. 2016, Technical Guidance - Protecting the Quality of Western Australia's Marine Environment.	Yes - assessed in section 9.
	Marine Fauna.	To protect marine fauna so that biological diversity and ecological integrity are maintained.	2016, Environmental Factor Guideline - Marine Fauna.	Yes - assessed in section 10.
Land	Flora and Vegetation.	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.	N/a - no land-based components.	No - the proposal is a 100% vessel-based marine operation.
	Landforms.	To maintain the variety and integrity of significant physical landforms so that environmental values are protected.	"	"
	Subterranean Fauna.	To protect subterranean fauna so that biological diversity and ecological integrity are maintained.	"	"
	Terrestrial Environmental Quality.	To maintain the quality of land and soils so that environmental values are protected.	"	"
	Terrestrial Fauna.	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.	"	"
Water	Inland Waters.	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.	N/a - no impacts on inland waters.	No - the proposal is a 100% vessel-based marine operation.
Air	Air Quality.	To maintain air quality and minimise emissions so that environmental values are protected.	2020, Environmental Factor Guideline - Air Quality.	Yes - assessed in section 11.

Theme	Environmental Factor	Objective	EPA Guidance	Relevant to BKA Proposal?
	GHG Emissions.	To minimise the risk of environmental harm associated with climate change by reducing greenhouse gas emissions as far as practicable.	2023, Environmental Factor Guideline - Greenhouse Gas Emissions.	Not relevant as does not reach EPA's trigger. But still assessed in section 12.
People	Social Surroundings.	To protect social surroundings from significant harm.	2016, Environmental Factor Guideline - Social Surroundings. 2023, Interim Technical Guidance, EIA of Social Surroundings - Aboriginal cultural heritage.	Yes - assessed in section 13.
	Human Health.	To protect human health from significant harm.	N/a	No - the area is uninhabited and vessel crew will work under maritime safety system.

3. SIGNIFICANT IMPACT CRITERIA

3.1 State

1. The WA EPA assesses proposals that are likely to have a significant effect on the environment. The terms 'significant impact' and 'significant effect' are not defined in the EP Act, however the EPA's *Statement of Environmental Principles, Factors & Objectives* (EPA 2018) states that the ordinary or everyday meanings of these terms apply. When considering significant impact or effect, the EPA may have regard to various matters, including the following:

    a) Values, sensitivity and quality of the environment which is likely to be impacted.

    b) Extent (intensity, duration, magnitude and geographic footprint) of the likely impacts.

    c) Consequence of the likely impacts (or change).

    d) Resilience of the environment to cope with the impacts or change.

    e) Cumulative impact with other existing or reasonably foreseeable activities and connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment.

    f) Level of confidence in the prediction of impacts and the success of proposed mitigation.

    g) Public interest about the likely effect of the proposal, if implemented, on the environment, and public information that informs the EPA's assessment.

2. The EPA (2016) *Environmental Factor Guideline - Marine Fauna* also lists some examples of what can be considered as 'significant impact' specifically in relation to marine fauna, as follows (see also section 10 below):

    a) Harm of individuals and/or declines in the population or the range of species protected under state legislation.

    b) Reductions in populations of species of local and regional importance.

    c) Impacts to species or groups of species that fulfil critical ecological functions within the ecosystem.

    d) Loss or impact to critical marine fauna habitat, including habitats such as nesting beaches, nursery areas, sea lion haul out areas, specific foraging or breeding areas, and fish spawning aggregation areas.

    e) Reduction in species diversity in an area, which may be due to factors such as migration or range contraction resulting from a decline in the quality of the local environment.

    f) Introduction and/or spread of invasive marine species or diseases.

3. BKA has therefore included a structured assessment of each of these criteria in each impact assessment section below, in order to assist in determining the likely significance of potential impacts.

3.2 Commonwealth

1. This report supports BKA's referral under the WA EP Act so the State criteria are used. However, as BKA is also referring the proposal under the Commonwealth EPBC Act, section 12 summarizes BKA's assessment of potential impacts on Matters of National Environmental Significance (MNES) as defined under the EPBC Act, and a separate report (Referral Report No. 7) addresses Commonwealth matters in detail.

2. In general, consideration of significant impact under the EPBC Act should include:
    a) the spatial scale of the proposed action and its impacts,
    b) the intensity of impacts, including whether they are likely to be temporary / reversible or permanent / irreversible.
    c) the temporal duration and frequency of the action and its impacts,
    d) the environmental context, for example, the sensitivity, value, quality and size of the environment, the site's connectivity to other habitats and its importance in the conservation of the environment; and
    e) whether mitigation measures will avoid or reduce these impacts.

3. The Commonwealth has published Significant Impact Guidelines (Dept of the Environment 2013), which provide specific significant impact criteria for each MNES, and BKA has systematically applied these criteria in Referral Report No 7 and its separate referral submission to DCCEEW under the EPBC Act.

4. LOCAL ASSESSMENT UNIT

1. The WA EPA *Technical Guidance on the Protection of Benthic Communities and Habitats* (EPA 2016) requires that a spatially-defined Local Assessment Unit (LAU) should be determined within which potential impacts are assessed.

2. The determination of the LAU boundaries should be specific to the location and should be configured to cover the full area within which impacts might occur from the proposal. This should take into account aspects of the local marine environment such as coastal geomorphology, bathymetry, hydrodynamics, the presence of islands and reefs, biological attributes including the distribution of habitat and community types and ecological connectivity of the area. Jurisdictional and administrative factors such as State coastal waters and marine reserve boundaries should also be taken into account.

3. The Technical Guidance states that while LAU boundaries should be site-specific, marine LAUs in WA would typically be approximately 50 km^2 (e.g. a rectangular area defined by a 10 km stretch of coastline extending 5 km offshore or to the limit of State Waters).

4. Figure 4 shows the LAU used by BKA for the CG proposal, overlain on the Benthic Habitat Map for CG. The LAU covers a marine area of over 2,800 km^2, very significantly larger than the 50 km^2 reference stated by the EPA. This does not in any way imply potential for impacts throughout the area, but reflects BKA's conservatively precautionary approach to impact assessment, ensuring that all relevant environmental resources and values and habitats and communities of the general area are included.

5. As shown on Figure 4 the LAU is centred on the proposed operational area and includes:

   - all coastal and marine areas within the main body of CG,
   - all of the coasts of Adolphus Island at the southern end of the main body of CG,
   - all of the coasts of Lacrosse Island at the entrance to CG,
   - the complex of mangrove-lined inlets and on the eastern side of CG known as the False Mouths of the Ord and part of the Ord River Floodplain Ramsar Wetland,
   - the three mangrove-lined rivers on the western side of CG, from north to south the Helby, Lyne and Thompson Rivers,
   - seaward to include the part of the State North Kimberley Marine Park located just offshore from CG,
   - east along the coastline outside of CG to include the beaches east of Cape Domett; and
   - west along the coastline outside of CG to include the beaches west of Cape Dussejour.

6. While the requirement to define a LAU is stated in the EPA guidance on benthic communities and communities, BKA has used this LAU for the assessment of all REFs.

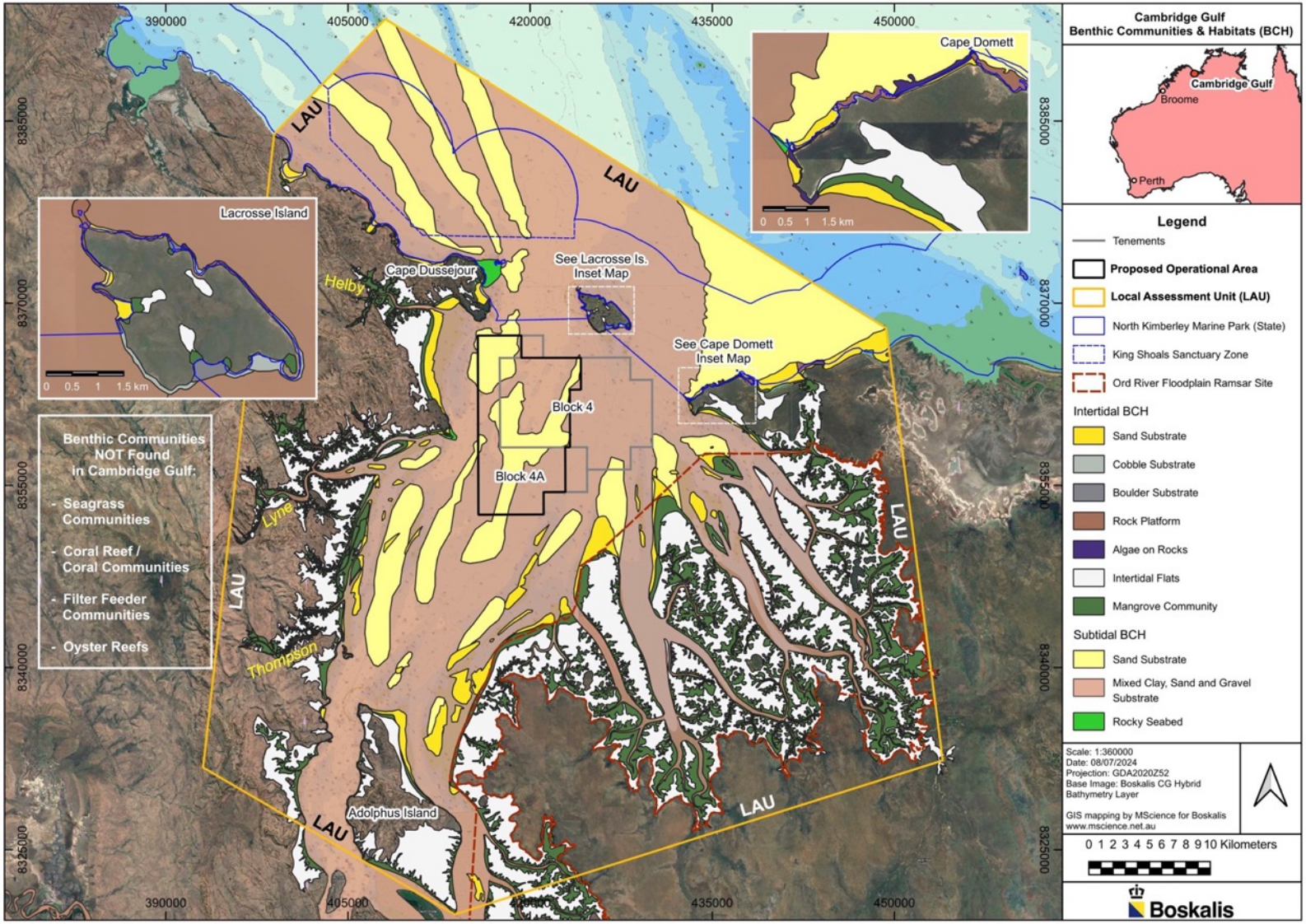


FIGURE 4: *The Local Assessment Unit (LAU) used by BKA for the CG proposal, overlain on the Benthic Habitat Map for CG.*

5. STUDIES & DATASETS USED TO INFORM THE IMPACT ASSESSMENTS

1. BKA has sought to achieve as much scientific certainty as possible by supporting and informing the impact assessments presented in this report with a very comprehensive suite of data. This includes sourcing and using a wide range of pre-existing data from external sources and previous studies of the area; and BKA-collected data. The latter includes surveys and sampling that BKA commissioned or has undertaken directly, including in both the dry- and wet-seasons, and ongoing data collection, as follows:

   a) Sand exploration survey February - March 2023. This included the following within Block 4 (E80/5655):

      - Side-scan sonar and sub-bottom profiler surveys.
      - Vibro-core sampling of the seabed sediments at 35 sites.
      - Grab sampling of the seabed sediments at 35 sites, both to asses sediment types and qualitative assessment of benthic biota.
      - Drop camera deployment at 17 sites to assess benthic communities and habitats and assess water clarity / turbidity.
      - Secchi disc readings at 17 sites to assess water clarity / turbidity.
      - Observing for marine-mega fauna (MMF) for two hours per day over nine days.
      - Nine days of observations of general environmental conditions.

   b) Dry season environmental survey July - August 2023. This included the following throughout CG and offshore:

      - Three replicate benthic grab samples plus drop camera at 105 sites in CG, 27 sites at King Shoals (KS) and 81 sites offshore, for qualitative and quantitative assessment of benthic biota, plus photographic record and visual descriptions of benthic sediment types.
      - Grab samples of sediments at 21 sites in Block 4 for contamination assessment according to NAGD (2009).
      - Vertical water quality profiles at 53 sites in CG, 20 sites at KS and 30 sites offshore.
      - Midwater total suspended solids (TSS) and chlorophyll sampling at 31 sites in CG, three sites at KS and 20 sites offshore.
      - Aerial drone high resolution video and photogrammetry surveys of key intertidal habitats around CG at low tide.
      - Aerial drone surveys of all beaches and coastal sand areas around CG that could be turtle nesting areas.
      - Eight days of dedicated vessel-based MMF surveys covering >800 km of transects.
      - Twenty days of incidental MMF observations.
      - Twenty days of observations of general environmental conditions.

   a) Wet season environmental survey February - March 2024. This included the following throughout CG:

      - High resolution hydrographic survey of the proposed operational area and 1 km buffer, including repeat surveys over a lunar tidal cycle to assess seabed dynamics and changes to seabed morphology.
      - Three replicate benthic grab samples at 26 sites in CG and 14 sites at KS, for qualitative and quantitative assessment of benthic biota, plus photographic record and visual descriptions of benthic sediment types.
      - Vertical water quality profiles each hour over 13-hour spring tidal cycle at each of three sites in, north and south of the proposed operational area. This included Niskin suspended solids sampling at midwater and near-seabed, and co-deployment of YSI multi-sonde and Aquadopp ADCP for current speed and direction.
      - Midwater total suspended solids (TSS) and chlorophyll sampling at 31 sites in CG, three sites at KS and 20 sites offshore.
      - Aerial drone high resolution video and photogrammetry surveys of key intertidal habitats around CG at low tide.
      - Aerial drone high resolution (2 cm) LiDAR and photogrammetry surveys of the four main turtle nesting beaches in CG area at low tide.
      - eDNA sampling targeting Sawfish and River Sharks at 20 sites in proposed operational area and up rivers and inlets on west and east coasts of CG.
      - Nine days of dedicated vessel-based MMF surveys covering >800 km of transects.
      - Twenty days of incidental MMF observations.
      - Twenty days of observations of general environmental conditions.

   b) Ongoing in-situ oceanographic and water quality monitoring since June 2023. This includes:

      - In-situ seabed ADCPs / AWACS at 10 sites throughout CG deployed for various periods depending on site, up to 90 days plus at some sites to give full range of hydrodynamic conditions.
      - In-situ seabed light meters and multi-sonde sensors at eight sites throughout CG, to collect long-term near-seabed light (PAR /DLI), turbidity, temperature, salinity and pH data (ongoing).

2. The main studies and datasets used to support the impact assessments presented in this report are contained in tables in Annex 1. In order to assist in determining the degree of reliability and certainty of the assessments of each key environmental factor (KEF) as presented in sections 7 to 13, Annex 1 is arranged into sub-annexes for each KEF. Each KEF is in turn separated into pre-existing data sourced from previous studies and other parties, and BKA-collected data. Annex 1 also includes maps showing the distribution of data collection points for the various datasets. Figure 5 below shows one example – which is a very small component of the much larger suite of datasets and maps presented in Annex 1.

3. Further details on all relevant data relating to hydrodynamics, sediment dynamics and coastal process assessments undertaken by Port & Coastal Solutions (PCS) for BKA are contained in PCS (2024c) - *Factual Data Report* (an annex to Referral Report No. 5).

4. Referral Report No. 9 - *IMSA Metadata Package Statement* (BKA 2024h) presents all relevant metadata details in accordance with the EPA's Index of Marine Surveys for Assessments (IMSA) guidelines.

5. Some key features of the datasets used include:

    a) Some of the datasets provide data extending back over many years or decades, which assists in determining seasonal, inter-seasonal and longer-term patterns and trends. These include but are not limited to.

        - meteorological data dating back to the 1950s,
        - river level and discharge data dating back to the 1960s,
        - tidal data dating back to the 1980s,
        - satellite imagery dating back to the 1980s and used to assess coastal changes and derive total suspended matter correlations, to assess long-term trends in suspended matter / turbidity; and
        - water quality data collected in CG by the Australian Institute of Marine Science (AIMS) from 1999 through 2004.

    b) Some of the BKA-collected datasets provide data that had never been collected in CG previously. In addition to informing the impact assessments in this report, they also inform general scientific knowledge and understanding of CG and will help to improve environmental protection and biodiversity conservation in the area. All data collected by BKA can be made freely-available to relevant parties, in addition to submitting via IMSA. Such 'new' data includes:

        - the first known benthic grab sampling in CG and at KS,
        - the first known seabed sediment contamination sampling in CG,
        - the first known aerial drone surveys of inter-tidal habitats and turtle nesting areas in and near CG,
        - the first known high resolution aerial drone LiDAR and photogrammetry surveys of the four main turtle nesting beaches in the CG area, providing a powerful baseline for future monitoring; and
        - the first known marine eDNA sampling in CG.

6. To support assessment of potential impacts on Aboriginal cultural heritage, BKA has undertaken what may be the most intensive and comprehensive survey for underwater Aboriginal cultural heritage ever undertaken anywhere in Australia to date. This included comprehensive seabed surveys throughout CG and engaging with the two TO groups on this issue. See Referral Report No. 3. - *Traditional Owners, Native Title & Aboriginal Cultural Heritage*.

7. Overall, the impact assessments presented in this report are supported and informed by a very comprehensive suite of a wide-range of relevant data, which strengthens the reliability and degree of certainty of the assessments.

8. As outlined above, BKA also has an ongoing data collection program in place in CG, including in-situ seabed mounted oceanographic and water quality monitoring instruments.

9. Should the proposal be approved and proceed, BKA proposes to also implement a comprehensive environmental and biodiversity research and monitoring program, in consultation and cooperation with TOs and other relevant stakeholders such as DWER, DBCA and DPIRD Fisheries, as described in section 17. This would provide data to further assist environmental protection and biodiversity conservation in the area.

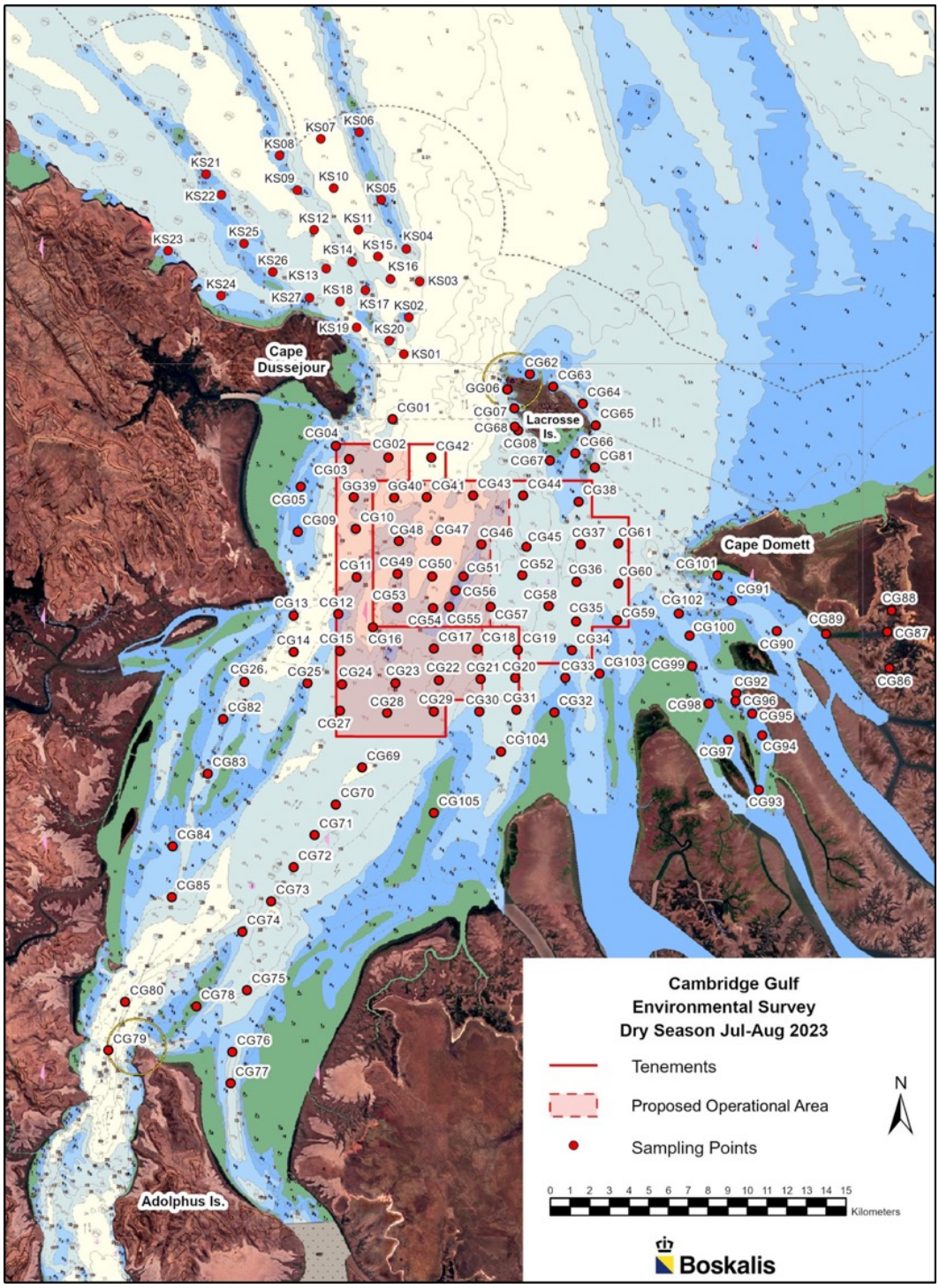


FIGURE 5: *One example of a map showing the distribution of data collection points in CG. This example is a very small component of the much larger suite of datasets and maps presented in Annex 1.*

6. SUMMARY ASSESSMENT OF ENVIRONMENTAL PRINCIPLES & FACTORS

In order to provide a summary overview of the more detailed impact assessments for each KEF presented in sections 7 to 13 below, Table 2 presents a summary assessment of the BKA proposal against each of the EPA's five environmental principles listed in section 2.2, and Table 3 presents a summary assessment of the proposal against each of the KEFs listed in section 2.3.

TABLE 2: *Summary assessment of the BKA proposal against the EPA's five environmental principles*

EPA Environmental Principle	Summary assessment of the BKA proposal
The precautionary principle: – *Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.*	BKA fully embraces the precautionary principle. The proposal does not pose a threat of serious or irreversible damage, as outlined in the impact assessments for each REF presented in the sections below. BKA has sought to achieve as much scientific certainty as possible by supporting the impact assessments with a very comprehensive suite of data from both its own data collection campaigns, including in both the dry and wet seasons, and from external sources and previous studies of the area, as outlined in section 5 and detailed in Annex 1. BKA has an ongoing data collection program in place and should the proposal be approved and proceed, BKA proposes to also implement a comprehensive environmental research and monitoring program, in cooperation with TOs and other relevant partners, as described in section 17. BKA does not propose to postpone measures to prevent environmental impacts, but will include best practice impact prevention, mitigation, monitoring and management measures from the design phase, as outlined for each KEF in the sections below and integrated in section 17.
The principle of intergenerational equity: – *The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.*	BKA fully embraces the principle of intergenerational equity. The proposal does not pose a threat of permanent, long-term, irreversible environmental impacts, as outlined in the impact assessments for each REF presented in the sections below. The proposal therefore does not pose a threat to the health, diversity and productivity of the environment of the area for future generations. Should the proposal be approved and proceed, BKA proposes to implement a comprehensive environmental research and monitoring program, in cooperation with TOs and other relevant partners, as described in section 17. This will provide key data to inform, improve and enhance protection of the environment of the area for future generations, including TOs.
The principle of the conservation of biological diversity and ecological integrity: – *Conservation of biological diversity and ecological integrity should be a fundamental consideration.*	Conservation of biological diversity and ecological integrity is a core priority of the Boskalis corporate Environment & Social Policy. BKA must also comply with the WA *Biodiversity Conservation Act* and the Commonwealth EPBC Act. BKA has undertaken comprehensive field studies of marine biodiversity in the CG area, as outlined in Referral Report No. 3 - *Existing Environmental Descriptions*, and referenced in section 6 - Benthic Communities & Habitats and section 9 - Marine Fauna, below. Should the proposal be approved and proceed, BKA proposes to implement a comprehensive biodiversity research and monitoring program, in cooperation with TOs and other relevant partners, as described in section 17. This will provide key data to inform, improve and enhance protection of the biodiversity and ecological integrity of the area for future generations, including TOs.
Principles relating to improved valuation, pricing and incentive mechanisms:	
– *Environmental factors should be included in the valuation of assets and services.*	Not relevant to this proposal.

EPA Environmental Principle	Summary assessment of the BKA proposal
– *The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance or abatement.*	BKA fully embraces the polluter pays principle. The proposed operation is highly unlikely to generate pollution. The Sand Production Vessel (SPV) will carry mandatory third-party protection and indemnity (P&I) insurance as required by international and Australian maritime laws. The SPV will generate small volumes of sewage and domestic garbage from daily crew activities. These will not be discharged in Australian waters or land areas and will be managed on-board in accordance with the MARPOL Convention, at BKA's cost (see also last principle below).
– *The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any wastes.*	The proposed operation will export the natural resource of marine sand from CG. BKA will pay mining royalties per tonne of sand at a rate set by the WA Government. BKA is also offering to pay voluntary royalties per tonne of sand to the two TO groups of the CG area (see Referral Report No 4 - Traditional Owners). The proposed operation does not involve the disposal of any wastes in Australian land or sea areas (see also last principle below).
– *Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.*	BKA fully embraces undertaking all of its business operations in the most cost-effective way possible. BKA sees improving environmental performance and sustainability as a core part of improving overall business performance and sustainability. As part of its continuous improvement program BKA routinely invests in the development and implementation of its own solutions and responses to environmental issues. Two examples are ongoing improvements to turbidity reduction devices on its dredging fleet and R&D of automated, AI-support marine mega-fauna observation systems (see Annexes 3 and 4).
The principle of waste minimisation: – *All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.*	Waste minimization is a high priority on marine vessels where space can be limited. The SPV will generate small volumes of domestic garbage and sewage from daily crew activities. The SPV will have a Garbage Management Plan that is based on the principle of waste minimisation, as required by MARPOL Annex V and the implementing Australian law, the Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act* and related Marine Orders (administered by the Australian Maritime Safety Authority - AMSA). The SPV will not discharge garbage when in Australian waters or place any garbage ashore in the Port of Wyndham or any other Australian port. All garbage will be kept on-board and managed in accordance with MARPOL Annex V, and discharged to approved port waste reception facilities at the sand destination port (Singapore). The SPV will not discharge sewage when in Australian waters (it will be kept on-board in holding tanks), and will comply with MARPOL Annex IV requirements for on-board sewage treatment systems and discharge standards when sewage is discharged outside of Australian waters.

TABLE 3: *Summary assessment of the BKA proposal against each of the seven KEFs*

Key Environmental Factor (KEF)	Summary assessment of the BKA proposal
Benthic Communities & Habitats (BCH):	Refer section 7 for detailed assessment. Due to the extreme environmental conditions including permanent lack of light at the seabed, general lack of hard, stable substrate, strong tidal currents and constantly moving seabed sediments, the LAU does not host benthic primary producer communities or sensitive benthic communities in the form of coral reefs, seagrass beds, sponge beds, macroalgae communities etc, so there is no potential for impacts on such communities (this is one of the key factors why BKA selected CG in the alternatives screening process – see section 18). The main intertidal BCH in the LAU comprise: – a relatively thin band of mangroves along most of the coastline within CG, backed by extensive salt- and mud-flats, – rocky shores and rock platforms, with very little biota although some areas have turf algae, – intertidal cobble and boulder substrate, with very little biota; and – intertidal sand substrate, with very little biota. The main subtidal BCH in the LAU comprise: – some small areas of rocky seabed, with some small biota, – seabed sand substrate, with very little biota; and – seabed mixed clay, silt, sand and gravel substrate, with very little biota. The seabed benthic habitat within the proposed operational area, which will be directly affected by the proposed sand extraction, comprises dynamic sand waves formed and constantly moved by the prevailing tidal currents, and contains very little biota. The likely environmental outcomes with regard to BCH, at the end of the 15-year project timeframe, are assessed as follows: – There will be no impacts on benthic primary producer communities / sensitive benthic ecological communities in the form of coral reefs, seagrass beds, sponge beds, macroalgae communities etc, as they are not present in or near CG. – There will be no irreversible loss of benthic communities and habitats. – There will be no significant or measurable physical changes to benthic habitats. – There will be no significant or measurable changes to biological diversity and ecological integrity of benthic communities in or near CG. – There will be no significant or measurable changes in composition, structure, function and processes of benthic communities in or near CG. – The proposed operational area will be on average <1m deeper than the pre-project seabed. It will still comprise sand with similar seabed morphology and thus the same habitat features as pre-project (dynamic sand waves formed and constantly moved by tidal currents).
Coastal Processes:	Refer section 8 for detailed assessment. The coastal areas of CG that comprise rocky cliffs, rocky shores and intertidal rock platforms are fixed, stable substrates and therefore will not be potentially affected by the proposal. Of most relevance to this assessment are the coastal, intertidal and subtidal areas that are comprised of more mobile substrates, and which may therefore be potentially affected by any changes to sediment dynamics that might be caused by the extraction of up to 70 million m^3 of sand from the proposed operational area over 15 years. In assessing potential impacts of the proposal on coastal processes, BKA focused on whether the proposal will alter the natural coastal dynamics and in turn, the coastal ecosystems and values that the coastal environment supports, in particular: – the mangroves around the coast of CG, and especially the eastern coastline and False Mouths of the Ord (which appear to be naturally highly dynamic with numerous areas of significant natural erosion and undercutting of mangroves); and – the turtle nesting beaches on the seaward sides of Cape Domett and Cape Dussejour, and at Turtle Bay on Lacrosse Island. BKA's studies, including calibrated and verified modelling indicate that the proposed operation is unlikely to cause significant changes to coastal processes and there are unlikely to be any significant measurable changes to coastal processes in or near CG, including in relation to inter-tidal sand banks, sand beaches and mangrove areas (see Referral Report No. 5 - PCS 2024a).

Key Environmental Factor (KEF)	Summary assessment of the BKA proposal
Marine Environmental Quality (MEQ):	Refer section 9 for detailed assessment. Overall, the receiving environment in CG in terms of MEQ can be summarized as being free of contaminants and pollutants, with no significant sources of potential contamination along the immediate coastline or in the broader catchment. CG has normal sea temperature, salinity and pH values, relatively low chlorophyll *a* concentrations, and extremely high TSS and turbidity levels and very low (generally zero) light levels at the seabed, throughout the year. There are three possible (but unlikely) mechanisms whereby the proposed operation could potentially affect MEQ and the supported environmental values in CG: – Potential mobilisation of any existing (pre-project) contaminants that might be present in the sand as it is dredged. This has been assessed and the sand is free of contaminants. – Potential alteration of the suspended sediment and turbidity values in CG. BKA engaged PCS (2024a) (Referral Report No. 5) and it is assessed that the proposed operation is unlikely to significantly alter the natural suspended sediment and turbidity values in CG, which are naturally extremely high and dynamic. Further modelling is ongoing and will be reported in subsequent report to be submitted to EPA. – Potential marine pollution from the Sand Production Vessel (SPV). The risk is very low and will be reduced further through best practice prevention and mitigation measures (refer Annex 2). The likely environmental outcomes with regard to MEQ at the end of the 15-year project timeframe are assessed as follows: – the proposed operation is unlikely to cause any changes in the level of contaminants in water, sediments or biota or any changes in the physical or chemical properties of waters and sediments relative to the natural state in CG; and – the proposed operation is therefore unlikely to cause any significantly impact on MEQ and the supported environmental values in CG.
Marine Fauna:	Refer section 10 for detailed assessment. CG provides habitat for several significant and protected marine fauna species, including: – Snubfin Dolphin (*Oracella heinshoni*). CG is within the overall boundary of the Commonwealth-defined breeding, calving, foraging and resting Biologically Important Area (BIA) for this species. Surveys observed a few sightings (4 in Feb 2024 and 11 in July 2023), with different sightings possibly being the same individual(s). – Humpback Dolphin (*Sousa sahulensis*). – Flat Back Turtles *(Natator depressus)*. CG is within inter-nesting BIA 60 km radius around a globally important nesting beach on the seaward side of Cape Domett outside of CG. There are also turtle nesting beaches with lesser numbers on the seaward coast west of Cape Dussejour, at Turtle Bay on the NW side of Lacrosse Island and at East Bank Point (Barnett Point) within CG. – Green Turtles (*Chelonia mydas*). There is a foraging BIA offshore from CG but no food sources within CG and surveys did not sight any in CG. – Olive Ridley Turtles (*Lepidochelys olivacea*). There is a foraging BIA offshore from CG but no food sources in CG and there are no recorded observations. – Saltwater Crocodiles *(Crocodylus porosus).* – Sawfish (*Pristis spp* and *Anoxypristis cuspidae).* – River Sharks *(Glyphis spp).* CG and especially the mangrove-lined coast and inlets provide habitat for a range of fish species that are typically found in such areas, including Barramundi (*Lates calcarifer*) and Threadfin Salmon (*Eleutheronema tetradactylum*), that are targeted by both commercial and recreational fishermen. The mangrove-lined coast and inlets around CG provide habitat for Mud Crabs (*Scylla spp*) and nursery areas for Red Legged Banana Prawns (*Penaeus indicus*) and White Banana Prawns (*P. merguiensis*).

Key Environmental Factor (KEF)	Summary assessment of the BKA proposal
	Potential impacts on marine fauna will be avoided and minimized through the following factors and measures: – None of the marine fauna species of concern are likely to be present in the proposed operational area in significant numbers, if at all. Their primary habitats in the CG area are either offshore (turtles) or along the mangrove-lined coast and up the inlets and rivers around CG, and not in or near the proposed operational area. The proposed operation will not impact on their primary habitats. – The SPV will enter and depart CG via West Entrance in order to maintain maximum distance (17 km) from the most important turtle nesting beach at Cape Domett. – The SPV will only be present in CG for one to two days every two weeks, and there will be zero operational activity in CG for 86% of the time during the project's lifespan. – The SPV will operate in CG at very low speeds (~2 knots) and will implement MMF observation and avoidance systems and procedures. – The SPV will be fitted with turtle-safe lighting and marine fauna deflector chains on the drag-head. – The SPV will be a 'new-build' vessel and thus able to incorporate relevant best practice noise reduction measures from the design-phase, as per the IMO 2023 Underwater Noise Guidelines (IMO 2023). As the design parameters for the SPV mature (it is still in conceptual phase), modelling of likely noise emissions will be undertaken in accordance with the IMO Guidelines, and used to inform optimum design and incorporation of noise reduction measures. While even with such measures there is always a possibility that a vessel at sea can have an interaction with marine fauna, such an interaction would not constitute significant impact as per criteria under the WA EP Act and Commonwealth EPBC Act. The likely environmental outcomes with regard to marine fauna at the end of the 15-year project timeframe, are assessed as follows: – There are unlikely to be any significant impacts on marine fauna in or near CG, including protected species and species of conservation significance. – The protection, conservation and management of key marine fauna species in the CG area will be substantially strengthened and improved through BKA's support for research and monitoring of the biology, ecology and behaviour of these species, in close consultation and cooperation with TO and other relevant stakeholders.
Air Quality:	Refer section 11 for detailed assessment. There is no urban, industrial or other development on the coast or in the immediate catchment of CG that could be potential sources of air pollution. The proposal does not involve the construction and operation of any shore-based facilities or infrastructure that could be sources of air pollution. The Sand Production Vessel (SPV) will generate routine air emissions from its engines and on-board machinery. The SPV will comply with Annex VI (Air Pollution) of the *International Convention for the Prevention of Pollution form Ships* (MARPOL) and the implementing Australian regulations (AMSA Marine Order 97). These regulations set strict standards and limits on emissions of nitrous oxides (NOx), sulphur oxides (SOx) (including setting sulphur content limits for marine fuels), volatile organic compounds (VOCs), particulate matter, ozone depleting substances and greenhouse gases from ships. As part of BKA's fleet decarbonisation program, the SPV will be designed for dual-fuel use, allowing adoption of alternative cleaner fuels such as methanol as they become viable in future. The vessel could also potentially be fitted with Rotor Sails which can cut fuel consumption and this emissions on large ships by up to 30%. Through these measures the SPV will not cause negative impacts on human health and amenity or the broader environment through impacts on air quality in the CG area.

Key Environmental Factor (KEF)	Summary assessment of the BKA proposal
Greenhouse Gas Emissions:	Refer section 12 for detailed assessment. The proposal does not involve the construction and operation of any shore-based facilities or infrastructure that could be sources of greenhouse gas emissions. The GHG emissions while the Sand Production Vessel (SPV) is operating in WA waters are calculated to be in the order of 13,000 metric tonnes/year of CO2-e, or 13% of the EPA trigger value of 100,000 tonnes per year. This Environmental Factor is therefore not triggered for the proposal in terms of the EP Act referral. The SPV will comply with Annex VI (Air Pollution) of the *International Convention for the Prevention of Pollution form Ships* (MARPOL) and the implementing Australian regulations (AMSA Marine Order 97). These regulations set strict standards and limits on emissions of GHG from ships, and require ships to implement a range of on-board energy efficiency and emissions reduction strategies and plans, including having an IMO-compliant ship-specific Energy Efficiency Design Index (EEDI) and Shipboard Energy Efficiency Management Plan (SEEMP). As outlined under air- quality above, as part of BKA's fleet decarbonisation program, the SPV will be designed for dual-fuel use, allowing adoption of alternative cleaner fuels such as methanol as they become viable in future. The vessel could also potentially be fitted with Rotor Sails which can cut fuel consumption and thus emissions on large ships by up to 30%.
Social Surroundings:	Refer section 13 for detailed assessment. The potential for significant impacts on social surroundings in CG is limited by the fact that the area is completely uninhabited, with no road access and no built facilities or infrastructure. Wyndham is too distant from the proposed operational area for social surroundings there to be affected. The proposal does not include any facilities or activities in Wyndham that could impact on social surroundings. The SPV will not enter the Port of Wyndham as it will be too large to do so. A small vessel might be based in the Port of Wyndham to support environmental monitoring in CG and for occasional transfers to and from the SPV in CG if needed. The aesthetic values of CG will not be affected by the proposal as there will not be any alteration of the coastline or construction of any onshore or marine facilities or infrastructure, except perhaps a small, 10 m high meteorological mast on the coast. This would be painted to blend with the environment. The SPV will only be present in CG for one to two days every two weeks, so there will be zero visual activity in CG for 86% of the time during the project's lifespan. The Aboriginal cultural heritage sites on Lacrosse Island and on the adjacent mainland will not be impacted by the proposal, as there will not be any construction of onshore facilities or any land-based operations, except perhaps the small meteorological mast mentioned above, which would have TO approval and cultural heritage clearance. The commercial vessels that transit to and from the Port of Wyndham will not be impacted by the proposal as normal navigational safety laws and procedures will apply to the SPV, and BKA is consulting closely with relevant maritime authorities on this. Recreational and commercial fishing will not be affected by the proposal as neither are active in the proposed operational area and the proposed operation will not affect fish stocks in CG. The outcomes with regard to social surroundings are positive, including: – Payment of royalties to the State of WA – Payment of royalties to the two TO groups in the area (BAC and MG Corp). – Job and career development opportunities for local TOs and other Australians (initially 40 jobs on the SPV and more in the Boskalis global fleet). – Long-term contracts for TOs and others for project support and environmental monitoring. – Improved knowledge, understanding, protection and conservation of the environment, biodiversity and fisheries of the CG area through funding of scientific research on these issues in consultation and cooperation with relevant partners. – Sponsorship of important community groups and initiatives.

7. IMPACT ASSESSMENT - BENTHIC COMMUNITIES & HABITATS

7.1 Relevant EPA Guidance & Objective

1. The EPA has published three guidance documents relating to benthic communities and habitats as follows;

   - EPA 2016, *Environmental Factor Guideline - Benthic Communities & Habitats.*
   - EPA 2016, *Technical Guidance - Protection of Benthic Communities & Habitats.*
   - EPA 2021, *Technical Guidance - Environmental Impact Assessment of Marine Dredging Proposals.*

2. The Objective of the Environmental Factor Guideline is:

   - *To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained*. Ecological integrity is defined as the *composition, structure, function and processes of ecosystems, and the natural variation of these elements*.

3. The Environmental Factor Guideline defines benthic communities as *biological communities that live in or on the seabed* and benthic habitats as the *seabed substrates that benthic communities grow on or in*.

4. In accordance with the Guideline's Objective, it states that the EPA is mainly concerned with changes that are likely to significantly impact on biological diversity and ecological integrity. The EPA is therefore mainly focused on whether any losses to benthic communities or habitats are temporary or permanent. These matters are addressed in section 7.3 below.

5. The 2016 Technical Guidance highlights the importance of benthic primary producer communities including but not limited to *coral reefs, algal-dominated biogenic reefs, algal-dominated rocky reefs, seagrass meadows, mangrove forests* and *algal mats* and *salt marshes growing on intertidal sand/mud flats.*

6. The 2016 Technical Guidance explains how impacts on benthic communities and habitats should be assessed and sets out the type and form of the information that should be presented in the impact assessment. It sets out eight steps that should be followed in presenting information about the distribution and spatial extent of benthic communities and habitats in the area and for assessing potential impacts. These eight steps are addressed in section 7.3.7 below.

7. The 2021 Technical Guidance deals specifically with the impacts of dredging on benthic communities and habitats, particularly direct loss by removal or burial, and the indirect impacts from the effects of sediment plumes. With regard to the latter the Guidance recommends three key types of predictive modelling in a logical sequence:

   - hydrodynamic modelling,
   - sediment transport modelling; and
   - ecological response modelling, including biological effects criteria.

8. The 2021 Technical Guidance includes a spatially-based zonation scheme for describing the predicted extent, severity and duration of impacts from the dredging on benthic communities and habitats, as follows:

   - Zone of High Impact (ZoHI): This is the zone where serious damage is predicted, where impacts are considered to be irreversible or where any recovery, if possible, would be unlikely to occur for at least five years.

   - Zone of Moderate Impact (ZoMI): This is the zone within which predicted impacts on benthic organisms are sub-lethal, and/or the impacts are recoverable within a period of five years following completion of the dredging activities.

   - Zone of Influence (ZoI): This is the zone within which changes in environmental quality associated with dredge plumes would not result in a detectible impact on benthic biota.

9. Because the proposed operation has some similarities to dredging, relevant aspects of the 2021 Guidance are discussed in section 7.3.

10. The 2021 Guidance recommends that modelling should comply with best practice guidelines such as the WAMSI / CSIRO *Guideline on dredge plume modelling for environmental impact assessment* (Sun et al 2019). BKA has required its modeling consultants Port & Coastal Solutions (PCS) to apply these guidelines (see Referral Report No. 5 - *Cambridge Gulf Metcocean & Sediment Dynamics (PCS 2024a, b & c*).

11. The 2021 Guidance also recommends that the proponent engage independent peer review of the modelling work – which BKA has done for sequential stages, including review of the data collection and modelling design (terms of reference) and of draft data analysis and modelling reports from PCS.

7.2 Receiving Environment

1. A detailed description of the receiving environment with respect to benthic communities and habitats is presented in Referral Report No. 2 - *Proposal Setting & Existing Environmental Descriptions*. This includes detailed descriptions of the methods used to map, assess and describe the benthic communities and habitats within the LAU, detailed descriptions of each benthic community and habitat and numerous supporting images and graphics. These are not repeated in detail in this report, although the overall benthic habitat map for the LAU is shown in Figure 2 in section 4 above, and each benthic community and habitat type is summarized in sections 7.2.1 to 7.2.10 below.

7.2.1 Lack of significant primary producer communities / sensitive benthic communities

1. Due to the extreme environmental conditions including permanent lack of light at the seabed, general lack of hard, stable substrate, strong tidal currents and constantly moving sediments, CG does not host significant primary producer communities in the form of coral reefs, seagrass beds, sponge beds, macroalgae communities etc, so there is no potential for impacts on such communities (this was a key factor in selecting CG in the alternatives screening process – section 18).

7.2.2 Benthic habitat in the proposed operational area

1. The proposed operational area where sand is proposed to be extracted is shown on Figure 1 and covers an area of ~100 km^2, located slightly west of the center of the main body of CG. High-resolution hydrographic surveys of the area and a 1 km buffer zone carried out in February and March 2024 show that the benthic habitat in this area mainly comprises highly mobile sand waves, formed and constantly moved by the prevailing strong tidal currents. The sand waves have vertical heights ranging from 1 to 8 m and horizontal wavelengths of between 50 and 200 m (Figures 6 to 8) (see Referral Report No. 5).

2. Repeat high resolution hydrographic surveys of two Target Areas in the proposed operational area over a month-long lunar tidal cycle in February-March 2024, measured horizontal migration of the seabed sand-forms by up to 10 m over just 27 days, showing that they are highly dynamic and constantly moving (see Referral Report No. 5).

3. The dry season (July 2023) and wet season (February 2024) benthic surveys reported in Referral Report No. 2 show that the sand in this area is largely devoid of benthic biota, due to permanent lack of light at the seabed, lack of stable hard substrate and constant movement of the sand under the influence of strong tidal currents. Most benthic grab samples from sand areas returned no biota after sieving to 500 microns (Figure 9). Benthic grab samples that returned biota were mostly from non-sand areas where the seabed substrate comprises mixed clay, silt and/or gravel, with a few small organisms such as small hydroids, bryozoans, sponges etc, attached to small pebbles and stones (Figure 10) (see Referral Report No. 2).

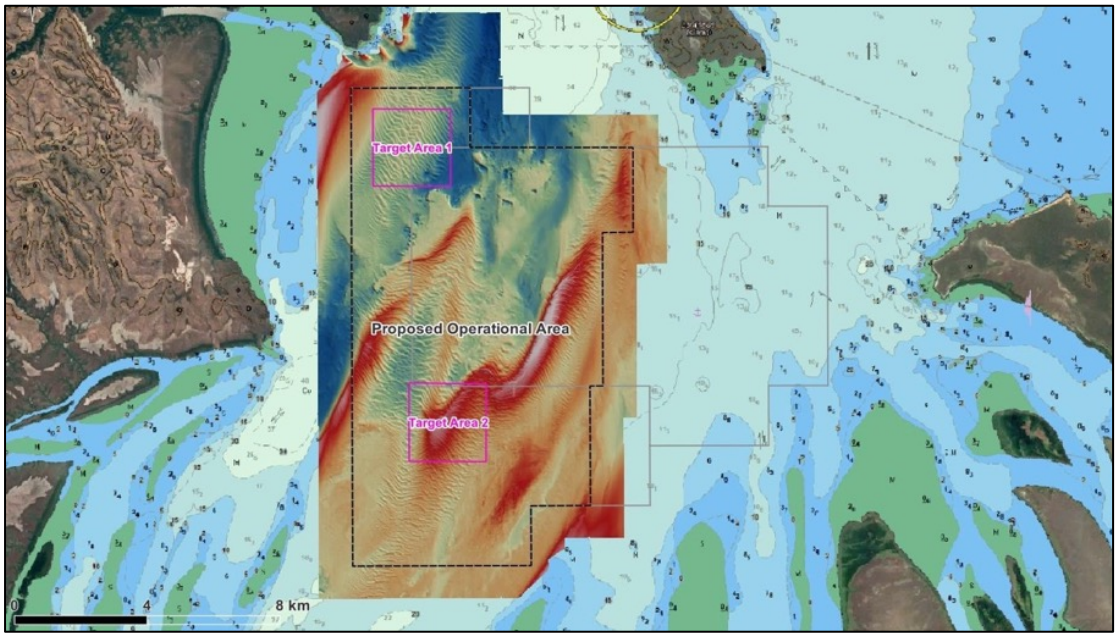


FIGURE 6: *High resolution hydrographic survey of the proposed operational area showing the benthic sand substrate.*

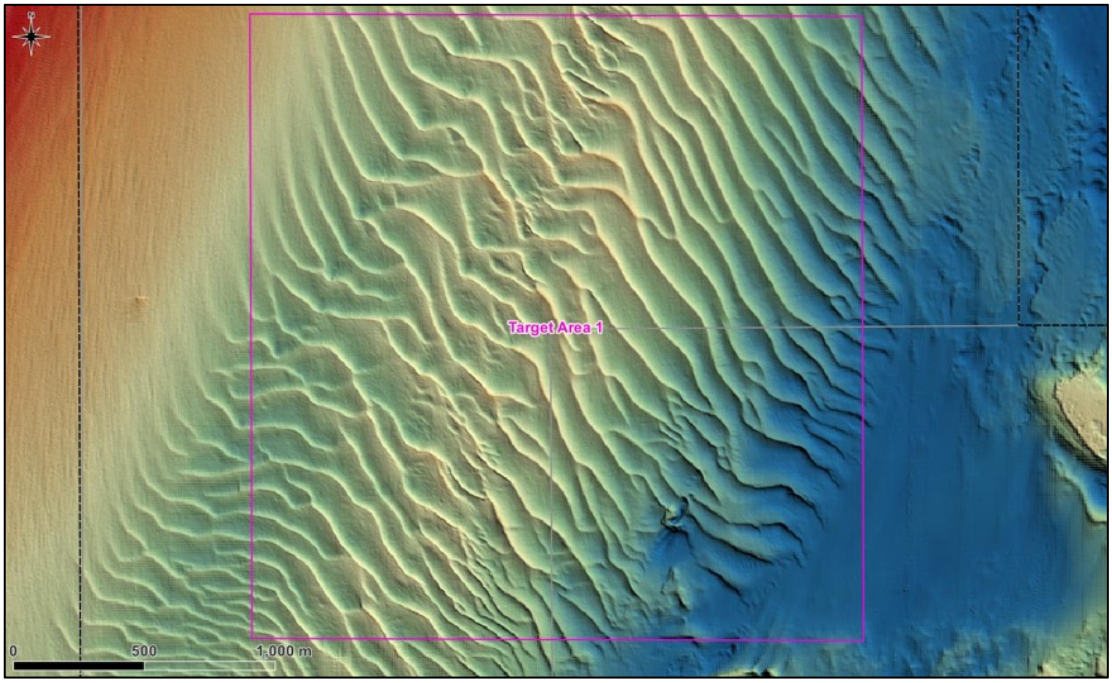


FIGURE 7: *Digital elevation model generated from the high-resolution hydrographic survey of Target Area 1 in the proposed operational area showing the benthic substrate comprised of sand waves. The sand waves have vertical heights ranging from 1 to 8 m and horizontal wavelengths of between 50 and 200 m.*

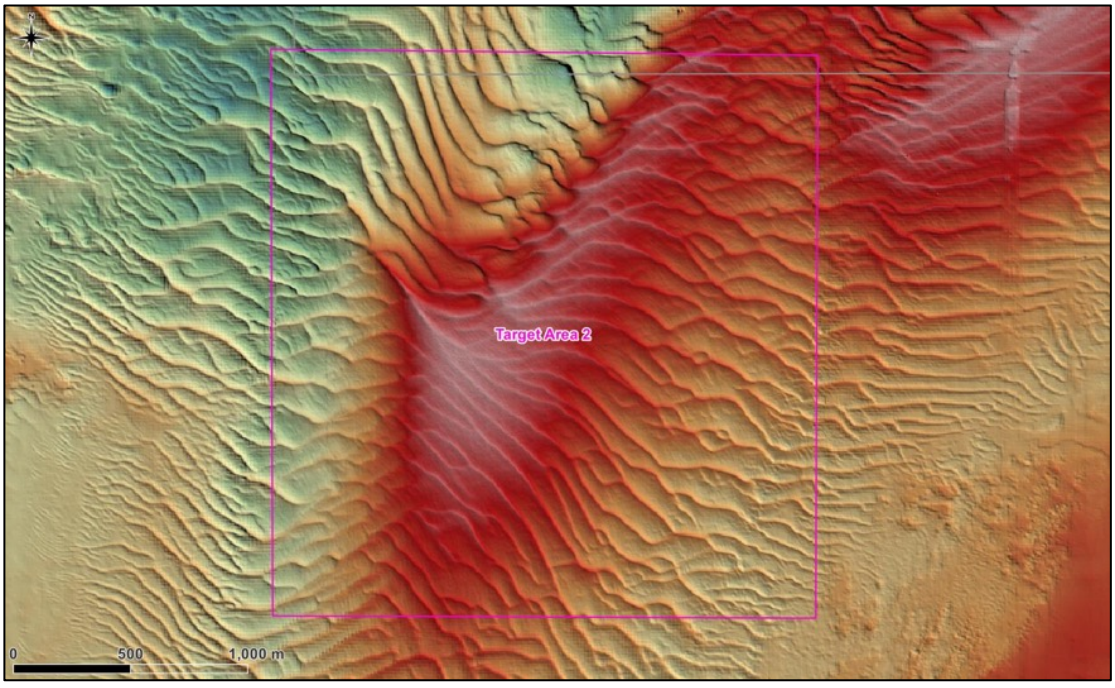


FIGURE 8: *As per Figure 7 but for Target Area 2. Red indicates higher (shallower) bathymetry.*

Pre-sieve **Post-sieve** (500 microns)

FIGURE 9: *Benthic grab sand sample before and after sieving to 500 microns. Most benthic grab samples from sand areas, including in the proposed operational area, returned no biota after sieving to 500 microns. This example is from site WS49 in the centre of the proposed operational area, and is typical of sand samples from throughout this area and CG overall. See Referral Report No. 3 for details and results of all sampling.*

FIGURE 10: *Benthic grab samples that returned biota were mostly from non-sand areas where the seabed substrate comprises mixed clay, silt and/or gravel, with a few small organisms such as small hydroids, bryozoans, sponges etc, attached to small pebbles and stones. See section 7.2.10 for summary and Referral Report No. 3 for full details.*

7.2.3 Mangroves

1. The EPA guidance on benthic communities and habitats defines mangroves as a benthic community - as they grow on inter-tidal substrates. Mangroves are the most significant benthic community in CG, comprising a relatively thin band along most of the coastline within CG, backed by extensive salt- and mud-flats (Figure 11). Mangroves cover a total area of ~350 km^2 within the LAU, as shown on Figure 4 in section 4 above. Fifteen species of mangrove tree have been identified in CG, with *Sonneratia alba, Rhizophora stylosa, Avicennia marina* and *Bruguiera spp* being common, depending on the location.

2. The Helby, Lyne and Thompson Rivers that flow into CG on the western side are mangrove-lined, and on the eastern side there is a large network of wide, mangrove-lined inlets and salt- and mud-flats, known as the 'False Mouths of the Ord', which is part of the Ord River Floodplain Ramsar Wetland (Figure 12).

3. As described in Referral Report No. 2, the eastern coastline and the Ramsar Wetland appear to be naturally highly dynamic with numerous areas of significant natural erosion and undercutting of mangroves. These erosion areas mainly face to the north-west and may therefore be impacted by north-westerly winds and waves and may be less sheltered from cyclone impacts than other parts of CG (Figures 13A & B).

4. The proposal will not impact on mangrove areas as outlined in section 7.3 below. The closest distance between the proposed operational area and mangroves is ~4 km, between the north-west corner of the operational area and the mouth of the Helby River on the north-west coast of CG. Most mangrove areas are >10 km from the outer boundaries of the operational area.

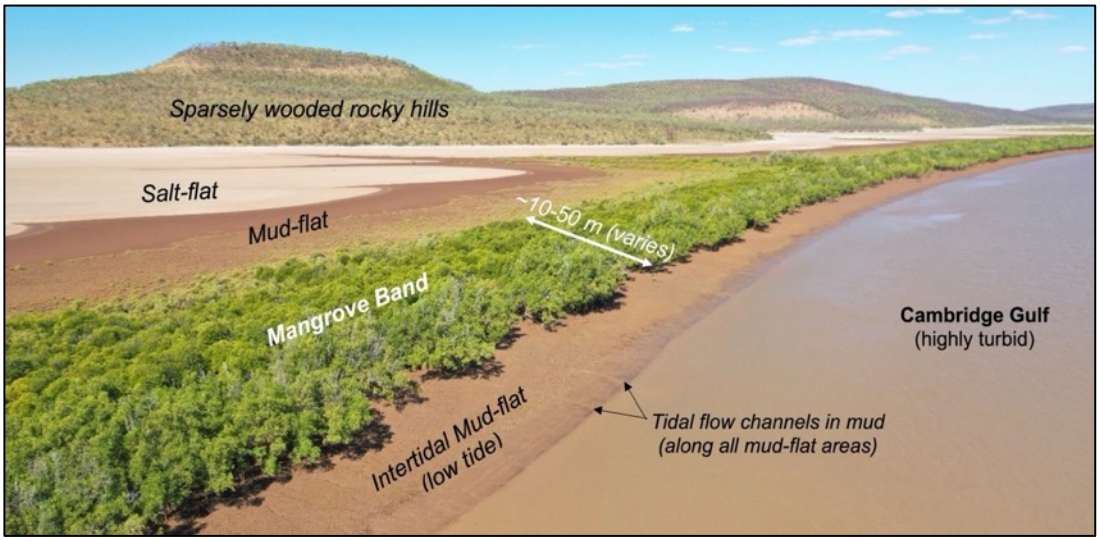


FIGURE 11: *The typical coastal environment that lines the majority of the coastline within CG. This shows the relatively narrow band of mangroves that constitute the most significant benthic community in CG.*

FIGURE 12: *The narrow bands of mangrove that line the inlets in the Ramsar wetland on the eastern side of CG.*

FIGURE 13A & B: *Two examples of numerous areas of significant natural erosion and undercutting of mangroves in the Ramsar area on the eastern side of CG, indicating a naturally highly dynamic environment. The are many other such areas - see Referral Report No. 3. (images: Raaymakers Feb 2024).*

7.2.4 Intertidal salt- & mud-flats

1. Most of the mangrove areas in CG are backed by extensive salt- and/or mud-flats as shown on Figure 4 in section 4 and on Figures 11 and 12. These are inundated by seawater on spring high tides and partially dry out and are exposed to the sun on spring low tides. This habitat is hypersaline especially during the dry season, with limited vegetation cover, mainly comprising low, salt-tolerant grasses and succulents around the edges and on slightly higher parts of the flats. They can be inundated by freshwater and brackish water during wet season runoff events. They provide habitat for shore birds and wading birds, although numbers are not high in CG.

2. The proposal will not impact on these areas as outlined in section 3 below.

7.2.5 Rocky shores & rock platforms (some with turf algae on rocks)

1. There are isolated outcrops of rocky shore with intertidal rocky substrate at the following locations:

   - at both Cape Domett on the eastern side and at Cape Dussejour on the western side of the entrance to CG,
   - at some points on the coast of Lacrosse Island,
   - at Vancouver Point and Myrmidon Ledge on the northern point of the mouth of the Lyne River on the west of CG; and
   - at parts of the coast around Adolphus Island at the southern end of the LAU.

2. Figure 14 shows an example of this habitat type – at Vancouver Point on the western side of CG. No evidence of benthic communities or biota was observed on these areas by high-resolution aerial drone photo and video surveys and vessel-based photographic surveys at low tide. Habitat suitability is limited by the extreme environmental conditions of the area.

3. As shown on Figure 15 there are also intertidal rock platforms at Cape Domett and along the northern coast of Lacrosse Island. Some of the rock platforms support a thin layer of green filamentous turf algae and some barnacles at the tide line, with no evidence of macroalgae, other algae or other benthic communities or biota.

4. The proposal will not impact on these areas as outlined in section 3 below.

FIGURE 14: *Example of isolated outcrop of rocky shore with intertidal rocky substrate found in parts of CG – this is Vancouver Point on the western side of CG.*

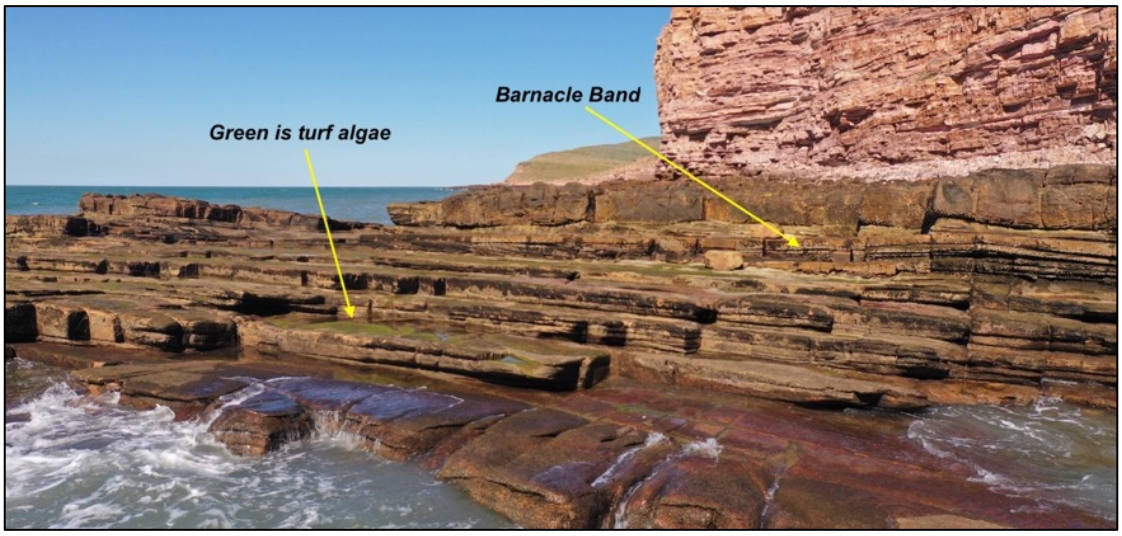


FIGURE 15: *Example of intertidal rock platform on the northern coast of Lacrosse Island, with a a thin layer of green filamentous turf algae and band of barnacles. This habitat type is also found at Cape Domett.*

7.2.6 Intertidal Cobble & Boulder Substrate

1. There is intertidal cobble and boulder beach substrate along the south western, southern and south eastern coast, and at a small bay on the northern coast, of Lacrosse Island. Figure 16 shows an example of this habitat type. No evidence of benthic communities or biota was observed on these areas by high-res aerial drone photo and video surveys at low tide, with habitat suitability limited by the extreme environmental conditions of the area.

2. The proposal will not impact on these areas as outlined in section 3 below.

FIGURE 16: *Example of intertidal cobble and boulder beach substrate on the eastern tip of Lacrosse Island.*

7.2.7 Intertidal Sand Substrate

1. There are extensive areas of intertidal sand-substrate forming sandbanks, sandbars and sandflats around the coast of CG as shown on Figure 4 in section 4 and detailed further on Figure 17. The main intertidal sand areas are, moving clockwise from the top left of Figure 17:

    - Bare Hill Bay Sandflat in the small bay on the seaward northern side of Cape Dussejour,
    - Shakespeare Bay Sandflat on the seaward coast east of Cape Domett,
    - the Eastern Sandbars extending seaward from the mangrove points on the eastern side of CG, at the so-called ‘False Mouths of the Ord’,
    - Barnett Point Sandbar extending north of Barnett Point (which could be considered part of the Eastern Sandbars),
    - East Bank off the western side of Barnett Point,
    - Guthrie Banks on the west coast south of the mouth of the Lyne River,
    - the Lyne River Sandbanks at the mouth of the Lyne River; and
    - Western Sandflat along the western coast from Cape Dussejour south to Vancouver Point, just north of the mouth of the Lyne River.

2. Figure 18 shows an example of this habitat type at East Bank on the eastern side of CG. These inter-tidal sand areas were surveyed at low tide for seagrasses, macro-algae and other benthic communities and biota, using high resolution aerial drone video and photography, and vessel-based visual and photographic surveys, and no evidence of benthic communities or biota was observed (see Referral Report No. 2 for detailed description). Habitat suitability is limited by the highly dynamic

nature of the sand substrate and the extreme environmental conditions of the area, with strong tidal currents and high natural turbidity.

3. The proposal will not impact on these areas as outlined in section 7.3 below.

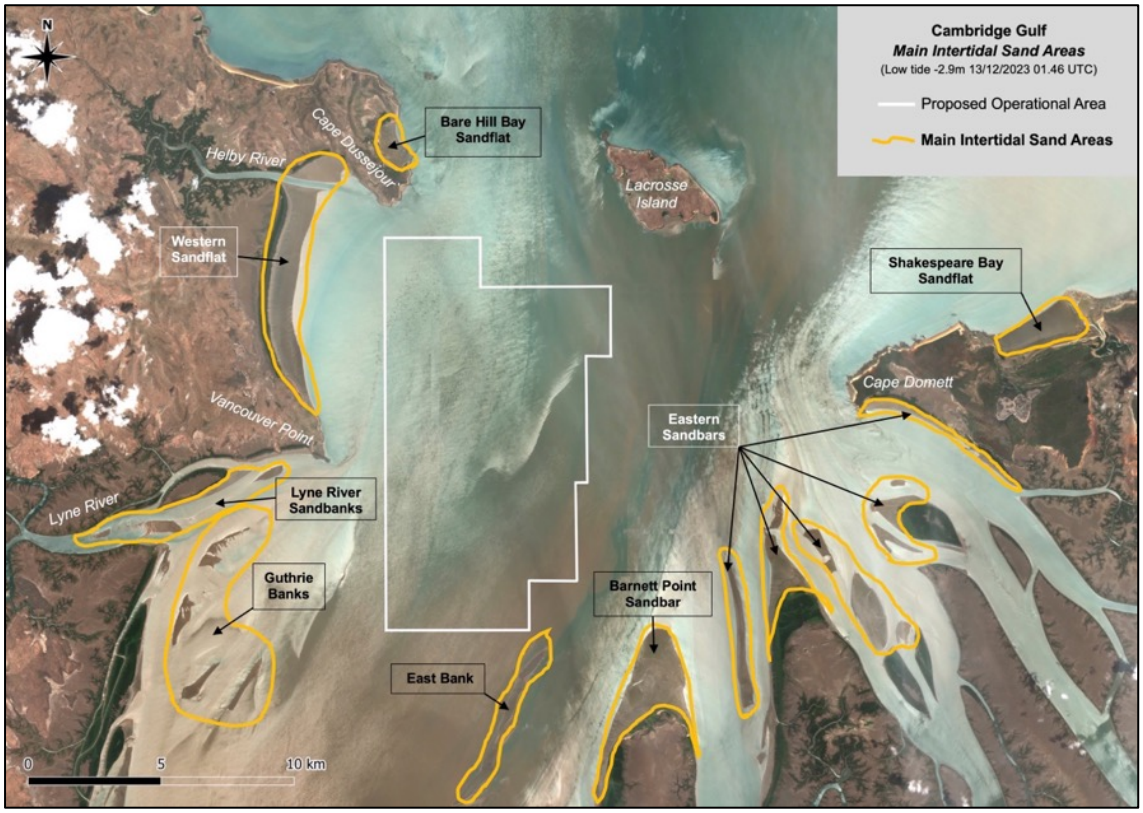


FIGURE 17: *The main intertidal sand habitats in CG.*

FIGURE 18: *Example of intertidal sand habitat found around the coast of CG. This is East Bank on the eastern side of CG, on the western side of Barnett Point.*

7.2.8 Subtidal Sand Substrate

1. In addition to the subtidal sand-substrate in the proposed operational area as summarized in section 7.2.2, there are also extensive areas of subtidal sand-substrate at the following locations throughout the LAU, as shown on Figure 4 on section 4:

    - King Shoals seaward of the western entrance to CG,
    - most of the seabed to seaward north / northeast of Cape Dommet,
    - subtidal sand areas around the intertidal Guthrie Banks, south of the mouth of the Lyne River,
    - subtidal extensions of the intertidal Eastern Sandbanks and Barnett Point Sandbar, off the 'False Mouths of the Ord,
    - subtidal extensions of East Bank on the western side of Barnett Point; and
    - off the mouth of the Helby River.

2. As with the sand substrate in the proposed operational area as summarized in section 7.2.2, benthic grab sampling of other subtidal sand areas found very little benthic biota, with most benthic grabs from these areas with sieving to 500 microns returning no biota at all. This is most likely due to the lack of light at the seabed and constant movement and reworking of the sand under the influence of strong tidal currents, which inhibits colonization and survival of benthic organisms on and in this substrate (see Referral Report No. 2 for detailed description).

3. The proposal will not impact on these areas as outlined in section 3 below.

7.2.9 Subtidal Mixed Clay, Silt, Sand & Gravel Substrate

1. As shown on Figure 4 in section 4, subtidal seabed areas throughout the LAU that do not comprise sand substrate appear to mostly comprise clay, silt or gravel or various mixtures of these, sometimes with sand in the mix. This includes the deeper gullies between the sand ridges at King Shoals.

2. Benthic grab sampling indicate that these areas support a slightly higher abundance and diversity of very small benthic invertebrates than the sand areas, mainly small hydroids, bryozoans, sponges etc as shown on Figure 10. However, abundance and diversity are very low, again due to the extreme environmental conditions including strong tidal currents, lack of light at the seabed and the unstable / mobile nature of the substrate (see Referral Report No. 2 for detailed description).

3. The proposal will not impact on these areas as outlined in section 3 below.

7.2.10 Subtidal Rocky Seabed

1. As shown on Figure 4 in section 4, there is a small area of rocky seabed habitat between Cape Dussejour and Fathom Rock near the western entrance to CG. Benthic grab sampling indicates that this area supports a higher abundance and diversity of benthic organisms than other parts of CG, as the rocky seabed provides a better substrate for attachment of these organisms than the predominant mobile sediment areas.

4. Benthic organisms found in this area were mainly small hydroids, other coelenterates, bryozoans, sponges etc, attached to small rocks, as shown on Figure 19 (see Referral Report No. 2 for detailed description).

2. The proposal will not impact on these areas as outlined in section 3 below.

FIGURE 19: *Example of benthic biota found on the rocky seabed substrate between Cape Dussejour and Fathom Rock near the western entrance to CG.*

7.3 Impact Assessment

1. Section 3.1 summarizes the eight benthic assessment steps that are recommended to be followed as outlined in EPA 2016, *Technical Guidance - Protection of Benthic Communities & Habitats*. Sections 7.3.2 to 7.3.7 present the impact assessments for each of the main benthic community and habitat types found in CG.

7.3.1 Eight benthic assessment steps from the EPA 2016 Technical Guidance

1. As outlined in section 7.1 the EPA 2016 *Technical Guidance - Protection of Benthic Communities & Habitats* sets out eight steps that should be followed in presenting information about the distribution and spatial extent of benthic communities and habitats in the area and for assessing potential impacts. These are addressed in Table 4.

TABLE 4: *Assessment against the eight steps in* EPA 2016 *Technical Guidance - Protection of Benthic Communities & Habitats*

Step	Assessment
1. What is the Local Assessment Unit (LAU)?	Refer section 4 and Figure 4.
2. What is there now? What is the current area of each benthic community type and associated habitat within the LAU?	Areas have been calculated on GIS as per the Benthic Habitat Map (Figure 4 in section 4): – Coral, seagrass, sponge, macro-algae communities etc: Zero km^2 – Mangroves: 350 km^2 – Intertidal salt- & mud-flats: 602.24 km^2 – Rocky shores & rock platforms (some with turf algae on rocks): 5.1 km^2 – Intertidal Cobble & Boulder Substrate: 0.57 km^2 – Intertidal Sand Substrate: 73.03 km^2 – Subtidal Sand Substrate: 356.35 km^2 – Subtidal mixed Clay, Silt, Sand & Gravel Substrate: 1462.56 km^2 – Subtidal rocky Seabed: 3.51 km^2
3. Do any of the benthic communities have any particular tenure or conservation, ecological or social values that should be considered?	The King Shoals sand bank habitat is within a Sanctuary Zone of the North Kimberley Marine Park (State). Mangroves and salt- and mud-flat habitat on the eastern side of CG (known as the False Mouths of the Ord) are part of the Ord River Floodplain Ramsar wetland, which is protected as the State-designated Ord River Nature Reserve. Neither of these areas will be directly or indirectly affected by the proposal.
4. What area of each community and habitat was originally present within the LAU? (original baseline).	The same as listed against Step 2 as there has been no previous development in CG.
5. What percentage of the original area of each benthic community and its associated habitat is present now?	100% as there has been no previous development in CG.
6. How much more will be impacted and lost if this proposal was implemented?	There will be temporary impacts from the removal of an average of <1m depth of sand from within the proposed operational area of up to 100 km^2 over up to 15 years, with each two-day sand loading cycle every two-weeks covering approx. 0.5 km^2. As outlined in section 7.3.3 horizontal sand migration into and through the area is very rapid under the influence of tidal currents, and seabed morphology will restore rapidly (within weeks to months) under natural sand dynamics. As outlined in section 7.3.3 most sand grab samples from within the proposed operational area returned no biota after sieving to 500 microns. This is most likely due to the lack of light at the seabed and constant movement and reworking of the sand under the influence of strong tidal currents, which inhibits colonization and survival of benthic organisms on and in this substrate. The sand area therefore does not host any significant benthic communities. No other benthic areas will be impacted or lost.
7. How much would be lost in total if the proposal proceeds?	As per 6.
8. What will be the consequences for biological diversity and ecological integrity if the proposal proceeds?	There will be no significant or measurable permanent or irreversible changes to biological diversity and ecological integrity of benthic communities in or near CG.

7.3.2 Potential impacts on primary producer / significant benthic communities

1. As outlined in section 7.2.1 there is a lack of significant benthic communities in CG, including primary producers such as coral, seagrass, sponge and macroalgae communities, due to permanent lack of light at the seabed, lack of stable hard substrate and constant movement of seabed sediments under the influence of strong tidal currents.

2. There is therefore no potential for impacts from the proposal on such communities, which is one of the reasons that BKA selected CG in the screening process (see section 19).

3. As outlined above the most significant benthic community is the mangroves that line the coast, inlets and rivers of CG. Mangrove areas will not be directly affected by the proposed operation, which does not involve any facilities, infrastructure, activities or operations on coastal areas. The proposal is for a 100% vessel-based marine operation.

7.3.3 Direct (but temporary) impacts within the proposed operational area

1. The main direct impact of the proposed operation on benthic habitat will be the physical removal of sand from within the proposed operational area, as shown on both Figures 1 and 2 above. This covers an area of 100 km^2. During each two-day sand-loading cycle the SPV will only cover approximately 0.5 km^2 and will remove approximately 40 cm of sand from the surface of the seabed in that area. The SPV will work over the whole area over 15 years. As outlined in section 1 there will be a two-week gap between each two-day sand loading cycle as the SPV delivers the sand to South East Asia and then voyages back to CG.

2. Sand exploration surveys indicate that there is a minimum of 300 million m^3 of sand in the proposed operational area and likely several times more than this volume. There are several orders of magnitude higher volumes of sand throughout CG overall. It is proposed to export up to 70 million m^3 of sand. This is a maximum of only 23% of the minimum volume of 300 million m^3 of sand estimated to occur in the proposed operational area, and a much smaller % of the volume of sand that occurs throughout CG overall.

3. Conceptually, because there will be direct removal of seabed sand in the proposed operational area, it could be classified as the Zone of High Impact (ZOHI) as defined in EPA 2021, *Technical Guidance - Environmental Impact Assessment of Marine Dredging Proposals*, as outlined above. However, the ZOHI is defined as the area where serious damage is predicted, where impacts are considered to be irreversible or where any recovery would be unlikely to occur for at least five years. It is assessed that the removal of sand from within this area will not cause serious damage to the benthic community and any impacts will be reversible within a matter of weeks or months, for the reasons below.

4. As outlined in section 7.2.2 the benthic surveys reported in Referral Report No. 2 show that the sand in this area is largely devoid of benthic biota, due to permanent lack of light at the seabed, lack of stable hard substrate and constant movement of the sand under the influence of strong tidal currents. The sand area therefore does not host any significant benthic communities. Removal of sand which contains almost no benthic biota will therefore not cause significant impacts on the benthic community.

5. Repeat high resolution hydrographic surveys carried out in the proposed operational area over a month-long lunar tidal cycle in February-March 2024, measured horizontal migration of the seabed sand-forms by up to 10 m over just 27 days, showing that they are highly dynamic and constantly moving (see Referral Report No. 5).

6. Any organisms removed with the sand will be a temporary impact as the area will be rapidly recolonized including sand migration from immediately adjacent areas as outlined above. The SPV will not remove all of the sand from any area, and each run will vacuum only approximately 40 cm from the sand surface.

7. As outlined in section 7.4 on Coastal Processes below, at the end of the 15-year project timeframe, if the proposed 70 million m^3 of sand is exported, the sand area within the proposed operational area will be on average <1m deeper than the pre-project seabed. It will still comprise sand with similar seabed morphology and dynamics and thus the same habitat features as before sand extraction (highly dynamic sand waves formed and constantly moved by the prevailing hydrodynamics).

8. The proposed operation will not cause any other direct impacts on benthic communities and habitats, including in areas outside of the proposed operational area.

7.3.4 Potential indirect impacts - sediment plumes & application of ZoHI, ZoMI & ZoI

1. Potential indirect impacts on benthic communities and habitats include the generation and dispersal of sediment plumes by the operation, which could potentially impact on benthic communities through sedimentation and reduction in light reaching those communities, through increased turbidity.

2. As outlined in section 9 below on Marine Environmental Quality, suspended sediment concentrations (SSC) and turbidity levels in CG are extremely high naturally. BKA's various water quality sampling campaigns in CG from June 2023 to end June 2024, including vertical water quality profiles and in-situ sensors at the seabed, have measured the following key values for total suspended solids (TSS) and turbidity (see Referral Report No. 5 / PCS (2025a & b) for details):

    a) TSS concentration:
        - Dry-season mean TSS in the mid-water column of 57.2 mg/L and a peak value of more than 220 mg/L.
        - Wet-season mean TSS in the mid-water column of 54.7 mg/L and a peak value of 155.6 mg/L.

    b) Turbidity in the water column:
        - Dry-season mean turbidity in the water column of 29.5 NTU and a peak value of 114.9 NTU.
        - Wet-season mean turbidity in the water column of 17.2 NTU and a peak value of 55.6 NTU.

    c) Turbidity near the seabed:
        - Dry-season mean turbidity near the seabed of 51.9 NTU and a peak value of 282.8 NTU.
        - Wet-season mean turbidity near the seabed of 67.8 NTU and a peak value of 596.9 NTU.

3. Time series monitoring by the Australian Institute of Marine Science (AIMS) between 1999 and 2004 at various depths in the water column at multiple sites under a range of conditions in CG, measured peaks in SSC ranging from around 75 mg/L in the proposed operational area, to 5,000 mg/L in West and East Arms either side of Adolphus Island, south of the main body of CG (AIMS 2007, in Referral Report No. 5 / PCS 2024a, b & c).

4. All of the above are extremely high values and range from one to four orders of magnitude higher than for similar tropical marine environments in northern Australia, as outlined in section 9 below on Marine Environmental Quality.

5. Based on data from both the dry-season environmental survey in July-August 2023 and the wet-season environmental survey in February-March 2024, BKA has derived turbidity / total suspended solids (TSS) correlations as follows (see Referral Report No. 5 / PCS 2024a, b & c):

    a) Dry-season turbidity / TSS correlation: 1 NTU = 1.72 mg/L.
    b) Wet-season turbidity / TSS correlation: 1 NTU = 2.77 mg/L.

6. As a further measure of water clarity / turbidity, during the sand exploration survey in March 2023 BKA's consultants took Secchi disc readings at 17 sites in the proposed operational area, recording the following values (see Referral Report No. 2 for details):

    a) a maximum (clearest) Secchi depth of 0.82 m,
    b) a minimum (most turbid) Secchi depth of 0.15 m; and
    c) a mean Secchi depth of 0.40 m

7. This compares to:

    a) a Secchi range of 1.5 to 5.5.m for King Bay near Dampier (SKM 2003),
    b) a mean Secchi of 2.28 m for Darwin Harbour and Van Diemen Gulf (Blondeau et al 2017),
    c) a median Secchi of 1.4 m for Tonwsville enclosed coastal waters; and
    d) a median Secchi of 2.5 for Townsville open coastal waters (Dry Tropics Partnership 2021).

8. This shows that water clarity in CG is an order of magnitude lower than other tropical coastal marine environments in northern Australia.

9. The high SSC and turbidity in CG prevent sunlight from reaching the seabed, which is essential for primary-producer benthic biota. BKA's monitoring has measured benthic light values (Photosynthetically Active Radiation or PAR) of zero or near-zero constantly and all sites throughout CG (see Referral Report No. 5 / PCS (2025a & b) for details). There is a permanent aphotic zone near the seabed throughout CG, due to the constant suspension of seabed sediments by tidal currents.

10. Figure 20 shows screen shots from three examples of drop camera videos undertaken at 134 sites across CG and KS in March 2023 and July-August 2023. These show the completely blacked-out aphotic zone for several meters above the seabed, caused by the constantly suspended sediment layer. 100% of the videos across CG and KS showed exactly the same result. This inhibits the development of benthic communities in CG. All of the 134 videos are available from BKA.

11. These environmental conditions are reflected in a lack of sediment-sensitive benthic communities in the LAU such as coral, seagrass, sponge and macroalgae communities. There is therefore no potential for impacts from sediment plumes from the operation on such communities. As outlined in section 7.2 the most significant benthic community in the LAU is the relatively thin band of mangroves along most of the coastline within CG. These are not turbidity-sensitive and in fact thrive in highly turbid conditions.

12. Never-the-less, despite the lack of sediment-sensitive benthic communities, in assessing the potential impacts of sediment plumes BKA has applied and followed the *EPA 2021 Technical Guidance on Environmental Impact Assessment of Marine Dredging Proposals*).

13. As outlined in section 7.1, the *2021 Technical Guidance* includes applying, if relevant, a spatially-based zonation scheme for describing the predicted extent, severity and duration of impacts from the dredging on benthic communities and habitats, with the three zones being:

    - Zone of High Impact (ZoHI),
    - Zone of Moderate Impact (ZoMI); and
    - Zone of Influence (ZoI).

14. The *2021 Technical Guidance* also recommend the application of biological response modelling and setting of trigger levels for receptor benthic biota, considering the sensitivity of relevant benthic species to turbidity, benthic light reduction and sedimentation, and modelling of likely 'worst-case' and 'best-case' impacts, as defined in the guidance.

15. BKA has assessed the application of these zones to the proposal and finds that they are not so relevant or applicable, given the lack of sensitive benthic communities or biota in or near CG. The assessment of each zone in relation to the proposal is summarized in Table 6, and none of them are found to be relevant or applicable.

16. The lack of sediment-sensitive benthic communities and biota in the LAU also means that it is not possible to set biological response triggers or undertake biological response modelling, as outlined in the *2021 Technical Guidance*, as there is no biota in the LaU to which response triggers and modelling can be applied.

17. In addition to the lack of sensitive benthic communities and biota that might be impacted, potential sediment plumes from the operation will be very much reduced by the following factors, which differentiate the proposed operation from conventional dredging:

    a) The SPV will only operate in CG for one to two days very two weeks, or 52 days per year. There will be zero operational activity in CG for 86% of the time during the project's lifespan.

    b) The constant movement and reworking of the seabed sediments in CG by strong tidal currents cause the sands to be well-sorted with the finer fractions of silt (which cause turbidity), being separated out and mostly kept in suspension (hence the high natural turbidity levels in CG).

    c) The operation will only target the well-sorted sand, which does not contain the fine silts that generate most turbidity (the market requires the sand to meet a minimum grain size, so there is no productive value in taking fine material).

    d) There will be no dumping of sediments in CG, as would normally be carried out for a conventional port dredging operation, and which can be a significant source of sediments plumes. In this case the sand will be exported to the destination market port, eliminating dumping as a source of sediment plumes in CG.

    e) While not really necessary given the above factors, as an additional precaution the SPV will be fitted with best practice turbidity reduction measures, including a 'green valve' at the overflow water intake and discharge of overflow water at the keel rather than at the gunwale (refer Annex 3).

18. Overall, the proposed operation is unlikely to change the natural suspended sediment and turbidity regime to any degree that is biologically significant.

19. Despite the above factors BKA has commissioned Port & Coastal Solutions (PCS) to undertake modelling of potential sediment plume generation and dispersal from the proposed operation, including potential for elevations above natural background levels and their predicted spatial and temporal extent, under a range of operational and environmental conditions. This modelling is currently underway (August 2024) and will be reported and submitted to EPA in a supplementary Referral Report - *Hydrodynamic, Coastal Process & Sediment Plume Modelling* (PCS 2024d).

20. Up to June 2024 PCS assessed all available data on SSC and turbidity in CG, including analysing and describing spatial and temporal patterns in these parameters under the influence of different tide and wind conditions and seasonal factors such as wet-season runoff. The findings are reported in PCS (2024a, b & c) (Referral Report No. 5), and are not repeated here for reasons of economy. Overall, the analysis showed that SSC varies over each tidal cycle, with lower SSC around high water due to offshore waters with low SSC being imported into CG, and higher SSC around low water due to upstream waters from the West and East Arms with very high SSC flowing into CG. The analysis also showed that SSC can be increased due to large waves and high river discharge, but the surface water SSC during these events was not significantly higher than during large spring tides.

21. To better understand the spatial variability in SSC and thus turbidity in the CG region, and how this is affected by the metocean conditions, Sentinel-2 satellite imagery was sourced from Copernicus (2023) and processed by PCS to provide satellite-derived SSC spatial maps. In addition, metocean conditions prior to and at the time the images were captured and analysed to provide additional context to the images. Two examples of satellite-derived SSC distribution for the CG area are presented in Figure 21 for spring tide conditions and Figure 22 for neap tide conditions. These show the naturally high SSC in the area. Further satellite images and full analysis are contained in PCS (2024a) (Referral Report No. 5).

22. Figures 21 and 22 show SSC values of 50 mg/l over extensive areas – again these are very extremely high values compared to many similar tropical marine environments in northern Australia. It is important to note that in high SSC environments such as CG, the satellite-derived SSC will typically provide an indication of SSC in the upper water column and can only determine the SSC up to a certain concentration threshold (as values above that will cause the same light-blocking of the water column, as sensed by the satellite). For CG that value is around 50 mg/L. This means that in the areas with 50 mg/l shown on Figures 21 and 22, the actual SSC could be higher and possibly much higher than 50 mg/l.

23. As part of modelling work for the BKA proposal, PCS has applied the Danish Hydraulics Institute (DHI) MIKE Sediment Transport Model which is designed specifically for sediment transport studies in coastal and estuarine environments with fine-grained and sand sized sediment, and for dredging studies. This included modelling SSC in the CG region under various tidal and seasonal conditions, and comparing modelled SSC and satellite-derived SCC under these conditions. Figure 23 shows two examples of modelled versus satellite derived SSC distributions. Further comparative images and full analysis are contained in PCS (2024a) (Referral Report No. 5). Comparison between the modelled and satellite-derived SSCs for comparable tidal states shows similar spatial patterns and magnitudes, which provides further confidence that the MIKE MT model is able to simulate the sediment transport processes that result in sediment being suspended in CG.

24. Overall, it is assessed that the proposal will not cause significant, permanent, irreversible or even moderate or minor impacts on benthic biota and communities from suspended sediment plumes, turbidity or sedimentation, for the following reasons:

a) *There are no sediment-sensitive benthic communities or biota in the LAU that could potentially be impacted.*

b) *Natural SSC and turbidity levels are extremely high, and the proposed operation is unlikely to change the natural suspended sediment and turbidity regime to any degree that is biologically significant.*

c) *Potential sediment plumes from the SPV will be very much reduced by key factors that differentiate the proposed operation from conventional dredging, as follows:*

- *Limited activity in CG: The SPV will only operate in CG for one to two days very two weeks, or 52 days per year. There will be zero operational activity in CG for 86% of the time during the project's lifespan.*

- *Avoidance of turbidity-causing fine silts: The sand that will be targeted by the SPV must meet market specifications above a certain coarseness, and thus will not contain fine sediments that cause turbidity. The sand on the seabed in CG is constantly moved, mixed and sorted by the strong tidal currents, and the fine sediments are kept in constant suspension (hence the high natural suspended sediment and turbidity levels in CG). By design and intent, in order to meet the market requirements for a certain sand specification, the process of dredging the sand will not stir up and disperse the fine sediments that typically cause the most turbidity.*

- *No dumping: In conventional port dredging operations using a Trailer Suction Hopper Dredger (TSHD), which the SPV will be similar to, once full of dredged material the TSHD will sail to a designated dump site and deposit the dredged material by opening doors in the bottom of its hull. The dumping process can be one of the most significant causes of increased suspended sediment and turbidity across a large area. In the case of this operation, there will be zero dumping, as the sand will be exported to an overseas market – completely eliminating this source of suspended sediment and turbidity.*

d) *While not really necessary given the above factors, as an additional precaution the SPV will be fitted with best practice turbidity reduction measures, including a 'green valve' at the overflow water intake and discharge of overflow water at the keel rather than at the gunwale (refer Annex 3).*

TABLE 5: *Assessment of ZoHI, ZoMI and ZoI in relation to the proposal.*

Zone	**Assessment in relation to the proposal**
Zone of High Impact (ZoHI): This is the zone where serious damage is predicted, where impacts are considered to be irreversible or where any recovery, if possible, would be unlikely to occur for at least five years:	As outlined in section 7.3.3, conceptually, because there will be direct removal of seabed sand, the proposed operational area could be classified as the ZoHI. However, the ZoHI is defined as the area where serious damage is predicted, where impacts are considered to be irreversible or where any recovery would be unlikely to occur for at least five years. As outlined in section 7.3.3, it is assessed that the removal of sand from within this area will not cause serious damage due to the lack of any significant benthic community or biota in this area. It is assessed that any impacts will be reversible within weeks or months, due to the high rate of horizontal migration of seabed sand waves in this area (up to 10 m over a lunar tidal cycle). The proposed operation will also not cause any serious damage or irreversible impacts to benthic areas outside of the proposed operational area. It is therefore assessed that there is no ZoHI associated with the proposal that meets the definition of ZoHI in the EPA Technical Guidance.
Zone of Moderate Impact (ZoMI): This is the zone within which predicted impacts on benthic organisms are sub-lethal, and/or the impacts are recoverable within a period of five years following completion of the dredging activities:	It is difficult to apply a ZoMI to the proposed operation due to the lack of any significant, sediment-sensitive benthic communities or biota throughout the LAU. Potential sediment plumes from the operation will be very much reduced by a number of factors, which differentiate the proposed operation from conventional dredging. Even if the proposed operation did generate significant dispersal of suspended sediment and turbidity plumes at concentrations above the already very high background levels, there are no sediment-sensitive benthic communities or biota present in the LAU that would be impacted. It is therefore assessed that there is no ZoMI associated with the proposal that meets the definition of ZoMI in the EPA Technical Guidance.
Zone of Influence (ZoI): This is the zone within which changes in environmental quality associated with dredge plumes would not result in a detectible impact on benthic biota:	Given the lack of any significant, sediment-sensitive benthic communities or biota throughout the LAU, any potential changes in environmental quality associated with dredge plumes would not result in a detectible impact on benthic biota.

FIGURE 20: *Screen shots from three examples of the drop camera videos undertaken at 134 sites across CG and King Shoals in March 2023 and July-August 2023. These show the completely blacked-out aphotic zone near the seabed caused by a constantly suspended sediment layer for several meters above the seabed. 100% of the videos show exactly the same result. This inhibits the development of benthic communities in CG. All of the 134 videos are available from BKA.*

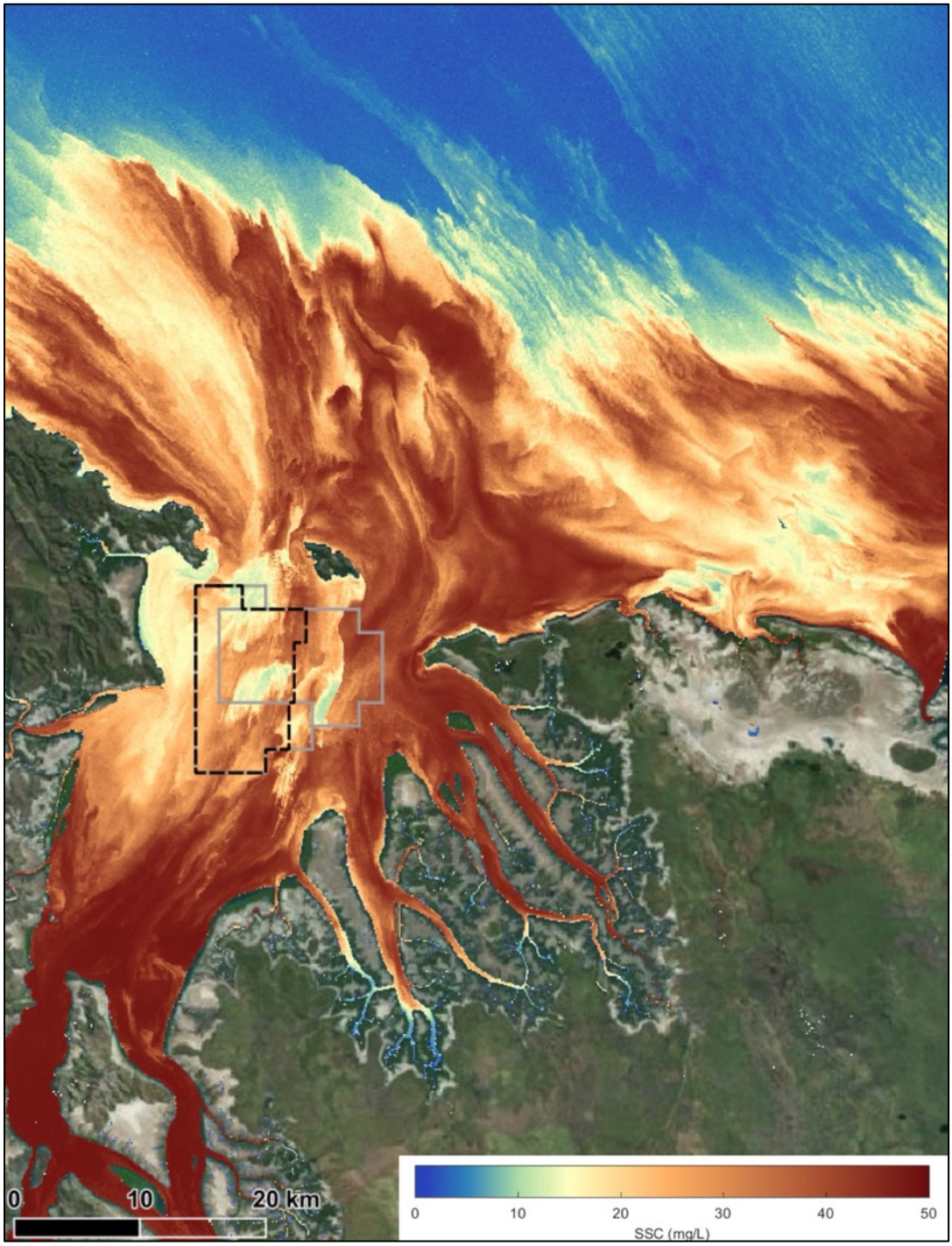


FIGURE 21: *Satellite-derived SSC for Sentinel 2 image captured on 12/05/2023 at neap tidal conditions just after the end of the wet season (PCS 2024a in Referral Report No. 5)*

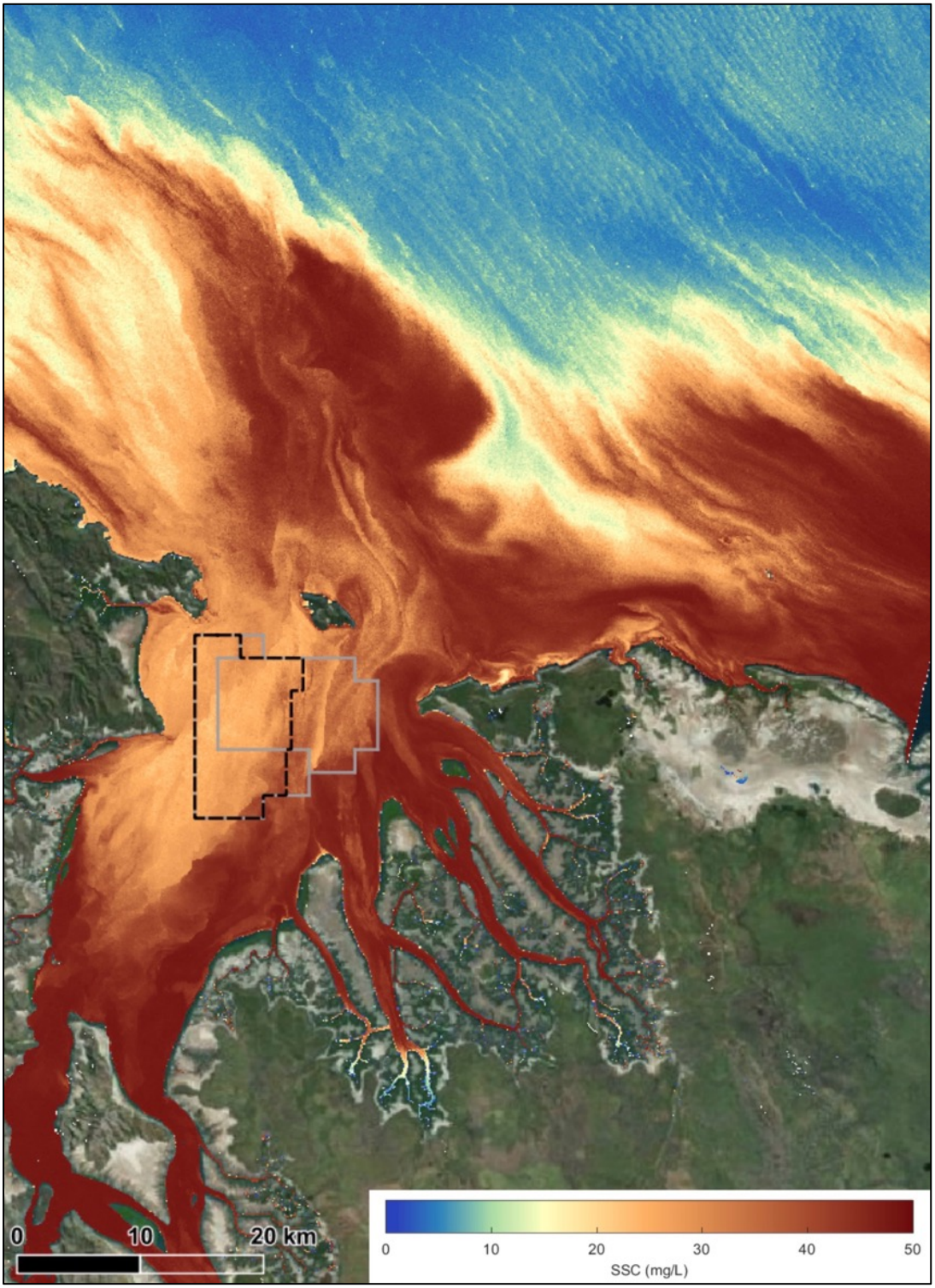


FIGURE 22: *Satellite-derived SSC for Sentinel 2 image captured on 22/05/2023 at spring tidal conditions just after the end of the wet season with an H_s of 0.8 m and a 10-knot easterly wind (PCS 2024a in Referral Report No. 5)*

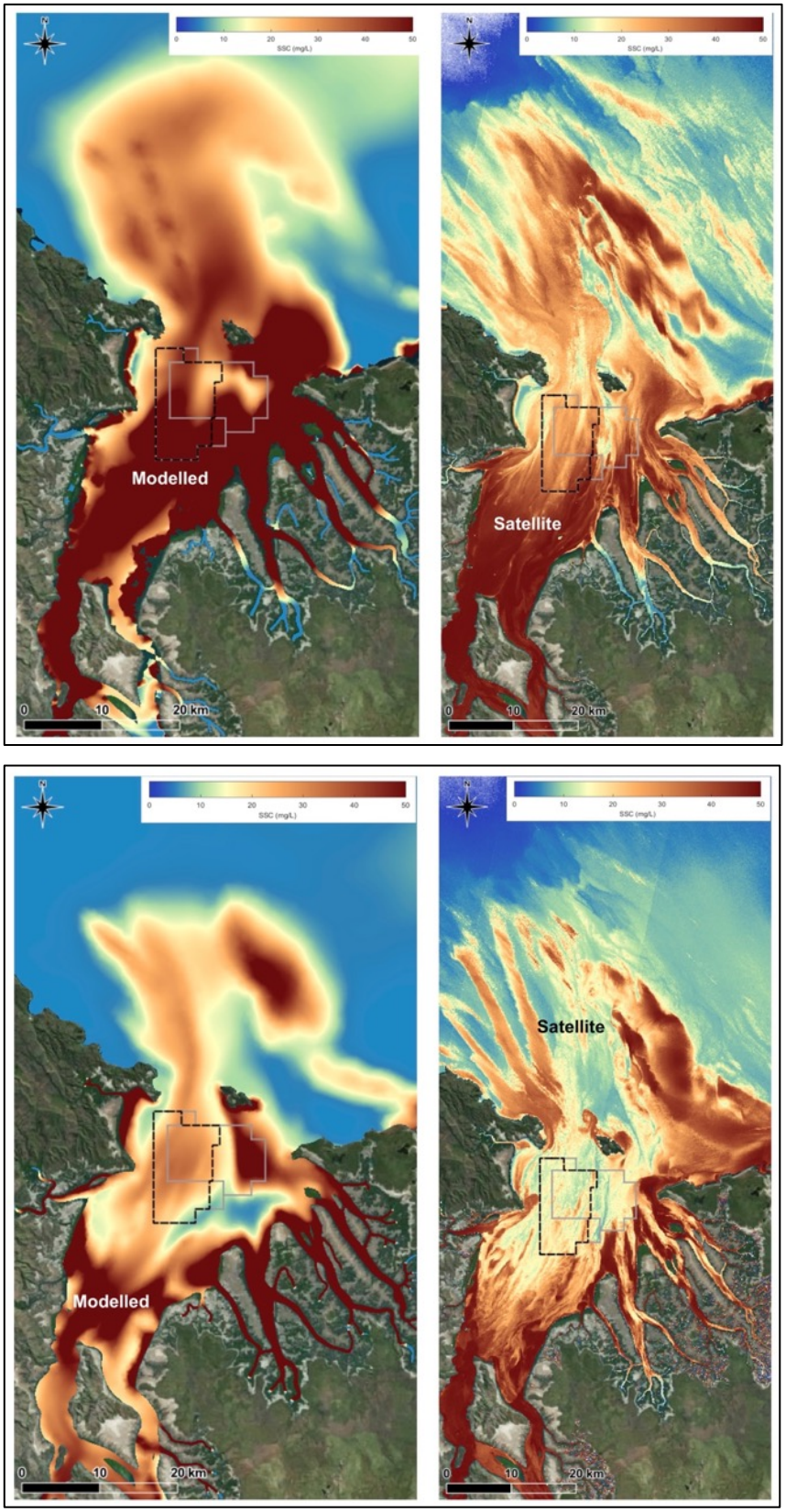


FIGURE 23: *(PCS 2024a in Referral Report No. 5)*

Top: *Modelled SSC in the CG region at the end of the ebb stage of the tide during a spring tide (left) and satellite image showing SSC during comparable spring tide conditions (right).*

Bottom: *Modelled SSC in the CG region at the end of the flood stage of the tide during a spring tide (left) and satellite image showing SSC during comparable spring tide conditions (right).*

7.3.5 Potential indirect impacts - possible changes to coastal processes causing benthic impacts

1. The proposed extraction of up to 70 million m^3 of sand over 15 years could potentially affect the existing sediment dynamics and coastal processes in CG, which could potentially cause indirect impacts on benthic communities - in particular the mangrove communities that line the coast, inlets and rivers of CG.

2. As outlined in section 7.2.3 and shown on Figure 13 the mangrove communities in CG appear to be dynamic and especially on the eastern coastline and False Mouths of the Ord there are numerous areas of significant natural erosion and undercutting of mangroves.

3. As outlined under section 9 on Coastal Processes below, in assessing potential impacts BKA has followed the *EPA Environmental Factor Guideline on Coastal Processes*, including commissioning comprehensive modelling of likely changes to coastal processes. Assessment by PCS (2024a) (Referral Report No. 5) indicates that the proposal will not cause measurable changes to coastal processes either during or at the end of the project lifespan, and therefore will not cause impacts to mangrove communities through this mechanism.

4. *Overall, it is assessed that the operation is unlikely to cause significant changes to coastal processes, and thus is unlikely to cause significant impacts on mangroves or other benthic communities and habitats.*

7.3.6 Potential indirect impacts - possible marine pollution from the SPV

1. The proposal could potentially impact on benthic communities and habitats, and especially the mangrove communities that line the coast of CG, by causing marine pollution.

2. The proposal does not involve the construction and operation of any shore-based facilities or infrastructure so there will be no land-based sources of marine pollution.

3. Potential vessel-sourced pollution from the SPV includes possible oily bilge water discharges, sewage discharges and garbage discharges – these will be avoided through the following prevention measures, which mean that there will be no waste streams from the operation of the SPV into CG (these measures are presented further in section 7.4 - Mitigation Hierarchy):

    a) Compliance with maritime laws: The SPV will comply with all relevant requirements of the *International Convention for the Prevention of Pollution form Ships* (MARPOL) and the implementing Australian law - the Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act* and related Marine Orders (administered by AMSA).

    b) No waste streams from the SPV into CG: There will be no waste streams from the operation of the SPV into CG, including:

        - Bilge water: The SPV will not discharge bilge water when in Australian waters, and will comply with MARPOL Annex I requirements for oily-water separators and discharge standards when bilge water is discharged outside of Australian waters.

        - Sewage: The SPV will not discharge sewage when in Australian waters (it will be kept on-board in holding tanks), and will comply with MARPOL Annex IV requirements for on-board sewage treatment systems and discharge standards when sewage is discharged outside of Australian waters.

        - Garbage: The SPV will not discharge garbage when in Australian waters or place any garbage ashore in the Port of Wyndham or any other Australian port. All garbage will be kept on-board and managed in accordance with MARPOL Annex V and the vessels' IMO-compliant Garbage Management Plan, and discharged to approved port waste reception facilities at the sand destination port (Singapore).

4. The operation of a vessel always presents a certain risk of potential fuel-oil spills in the event of an incident such as a grounding or collision with another vessel. An oil spill risk assessment has been carried out as contained in Annex 2. The risk is very low and will be reduced further through the following best practice prevention and mitigation measures (these measures are presented further in section 7.4 - Mitigation Hierarchy):

    a) No refuelling in Australian waters: The SPV will not undertake any bunkering (refuelling) in Australian waters – eliminating the risk of spills from this potential source (which global statistics indicate is the highest frequency cause of spills).

    b) Prevention of accidents potentially resulting in oil spill: The risk of the SPV grounding or colliding with another vessel in CG is extremely low due to very low shipping traffic in CG (average of 1.3 ships per week for the last three financial years (CGL 2024), and the very low presence of the SPV in CG (one to two days every two weeks).

The low risk will be reduced further through strict compliance with navigational safety and traffic separation requirements of the International Maritime Organization (IMO), AMSA and the Kimberley Ports Authority (KPA) (with whom BKA is consulting closely) (see also Annex 2).

c) Prevention of oil spill should an accident occur: The risk of a grounding or collision actually resulting in release of pollution will be avoided and minimized in that the SPV will be designed, built and operated in full compliance with MARPOL Annex I, including relevant protection of fuel tanks to prevent puncturing and loss of fuel (see also Annex 2).

d) Alternative, less polluting future fuel options: As part of BKA's fleet decarbonisation program, the SPV will be designed for dual-fuel use, allowing adoption of alternative fuels such as methanol as they become viable in the future. Methanol is a semi-volatile, low viscosity compound that is highly miscible with water, and as such disperses rapidly if spilled into the marine environment. Since it is infinitely water soluble, it does not accumulate in sediments.

e) Lighter, less persistent fuel oil: Any hydrocarbon-based fuels used will not be Heavy Fuel Oil (HFO) but will be lighter fuels such as Marine Diesel Oil (MDO) or Intermediate Fuel Oil (IFO), which are less persistent in the marine environment.

f) Shipboard Oil Pollution Emergency Plan: The SPV will have an IMO- and AMSA-compliant Shipboard Oil Pollution Emergency Plan (SOPEP) and equipment for responding in the highly unlikely event of a spill, with a program of regular training and exercises, in cooperation with relevant agencies.

g) Rapid breakdown of oil in tropical conditions. In the highly unlikely event of a spill of fuel from the SPV, it would likely be a small volume and disperse very quickly under the influence of the strong tidal currents, high temperatures and strong solar UV radiation typical of CG (refer Annex 2).

5. *Overall, given the above factors and measures, it is assessed that there is a low likelihood of marine pollution from the SPV occurring and if it does occur, of causing significant and irreversible impacts to benthic communities and habitats.*

7.3.7 Potential indirect impacts - introduced marine pests

1. On each arrival in CG the SPV could potentially introduce marine pest species via ballast water or biofouling, which could potentially cause impacts on benthic communities (noting that there are no significant benthic communities in CG except for mangroves).

2. The potential introduction of marine pests will be avoided and minimized as follows:

    a) The SPV will be equipped with an IMO-compliant ballast water treatment system consistent with the IMO *International Convention for the Control & Management of Ships' Ballast Water & Sediments*, and as required by the Commonwealth ballast water regulations under the Commonwealth *Biosecurity Act* and relevant amendments.

    b) The SPV will implement a biofouling management plan with stringent biofouling prevention, management, mitigation and monitoring measures, consistent with the IMO biofouling guidelines (IMO 2023) and as required by the Commonwealth biofouling regulations under the Commonwealth *Biosecurity Act* and relevant amendments.

3. Biofouling management measures will include, *inter alia*:

    a) Maintenance of a high-grade, IMO-compliant anti-fouling system on the SPV's wet hull.

    b) Regular in-water inspections and when necessary, cleaning in Singapore – with a priority focus on niche areas.
    c) Periodic dry docking, out-of-water hull cleaning and repainting / refresh of the anti-fouling system.
    d) Required reporting to Australian authorities including before each arrival in Australian waters, as per the Commonwealth ballast water and biofouling requirements.

4. As the SPV will operate in CG which is within State Internal Waters, it will also comply with relevant requirements of the WA *Biosecurity and Agriculture Management Act* and undertake reporting under the WA Department of Primary Industries & Regional Development (DPIRD) (Fisheries) Vessel Check program (https://vessel-check.com/).

5. Although the risk of marine pest introduction is low through implementation of the avoidance and prevention measures outlined above, potential impacts will be further minimized and mitigated through development and implementation of an Introduced Marine Pests - Monitoring, Detection & Response Plan (IMP-MRP), in consultation with relevant stakeholders.

6. The measures outlined above are presented further in section 7.4 - Mitigation Hierarchy.

7. The risk of introduced marine pests will be further minimized by the extreme environmental conditions in CG, which are not conducive to colonization by marine species, as evidenced by the general lack of benthic biota in CG.

8. *Overall, given the above factors and measures, it is assessed that there is a low likelihood of marine pest species being introduced to CG by the SPV and causing significant impacts being caused to benthic communities and habitats.*

7.4 Application of the Mitigation Hierarchy & Assessment of Residual Impacts

1. There are four sequential levels in the WA EPA impact mitigation hierarchy:

    a) Avoid (prevent) impacts.
    b) Minimise (mitigate) impacts.
    c) Rehabilitate impacts.
    d) Offset impacts.

2. Table 6 presents the mitigation hierarchy applied to benthic communities and habitats, listing the main potential impact categories discussed above, identifying relevant impact avoidance, minimisation, rehabilitation and offset measures and assessing the predicted residual impacts for each.

3. As outlined above most potential impacts on benthic communities and habitats will be avoided (prevented), due to the lack of sensitive benthic communities and biota in CG except for mangroves, and the nature of the operation with a lack of likely impact-causing mechanisms.

4. However, BKA still proposes to implement a range of measures to avoid, prevent, minimize and mitigate potential impacts on benthic communities and habitats, as outlined in Table 6.

5. As outlined in Table 6 it is assessed that both the rehabilitation and offset levels of the impact mitigation hierarchy are not triggered for most potential impacts on benthic communities and habitats, as there will not be any significant impacts that require rehabilitating or offsetting. Despite this, if the proposal proceeds BKA will seek to implement a comprehensive environmental and biodiversity research and monitoring program, in consultation and cooperation with TOs and other relevant stakeholders as described in section 17. This would provide data to further assist environmental protection and biodiversity conservation in the area.

6. Table 6 does identify a low potential need for rehabilitation in relation to a potential oil spill from the SPV or a marine pest introduction being caused by the SPV. In the highly unlikely event of an accidental oil spill occurring from the SPV and causing impacts on benthic communities such as mangroves, BKA would implement an appropriate rehabilitation program, in consultation with relevant stakeholders. Similarly, In the highly unlikely event of marine pest introduction occurring from the SPV and causing impacts on benthic communities, BKA would implement an appropriate rehabilitation program, in consultation with relevant stakeholders.

7. As outlined in Table 6, overall, it is assessed that there will not be any residual impacts on benthic communities and habitats from any of the potential impact categories, because impacts will be effectively avoided, prevented, minimized and mitigated, and where necessary, rehabilitated.

TABLE 6: *Mitigation hierarchy & assessment of residual impacts for benthic communities & habitats.*

Potential Impact Category	**Impact Avoidance / Prevention**	**Impact Minimization / Mitigation**	**Rehabilitation & Offsets**	**Residual Impacts**
1. Impacts on primary producer / sensitive benthic communities:	Impacts will be avoided / prevented by the fact that primary producer / sensitive benthic communities do not exist in the LAU, due to the extreme environmental conditions. This is one of the reasons why BKA selected CG in the alternatives screening process (section 18).	Impact minimization is not required as impacts will be fully avoided / prevented.	Rehabilitation is not required as impacts will be fully avoided / prevented. Offsets are not required as impacts will be fully avoided / prevented. Never-the-less, if the proposal is approved and proceeds, BKA will seek to implement a comprehensive environmental and biodiversity research and monitoring program, in consultation and cooperation with relevant stakeholders as described in section 17. This would further assist environmental protection and biodiversity conservation in the area.	None as there will not be any primary impacts.
2. Direct (but temporary) impacts within the proposed operational area:	The physical removal of sand from the seabed within the proposed operational area cannot be avoided, as exporting sand is the purpose of the proposal. Significant impacts on benthic communities and biota will be avoided by the fact that there are no significant benthic communities in the proposed operational area, and the sand substrate is largely devoid of benthic biota, due to permanent lack of light at the seabed, lack of stable hard substrate and constant movement of the sand under the influence of strong tidal currents.	While primary impacts will not be significant for the reasons stated in the columns to the left, impacts will be further minimized by the factors below. It is proposed to export only 23% of the minimum volume of sand estimated to occur in the proposed operational area of 300 million m^3, and a much smaller % of the volume of sand that occurs throughout CG overall. During each two-day sand-loading cycle the SPV will only cover approximately 0.5 km^2 and will remove approximately 40 cm of sand from the surface of the seabed in that area. There will be a two-week gap, with zero operational activity in CG, between each two-day sand loading cycle.	Rehabilitation is not required as primary impacts will not be significant and natural reformation of seabed sand-forms will be rapid within weeks or months of each sand loading cycle. Feb 2024 surveys measured horizontal migration of the seabed sand-forms by up to 10 m over a month lunar tidal cycle, showing that they are highly dynamic and constantly moving. Natural reformation of seabed sand-forms will be rapid within weeks or months of each sand loading cycle. At the end of the 15-year project timeframe, if the proposed 70 million m^3 of sand is exported, the sand area within the proposed operational area will be on average <1m deeper than the pre-project seabed. It will still comprise sand with similar seabed morphology and dynamics and thus the same habitat features as before sand extraction. Offsets - As per impact category no. 1. above.	None as primary impacts will not be significant and natural reformation of seabed sand-forms will be rapid within weeks or months of each sand loading cycle.

Potential Impact Category	**Impact Avoidance / Prevention**	**Impact Minimization / Mitigation**	**Rehabilitation & Offsets**	**Residual Impacts**
3. Indirect impacts - sediment plumes:	Potential impacts from sediment plumes will be avoided / prevented by the fact that sediment- and turbidity-sensitive benthic communities and biota do not exist in the LAU. Suspended sediment and turbidity levels in the LAU are naturally very high and the proposed operation is unlikely to change the natural suspended sediment and turbidity regime to any degree that is biologically significant.	While primary impacts will not be significant for the reasons stated in the column to the left, impacts will be further minimized by the factors below. Potential sediment plumes from the SPV will be very much reduced by key factors that differentiate the proposed operation from conventional dredging, as follows: – Limited activity in CG: The SPV will only operate in CG for one to two days very two weeks, or 52 days per year. There will be zero operational activity in CG for 86% of the time during the project's lifespan. – Avoidance of turbidity-causing fine silts: The operation will only target the well-sorted sand, which does not contain the fine silts that generate most turbidity (the market requires the sand to meet a minimum grain size, so there is no productive value in taking fine material). – No dumpling: There will be no dumping of sediments in CG, as would normally be carried out for a conventional port dredging operation, and which can be a significant source of sediments plumes. In this case the sand will be exported to the destination market port, eliminating dumping as a source of sediment plumes in CG. – SPV green-valve: While not really necessary given the above factors, as an additional precaution the SPV will be fitted with best practice turbidity reduction measures, including a 'green valve' at the overflow water intake and discharge of overflow water at the keel rather than at the gunwale (refer Annex 3).	Rehabilitation is not required as primary impacts will not be significant. Offsets - As per impact category no. 1. above.	None as there will not be any primary impacts.
4. Indirect impacts - possible changes to coastal processes causing benthic impacts:	The physical removal of sand from the seabed within the proposed operational area cannot be avoided, as exporting sand is the purpose. The key question is whether the proposed removal of sand will affect the natural supply of sediments to coastal mangrove communities and alter coastal process, including natural patterns	While primary impacts will not be significant for the reasons stated in the column to the left, impacts will be further minimized by the same factors listed against impact category no. 2 above.	Rehabilitation is not required as primary impacts will not be significant. Offsets - As per impact category no. 1. above.	None as there will not be any significant primary impacts.

Potential Impact Category	Impact Avoidance / Prevention	Impact Minimization / Mitigation	Rehabilitation & Offsets	Residual Impacts
	of accretion and erosion in these areas, and in turn affect the mangrove themselves. As outlined in section 7.2.3 and shown on Figure 13 the mangrove communities in CG appear to be dynamic, and especially on the eastern coastline and False Mouths of the Ord there are numerous areas of significant natural erosion and undercutting of mangroves. Assessment by PCS (2024a) (Referral Report No. 5) indicates that the proposal will not cause measurable changes to coastal processes either during or at the end of the project lifespan, and therefore will not cause impacts to mangrove communities through this mechanism.			
5. Indirect impacts - possible marine pollution from the SPV:	Operational discharges: Possible discharges of oily bilge water, sewage and garbage will be avoided through the following measures: – Compliance with maritime laws: The SPV will comply with all relevant requirements of the *International Convention for the Prevention of Pollution form Ships* (MARPOL) and the implementing Australian law - the Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act* and related Marine Orders (administered by AMSA). – No waste streams from the SPV into CG: There will be no waste streams from the operation of the SPV into CG, including: – Bilge water: The SPV will not discharge bilge water when in Australian waters, and will comply with MARPOL Annex I requirements for oily-water separators and discharge standards when bilge water is discharged outside of Australian waters. – Sewage: The SPV will not discharge sewage when in Australian waters (it will be kept on-board in holding tanks), and will comply with MARPOL Annex IV requirements for on-board sewage treatment systems and discharge	Although the risk is assessed as very low (Annex 2), even with the avoidance and prevention measures outlined in the column to the left, with any vessel operation at sea there is always a residual possibility of an accidental oil spill occurring. Should this occur, potential impacts will be minimized and mitigated through the following measures: – Alternative, less polluting future fuel options: As part of BKA's fleet decarbonisation program, the SPV will be designed for dual-fuel use, allowing adoption of alternative fuels such as methanol as they become viable in the future. Methanol is a semi-volatile, low viscosity compound that is highly miscible with water, and as such disperses rapidly if spilled into the marine environment. Since it is infinitely water soluble, it does not accumulate in sediments. – Shipboard Oil Pollution Emergency Plan: The SPV will have an IMO- and AMSA-compliant Shipboard Oil Pollution Emergency Plan (SOPEP) and equipment for responding in the highly unlikely event of a spill, with a program of regular training and exercises, in cooperation with relevant agencies.	Rehabilitation - In the highly unlikely event of an accidental oil spill occurring from the SPV and causing impacts on benthic communities such as mangroves, BKA would implement an appropriate rehabilitation program, in consultation with relevant stakeholders. Offsets - are not required as impacts will be avoided, prevented, minimized, mitigation, and if necessary, rehabilitated. Never-the-less, if the proposal is approved and proceeds, BKA will seek to implement a comprehensive environmental and biodiversity research and monitoring program, in consultation and cooperation with relevant stakeholders as described in section 17. This would further assist environmental protection and biodiversity conservation in the area.	In the highly unlikely event of an accidental oil spill occurring from the SPV any residual impacts that might occur would be temporary and addressed through an appropriate rehabilitation program, in consultation with relevant stakeholders.

Potential Impact Category	Impact Avoidance / Prevention	Impact Minimization / Mitigation	Rehabilitation & Offsets	Residual Impacts
	standards when sewage is discharged outside of Australian waters. – Garbage: The SPV will not discharge garbage when in Australian waters or place any garbage ashore in the Port of Wyndham or any other Australian port. All garbage will be kept on-board and managed in accordance with MARPOL Annex V and the vessels' IMO-compliant Garbage Management Plan, and discharged to approved port waste reception facilities at the sand destination port (Singapore). Accidental oil spill: Accidental oil spills will be avoided through the following prevention measures: – No refuelling in Australian waters: The SPV will not undertake any bunkering (refuelling) in Australian waters – eliminating the risk of spills from this potential source (which global statistics indicate is the highest frequency cause of spills). – Prevention of accidents potentially resulting in oil spill: The risk of the SPV grounding or colliding with another vessel in CG is extremely low due to very low shipping traffic in CG (average of 1.3 ships per week for the last three financial years (CGL 2024), and the very low presence of the SPV in CG (one to two days every two weeks). The low risk will be reduced further through strict compliance with navigational safety and traffic separation requirements of IMO, AMSA and KPA (with whom BKA is consulting closely) (see also Annex 2). – Prevention of oil spill should an accident occur: The risk of a grounding or collision actually resulting in release of pollution will be avoided and minimized in that the SPV will be designed, built and operated in full compliance with MARPOL Annex I, including relevant protection of fuel tanks to prevent puncturing and loss of fuel (see also Annex 2).			

Potential Impact Category	**Impact Avoidance / Prevention**	**Impact Minimization / Mitigation**	**Rehabilitation & Offsets**	**Residual Impacts**
6. Indirect impacts - possible introduced marine pests:	Potential introductions of marine pests will be avoided through the following measures: – The SPV will be equipped with an IMO-compliant ballast water treatment system consistent with the IMO *Ballast Water Convention*, and as required by the Commonwealth ballast water regulations under the *Biosecurity Act*. – The SPV will implement a biofouling management plan with stringent biofouling prevention, management, mitigation and monitoring measures, consistent with the IMO biofouling guidelines (IMO 2023) and as required by the Commonwealth biofouling regulations under the *Biosecurity Act*. – Biofouling management measures will include: – Maintenance of a high-grade, IMO-compliant anti-fouling system on the SPV. – Regular in-water inspections and when necessary, cleaning in Singapore – with a priority focus on niche areas. – Periodic dry docking, out-of-water hull cleaning and refresh of anti-fouling system. – Required reporting to Australian authorities including before each arrival in Australian waters, as per the Commonwealth ballast water and biofouling requirements. – As the SPV will operate in CG which is within State Internal Waters, it will also comply with relevant requirements of the WA *Biosecurity and Agriculture Management Act* and undertake reporting under the WA DPIRD (Fisheries) Vessel Check program. The risk of introduced marine pests will be further minimized by the extreme environmental conditions in CG, which are not conducive to colonization by marine species, as evidenced by the general lack of benthic biota in CG.	Although the risk of marine pest introduction is low through implementation of the avoidance and prevention measures outlined in the column to the left, potential impacts will be further minimized and mitigated through development and implementation of an Introduced Marine Pests - Monitoring, Detection & Response Plan (IMP-MDRP), in consultation with relevant stakeholders.	Rehabilitation - In the highly unlikely event of marine pest introduction occurring from the SPV and causing impacts on benthic communities, BKA would implement an appropriate rehabilitation program, in consultation with relevant stakeholders. Offsets - are not required as impacts will be avoided, prevented, minimized, mitigation, and if necessary, rehabilitated. Never-the-less, if the proposal is approved and proceeds, BKA will seek to implement a comprehensive environmental and biodiversity research and monitoring program, in consultation and cooperation with relevant stakeholders as described in section 17. This would further assist environmental protection and biodiversity conservation in the area.	In the highly unlikely event of a marine pest introduction occurring from the SPV any residual impacts that might occur would be temporary and addressed through an appropriate rehabilitation program, in consultation with relevant stakeholders.

7.6 Likely Environmental Outcomes

1. The likely environmental outcomes with regard to benthic communities and habitats, both during and at the end of the 15-year project timeframe, are assessed as follows:

    a) There will be no impacts on benthic primary producer communities / sensitive benthic ecological communities in the form of coral communities, seagrass beds, sponge beds, macroalgae communities etc, as these communities are not present in or near CG.

    b) There will be no irreversible loss of benthic communities and habitats in or near CG.

    c) There will be no significant or measurable physical changes to benthic habitats in or near CG.

    d) There will be no significant or measurable changes to biological diversity and ecological integrity of benthic communities in or near CG.

    e) There will be no significant or measurable changes in composition, structure, function and processes of benthic communities in or near CG.

    f) The sand area within the proposed operational area will be on average <1m deeper than the pre-project seabed. It will still comprise sand with similar seabed morphology and thus the same habitat features as pre-project (dynamic sand waves formed and constantly moved by the prevailing tidal currents).

7.7 Assessment Against EPA Significant Impact Criteria

1. As outlined in section 3.1 the terms ‘significant impact’ and ‘significant effect’ are not defined in the EP Act, however the EPA’s *Statement of Environmental Principles, Factors & Objectives* (EPA 2018) states that when considering significant impact or effect, the EPA may have regard to various matters, as listed in section 3.1, amongst others.

2. In order to assist in assessing whether the proposal will cause significant impacts on benthic communities and habitats, Table 7 presents an assessment against each of the criteria listed in the EPA’s *Statement of Environmental Principles, Factors & Objectives.*

TABLE 7: *Assessment of potential impacts on benthic communities and habitats against EPA significant impact criteria*

*****From *Statement of Environmental Principles, Factors & Objectives* (EPA 2018)

EPA Significant Impact Criteria*	Benthic Communities & Habitats Assessment
1. Values, sensitivity and quality of the environment which is likely to be impacted:	There are no significant benthic primary producer communities / sensitive benthic communities such as coral, seagrass, sponge and macro-algae communities in the LAU. There is therefore no potential for impacts from the proposal on such communities, which is one of the reasons that BKA selected CG in the screening process. The seabed in the proposed operational area which is the only area that will be directly impacted by the proposal (removal of sand) comprises constantly moving sand waves and supports very little biota. The lack of biota is likely due to the constant movement of the sand and the total lack of sunlight at the seabed throughout CG, due to constant suspension of sediments by strong tidal currents. Other seabed areas in the LAU outside of the proposed operational area include mixed clay, silt, sand and gravel substrate, intertidal rocky shores and rock platforms (some with turf algae on rocks) and intertidal cobble and boulder substrate. All of these habitats support very little benthic biota due to the extreme environmental conditions (strong currents, high tidal range and naturally high turbidity). These areas will not be impacted by the proposal. There is a small area of rocky seabed habitat between Cape Dussejour and Fathom Rock near the western entrance to CG which appears to supports a slightly higher abundance and diversity of benthic organisms than other parts of CG. This is likely because the rocky seabed provides a better substrate for attachment of these organisms than the predominant mobile sediment areas. Benthic organisms found in this area were mainly very small hydroids, other coelenterates, bryozoans etc, attached to small rocks. This area will not be impacted by the proposal. The most significant benthic community in CG is the mangroves that comprises a relatively thin band along most of the coastline, backed by extensive salt- and mud-flats. The Helby, Lyne and Thompson Rivers that flow into CG on the western side are mangrove-lined, and on the eastern side there is a large network of wide, mangrove-lined inlets and salt- and mud-flats, known as the 'False Mouths of the Ord', which is part of the Ord River Floodplain Ramsar Wetland. These are all important habitat and nursery areas for a range fish species, mud crabs and banana prawns. As outlined in the assessments above these areas will not be impacted by the proposal.
2. Extent (intensity, duration, magnitude and geographic footprint) of the likely impacts:	The seabed in the proposed operational area is the only area that will be directly impacted by the proposal (removal of sand). The total area of the proposed operational area is ~100 km^2 (roughly 15 km by 10 km although it is not a regular rectangle hence well less than 150 km^2) (Figure 1). The drag-head on the SPV will be ~6 m wide and during each two-day sand-loading cycle the SPV will only cover approximately 0.5 km^2. The SPV will work over the whole proposed operational area over 15 years. As outlined in section 1 there will be a two-week gap between each two-day sand loading cycle as the SPV delivers the sand to South East Asia and then voyages back to CG. The SPV will not remove all of the sand from any area, and each run will vacuum only approximately 40 cm from the sand surface. BKA's sand exploration surveys estimate that there is a minimum of 300 million m^3 of sand in the proposed operational area, and likely much more than this (possibly triple or more). BKA proposes to export up to 70 million m^3 of sand over 15 years, which is a maximum of only 23% of the minimum amount of sand in the proposed operational area (see section 1.1). As outlined in section 8 on Coastal Processes below, at the end of the 15-year project timeframe, if the proposed 70 million m^3 of sand is exported, the sand area within the proposed operational area will be on average <1m deeper than the pre-project seabed. It will still comprise sand with similar seabed morphology and dynamics and thus the same habitat features as before sand extraction (highly dynamic sand waves formed and constantly moved by the prevailing hydrodynamics).

EPA Significant Impact Criteria*	Benthic Communities & Habitats Assessment
	Conceptually, because there will be direct removal of seabed sand in the proposed operational area, it could be classified as the Zone of High Impact (ZOHI) as defined in EPA 2021, *Technical Guidance - Environmental Impact Assessment of Marine Dredging Proposals*, as outlined above. However, the ZOHI is defined as the area where serious damage is predicted, where impacts are considered to be irreversible or where any recovery would be unlikely to occur for at least five years. It is assessed that the removal of sand from within this area will not cause serious damage to the benthic community and any impacts will be reversible within a matter of weeks or months, for the reasons below. As outlined above the benthic surveys reported in Referral Report No. 2 show that the sand in this area is largely devoid of benthic biota, due to permanent lack of light at the seabed, lack of stable hard substrate and constant movement of the sand under the influence of strong tidal currents. Removal of sand which contains almost no benthic biota will therefore not cause significant impacts on the benthic community. Repeat high resolution hydrographic surveys carried out in the proposed operational area over a month-long lunar tidal cycle in February-March 2024, measured horizontal migration of the seabed sand-forms by up to 10 m over just 27 days, showing that they are highly dynamic and constantly moving (refer Referral Report No. 5). Any small benthic organisms that were found to be present in sand areas exist in a highly dynamic, constantly moving substrate. Any organisms removed with the sand will be a temporary impact as the area will be rapidly recolonized including sand migration from immediately adjacent areas as outlined above. As outlined in the assessments above the proposed operation will not cause any other direct impacts on benthic communities and habitats, including in areas outside of the proposed operational area.
3. Consequence of the likely impacts (or change):	There will be temporary impacts from the removal of an average of <1m depth of sand from within the proposed operational area of up to 100 km^2 over up to 15 years, with each two-day sand loading cycle every two-weeks covering approx 0.5 km^2. As outlined in section 7.3.2 and against point 2 above horizontal sand migration into and through the area is very rapid under the influence of tidal currents and seabed morphology will restore rapidly (within weeks to months) under natural sand dynamics. As outlined in section 7.3.2 and against point 2 above most sand grab samples returned no biota at all after sieving to 500 microns. The consequence of the likely impacts is therefore minor. No other benthic areas will be impacted or lost.
4. Resilience of the environment to cope with the impacts or change:	The environment of CG is naturally resilient as it is adapted to extreme conditions and constant change, including a high tidal range of up to 8 m, strong tidal currents which can exceed 2 m/s (4 knots), constantly moving seabed sediments, very high natural turbidity and total lack of light at the seabed, and frequent exposure to tropical cyclones. The eastern coastline and False Mouths of the Ord appear to be naturally highly dynamic with numerous areas of significant natural erosion and undercutting of mangroves. These erosion areas mainly face to the north west and may therefore be impacted by north westerly winds and waves and less sheltered from cyclone impacts than other parts of CG (see section 7.2.3 Fig 13).
5. Cumulative impact with other existing or reasonably foreseeable activities, developments and land uses connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment:	The potential for cumulative impacts on benthic communities and habitats is limited by the fact that the area is completely uninhabited, with no road access and no development, built facilities or infrastructure. Human activity in CG is restricted to vessel-based operations, including: – commercial vessels that transit through CG entering and departing the Port of Wyndham (on average 1.3 per week), – small private vessels from Wyndham and Kununurra used mainly for recreational fishing along the coast and up the inlets of CG; and

EPA Significant Impact Criteria*	Benthic Communities & Habitats Assessment
	– one commercial gillnet fisherman who is sometimes active in CG (and also along the adjacent coast outside CG). None of these cause significant impacts on benthic communities and habitats, so do not add cumulative impacts for this environmental factor. Based on discussions held with a broad range of local and State stakeholders as part of BKA's consultation program it appears unlikely that there will be other developments in CG in the foreseeable future (see Referral Report No. 6).
6. Level of confidence in the prediction of impacts and the success of proposed mitigation:	BKA has sought to achieve as much scientific certainty as possible by supporting the impact assessments with a very comprehensive suite of data from both its own data collection campaigns, including in both the dry and wet seasons, and from external sources and previous studies of the area, as outlined in section 5 and Annex 1. Hydro- and sediment dynamics assessments and modelling are strongly supported by comprehensive field data and are extremely well calibrated and validated, and have been subject to independent peer review (see Referral Report No. 5). BKA has an ongoing data collection program in place and should the proposal be approved and proceed, BKA proposes to also implement a comprehensive environmental research and monitoring program, in cooperation with TOs and other relevant partners, as described in section 17. The range of mitigation measures proposed as outlined in Table 6 are based on proven best-practices that have been successfully applied globally.
7. Public interest about the likely effect of the proposal, if implemented, on the environment, and public information that informs the EPA's assessment:	BKA recognises that social licence is as important as regulatory licence for such proposals. In order to ensure that the views, perspectives and positions of relevant key stakeholders are identified and addressed, since mid-2022 BKA developed a stakeholder analysis and has undertaken an ongoing program of direct, in-person consultations with a wide range of key stakeholders at the local, State and Commonwealth levels. Stakeholders consulted include the two TO groups in the CG area (Balanggarra and Miriuwung-Gajerrong), the recreational and commercial fishing sectors, the Port of Wyndham, the environmental NGO sector, local government and local business sector, all relevant State government departments and some Commonwealth agencies. Several groups have been met with more than once as part of an ongoing consultation program. No major objections to the proposal have been raised to date and some stakeholders support the proposal, including the two TO groups who have issued letters of support. BKA is working with both TO groups to develop MoUs for their involvement in the proposal, including employment and business opportunities. Stakeholder engagement is ongoing and should the proposal be approved and go-ahead, a Stakeholder Reference Group (SRF) or similar could be established and operated throughout the life of the project. Full details of stakeholder engagement and consultations to date can be found in Referral Report No. 6 - *Stakeholder Engagement & Consultations and* No. 3 - *Traditional Owners, Native Title & Aboriginal Cultural Heritage* and

8. IMPACT ASSESSMENT - COASTAL PROCESSES

8.1 Relevant EPA Guidance & Objective

1. The EPA has published one guidance document relating to coastal processes - EPA 2016, *Environmental Factor Guideline - Coastal Processes*.

2. The Environmental Factor Guideline defines coastal processes as:

   > *. . . any action of natural forces on the coastal environment.*

3. The Guideline recognizes that coastal environments are naturally dynamic, with their morphology at any point in time being determined by the interaction between their structure and innate mobility (e.g. from relatively immobile hard rocky cliffs to mobile, unconsolidated sand) and the intensity and degree of exposure to key geophysical and environmental processes (e.g. wind strength and wave height, current speed and direction).

4. The Objective of the Guideline is:

   - *To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected*.

5. This objective recognises the fundamental link between the geophysical processes which shape the coastal environment and the environmental values that they support. These uses include the maintenance of ecosystem values, landforms, amenity, recreation, tourism, commercial, urban and industrial use.

6. Therefore, in assessing potential impacts of the proposal on coastal processes, BKA focused on whether the proposed removal of up to 70 million m^3 of sand from within the main body of CG will potentially alter sediment transport and supply pattern and the natural coastal erosion and accretion patterns in CG. BKA has also focused on whether any such change might alter the significant coastal ecosystems and values that the coastal environment supports. The most significant coastal ecosystems and values in CG are described in section 8.2 and shown on Figure 22.

7. The Guideline describes considerations that should be taken into account when assessing the potential impacts of proposals on coastal processes, including *inter alia*:

   - predicting potential changes to coastal processes using analyses and modelling to a standard consistent with recognised published guidance; and

   - predicting potential changes to coastal processes in the context of the latest climate change projections.

8. BKA has commissioned detailed coastal process analysis and modelling by Port & Coastal Solutions (PCS), supported by a comprehensive suite of field data from both BKA's own field data collection campaign and external sources (see section 5 above and Annex 1.2). BKA required PCS to apply recognised published guidance to the analysis and modelling and include consideration of climate change implications (see Referral Report No. 5 / PCS 2024a).

9. The Guideline recommends independent peer review of coastal process modelling and predicted impacts. BKA engaged independent peer review of the modelling work for sequential stages, including review of the data collection and modelling design (terms of reference) and of the data analysis and modelling reports from PCS. The peer review reports are attached to Referral Report No. 5.

8.2 Receiving Environment

1. A detailed system understanding including a description of the receiving environment with respect to coastal processes, including the hydrodynamics and sediment dynamics that drive coastal processes in CG, is presented in Referral Report No. 5 / PCS (2024a & b). A conceptual model for sediment transport and coastal processes in CG has been developed by PCS (2024a), as shown in Figure 24.

2. The description of the receiving environment for benthic communities and habitats in section 7.2 above describes the environmental values that are formed and influenced by coastal processes, as most of the benthic communities and habitats are coastal. These descriptions are not repeated in detail here for reasons of economy. Some of the main features are summarized below.

3. The main influencing factors on coastal processes in CG are as follows:

a) The underlying geology and geomorphology of the coast and seabed,

b) The input of sediments from the surrounding catchment via the various rivers that drain the catchment into CG (see below).

c) The prevailing meteorology, including a dry season from May to October with very little rainfall and prevailing easterly winds, a wet season from November to May with sometimes extreme rainfall and very high terrestrial runoff, more westerly but variable winds, frequent tropical squalls and occasional tropical cyclones.

d) The prevailing hydrodynamics, with CG being primarily a tidally-driven system with a large tidal range of 8m and measured tidal currents of > 2 m/s (4 knots), plus the effects of waves, including influences from the larger Joseph Bonaparte Gulf offshore from CG.

4. There are five main rivers that discharge sediments into the upstream parts of CG, upstream of Adolphus Island. These are the Durack, Forrest, King, Ord and Pentecost, along with a number of smaller tributaries. The small Helby, Lyne and Thompson Rivers are located on the west coast of the main body of CG. The total catchment area for CG is approximately 87,000 km^2 with 62% of this being the Ord River catchment (DataWA 2023).

5. Except for the Ord River, which has an overall length of 650 km, all of the rivers are quite small, but can have very high, acute, short-term flows during the tropical wet season. The wet season river discharges can vary by orders of magnitude year to year. There is also significant daily variability in river flows, with very high flows following tropical cyclones only lasting a matter of days (Wolanksi et al 2001). As outlined above the rivers all discharge sediment into CG. The supply of sediment varies significantly due to the high variability in river discharges. Peaks in sediment supply occur in the wet season, with limited sediment supply during the dry season (PCS 2024a & b).

6. The rivers supply a combination of sand and fine-grained silt and clay. The sediment deposited in CG is subject to regular reworking by the strong tidal currents, resulting in well-sorted sand which, over time is deposited to form extensive intertidal and subtidal sandbanks. The most significant intertidal sandbanks are described in section 7.2.7 above and are shown on Figure 17 in that section. The most significant subtidal sandbanks include the area within the proposed operational area, which are proposed to be sourced and exported, and are assessed to be highly dynamic, as described in section 7.2.2.

7. The building of two dams on the Ord River, one near Kununurra and one for the Ord River Irrigation Scheme, has interrupted the supply of sediment to CG from that source, but is also causing significant build-up of sediment in the lower Ord just south of Adolphus Island, due to the lack of wet-season flushing since building of the dams (Wolanksi et al 2001) (PCS 2024a).

8. Of most relevance to this impact assessment are those coastal areas that are comprised of more mobile substrates and may therefore be potentially affected by any changes to sediment dynamics that might be caused by the proposed extraction of up to 70 million m^3 of sand from the proposed operational area over 15 years. Consistent with the EPA requirements, BKA assessed the most significant coastal ecosystems and values in CG that are influenced by coastal processes, and which could potentially be impacted by changes in coastal processes. These comprise the following, as shown on Figure 25:

    a) Mangroves: The mangrove communities around the entire coast of CG.

    b) Ramsar Wetland: The mangrove-lined tidal inlets and channels backed by extensive mud- and salt-flats that form the so-called ‘False Mouths of the Ord’ on the eastern side of CG. This area is part of the Ord River Floodplain Ramsar Wetland and is protected as part of the State-designated Ord River Nature Reserve.

    c) Flatback Turtle nesting sites: As follows (Figures 25 & 26):

        - 1. Cape Domett Seaward Beach (1.9 km) – the main nesting beach (449 track sets and 190 nests counted in July 2023 aerial drone survey),
        - 1A. Cape Domett Small Beach (0.4 km) (seven track sets and nests counted in July 2023),
        - 2. Turtle Bay on NW side of Lacrosse Island (0.3 km) (six track sets and nests counted in July 2023),
        - 3. Turtle Beach West (3 km) west of Cape Dussejour (34 track sets and 28 nests counted in July 2023); and
        - 4. Barnett Point within CG (82 track sets and 13 nests counted in July 2023).

9. The beaches are all located on seaward coasts outside of CG while Barnett Point is located inside CG with no beach. At Barnett Point the nesting occurs on sand ridges (cheniers) that are protected behind mangroves.

10. The impact assessments in section 8.3 focus on whether the proposal is likely to cause changes to coastal processes that in turn might cause impacts on these main coastal ecosystems and values in CG.

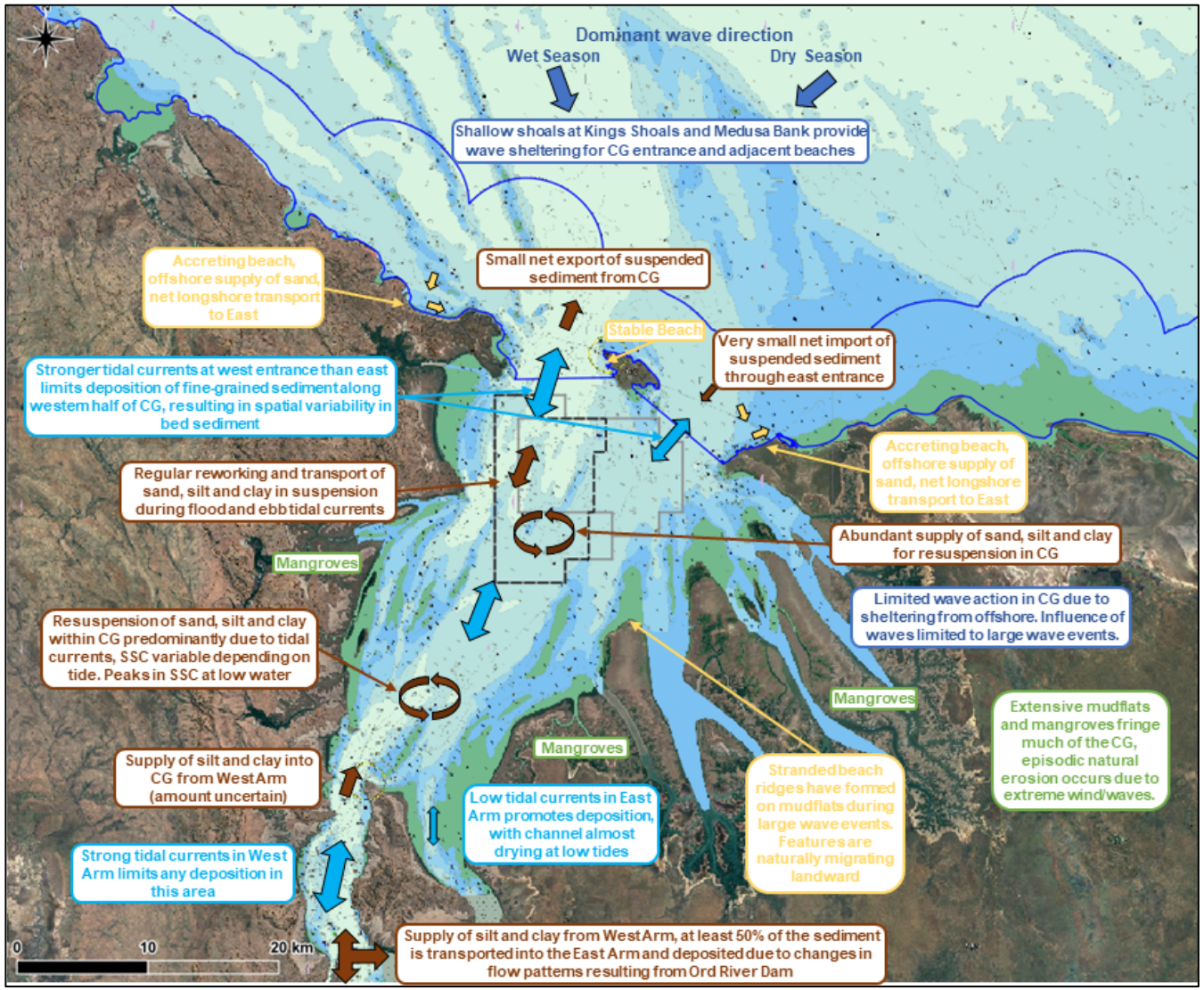


FIGURE 24: *A conceptual sediment transport and coastal processes system understanding for CG. (Note: text and arrows in dark blue relate to waves, pale blue relates to tidal currents, brown relates to sediment transport, yellow relates to beach changes and local sand supply and green relates to mangroves) (see Referral Report No. 5 / PCS (2024a)*

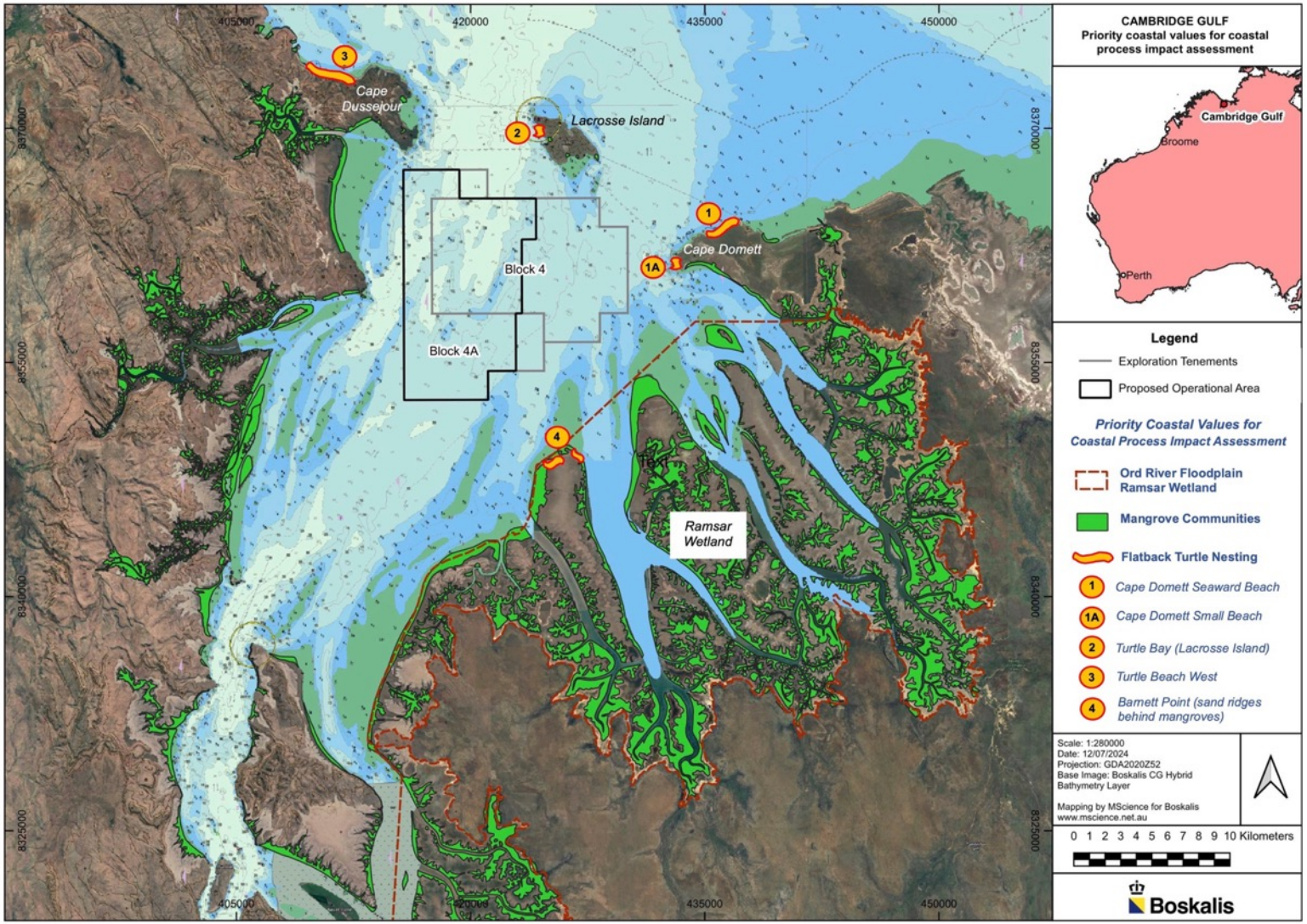


FIGURE 25: *The most significant coastal ecosystems and values in CG that are formed and influenced by coastal processes comprise the the mangroves around the coast of CG, including the mangrove-lined inlets in the Ord River Floodplain Ramsar Wetland; and five Flatback Turtle nesting sites.*

1. Cape Domett Seaward Beach (midpoint looking west)

1. Cape Domett Seaward Beach (midpoint looking east)

1A. Cape Domett Small Beach (looking to Lacrosse Island)

2. Turtle Bay (NW side of Lacrosse Island)

3. Turtle Beach West (looking west from Cape Dussejour)

4. Barnett Point (from east side)

FIGURE 26*: The five main Flatback Turtle nesting sites in the CG area, which are formed and influenced by coastal processes. The top two images are both of Cape Domett Seaward Beach. At Barnett Point (bottom right) there is no beach and the turtles nest on sand ridges (cheniers) behind the mangroves.*

8.3 Impact Assessment

1. Potential changes to coastal processes from the proposed extraction or up to 70 million m^3 of sand over up to 15 years from within the proposed operational areas, and potential resulting impacts on the three linked coastal values of mangrove communities, the Ramsar wetland and turtle nesting beaches, were assessed by PCS (2024a & B) (referral Report No. 5). Detailed assessment is contained in those reports and are summarized for each key coastal value below.

8.3.1 Modeling to support the impact assessment

1. In order to support the assessment of potential impacts on coastal processes and linked coastal values, BKA commissioned PCS to establish and run the following models, using all available data from pre-existing sources and from BKA's data collection program in CG (as presented in Annex I). PCS used the Danish Hydraulic Institute (DHI) MIKE suite of models, with a Flexible Mesh (FM) three-dimensional (3D) approach:

    a) Hydrodynamic model – DHI MIKE hydrodynamic (HD) model.

b) Spectral wave model – DHI MIKE Spectral Wave Model (SWM).

c) Sediment transport model – DHI MIKE Sediment Transport Model (STM), which is designed specifically for sediment transport studies in coastal and estuarine environments with fine-grained and sand sized sediment, and for dredging studies.

d) Beach processed model – DHI MIKE littoral drift (LITDRIFT) and littoral profile (LITPROF) models.

2. The models were calibrated and validated using all available relevant datasets and found to be reliable and accurate relative to real-world conditions in the CG area. They were run to assess potential impacts of the proposal on hydrodynamics, sediment dynamics and coastal processes. Details are reported in Referral Report No. 5 / PCS (2024a) and are not repeated here for reasons of economy.

3. The findings can be summarized as follows, based on the end-state deepening of the proposed operational area by an average of -1 m across the area, from sourcing the full 70 million m^3 of sand over 15 years:

    a) Hydrodynamic modelling:
        - Changes in water level (tide level) in CG are predicted to be extremely minor within ±0.01 m (±1 cm), with no measurable impact on tidal range.
        - The phasing of the tidal propagation upstream of the proposed operational area is predicted to be changed by 27 seconds (earlier).
        - Changes in current speeds are predicted to be extremely minor and will only occur within and adjacent to the proposed operational area, with a reduction in current speed of up to -0.01 m/s, and small localised areas with a predicted increase in current speed of up to 0.01 m/s adjacent to the boundary of the proposed operational area.
        - Changes in current direction are predicted to be negligible during the flood and ebb stages of the tide.

    b) Spectral wave modelling:
        - The deepening of the proposed operational area is not predicted to impact the wave conditions in CG for the majority of the time.
        - A small change in wave height in CG of below 0.01 m (1 cm) is predicted during large wave events when wave heights range from 1 to 2 m, such as during wet season cyclones and tropical lows.

    c) Sediment transport modelling:
        - The STM model was not considered to be sufficiently developed at June 2024 to reliably predict changes to sediment transport or erosion and accretion rates. Modelling is ongoing with additional data and will be reported in a supplementary report (see below).
        - However, the predicted impacts to hydrodynamics and waves were used to qualitatively assess potential impacts on sediment transport and coastal processes. The small and localised predicted changes to the hydrodynamics are considered unlikely to noticeably change the sediment dynamics and sediment transport rates in CG. The only predicted change is a potential small increase in sedimentation in the proposed operational area (due to a very slight reduction in current speeds in this area).
        - As predicted very minor changes to wave conditions were limited to within CG and only during large wet season wave events, the changes in waves are not expected to directly impact sediment transport rates (of sand and fine-grained silt and clay) or coastal processes (i.e. no changes to mangroves or beaches) either within outside of CG.
        - The findings will be assessed in more detail as the STM model is developed further with additional data inputs.

    d) Beach process modelling:
        - At the Cape Domett beaches, Turtle Bay on Lacrosse Island and Turtle Beach West, the modelling supported by satellite assessment of beach dynamics, indicates that the primary sand sources for each beach are from offshore. It is therefore unlikely that the proposal, which is located within CG, will affect sand supply to these beaches.
        - The findings will be assessed further as the STM model is developed with additional data inputs.

4. It is possible that less than 70 million m^3 of sand will be exported, based on market demand, in which case the predicted changes would be less than described above.

5. All steps in the modelling process including data collection planning and data analysis, model design and setup and model outputs were subject to independent peer reviews.

6. BKA has continued to collect metocean data in CG since the modelling reported in PCS (2024a) was undertaken before

June 2024. As additional data is provided to PCS, further modelling is being undertaken to benefit from more comprehensive datasets and thus provide even stronger modelling predictions. As outlined in section 7.3.4, PCS is also undertaking suspended sediment and plume dispersal modelling for BKA. These will be reported and submitted to EPA in a supplementary Referral Report - *Hydrodynamic, Coastal Process & Sediment Plume Modelling* (PCS 2024d).

8.3.2 Potential impacts on mangrove communities

1. Mangroves are dependent on and are influenced by coastal processes as they grow on intertidal sediments, and changes to sediment supply, both from landward and seaward sources, can in turn cause changes in mangrove communities.

2. Anthony et al (2020) provides a comprehensive review of the links between sediment dynamics and mangroves, and Figure 27 shows the main processes described by Anthony et al (2007) that are also fully applicable in CG. Most sediments in mangrove communities come from landward catchment sources, although seaward sources form long-shore drift and local deposition can also contribute, as shown on Figure 27. It is the latter sediment source that is relevant to this assessment, as the proposal does not include any facilities or activities in the catchment, and only involves the proposed sourcing of sand from within the centre of CG, which is seaward of all mangroves in CG.

3. As outlined in Anthony et al (2007) potential impacts on mangroves from changes in sediment supply are caused by three main mechanisms:

    a) increased volume and/or rate of sediment supply,
    b) decreased volume and/or rate of sediment supply; and/or
    c) changes in the composition of supplied sediment.

4. Increased sediment supply can cause sedimentation and potentially smother mangrove seedlings and aerial roots, and cause changes to the elevation, morphology and tidal inundation profile of the substrate, changing its suitability for mangroves. These factors can cause changes in the local distribution of mangroves, including recession from the coastline as the substrate elevation, morphology and tidal inundation profile become unsuitable, and also expansion of mangroves as suitable substrate can be expanded by changes to elevation, morphology and tidal inundation profile.

5. Decreased sediment supply can reduce sedimentation, reduce substrate elevation and change the substrate morphology and tidal inundation profile. As with increased sediment supply, these factors can have both negative and positive impacts on mangroves, as the changed conditions could be either less or more suitable for mangroves.

6. Both increased and decreased sediment supply can also cause changes in the species composition and zonation of the mangrove community, as some species of mangrove trees have different substrate elevation, morphology and tidal inundation preferences. This is exemplified by species zonation bands often seen from seaward to landward in many mangrove communities, including in CG (Cresswell & Semenukk 2011).

7. Changes in the composition of supplied sediment are less significant for mangroves, as many species of mangrove trees can grow in a wide range of sediment types and sizes, from fine muds to coarse sands. However, changes in the composition of supplied sediment can cause changes in the species composition and zonation of the mangrove community, as some species have sediment-type preferences.

8. The actual changes that might occur in any particular area will depend on site-specific conditions and the species of mangroves present in the area.

9. While mangroves are influenced by sediment dynamics and coastal processes, they in turn have a very significant influence on sediment dynamics and coastal processes. Their complex root systems act as sediment traps and wave-energy dissipaters, and their seaward vegetative canopies can dissipate the effects of winds on the coast. Through these factors mangroves can assist the process of coastal stabilization and accretion, and one of the most significant ecosystem services provided by mangroves is coastal protection and erosion prevention (Lymburner et al 2020) (Alongi, 2008).

11. When assessing the potential impacts of possible changes in coastal processes on mangroves, it is important to note that mangrove communities are not static but are highly dynamic in nature, being on the land/ocean interface. Their extent, state and dynamics are influenced not only by sediment dynamics but also by freshwater and tidal inundation, salinity differences and exposure to high winds and waves (Lymburner et al 2020) (Alongi, 2008).

12. As outlined in section 7.2.3 and shown on Figure 13 in that section, the mangrove areas in CG and especially on the eastern coastline and in the Ramsar area appear to be highly dynamic, with numerous areas of significant natural erosion and undercutting of mangroves. Additional images of some of these areas are shown in Figure 28. These natural erosion areas mainly face to the north-west and may therefore be impacted by north westerly winds and waves. They may be less sheltered from cyclone impacts than other parts of CG (see Referral Report No. 2 for detailed description and further images of these areas).

13. Previous studies have assessed historical changes in the extent of mangrove communities in CG. Studies by Jennings (1975) and Thom et al. (1975) report a net gain of mangroves in CG over 20 years from 1955 to 1975, based on comparisons of aerial photographs. A more recent comparison of satellite imagery taken 24 years apart (1996-2020) demonstrated an estimated net reduction in mangrove area in CG of 9,077 ha, as shown on Figure 28 (Global Mangrove Watch, 2020; Bunting et al., 2022). This scale of loss (especially if caused by cyclones) is not unprecedented. Paling et al. (2008) reported on the loss of 5,700 ha of mangroves from Exmouth (WA) following a single cyclone in 1999 (TC Vance), followed by significant recovery in the subsequent decade.

14. Construction of the Ord River Dam also has affected mangrove distribution and extent in the Lower Ord River upstream from CG. Studies by Semeniuk (2000) and Wolanski et al. (2001 and 2004) estimated a major accumulation of sediment of about 20 million m^3 in the estuarine sections of the Lower Ord River over a 30-year period after the Ord River Dam was completed in 1971. This sedimentation caused a 50% decrease in cross-sectional areas of the estuary over the same period, which resulted in an increase in the extent of mangroves in the Ord River estuary.

10. Considering the points above, in order to assess potential impacts of the proposal on mangroves through possible changes in coastal processes, it is necessary to assess whether the proposal will cause any measurable changes in sediment supply to mangrove areas, and whether any such changes are significant in terms of causing serious or permanent/irreversible impacts on mangroves, within the context of their natural dynamics.

11. As outlined in section 8.3.1 these factors were assessed by PCS (2024 a & B) (Referral Report No. 5), which found that the proposal is unlikely to change hydrodynamics or sediment transport to any degree that would in turn affect the mangrove communities of CG. The mangrove areas receive most of their sediments from terrestrial sources as shown on Figure 27, and not from the proposed operational area which is located seaward of all mangrove areas. The mangrove areas in CG are also naturally dynamic, as discussed above and shown in Figures 28 and 29.

12. *Overall, it is assessed that it is unlikely that the proposal will cause significant, irreversible or even moderate or minor impacts on mangrove areas through changes to coastal processes.*

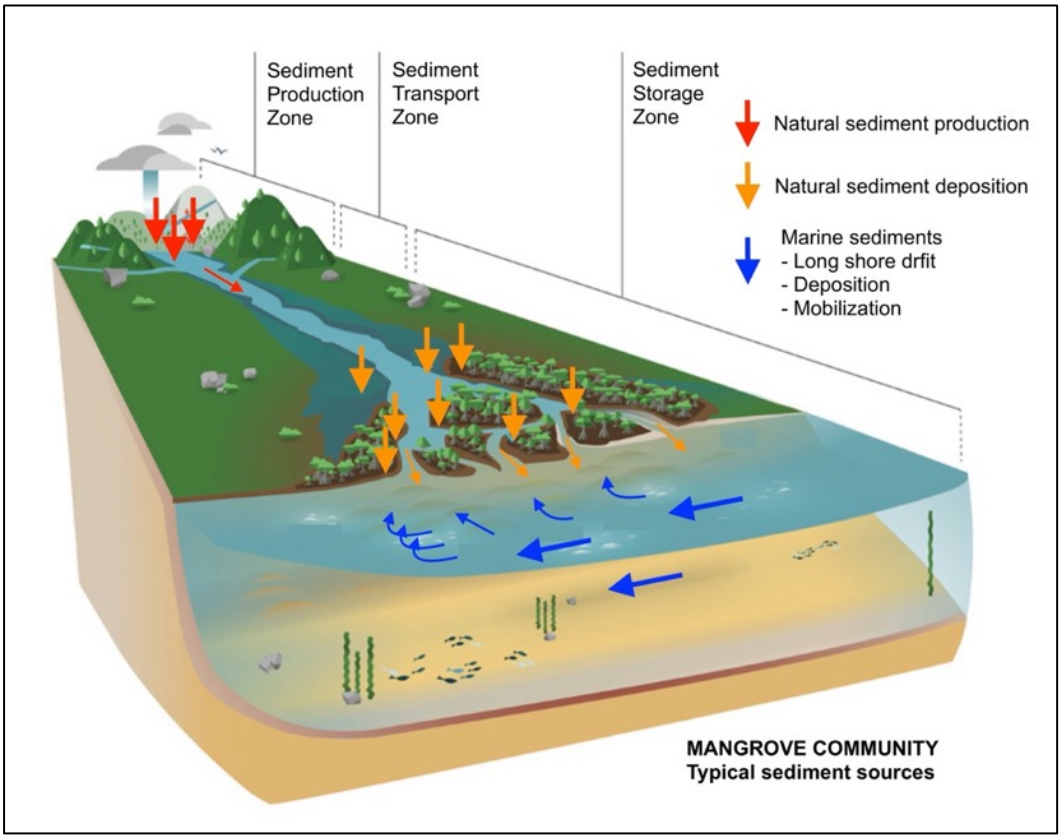


FIGURE 27*: Most sediments in mangrove communities come from landward catchment sources, although seaward sources form long-shore drift and local deposition and mobilization can also contribute. It is the latter sediment source that is relevant to this assessment, as the proposal does not include any facilities or activities in the catchment, and only involves the proposed extraction of sand from within the centre of CG, which is seaward of all mangroves in CG (adapted from Anthony et al 2020).*

FIGURE 28*: Examples of natural dynamics of mangroves in CG under the influence of sediment dynamics, waves and wind, including cyclones (mages: Raaymakers July 2023 & Feb 2024) (see Referral Report No. 2 for full details including mapped locations). Assessment of potential impacts of proposals needs to consider the context of natural dynamics.*

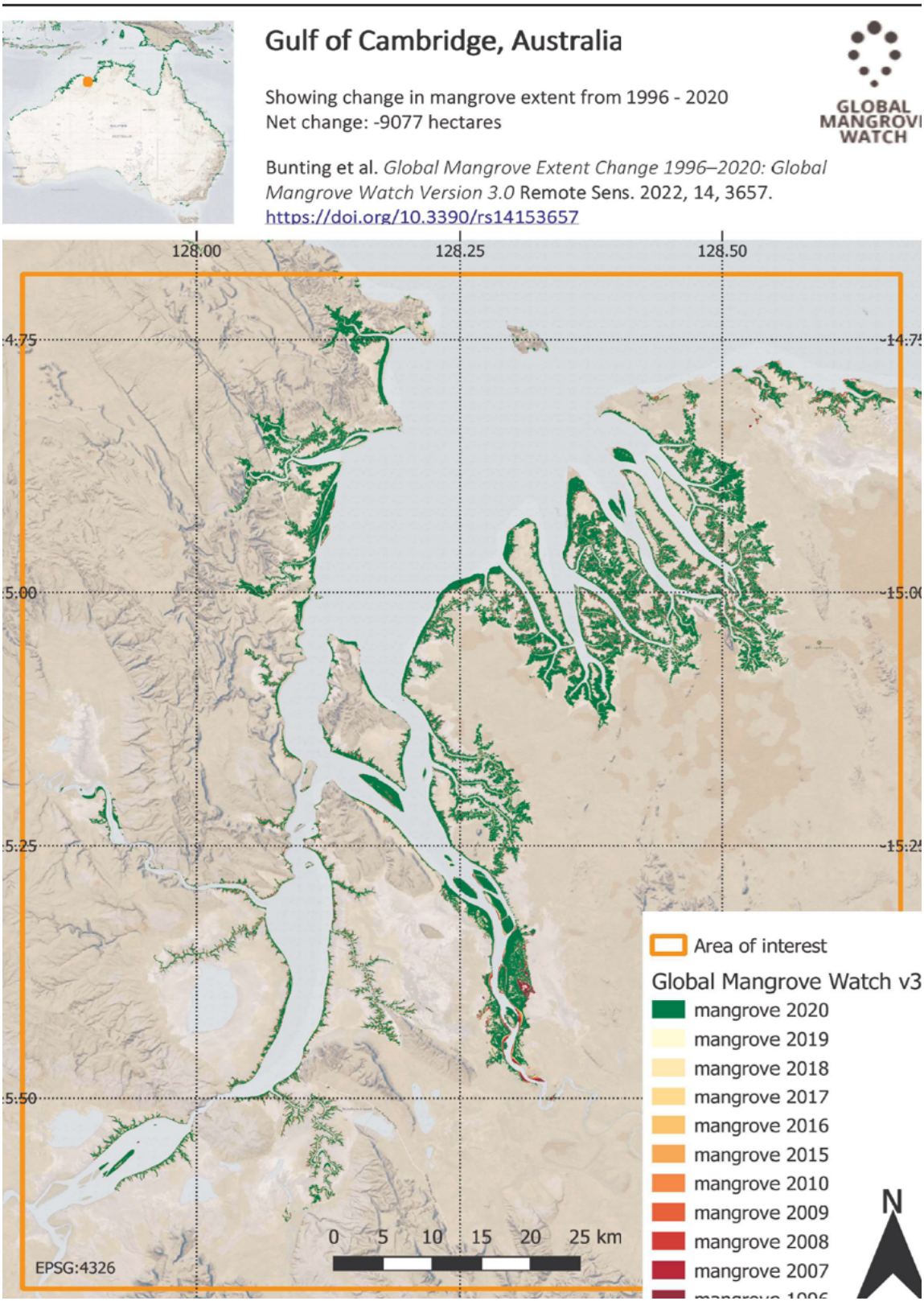


FIGURE 29. *Mangrove extent in 2020 (green) and net change since 1996 indicating an estimated net reduction in mangrove area of 9,077 ha in CG (source: http://www.globalmangrovewatch.org/)*

8.3.3 Potential impacts on Ramsar wetland

1. The primary coastal habitat in the Ramsar wetland is a narrow band of mangroves lining the maize of inlets and tidal channels that form the so-called 'False Mouths of the Ord', backed by extensive mud- and salt-flats, as shown on Figure 4 in section 4 and Figure 12 in section 7.2.3.

2. It is assessed that the proposal will not affect coastal processes in the Ramsar wetland and the mangroves within the wetland will therefore not be impacted by the proposal, as per the assessment for mangroves in CG overall as presented in section 8.31.

3. The mud- and salt-flats within the Ramsar wetland are located to landward of and are protected by the coastal mangrove band. It therefore follows that if the proposal does not affect coastal processes in way that impacts negatively on mangroves, it will not cause impacts on the mud- and salt-flats behind the mangroves.

4. *Overall, it is assessed that it is unlikely that the proposal will cause significant, irreversible or even moderate or minor impacts on the Ramsar wetland through changes to coastal processes.*

8.3.4 Potential impacts on Flatback Turtle nesting areas

1. As outlined in section 8.2, four of the five Flatback Turtle nesting areas in the LAU are sandy beaches. All four beaches are located on the seaward coasts outside of CG and face to the north or north-west, being exposed directly to offshore wind, wave and tide conditions of Joseph Bonaparte Gulf. Sand is of-course a mobile substrate subject to movement by wind, waves and tides, and sandy beaches can often have naturally dynamic morphology.

2. The fifth turtle nesting area in the LAU is Barnett Point, located within CG and not a beach as such. At this site nesting occurs on sand ridges (cheniers) located behind mangroves. The site also faces directly north to seaward, and is exposed to the offshore influences of Joseph Bonaparte Gulf through the East Entrance between Lacrosse Island and Cape Domett (Figure 24).

3. It is necessary to assess if the proposal could potentially cause changes in marine sediment supply to the beach areas, that might in turn affect the dynamics of beach morphology, including accretion and erosion patterns.

4. Changes in beach morphology can potentially affect turtle nesting in the following ways (Gammon et al 2023) (Yamamoto et al 2015):

    a) Accretion can increase the area of a beach that is suitable and available for nesting.

    b) Erosion can reduce the area of a beach that is suitable and available for nesting.

    c) Changes in beach elevation and slope can potentially affect beach accessibility for turtles, however the changes have to be significant as most turtle species can utilize a range of beach elevations and slopes.

    d) Changes in beach sediment composition can affect the suitability of the beach for nesting. For example, *in extremis*, if natural sand supply to a beach is interrupted sufficiently, it could expose a different substrate beneath such as rock, in which turtles cannot dig nests. More subtle changes in sediment composition such as grain size, type and/or colour can potentially alter the temperature regime within the sand and affect hatchling gender ratios,

    e) Acute sedimentation events (for example as a result of a cyclones) that cover nests with an additional sediment layer during the incubation period can also change the temperature regime within the sand and affect hatchling gender ratios. If the sedimentation is thick enough, it can impede hatchling egress.

5. For reasons that are not yet well understood, Flatback Turtles seem to be able to nest under a range of beach conditions and may have a preference for nesting on beaches that are exposed and face directly to the sea (Gammon et al 2023). This is the case in the CG as outlined above and shown on Figures 25 and 26.

6. Historical changes of the Cape Domett Seaward Beach, Turtle Bay on Lacrosse Island and Turtle Beach West are assessed in Referral Report No. 5 / PCS (2024a & b). Analysis of shoreline positions at cross-shore profiles was undertaken by PCS using CoastSat historical satellite imagery as shown on Figure 30. The analysis is based on satellite imagery from 1988 to 2023. Over this period a total of 36 TCs have passed within 200 km of the entrance to CG, meaning that multiple extreme wave and river discharge conditions will have occurred. Therefore, the results show how the shoreline at the beaches has changed due to typical conditions and extreme events. The shoreline positions were normalised at each cross-section by subtracting the mean shoreline position throughout the analysis period (1988 to 2023).

7. At Cape Domett Seaward Beach, Turtle Bay and Turtle Beach West, sufficient imagery was available during both the wet and dry season periods to allow the shoreline position to be mapped separately for these periods. At Barnett Point it was not possible to analyse the shoreline position separately for wet and dry season periods, due to the extensive sandflats that front the coast here, which limit the ability of the CoastSat tool in identifying the shoreline. The annual change in shoreline position was therefore analysed for this site. The analysis showed that:

    a) the seaward beaches outside of CG (Cape Domett and Turtle Beach West) have been advancing since 1994,

    b) Turtle Bay on Lacrosse Island has remained stable,

    c) the stranded beach ridge (chenier) at Barnett Point inside CG has been retreating at either end but remained stable in the centre; and

    d) the shoreline positions at the two seaward beaches and the beach on Lacrosse Island differed between the wet and dry seasons, indicating a potential change in the beach profile shape due to the different wave conditions which occur during the different seasons.

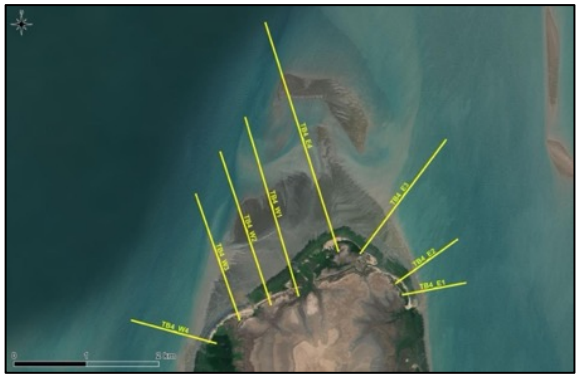
8. As outlined in section 8.3.1 modelling with the MIKE LITDRIFT and LITPROF models, supported by the CoastSat assessment of beach dynamics, indicates that the primary sand sources for each beach are from offshore. It is therefore unlikely that the proposal, which is located within CG, will affect sand supply to these beaches. As also outlined in section 8.3.1 the hydrodynamic and spectral wave modelling found that the proposal is unlikely to change hydrodynamics or sediment transport to any degree that would in turn affect sediment supply to the turtle nesting areas. The findings will be assessed further as the STM model is developed with additional data inputs.

9. *Overall, it is assessed that it is unlikely that the proposal will cause significant, irreversible or even moderate or minor impacts on the turtle nesting areas through changes to coastal processes.*

Cape Domett Seaward Beach

Turtle Bay (Lacrosse Island)

Turtle Beach West



Barnett Point

FIGURE 30: *Cross-shore profiles adopted to assess historical shoreline change at four turtle nesting areas (PCS 2024a)*

8.3.5 Summary of impacts on coastal processes & linked coastal values

1. Overall, it is assessed that it is unlikely that the proposal will cause significant, irreversible or even moderate or minor impacts on mangroves, the Ramsar wetland and/or turtle nesting areas through changes to coastal processes.

8.4 Application of the Mitigation Hierarchy & Assessment of Residual Impacts

1. As outlined above there are four sequential levels in the WA EPA impact mitigation hierarchy:

    a) Avoid (prevent) impacts.
    b) Minimise (mitigate) impacts.
    c) Rehabilitate impacts.
    d) Offset impacts.

2. Table 8 presents the mitigation hierarchy applied to coastal processes and the three linked key coastal values of mangrove communities, the Ramsar wetland and turtle nesting areas. Table 8 lists the main potential impact for each coastal value as discussed above, identifies relevant impact avoidance, minimisation, rehabilitation and offset measures and assesses the predicted residual impacts for each.

3. Overall, as outlined above and summarised in Table 8, potential impacts on coastal values that are linked to coastal processes will be avoided and prevented because:

    a) the proposal is unlikely to change hydrodynamics or sediment transport to any degree that would in turn affect the coastal values,
    b) the main sediment supply for each of the three coastal values is not from the proposed operational area, and
    c) all three coastal values are naturally dynamic.

4. Impact minimization / mitigation is not required as impacts will be fully avoided / prevented. Because the proposal is unlikely to cause significant primary impacts, there will not be any residual impacts.

5. Never-the-less, should the proposal be approved and proceed, BKA will seek to implement a comprehensive environmental and biodiversity research and monitoring program, in consultation and cooperation with relevant stakeholders as described in section 17. This would further assist protection and conservation of the coastal values of CG.

TABLE 8: *Mitigation hierarchy & assessment of residual impacts for coastal processes.*

Coastal Value	Potential Impact of the proposal	Impact Avoidance / Prevention	Impact Minimization / Mitigation	Rehabilitation & Offsets	Residual Impacts
Mangrove Communities	Changes to natural sediment supply that in turn cause changes to aerial extent (positive or negative), species composition and/or zonation of mangroves in CG.	Impacts will be avoided / prevented because the proposal is unlikely to change hydrodynamics or sediment transport to any degree that would in turn affect the mangrove communities. The mangrove areas receive most of their sediments from terrestrial sources as shown on Figure 27, and not from the proposed operational area which is located seaward of all mangrove areas. The mangrove areas in CG are also naturally dynamic, as discussed in section 8.3.2 and shown in Figures 28 and 29.	Impact minimization / mitigation is not required as impacts will be fully avoided / prevented.	Rehabilitation is not required as impacts will be fully avoided / prevented. Offsets are not required as impacts will be fully avoided / prevented. Never-the-less, should the proposal be approved and proceed, BKA will seek to implement a comprehensive environmental and biodiversity research and monitoring program, in consultation and cooperation with relevant stakeholders as described in section 17. This would further assist protection and conservation of the coastal values of CG.	None as there will not be any primary impacts.
Ramsar Wetland	The primary coastal habitat in the Ramsar wetland is a narrow band of mangroves backed by extensive mud- and salt-flats.	Mangroves: As above. Mud- and salt-flats: It follows that if the proposal does not affect coastal processes in way that impacts negatively on mangroves, it will not cause impacts on the mud- and salt-flats, which are located behind the mangroves.	Impact minimization / mitigation is not required as impacts will be fully avoided / prevented.	As per mangroves above.	None as there will not be any primary impacts.
Turtle Nesting Areas	Changes to natural sediment supply that in turn cause changes to the morphology and/or composition of the turtle nesting areas that makes them less suitable or unsuitable for turtle nesting.	Impacts will be avoided / prevented because the proposal is unlikely to change hydrodynamics or sediment transport to any degree that would in turn affect the turtle nesting areas. The turtle nesting areas receive most of their sediments from offshore sources and not from the proposed operational area. The turtle nesting areas are also naturally dynamic, as discussed in section 8.3.4.	Impact minimization / mitigation is not required as impacts will be fully avoided / prevented.	As per mangroves above.	None as there will not be any primary impacts.

8.5 Likely Environmental Outcomes

1. The likely environmental outcomes with regard to coastal processes at the end of the 15-year project timeframe are assessed as follows:

   - The sand area within the proposed operational area will be on average <1m deeper than the pre-project seabed, and it will still comprise sand with similar seabed morphology and thus the same coastal process features (dynamic sand waves formed and constantly moved by the prevailing hydrodynamics).

   - There are unlikely to be any significant or measurable changes to coastal processes in or near CG, including in relation to the linked coastal values of mangroves areas, the Ramsar wetland and turtle nesting areas.

8.6 Assessment Against EPA Significant Impact Criteria

1. As outlined in section 3.1 the terms 'significant impact' and 'significant effect' are not defined in the EP Act, however the EPA's *Statement of Environmental Principles, Factors & Objectives* (EPA 2018) states that when considering significant impact or effect, the EPA may have regard to various matters, as listed in section 3.1, amongst others.

2. In order to assist in assessing whether the proposal will cause significant impacts on coastal processes, Table 9 presents an assessment against each of the criteria listed in the EPA's *Statement of Environmental Principles, Factors & Objectives.*

TABLE 9: *Assessment of potential impacts on coastal processes against EPA significant impact criteria*

*****From *Statement of Environmental Principles, Factors & Objectives* (EPA 2018)

EPA Significant Impact Criteria*	Coastal Processes Assessment
1. Values, sensitivity and quality of the environment which is likely to be impacted:	The value of the coastal processes in CG is linked to the environmental values that they support, with the most important being: – Mangroves: The mangrove communities around the entire coast of CG. – Ramsar Wetland: The mangrove-lined tidal inlets and channels backed by extensive mud- and salt-flats that form the so-called 'False Mouths of the Ord' on the eastern side of CG. This area is part of the Ord River Floodplain Ramsar Wetland and is protected as part of the State-designated Ord River Nature Reserve. – Flatback Turtle nesting sites: As follows (Figures 25 & 26): – Cape Domett Seaward Beach (1.9 km) – the main nesting beach (449 track sets and 190 nests counted in July 2023 aerial drone survey), – 1A. Cape Domett Small Beach (0.4 km) (seven track sets and nests counted in July 2023), – Turtle Bay on NW side of Lacrosse Island (0.3 km) (six track sets and nests counted in July 2023), – Turtle Beach West (3 km) west of Cape Dussejour (34 track sets and 28 nests counted in July 2023); and – Barnett Point within CG (82 track sets and 13 nests counted in July 2023). – The beaches are all located on seaward coasts outside of CG while Barnett Point is located inside CG with no beach. At Barnett Point the nesting occurs on sand ridges (cheniers) that are protected behind mangroves.
2. Extent (intensity, duration, magnitude and geographic footprint) of the likely impacts:	The assessment of potential impacts on coastal processes contained in (Referral Report No. 5 / PCS 2024a & b) indicates that there are unlikely to be measurable impacts on coastal processes from the proposal.
3. Consequence of the likely impacts (or change):	As per point 2 above.
4. Resilience of the environment to cope with the impacts or change:	The environment of CG is naturally resilient as it is adapted to extreme conditions and constant change, including a high tidal range of up to 8 m, strong tidal currents which can exceed 2 m/s (4 knots), constantly moving seabed sediments, very high natural turbidity and total lack of light at the seabed, and frequent exposure to tropical cyclones (see Referral Report No 2). As outlined in section 7.2.3 and shown on Figure 13 in that section, the mangrove areas in CG and especially on the eastern coastline and in the Ramsar area appear to be highly dynamic, with numerous areas of significant natural erosion and undercutting of mangroves. Additional images of some of these areas are shown in Figure 28. These natural erosion areas mainly face to the north-west and may therefore be impacted by north westerly winds and waves. They may be less sheltered from cyclone impacts than other parts of CG. The turtle nesting areas in CG are also naturally dynamic including being affected by seasonal changes (dry- and wet-season) in morphology and being acutely impacted by periodic cyclones.
5. Cumulative impact with other existing or reasonably foreseeable activities, developments and land uses connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment:	As per response to this item in Table 4 in section 7.7 above – there is very low potential for cumulative impact given the lack of other developments and activity and in CG. As outlined in section 8.2, the building of two dams on the Ord River, one in 1963 near Kununurra located 120 km upstream from CG and one in 1973 for the Ord River Irrigation Scheme located 150 km upstream from CG, has interrupted the supply of sediment to the lower Ord River which drains into the East Arm of CG. This also caused significant build-up of sand and silt in the lower Ord just south of

EPA Significant Impact Criteria*	Coastal Processes Assessment
	Adolphus Island, due to the lack of wet season flushing since building of the dams, and inflow of sediment from the West Arm of CG (Wolanksi et al 2001). At June 2024 PCS is still undertaking modelling simulations at the end of the 15 years of sand sourcing compared a pre-European conditions simulation, to show the 'cumulative' impacts of the Ord River Dam and the proposed sand sourcing. This will be reported and submitted to EPA in a supplementary Referral report.
6. Level of confidence in the prediction of impacts and the success of proposed mitigation:	BKA has sought to achieve as much scientific certainty as possible by supporting the impact assessments with a very comprehensive suite of data from both its own data collection campaigns, including in both the dry and wet seasons, and from external sources and previous studies of the area, as outlined in section 5 and detailed in Annex 1. Hydro- and sediment dynamics assessments and modelling are strongly supported by comprehensive field data and are extremely well calibrated and validated, and have been subject to independent peer review (see Referral Report No. 5 / PCS 2024a, b & c). BKA has an ongoing data collection program in place and should the proposal be approved and proceed, BKA proposes to also implement a comprehensive environmental research and monitoring program, in cooperation with TOs and other relevant partners, as described in section 17.
7. Public interest about the likely effect of the proposal, if implemented, on the environment, and public information that informs the EPA's assessment:	As per response to this item in Table 4 in section 7.7 above – BKA has undertaken a comprehensive stakeholder engagement and consultation program which will be ongoing. No major objections to the proposal have been raised to date and some stakeholders support the proposal, including the two TO groups who have issued letters of support. See Table 4 above and Referral Report No. 6 - *Stakeholder Engagement & Consultations* and No. 3 - *Traditional Owners, Native Title & Aboriginal Cultural Heritage.*

9. IMPACT ASSESSMENT - MARINE ENVIRONMENTAL QUALITY

9.1 Relevant EPA Guidance & Objective

1. The EPA has published two guidance documents relating to marine environmental quality (MEQ):

   - EPA 2016, *Environmental Factor Guideline - Marine Environmental Quality*.
   - EPA 2016, *Technical Guidance - Protecting the Quality of Western Australia's Marine Environment.*

2. The Environmental Factor Guideline defines MEQ as:

   - *. . . the level of contaminants in water, sediments or biota or to changes in the physical or chemical properties of waters and sediments relative to a natural state*. It does not include noise pollution, which is dealt with separately under the marine fauna factor.

3. The Objective of the Guideline is:

   - *To maintain the quality of water, sediment and biota so that environmental values are protected.*

4. In further explanation of the Objective:

   - *Environmental value* is defined under the *EP Act* as a *beneficial use or an ecosystem health condition*.

   - *Beneficial uses* are uses of the environment which are conducive to public benefit, safety or health or to aesthetic enjoyment. *Ecosystem health condition* is the condition of the environment itself and is measured in terms of ecological structure, function or processes. Both types of environmental values can be affected by emissions, degradation of the environment, or by loss or damage to natural habitats.

5. A set of five environmental values that require protection from the effects of pollution, waste discharges and deposits in marine environments have been agreed through the National Water Quality Management Strategy (NWQMS), with associated Environmental Quality Objectives (EQOs). The five environmental values that the EPA generally expects to be protected throughout WA's coastal waters are:

   - ecosystem health
   - fishing and aquaculture
   - recreation and aesthetics
   - industrial water supply
   - cultural and spiritual.

6. BKA has assessed the potential impacts of the proposal on MEQ against these five values and their respective EQOs, as presented in section 9.3.

7. The *Technical Guidance - Protecting the Quality of Western Australia's Marine Environment* outlines an Environmental Quality Management Framework (EQMF) for protecting and maintaining MEQ in WA, based on the approach outlined in the NWQMS. This includes a recommendation for the proponent to develop an Environmental Quality Management Plan (EQMP) which protects the EQOs for each of the five environmental values stipulated by EPA.

8. The EQMP approach is addressed in section 9.6, noting that the proposed does not involve the discharge of wastes, pollutants or contaminants, which limits the scope for an EQMP.

9.2 Receiving Environment

1. A description of the receiving environment with respect to MEQ is presented in Referral Report No. 2 - *Proposal Setting & Existing Environmental Descriptions*. Section 7.3.4 above summarized suspended sediment and turbidity conditions in CG in the context of assessing potential impacts of sediment plumes from the proposed operation on benthic communities, and these are described further in Referral Report No. 5 / PCS (2024a&b). Detailed description is not repeated here for reasons of economy, however some of the main features are summarized below. Overall, it is assessed that the existing (baseline) MEQ of CG is in a natural condition and free of contaminants and pollutants, while suspended sediment concentrations and turbidity levels are naturally very high (see Figure 31) and chlorophyll levels are relatively low.

2. Cambridge Gulf (CG) has a mean water depth is approximately 12 m LAT with a macrotidal environment with semi-diurnal tides and a spring tidal range of 8 m. The large tidal range causes high current velocities, which can exceed 2 m/s (4 knots).

This causes very high natural turbidity from constant suspension of sediments with every change of the tide, and permanent aphotic conditions at the seabed, as described in section 7.3.4.

3. Monitoring by BKA through 2023 and 2024 has consistently measured almost zero light at the seabed throughout CG in both the winter dry season and summer wet season.

4. The monitoring by BKA between June 2023 through June 2024 has measured physical water quality parameters as presented in Table 9.

5. There is no urban, industrial or other development on the coast or in the immediate catchment of CG that could be potential sources of contaminant inputs to the receiving marine environment.

6. Currently, the only potential source of marine pollution within CG itself, is the ships that transit through CG when entering and departing the Port of Wyndham. Over the three-financial year period 2019/20 to 2022/23 there was an average of 1.3 commercial ship transits per week through CG (CGL 2024). These included small cruise ships, bulk carriers, petroleum tankers and general cargo ships.

7. All such ships that enter Australian ports must comply with the *International Convention for the Prevention of Pollution form Ships* (MARPOL) and the implementing Australian law - the Commonwealth *Protection of the Sea (Prevention of Pollution from Ships) Act* and related Marine Orders (administered by AMSA). Assuming that they comply, these ships should not cause negative impacts on MEQ in the CG area.

8. As outlined in section 8.2 above, in the wider catchment, including upstream of Adolphus Island, five main rivers discharge into CG, the Durack, Forrest, King, Ord and Pentecost, along with a number of smaller tributaries. The rivers all discharge sediment into CG. Apart from the Ord, which has two dams and significant areas of irrigated agriculture, all of the other rivers are still 'wild', with very little clearing of natural vegetation or development. There are therefore limited potential sources of contaminant inputs to the receiving marine environment in CG from those rivers.

9. There is potential for inputs of chemical contamination to the receiving marine environment in GG via the Ord River from the Ord River Irrigation Scheme area, where chemical pesticides and fertilizers are used on farms. However, such contaminants are mainly carried attached to sediments, and as outlined above the two dams on the Ord have interrupted sediment flow into CG, likely significantly reducing the potential for contaminants to be carried into CG via the Ord River.

10. Robson et al (2008) (CSIRO) report on regular, ongoing water quality monitoring undertaken by the WA Government in the Lower Ord (below the dams) and also undertook additional measurements of nutrient concentrations and other water and sediment quality parameters in 2006 and 2007. They did not report contamination in the system. They also reported that any dissolved inorganic nutrients entering the Lower Ord from potential upstream sources would be rapidly taken up by algae, while organic nutrients would be broken down by bacteria, both of which are abundant in the system, and thus nutrients are unlikely to reach downstream areas (including CG).

11. To assess for potential contamination of sediments in CG, in July 2023 BKA collected sediment samples from 21 sites within and around exploration tenement E80/5655, for analysis according to the Australian National Assessment Guidelines for Dredging (NAGD) 2009 (Figure 33). Testing was undertaken by ALS NATA accredited laboratory for organic compounds (various hydrocarbons, organochlorine pesticides, dioxins, organotin compounds etc) and a suite of metals (including arsenic and mercury). All parameters for all samples returned below the NAGD screening levels or below limits of detection, indicating that the sediments are free of contamination (reported in Referral Report No. 2).

12. Overall, the receiving environment in CG in terms of MEQ can be summarized as being free of contaminants and pollutants, with no significant sources of potential contamination along the immediate coastline or in the broader catchment, with normal sea temperature, salinity ad pH, with expected variation between the dry- and wet-seasons, with relatively low chlorophyll-*a* values and with extremely high SSC and turbidity levels and very low (zero) light levels at the seabed, throughout the year.

13. The five environmental values that are linked to MEQ by EPA are described for CG in Table 10. This shows that the main environmental value is ecosystem health, while the other four are not so relevant or not relevant at all, given the situation in CG, as indicated in Table 10.

TABLE 9: *Minimum, maximum and mean values recorded for basic physical water quality parameters from BKA's sampling in CG June 2023 to end June 2024.*

NOTE: The seabed in-situ sensors remain in CG into 2025 to provide ongoing inter-seasonal data.

Parameters	Vertical Water Profiles						Seabed In-situ Sensors					
	Dry-season			Wet-season			Dry-season			Wet-season		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
TSS (mg/L):	6.0	220	52.7	12.0	155.6	54.7	N/a	N/a	N/a	N/a	N/a	N/a
Turbidity (NTU):	2.8	114.9	29.5	5.0	55.6	17.2	0.3	282.8	51.9	1.4	596.9	67.8
Sea Temp (ºC):	23.0	24.4	23.9	30.9	31.3	31.1	24.5	30.0	27.6	28.0	32.9	30.2
Salinity (PSU):	29.5	32.9	31.7	27.4	32.4	30.6	21.3	34.1	29.5	7.5	34.5	28.2
pH:	Not Measured			8.6	8.7	8.6	8.3	8.6	8.5	8.0	8.6	8.4
Chlorophyll-a:	0.29 µg/L	1.26 µg/L	0.6 µg/L	0.04 RFU	0.47 RFU	0.07 RFU	N/a	N/a	N/a	N/a	N/a	N/a

TSS = Total Suspended Solids.
mg/L = Milligrams per litre.
NTU = Nephelometric Turbidity Unit.
PSU = Practical Salinity Unit.
pH = Potential of Hydrogen (concentration of hydrogen ions which is a measure of acidity / alkalinity).
µg/L = Micrograms per litre.
RFU = Relative Fluorescence Units.

Note for TSS:
- Dry-season data are based on suspended sediments filtered from Niskin water samples, taken from midwater at 53 sites spread throughout CG at random stages of the tide, = 53 samples.
- Wet season data are based on suspended sediments filtered from Niskin water samples, taken from midwater and near seabed every hour over 13 hours over a spring tidal cycle from low to high to low tide, at three fixed sites in CG, = 78 samples.
- These differences in sampling approaches between the seasons should be taken into account when assessing seasonal differences.

Note for Vertical Profile Turbidity, Temp, Salinity, pH and Chlorophyll-a.
- Dry-season data are based on near-continuous sampling by a YSI multi-sonde probe, lowered down the water column from surface to seabed, at 53 sites spread throughout CG at random stages of the tide, = 53 profiles (one at each of the 53 sites).
- Wet season data are based on near-continuous sampling by the same YSI multi-sonde probe, lowered down the water column from surface to seabed, every hour over 13 hours over a spring tidal cycle from low to high to low tide, at three fixed sites in CG, = 78 profiles.
- These differences in sampling approaches should be taken into account when assessing seasonal differences.
- The values for turbidity from the seabed in-situ sensors may be more suitable for comparing seasonal differences.

TABLE 10: *The five environmental values that are linked to MEQ and their relevance in CG.*

Environmental Value linked to MEQ	Relevance & situation in Cambridge Gulf
1. Ecosystem health:	Overall, it is assessed that the existing (baseline) MEQ of CG is in a natural condition and free of contaminants and pollutants, while suspended sediment concentrations and turbidity levels are naturally very high (see Table 9 and Figures 31 & 32) and chlorophyll levels are relatively low. The health of the biological communities that are present in CG, and especially the mangrove communities around the coast of CG and the marine species that they support, are dependent on the maintenance of this natural, uncontaminated condition.
2. Fishing & aquaculture:	Small private vessels from Wyndham and Kununurra use CG for recreational fishing along the coast and up the inlets of CG. One commercial gillnet fisherman is sometimes active in CG, targeting Barramundi (*Lates calcarifer*) and Threadfin Salmon (*Eleutheronema tetradactylum*). He also works the adjacent coast outside CG. Three commercial gillnet fishermen based in Broome located over 1,000 km by sea to the west are licenced to fish in CG but currently do not. The mangroves around the coast of CG are important habitat for mud crabs (*Scylla spp*). There are three commercial crab fishermen licenced to fish CG. Two are based in Broome and are not currently active in CG, and one is based in Port Headland and their licence is for sale. The mangroves around the coast of CG are important nursery areas for Banana prawns (*Penaeus indicus* and *P. merguiensis)*, although the adults are trawled in waters over 50 to 100 km offshore from CG. Both the recreational and commercial fishing sectors depend on the maintenance of the natural, uncontaminated condition of MEQ of CG to ensure the health of fish, crab and prawn stocks. There is currently no aquaculture in CG and no proposals to develop aquaculture in the foreseeable future. The extreme environmental conditions of CG including strong tidal currents and naturally very high turbidity levels most likely make aquaculture non-viable in CG.
3. Recreation and aesthetics:	The only recreational activity in CG is recreational fishing as addressed against point 2 above. There is no swimming or water sports in CG as the area is uninhabited by humans and due to the presence of crocodiles, river sharks, stinging jellyfish, strong tidal currents and naturally very high turbidity levels. While the surrounding coast and landward backdrop of CG have high aesthetic value due to the rugged natural beauty of the area, the aesthetic value of the marine environment is very low due to naturally very high turbidity levels – the local TO groups refer to the area as 'Brown Water Country' (Figures 31 and 32).
4. Industrial water supply:	There is currently no industry that requires water supply in CG and no proposals to develop any such industry in the foreseeable future.
5. Cultural and spiritual:	There are significant land-based Aboriginal cultural heritage sites on the eastern side of CG and on Lacrosse Island – which are not affected by MEQ. BKA has consulted with the TO groups about marine-based cultural heritage and undertook an extremely comprehensive survey for potential underwater Aboriginal cultural heritage, and found no indications of such (see Referral Report No. 3 - *Traditional Owners, Native Title & Aboriginal Cultural Heritage*). As outlined above the local TO groups refer to the area as 'Brown Water Country' due to the naturally very high turbidity levels (Figures 31 and 32).

FIGURE 31: *Suspended sediment concentrations and turbidity levels are naturally very high in CG, as shown in the wake of a vessel used by BKA for environmental survey work.*

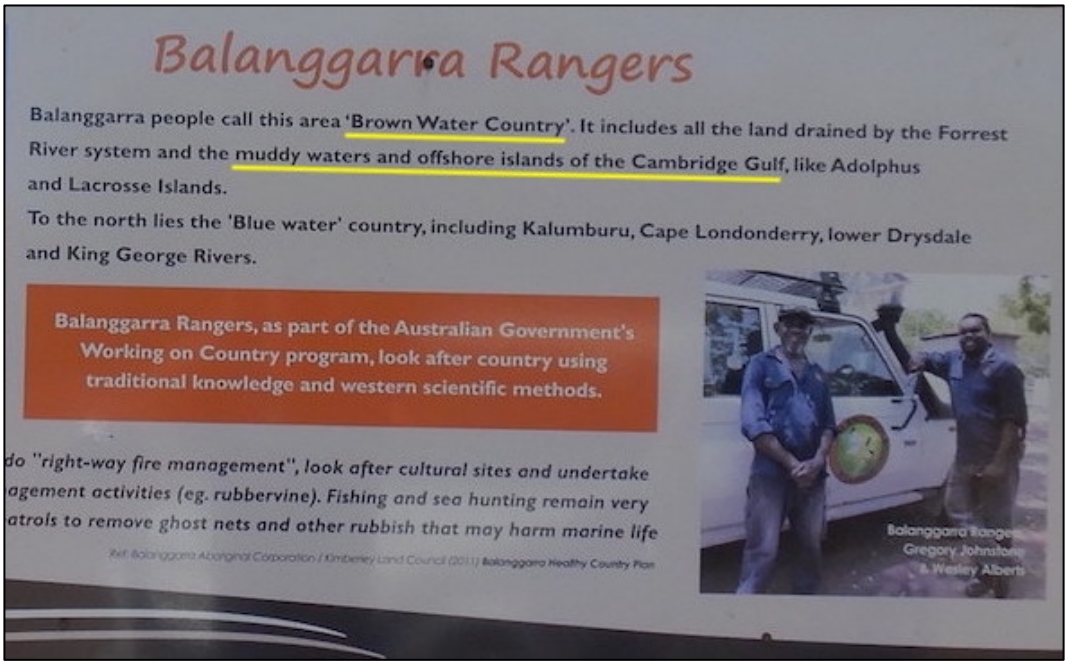


FIGURE 32: *An interpretive sign by the Balanggarra Indigenous Rangers at the Port of Wyndham public jetty, with reference to the area as 'Brown Water Country' and the 'muddy waters' of Cambridge Gulf.*

9.3 Impact Assessment

1. The proposal does not involve the construction and operation of any shore-based facilities or infrastructure that could be sources of contaminant inputs to the marine waters of CG, and there will be no waste streams from the operation of the SPV into the marine waters of CG.

2. There are three possible (but unlikely) mechanisms whereby the proposed operation could potentially affect MEQ and the supported environmental values in CG:

    a) potential mobilisation of any existing (pre-project) contaminants that might be present in the sand that might be disturbed and released when it is dredged,
    b) potential alteration of the suspended sediment and turbidity values in CG; and
    c) potential marine pollution from the SPV.

3. Each of these is assessed in sections 9.3.1 to 9.3.3 respectively. Section 9.3.4 assesses potential impacts on each of the five environmental values associated with MEQ, and section 9.3.5 assesses potential impacts within the EPA's EQMP / EQO framework, noting that the proposal does not involve the discharge of wastes, pollutants or contaminants, which limits the scope for an EQMP.

9.3.1 Potential mobilisation of any contaminants that might be present in the sand

1. As outlined in section 9.2 there is potential for inputs of chemical contamination to the receiving marine environment in GG via the Ord River from the Ord River Irrigation Scheme area, where chemical pesticides and fertilizers are used on farms. However, the agricultural area is located over 150 km upstream from CG and there are two dams on the Ord River between the agricultural area and CG. Contaminants are mainly carried attached to sediments, and as outlined above the two dams have interrupted sediment flow into CG, likely significantly reducing the potential for contaminants to be carried into CG via the Ord River.

2. Never-the-less, BKA sought to assess whether the sand that it proposes to extract from CG contains any contamination. The process of sand-sourcing could potentially physically disturb and mobilise any contaminants that might be present, causing them to be released into the surrounding waters and thus affect MEQ.

3. As outlined in section 9.2, in July 2023 BKA collected sediment samples from 21 sites within and round the proposed operational area as shown on Figure 33. All samples were collected in accordance the procedures set out in the Australian National Assessment Guidelines for Dredging (NAGD 2009), and sent to an ALS NATA accredited laboratory for analysis according to the NAGD procedures. Contaminants analysed for were:

    - Metals and metaloids:
        - Antimony.
        - Arsenic.
        - Cadmium.
        - Chromium.
        - Copper.
        - Lead.
        - Nickel.
        - Silver.
        - Zinc.
        - Mercury.

    - Total Petroleum Hydrocarbons (TPH):
        - C6 - C9 Fraction.
        - C10 - C14 Fraction.
        - C15 - C28 Fraction.
        - C29 - C36 Fraction.
        - C10 - C36 Fraction (sum).

    - Polynuclear Aromatic Hydrocarbons - Sum of PAHs.

    - Organotin Compounds -Tributyltin.

    - Polychlorinated biphenyls:
        - Total Polychlorinated biphenyls (PCBs).
        - Aroclors (1016, 1221, 1232, 1242, 1248, 1254 and 1260).

4. The analytical results from ALS are presented in Referral Report No. 2. All parameters for all samples returned below the NAGD screening levels or below limits of detection, indicating that the sediments are free of contamination.

5. Given that the sand in CG is highly dynamic and constantly re-worked and flushed by the strong tidal currents, it is unlikely to retain any contaminants.

6. *It is therefore assessed that there is no potential for impacts on the MEQ of CG from mobilisation of contaminants by the proposed sand-sourcing operation.*

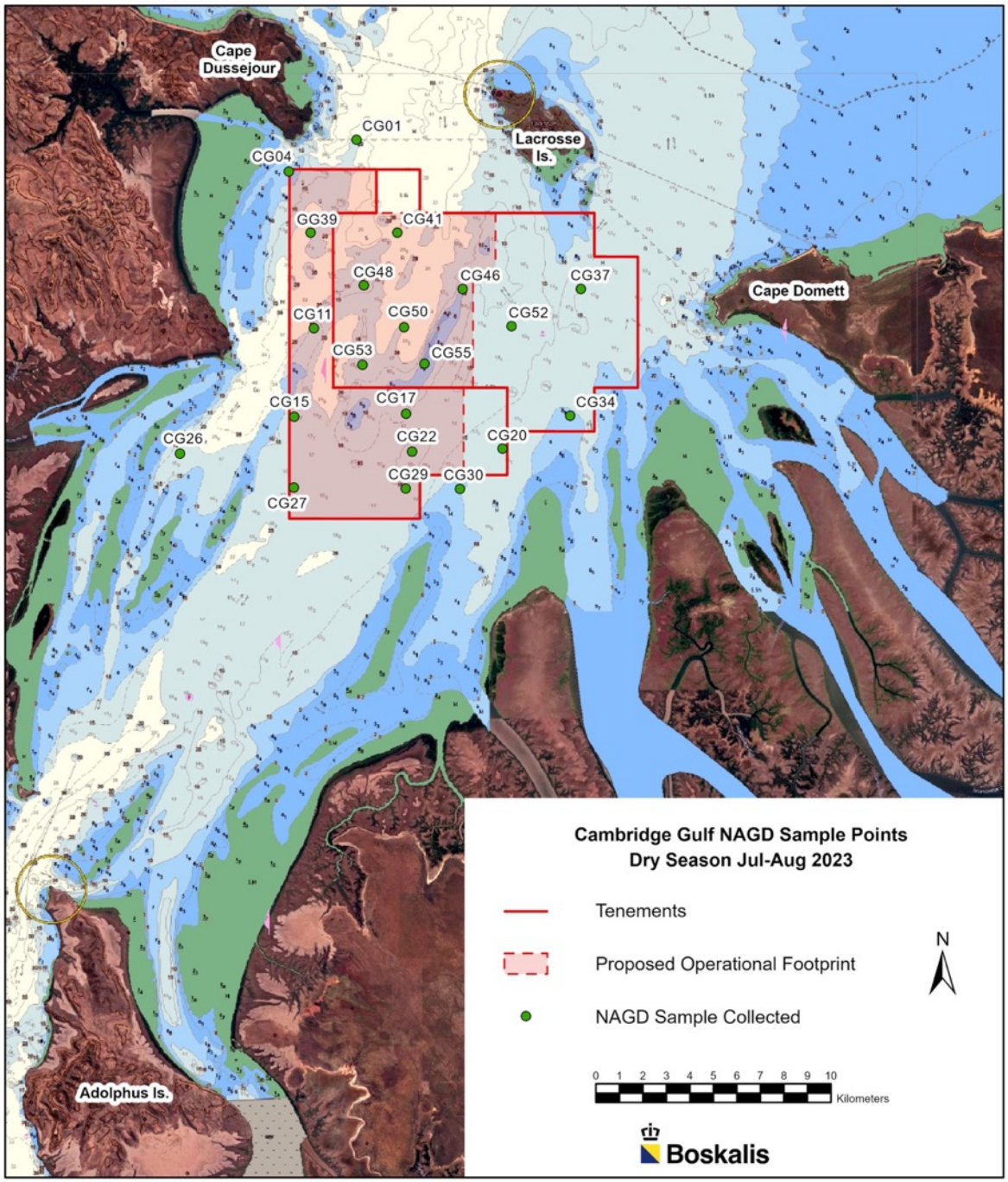


FIGURE 33: *The 21 sample points where sediment was collected for contamination assessment according to NAGD (2009).*

9.3.2 Potential alteration of the suspended sediment and turbidity values in CG

1. As outlined in the impact assessment for benthic communities and habitats in section 7.3.4, BKA assessed the generation of sediment plumes from the proposed operation, including applying relevant aspects of the *EPA Technical Guidance on Environmental Impact Assessment of Marine Dredging Proposals*. The findings summarized in section 7.3.4 are not repeated here for reasons of economy.

2. As outlined in section 7.3.4 and detailed in Referral Report No. 5 / PCS 2024a, these studies indicate that the proposed operation is unlikely to significantly alter the natural suspended sediment and turbidity values in CG, which are naturally extremely high and dynamic.

3. It is therefore assessed that there is no potential for impacts on the MEQ of CG from changes to suspended sediment and turbidity levels in CG from the proposed operation.

9.3.3 Potential marine pollution from the SPV

1. As outlined in the impact assessment for benthic communities and habitats in section 7.3.6 above, when operating in CG the SPV could be a potential source of marine pollution, which in turn could potentially impact on MEQ and the supported environmental values in CG.

2. The risk of such pollution will be avoided and minimized through the prevention and mitigation measures outlined for marine pollution in sections 7.3.6 and 7.4 above – which are not repeated here for reasons of economy. An oil spill risk assessment has been carried out as contained in Annex 2. The risk is very low and will be reduced further through best practice prevention and mitigation measures as outlined in section 7.4.

3. In the highly unlikely event of an oil spill from the SPV the environmental consequences would likely be low and would not be permanent or irreversible, as outlined in sections 7.3.6 and 7.4.

4. It is assessed that the proposed operation is unlikely to cause marine pollution that would significantly impact on MEQ and the supported environmental values in CG.

9.3.4 Potential impacts on environmental values linked to marine environmental quality

1. Table 11 assess potential impacts of the proposal on the five environmental values that are linked to MEQ as described in Table 10 in section 9.2 above, taking into consideration the nature and relevance each environmental value in CG as presented in Table 10.

2. As presented in Table 11 it is assessed that the proposal will not impact on any of the five environmental values as the proposal will not change the MEQ of the area, and some of the values are not relevant to CG, as follows:

    a) Aquaculture: There is currently no aquaculture in CG and no proposals to develop aquaculture in the foreseeable future. The extreme environmental conditions of CG including strong tidal currents and naturally very high turbidity most likely make aquaculture non-viable in CG

    b) Recreation: Other than recreational fishing there are no other recreational uses such as swimming or water sports in CG, as the area is uninhabited by humans and due to the presence of crocodiles, river sharks, stinging jellyfish, strong tidal currents and naturally very high turbidity.

    c) Aesthetics: The aesthetic value of the marine environment is very low due to naturally very high turbidity – the local TO groups refer to the area as ‘Brown Water Country’ (Figures 31 and 32).

    d) Industrial water supply: There is currently no industry that requires water supply in CG and no proposals to develop any such industry in the foreseeable future.

    e) Cultural and spiritual: Comprehensive assessment including consultation with TOs and field surveys have not identified cultural or spiritual values that could be impacted by changes in MEQ.

TABLE 11: *Potential impacts of the proposal on environmental values that are linked to MEQ.*

Environmental Value linked to MEQ	Potential impacts of the proposal
1. Ecosystem health:	The proposal will not impact on ecosystem health as it will not cause any changes to MEQ for the following reasons: – The proposal does not involve the construction and operation of any shore-based facilities or infrastructure that could be sources of contaminant inputs to CG. – There are no waste streams from the operation of the SPV into CG. – The operation will not cause mobilization of contaminants in the dredged sand, as sampling according to NAGD (2009) indicates that the sand is free of contaminants (Referral Report No. 2). – The proposed operation is unlikely to significantly alter the natural suspended sediment and turbidity values in CG, which are naturally extremely high and dynamic. The ecosystem health and biota of CG are already highly adapted to and limited by the naturally extremely high suspended sediment and turbidity levels, and there are no sediment- and turbidity-sensitive ecological communities in the LAU. – The potential risk of marine pollution from the SPV will be addressed through the impact avoidance (prevention) and minimization (mitigation) measures outlined in section s 7.3.6 and 7.4.
2. Fishing & aquaculture:	The proposal will not impact on recreational and commercial fishing through changes to MEQ for the same reasons outlined for ecosystem health above – ecosystem health upon which fishing depends will not be impacted. The proposal will not impact on aquaculture through changes to MEQ as it is assessed that the proposal will not change the MEQ of the area, and there is currently no aquaculture in CG and no proposals to develop aquaculture in the foreseeable future. The extreme environmental conditions of CG including strong tidal currents and naturally very high turbidity levels most likely make aquaculture non-viable in CG.
3. Recreation and aesthetics:	The only recreational activity in CG is recreational fishing and this will not be impacted as addressed against point 2 above. The proposal will not impact on other recreational values as it is assessed that the proposal will not change the MEQ of the area, and there are no other recreational uses such as swimming or water sports in CG, as the area is uninhabited by humans and due to the presence of crocodiles, river sharks, stinging jellyfish, strong tidal currents and naturally very high turbidity. The proposal will not impact on aesthetics of the marine area as it is assessed that the proposal will not change the MEQ of the area, and the aesthetic value of the marine environment is very low due to naturally very high turbidity – the local TO groups refer to the area as 'Brown Water Country' (Figures 31 and 32).
4. Industrial water supply:	The proposal will not impact on industrial water supply as it is assessed that the proposal will not change the MEQ of the area, there is currently no industry that requires water supply in CG and no proposals to develop any such industry in the foreseeable future.
5. Cultural and spiritual:	The proposal will not impact on cultural and spiritual values as it is assessed that the proposal will not change the MEQ of the area, and BKA has consulted with the TO groups about marine-based cultural heritage and undertook an extremely comprehensive survey for potential underwater Aboriginal cultural heritage, and found no indications of such (see Referral Report No. 3 - *Traditional Owners, Native Title & Aboriginal Cultural Heritage*). As outlined above the local TO groups refer to the area as 'Brown Water Country' due to the naturally very high turbidity (Figures 31 and 32).

9.4 Application of the Mitigation Hierarchy & Assessment of Residual Impacts

1. There are four sequential levels in the EPA impact mitigation hierarchy:

    a) Avoid (prevent) impacts.
    b) Minimise (mitigate) impacts.
    c) Rehabilitate impacts.
    d) Offset impacts.

2. Table 12 presents the mitigation hierarchy applied to MEQ and the environmental values that are supported by MEQ. Table 8 lists the main potential impact for each value as discussed above, identifies relevant impact avoidance, minimisation, rehabilitation and offset measures and assesses the predicted residual impacts for each.

6. Overall, as outlined above and summarised in Table 12, potential impacts on MEQ and associated values will be avoided and prevented because the proposed operation will not cause any significant changes to MEQ in CG.

7. For most potential impacts, impact minimization / mitigation is not required as impacts will be fully avoided / prevented. Because the proposal is unlikely to cause significant primary impacts, there will not be any residual impacts.

8. There is a low potential for residual impacts from a possible accidental oil spill, and this is addressed through the same measures as outlined for potential marine pollution impacts on benthic communities in sections 7.3.6 and 7.4 above.

TABLE 12: *Mitigation hierarchy & assessment of residual impacts for MEQ*

Environmental Value linked to MEQ	**Potential Impact of the proposal**	**Impact Avoidance / Prevention**	**Impact Minimization / Mitigation**	**Rehabilitation & Offsets**	**Residual Impacts**
1. *Ecosystem health:*	Potential mobilisation of any contaminants that might be present in the sand.	Impacts will be avoided / prevented because there are no contaminants in the sand.	Impact minimization / mitigation is not required as impacts will be fully avoided / prevented.	Rehabilitation is not required as impacts will be fully avoided / prevented. Offsets are not required as impacts will be fully avoided / prevented.	None as there will not be any primary impacts.
	Potential alteration of the suspended sediment and turbidity values in CG.	Impacts will be avoided / prevented because the proposed operation is unlikely to significantly alter the natural suspended sediment and turbidity values in CG, which are naturally extremely high and dynamic.	While primary impacts will not be significant, potential sediment plumes from the SPV will be futrher reduced by key factors that differentiate the proposed operation from conventional dredging, as detailed for benthic communities in Table 6 in section 7.4, including: – Zero activity in CG for 86% of the time. – Avoidance of turbidity-causing fine silts. – No dumpling. – SPV green-valve (refer Annex 3).	Rehabilitation is not required as impacts will be fully avoided / prevented. Offsets are not required as impacts will be fully avoided / prevented.	None as there will not be any primary impacts.
	Potential marine pollution from the SPV.	Impacts will be avoided / prevented through the measures outlined for potential impacts of marine pollution on benthic communities in Table 6 in section 7.4. These are not repeated here for reasons of economy.	As per the measures outlined for potential impacts of marine pollution on benthic communities in Table 6 in section 7.4. These are not repeated here for reasons of economy.	As per Table 6 in section 7.4.	As per Table 6 in section 7.4.
2. *Fishing & aquaculture:*	Potential mobilisation of any contaminants that might be present in the sand.	As per response to Value 1 – no impacts on fishing. There is no aquaculture or plans for aquaculture in CG.	Impact minimization / mitigation is not required as impacts will be fully avoided / prevented.	Not required	None.
	Potential alteration of the suspended sediment and turbidity values in CG.	As per response to Value 1 – no impacts on fishing. No impacts on aquaculture as there is no aquaculture or plans for aquaculture in CG.	Impact minimization / mitigation is not required as impacts will be fully avoided / prevented.	Not required	None.

Environmental Value linked to MEQ	**Potential Impact of the proposal**	**Impact Avoidance / Prevention**	**Impact Minimization / Mitigation**	**Rehabilitation & Offsets**	**Residual Impacts**
	Potential marine pollution from the SPV.	Impacts will be avoided / prevented through the measures outlined for potential impacts of marine pollution on benthic communities in Table 6 in section 7.4. These are not repeated here for reasons of economy.	As per the measures outlined for potential impacts of marine pollution on benthic communities in Table 6 in section 7.4. These are not repeated here for reasons of economy.	As per Table 6 in section 7.4.	As per Table 6 in section 7.4.
3. ***Recreation and aesthetics:***	Potential mobilisation of any contaminants that might be present in the sand.	The only recreational activity is fishing – no impacts as per value 2.	Impact minimization / mitigation is not required as impacts will be fully avoided / prevented.	Not required	None.
	Potential alteration of the suspended sediment and turbidity values in CG.	The only recreational activity is fishing – no impacts as per value 2.	Impact minimization / mitigation is not required as impacts will be fully avoided / prevented.	Not required	None.
	Potential marine pollution from the SPV.	Impacts will be avoided / prevented through the measures outlined for potential impacts of marine pollution on benthic communities in Table 6 in section 7.4. These are not repeated here for reasons of economy.	As per the measures outlined for potential impacts of marine pollution on benthic communities in Table 6 in section 7.4. These are not repeated here for reasons of economy.	As per Table 6 in section 7.4.	As per Table 6 in section 7.4.
4. ***Industrial water supply:***	Potential mobilisation of any contaminants that might be present in the sand.	Impacts will be avoided / prevented as there is no industrial water supply or plans for industrial water in CG.	Impact minimization / mitigation is not required as there is no industrial water supply or plans for industrial water in CG.	Not required	None.
	Potential alteration of the suspended sediment and turbidity values in CG.	Impacts will be avoided / prevented as there is no industrial water supply or plans for industrial water in CG.	Impact minimization / mitigation is not required as there is no industrial water supply or plans for industrial water in CG.	Not required	None.
	Potential marine pollution from the SPV.	Impacts will be avoided / prevented as there is no industrial water supply or plans for industrial water in CG.	Impact minimization / mitigation is not required as there is no industrial water supply or plans for industrial water in CG.	Not required	None.
5. ***Cultural and spiritual:***	Potential mobilisation of any contaminants that might be present in the sand.	Impacts will be avoided / prevented as no spiritual or cultural values have been identified for marine areas in CG.	Impact minimization / mitigation is not required as no spiritual or cultural values have been identified for marine areas in CG. The proposal will not change MEQ in a way that would impact on such values if they were present.	Not required	None.

Environmental Value linked to MEQ	**Potential Impact of the proposal**	**Impact Avoidance / Prevention**	**Impact Minimization / Mitigation**	**Rehabilitation & Offsets**	**Residual Impacts**
		The proposal will not change MEQ in a way that would impact on such values if they were present.			
	Potential alteration of the suspended sediment and turbidity values in CG.	Impacts will be avoided / prevented as no spiritual or cultural values have been identified for marine areas in CG. The proposal will not change MEQ in a way that would impact on such values if they were present.	Impact minimization / mitigation is not required as no spiritual or cultural values have been identified for marine areas in CG. The proposal will not change MEQ in a way that would impact on such values if they were present.	Not required	None.
	Potential marine pollution from the SPV.	Impacts will be avoided / prevented as no spiritual or cultural values have been identified for marine areas in CG. The proposal will not change MEQ in a way that would impact on such values if they were present.	Impact minimization / mitigation is not required as no spiritual or cultural values have been identified for marine areas in CG. The proposal will not change MEQ in a way that would impact on such values if they were present.	Not required	None.

9.5 Likely Environmental Outcomes

1. The likely environmental outcomes with regard to MEQ at the end of the 15-year project timeframe are assessed as follows:

    a) the proposed operation is unlikely to cause any changes in the level of contaminants in water, sediments or biota or any changes in the physical or chemical properties of waters and sediments relative to the natural state in CG; and

    b) the proposed operation is therefore unlikely to cause any significant impact on MEQ and the supported environmental values in CG.

9.6 EQMP / EQO Framework

1. The scope to develop a full EQMP / EQO framework for the proposed operation in CG is influenced by the following factors:

    a) the receiving environment in CG is free of contaminants and pollutants, with no significant sources of potential contamination along the immediate coastline or in the broader catchment,

    b) the overall objective should be to maintain this state,

    c) the proposed operation is unlikely to cause any changes in the level of contaminants in water, sediments or biota or any changes in the physical or chemical properties of waters and sediments relative to the natural state in CG, simplifying the ability to achieve the overall objective of maintaining the current state; and

    d) the proposal will not impact on any of the five environmental values and some of the values are not relevant to CG, as outlined in section 9.3.4.

2. Table 13 lists the five environmental values and their respective EQO options as listed in EPA 2016, *Technical Guidance - Protecting the Quality of Western Australia's Marine Environment*, and assesses how the proposal relates to each of these. This shows that:

    a) The maximum EQO for ecosystem health to *maintain ecosystem integrity at a maximum level of ecological protection* is desirable and should be possible to achieve by the proposal.

    b) The EQO for fishing that *seafood (caught or grown) is of a quality safe for eating* is desirable and should be possible to achieve by the proposal.

    c) The EQO for secondary contact recreation (fishing and boating) that *water quality is safe for secondary contact recreation* is desirable and should be possible to achieve by the proposal.

    d) The EQOs for aquaculture, primary contact recreation, aesthetics, industrial water supply and cultural and spiritual values are not relevant in CG, however the proposal would not change MEQ in any way that would affect these EQOs.

3. These factors can be used as a basis to build a more developed EQMP framework for CG, which should ideally be done in consultation with relevant agencies and stakeholders than by BKA alone, should the project proceed toward approval and implementation.

TABLE 13: *The five environmental values and the respective EQO options for each as listed in EPA 2016, Technical Guidance - Protecting the Quality of Western Australia's Marine Environment, and how the proposal relates to each of these.*

Environmental Value linked to MEQ	Environmental Quality Objective (EQO) Options (from EPA 2016)	Assessment in Relation to the Proposal
Ecosystem health:	*Maintain ecosystem integrity at a maximum level of ecological protection.*	This EQO is desirable and should be possible as: – the receiving environment in CG is free of contaminants and pollutants, with no significant sources of potential contamination along the immediate coastline or in the broader catchment; and – the proposed operation is unlikely to cause any changes in the level of contaminants in water, sediments or biota or any changes in the physical or chemical properties of waters and sediments relative to the current natural state in CG, simplifying the ability to achieve this EQO and maintain the current state.
	Maintain ecosystem integrity at a high levelof ecological protection.	The EQO above is recommended for ecosystem health.
	Maintain ecosystem integrity at a moderatelevel of ecological protection.	The EQO above is recommended for ecosystem health.
	Maintain ecosystem integrity at a low level of ecological protection.	The EQO above is recommended for ecosystem health.
Fishing & aquaculture:	*Seafood (caught or grown) is of a quality safe for eating.*	Fish and mud crabs are caught and eaten from CG. This EQO is desirable and should be possible as the proposed operation is unlikely to cause any changes in MEQ that would affect the quality and safety of seafood in CG.
	Water quality is suitable for aquaculture.	Not relevant as there is currently no aquaculture in CG and no proposals to develop aquaculture in the foreseeable future. The extreme environmental conditions of CG including strong tidal currents and naturally very high turbidity levels most likely make aquaculture non-viable in CG. In any case the proposal will not change water quality in any way that would make it any less suitable for aquaculture.
Recreation and aesthetics:	*Water quality is safe for primary contact recreation (e.g. swimming and diving).*	Not relevant as there is no primary contact recreation in CG, as the area is uninhabited by humans and due to the presence of crocodiles, river sharks, stinging jellyfish, strong tidal currents and naturally very high turbidity. In any case the proposal will not change water quality in any way that would make it any more unsuitable for primary contact recreation.
	Water quality is safe for secondary contact recreation (e.g. fishing and boating).	Fishing and boating is the only marine recreational activity in CG. This EQO is desirable and should be possible as the proposed operation is unlikely to cause any changes in water quality that would affect secondary contact recreation.
	Aesthetic values of the marine environmentare protected.	Not relevant as the aesthetic value of the marine environment is low due to naturally very high turbidity – the local TO groups refer to the area as 'Brown Water Country' In any case the proposal will not change water quality in any way that would reduce aesthetic values.

Environmental Value linked to MEQ	**Environmental Quality Objective (EQO) Options** (from EPA 2016)	**Assessment in Relation to the Proposal**
Industrial water supply:	*Water quality is suitable for industrial use.*	Not relevant as there is currently no industry that requires water supply in CG and no proposals to develop any such industry in the foreseeable future. In any case the proposal will not change water quality in any way that would make it unsuitable for industrial use.
Cultural and spiritual:	*Cultural and spiritual values of the marine environment are protected.*	Not relevant as BKA has consulted with the TO groups about marine-based cultural heritage and undertook an extremely comprehensive survey for potential underwater Aboriginal cultural heritage, and found no indications of such. In any case the proposal will not change MEQ in any way that would impact on any cultural and spiritual values.

9.7 Assessment Against EPA Significant Impact Criteria

1. As outlined in section 3.1 the terms 'significant impact' and 'significant effect' are not defined in the EP Act, however the EPA's *Statement of Environmental Principles, Factors & Objectives* (EPA 2018) states that when considering significant impact or effect, the EPA may have regard to various matters, as listed in section 3.1, amongst others.

2. In order to assist in assessing whether the proposal will cause significant impacts on MEQ, Table 14 presents an assessment against each of the criteria listed in the EPA's *Statement of Environmental Principles, Factors & Objectives.*

TABLE 14: *Assessment of potential impacts on MEQ against EPA significant impact criteria*

*****From *Statement of Environmental Principles, Factors & Objectives* (EPA 2018)

EPA Significant Impact Criteria*	MEQ Assessment
1. Values, sensitivity and quality of the environment which is likely to be impacted:	The receiving environment in CG is free of contaminants and pollutants, with no significant sources of potential contamination along the immediate coastline or in the broader catchment. Only two of the environmental values that are linked to MEQ are fully relevant in CG – ecosystem health and fishing (both commercial and recreational – both in very low intensities). Aquaculture, primary contact recreation, industrial water supply and marine cultural and spiritual values do not feature in CG.
2. Extent (intensity, duration, magnitude and geographic footprint) of the likely impacts:	The proposed operation is unlikely to cause any changes in the level of contaminants in water, sediments or biota or any changes in the physical or chemical properties of waters and sediments relative to the current natural state in CG,
3. Consequence of the likely impacts (or change):	As per 2 above.
4. Resilience of the environment to cope with the impacts or change:	The environment of CG is naturally resilient as it is adapted to extreme conditions and constant change, including a high tidal range of up to 8 m, strong tidal currents which can exceed 2 m/s (4 knots), constantly moving seabed sediments, very high natural turbidity and total lack of light at the seabed, and frequent exposure to tropical cyclones (see Referral Report No 5 / PCS 2024a, b & c).
5. Cumulative impact with other existing or reasonably foreseeable activities, developments and land uses connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment:	As per response to this item in Table 4 in section 7.7 above – there is very low potential for cumulative impact given the lack of other developments and activity and in CG.
6. Level of confidence in the prediction of impacts and the success of proposed mitigation:	BKA has sought to achieve as much scientific certainty as possible by supporting the impact assessments with a very comprehensive suite of data from both its own data collection campaigns, including in both the dry and wet seasons, and from external sources and previous studies of the area, as outlined in section 5 and Annex 1. Hydro- and sediment dynamics assessments and modelling are strongly supported by comprehensive field data and are extremely well calibrated and validated, and have been subject to independent peer review (see Referral Report No. 5). BKA has an ongoing data collection program in place and should the proposal be approved and proceed, BKA proposes to also implement a comprehensive environmental research and monitoring program, in cooperation with TOs and other relevant partners, as described in section 17.
7. Public interest about the likely effect of the proposal, if implemented, on the environment, and public information that informs the EPA's assessment:	As per response to this item in Table 4 in section 7.7 above – BKA has undertaken a comprehensive stakeholder engagement and consultation program which will be ongoing. No major objections to the proposal have been raised to date and some stakeholders support the proposal, including the two TO groups who have issued letters of support. See Table 4 above and Referral Report No. 6 - *Stakeholder Engagement & Consultations* and No. 3 - *Traditional Owners, Native Title & Aboriginal Cultural Heritage.*

10. IMPACT ASSESSMENT - MARINE FAUNA

10.1 Relevant EPA Guidance & Objective

1. The EPA has published one guidance document relating to marine fauna - EPA 2016, *Environmental Factor Guideline - Marine Fauna*. The Guideline defines marine fauna as:

   - *Animals that live in the ocean or rely on the ocean for all or part of their lives.*

2. This definition is extremely broad and includes animals ranging in size from microscopic zooplankton to the blue whale. While benthic animals that are attached to the seabed such as corals, sponges etc are also marine fauna, they are typically considered under the environmental factor of *Benthic Communities and Habitats*, as presented in section 7. Therefore, for the purposes of this assessment, marine fauna includes all marine animals that are not attached to the seabed.

3. The Objective for marine fauna is:

   - *To protect marine fauna so that biological diversity and ecological integrity are maintained*.

4. In the context of this objective e*cological integrity* is the composition, structure, function and processes of ecosystems, and the natural variation of these elements. This acknowledges the importance of protecting marine fauna for their ecological roles. The EPA also recognises the iconic nature of many marine animals including traditional aboriginal cultural usage. The larger species can be seen by many as indicators of the 'health' of the marine environment.

5. The guideline requires impact assessments to consider both *direct* and *indirect* impacts on marine fauna, as well as links to potential impacts on *critical habitats* upon which the fauna are dependent, and temporal / seasonal patterns and *key ecological windows*, such as breeding, spawning, feeding or migration periods.

6. The guideline states that the EPA is focussed on 'significant' impacts to marine fauna, and lists some examples of what can be considered as 'significant', as follows:

   a) harm to individuals and/or declines in the population or the range of species protected under state legislation,
   b) reductions in populations of species of local and regional importance,
   c) impacts to species or groups of species that fulfil critical ecological functions within the ecosystem,
   d) loss or impact to critical marine fauna habitat, including habitats such as nesting beaches, nursery areas, sea lion haul out areas, specific foraging or breeding areas, and fish spawning aggregation areas
   e) reduction in species diversity in an area, which may be due to factors such as migration or range contraction resulting from a decline in the quality of the local environment
   f) introduction and/or spread of invasive marine species or diseases.

7. BKA has addressed these points in the impact assessments in section 10.3 below.

10.2 Receiving Environment

1. A detailed description of the receiving environment with respect to marine fauna is presented in Referral Report No. 2 - *Proposal Setting & Existing Environmental Descriptions*. This includes the dry- and wet-season marine mega-fauna (MMF) surveys commissioned by BKA in July 2023 and February 2024. Detailed description is not repeated here for reasons of economy, and this section provides a summary only.

2. Dugong (*Dugong dugong*) are not found in CG due to lack of food-source (seagrasses), the MMF surveys commissioned by BKA did not observe any Dugong, and the local TOs, DBCA staff and commercial fisherman with over 20-years of experience in CG all advise that Dugong are not seen in CG.

3. The CG area provides habitat for a range of marine fauna species, including some significant protected species, including:

   a) Australian Snubfin Dolphin (*Orcaella heinshoni*): Snubfin Dolphins inhabit turbid inshore waters, bays and estuaries, and CG is within a Commonwealth-defined breeding, calving, foraging and resting Biologically Important Area (BIA) for this species (Figure 34). BKA commissioned an nine-day MMF survey covering over 800 km of transects throughout CG in February 2024 which recorded four sightings, and am eight-day survey in July 2023 also covering over 800 km of transects which recorded 12 sightings. In both surveys most sightings were in the southern part of CG towards and around Adolphus Island, which is 20 km south of the closest (southern) boundary of the proposed operational area, although two and three sightings were in the proposed operational area for each survey respectively (full results are in Referral Report No. 2).

The main local commercial fisherman who has over 20-years of experience working in CG, confirmed that Snubfins are mostly seen near and around Adolphus Island (Douglas pers comms 2024). This may be where their preferred food source is located - small fish, crustaceans and cephalopods (Marshe et al 1989). However, there were two and three sightings in the proposed operational area in the 2024 and 2023 surveys respectively, so they do appear to pass through this area. Douglas (pers. comms 2024) also advised that there is a marked reduction in sightings of Snubfin Dolphins in CG in the wet season, as per the BKA surveys, as they seem to move to other areas, possibly offshore away from the wet season freshwater and terrestrial sediment inputs.

A nine-day survey over a much larger area than CG in August 2016 by Brown et al (2016) recorded 34 sightings, mainly near Cape Dussejour and outside of CG, and none in the proposed operational area. The number of sightings cannot be directly compared to the BKA surveys as in addition to CG, they also surveyed out into Joseph Bonaparte Gulf and 50 kms westward along the coast to the Berkley River and up that river.

It should be noted that for all surveys, different sightings could possibly be the same individual(s), so the actual number of dolphins may be less than the number of sightings. This indicates that the population of Snubfins within CG could be in the order of less than 10 individuals or a few tens at most. These numbers are extremely low compared to other sites such as Roebuck Bay at Broome with an estimated population of ~130 Snubfin Dolphins (DBCA 2024), and other areas with higher numbers such as Cone Bay and Cygnet Bay in the West Kimberley (Brown et al 2016). This may be reflective of the extreme environmental conditions in CG, which may not be as suitable for this species as the areas further west, where waters are less turbid and food sources more abundant.

b) Australian Humpback Dolphin (*Sousa sahulensis*). Like Snubfins this species also inhabits inshore waters, and CG is within their overall geographical range. BKA's survey in February 2024 recorded one sighting just to the north of the proposed operational area, towards Cape Dussejour, and the survey in July 2023 had no sightings. The broader-area survey in August 2016 by Brown et al (2016) recorded 42 sightings, mostly near Cape Dussejour and outside and to the west of CG, and none in the proposed operational area. There is an area of expansive inter-tidal sand-banks along the coast just south of Cape Dussejour, and Humpback Dolphins are known to target such areas for feeding (Parra & Jefferson 2017), which may be why most sightings have been in that area. As above, for all surveys different sightings could possibly be the same individual(s), so the actual number of dolphins may be less than the number of sightings. These numbers are quite low considering that typical local area population sizes for Humpback Dolphins average ~50 to 90 individuals (based mainly on Queensland data due to lack of published studies in WA to date) (Parra & Cagnazzi 2016).

c) Flatback Turtle *(Natator depressus):* There is a globally significant 2 km-long nesting beach for Flatback Turtles on the seaward side of Cape Domett to the east of CG, 12 km east of the closest (eastern) boundary of the proposed operational area. Cape Domett Beach is estimated to host over 3,000 nesting turtles annually, with peak nesting in July-September, which contrasts with the west coast of WA where nesting is in the summer months (Whiting et al 2008).

d) The WA Department of Biodiversity Conservation & Attractions (DBCA) in cooperation with the local Traditional Owners (TOs) has been monitoring turtle besting at the Cape Domett Seaward Beach annually since 2012, for around 14 nights each year starting in the first week of August in the peak of the nesting season. The data from this monitoring was provided to BKA by DBCA for analysis. The 11-year period 2013-2022 was analysed, with 2012 being excluded due to non-standard survey design. Over that period a total of 6,844 Flatback and 12 Green turtle track sets were observed at the Cape Domett Seaward Beach. This equates to an average of 626 Flatback track sets per year (noting that the survey periods were not always 14 nights, only 13 nights were surveyed in 2013 and 2014 and only 7 nights in 2021). The highest recorded overnight track count was 223 in 2019. The average overnight flatback turtle track counts were similar across the entire survey period, with a highest mean count of 63.4 in 2021 and lowest of 27.4 in 2014 (Price & Raaymakers 2024 in Referral Report No. 2).

e) Aerial drone and coastal surveys by BKA in July 2023 also mapped Flatback Turtle nesting (in much lower numbers than at Cape Domett) at Turtle Beach West on the seaward coast of Cape Dussejour, at Turtle Bay on the NW side of Lacrosse Island and at Barnett Point within CG (Figure 35). At Barnett Point the turtle nesting occurs on sand ridges (cheniers) located behind mangroves, and not on an open beach.

f) As outlined in section 8.2, one-off aerial drone surveys off these turtle nesting sites in July 2023, near peak nesting period, assessed turtle tracks and nests from high resolution imagery along the full length of each site, with the following results (1 track set = upward and downward track = one nesting attempt) (see Referral Report No. 2 for details):

- Cape Domett Seaward Beach: 449 track sets / 190 nests.
- Cape Domett Small Beach: 7 track sets / 7 nests.
- Turtle Beach West (Cape Dussejour): 34 track sets / 28 nests.
- Turtle Bay (Lacrosse Island): 6 track sets / 6 nests.
- East Bank Point (Barnett Point): 82 track sets / 13 nests.

g) Studies on the Pilbara Coast of WA indicate that the inter-nesting area for Flatback Turtles in that region can range from 3.4 to 60 km from the nesting beach (Whittock et al 2014), with an average inter-nesting interval of around 13 days (Thums et al 2019), during which female turtles rest on the seabed before coming ashore for subsequent nesting efforts. Based on this, the then Commonwealth Department of the Environment & Energy (now DCCEEW) designated an inter-nesting 'buffer' BIA over a 60 km radius around Cape Domett and Lacrosse Island, which includes the proposed operational area in CG (Commonwealth of Australia 2017) (Figures 36 & 37). This is discussed further in the impact assessment for Flatback Turtles in section 10.3.2 below.

a) Green Turtle (*Chelonia mydas*): There is a broadly defined foraging BIA for this species offshore from CG in Joseph Bonaparte Gulf, which will not be impacted by the proposal (Figure 38). No food sources for this species (seagrass, macroalgae etc) are present in CG, and there are no recorded observations in CG (see Referral Report No. 2).

b) Olive Ridley Turtle (*Lepidochelys olivacea*): There is a broadly defined foraging BIA for this species offshore from CG in Joseph Bonaparte Gulf, which will not be impacted by the proposal (Figure 39). This species mainly feeds on molluscs which are generally not present in CG, and there are no recorded observations in CG.

c) Saltwater Crocodile *(Crocodylus porosus):* Saltwater Crocodiles inhabit CG, especially up the rivers and inlets, with the highest numbers being present up the lower Ord River, over 35 km upstream from the proposed operational area (Kay 2004, Taylor pers, comms. 2024).

d) Sawfish (3 x *Pristis spp* and *Anoxypristis cuspidata):* Sawfish are large, shark-like rays with saw-like tooth-studded snouts (rostra) that inhabit warm, shallow, coastal waters, estuaries and rivers. The upstream areas of the rivers and creeks that discharge into CG provide habitat that may be suitable for the four species of Sawfish that occur in northern WA waters – the Freshwater (also called Largetooth) Sawfish *Pristis pristis*, the Green Sawfish *P. zijsron*, the Dwarf Sawfish *P. clavata* and the Narrow Sawfish *Anoxypristis cuspidata*. However, no previously published papers, reports or verifiable data could be found confirming their presence in CG. BKA commissioned eDNA sampling throughout CG and up the rivers and creeks in February 2024, and found trace DNA evidence of the presence of the Narrow Sawfish *Anoxypristis cuspidae* at one site ~8 km upstream in the Lyne River on the western side of CG, but not at other sites.

e) River Sharks *(Glyphis spp):* Two species of river sharks; the Speartooth Shark (*Glyphis glyphis*) and the Northern River Shark (*G. garricki*) have been found in the Lower Ord River over 30 km upstream of the proposed operational area (Kyne online, no published reports or papers found). The eDNA sampling commissioned by BKA as cited above did not detect DNA evidence of river sharks at any sites in CG itself or in upstream areas on both the west and east side of CG.

f) Boney fishes: The waters of CG overall and especially the mangrove-lined coast and inlets provide habitat for a range of fish species that are typically found in such areas, including Barramundi (*Lates calcarifer*) and Threadfin Salmon (*Eleutheronema tetradactylum*), that are targeted by both commercial and recreational fishermen. Environmental surveys and stakeholder consultations as detailed in Referral Report No. 3 indicate that the proposed operational area does not provide suitable habitat for benthic or demersal fishes or support populations of such, due to the nature of the substrate (highly dynamic sand waves), strong tidal currents, lack of seabed light and lack of food sources for fishes.

g) Mud Crabs (*Scylla spp*): The mangrove-lined coast and inlets around CG provide habitat for Mud Crabs.

h) Prawns: The mangrove-lined coast and inlets around CG provide nursery areas for Red Legged Banana Prawns (*Penaeus indicus*) and White Banana Prawns (*P. merguiensis*) (Loneragan et al 2002). Banana prawns are flushed seaward from upstream mangrove areas during wet seasons rains and migrate offshore into Joseph Bonaparte Gulf – where the adults are targeted by the trawl fishery approximately 100 k offshore from CG.

4. See Referral Report No. 2 - *Proposal Setting & Existing Environmental Descriptions* for a more detailed description of the marine fauna of CG.

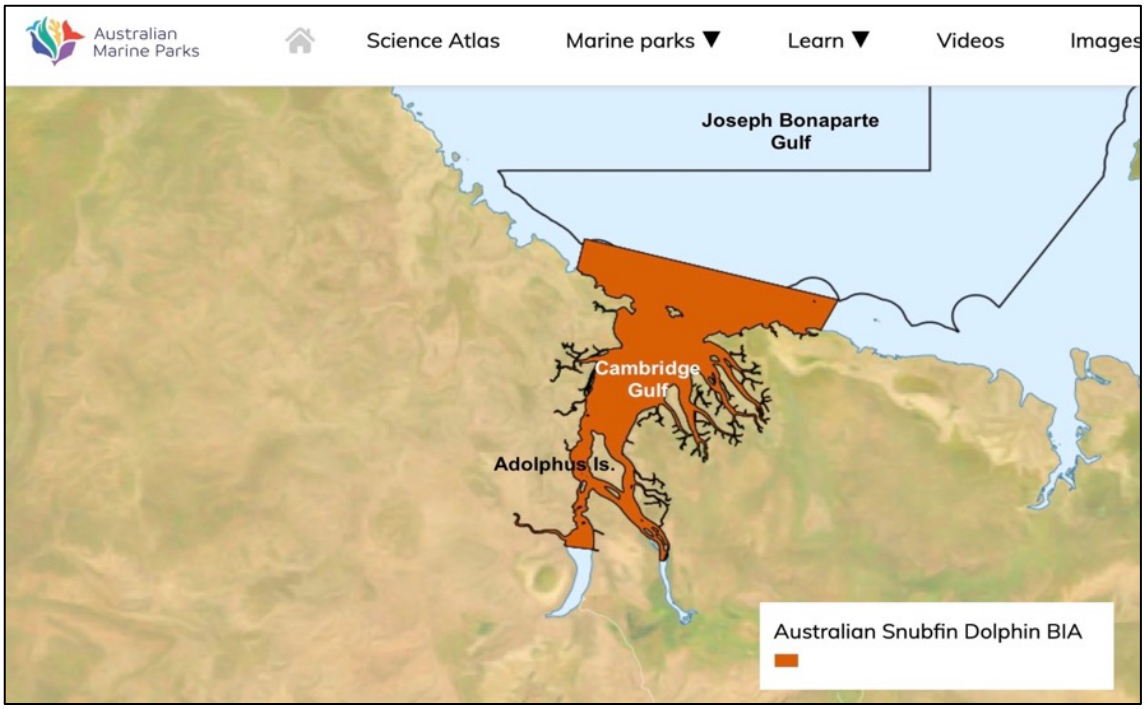


FIGURE 34: *Cambridge Gulf is within a Commonwealth-defined breeding, calving, foraging and resting Biologically Important Area (BIA) for the Australian Snubfin Dolphin (Orcaella heinshoni) (map source: Australian Marine Parks)*

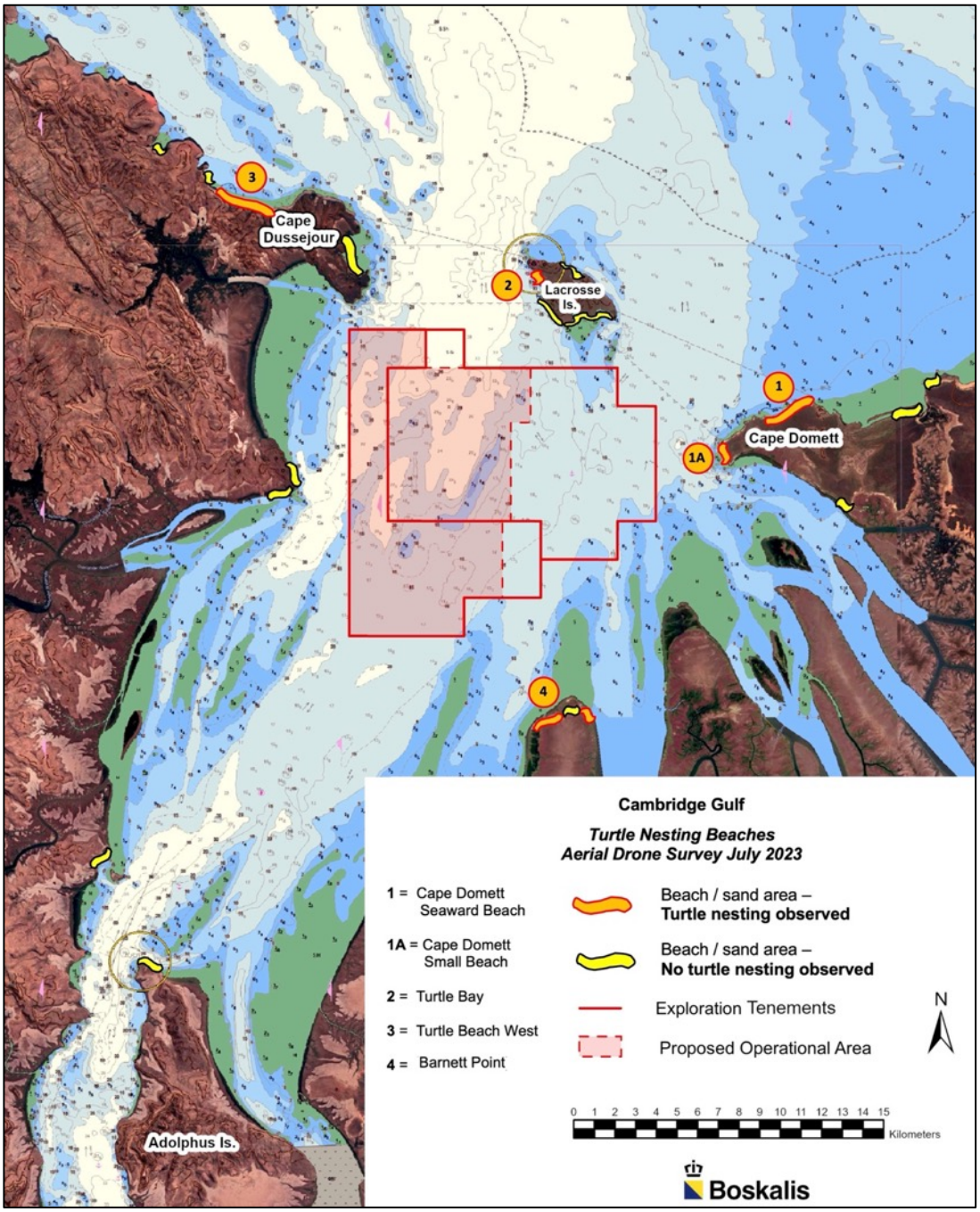


FIGURE 35: *Flatback Turtle nesting beaches in the CG area. Cape Domett Seaward Beach supports the majority of nesting.*

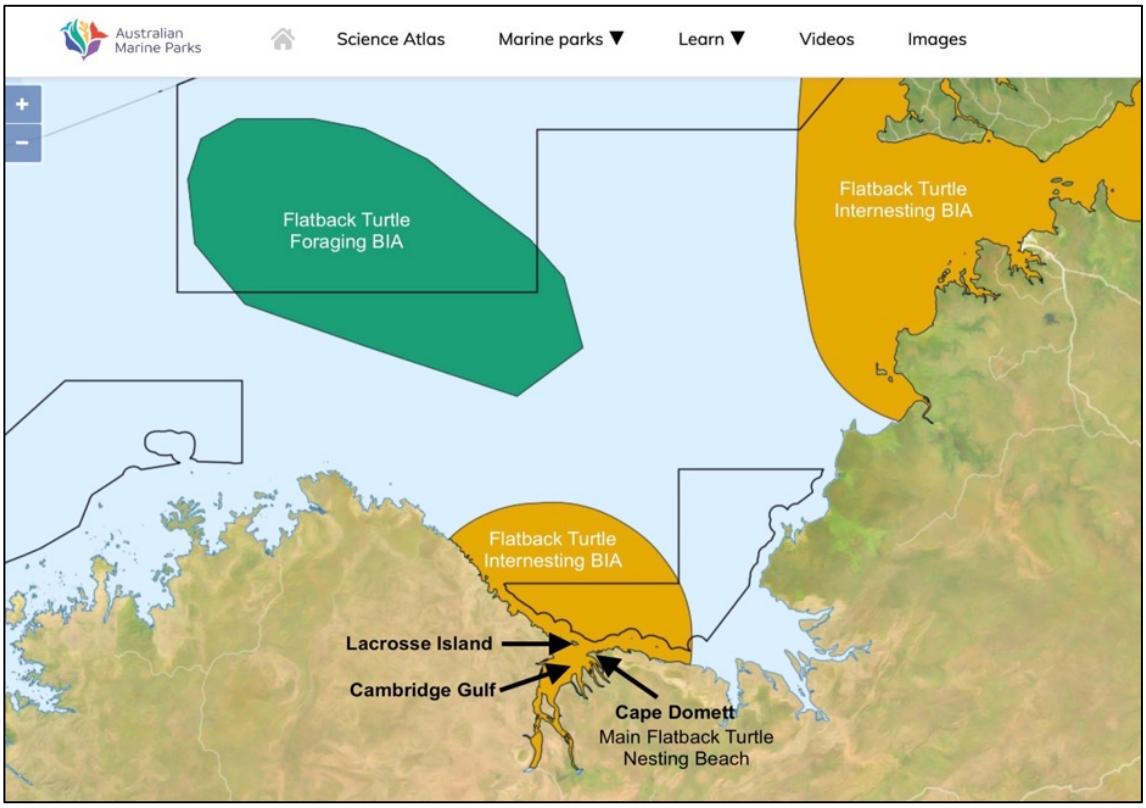


FIGURE 36: *The inter-nesting 'buffer' BIA for Flatback Turtles over a 60 km radius around Cape Domett and Lacrosse Island (map source: Australian Marine Parks).*

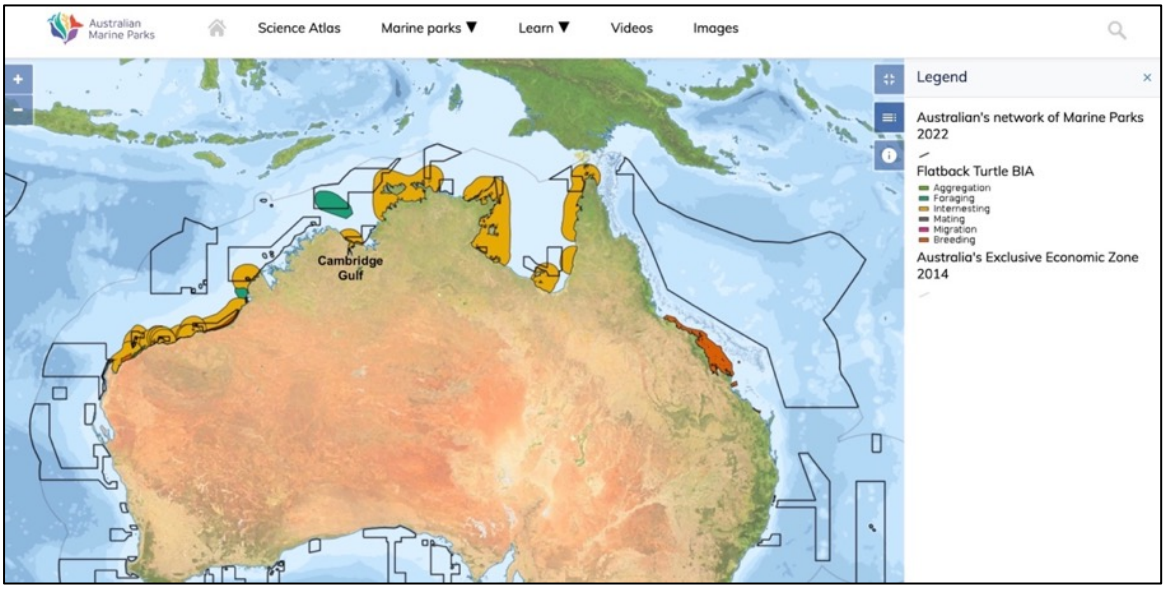


FIGURE 37: *BIAs for Flatback Turtles at national level (map source: Australian Marine Parks).*

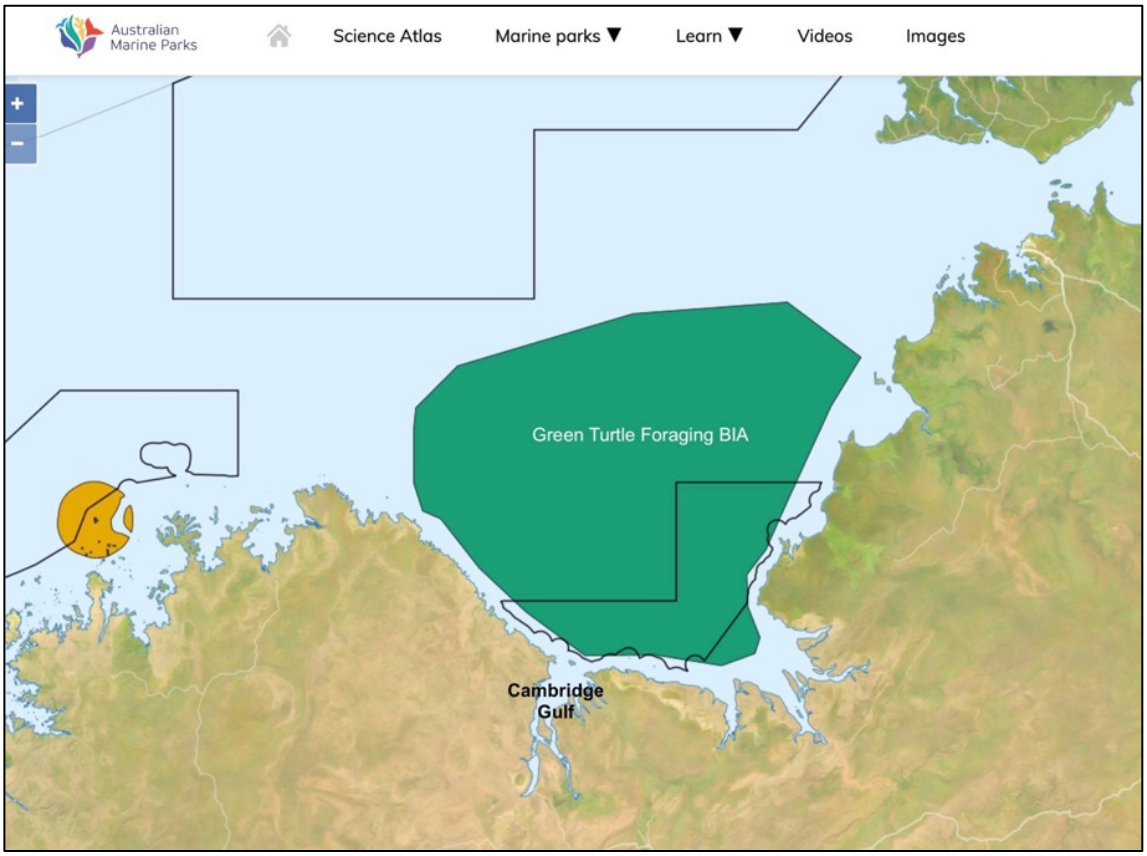


FIGURE 38: *The foraging BIA for Green Turtles offshore from CG (map source: Australian Marine Parks).*

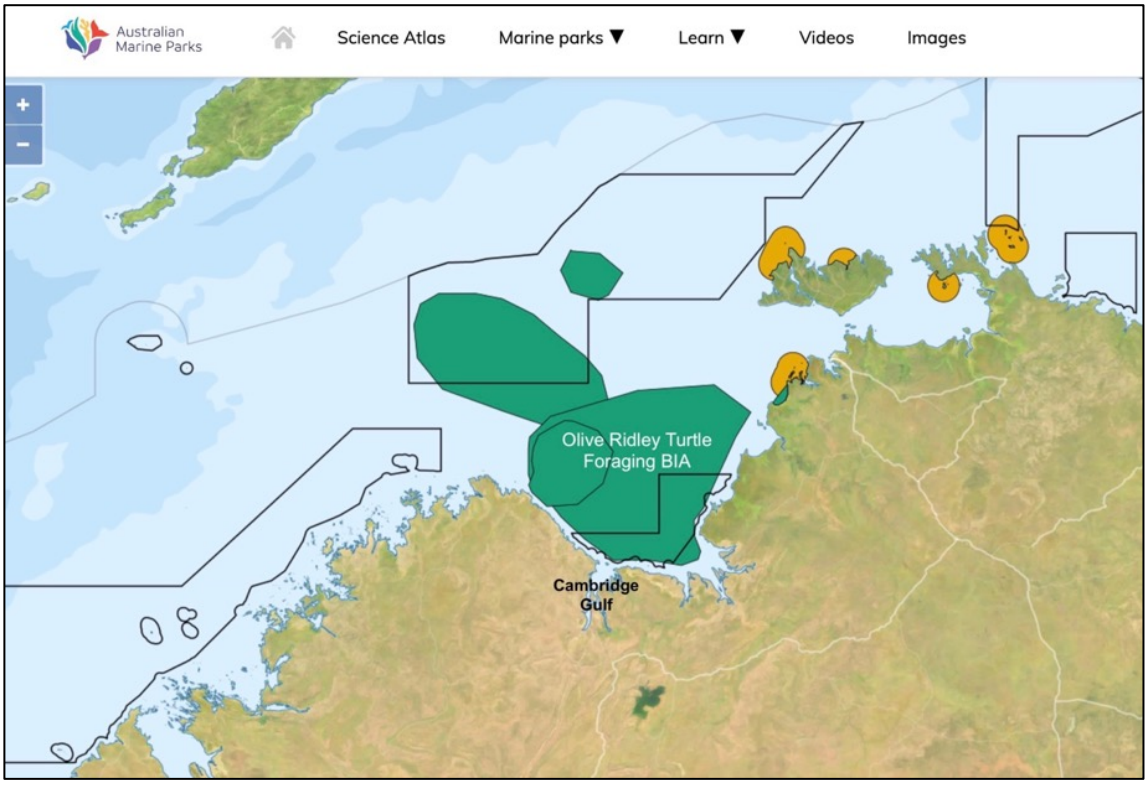


FIGURE 39: *The foraging BIA for Oilve Ridley Turtles offshore from CG (map source: Australian Marine Parks).*

10.3 Impact Assessment

The potential impacts of the proposal on each of the marine fauna described under receiving environment above are assessed in each of the following sections.

10.3.1 Snubfin & Humpback Dolphins

1. Small numbers of these two dolphin species have been observed in CG as summarized in section 10.2 and detailed in Referral Report No. 2. Most sightings were outside of the proposed operational area, but included two and three sightings of Snubfins in the proposed operational area in the 2024 and 2023 surveys respectively, so this species does appear to pass through this area.

2. There is therefore potential for the proposal to cause impacts on these animals through two mechanisms – potential vessel strike and possible underwater noise impacts from the Sand Production Vessel (SPV). Each of these potential impacts are assessed in turn below.

Potential vessel strike by the SPV:

1. The likelihood of vessel strikes occurring is assessed as being very low for the following reasons:

    a) Dedicated surveys and long-term local knowledge indicate that both species are not common in the proposed operational area, but are mainly found in feeding areas closer to shore away from the proposed operational area, which reduces the likelihood of encounters.

    b) Both species are naturally shy and elusive of human activity and will avoid vessel operations (DRA 2024), unlike some other dolphin species that are attracted to moving vessels to ride bow waves. Large, healthy populations of both species are present in areas that have significant vessel traffic, including the largest known population of Snubfins in WA around the Port of Broome in Roebuck Bay (~130 individuals) (DBCA 2024), and populations of Humpback Dolphins along the Pilbara coast, which has several major industrial ports and large volumes of commercial shipping traffic (Hanf et al 2016).

    c) In contrast to these other busy shipping areas, the SPV will only be present in CG for one to two days every two weeks, and there will be zero operational activity in CG for 86% of the time during the project's lifespan, further reducing the likelihood of encounters.

    d) During the brief periods that the SPV will be operating in CG, it will travel at very low speeds (~2 knots), and will implement best-practice Marine Mega-fauna (MMF) observation and avoidance systems and procedures, in accordance with relevant guidelines. Boskalis has extensive global experience in implementing effective MMF observation and avoidance systems and procedures on its vessels, and is developing new automated systems using camera imaging and AI to improve their effectiveness, as described in Annex 4.

2. The proposed impact avoidance and mitigation measures are detailed further in section 10.4 below.

3. If the proposal proceeds, BKA will look to support research and monitoring of the biology, ecology and behaviour of Snub Fin and Humpback Dolphins in the CG area, in close coordination with relevant stakeholders including DBCA the local TO ranger groups. This will provide scientific data to support improved protection, conservation and management of these species, both in CG and in other areas (see section 17*).*

Potential underwater noise impacts from the SPV:

1. Like all cetaceans both Snubfin and Humpback Dolphins produce a variety of sounds described as broadband clicks, pulses and whistles. Clicks and pulses appear to be used to search for prey and navigation (echo-location) while whistles are thought to be used to communicate during social behaviours (DRA 2024). Their use of sound for foraging, navigation and communication means that when additional noise from anthropogenic sources is introduced to the underwater environment, it could potentially impact on their prey detection rates and /or impede their ability to communicate through sound masking. Additional noise from anthropogenic sources can also cause behavioural changes through stress and disturbance of resting activities if normal sound tolerances are exceeded (Marley et al 2017).

2. Dolphin hearing sensitivity varies among species, populations, and even individuals. However, as hearing abilities can be difficult to measure in wild animals, frequencies in which animals produce sounds are often used as an indicator of their hearing sensitivities, since these generally overlap (Marley et al 2017).

3. Snubfin dolphin whistles on the east coast of Australia have been recorded between frequencies of 0.5 and 13 kHz (Berg Soto et al 2015, Parijs et al 2000) and at Roebuck Bay in WA between frequencies of 1.9 to 17.5 kHz (Marley et al 2017). Based on this research, Snubfin Dolphin whistles could be expected to over-lap with received noise from sound sources

with acoustic energy between 0.5 and 22 kHz and octave band levels (OBLs) centred on 640, 1280, 2560 and 5120 Hz (Marley et al 2017).

4. The sound production and hearing characteristics of Humpback Dolphins have been studied by multiple researchers, as reviewed in Li et al (2018), reporting typical frequencies of between 0.52 and 33 kHz, although there is wide variation between populations.

5. The SPV design will be based on a Trailer Suction Hopper Dredger (TSHD) with some simplifications, so the general noise emission characteristics of a typical TSHD can be used as an indicative baseline for initial assessment. The underwater sound sources from a typical TSHD are shown on Figure 40, and each of these will be present on the SPV. The most significant sources shown on Figure 40 are likely to be from cavitation of the main propeller and occasional noise from the bow thruster when used to manoeuvre the vessel (de Jong et al. 2010).

6. However, the SPV will be quieter than a typical TSHD as it will be a newbuild, specialized vessel, and it will incorporate relevant best practice noise reduction measures from the design-phase, as per the IMO 2023 Underwater Noise Guidelines (IMO 2023) (see further below).

7. Assessments of underwater noise from TSHDs have been carried out by a range of studies including, *inter alia* de Jong et al (2010), Robinson et al (2011) and Reine et al (2014). These studies indicate that in general, dredging produces predominantly low-frequency sounds (<1000 Hz), which is well below the mid-frequency repertoire reported for dolphins as outlined above (Figure 41).

8. Dredge noise emissions are typically steady and non-impulsive (i.e. they do not exhibit a rapid sound pressure rise time and decay). Noise emitted by dredging is broadband, with most energy below 1 kHz and unlikely to cause damage to marine mammal auditory systems and are not at sufficient intensities (source sound pressure levels - SPLs) to pose risks of mortality or injury (Suedel et al. 2019). Overall based on literature review, SPLs of TSHDs range from 172 to 190 dB re 1µPa at 1 m (Table 15).

9. Overall, the likelihood of underwater noise impacts from the SPV on Snubfin and Humpback Dolphins is assessed as being low for the following reasons:

    a) There is a separation in the sound generation profiles of TSHDs and the sound repertoires of the dolphin species.

    b) As outlined for potential vessel strikes above:

        - Both species are not common in the proposed operational area, but are mainly found in feeding areas closer to shore away from the proposed operational area, and both species are naturally shy and elusive of human activity and will avoid vessel operations. This will reduce the likelihood of exposure to noise from the SPV (and considering the large size of CG – over 3,700 km^2 of marine area up past Wyndham).

        - Large, healthy populations of both species are present in areas that have significant vessel traffic, including the largest known population of Snubfins in WA around the Port of Broome and populations of Humpback Dolphins along the Pilbara coast, which has several major industrial ports and large volumes of commercial shipping traffic (Hanf et al 2016). This indicates that they may not be overly-sensitive to vessel noise.

        - In contrast to these other busy shipping areas, the SPV will only be present in CG for one to two days every two weeks. There will be zero operational activity and therefore zero additional sound emissions in CG for 86% of the time during the project's lifespan.

        - During the brief periods that the SPV will be operating in CG, it will travel at very low speeds and will implement best-practice Marine Mega-fauna (MMF) observation and avoidance systems and procedures, in accordance with relevant guidelines. If dolphins are observed in proximity to the SPV, operations can be slowed or halted to avoid potential noise impacts. Boskalis has extensive global experience in implementing effective MMF noise monitoring and avoidance procedures, as described in Annex 4.

    c) Natural suspended sediment concentrations in CG are permanently extremely high, and studies indicate that sound propagation is reduced in turbid waters, with the suspended sediment particles in the water column acting as a buffer of noise. Data indicates that in such areas underwater sound carries over far less distances than often postulated (WODA 2015).

    d) The tidal range in CG is high (up to 8 m) and tidal currents are very strong (>2 m/s), which generate significant natural underwater noise with every tidal cycle. This can mask anthropogenic sources, as measured in Roebuck Bay by Marley et al (2017). Marley et al (2017) also found that fish choruses had a greater risk of competing for dolphin acoustic space than vessel noise around the Port of Broome in Roebuck Bay. The fact that Broome has

much higher daily vessel activity than will be present in CG from the proposal, indicates that noise from tidal currents, fish choruses and other natural sources may also be more significant than SPV sources in CG.

10. As outlined above, the SPV will be a 'newbuild' vessel and thus able to incorporate relevant best practice noise reduction measures from the design-phase, as per the IMO 2023 Underwater Noise Guidelines (IMO 2023). As the design parameters for the SPV mature (it is still in conceptual phase), modelling of likely noise emissions will be undertaken in accordance with the IMO Guidelines, and used to inform optimum design and incorporation of noise reduction measures.

11. If the proposal proceeds, BKA will look to support research and monitoring of the acoustic characteristics of the two dolphin species and of the CG environment, in close coordination with relevant stakeholders, including DBCA and the local TO ranger groups. This will provide scientific data to support improved protection, conservation and management of these species, both in CG and in other areas (see section 17).

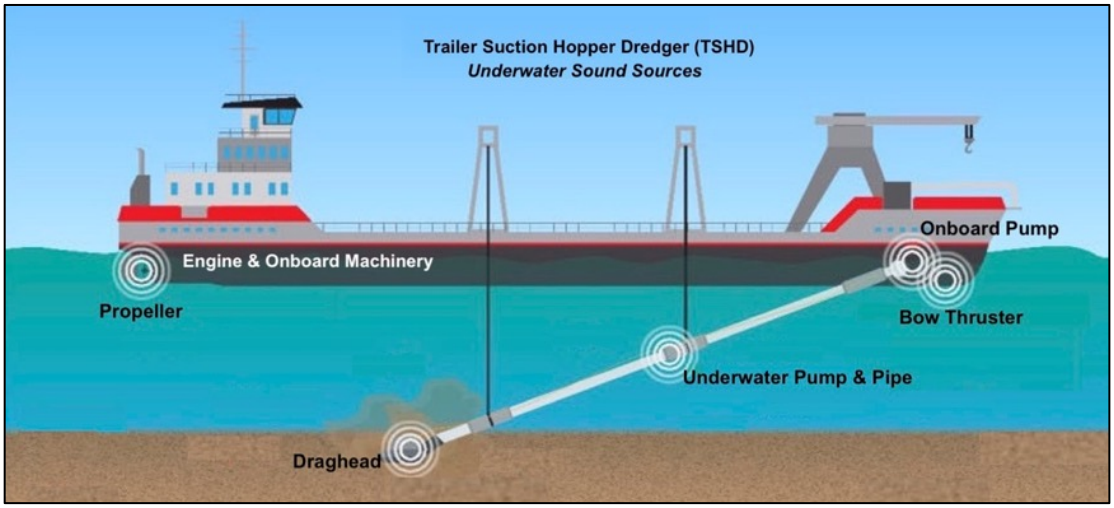


FIGURE 40: *Underwater sound sources from a typical TSHD. These will all be present on the SPV. The propeller and bow thruster are the more significant sound sources (source: WODA).*

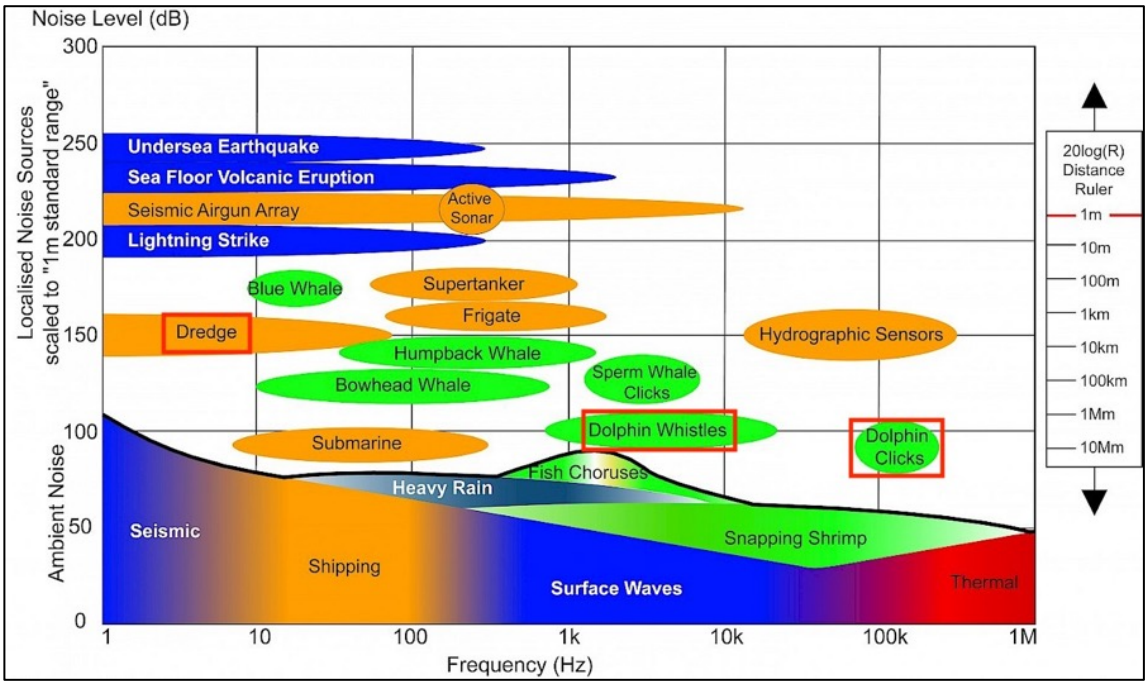


FIGURE 41: *Levels and frequencies of anthropogenic and naturally occurring sound sources in the marine environment. Note as highlighted by red boxes the relative positions of dredge and dolphin whistles and clicks (source: OSPAR 2009).*

TABLE 15. *Reported underwater Sound Pressure Levels (SPLs) for THSDs (source: WEDA 2019)*

NOTE: Many of the vessels assessed in the studies in Table 15 are quite old and some have since been decommissioned, and would not have incorporated noise reduction measures. The SPV will be a newbuild vessel and will incorporate relevant noise reduction measures as per IMO (2023).

TSHD Name	Installed Power (kW)	TSHD Capacity (m^3)	SPL	Reference
Cornelis Zanen	12,064	8,000	142 dB (at 930 m)	Greene 1987
Geophotes X(Inai Selasih)	15,384	8,000	139 dB (at 430 m)	Greene 1987
W.D. Gateway	13,870	12,000	131 dB (at 1.5 km)	Greene 1987
Columbia	2,800	-	177 dB re 1 µPa-m	Gerstein et al.2006
The City of Westminster	2 x 1,950	2,700	186 dB re 1 µPa-m	Parvin et al.2007
Dredger #1	8,000 - 30,000	3,000 - 20,000	186 dB re 1 µPa-m (45 Hz)[a]	de Jong et al.2010
Dredger #2	8,000 - 30,000	3,000 - 20,000	176 dB re 1 µPa-m (500 Hz)[a]	de Jong et al.2010
Dredger #3	8,000 - 30,000	3,000 - 20,000 m^3	174 dB re 1 µPa-m (350 Hz)[a]	de Jong et al.2010
Dredger #4	8,000- 30,000	3,000 - 20,000	177 dB re 1 µPa-m (300 Hz)[a]	de Jong et al.2010
Dredger #6	8,000 - 30,000	3,000 - 20,000	172 dB re 1 µPa-m (63 Hz)[a]	de Jong et al.2010
Dredger #7	8,000- 30,000	3,000 - 20,000	173 dB re 1 µPa-m (45 Hz)[a]	de Jong et al.2010
Liberty Island	12,353	5,003	179 dB re 1 µPa-m	Reine et al.2014a
Dodge Island	6,972	2,754	175 dB re 1 µPa-m	Reine et al.2014a
Padre Island	7,006	2,754	173 dB re 1 µPa-m	Reine et al.2014a
Atchafalaya	2,209	2,300	173 dB re 1 µPa-m	Reine et al.2014a

10.3.2 Flatback Turtles

1. As outlined in section 10.2 and shown on Figures 36 and 37 there is a globally significant Flatback Turtle nesting beach on the seaward side of Cape Domett, which is ~13 km from the closest boundary of the proposed operational area.

2. There are also lesser turtle nesting sites at:

    a) Turtle Beach West on the seaward coast west of Cape Dussejour (~8 km from the closest boundary of the proposed operational area),

    b) Turtle Bay on the north west side of Lacrosse Island (~4.5 km from the closest boundary of the proposed operational area); and

    c) Barnett Point) within CG (~6 km from the closest boundary of the proposed operational area).

3. While the proposed operation will not directly impact on any of the turtle nesting sites, it is important to consider the potential for indirect impacts, which could possibly occur via the following two mechanisms:

    a) potential changes to sediment dynamics and coastal processes from the extraction of sand from within the proposed operational area, and any subsequent changes to sand supply to the turtle nesting sites that might affect their geomorphology, and in turn might affect turtle nesting; and

b) potential impacts of vessel lighting on nesting turtles and especially on emerging hatchlings.

4. Potential changes to nesting beach morphology are addressed in section 8.3.4 on coastal processes and the likelihood of impacts is assessed as low as outlined in that section. The potential impacts of vessel lighting are discussed below followed by discussion and assessment of the inter-nesting buffer BIA for Flatback Turtles that is declared over a 60 km radius around Cape Domett and Lacrosse Island, as identified in section 10.1 and shown on Figures 36 and 37.

Potential impacts of vessel lighting:

1. In order to address potential impacts of vessel lighting on nesting and hatching turtles, the SPV will be permanently fitted with turtle safe lighting in accordance with the *National Light Pollution Guidelines for Wildlife* (Commonwealth of Australia, 2020), which are also applied by the WA Department of Biodiversity Conservation & Attractions (DBCA). The turtle safe lighting will be used as standard on the SPV at all times of the year. The vessel's navigational lights that are mandatory under IMO and AMSA maritime safety regulations will have to be the required standard lights. However, these are limited to a red (port) and a green (starboard) side light and a white mast-head light and stern light.

2. Irrespective of the use of turtle safe lighting, light exposure from the SPV will be limited by the fact that the SPV will only operate in CG for one to two nights every two weeks – there will be zero light source from the SPV in CG for 86% of time during the project lifespan, as the SPV will not be present – it will be away for two weeks every two weeks to deliver sand to SE Asia and then return.

3. Light exposure from the SPV will also be limited by geography, distances and aspect of the turtle nesting sites relative to the area where the SPV will operate, as follows:

    a) the nesting beach at Cape Dommet is ~13 km away, faces to seaward and is screened from the proposed operational area by the Cape,

    b) the nesting beach west of Cape Dussejour is ~8 km away, also faces to seaward and is fully screened from the proposed operational area by the Cape and adjacent hills,

    c) the nesting site at Turtle Bay on Lacrosse Island is ~4.5 km distant, faces to the north west and is screened from the proposed operational area by the southern headland of the bay; and

    d) while the nesting area at Barnett Point does face towards the proposed operational area, the nesting and hatching areas are screened behind mangroves, and the site is ~6 km from the closest boundary of the area.

4. All of the distances between the proposed operational area and the turtle nesting site are minimums (closest boundary). If the SPV is operating and in a more distant part of the proposed operational area, it could be more than an additional 10 km away from any of the turtle nesting sites (refer Figure 35). All of the minimum distances are well beyond the horizon for turtles at beach level or sea level (the horizon is about 4.8 km for a 1.7 m tall human standing at sea level and looking out to sea).

5. As an added precaution the SPV will enter and depart CG via West Entrance (west of Lacrosse Island), which is 16 km away from the most important nesting beach at Cape Domett, screened from the seaward nesting beach west of Cape Dussejour, and 22 km from the nesting site at Barnett Point.

6. Given all of these factors, it is assessed that the proposed operation will not cause any negative impacts on nesting and hatching turtles from vessel lighting.

Inter-nesting buffer BIA:

1. The Commonwealth DCCEEW can declare BIAs over areas where a specific biologically important behaviour for species that are protected under the EPBC Act is assessed to occur, such as breeding, foraging, resting and migration areas. The BIAs do not have any legal standing or regulatory bases, but they should be taken into account when assessing potential impacts of proposed developments.

2. In addition to the turtle nesting sites themselves, as outlined in section 10.2 and shown on Figures 36 and 37 there is an inter-nesting buffer BIA for Flatback Turtles declared over a 60 km radius around Cape Domett and Lacrosse Island, which includes CG. This implies that inter-nesting Flatback Turtles could be present within CG, including within the proposed operational area, which would raise the potential for the following impacts:

    a) potential vessel strike by the SPV if turtles are at or near the sea surface within the proposed operational area,

b) potential entrainment in the SPV's drag-head if turtles are on the seabed within the proposed operational area; and

c) potential underwater noise impacts from the SPV within the proposed operational area.

3. The potential for such impacts is predicated on the assumption that there is a scientific basis for the inter-nesting buffer to extend shoreward to include CG, and on the assumption that the waters of CG are actually used as inter-nesting habitat by the Flatback Turtles that nest at Cape Domett and the other nesting sites in the area. An objective assessment based on the realities of the environmental conditions within CG, and the findings of dedicated MMF surveys, indicate that the waters and seabed within CG are highly unlikely to actually be used as inter-nesting habitat by Flatback Turtles.

4. Inter-nesting BIAs are areas where marine turtles 'rest' between nocturnal nesting events, often being inactive and resting on the seabed to conserve energy for the next nesting event (Hays et al 1999). As outlined in section 10.2 studies on the Pilbara Coast of WA indicate that the inter-nesting area for Flatback Turtles in that region can range from 3.4 to 60 km from the nesting beach (Whittock et al 2014), with an average inter-nesting interval of around 13 days (Thums et al 2019). It is understood that the 60 km radius for the inter-nesting buffer around the Cape Domett nesting beach is derived from the range of up to 60 km assessed by Whittock et al (214) for the Pilbara, without considering site conditions and turtle behaviour in the Cape Domett area.

5. The 60 km inter-nesting buffer is likely to be appropriate for the areas to seaward and extending offshore from Cape Domett, Lacrosse Island, Cape Dussijour and CG in general. However, it is assessed that the area within CG is highly unlikely to be used as inter-nesting habitat, due to the hostile environmental conditions, the known inter-nesting behaviour of Flatbacks and their preference for offshore areas for inter-nesting.

6. As outlined in various sections above the environmental conditions within CG and especially in the proposed operational area are extremely dynamic, with tidal currents in excess of 2 m/s (4 knots), constantly moving seabed sediments and no light at the seabed. These conditions make the area highly unsuitable for marine turtles to use as an inter-nesting resting area – they would have to expend significant energy just to remain there, and would be buffeted around on the seabed in totally dark conditions.

7. The main nesting beaches in the CG area are on the seaward coast and face out to sea. After each nesting event Flatbacks would most likely head straight offshore to the inner waters of Joseph Bonaparte Gulf for their inter-nesting rest, before coming back to the beach again. Flatbacks are known for heading quickly offshore between nesting efforts (MacIntyre pers comms. 2024).

8. There is also no feeding habitat for Flatbacks (or other turtle species) within CG. Flatbacks are carnivorous, feeding mostly on soft-bodied prey such as sea cucumbers, soft corals and jellyfish (DCCEEW). Based on benthic sampling undertaken at a control site offshore in Joseph Bonaparte Gulf in July 2023 (see Referral Report No. 3) - there is feeding habitat, clearer water and less strong currents offshore - which is another reason that Flatback mostly to head offshore and not into CG for inter-nesting.

9. As outlined in section 10.1 above and reported in detail in Referral Report No. 3, in addition to arial drone surveys of the nesting sites, dedicated on-water MMF surveys were undertaken over nine-days each in February 2024 and July 2023, covering over 600 km of transects for each survey. This extremely comprehensive survey effort included observing for marine turtles at sea throughout CG and in the proposed operational area, with the following findings:

    a) February 2024:

        - Two unidentified turtle sightings in CG, one inside the proposed operational area, and no other sightings.

    b) Late July 2023 (near peak nesting period):

        - Five Flatback Turtle sightings (three near Cape Domett where the main nesting beach is, one near Adolphus Island and one on west side of CG).

        - Seven unidentified turtle sightings (one near Cape Domett, one near Adolphus Island, one on west side of CG, one on east side of CG, two near Lacrosse Island and one within the proposed operational area).

10. As with the dolphin sightings, different sightings could be the same individual(s), so the actual number of turtles may be less than the number of sightings. These are very low numbers of on-water sightings considering the very large area covered, especially in late July 2023 near the peak nesting season, when hundreds of tracks and nests were observed on the nesting beaches. These low sighting numbers tend to indicate that the area within CG is not used as an inter-nesting, resting or foraging area. It should also be noted that only one turtle was observed within the proposed operational area during each survey.

11. Never-the-less, there is a possibility that inter-nesting Flatback Turtles could be present within CG, including within the

proposed operational area. It is therefore necessary to assess the potential for vessel strike by the SPV, potential entrainment in the SPV's drag-head and potential underwater noise impacts on turtles from the SPV within the proposed operational area, as follows:

Potential vessel strike by the SPV:

1. As for dolphins above, the likelihood of vessel strikes on turtles occurring is assessed as being very low for the following reasons:

    a) The very low numbers of turtles observed with CG and especially within the proposed operational area, including in late July 2023 near the peak nesting season.

    b) The fact that extreme environmental conditions in proposed operational area, including string tidal currents, highly dynamic seabed sand-forms and lack of light at the seabed make it inhospitable for marine turtles.

    c) The low operational presence of the SPV in CG, with no presence at all for 86% of the time during the project's lifespan, as outlined above.

    d) During the brief periods that the SPV will be operating in CG, it will travel at very low speeds (~2 knots), and will implement best-practice Marine Mega-fauna (MMF) observation and avoidance systems and procedures, in accordance with relevant guidelines. Boskalis has extensive global experience in implementing effective MMF observation and avoidance systems and procedures on its vessels, and is developing new automated systems using camera imaging and AI to improve their effectiveness, as described in Annex 4.

2. The proposed impact avoidance and mitigation measures are detailed further in section 10.4 below.

Potential entrainment in the SPV's drag-head:

1. The SPV's dragh-head that will drag along the seabed to vacuum up sand, will be ~6 m wide and will have an extremely strong vacuuming force driven by powerful pumps when in operation. Any marine turtles that are on or near the seabed in the path of the drag-head would potentially be entrained and would suffer almost certain mortality.

2. The likelihood of turtles being entrained in the drag-head is assessed as being very low for the following reasons:

    a) The low probability of turtles actually being on or near the seabed in the proposed operational area, for the same reasons listed for vessel strikes above.

    b) The low operational presence of the SPV in CG, with no presence at all for 86% of the time during the project's lifespan, as outlined above.

    c) The drag-head will be fitted with marine-fauna deterrent / deflector chains ('turtle ticklers') as shown in Figure 42. Trials of a variety a design options by Chevron Australia during the Gorgon-Barrow Island project in WA, including on Boskalis dredgers, showed this chain design to be the most effective and they are now standard on Boskalis' dredgers in turtle areas.

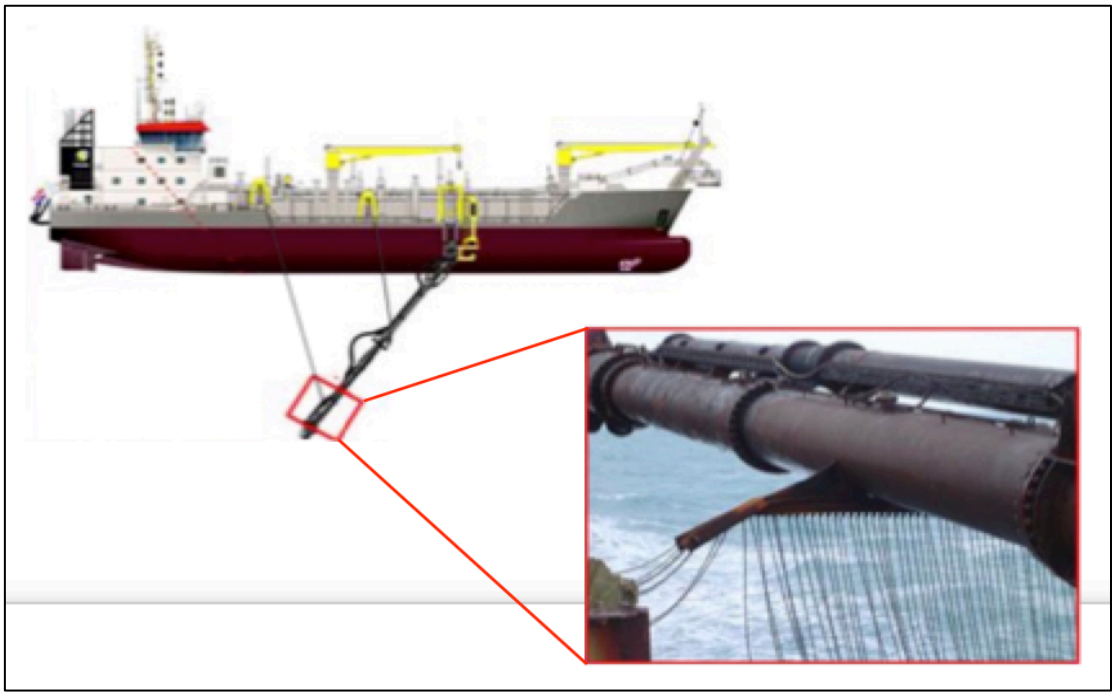


FIGURE 42: *Marine-fauna deterrent / deflector chains ('turtle ticklers') are standard on Boskalis' dredgers in turtle areas.*

Potential underwater noise impacts from the SPV:

1. Marine turtles do not have external ears and very little is known about the effects of underwater noise on turtles – although there is evidence that they are most sensitive to low frequency sound <1,00 hz, which are naturally most prevalent in the marine environment (NOAA 2023).

2. The likelihood of turtles being impacted by underwater noise from the SPV is assessed as being very low for the following reasons:

    a) The low probability of turtles actually being in the proposed operational area, for the same reasons listed for vessel strikes above.

    b) The low operational presence of the SPV in CG, with no presence at all for 86% of the time during the project's lifespan, as outlined above.

    c) The fact that the SPV will be a 'new-build' vessel and thus able to incorporate relevant best practice noise reduction measures from the design-phase, as per the IMO 2023 Underwater Noise Guidelines (IMO 2023). As outlined above, as the design parameters for the SPV mature (it is still in conceptual phase), modelling of likely noise emissions will be undertaken in accordance with the IMO Guidelines, and used to inform optimum design and incorporation of noise reduction measures.

Overall assessment for Flatback Turtles:

1. Overall, it is assessed that there is a very low likelihood of the proposal causing significant impacts on Flatback Turtles, and there are unlikely to be:
    a) changes to coastal processes that might affect turtle nesting beaches,
    b) impacts from SPV lighting on nesting and hatching turtles,
    c) significant vessel strikes on turtles,
    d) significant entrainment of turtles in the SPV's drag-head; or
    e) significant impacts of underwater noise from the SPV on turtles.

2. If the proposal proceeds, BKA will look to support research and monitoring of the biology, ecology and behaviour of Flatbacks and other turtle species in the CG area, in close coordination with relevant stakeholders including DBCA and the local TO ranger groups. This will provide scientific data to support improved protection, conservation and management of these species, both in CG and in other areas (see section 17).

10.3.3 Green & Olive Ridley Turtles

1. As outlined in section 10.2 there are broadly defined foraging BIAs for these two species offshore from CG in Joseph Bonaparte Gulf, which will not be impacted by the proposal (Figures 38 & 39). The MMF surveys conducted in February 2024 and July 2023 did not observe either of these species in or near CG. Twelve years of monitoring Flatback Turtle nesting at the Cape Domett beach by DBCA recorded a total of 12 Green Turtles nesting on that beach, equating to an average of one per year, amongst hundreds of Flatback nests per survey – these are considered opportunistic nesting attempts by the occasional Green Turtle and the area is obviously not a Green Turtle rookery (refer also Referral Report No. 2 and Price & Raaymakers 2024).

2. There are no previous recorded sightings of Olive Ridley Turtles within CG. The nearest rookery for Olive Ridleys is in northwest Arnhem Land in the Northern Territory, 1,000 km by sea from CG (DCCEEW).

3. It seems unlikely that waters within CG and the proposed operational area would be used for foraging or other purposes by either Green or Olive Ridley Turtles, for similar reasons described for Flatback Turtles in section 10.3.2. The environmental conditions are inhospitable. There are no food sources for Green Turtles (seagrass, macroalgae etc) and Olive Ridleys (mainly molluscs) in CG due to the extreme environmental conditions.

4. Of-course, despite the points above, because CG is within the overall broad geographic range of these two species, and because there are foraging BIAs for both species located offshore in Joseph Bonaparte Gulf, there is always the possibility that occasional individuals could be found within CG and in the proposed operational area. In such cases the potential for impacts is assessed to be very low for the same reasons as outline for Flatback Turtles in section 10.3.2, including:

    a) The low operational presence of the SPV in CG (not present for 86% of the time).
    b) The use of turtle safe lighting on the SPV.
    c) The use of marine fauna deterrent / deflector chains ('turtle tickler') on the SPV drag-head.
    d) The incorporation of best-practice noise reduction measures in the SPV design, as per the IMO 2023 Underwater Noise Guidelines.
    e) The very slow speed of the SPV when operating in CG (~2 knots).
    f) The implementation of MMF observation and avoidance procedures for the SPV.

5. As outlined for Flatback Turtles in section 103.2, if the proposal proceeds BKA will look to support research and monitoring of the biology, ecology and behaviour of marine turtles in the CG area, in close coordination with relevant stakeholders including DBCA and the local TO ranger groups. This will provide scientific data to support improved protection, conservation and management of these species, both in CG and in other areas (see section 17*).*

6. Overall, it is assessed that there is a very low probability that the SPV will interact with these marine turtle species in CG, and this probability will be reduced further by the proposed impact avoidance and minimization measures.

10.3.4 Saltwater Crocodiles

1. As outlined in section 10.3.2 Saltwater Crocodiles inhabit CG, mainly up the rivers and inlets and especially in the Lower Ord River, over 35 km upstream from the proposed operational area. While it is possible that Crocodiles do transit through the proposed operational area, the probably of interaction with the SPV would be very low, due to the fact that the SPV will not be present in CG for 86% of the time during the project's lifespan, the very low speeds at which it will operate, and the implementation of MMF observation and avoidance systems and procedures.

2. Overall, it is assessed that there is a very low probability that the SPV will interact with Saltwater Crocodiles in CG, and this probability will be reduced further by the proposed impact avoidance and minimization measures.

10.3.5 Sawfish

1. As outlined in section 10.2 the upstream areas of the rivers and creeks that discharge into CG provide habitat that may be suitable for the four species of sawfish that occur in northern WA waters – the Freshwater (Largetooth) Sawfish *Pristis pristis*, the Green Sawfish *P. zijsron*, the Dwarf Sawfish *P. clavata* and the Narrow Sawfish *Anoxypristis cuspidata*.

2. However, no previously published papers, reports or verifiable data could be found confirming their presence in CG. The eDNA sampling commissioned by BKA in February 2024 found trace DNA evidence of the presence of the Narrow Sawfish at one site ~8 km upstream in the Lyne River on the western side of CG, but not at other sites, and no evidence of the other species, including in the proposed operational area.

3. The preferred habitat of Sawfish is well up the rivers and inlets, especially during their reproduction (pupping) phase. However, adults of some species are known to migrate to coastal waters and it is therefore possible that Sawfish could

occasionally move through the proposed operational area. In such cases the potential for impacts is assessed to be low for the following reasons:

a) The low operational presence of the SPV in CG (not present for 86% of the time).
b) The use of marine fauna deterrent / deflector chains on the SPV drag-head.
c) The incorporation of best-practice noise reduction measures in the SPV design, as per the IMO 2023 Underwater Noise Guidelines.
d) The very slow speed of the SPV when operating in CG (~2 knots).

4. As outlined for dolphins and turtles above, if the proposal proceeds BKA will look to support research and monitoring of the biology, ecology and behaviour of sawfish in the CG area, in close coordination with relevant stakeholders including DBCA and the local TO ranger groups. This will provide scientific data to support improved protection, conservation and management of these species, both in CG and in other areas (see section 17*).*

5. Overall, it is assessed that there is a very low probability that the SPV will interact with sawfish in CG, and this probability will be reduced further by the proposed impact avoidance and minimization measures.

10.3.6 River Sharks

1. As outlined in section 10.2 two species of River Sharks have been found to inhabit the Lower Ord over 30 km upstream of the proposed operational area, including during their reproduction (pupping) phase (Kyne online, no published reports or papers found).

2. While it is possible that river sharks could transit through the proposed operational area in CG, the environment in that area is not their preferred habitat, and eDNA sampling of seabed sediments in February 2024 did not detect any evidence of their presence in CG including in the proposed operational area (see Referral Report No. 3). If they do move through this area, the probability of interaction with the SPV would be very low, for the same reasons as outlined for sawfish in section 10.3.5.

3. As outlined for dolphins, turtles and sawfish above, if the proposal proceeds BKA will look to support research and monitoring of the biology, ecology and behaviour of river sharks in the CG area, in close coordination with relevant stakeholders including DBCA and the local TO ranger groups. This will provide scientific data to support improved protection, conservation and management of these species, both in CG and in other areas (see section 17*).*

4. Overall, it is assessed that there is a very low probability that the SPV will interact with these river sharks in CG, and this probability will be reduced further by the proposed impact avoidance and minimization measures.

10.3.7 Boney Fishes

1. As outlined in section 10.2 and detailed in Referral Report No. 3, the mangrove-lined coast and inlets of CG provide habitat for a range of fish species, including target species for the local commercial gillnet fisherman and recreational fishermen from Wyndham and Kununurra. The proposed operation will not cause direct impacts on these fish habitat areas.

2. As outlined in section 10.2 and detailed Referral Report No. 3, the proposed operational area is not suitable as fish habitat due to the extreme environmental conditions, including constantly high suspended sediment and turbidity, lack of sunlight at the seabed, strong tidal currents, constantly moving substrate and lack of food sources for fishes. The area does not appear to support significant populations of benthic, demersal or pelagic fishes.

3. During consultations with the commercial gillnet fisherman who is sometimes active in CG he advised that he sets his nets on intertidal banks along coastal areas and is not concerned about the proposed operation in the center of CG (Douglas pers. comms 2023 & 2024). During consultations with the recreational fishing sector, they advised that the proposed operational area in the center of CG is referred to as ‘the washing machine’ due to the effects of currents. Even in more sheltered areas along the coast and up the creeks and inlets they advised that recreational fishing focusses on neap tide periods when currents are less extreme.

4. A review by Wenger (2017) identified the main potential impacts of dredging on fishes. These include:

a) Potential entrainment of fish in the drag-head.

b) Loss of benthic habitat and prey from the removal of the seabed substrate.

c) Underwater noise which can cause flight response of fish away from the area, and in the case of explosive noise, damage to the swim bladders of fishes (not applicable to this operation which will not cause explosive noise).

d) Suspended sediment plumes, which can reduce visibility and affect visual predators, affect fish gills and especially the gills of fish larvae, and affect buoyant and demersal fish eggs that might be in the area.

e) Resettlement of suspended sediments on the seabed (sedimentation), which can affect benthic feeders, benthic spawners and fish eggs that might be present on the seabed.

f) Potential release and mobilization of any toxicants that might be present in the seabed sediments, which can be harmful to fishes, especially low mobility species, small bodied species and fish eggs and larvae.

5. Table 16 assesses each of these potential effects in relation to the BKA proposal, and finds that there is a low likelihood of each potential effect occurring, for the reasons listed in Table 16. Table 17 lists the main fish species of the CG area that are of fishery or conservation interest and assesses the likelihood of impacts from the BKA proposal. This shows that the likelihood of impacts is very low for all species due to their habitat preferences differing significantly from the environmental conditions in the proposed operational area, and they are therefore unlikely to be present in that area.

6. *Overall, it is assessed that the proposal is unlikely to cause significant impacts on fishes, including because the key fish species of CG prefer costal and upstream habitats, the proposed operational area is not suitable as fish habitat due to the extreme environmental conditions, does not appear to support significant populations of benthic, demersal or pelagic fishes, and is not targeted by commercial or recreational fishers.*

7. If the proposal proceeds, BKA will look to support research and monitoring of the biology, ecology and behaviour of fish species in the CG area, in close coordination with relevant stakeholders including DPIRD Fisheries and commercial and recreational fishers, to provide scientific data to support improved management of these species.

TABLE 16: *Assessment of each possible effect on fish in relation to the BKA proposal.*

Possible Effect	Assessment in Relation to BKA proposal
Entrainment in drag-head:	As outlined in section 10.2, environmental surveys and stakeholder consultations indicate that the proposed operational area does not provide suitable habitat for benthic, demersal or pelagic fishes or support significant populations of fishes, due to the nature of the substrate (highly dynamic sand waves), strong tidal currents, lack of seabed light and lack of food sources for fishes. The use of marine fauna deterrent / deflector chains on the drag-head will assist in causing any fish that might be present in the path of the drag-head to move away. *Given these factors it is assessed that there is a very low likelihood of the proposed operation causing significant entrainment of fishes in the drag-head.*
Loss of seabed habitat and prey:	As outlined against item 1 above the proposed operational area does not provide suitable habitat for benthic, demersal or pelagic fishes and does not appear to support significant populations of fishes. As outlined in section 7.2.2 the seabed habitat within the proposed operational area comprises highly dynamic sand waves, constantly moved by strong tidal currents, with a lack of seabed light and a lack of benthic biota that would provide prey for fishes. As outlined in section 7.3.2 the proposed operation will remove an approximate 40 cm layer of sand from an area of approximately 0.5 km^2 on each two-week cycle, resulting in an average reduction of <1m depth of sand from within the proposed operational area of up to 100 km^2 over up to 15 years. As outlined in section 7.3.2 horizontal sand migration into and through the area is very rapid under the influence of tidal currents, and seabed morphology will restore rapidly (within weeks to months). As outlined in section 7.3.2 there are very few, very small benthic biota in the sand area (e.g. small amphipods), with most sand grab samples returning no biota at all after sieving to 500 microns. *Given these factors it is assessed that there is a very low likelihood of the proposed operation causing significant impacts on fishes from the loss of seabed habitat and prey.*
Underwater noise:	As outlined against item 1 above the proposed operational area does not provide suitable habitat for benthic, demersal or pelagic fishes and does not appear to support significant populations of fishes. As outlined in section 10.3.1 the SPV design will incorporate best-practice noise reduction measures, as per the IMO 2023 Underwater Noise Guidelines. *Given these factors it is assessed that there is a very low likelihood of the proposed operation causing significant impacts on fishes from underwater noise.*
Suspended sediment plume:	As outlined against item 1 above the proposed operational area does not provide suitable habitat for benthic, demersal or pelagic fishes and does not appear to support significant populations of fishes.

Possible Effect	Assessment in Relation to BKA proposal
	As outlined in section 7.3.3 and detailed in Referral Report No. 6, the proposed operation is unlikely to significantly alter the natural suspended sediment and turbidity values in CG, which are naturally extremely high and dynamic. *Given these factors it is assessed that there is a very low likelihood of the proposed operation causing significant impacts on fishes from suspended sediment plumes.*
Settlement of sediments (sedimentation):	As outlined against item 1 above the proposed operational area does not provide suitable habitat for benthic, demersal or pelagic fishes and does not appear to support significant populations of fishes. As outlined in section 7.3.3 the constant movement and reworking of the sand in the proposed operational area by strong tidal currents keeps the finer fractions of silt in constant suspension near the seabed, preventing them from settling (hence the lack of light near the seabed in CG)). *Given these factors it is assessed that there is a very low likelihood of the proposed operation causing significant impacts on fishes from settlement of sediments (sedimentation).*
Potential release of toxins:	As outlined against item 1 above the proposed operational area does not provide suitable habitat for benthic, demersal or pelagic fishes and does not appear to support significant populations of fishes. As outlined in section 9.2 the sediments within the proposed operational area are not contaminated as per NAGD (2009). *Given these factors it is assessed that the proposed operation will not cause impacts on fishes from the potential release of toxins.*

TABLE 17: *The main fish species of the CG area that are of fishery or conservation interest and likelihood of impacts*

Species	Species & Characteristics	Likelihood of impacts	References
Barramundi (*Lates calcarifer*)	A prized food-fish that is important to commercial and recreational fisheries (also farmed). Widely distributed across coastal northern Australia and Indo-West Pacific. Targeted by the commercial gillnet fisherman who is active in CG and sets his nets on intertidal banks along coastal areas (Douglas pers. comms 2023 & 2024). Targeted by recreational fisherman in CG along coast and up inlets, creeks and rivers (Gooding pers. comms 2024). Opportunistic predator that feeds on a wide variety of prey. Inhabits freshwater rivers and lagoons, estuaries and coastal mangrove areas depending on life-stage - complex life cycle freshwater, estuarine and marine phases. Protandrous hermaphrodite, which matures first as a functional male fish and undergoes sex change to become female. Adults migrate in early wet season (October) from freshwater to coastal estuaries assisted by heavy flooding of rivers and streams. Night-time spawning during wet season in/around tidal mudflats. Flood tides wash eggs and larvae into mangrove and wetland habitats, where larvae and juveniles grow. On reaching age of one-year they migrate back to freshwater where they stay for next 3 to 4 years until sexually mature.	**Very Low** Preferred habitat is freshwater rivers and lagoons, estuaries and coastal mangrove areas depending on life-stage. Unlikely to be present in the proposed operational area which is open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	DPIRD Fisheries Fact Sheet: Barramundi https://www.fish.wa.gov.au/Documents/recreational_fishing/fact_sheets/fact_sheet_barramundi.pdf Russell (1987, 1990)
Threadfin Salmon (*Polydactylus macrochir*)	A prized food-fish that is important commercial and recreational fisheries. Widely distributed in coastal inshore waters of northern Australia and New Guinea. Targeted by the commercial gillnet fisherman who is active in CG and sets his nets on intertidal banks along coastal areas (Douglas pers. comms 2023 & 2024). Targeted by recreational fisherman in CG along the coast and up inlets and creeks. Juveniles mainly live in shallow inshore turbid waters where they feed on small prawns, crabs and worms. Adults also favour estuarine areas and coastal waters, where they aggregate in large schools over tidal flats and in river mouths around autumn and spring. Their pectoral threadfin filaments help to find food in turbid waters by picking up vibrations of moving prey such as worms, prawns and crabs hiding in mud and sand.	**Very Low** Preferred habitat is the mangrove areas, river mouths and tidal flats along the coast and up the inlets. Unlikely to be present in the proposed operational area which is open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	DPIRD Fisheries Fact Sheet: Threadfins https://www.fish.wa.gov.au/documents/recreational_fishing/fact_sheets/fact_sheet_threadfin.pdf Pember (2006)

Species	Species & Characteristics	Likelihood of impacts	References
Streamer Threadfin (*Parapolynemus verekeri*) Also known as Dwarf Paradise Fish.	A prized food-fish that is important commercial and recreational fisheries. Found in northern Australia and southern New Guinea. In Australia its distribution extends from CG to Point Stuart in the Northern Territory. Occurs in the lower parts of rivers, muddy estuaries and turbid shallow nearshore waters throughout whole life cycle. Assumed to take part in mass spawning and has a protracted spawning period of approx. 6 months, peaking during spring and early summer (Sep-Dec). Their pectoral threadfin filaments help to find food in turbid waters.	**Very Low** Preferred habitat is the lower parts of rivers, muddy estuaries and turbid shallow nearshore waters. Unlikely to be present in the proposed operational area which is open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	Fishes of Australia www.fishesofaustralia.net.au Pember (2006)
Black Jewfish (*Protonibea diacanthus*) Also known as Black-spotted Croaker.	A prized food-fish that is important commercial and recreational fisheries. Found throughout northern Australia and the wider Indo-Pacific region. Preferred habitat is tidal rivers, estuaries and turbid coastal waters. Feeds on/near the seabed on crustaceans and small fishes. Matures in around 4 years. Forms spawning aggregations and returns yearly to discreet coastal spawning grounds adjacent to rivers. Peak spawning is Nov-Dec. Listed as 'Near Threatened' on the IUCN Red List.	**Very Low** Preferred habitat is tidal rivers, estuaries and turbid coastal waters. Unlikely to be present in the proposed operational area which is open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	Northern Territory Government: Black Jewfish - *Protonibea diacanthus* https://nt.gov.au/marine/recreational-fishing/types-of-fish/fish-species/black-jewfish Fishing World: Black Jewfish https://fishingworld.com.au/fish-facts/fish-facts-black-jewfish/ DPID Fisheries (Saunders et al.): Black Jewfish *Protonibea diacanthus* https://fish.gov.au/2014-Reports/black_jewfish
Fingermark Bream (*Lutjanus rusellii*) Also known as Russel's Snapper & Golden Snapper.	A prized food-fish that is important commercial and recreational fisheries. Widely distributed in tropical Indo-Pacific and northern Australia. Adults inhabit inshore reefs and rocky areas, occasionally entering estuaries, while juvenile snapper are often seen in the lower reaches of freshwater streams, mangrove estuaries and turbid coastal waters. Recreational fishermen in CG target them in rocky areas at Vancouver Point / Myrmidon Ledge on the western side of CG and near Cape Dussejour and Cape Domett (Gooding pers. comms 2024). Feeds primarily on benthic invertebrates and small fishes. Reaches sexual maturity after 4 years. Prolonged spawning season from early September to late April, with adult fish moving to relatively shallow turbid nearshore waters and forming spawning aggregations.	**Very Low** Preferred habitat is inshore reefs and rocky areas and inshore waters and estuaries for spawning and juveniles. Unlikely to be present in the proposed operational area where there are no rocky reefs and which is open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	FishBase: Russell's Snapper *Lutjanus rusellii* https://www.fishbase.se/summary/176 fishIDER: Russell's Snapper *Lutjanus rusellii* https://fishider.org/en/guide/osteichthyes/lutjanidae/Lutjanus/Lutjanus-rusellii Rome & Newman (2010)

Species	Species & Characteristics	Likelihood of impacts	References
Nurseryfish (*Kurtus gulliveri*)	A prized food-fish that is important to recreational fisheries but not targeted by commercial fisheries. Found across northern Australia and southern New Guinea. Preferred habitat is fresh and brackish muddy waters in lower reaches of slow-flowing rivers and mangrove areas with high turbidity. Feeds on crustaceans (prawns and shrimps), small fish and insect larvae. Breeding occurs during the northern Australian dry season (May to November) Males carry egg clusters on a prominent hook on the forehead, which is considered an adaptation to environments with low oxygen and high turbidity.	**Very Low** Preferred habitat is fresh and brackish muddy waters in lower reaches of slow-flowing rivers and mangrove areas with high turbidity. Unlikely to be present in the proposed operational area which is open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	FishBase: *Kurtis gulliveri* Nurseryfish https://fishbase.mnhn.fr/summary/Kurtus-gulliveri Berra & Neira (2003)
Warrior Catfish (*Hemiarius dioctes*)	Important to commercial and recreational fisheries. Found across northern Australia and New Guinea. Preferred habitat is river systems ranging from upstream freshwater areas to estuarine and coastal mangrove areas. Predator that feeds on invertebrates and fish. Spawning occurs at the start of the wet season (Oct/Nov).	**Very Low** Preferred habitat is river systems ranging from upstream freshwater areas to estuarine and coastal mangrove areas. Unlikely to be present in the proposed operational area which is open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	FishBase: *Hemiarius dioctes* Warrior catfish (see: https://www.fishbase.se/summary/60002 Kailola (2000)
Scaly Croaker (*Nibea squamosa*)	Important to commercial and recreational fisheries. Found across northern Australia and New Guinea. Preferred habitat is river systems ranging from upstream freshwater areas to estuarine and coastal mangrove areas. Prefers soft sediments, most likely feeding on bottom-dwelling invertebrates and small fishes. Known to form spawning aggregations.	**Very Low** Preferred habitat is river systems ranging from upstream freshwater areas to estuarine and coastal mangrove areas. Unlikely to be present in the proposed operational area which is open-water in the centre of CG with depths around 20-30 m, strong currents, constantly shifting seabed sand-waves and lack of food resources for fishes.	Larson et al. (2020) Gorman (2020)

10.3.8 Mud Crabs

1. As outlined in section 10.2 the mangrove-lined coast and inlets around CG provide habitat for Mud Crabs. The proposed operation will not cause impacts on these crab habitat areas.

2. Adult female Mud Crabs migrate to clearer waters offshore each spring/early summer to spawn, and the multi-staged larvae are carried by currents and larval advection (active movement) back to inshore areas where they settle and continue the lifecycle (WA Fisheries 2013). It is therefore possible that the outward migrating adult females and the returning juveniles could potentially pass through the proposed operational area during these movements.

3. However, the location of the proposed operational area within the central, deep, open water area of CG, with very strong currents and constantly moving seabed, indicates that they are unlikely to migrate through this zone. They are more likely to move in and out of CG closer to the protection of the coastal mangrove habitats that they come from and go back to. They

likely exit and enter CG along the eastern coast past Cape Domett and along the western side past Cape Dussejour.

4. *Overall, it is assessed that the proposal is unlikely to cause significant impacts on mud crabs, as it will not impact on their primary habitat (mangrove areas) and it is unlikely that they would move through the proposed operational area in the centre of CG.*

5. If the proposal proceeds, BKA will look to support research and monitoring of the biology, ecology and behaviour of mud crabs in the CG area, in close coordination with relevant stakeholders, including DPIRD Fisheries and commercial and recreational fishers, to provide scientific data to support improved management of these species.

10.3.9 Banana Prawns

1. As outlined in section 10.2 and detailed in Referral Report No. 2, the Northern Prawn Fishery (NPF) targets Red Legged Banana Prawns (*Penaeus indicus*) in Commonwealth waters approximately 100 km offshore from CG. There are also White Banana Prawns (*P. merguiensis*) in the region, although in lower numbers. The proposal will not impact on those areas as they are too far away.

2. As outlined in section 10.2 and detailed in Referral Report No. 2, the mangrove-lined rivers, creeks and inlets around CG provide nursery areas for these species (Loneragan et al 2002). The proposed operation will not cause impacts on these nursery areas.

3. As detailed in Referral Report No. 2, Banana Prawns are flushed seaward from upstream mangrove areas during wet season rains, they reproduce offshore and the multi-staged larvae are carried by currents and larval advection back to inshore areas where they settle and continue the lifecycle (Loneragan et al 2002). It is therefore possible that the outward migrating prawns and the returning larvae / juveniles could potentially pass through the proposed operational area during these movements.

4. However, as with Mud Crabs as described above, the location of the proposed operational area within the central, deep, open water area of CG, with very strong currents and constantly moving seabed, indicates that they are unlikely to migrate through this zone. As described for mud crabs above, outward migrating prawns and the returning larvae / juveniles are more likely to move in and out of CG closer to the protection of the coastal mangrove habitats that they come from and go back to. They likely exit and enter CG along the eastern coast past Cape Domett and along the western coast past Cape Dussejour.

5. Even if there is movement through the proposed operational area, potential impacts are not likely to be significant, given the much larger context of CG, the fact that the SPV will not be present for 86% of the time during the project's lifespan, and the lack of mechanisms whereby the SPV might impact on these species given the nature of the operation and the natural background conditions in the proposed operational area.

6. *Overall, it is assessed that the proposal is unlikely to cause significant impacts on banana prawns, as it will not impact on their primary habitat (mangrove areas) and it is unlikely that they would move through the proposed operational area in the centre of CG.*

7. If the proposal proceeds, BKA will look to support research and monitoring of the biology, ecology and behaviour of banana prawns and their juveniles and larvae in the CG area, in close coordination with relevant stakeholders, including DPIRD Fisheries and the NPF, to provide scientific data to support improved management of these species.

10.4 Application of the Mitigation Hierarchy & Assessment of Residual Impacts

1. There are four sequential levels in the EPA impact mitigation hierarchy:

    a) Avoid (prevent) impacts.
    b) Minimise (mitigate) impacts.
    c) Rehabilitate impacts.
    d) Offset impacts.

2. Table 18 presents the mitigation hierarchy applied to marine and lists the main potential impact for each species as discussed above, identifies relevant impact avoidance, minimisation, rehabilitation and offset measures and assesses the predicted residual impacts for each.

3. Overall, as outlined above and summarised in Table 18, potential impacts on marine fauna will be effectively avoided / prevented and minimized / mitigated. Because the proposal is unlikely to cause significant primary impacts, there will not be any residual impacts.

4. Never-the-less, should the proposal be approved and proceed, BKA will seek to implement a comprehensive environmental and biodiversity research and monitoring program, in consultation and cooperation with relevant stakeholders as described in section 17. This would further assist protection and conservation of key marine fauna species both in CG and in other areas.

TABLE 18: *Mitigation hierarchy & assessment of residual impacts for marine fauna.*

Marine Fauna	Potential Impact of the proposal	Impact Avoidance / Prevention	Impact Minimization / Mitigation	Rehabilitation & Offsets	Residual Impacts
Australian Snubfin Dolphin (*Orcaella heinshoni*) **Australian Humpback** Dolphin (*Sousa sahulensis*).	Potential vessel strike by the SPV:	Low presence of these species in the proposed operational area. Naturally shy and elusive behaviour of these species, which unlike other dolphin species avoid vessels. Low presence of the SPV in CG (zero presence 86% of time during project lifespan).	Low operational speed of the SPV (~2 knots). Implementation of best-practice Marine Mega-fauna (MMF) observation and avoidance systems and procedures, in accordance with relevant guidelines.	None required. Never-the-less, should the proposal be approved and proceed, BKA will seek to implement a comprehensive environmental and biodiversity research and monitoring program, in consultation and cooperation with relevant stakeholders as described in section 17. This would further assist protection and conservation of these species both in CG and in other areas.	As with any vessel operating at sea there is always a possibility of an interaction with MMF. The measures listed in the columns to left make the likelihood very low.
	Potential underwater noise impacts from the SPV:	Low presence of these species in the proposed operational area. Naturally shy and elusive behaviour of these species, which unlike other dolphin species avoid vessels. Low presence of the SPV in CG (zero presence 86% of time during project lifespan). Separation of the sound generation profiles of the SPV and the sound repertoires of the dolphin species. Naturally very high suspended sediment concentrations in CG which reduces sound propagation (WODA 2015). Naturally high sound levels from high tidal range which can mask other sound sources (Marely et al 2017).	The SPV will be a 'newbuild' vessel and will incorporate relevant best practice noise reduction measures from the design-phase, as per the IMO 2023 Underwater Noise Guidelines (IMO 2023). As the design parameters for the SPV mature (it is still in conceptual phase), modelling of likely noise emissions will be undertaken in accordance with the IMO Guidelines, and used to inform optimum design and incorporation of noise reduction measures. Low operational speed of the SPV (~2 knots). Implementation of best-practice Marine Mega-fauna (MMF) observation and avoidance systems and procedures, in accordance with relevant guidelines.	None required. Never-the-less, should the proposal be approved and proceed, BKA will seek to support research and monitoring of the acoustic characteristics of the two dolphin species and of the CG environment, in close coordination with relevant stakeholders, including DBCA and the local TO ranger groups. This will provide scientific data to support improved protection, conservation and management of these species, both in CG and in other areas.	None.

Marine Fauna	**Potential Impact of the proposal**	**Impact Avoidance / Prevention**	**Impact Minimization / Mitigation**	**Rehabilitation & Offsets**	**Residual Impacts**
Flatback Turtle *(Natator depressus):*	Potential changes to nesting beach morphology:	Addressed in section 8.3.4 on coastal processes – the proposal will not cause changes to beach morphology.	Addressed in section 8.3.4 on coastal processes. Impact minimization / mitigation is not required as impacts will be fully avoided / prevented.	Addressed in section 8.3.4 on coastal processes. Rehabilitation or offsets are not required as impacts will be fully avoided / prevented.	None.
	Potential impacts of vessel lighting:	SPV will be permanently fitted with turtle safe lighting in accordance with the *National Light Pollution Guidelines for Wildlife* (Commonwealth of Australia, 2020). SPV lighting in the proposed operational area will not be visible to nesting and hatching turtles due to distance, aspect and screening by geographical features.	As an added precaution the SPV will enter and depart CG via West Entrance (west of Lacrosse Island), which is 16 km away from the most important nesting beach at Cape Domett, screened from the seaward nesting beach west of Cape Dussejour, and 22 km from the nesting site at Barnett Point.	None required. Never-the-less, should the proposal be approved and proceed, BKA will seek to implement a comprehensive environmental and biodiversity research and monitoring program, in consultation and cooperation with relevant stakeholders as described in section 17. This would further assist protection and conservation of this species both in CG and in other areas.	None.
	Potential vessel strike by the SPV:	Low presence of these species in the proposed operational area. Low presence of the SPV in CG (zero presence 86% of time during project lifespan).	Low operational speed of the SPV (~2 knots). Implementation of best-practice Marine Mega-fauna (MMF) observation and avoidance systems and procedures, in accordance with relevant guidelines.	None required. Never-the-less, should the proposal be approved and proceed, BKA will seek to implement a comprehensive environmental and biodiversity research and monitoring program, as per row above.	As with any vessel operating at sea there is always a possibility of an interaction with MMF. The measures listed in the columns to left make the likelihood very low.
	Potential entrainment in the SPV's dragh-ead (if turtle is on seabed):	Low presence of these species in the proposed operational area and very low likelihood of being present on the seabed in that area, due to extreme environmental conditions. Low presence of the SPV in CG (zero presence 86% of time during project lifespan). The drag-head will be fitted with marine-fauna deterrent / deflector chains ('turtle ticklers').	Low operational speed of the SPV (~2 knots). Implementation of best-practice Marine Mega-fauna (MMF) observation and avoidance systems and procedures, in accordance with relevant guidelines.	None required. Never-the-less, should the proposal be approved and proceed, BKA will seek to implement a comprehensive environmental and biodiversity research and monitoring program, as per row above.	As with any vessel operating at sea there is always a possibility of an interaction with MMF. The measures listed in the columns to left make the likelihood very low.

Marine Fauna	**Potential Impact of the proposal**	**Impact Avoidance / Prevention**	**Impact Minimization / Mitigation**	**Rehabilitation & Offsets**	**Residual Impacts**
	Potential underwater noise impacts from the SPV:	Low presence of this species in the proposed operational area. Low presence of the SPV in CG (zero presence 85% of time during project lifespan). Naturally very high suspended sediment concentrations in CG which reduces sound propagation (WODA 2015). Naturally high sound levels from high tidal range which can mask other sound sources (Marely et al 2017).	The SPV will be a 'newbuild' vessel and will incorporate relevant best practice noise reduction measures from the design-phase, as per the IMO 2023 Underwater Noise Guidelines (IMO 2023). As the design parameters for the SPV mature (it is still in conceptual phase), modelling of likely noise emissions will be undertaken in accordance with the IMO Guidelines, and used to inform optimum design and incorporation of noise reduction measures. Implementation of best-practice Marine Mega-fauna (MMF) observation and avoidance systems and procedures, in accordance with relevant guidelines. Implementation of best-practice Marine Mega-fauna (MMF) observation and avoidance systems and procedures, in accordance with relevant guidelines.	As above.	None.
Green Turtle (*Chelonia mydas*) **Olive Ridley Turtle** (*Lepidochelys olivacea*):	As per Flatback Turtle above except much lower likelihood of impacts as very low numbers of Green Turtles observed in the area (1 nest per year at Cape Domett since 2012 by DBCA) and no recorded observations of Olive Ridleys in CG to date – habitat conditions are not suitable and food sources are nor present.	As per Flatback Turtle above except much lower likelihood of impacts as per left column.	As per Flatback Turtle above except much lower likelihood of impacts as per far-left column.	As per Flatback Turtle above except much lower likelihood of impacts as per far-left column.	As per Flatback Turtle above except much lower likelihood of impacts as per far-left column.
Saltwater Crocodile *(Crocodylus porosus):*	Potential vessel strike by the SPV:	Low presence of these species in the proposed operational area. Low presence of the SPV in CG (zero presence 86% of time during project lifespan).	Low operational speed of the SPV (~2 knots). Implementation of best-practice Marine Mega-fauna (MMF) observation and avoidance systems and procedures, in	None required.	As with any vessel operating at sea there is

Marine Fauna	Potential Impact of the proposal	Impact Avoidance / Prevention	Impact Minimization / Mitigation	Rehabilitation & Offsets	Residual Impacts
			accordance with relevant guidelines.		always a possibility of an interaction with MMF. The measures listed in the columns to left make the likelihood very low.
Sawfish (3 x *Pristis spp* and *Anoxypristis cuspidata):*	Potential entrainment in the SPV's drag-head (these are epibenthic species).	Low presence of these species in the proposed operational area (preferred habitat is well upstream) and very low likelihood of being present on the seabed in the area, due to extreme environmental conditions. Low presence of the SPV in CG (zero presence 86% of time during project lifespan). The drag-head will be fitted with marine-fauna deterrent / deflector chains ('turtle ticklers').	Low operational speed of the SPV (~2 knots). Implementation of best-practice Marine Mega-fauna (MMF) observation and avoidance systems and procedures, in accordance with relevant guidelines.	None required. Never-the-less, should the proposal be approved and proceed, BKA will seek to implement a comprehensive environmental and biodiversity research and monitoring program, in consultation and cooperation with relevant stakeholders as described in section 17. This would further assist protection and conservation of these species both in CG and in other areas.	As with any vessel operating at sea there is always a possibility of an interaction with MMF. The measures listed in the columns to left make the likelihood very low.
River Sharks *(Glyphis spp):*	Potential entrainment in the SPV's drag-head (these are epibenthic species).	Low presence of these species in the proposed operational area (preferred habitat is well upstream) and very low likelihood of being present on the seabed in the area, due to extreme environmental conditions. Low presence of the SPV in CG (zero presence 86% of time during project lifespan). The drag-head will be fitted with marine-fauna deterrent / deflector chains ('turtle ticklers').	Low operational speed of the SPV (~2 knots). Implementation of best-practice Marine Mega-fauna (MMF) observation and avoidance systems and procedures, in accordance with relevant guidelines.	None required. Never-the-less, should the proposal be approved and proceed, BKA will seek to implement a comprehensive environmental and biodiversity research and monitoring program, as per row above.	As with any vessel operating at sea there is always a possibility of an interaction with MMF. The measures listed in the columns to left make the likelihood very low.
Boney fishes:	No impacts are predicted as the key fish species of CG prefer costal and upstream habitats, the proposed operational area is not suitable as fish habitat due to the extreme environmental conditions, and is not targeted by commercial or recreational fishers.	Impacts will be avoided / prevented as per left column.	Impact minimization / mitigation is not required as impacts will be avoided / prevented.	None required. Never-the-less, If the proposal proceeds, BKA will look to support research and monitoring of the biology, ecology and behaviour of fish species in the CG area, in close coordination with relevant stakeholders including DPIRD Fisheries and commercial and recreational fishers, to provide	None.

Marine Fauna	Potential Impact of the proposal	Impact Avoidance / Prevention	Impact Minimization / Mitigation	Rehabilitation & Offsets	Residual Impacts
				scientific data to support improved management of these species.	
Mud Crabs (*Scylla spp*):	No impacts are predicted as the proposal will not impact on mud-crab habitats areas (mangroves along the coast and io the inlets, rivers and creeks) either directly or indirectly. Females migrating out of CG to spawn and juveniles migrating back into CG to grow are unlikely to pass through the proposed operational area due to the extreme environmental conditions, and likely migrate along the coastal belt out and in of CG.	Impacts will be avoided / prevented as per left column.	Impact minimization / mitigation is not required as impacts will be avoided / prevented.	None required. Never-the-less, If the proposal proceeds, BKA will look to support research and monitoring of the biology, ecology and behaviour of mud crab species in the CG area, in close coordination with relevant stakeholders including DPIRD Fisheries and commercial and recreational fishers, to provide scientific data to support improved management of these species.	None.
Red Legged Banana Prawns (*Penaeus indicus*) **White Banana Prawns** (*P. merguiensis*)	No impacts are predicted directly on the fishing effort itself as the prawn-trawling grounds are ~100km offshore. No impacts are predicted on juvenile prawn nursery areas in CG (mangroves along the coast and up the inlets, rivers and creeks) as the proposal will not affect these areas either directly or indirectly. Young adults migrating out of CG to spawn and larvae / juveniles migrating back into CG to grow are unlikely to pass through the proposed operational area due to the extreme environmental conditions, and likely migrate along the coastal belt out and in of CG.	Impacts will be avoided / prevented as per left column.	Impact minimization / mitigation is not required as impacts will be avoided / prevented.	None required. Never-the-less, If the proposal proceeds, BKA will look to support research and monitoring of the biology, ecology and behaviour of pawn species in the CG area, in close coordination with relevant stakeholders including DPIRD Fisheries and commercial and recreational fishers, to provide scientific data to support improved management of these species.	None.

10.5 Likely Environmental Outcomes

1. The likely environmental outcomes with regard to marine fauna both during and at the end of the 15-year project timeframe, are assessed as follows:

    a) There are unlikely to be any significant impacts on marine fauna in or near CG, including protected species and species of conservation significance.

    b) The protection, conservation and management of key marine fauna species in the CG area will be substantially strengthened and improved through BKA's support for research and monitoring of the biology, ecology and behaviour of these species, in close consultation and cooperation with relevant stakeholders.

10.6 Assessment Against EPA Significant Impact Criteria

1. As outlined in section 10.1, the EPA (2016) *Environmental Factor Guideline - Marine Fauna* lists some examples of what can be considered as 'significant impact' specifically in relation to marine fauna. Table 19 presents an assessment against each of these.

TABLE 19: *Assessment of potential impacts of the proposal against EPA marine fauna significant impact criteria*

*From *Environmental Factor Guideline - Marine Fauna* (EPA 2016)

EPA Marine Fauna Significant Impact Criteria*	Potential Impacts of the Proposal
1. Harm to individuals and/or declines in the population or the range of species protected under State legislation:	As outlined in section 10.2 the following marine species are known to be present or could possibly be present in the general CG area that are listed under the WA *Biodiversity Conservation Act*: – Australian Snubfin Dolphin *(Orcaella heinshoni).* – Australian Humpback Dolphin *(Sousa sahulensis).* – Flatback Turtle *(Natator depressus).* – Green Turtle *(Chelonia mydas).* – Olive Ridley Turtle (*Lepidochelys olivacea*) – Saltwater Crocodile *(Crocodylus porosus)* – Freshwater Sawfish *(Pristis pristis).* – Green Sawfish *(P. zijsron).* – Dwarf Sawfish *(P. clavata).* – Narrow Sawfish *(Anoxypristis cuspidata).* – Speartooth Shark *(Glyphis glyphis).* – Northern River Shark *(G. garricki).* As outlined in the relevant sub-sections under section 10.3 the likelihood of these species being present in the proposed operational area is very low for all species, due to their habitat preferences differing significantly from the environmental conditions in the proposed operational area. Should individuals of these species occasionally enter the proposed operational area, the potential for impacts will be avoided and minimized through the measures outlined in section 10.4. It assessed as being highly unlikely that the proposal will cause a decline in the population or the range of any of these species.
2. Reductions in populations of species of local and regional importance:	As per item 1 above.
3. Impacts to species or groups of species that fulfil critical ecological functions within the ecosystem:	As per item 1 above.
4. Loss or impact to critical marine fauna habitat, including habitats such as nesting beaches, nursery areas, sea lion haul out areas, specific foraging or breeding areas, and fish spawning aggregation areas:	As outlined in section 7.3. the proposal will not impact on any marine fauna habitats, except within the proposed operational area. As outlined in section 7.3 the seabed habitat in this area comprises highly-dynamic sand waves and the sand is largely devoid of benthic biota, due to permanent lack of light at the seabed, lack of stable hard substrate and constant movement of the sand under the influence of strong tidal currents. Removal of sand which contains almost no benthic biota will therefore not cause significant impacts on the benthic community. The very few small benthic organisms that were found to be present in sand areas exist in a highly dynamic, constantly moving substrate. Any organisms removed with the sand will be a temporary impact as the area will be rapidly recolonized including sand migration from immediately adjacent areas as outlined in section 7.3.
5. Reduction in species diversity in an area, which may be due to factors such as migration or range contraction resulting from a decline in the quality of the local environment:	As outlined in section 9 the proposal will not cause a decline in the quality of the local marine environment, and will therefore not cause any reduction in species diversity, migration or range contraction by this factor.
6. Introduction and/or spread of invasive marine species or diseases:	As outlined in section 7.3.6 the potential introduction of invasive marine species will be avoided and minimized through the following measures:

EPA Marine Fauna Significant Impact Criteria*	Potential Impacts of the Proposal
	– The SPV will be equipped with an IMO-compliant ballast water treatment system consistent with the IMO *International Convention for the Control & Management of Ships' Ballast Water & Sediments*, and as required by the Commonwealth ballast water regulations under the Commonwealth *Biosecurity Act* and relevant amendments. – The SPV will implement a biofouling management plan with stringent biofouling prevention, management, mitigation and monitoring measures, consistent with the IMO biofouling guidelines (IMO 2023) and as required by the Commonwealth biofouling regulations under the Commonwealth *Biosecurity Act* and relevant amendments. Biofouling management measures will include, *inter alia:* – Maintenance of a high-grade, IMO-compliant anti-fouling system on the SPV's wet hull. – Regular in-water inspections and when necessary, cleaning in Singapore – with a priority focus on niche areas. – Periodic dry docking, out-of-water hull cleaning and repainting / refresh of the anti-fouling system. – Required reporting to Australian authorities including before each arrival in Australian waters, as per the Commonwealth ballast water and biofouling requirements. – As the SPV will operate in CG which is within State Internal Waters, it will also comply with relevant requirements of the WA *Biosecurity and Agriculture Management Act* and undertake reporting under the WA Department of Primary Industries & Regional Development (DPIRD) (Fisheries) Vessel Check program (https://vessel-check.com/). The risk of introduced marine pests will be further minimized by the extreme environmental conditions in CG, which are not conducive to colonization by marine species, as evidenced by the general lack of benthic biota in CG.

11. IMPACT ASSESSMENT - AIR QUALITY

11.1 Relevant EPA Guidance & Objective

1. The EPA has published one guidance document relating to air quality - EPA 2016, *Environmental Factor Guideline - Air Quality.* The objective is:

   - *To maintain air quality and minimise emissions so that environmental values are protected.*

2. 'Air' refers to all the air above the ground up to and including the stratosphere and air quality is defined as:

   - *The chemical, physical, biological and aesthetic characteristics of air.*

3. The objective recognises the fundamental link between good air quality and the environmental values it supports, including:

   a) human health,
   b) amenity and social surroundings,
   c) flora and vegetation,
   d) terrestrial environmental quality; and
   e) marine environmental quality.

11.2 Receiving Environment

1. The receiving environment for air quality in the CG area is detailed in Referral Report No. 3, and is summarised below.

2. The receiving environment is the atmosphere above CG, which has a hot, semi-dry climate. The annual average maximum temperature is 35.6 °C, one of the highest in Australia. The cooler, winter dry season runs from April to early November, with average maximum temperatures (measured at Wyndham) of 31° C and virtually no rainfall, and the hot, summer wet season runs from late November to March, with average maximum temperatures of 39.5° C. The wettest month is usually January with an average rainfall of 108 mm, although rainfall can be much higher during cyclones and tropical 'low' depressions (www.weather-atlas.com).

3. In general terms, the larger-scale winds are dominated by the seasonal monsoons. North-westerly winds generally blow during the Summer Monsoon centred on the months of January to March/April, followed by strong easterlies/south-easterlies over winter (the 'south-east trade winds') and then a gradual return to north-westerly conditions in spring. Immediately around Wyndham, in the south of CG, the spring and summer winds are almost due north-to-south and the winter regime effectively due westward (Pearce et al 2015). Average wind speeds tend to be strongest at between 20 and 40 km/hour from the east and south-east during winter and into spring , although highest (extreme) wind speeds occur during Tropical Cyclones in the summer wet season.

4. There is no urban, industrial or other development on the coast or in the immediate catchment of CG that could be potential sources of air pollution inputs to the receiving atmospheric environment.

5. Currently, the only potential source of air pollution in CG is the ships that transit through CG when entering and departing the Port of Wyndham. Over the three-financial year period 2019/20 to 2022/23 there was an average of 1.3 commercial ship transits per week through CG (CGL 2024). These included small cruise ships, bulk carriers, petroleum tankers and general cargo ships, all of which have air emissions from their engines and machinery.

6. All such ships that enter Australian ports must comply with Annex VI (Air Pollution) of the *International Convention for the Prevention of Pollution form Ships* (MARPOL) and the implementing Australian regulations (AMSA Marine Order 97). Assuming that they comply, these ships should not cause negative impacts on air quality in the CG area.

11.3 Impact Assessment

1. The proposal does not involve the construction and operation of any shore-based facilities or infrastructure that could be sources of atmospheric emissions or contaminants.

2. The Sand Production Vessel (SPV) will generate routine air emissions from its engines and on-board machinery. The SPV will comply with Annex VI (Air Pollution) of MARPOL and AMSA Marine Order 97.

3. These regulations set strict standards and limits on emissions of nitrous oxides (NOx), sulphur oxides (SOx) (including setting sulphur content limits for marine fuels), volatile organic compounds (VOCs), particulate matter, ozone depleting

substances and greenhouse gases from ships. Any hydrocarbon-based fuels used will be ultra-low-sulphur fuels to meet MARPOL SOx emissions standards.

4. As part of BKA's fleet decarbonisation program, the SPV will be designed for dual-fuel use, allowing adoption of alternative cleaner fuels such as methanol as they become viable in future. The vessel could also potentially be fitted with Rotor Sails which can cut fuel consumption and this emissions on large ships by up to 30%.

5. The coastline around CG uninhabited by humans so there is no potential for impacts on human health.

6. Potential air pollution will also be minimized by the low operational presence of the SPV in CG – there will be zero operational presence in CG for 86% of the time during the project's lifespan of up to 15 years.

7. *Through these measures the SPV will not cause negative impacts on human health and amenity or the broader environment through impacts on air quality in the CG area.*

11.4 Application of the Mitigation Hierarchy & Assessment of Residual Impacts

1. As outlined in the relevant sections above there are four sequential levels in the WA EPA impact mitigation hierarchy:

    a) Avoid (prevent) impacts.
    b) Minimise (mitigate) impacts.
    c) Rehabilitate impacts.
    d) Offset impacts.

2. As outlined above impacts on air quality will be avoided (prevented) through compliance with MARPOL Annex VI and AMSA Marine Order 97, and if viable and feasible, use of alternative fuels such as methanol and Rotor Sails.

3. Other statutory decision-making processes that are applicable to the proposal, include regulatory oversight of the SPV by AMSA for compliance with MARPOL Annex VI and Marine Order 97, which may include Port State Control inspections, as well as the SPV's Flag State and classification inspections and surveys which also check for such compliance.

4. It is assessed that there will not be any impacts that will require rehabilitation or offsets. It is assessed that due to the effective avoidance, prevention, minimization and mitigation of potential impacts there will not be any residual impacts that will require rehabilitation or offsets.

TABLE 20: *Mitigation hierarchy & assessment of residual impacts for air quality.*

Potential Impact	**Impact Avoidance / Prevention**	**Impact Minimization / Mitigation**	**Rehabilitation & Offsets**	**Residual Impacts**
1. *Routine air emissions from the SPV's engines and onboard machinery:*	Compliance with MARPOL Annex VI. The coastline around CG uninhabited by humans so there is no potential for impacts on human health.	Potential air pollution will be minimized by the low operational presence of the SPV in CG – there will be zero operational presence in CG for 86% of the time during the project's lifespan of up to 15 years. Any hydrocarbon-based fuels will be ultra-low-sulphur fuels to meet MARPOL SOx emissions standards. As part of BKA's fleet decarbonisation program, the SPV will be designed for dual-fuel use, allowing adoption of alternative cleaner fuels as they become viable. The vessel could potentially be fitted with Rotor Sails which can cut emissions by up to 30%.	Not required.	None.

11.5 Likely Environmental Outcomes

1. The likely environmental outcomes with regard to air quality both during and at the end of the 15-year project timeframe is that there will not be any negative impacts on human health and amenity or the broader environment through impacts on air quality in the CG area.

12. IMPACT ASSESSMENT - GREENHOUSE GAS EMISSIONS

12.1 Relevant EPA Guidance & Objective

1. The EPA has published one guidance document relating to greenhouse gas (GHG) emissions - EPA 2023, *Environmental Factor Guideline - Greenhouse Gas Emissions*. The objective is:

   - *To minimise the risk of environmental harm associated with climate change by reducing greenhouse gas emissions as far as practicable.*

2. The the geographical scope of the Guideline is the State of WA and its environment.

3. The Guideline defines Scope 1, 2 and 3 emissions as follows:

   - Scope 1 emissions are those released to the atmosphere as a direct result of an activity, or a series of activities, which are part of a proposal being considered by the EPA.

   - Scope 2 emissions are those from the independent consumption of an energy product by the proposal. The EPA acknowledges that scope 2 emissions from a proposal are also the scope 1 emissions from an independent energy proposal. However, scope 2 emissions are relevant to the consideration of a proposal because the proponent has control over its choice of independent energy quantity and source.

   - Scope 3 emissions are indirect GHG emissions other than scope 2 emissions that are generated in the wider community. Scope 3 emissions (both upstream and downstream) occur as a consequence of the activities of a proposal, but from sources not owned or controlled by the proponent as part of the proposal.

4. The Guideline states that the EPA will consider GHG emissions from a proposal where they are reasonably likely to exceed:
   - 100,000 tonnes CO2-e of scope 1 emissions in any year; or
   - 100,000 tonnes CO2-e of scope 2 emissions in any year.

12.2 Receiving Environment

1. The receiving environment is the same as summarised for air quality in section 11.2 above.

12.3 Impact Assessment

1. The proposal does not involve the construction and operation of any shore-based facilities or infrastructure that require consumption of energy to supply them with electricity and that could be sources of GHG emissions. The only source of emissions will be directly from the operation of the SPV itself under Scope 1. Scope 2 and 3 emissions are not relevant to this proposal.

2. As with air quality above, the SPV will generate routine GHG emissions (mainly CO_2 and NOx) from its engines and on-board machinery. The SPV will comply with Annex VI (Air Pollution) of the MARPOL Convention and the implementing Australian regulations (AMSA Marine Order 97).

3. These regulations set strict standards and limits on GHG emissions from ships, and require ships to implement a range of on-board energy efficiency and emissions reduction strategies and plans, including having an IMO-compliant ship-specific Energy Efficiency Design Index (EEDI) and Shipboard Energy Efficiency Management Plan (SEEMP).

4. Boskalis also has a commercial imperative to reduce GHG emissions from its vessels as some measures to improve energy efficiency can result in significant reductions in operating costs, sometimes as much as 30%. Boskalis' is implementing a progressive, fleet-wide decarbonisation program, if certain technologies and measures are proven to be technically feasible and economically viable.

5. Modelling of GHG emissions from the current conceptual design of the base-case SPV, using standard low-sulphur fuel oil, indicates that based on a two-week operational cycle including one to two days operating in CG, followed by the voyage between CG and the sand delivery port (Singapore) and return, with 25 voyages per year, the mean GHG emissions while the vessel is operating in WA waters will be in the order of 13,000 metric tonnes/year CO2-e, or 13% of the EPA trigger value.

6. The actual emissions will likely be much less than the base-case modelling which assumes a standard vessel. As part of Boskalis' fleet decarbonisation program, the SPV will be designed for dual-fuel use, allowing adoption of alternative cleaner fuels such as methanol as they become viable in future. The vessel could also potentially be fitted with Rotor Sails which can cut fuel consumption and this emissions on large ships by up to 30%.

7. The emissions overall could therefore be as low as or even lower than 13,000 metric tonnes/year CO2-e when operating in WA waters, potentially as low as or even lower than 9,100 metric tonnes/year CO2-e (70% of 13,000), or just 9% of the of the EPA trigger value.

8. *This environmental factor is therefore not relevant to the proposal – as the proposal does not exceed or even approach the EPA's trigger of 100,000 tonnes/year CO2-e.*

13. IMPACT ASSESSMENT- SOCIAL SURROUNDINGS

13.1 Relevant EPA Guidance & Objective

1. The EPA has published two guidance documents relating to social surroundings:

   - EPA 2016, *Environmental Factor Guideline* - Social Surroundings.

   - WA EPA 2023, *Interim Technical Guidance, Environmental impact assessment of Social Surroundings - Aboriginal cultural heritage.*

2. The objective of the *Environmental Factor Guideline* is:

   - *To protect social surroundings from significant harm.*

3. The definition of social surroundings under the EP Act requires that for social surroundings to be considered in an assessment, there must be a clear link between a proposal's impact on the physical or biological surroundings and any subsequent impact on peoples' aesthetic, cultural, economic or social surroundings.

4. Aboriginal cultural heritage is identified as a specific and significant value within social surroundings. The 2023 *Interim Technical Guidance* outlines the criteria for whether or not the EPA will assess Aboriginal cultural heritage, and how potential impacts on Aboriginal cultural heritage should be assessed.

5. Separate from the EP Act the WA *Aboriginal Cultural Heritage Act* (ACH Act) protects Aboriginal cultural heritage in WA, and is administered by the Department of Planning, Lands & Heritage (DPLH). The EPA considers that potential harm to Aboriginal cultural heritage within an activity area may be mitigated by the ACH Act processes in most cases. However, this will be determined on a case-by-case basis and EPA assessment may still be required:

   - where ACH Act processes are not reasonably likely to be meet the EPA's objectives for social surroundings; and

   - for proposals where there is likely to be a significant impact from physical or biological surroundings which directly affect to ACH values outside an activity area.

6. Section 13.3 addresses the requirements of the 2023 *Interim Technical Guidance.*

13.2 Receiving Environment

1. The receiving environment for social surroundings in the CG area is detailed in Referral Report No. 3, and in summary has the following main features:

   a) Lack of human habitation & activity:

   - The receiving environment for social surroundings in CG is strongly influenced by the fact that the area is completely uninhabited, with no road access and no built facilities or infrastructure at all, except for an AMSA navigation light on a hill on Lacrosse Island.

   - The closest human habitation is at Wyndham located 80 km upstream of CG.

   - Human presence in CG is restricted to vessel-based operations, including:
     - commercial vessels that transit through CG entering and departing the Port of Wyndham located 80 km upstream (an average of 1.3 ships per week),
     - small private vessels from Wyndham and Kununurra used mainly for recreational fishing along the coast and up the inlets of CG; and
     - one commercial gillnet fisherman who is sometimes active in CG (and also along the adjacent coast outside CG.

   b) Aesthetic values:

   - CG has very high aesthetic values in the form of wild, untouched, natural scenery including rugged limestone cliffs along parts of the coast.

c) Non-Aboriginal cultural heritage values:

- No non-Aboriginal cultural heritage values including historic shipwrecks have been identified in the proposed operational area.

d) Aboriginal cultural heritage values:

- Full details of consultations held with the two relevant TO groups in the area (Balanggarra and Miriuwung-Gajerrong), search of the WA Aboriginal Cultural Heritage Inquiry System (ACHIS) and the comprehensive marine surveys undertaken by BKA for Aboriginal cultural heritage are presented in Referral Report No. 3 - *Traditional Owners, Native Title & Aboriginal Cultural Heritage.* In summary:

- Marine-based / inside activity area: Consultation with the two relevant TO groups and comprehensive marine surveys have not identified Aboriginal cultural heritage within the activity area (proposed operational area).

- Marine-based / outside activity area: Consultation with the two relevant TO groups and comprehensive marine surveys have not identified Aboriginal cultural heritage in other marine areas of CG outside of the proposed operational area.

- Land-based / outside activity area: There are significant Aboriginal cultural heritage sites on Lacrosse Island and on the adjacent mainland centred on Cape Domett, which will not be impacted in any way by the proposal.

e) Economic activity:

- Economic activity in CG currently comprises:
  - commercial ships that transit to and from the Port of Wyndham,
  - recreational fishing; and
  - one commercial gillnet fisherman who is sometimes active in CG (and also along the adjacent coast outside CG).

- Based on discussions held with a broad range of local and State stakeholders as part of BKA's consultation program, it appears that, apart from this proposal, there is unlikely to be any other economic activity in CG in the foreseeable future.

13.3 Impact Assessment

1. The potential for significant impacts on social surroundings in CG is limited by the fact that the area is completely uninhabited, with no road access and no built facilities or infrastructure.

2. Wyndham is too distant from the proposed operational area for social surroundings there to be affected. The proposal does not include any facilities or activities in Wyndham that could impact on social surroundings. The Sand Production Vessel (SPV) will not enter the Port of Wyndham as it will be too large to do so. A small vessel might be based in the Port of Wyndham to support environmental monitoring in CG and for occasional transfers to and from the SPV if needed.

3. The aesthetic values of CG will not be affected by the proposal as there will not be any alteration of the coastline or construction of any onshore or marine facilities or infrastructure, except perhaps a small, 10 m high meteorological mast in the Cape Dussejour area. This would be painted to blend with the environment.

4. The SPV will only be present in CG for one to two days every two weeks, so there will be zero visual activity in CG for 86% of the time each year. As outlined above, over the last three financial years an average of 1.3 commercial ships transited through CG per week (CGL 2024).

5. There is no marine non-Aboriginal cultural heritage with the activity area (proposed operational area) that might be impacted.

6. There is no marine Aboriginal cultural heritage with the activity area (proposed operational area) that might be impacted.

7. Land-based Aboriginal cultural heritage sites on Lacrosse Island and on the adjacent mainland centred on Cape Domett will not be impacted by the proposal, as there will not be any construction of onshore facilities or infrastructure or any land-based operations, except perhaps the small meteorological mast mentioned above, which would have TO approval and cultural heritage clearance.

8. Despite the fact that the proposal will not impact on land-based sites, should the proposal be approved and go ahead, BKA is offering to assist the TO groups to enhance protection of these sites, by supporting the development and implementation of a joint Aboriginal Cultural Heritage Management Plan (ACHMP), in accordance with their needs and requirements.

9. The economic activity of commercial vessels that transit to and from the Port of Wyndham will not be impacted by the proposal as normal navigational safety laws and procedures will apply to the SPV. BKA is consulting closely with relevant maritime and port authorities on this. The proposal will bring economic benefits to the Port of Wyndham as outlined below.

10. Recreational and commercial fishing will not be affected by the proposal as neither are active in the proposed operational area and the proposed operation will not affect fish stocks in CG, as outlined in section 10.

11. The proposal will generate the following economic benefits for Wyndham, Kununurra, the surrounding region and the state of WA:

    a) Payment of royalties per dry-tonne of sand to the State under the WA *Mining Act* over the 15-year life of the proposal.

    b) Payment of additional royalties per dry-tonne of sand to the two registered TO groups in the area (BAC and MG Corporation). This is not legally required but is being offered by BKA under MoUs being developed with each TO group. This may include establishing trust-fund mechanisms to support TO community development initiatives.

    c) Up to forty jobs for Australian crew on the SPV (alternating two-week swings of 20 crew each), with first priority given to local TOs, including training and career development.

    d) Offer of marine crew cadetships and training to local TOs on the Boskalis global fleet.

    e) Support to TOs to establish a small marine services business in Wyndham to support the operation in CG, for example transferring people, equipment and supplies when needed (bulk provisioning and refuelling of the SPV will be done at Asian sand delivery port as it will be too large to enter the Port of Wyndham).

    f) Environmental monitoring contract for the 15-year life of the proposal, ideally with TO indigenous ranger groups, including training, vessel and equipment.

    g) Funding for scientific research on key marine biodiversity and fisheries issues in the CG area, in consultation and cooperation with relevant partners.

    h) Possible sponsorship of the Wyndham Volunteer Marine Rescue Group and other similar groups and community initiatives.

12. *Overall, it is assessed that there will not be any negative impacts from the proposal on peoples' aesthetic, cultural, economic or social surroundings. The proposal will generate significant socioeconomic benefits.*

13.4 Application of the Mitigation Hierarchy & Assessment of Residual Impacts

1. As there will not be any negative impacts from the proposal on peoples' aesthetic, cultural, economic or social surroundings the mitigation hierarchy is not triggered – all potential negative impacts will be avoided.

2. There will not be any residual impacts that will require rehabilitation or offsets.

13.5 Likely Environmental Outcomes

1. The likely outcomes with regard to social surroundings both during and at the end of the 15-year project timeframe are positive, including:

    a) Payment of royalties to the State of WA
    b) Payment of voluntary royalties to the two TO groups in the area (BAC and MG Corp).
    c) Multiple job and career development opportunities for local TOs and other Australians (initially 40 jobs on the SPV and more in the Boskalis global fleet).
    d) Long-term contracts for local TOs and others for project support and environmental monitoring.
    e) Improved knowledge, understanding, protection and conservation of the environment, biodiversity and fisheries of the CG area through funding of scientific research on these issues in consultation and cooperation with relevant partners.
    f) Sponsorship of important community groups and initiatives, such as the Wyndham Volunteer Marine Rescue Group.

14. IMPACT ASSESSMENT - PROTECTED AREAS

1. As shown on Figure 43 there are five protected areas in the general vicinity of CG, as follows:

    a) The State North Kimberley Marine Park which starts at the seaward entrance to CG along the territorial sea baseline and extends out to the 3 nm limit of State coastal waters.
    b) The Commonwealth Joseph Bonaparte Gulf Marine Park located seaward of the State Marine Park.
    c) The State Ord River Nature Reserve which covers the Ord River Floodplain Ramsar Wetland to the east of CG.
    d) The State Mijing Conservation Park located 20 km inland from the east coast of CG.
    e) The Balanggarra Indigenous Protected Area (BIPA) which commences 10 km inland from the west coast of CG.

2. Each of these is briefly described in the following sections along with an assessment of the potential impacts of the proposal.

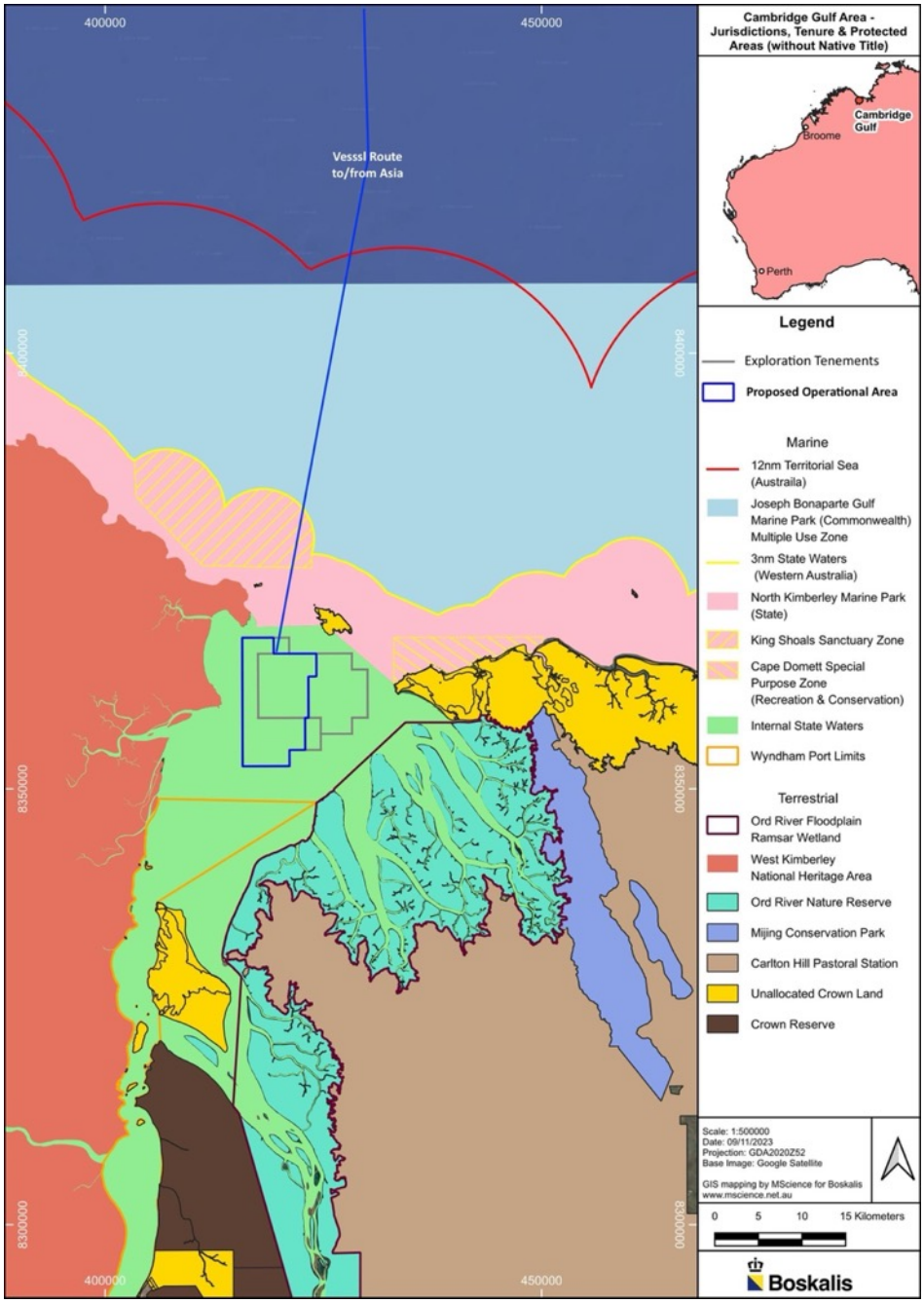


FIGURE 43: *Jurisdictions, Tenure & Protected Areas in the vicinity of the proposed operational area.*

14.1 The State North Kimberley Marine Park

1. The State North Kimberley Marine Park was gazetted in 2016 and starts at the seaward entrance to CG along the territorial sea baseline and extends out to the 3 nm limit of State coastal waters. The closest distance from the proposed operational area to the Marine Park is ~1.8 km from the northern boundary of the former to the southern boundary of the latter.

2. The Park is managed cooperatively with the two TO groups in the area, with a designated Balanggarra Management Area extending from CG to the west and a Miriuwung-Gajerrong Management Area extending from CG to the east. There are three Marine Park Zones in the CG area (Figure 44):

    a) Sanctuary Zone over King Shoals outside the western entrance to CG.
    b) Special Purpose Zone (Recreation & Conservation) extending east from Cape Domett.
    c) General Use Zone for the remaining areas.

3. Table 22 shows the activities that are permitted / prohibited in each zone. Vessel transits are permitted in all zones and there is a specific provision in the Marine Park Management Plan that no restrictions will be placed on commercial vessel transits to, from or within CG. The SPV will transit through the State Marine Park when arriving at and departing from CG, as marked on Figure 43, as per the commercial vessels that routinely enter and depart CG to service the Port of Wyndham (an average of 1.3 per week over the last three financial years). The SPV will comply with all relevant maritime laws and regulations and there will not be any discharges from the SPV when transiting the Marine Park.

4. The dry- and wet-season benthic surveys conducted by BKA to support this assessment, as detailed in Referral Report No. 3, included significant sampling in the State Marine Park including in the King Shoals Sanctuary Zone, under permit from DBCA. As detailed in Referral Report No. 3, the seabed substrate at King Shoals is mainly comprised of highly dynamic sand waves and supports relatively little benthic biota, with strong tidal currents, high turbidity and lack of light at the seabed. The most benthic biota was found in the General Use Zone on rocky seabed between Cape Dussejour and Fathom Rock, comprising a few very small hydroids, other coelenterates, bryozoans etc, attached to small rocks.

5. Given the factors above, it is assessed that the proposal will not cause any significant direct or indirect impacts on the State Marine Park.

TABLE 22: *The activities that are permitted / prohibited in each zone (source: North Kimberley Marine Park Management Plan)*

Activity	Sanctuary zones	Special purpose zone (recreation and conservation)	Special purpose zone (cultural heritage)	General use zones
Customary				
Customary activities (e.g. hunting and fishing)	Yes [a]	Yes [a]	Yes [a]	Yes [a]
Commercial				
Commercial gillnet fishing	No	No	Yes	Yes
Commercial prawn trawl fishing	No	No	Yes [b]	Yes [b]
Commercial fishing (other than gillnet and prawn trawl)	No	Yes	Yes	Yes
Pearling and associated activities	No	Assess	Yes	Yes
Aquaculture	No	Assess	Assess	Yes
Scenic flights (charter)	Yes	Yes	Yes	Yes
Ground-disturbing mineral and petroleum exploration and development [c]	No	Assess	No	Assess
Non-ground-disturbing geophysical surveys [d]	Assess	Assess	Assess	Assess
Ship loading and other mining related infrastructure (e.g. ship loading docks, cabling or pipelines)	No	Assess	No	Assess
General marine infrastructure (e.g. groynes or jetties)	No	Assess	Assess	Assess
Artificial structures (e.g. artificial reefs)	No	Assess	Assess	Assess
Dredging and dredge spoil dumping	No	Assess [e]	Assess [e]	Assess [e]
Charter tour operators – fishing	No	Yes	Yes	Yes
Charter tour operators – non-extractive (e.g. wildlife viewing)	Yes	Yes	Yes	Yes
Wildlife/fish feeding [f]	No	No	No	No
Recreational				
Boating (motorised and non-motorised)	Yes	Yes	Yes	Yes
Nature appreciation and wildlife viewing	Yes	Yes	Yes	Yes
Shore and boat fishing	No	Yes [h]	Yes	Yes
Other use				
Vessel transit [g]	Yes	Yes	Yes	Yes
Navigation aids	Yes	Yes	Yes	Yes
Research and monitoring	Yes	Yes	Yes	Yes
Anchoring (soft bottom only)	Yes	Yes	Yes	Yes
Seaplane, helicopter and remotely piloted aircraft (drone) launching and landing [i]	Assess	Assess	Assess	Yes
Vessel sewage discharge and de-ballasting	No	Yes [j]	Yes [j]	Yes [j]

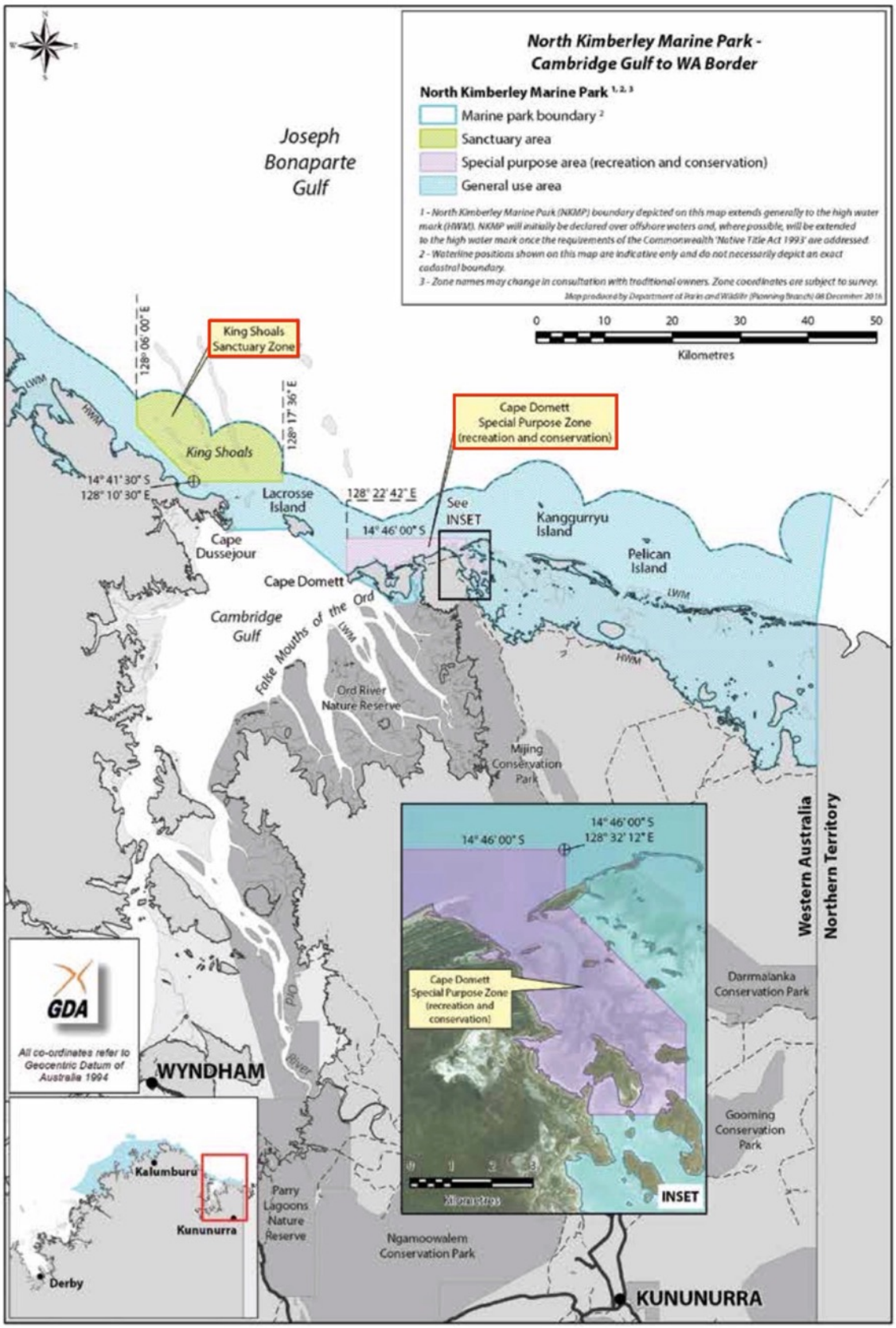


FIGURE 44: *The North Kimberley Marine Park zones in the CG area (source: North Kimberley Marine Park Management Plan)*

14.2 The Commonwealth Joseph Bonaparte Gulf Marine Park

1. The Joseph Bonaparte Gulf Marine Park covers Commonwealth waters seaward of the State Marine Park. The closest distance from the proposed operational area to the Marine Park is ~8 km from the northern boundary of the former to the southern boundary of the latter.

2. As shown on Figure 45 the Marine Park Zone immediately offshore from CG is a Multiple Use Zone which is the least restrictive zone, and vessel transits are permitted. The SPV will transit through the Commonwealth Marine Park when arriving at and departing from CG, as marked on Figure 43, as per the commercial vessels that routinely enter and depart CG to service the Port of Wyndham. The SPV will comply with all relevant maritime laws and regulations and there will not be any discharges from the SPV when transiting the Marine Park.

3. Given these factors, it is assessed that the proposal will not cause any significant direct or indirect impacts on the Commonwealth Marine Park.

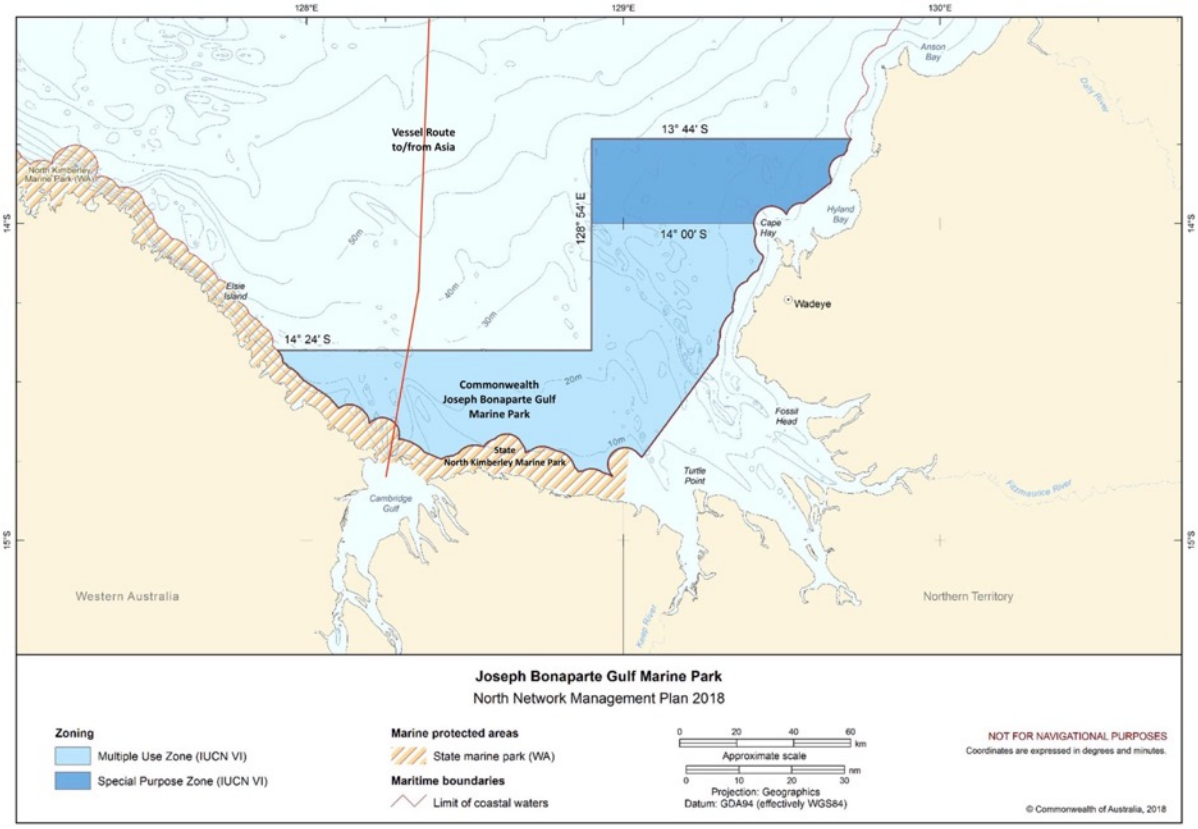


FIGURE 45: *The Commonwealth Joseph Bonaparte Gulf Marine Park (source: North Network Management Plan 2018)*

14.3 The State Ord River Nature Reserve

1. The State Ord River Nature Reserve covers the Ord River Floodplain Ramsar Wetland on the eastern side of CG (Figure 46). Part of the eastern boundary abuts the Mijing Conservation Park (see section 14.4).

2. The Ramsar Wetland is of international significance, being designated under the *Convention on Wetlands of International Importance* signed at Ramsar, Iran in 1971. The wetland comprises a complex system of estuarine inlets just inshore from Cape Domett, lined with relatively narrow bands of fringing mangroves and backed by tidal flats, known as the 'False Mouth of the Ord River'. It was listed under the Ramsar Convention in 1990 with the following values:

    a) The site represents the best example of wetlands associated with the floodplain and estuary of a tropical river system in the Kimberley region of WA.

    b) Of the 19 species of mangrove found in WA, 15 have been recorded within the Ramsar Site.

    c) It is a nursery, feeding and/or breeding ground for migratory birds and waterbirds.

d) The site supports a number of species protected under the EPBC Act, including Freshwater Sawfish (*Pristis microdon),* Green Sawfish *(Pristis zijsron),* Northern River Shark *(Glyphis garricki)*, Saltwater Crocodile *(Crocodylus porosus)* and the Australian Painted Snipe *(Rostratula australis)*.

e) The site regularly supports 1% of the population of Plumed Whistling Duck *(Dendrocygna eytoni)* and Little Curlew *(Numenius minutes)*.

3. The closest distance from the proposed operational area to the Ord River Nature Reserve is ~6 km from the eastern boundary of the former and the western boundary of the latter. There will therefore not be any direct impacts from the proposal on the reserve.

4. However, given its international significance as a Ramsar-listed wetland, BKA has given particular attention to assessing potential indirect impacts of the proposal on the area, including but not limited to potential changes to sediment dynamics and coastal processes, as presented in detail in Referral Report No. 6 - *Cambridge Gulf Metcocean & Sediment Dynamics - System Understanding, Conceptual Model & Initial Modelling & Supplementary Technical Note* (PCS 2024a).

5. As assessed in that report and presented in section 8 - *Coastal Processes* of this report, there does not appear to be significant sediment connection between the proposed operational area and the wetland – there appears to be net outflow of sediment from CG, the proposed operational area is located 'downstream' of the wetland, and most input appears to be on the western side of the Gulf (Wolanski et al 2001 & 2004), while the wetland is located on the eastern side. It is assessed that the proposal is unlikely to affect the wetland through changes to coastal processes.

6. In terms of coastal processes it should be noted that the wetland is formed by and naturally adapted to extreme inter-annual variations in wet season flooding and sedimentation and extreme natural destructive forces such as cyclones (Wolanski et al 2001 & 2004) (Hale 2008). As outlined in sections 7.2.3 and 8, the False Mouths of the Ord appear to be naturally highly dynamic with numerous areas of significant natural erosion and undercutting of mangroves. These erosion areas mainly face to the north west and may therefore be impacted by north westerly winds and waves and less sheltered from cyclone impacts than other parts of CG.

5. Because Ramsar sites are listed as Matters of National Environmental Significance (MNES) under the Commonwealth EPBC Act, a detailed assessment of potential impacts is included in Referral Report No. 8 - *Commonwealth Matters*. The assessment was undertaken in accordance with the DCCEEW Significant Impact Criteria for Ramsar wetlands, which are as follows:

Is there is a real chance or possibility that the proposal will result in:

- *Areas of the wetland being destroyed or substantially modified?*
- *A substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows?*
- *The habitat or lifecycle of native species, including invertebrate fauna and fish species, dependant upon the wetland being seriously affected?*
- *A substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health?*
- *An invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland?*

6. The assessment as presented in Referral Report No. 8, supported by Referral Report No. 6, finds that no significant impact is likely against each of these significant impact criteria.

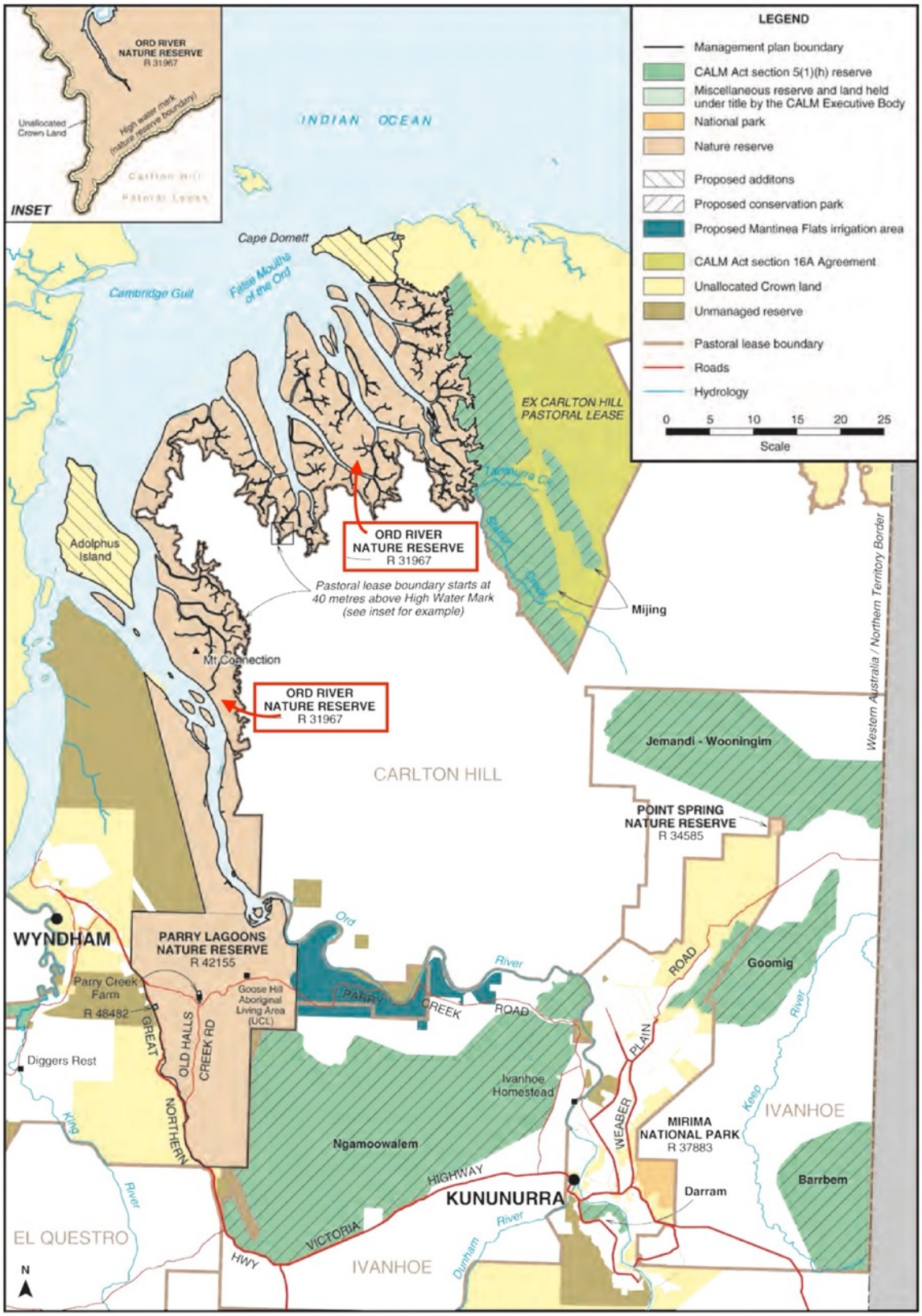


FIGURE 46: *The Ord River Nature Reserve which covers the Ord River Floodplain Ramsar Wetland (source: Ord River & Parry Lagoons Nature Reserves Management 2017)*

14.4 The State Mijing Conservation Park

1. On the eastern side of CG the Miriuwung-Gejerrong (MG) people co-manage a number of conservation areas jointly with DBCA, with their Indigenous Rangers being employed directly by DBCA. The land is owned by MG Corporation and leased to the State Government for conservation purposes, with agreed Joint Management Plans between the parties.

2. These areas are mainly clustered around Kununurra as shown on Figure 47. The closest of these to CG is the Mijing Conservation Park (MCP) just south of Cape Domett, abutting the north-eastern boundary of the Ord River Floodplain Ramsar wetland, which is protected by the State-designated Ord River Nature Reserve (Figure 43 and Figure 46).

3. The MCP covers 25,529 ha and is managed to protect a number of key biodiversity values. The landscape is defined by the Ningbing Range, consisting of limestone that was formed as part of an ancient (Devonian) barrier reef system and contains large deposits of marine fossils. The limestone range and its karst outcrops are surrounded by dense, low deciduous vine thickets. These are uniquely diverse and species rich in comparison to similar areas in the North and East Kimberley. The rugged topography of the range provides important refuge habitat for animals from fire. Freshwater creeks and waterbodies on the western side of the range towards CG provide important habitat for various waterbirds and other bird species (Graham & White 1999). There are also significant Aboriginal cultural heritage values throughout the MCP.

4. The closest distance between the MCP and the proposed operational area is over 20 km, and the proposal will therefore not cause any direct or indirect impacts on the MCP, or on any coastal or land areas around CG.

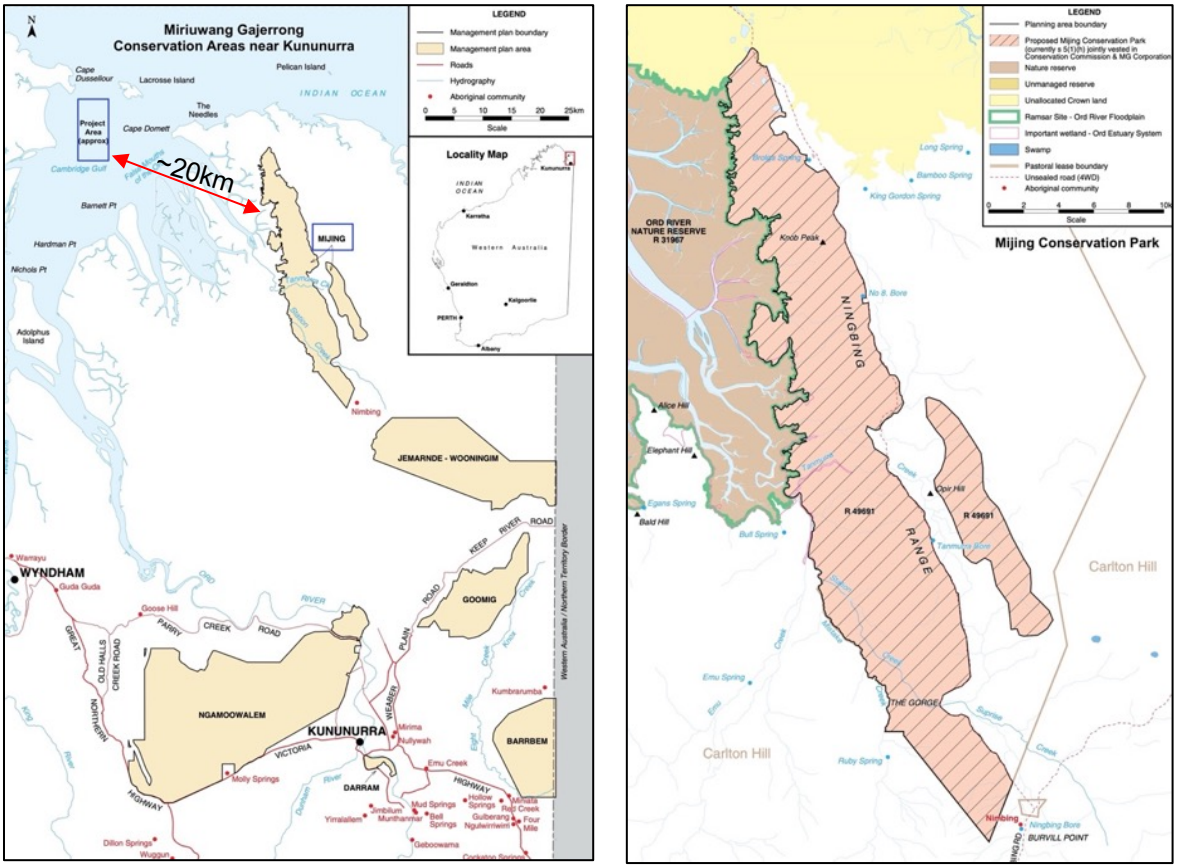


FIGURE 47: Left: *MG conservation areas near Kununurra.* Right: *The closest to CG is the Mijing Conservation Park (source: MG Corporation)*

14.5 The Balanggarra Indigenous Protected Area

1. An Indigenous Protected Area (IPA) is a voluntary agreement between TOs and the Australian Commonwealth Government to manage areas of their land and/or sea country for environmental protection, biodiversity conservation and cultural heritage preservation, balanced with sustainable use of the area to deliver cultural, social and economic benefits for the local indigenous people. Some areas of IPAs with high conservation value are recognized as part for the National Reserve System for protection of Australia's biodiversity and cultural heritage, and IPAs currently make up over 50% of the National Reserve System.

2. Management of IPAs is undertaken by the TOs including Indigenous Rangers, often in partnership with either or both the Commonwealth Government and/or the relevant State Government. Management plans for IPAs are developed in accordance with the TOs objectives for their area, and often seek to blend traditional indigenous approaches to natural resource management with modern scientific methods.

3. Nationally, the IPA program is jointly administered by the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) and the National Indigenous Australians Agency (NIAA), a Commonwealth Government Agency which coordinates implementation of much of the Australian Government's indigenous affairs program.

4. The Balanggarra IPA was declared in May 2013 and covers over 10,000 km^2 of the Balanggarra Native Title determination area to the west of CG as shown on Figure 48. The IPA includes both significant biodiversity values and cultural heritage sites, including significant areas of rock art with elegant human-like images of *Girri-girro* (Bradshaw figures).

5. The Balanggarra IPA is managed as a Category VI protected area under the classification scheme of the International Union for Conservation of Nature (IUCN), which is a protected area that allows sustainable use of natural resources. It is managed by the Commonwealth-funded Balangarra Indigenous Rangers in partnership with the WA Department of Biodiversity Conservation & Attractions (DBCA), in accordance with the vision, targets and principles outlined in the Balanggarra Healthy Country Plan. The BAC has also signed a Joint Management Agreement with DBCA for the joint management of the Balanggarra parts of the North Kimberley Marine Park.

6. The eastern boundary of the Balanggarra IPA is set back from the west coast of CG by around 10 km (Figures 43 and48), and the proposal will therefore not cause any impacts on the IPA, or on any coastal or land areas around CG.

7. Should the proposal be approved and go ahead, BKA is offering to support the TO groups in undertaking research and monitoring of marine biodiversity and key marine fauna species, which will enhance protection and management of marine areas.

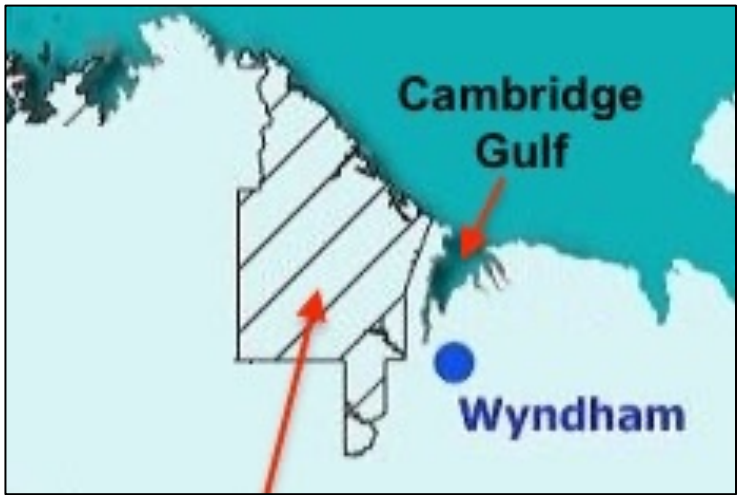


FIGURE 48: *The Balanggarra IPA (source: KLC)* [I am trying to source a better map]

14.6 Summary Assessment of Impacts on Protected Areas

1. Overall, it is assessed that the proposal will not cause any significant direct or indirect impacts on any of the five protected areas located in the general vicinity of CG.

2. There are no overlaps between the proposed operational area and any of the protected areas so there is no potential for direct impacts. The potential for indirect impacts has been assessed and found to be unlikely, due to the lack of relevant impact-causing mechanisms from the proposed operation, the distances between the proposed operational area and the protected areas, and the nature of the environments in the protected areas.

3. The SPV will transit through both the State and the Commonwealth Marine Parks when arriving at and departing from CG, as marked on Figure 43, as per the commercial vessels that routinely enter and depart CG to service the Port of Wyndham. The SPV will comply with all relevant maritime laws and regulations and there will not be any discharges from the SPV when transiting the Marine Parks.

15. IMPACT ASSESSMENT - COMMONWEALTH MATTERS

1. Detailed assessment of the proposal in relation to Commonwealth matters under the EPBC Act is contained in Referral Report No. 7 - *Commonwealth Protected Matters* (BKA 2024f). The findings of that report are not repeated here for reasons of economy, however the main findings are summarized below.

2. A search of the EPBC Act Protected Matters Search Tool (PMST) found that the proposed operational area is located within the general biological range of several threatened species and several migratory species, which are defined as MNES. The PMST search also found that a 10 km buffer around the proposed operational area overlaps with the range of some additional MNES species.

3. Due to the low resolution of biogeographical range data that supports the PMST, many of the species listed as likely to be present are actually highly unlikely to be in those areas. Large whale species, large shark species, wholly-pelagic offshore species, shore-based bird-species, fully land-based bird species and even some small terrestrial mammals are listed as being within CG – when local scale data and knowledge of habitat preferences versus environmental conditions in CG indicate that this is highly unlikely or even impossible. This is addressed for each species in the report where relevant.

4. The PMST search found that CG is within an inter-nesting buffer Biologically Important Area (BIA) for Flatback Turtles (*Natator depressus*) and a breeding, calving, feeding and resting BIA for the Australian Snubfin Dolphin (*(Orvaella heinsohni),* and these are assessed in detail.

5. The PMST search found that the 10 km buffer around the proposed operational area overlaps slightly with three area-based MNES, the West Kimberley National Heritage area (the eastern boundary of which follows the west coast of CG), the Ord River Floodplain Ramsar site located on the eastern side of CG, and Commonwealth waters including the Joseph Bonaparte Gulf Marine Park located offshore from CG.

6. The potential for the proposed sand-sourcing operation to cause significant impacts on the identified MNES is systematically assessed in accordance with the EPBC Act significant impact criteria for each MNES type, as per the Commonwealth Significant Impact Guidelines[1], considering the nature, scope, scale and duration of the proposed operation, and the application of the WA EPA's impact mitigation hierarchy of avoid, minimize, offset and rehabilitate impacts.

7. *This assessment in Referral Report No. 7 finds that the proposed action does not pose a risk of significant impact on any of the identified MNES, as defined by the Commonwealth Significant Impact Guidelines*

[1] www.dcceew.gov.au/environment/epbc/publications/significant-impact-guidelines-11-matters-national-environmental-significance

16. CUMULATIVE & HOLISTIC IMPACT ASSESSMENT

1. As outlined in section 3.1, when considering significant impact or effect, the EPA may have regard to various matters, including cumulative impact with other existing or reasonably foreseeable activities and connections and interactions between parts of the environment to inform a holistic view of impacts to the whole environment. These are discussed below.

16.1 Cumulative Impacts - Existing Uses in CG

a) The potential for cumulative impacts from the proposal is limited by the fact that the CG area is completely uninhabited, with no road access and no development, built facilities or infrastructure. Human activity in CG is restricted to vessel-based operations, including:

    a) commercial vessels that transit through CG entering and departing the Port of Wyndham (on average 1.3 per week),

    b) small private vessels from Wyndham and Kununurra used mainly for recreational fishing along the coast and up the inlets of CG; and

    c) one commercial gillnet fisherman who is sometimes active in CG (and also along the adjacent coast outside CG).

b) None of these other human uses of the area cause significant impacts on the environment, so do not add cumulative impacts for the BKA proposal.

c) Based on discussions held with a broad range of local and State stakeholders as part of BKA's consultation program it appears unlikely that there will be other developments in CG in the foreseeable future (see Referral Report No. 7 - *Stakeholder Consultations*).

16.2 Cumulative Impacts - Ord River Dams

1. There have been no previous developments in CG itself that provide a basis for the BKA proposal to cause cumulative impacts.

2. Upstream of CG, the building of two dams on the Ord River may provide a bases for triggering cumulative impacts. The Kununurra Diversion dam was built in 1963 near Kununurra located 120 km upstream from CG, and the Ord River Dam was built in 1973 for the Ord River Irrigation Scheme, located 150 km upstream from CG. Reportedly, the dams have interrupted the supply of sediment to the lower Ord River which drains into the East Arm of CG.

3. This also caused significant build-up of sand and silt in the lower Ord just south of Adolphus Island, due to the lack of wet season flushing since building of the dams, and inflow of sediment from the West Arm of CG. This has also caused an expansion of mangroves in the lower Ord (Wolanksi et al 2001).

4. At August 2024 PCS is undertaking modelling simulations at the end of the 15 years of proposed sand sourcing compared a pre-European conditions simulation, to show the 'cumulative' impacts of the Ord River Dam and the proposed sand sourcing. This will be reported and submitted to EPA in a supplementary Referral report.

16.3 Holistic Impact Assessment

1. In terms of holistic impact assessment, it is necessary to consider linkages and interactions between relevant environmental factors. For example, if there are changes to coastal processes, could that in turn cause impacts on benthic communities and habitats, if there are changes to marine environmental quality, could that in turn cause impacts on marine fauna, or if there are changes to air quality, could that impact on the environmental values that rely in good air quality, etc.

2. The EPA Environmental Factor Guidelines high-light the links between various environmental factors and the environmental values that they support – and the assessment of each environmental factor presented in the sections above explicitly assessed these linkages, as part of holistic impact assessment.

3. Overall, the assessments presented in the sections above find that because there are unlikely to be significant impacts on any one environmental factor and their supported environmental values, when combined as a whole, the holistic assessment is also that there are unlikely to be significant impacts overall.

17. ENVIRONMENTAL MANAGEMENT PLAN

1. It will be necessary to develop a comprehensive environmental management plan (EMP) for the proposal, ideally in consultation with relevant regulatory agencies including WA EPA, DWER, DBCA and DPIRD Fisheries, and because the proposal is subject the comprehensive environmental assessment and management framework of the WA Mining Act, also DEMIRS.

2. The EMP will follow the EPA environmental management hierarchy and include the impact avoidance, prevention, minimisation and mitigation measures outlined for each of the relevant EPA environmental factors, as presented in the mitigation hierarchy tables for each factor in section 7.4 for BCH, section 8.4 for coastal processes, section 9.4 for MEQ, section 10.4 for marine fauna, section 11.4 for air quality and section 13.4 for social surroundings. The mitigation hierarchy tables in those sections are not repeated here for reasons of economy. These will be integrated into the EMP as it is developed.

3. The EMP will also address the following requirements of DEMIRS, as outlined in their *Statutory Guidelines for Mining Proposals* and related guidance:

    a) In addition to the EPA environmental factors, it will address the DEMIRS environmental factors, with biodiversity being a key common factor.

    b) It will include an overall Environmental Management System (EMS) for the proposed operation.

    c) It will include an Environmental Risk Assessment (ERA) that:
        - Identifies all the environmental risk pathways affecting DMIRS Environmental Factors across all phases of the mine life and that may arise from unexpected or emergency conditions.
        - Includes analysis of risks to derive an inherent risk rating, prior to the application of treatments.
        - Identifies appropriate risk treatments.
        - Includes an evaluation of the risk pathways to derive a residual risk rating.
        - Demonstrates that all residual risks are as low as reasonably practicable (ALARP).

    d) It will include an Environmental Outcomes, Performance Criteria & Monitoring, including a table of site-specific environmental outcomes that the operation will achieve, along with performance criteria for each outcome.

    e) It will also include a description of the monitoring that will be undertaken to measure each performance criteria.

    f) It will include a Mine Closure Plan (MCP).

4. BKA would seek to undertake environmental monitoring in cooperation with the Traditional Owners (TOs) and relevant regulatory authorities. Monitoring activities could include, *inter alia:*

    a) periodic bathymetric surveys to assess seabed dynamics in response to sand removal; and

    b) periodic drone-Lidar surveys of the Cambridge Gulf coastline to assess coastal dynamics in response to sand removal.

5. Should the project be approved, BKA is prepared to support, in consultation and cooperation with the local TOs and other relevant stakeholders such as DWER, DBCA and DPIRD Fisheries, and within reason relative to the scale of the project:

    a) long-term research and monitoring of Flatback Turtles, Snubfin Dolphins, Humpback Dolphins, River Sharks and Sawfish in Cambridge Gulf; and

    b) long-term research and monitoring of ecological connections between Cambridge Gulf and offshore areas including in relation to the prawn fishery, mud crabs and other commercial fish species.

6. The EMP will include relevant reporting, review and management response arrangements.

18. ASSESSMENT OF ALTERNATIVES

1. Currently most construction sand in Australia comes from land-based sources, which can cause relatively high environmental impacts including clearing of terrestrial vegetation and habitat, impacts on terrestrial fauna, potential impacts on freshwater courses and groundwater, high aesthetic impacts, high rehabilitation costs with mixed success rates, and high transport cost and carbon footprint including reliance on trucking and a need for multi-handling.

2. BKA is seeking to develop marine sands as a more sustainable alternative to land-based sands, because:

    a) there is no requirement to clear vegetation/habitat,

    b) there are no impacts on freshwater courses or groundwater,

    c) there are no aesthetic impacts,

    d) there is natural replenishment from catchment sources; and

    e) there are much lower transport cost and carbon footprint through the use of a marine vessel with no need for multi-handling.

3. BKA has undertaken a screening of potential alternative marine sand sites including:

    a) Other potential sites across the north of WA such as, from west to east Admiralty Bay, Vansittart Bay, Napier Broome Bay and Unsurveyed Bay, as shown on Figure 50. These were screened out as they have lower suspended sediment regimes / clearer water and more significant environmental values including coral and seagrass communities, which are not present in CG (the Balanggarra people referred to CG as 'brown water country' and the coastal waters west of CG as 'blue water country' – BKA wishes to avoid blue water country).

    b) Blocks 1, 2, 2A and 3 offshore from CG as shown on Figure 51. Based on analysis of existing data Blocks 1 and 3 appear to have very significant sand resources, but were screened out as they are in the Commonwealth Joseph Bonaparte Gulf Marine Park, as was Block 2. While sand sourcing can be permitted in the Multiple Use Zone Marine Park subject to assessment and conditions, as an environmentally-responsible company BKA prefers not to seek to undertake developments in protected areas where suitable alternatives exist.

    c) Block 2A is outside of the Commonwealth Marine Park but was screened out as, based on analysis of existing data, it does not appear to have a significant sand resource.

4. There are also two are possible alternative sand sources in the immediate vicinity to seaward of CG as shown on Figure 52:

    a) King Shoals on the western side; and

    b) Medusa Banks on the eastern side.

5. Based on analysis of existing data both of these areas contain sand resources that are likely orders of magnitude greater than within CG.

6. However, despite its abundant sand resource, King Shoals were screened out as they are located within a Sanctuary Zone of the State North Kimberley Marine Park (even though benthic surveys indicate that they do not support significant benthic communities – see section 7.2 and Referral Report No. 2).

7. Medusa Banks were screened out as they are located immediately offshore from the Cape Domett turtle nesting beach and protecting that beach is an extremely high priority for BKA.

8. The screening process has therefore arrived at Blocks 4 and 4A within CG, equating to DEMIRS Exploration Tenements E80/5655 and E80/6009, as being the preferred site. Benefits of the site within CG include:

    a) There is a very significant sand resource in CG with ongoing natural inputs from the catchment.

    b) There is an existing operational port at Wyndham with commercial shipping traffic through CG, whereas alternatives are 'greenfield' sites with no existing operational activity.

    c) There is very low potential for impacts on other uses and users of the area, as there is very limited use of CG by other marine users, including:

- only one active gillnet fisherman (currently not active and supportive of the proposal),
- a focus of recreational fishing on areas near the coast and up inlets, and not in the proposed operational area where strong currents make conditions unworkable for fishing (the sector has been consulted and is not concerned about the proposal); and
- no tourism sector in CG (although cruise vessels do pass through CG to access the Port of Wyndham for fuelling and resupply, and there are two recreational fishing tour operators based in Wyndham, who target upstream areas and whos' vessels are not certified to operate in CG).

d) The area is highly dynamic with strong tidal currents (>2 m/s), a constantly moving seabed, a permanently dark aphotic resuspension layer at the seabed, and extremely high natural suspended sediment and turbidity levels

e) Due to the extreme environmental conditions the area does not host sensitive benthic ecological communities including coral reefs, seagrass beds, sponge beds, macroalgae communities etc, so there is no potential to impact on such communities.

f) Due to the extreme environmental conditions the sand in the proposed operational area and seabed sediments through CG support very low abundance and diversity of very small benthic invertebrates. Most benthic grab samples from sand areas returned no biota at all with sieving to 500 microns, and some samples from non-sand areas returned small numbers of small hydroids attached to small rocks and some other small invertebrates (refer Referral Report No. 2).

9. *Overall, the proposed site in CG is the better option over the assessed alternatives in terms of comparative net environmental outcomes.*

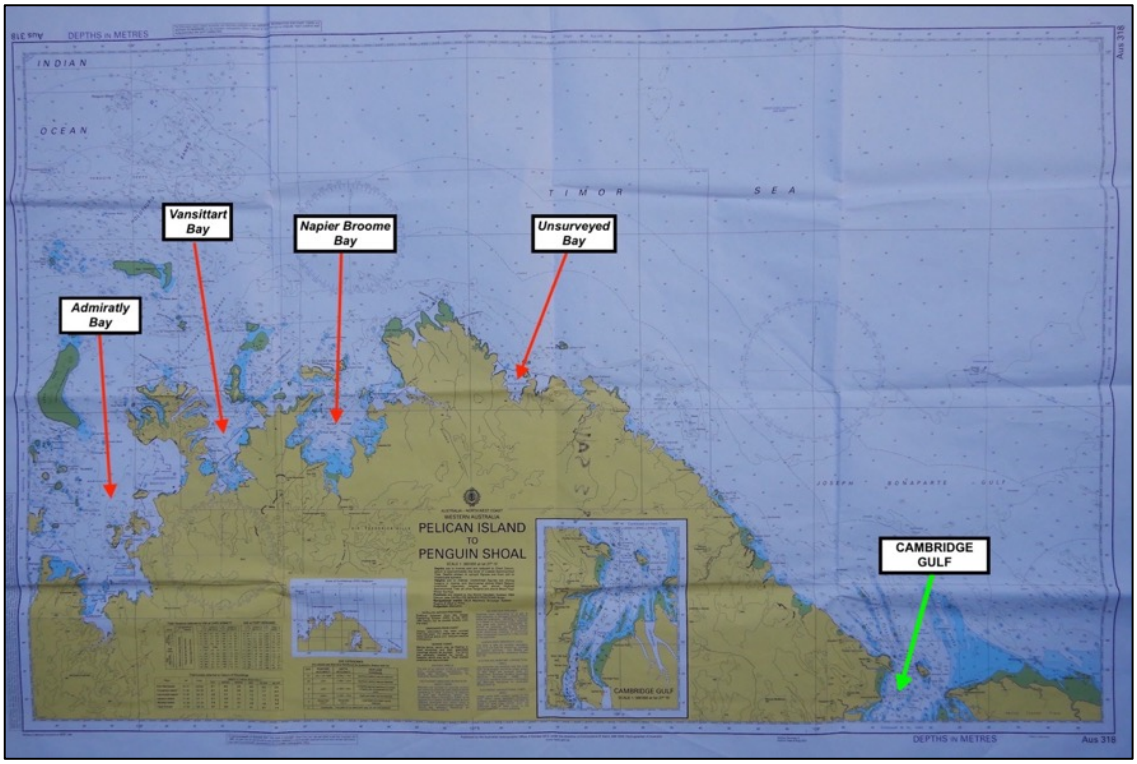


FIGURE 50: *Potential alternative sand source areas across the north of WA to the west of CG. These were screened out as the have clearer water and more significant environmental values including coral and seagrass communities, which are not present in CG (Chart AUS 318).*

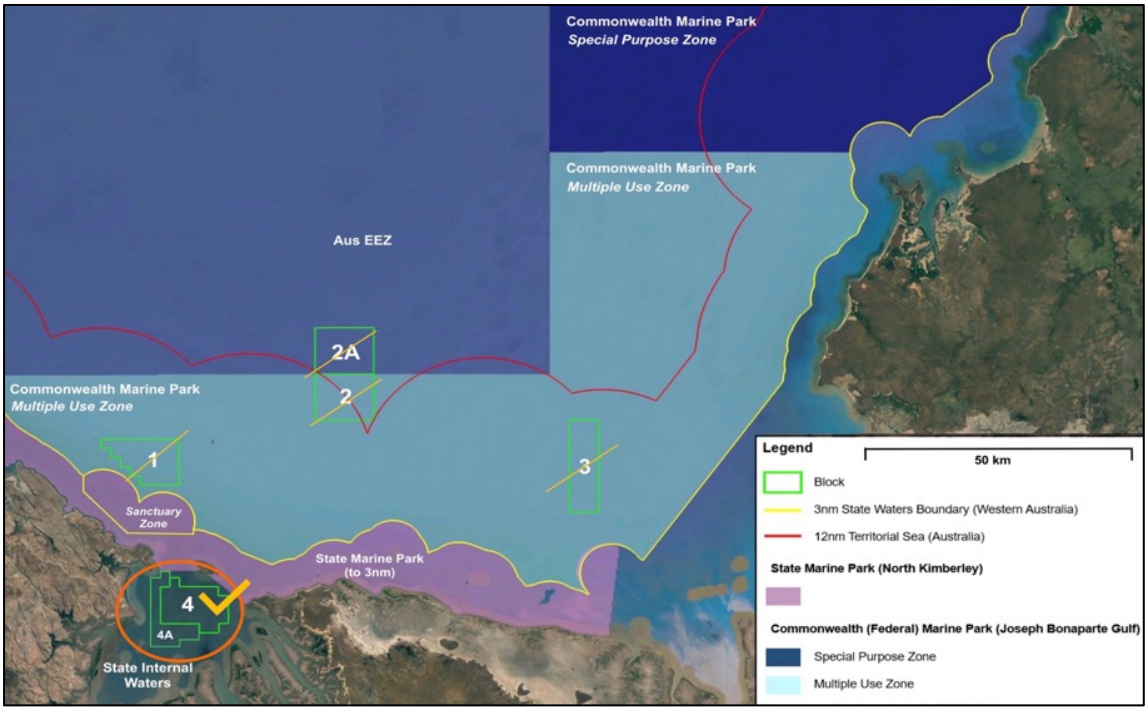


FIGURE 51: *Potential alternative sand source areas offshore from CG – Blocks 1, 2, 2A and 3.*

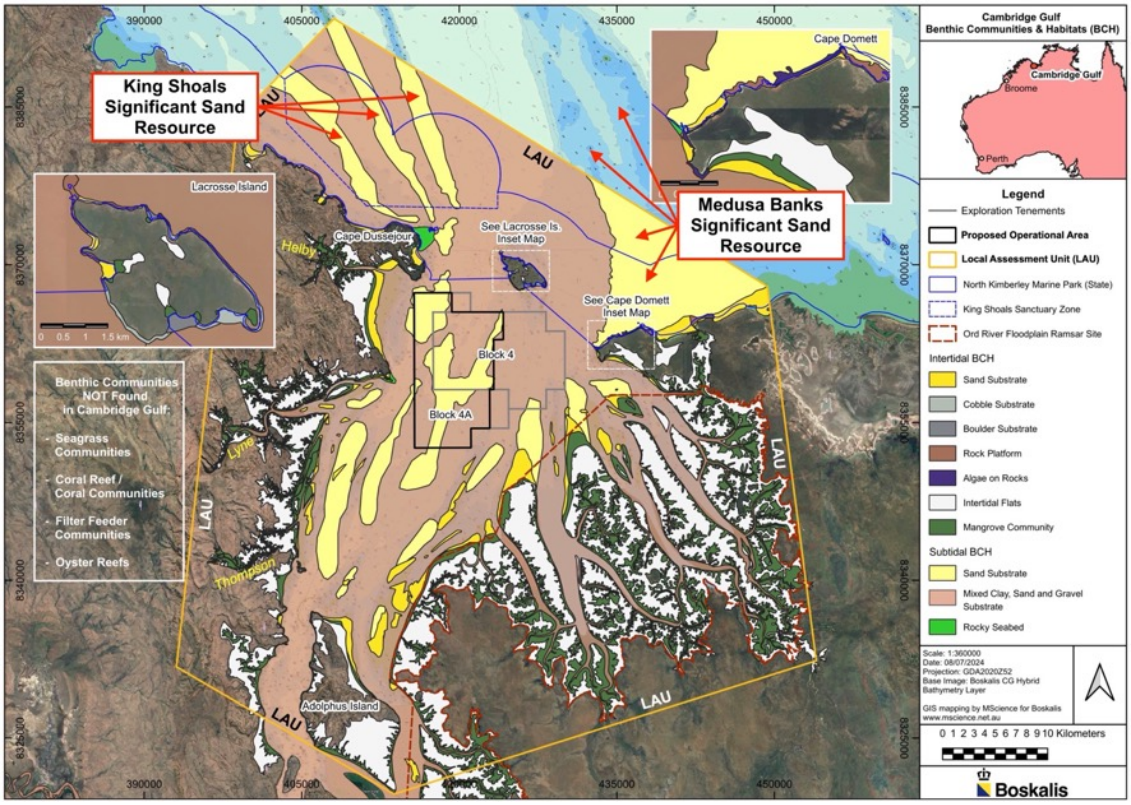


FIGURE 52: *Two potential alternative sand sources in the immediate vicinity of CG - King Shoals on the western side and Medusa Banks on the eastern side to seaward of CG.*

19. OTHER STATUTORY DECISION-MAKING PROCESSES

1. Two of the main statutory decision-making processes that are applicable to the proposal other than the WA EP Act are outlined in the sections below. There are multiple other laws and regulations that apply to the proposal.

2. A detailed assessment of all relevant state, commonwealth and international laws and how they apply to the proposal is presented in Referral Report No. 1 - *Environmental Regulatory Framework* (BKA 2024a).

19.1 WA Mining Act

1. In order for the proposal to proceed to operational phase BKA is applying to the WA Department of Energy, Mines, Industry Regulation & Safety (DEMIRS) to convert the CG Mining Exploration Tenements to a Mining Licence under the WA *Mining Act*, for a reduced area as shown as the proposed operational area on Figures 1 and 2 in section 1.

2. This includes addressing the Mining Act's comprehensive environmental assessment framework, which in itself constitutes a thorough environmental impact assessment and requires a mandatory environmental management plan and system for the proposal. In addressing these requirements BKA is following relevant DEMIRS standards and guidelines, including:

    a) Statutory Guidelines for Mining Proposals 2020.
    b) Environmental Regulatory Strategy 2021.
    c) Environmental Objectives Policy for Mining 2020.
    d) Environmental Applications Administrative Procedures 2021.

3. In accordance with these requirements BKA is developing and will submit the following to DEMIRS:

    a) an Environmental Group Site (EGS) Details Form,
    b) a Mining Proposal Checklist,
    c) a report on Stakeholder Engagement activities and outcomes (as per EP Act Referral Report No. 7),
    d) a report on Baseline Environmental Data (as per EP Act Referral Report No. 3)
    e) an Environmental Risk Assessment (ERA),
    f) an Environmental Outcomes, Performance Criteria & Monitoring Plan (EOPCMP)(addressing relevant DEMIRS Environmental Factors),
    g) an Environmental Management System (EMS); and
    h) a Mine Closure Plan (MCP).

19.2 International Maritime Law & Regulatory Oversight of the SPV by AMSA

1. As an internationally-registered vessel the SPV will be designed, built and operated in full compliance with all relevant latest requirements of the International Maritime Organization (IMO) and the Australian Maritime Safety Authority (AMSA), including COLREGs, SOLAS, STCW, AFS Convention, BWM Convention and MARPOL and the relevant implementing Australian laws and regulations, including *inter alia* the *Navigation Act* and the *Protection of the Sea (Prevention of Pollution form Ships) Act* and AMSA Marine Orders.

2. AMSA will have regulatory oversight of the SPV which may include Port State Control inspections. In addition, there will be Flag State and classification society inspections and surveys of the SPV which also check for such compliance.

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ANNEX 1: MAIN DATASETS USED TO INFORM IMPACT ASSESSMENTS

The main datasets used are listed according to Key Environmental Factors (KEFs) as follows:

- Annex 1.1: Benthic communities & habitats.
- Annex 1.2: Coastal Processes.
- Annex 1.3: Marine Environmental Quality.
- Annex 1.4: Marine Fauna.
- Annex 1.5: Air Quality.
- Annex 1.6: Greenhouse Gas Emissions.
- Annex 1.7: Social Surroundings.

Supporting Figures for each KEF are presented after the Annexes, in sequence cited.

Note: In addition to the main studies and datasets listed under each environmental factor in Annexes 1.1 to 1.7, the impact assessments are also informed by additional studies, reports, papers and other sources as cited in each section of this report and listed in the References section.

A.1.1: Main Datasets Used to Inform Impact Assessment for Benthic Communities & Habitats

Study / Dataset	By	Key Data	Temporal Scope	Spatial Scope
Pre-existing Studies & Datasets				
Australian National Intertidal-Subtidal Benthic (NISB) Habitat Classification Scheme.	Commonwealth DCCEEW & UTAS (Mount et al 2007).	Defines NISB habitat classes such coral reef, rock dominated habitat, sediment dominated habitat, mangroves, saltmarsh, seagrass, macroalgae and filter feeders (e.g. sponges) etc.	Published 2007.	National
Australian Estuarine, Coastal and Marine (ECM) National Habitat Map Series.	Commonwealth DCCEEW & UTAS (Mount & Bricher 2008).	10 km and 50 km tile maps for each State showing the NISB habitat classes. The map for Cambridge Gulf area derives intertidal sand substrate, mangrove and salt marsh habitats.	Data from 1987 to 2007.	All of CG
British Admiralty Chart 1049 - A Plan of Cambridge Gulf.	British Admiralty.	Despite age shows coastline types, islands, bathymetry, mangroves and seabed substrates (habitats) - sand and mud.	Published 1826.	All of CG
Chart AUS 726 - Approaches to Cambridge Gulf. *Chart AUS 318 - Cambridge Gulf Inset.*	Australian Hydrographic Office (AHO).	Accurately maps bathymetry, coastline types, islands, beaches, mangroves, intertidal flats, reefs and seabed substrates (habitats) - sand and mud.	Published 2003.	CG and seaward
NATMAP SD52-10 - Medusa Banks. *NATMAP SD52-14 - Cambridge Gulf.*	Geoscience Australia.	Accurately maps coastline, islands, mangroves, wetlands, intertidal flats and reefs (habitats).	Published 2005.	CG and seaward
Digital Earth Australia - Processed Landsat Imagery of Cambridge Gulf.	Geoscience Australia.	Mangrove canopy cover. High and low tide and intertidal extents. Maximum extent of geomorphic sand bank units.	1987 to the present day.	All of CG
CSIRO (2009) Ecological Patterns & Processes in the Lower Ord Estuary.	Gehrke (2009) (CSIRO)	Delineates and describes habitat types from the upriver freshwater zone to where the estuarine zone enters CG.	Uses a wide range of historical data.	The Lower Ord Estuary from Kununurra to CG.
BKA Studies & Datasets				
Aerial Drone Surveys (key intertidal habitats at low tide)	EcoStrategic & Sensorem for BKA.	High resolution video and photographic imagery of all key inter-tidal habitats in CG at low tide, assessed for potential presence of seagrasses, macroalgae, filter feeder and other benthic communities. High resolution ortho-mosaics of key inter-tidal sites.	Dry season environmental survey Jul 2023. Wet season environmental survey Feb 2024.	All main inter-tidal habitats in CG (Fig A1.1)

Study / Dataset	By	Key Data	Temporal Scope	Spatial Scope
Sub-bottom Profiler.	Metinco for BKA.	Seabed sediment (habitat) types and distribution.	Sand exploration survey Jan-Feb 2023.	Block 4 (Exploration Tenement) (Fig A.1.2)
Multi-beam Hydrographic Surveys.	BKA.	High resolution digital elevation model of seabed allowing definition of seabed morphology and habitat types. Repeat surveys over lunar tidal cycle also allowed assessment of seabed movement.	Wet season environmental survey Feb-Mar 2024.	Proposed operational area + 1 km buffer (Fig A.1.3)
Benthic Drop Camera Surveys.	EcoStrategic for BKA.	Video imagery of benthic communities & habitats.	Sand exploration survey Mar 2023.	17 sites in Block 4 (Exploration Tenement)
			Dry season environmental survey Jul 2023.	105 sites throughout CG, 27 at King Shoals (KS) (Fig A.1.4) & 81 offshore.
Benthic Grab Sampling: – 5 L Van Veen Grab. – 3 replicate grabs at each site. – Sieving to 500 microns. – Ethanol preservation of biota for lab ID.	EcoStrategic for BKA. Analysis by Benthic Australia.	Photographs of all steps in processing of all samples. Photographs and record of substrate (habitat) type in each sample. Taxonomy, abundance and diversity of benthic biota in each sample.	Dry season environmental survey Jul 2023.	105 sites throughout CG, 27 at KS (Fig A.1.4) & 81 offshore.
			Wet season environmental survey Feb 2024.	26 sites in CG and 14 at KS (Fig A.1.5).

A.1.2: Main Datasets Used to Inform Impact Assessment for Coastal Processes

Study / Dataset	By	Key Data	Temporal Scope	Spatial Scope
Pre-existing Studies & Datasets				
Sedimentation in an Arid Macrotidal Alluvial River System: Ord River, Western Australia.	Coleman & Wright (1978)	Comprehensive description and mapping of tidal-plain and fluvial sediment depositional environments and associated coastal processes in Ord River and CG. Sediment data, water level (tidal) data, current data and river flow data.	Published 1978	Lower Ord River and all of CG.
AIMS Ord River & Cambridge Gulf Hydrodynamics & Sediment Movement Study. https://apps.aims.gov.au/metadata/view/54e833b0-60f5-11dc-9ca3-00008a07204e	Australian Institute of Marine Science (AIMS). Analysed for BKA by PCS (2024a, b & c)	Full data set provided by AIMS to BKA: – ADCP Current speed & direction. – Water levels (tides). – Total suspended solids (TSS) / turbidity.	Oct 2000. Jan to Feb 2002	9 sites in CG (Fig A.1.6).
		– CTD temperature & salinity.	1999 through 2004	Multiple sites from up rivers through CG to offshore (Fig A.1.7).
Port of Wyndham Tide Gauge.	WA Department of Transport (DoT). Analysed for BKA by PCS (2024a, b & c)	Water levels (tides)	1985 to 2022	Wyndham.
Cambridge Gulf Tide Model (predictions)	Australian Hydrographic Office (AHO). Analysed for BKA by PCS (2024a, b & c)	Water levels (tides) (predicted)	Infinite	Cape Domett & Lacrosse Island (Fig A.1.6)
Meteorological data.	Bureau of Meteorology (BoM). Analysed for BKA by PCS (2024a, b & c)	Wind speed & direction & rainfall.	1951 to 2023	Wyndham Airport (Fig A.1.8)
			1996 to 2023	Port Keats Airport (Fig A.1.8)
IMOS Offshore oceanographic data.	Integrated Marine Observing System (IMOS). Analysed for BKA by PCS (2024a, b & c)	– ADCP Current speed & direction. – Water levels (tides).	2010 to 2019	3 sites in Joseph Bonaparte Gulf from inshore to offshore (Fig A.1.8)
CAWCR Wave & Wind Hindcast Model.	Collaboration for Australian Weather & Climate Research (CAWCR) (CSIRO & BoM).	Wave and wind conditions (hindcast modelled).	1979 to 2024	1 site at entrance to CG and 1 site offshore (Fig A.1.8)

Study / Dataset	By	Key Data	Temporal Scope	Spatial Scope
	Analysed for BKA by PCS (2024a, b & c)			
Cape Domett Meteorological Data.	University of WA (Bentley 2018). Analysed for BKA by PCS (2024a, b & c)	Wind speed & direction & rainfall.	Nov 2013 to Aug 2024	1 site at Cape Domett seaward beach (Fig A.1.8)
WA Stream Gauge Monitoring.	WA Department of Water & Environmental Regulation (DWER). Analysed for BKA by PCS (2024a, b & c)	River levels and discharge.	1967 to 2025.	5 sites upstream of CG (Fig A.1.9).
LiDAR and Landsat satellite imagery.	Geoscience Australia. Analysed for BKA by PCS (2024a, b & c)	Bathymetric data for subtidal areas. LiDAR data for coastal / intertidal areas (25 m & 30 M resolution).	Unknown	All of CG.
Satellite imagery.	U.S. Geological Survey. Analysed for BKA by PCS (2024a, b & c)	Landsat 5, 7 & 8 sensors, and Sentinel-2 sensor. Processed to derive shoreline positions & changes over time.	1988 to 2024	All of CG.
BKA Studies & Datasets				
In-situ Seabed ADCPs / AWACS (ongoing)	Data collection by BKA. Analysed for BKA by PCS (2024a, b & c)	Current speed & direction, water levels (tides) & waves.	Since June 2023 - ongoing. Various periods depending on site, up to 90 days plus at some sites to give full range of conditions.	10 sites throughout CG (Fig A.1.10)
Vertical Water Quality Profiles, included: – *Niskin water samplers – Suspended sediment sampling.* – Co-deployment of multi-sonde water quality probe to provide coincident turbidity, temp, salinity, pH and chlorophyll data. – Wet season with co-deployment of Aquadopp ADCP to provide coincident current speed and direction data.	Sampling by EcoStrategic for BKA. Dry season sample analysis by MAFRL. Wet season sample analysis by Microanalysis Labs Perth. Data Analysed for BKA by PCS (2024a, b & c)	TSS concentrations in the water column in CG under range of seasonal and tidal conditions to support sediment dynamics modelling and turbidity modelling. Dry- and wet season TSS-NTU correlations to support sediment dynamics and turbidity modelling. Wet season - PSD and elemental composition of suspended sediments in CG under range of spring tidal conditions to support sediment dynamics and turbidity assessment and modelling. Wet season co-deployment of Aquadopp ADCP provided coincident current speed and direction data to	Dry season environmental survey. 17 to 30 Jul 2023, single mid-water sample at each site.	31 sites in CG. 3 sites at KS. (Fig A.1.11) 20 sites offshore (Fig A.1.12)
			Wet season environmental survey. 24, 25 & 27 Feb 2024.	3 sites in and north and south of proposed operational area (Fig A.1.13)

Study / Dataset	By	Key Data	Temporal Scope	Spatial Scope
		support sediment dynamics and turbidity assessment and modelling.	Hourly sampling every hour over 13-hour spring tidal cycle, at midwater and near seabed at each site.	
Seabed Sediment Sampling (Vibro-cores).	SEAS Offshore with BKA. PSD analysis by GBAD Services Singapore.	Visual description of seabed sediment types – all samples – penetrating to depth of up to 7 m below seabed. PSD of 21 samples using BS EN 93301: 2012. Data to support sediment dynamics assessment and modelling.	Sand Exploration Survey March 2023.	35 sites within Block 4 (BKA's Exploration Tenement E80/5655) (Fig A.1.14)
Seabed Sediment Sampling (Van Veen grabs).	Sampling by EcoStrategic for BKA. Dry season sample analysis by BKA. Wet season sample analysis by Microanalysis Labs Perth. Analysed for BKA by PCS (2024a, b & c)	Visual description of seabed sediment types – all samples. PSD of 74 samples using Mastersizer. Elemental composition of 45 samples using Scanning Electron Microscope (SEM). Data to support sediment dynamics and turbidity assessment and modelling.	Dry season environmental survey Jul 2023	105 sites throughout CG and 27 sites at King Shoals (Fig 1.1.4)
			Wet season environmental survey Feb 2024	74 sites throughout CG, at KS and upstream to Pentecost River (Fig A.1.15).
Sub-bottom Profiler.	Metinco for BKA.	Seabed sediment types and distribution.	Sand exploration survey Jan-Feb 2023.	Block 4 (Exploration Tenement) (Fig A.1.1)
Multi-beam Hydrographic Surveys.	BKA. Analysed for BKA by PCS (2024a, b & c)	High resolution digital elevation model of seabed allowing definition of seabed morphology and bathymetry. Repeat surveys over lunar tidal cycle also allowed assessment of seabed movement to support sediment dynamics assessment and modelling.	Wet season environmental survey Feb-Mar 2024.	Proposed operational area + 1 km buffer.
Aerial Drone LiDAR & Photogrammetry.	Sensorem for BKA. Analysed for BKA by PCS (2024a, b & c)	High-resolution (2cm) LiDAR data to develop Digital Surface Model (DSM) and Digital Elevation Model (DEM) plus high-resolution photogrammetry of four high priority beach areas.	Wet season environmental survey Feb-Mar 2024.	Cape Domett large beach, Cape Domett small beach. Turtle Bay (Lacrosse Is.) Turtle Beach West (west of Cape Dussejour).

A.1.3: Main Datasets Used to Inform Impact Assessment for Marine Environmental Quality

Note: Some of the studies and datasets listed in Table 3 for coastal processes also support the assessment of marine environmental quality. These are identified Table 4 with a reference to Table 3 for details.

Study / Dataset	By	Key Data	Temporal Scope	Spatial Scope
Pre-existing Studies & Datasets				
AIMS Ord River & Cambridge Gulf Hydrodynamics & Sediment Movement Study.	As listed in Annex 1.2.	As listed in Annex 1.2.	As listed in Annex 1.2.	As listed in Annex 1.2.
CSIRO (2003) The Response of the Lower Ord River and Estuary to Management of Catchment Flows and Sediment and Nutrient Loads.	Parslow et al (2003) (CSIRO)	Field sampling of nutrient cycling, primary productivity and water quality in the river, estuary and underlying sediments. Integrated simulation models of hydrodynamics, water quality, nutrient cycling and primary production.	2002 to 2003.	Lower Ord River from Kununurra to CG.
CSIRO (2008) Response of the Lower Ord River and Estuary to Changes in Flow and Sediment and Nutrient Loads.	Robson et al (2008) (CSIRO)	Includes referencing term-term and ongoing river monitoring by DWER. Data and conceptual numerical models of water flow, sediment loads, nutrient loads and primary productivity in Lower Ord River which discharges into CG. Regular monthly monitoring at several sites for nutrient concentrations, salinity, temperature, chlorophyll *a,* oxygen concentrations and turbidity. Specific dry-season (Aug 2006) and wet-season (Feb 2007) sampling campaigns for organic matter and carbon sources and water quality (parameters above) at additional sites not sampled in regular monthly monitoring. Sampling of sediments to better characterise the physical nature of the river bed and nutrient content of sediments. Measurements and incubations to enable estimates of primary production and system metabolism. Measurements of algal photosynthetic activity and the degree to which algal growth constrained by light and nutrient availability. Measurements to identify algal-bacterial interactions. Measurements of the physical environment of the river, including water velocity and water depth over the course of the tidal cycle, the shape of the river bed in tidal creeks, and changes in salinity, temperature and turbidity over tidal cycle.	Monthly monitoring – not specified in the report (DWER river monitoring goes back to 1960s). Dry-season sampling Aug 2006. Wet-season sampling Feb 2007.	Multiple sites along the Lower Ord River from Kununurra to CG.

Study / Dataset	By	Key Data	Temporal Scope	Spatial Scope
		Measurements of rate processes, such as primary production, photosynthetic activity, and metabolism.		
WA Department of Environment & Conservation - Ecological Character Description of the Ord River Floodplain Ramsar Site.	Hale (2008)	Section 3.2.4 on Water Quality reviews existing data and previous studies to describe salinity, suspended solids, dissolved oxygen, nutrients and toxicants in the Ord River Floodplain.	Published 2008. Cites studies and data back to 1975.	Ord River Floodplain Ramsar Site on the eastern side of CG.
BKA Studies & Datasets				
In-situ Seabed Light Meters & Multi-Sonde Sensors. (ongoing)	Data collection by BKA. Analysed for BKA by PCS (2024a, b & c)	Near-seabed light (PAR /DLI). Near-seabed turbidity, temperature, salinity and pH.	Since June 2023 - ongoing. Various periods depending on site, up to 90 days plus at some sites to give full range of conditions.	8 sites throughout CG (Fig A.1.10).
Vertical Water Quality Profiles. (Niskin TSS & chlorophyll)	As listed in Annex 1.2.	As listed in Annex 1.2.	As listed in Annex 1.2.	As listed in Annex 1.2 (Fig A.1.11).
Vertical Water Quality Profiles. (YSI multi-sonde)	EcoStrategic for BKA.	Turbidity (NTU), temperature, salinity, pH and chlorophyll-a through water column surface to seabed.	Dry season environmental survey Jul 2023	53 sites in CG, 20 sites at KS and 30 sites offshore (Fig A.1.11).
Sediment Quality Sampling. (Van Veen grabs)	Sampling by EcoStrategic for BKA. Sample analysis by ALS laboratories.	Assessment of the suite of toxicants specified in the National Assessment Guidelines for Dredging (NAGD 2009) against NAGD screening and trigger levels according to NAGD methods.	Dry season environmental survey Jul 2023	21 sites within and near the proposed operational area (Fig A.1.16).
Secchi Disc Readings (water clarity)	EcoStrategic for BKA.	Secchi depth (m) as a measure of water clarity / turbidity.	Sand exploration survey Mar 2023.	17 sites in Block 4 (Exploration Tenement) (Fig A.1.14).
Drop Camera Profiles (water clarity)	EcoStrategic for BKA.	Primary purpose was for video imagery of benthic communities & habitats but also provides record of water clarity through the water column and at the seabed.	Sand exploration survey Mar 2023.	17 sites in Block 4 (Exploration Tenement)
			Dry season environmental survey Jul 2023.	90 sites throughout CG, 27 at King Shoals (KS) (Fig A.1.4) & 81 offshore (Fig A.1.14).

A.1.4: Main Datasets Used to Inform Impact Assessment for Marine Fauna

Note: Marine fauna excludes benthic fauna which are addressed in Annex 1.1.

Study / Dataset	By	Key Data	Temporal Scope	Spatial Scope
Pre-existing Studies & Datasets				
Cape Domett Turtle Nesting Study 2006-2007.	Whiting et al 2008.	– Counts of nesting turtle tracks and nests. – Abundance estimates. – Morphometrics of adults, eggs and hatchlings. – Spatial distribution of nesting. – Proportion of nesting attempts resulting in egg deposition. – Assessment of threats to adults, eggs and hatchlings.	Published 2008. Site surveys for 4-5 nights every 7 weeks between Apr 2006 & Mar 2007. Additional survey of 13 nights in Sept 2006.	Cape Domett seaward beach.
Cape Domett Turtle Nesting Surveys 2012 - 2022.	DBCA with indigenous rangers. Analysed by EcoStrategic for DBCA & BKA (Price & Raaymakers 2024)	All data provided by DBCA to BKA for analysis. – Counts of nesting turtle tracks and nests. – Counts of nest hatchings. – Observations of predation on nests.	Starting 1st week of August (peak nesting season) each year: – 2012: 8 nights. – 2013: 13 nights. – 2014: 13 nights. – 2015: 13 nights. – 2016: 14 nights. – 2017: 14 nights. – 2018: 14 nights. – 2019: 14 nights. – 2020: 14 nights. – 2021: 7 nights. – 2022: 14 nights.	Cape Domett seaward beach.
Cambridge Gulf Snubfin & Humpback Dolphin Survey 2012-2014.	Brown et al 2016. Brown et al 2017.	All dolphin sightings including locations, species ID where possible, photographs where possible, movement and behaviour. Survey track and observer effort data.	Site surveys between one and four times from 2012–2014 during the months of Apr–Jun and Sep–Oct.	Most of CG, out into Joseph Bonaparte Gulf and west along the coast to and up Berkely River.
Cambridge Gulf & Order River Crocodile Study 2001-2003.	Kay, 2004.	Movements and home ranges of radio tracked saltwater crocodiles.	Published 2004. Tracking Oct 2021 to May 2003.	CG and lower Ord River.
Cambridge Gulf & Order River - River Shark Surveys 2015, 2019	P Kyne, Charles Darwin Univ. No published report found.	Catches and observations in Lower Ord River.	2015 and 2019.	Lower Ord River.

Study / Dataset	By	Key Data	Temporal Scope	Spatial Scope
Cambridge Gulf Banana Prawn Surveys	Loneragen et al (2002) (CSIRO)	Presence, distribution and abundance of juvenile red-legged banana prawns (*Penaeus indicus*) and white banana prawns (*P. merguiensis*).	Published 2024. Sampling 1997 & 1998.	All of CG including up inlets & creeks.
BKA Studies & Datasets				
Aerial Drone Surveys of Turtle Nesting Beaches.	EcoStrategic for BKA.	Counts of nesting turtle tracks and nests on each beach and sand area surveyed.	Dry-season Jul 2023: 9 days. (near peak nesting season)	All beaches and sand areas that could potentially host turtle nesting in CG, at Lacrosse Is. and along the adjacent seaward coasts at both Cape Domett and Cape Dussejour (Fig A.1.17).
Dedicated Marine Mega-fauna (MMF) Surveys: Structured boat-based surveys targeting any and all MMF with particular attention to: – Dugong. – Snubfin, Humpback & other dolphins. – Marine turtles. – Crocodiles. – Seasnakes. – Sharks & rays. – Significant fish sightings.	Dry-season environmental survey Jul 2023: Dr Helen Penrose & Kristina Heidrich via EcoStrategic for BKA. Wet-season environmental survey Feb 2024: Mia McIntyre & Jasmin Hunt via EcoStrategic for BKA.	All MMF sightings including GPS locations, species ID where possible, photographs where possible, movement and behaviour. Survey track and observer effort data. Environmental conditions observations.	Dry-season Jul 2023: 9 days. Wet-season Feb 2024: 9 days.	Both surveys covered >600 km of transects all over CG, around Lacrosse Island and along the outside coast, and upstream past Adolphus Island towards Wyndham (Fig A.1.18).
Incidental MMF Observations: During the sand exploration survey Mar 2023 and the two environmental surveys Jul 2023 and Feb 2004, as part of day-to-day work all team members and vessel crew maintained a watch for MMF including the target species listed above, with a standard data form provided to record sightings.	Sand exploration survey Mar 2023: EcoStrategic for BKA. Both dry- and wet-season environmental surveys: All environmental team and vessel crew.	All MMF sightings including GPS locations, species ID where possible, photographs where possible, movement and behaviour.	Sand exploration survey Mar 2023: 9 days. Dry-season environmental survey Jul 2023: 20 days. Wet-season environmental survey Feb 2024: 20 days.	All over CG, around Lacrosse Island and along the outside coast, and upstream past Adolphus Island to Wyndham.
Aerial Drone MMF Observations: All aerial drone videos and imagery taken during both the dry- and wet-	EcoStrategic for BKA.	Marine fauna sightings including locations, species ID where possible, video screenshot or photograph and notes on movement and behaviour.	Dry-season Jul 2023: 9 days.	All coastal areas of CG including up inlets and creeks, around Lacrosse

Study / Dataset	By	Key Data	Temporal Scope	Spatial Scope
season surveys were analysed for signs of marine fauna.			Wet-season Feb 2024: 9 days.	Is. and along the adjacent seaward coasts at both Cape Domett and Cape Dussejour.
eDNA sampling. Targeting Sawfish & River Sharks.	University of Canberra EcoDNA centre for BKA with EcoStrategic support for sampling.	Presence / absence of target species and proxy indication of abundance.	Wet season environmental survey Feb 2024.	20 sites in proposed operational area and up rivers and inlets on west and east coasts of CG (Fig A.1.20).

A.1.5: Main Datasets Used to Inform Impact Assessment for Air Quality

Pre-existing Studies & Datasets

1. Apart from general climate and weather data, no previous studies of air quality in the CG area could be found.

2. There is no human habitation, development or industry in the immediate area that produce air emissions. Bush fires and prescribed burning in the dry season cause the main impacts on air quality.

BKA Studies & Datasets

1. No specific studies have been undertaken on air quality as the Sand Production Vessel (SPV) will comply with MARPOL Annex VI and AMSA Marine Order 97 and will not cause air pollution impacts in CG.

A.1.6: Main Datasets Used to Inform Impact Assessment for Greenhouse Gas Emissions

Pre-existing Studies & Datasets

1. Not relevant as the Sand Production Vessel (SPV) will be a new-build vessel.

BKA Studies & Datasets

1. BKA used fuel consumption and emissions data for a typical base-case vessel design that the SPV will be based on, and factored in the operational and voyage parameters that will apply to the proposed operation, as presented in Annex 6.

2. This is a 'worst-case' scenario as it does not include possible emissions reduction measures such as a future switch to alternative fuels as they become viable and fitting of Rotor Sails.

A.1.7: Main Datasets Used to Inform Impact Assessment for Social Surroundings

Pre-existing Studies & Datasets

1. BKA has assessed general socioeconomic data for the area from the Shire of Wyndham & East Kimberley, the Kimberley Development Commission, DPIRD, DPLH, Australian Bureau of Statistics and other sources. These are listed in the References section of Referral Report *No. 3 - Proposal Setting & Existing Environmental Descriptions*.

2. BKA has used the WA Aboriginal Cultural Heritage Inquiry System (ACHIS) to inform this aspect of social surroundings impact assessment.

BKA Studies & Datasets

1. BKA has undertaken and continues to undertake a comprehensive stakeholder engagement and community consultation program with a wide range of relevant stakeholders, including the two TO groups in the area, including to assess and address impact assessment of social surroundings. See Referral Report No. 7 - *Stakeholder Engagement & Consultations* and No. 4 - *Traditional Owners, Native Title & Aboriginal Cultural Heritage*.

2. To support assessment of potential impacts on Aboriginal cultural heritage, BKA has undertaken what may be the most intensive and comprehensive survey for underwater Aboriginal cultural heritage ever undertaken anywhere in Australia to date. This included comprehensive seabed surveys throughout CG and engaging with the two TO groups on this issue. See Referral Report No. 4.

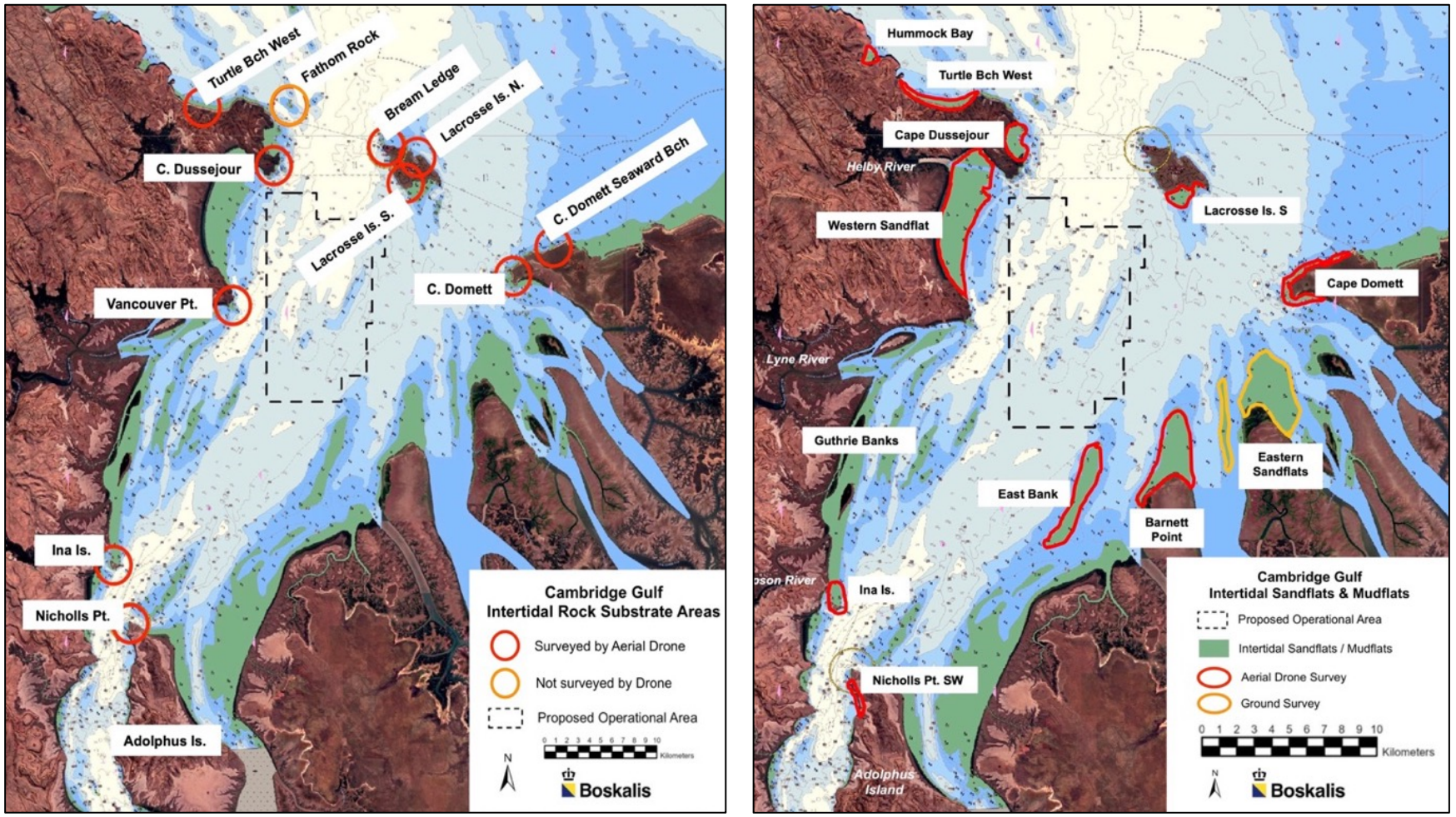

FIGURE A.1.1: *Areas targeted by aerial drone surveys to assess for intertidal benthic communities.*
LEFT: ***Intertidal rock substrate*** *areas targeted to assess for corals, sponges, oysters / other bivalves, macroalgae and other algae and any other benthic biota.*
RIGHT: ***Intertidal sandflat / mudflat*** *areas targeted to assess for seagrass and any other intertidal benthic biota.*

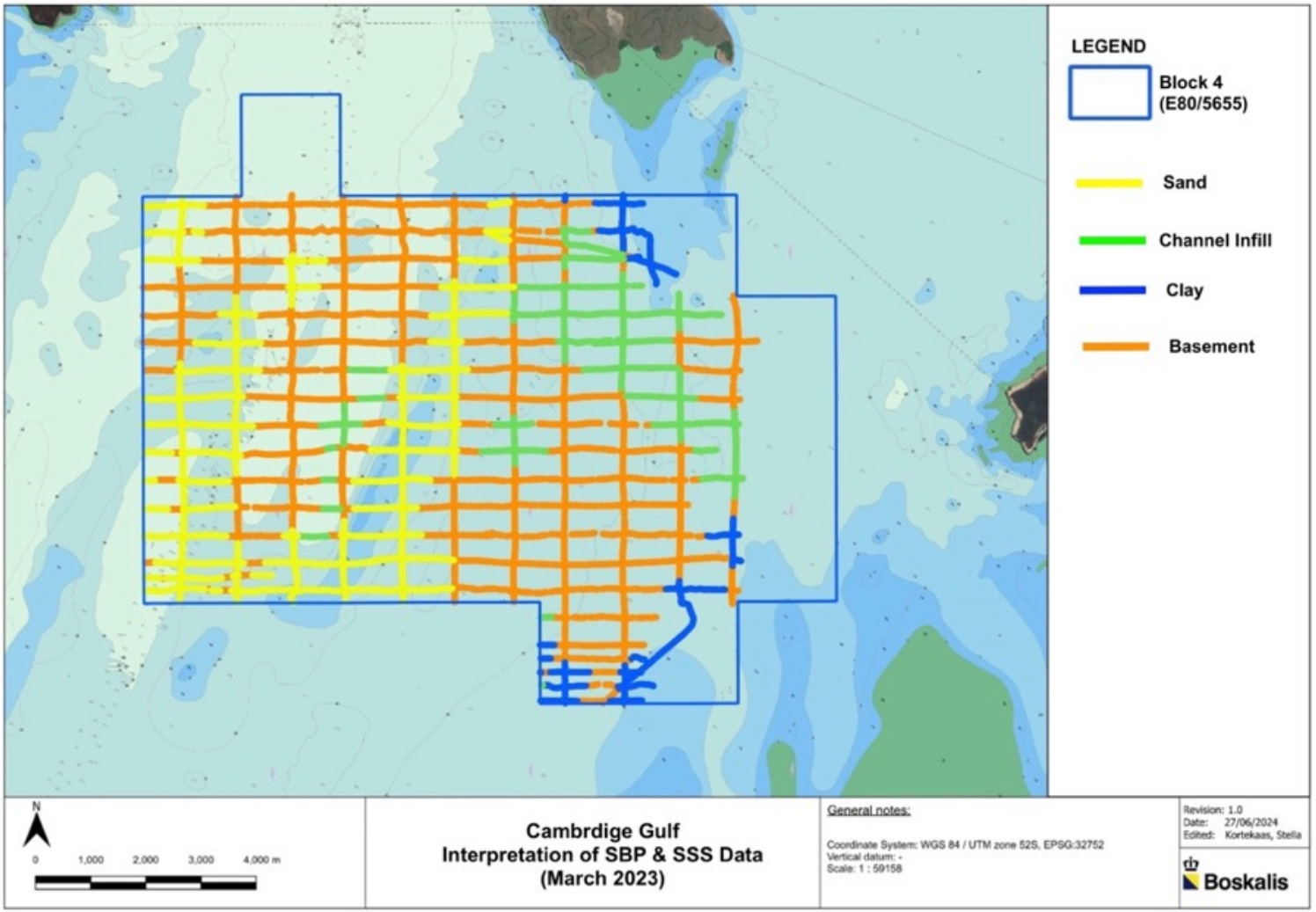

FIGURE A.1.2: *Sub-bottom profiler transects undertaken in Block 4 (Exploration Tenement E80/5655) as part of the Sand Exploration Survey in Feb-March 2023, which also informs the assessment of benthic communities and habitats. Sand areas are marked in yellow in the western part of the block.*

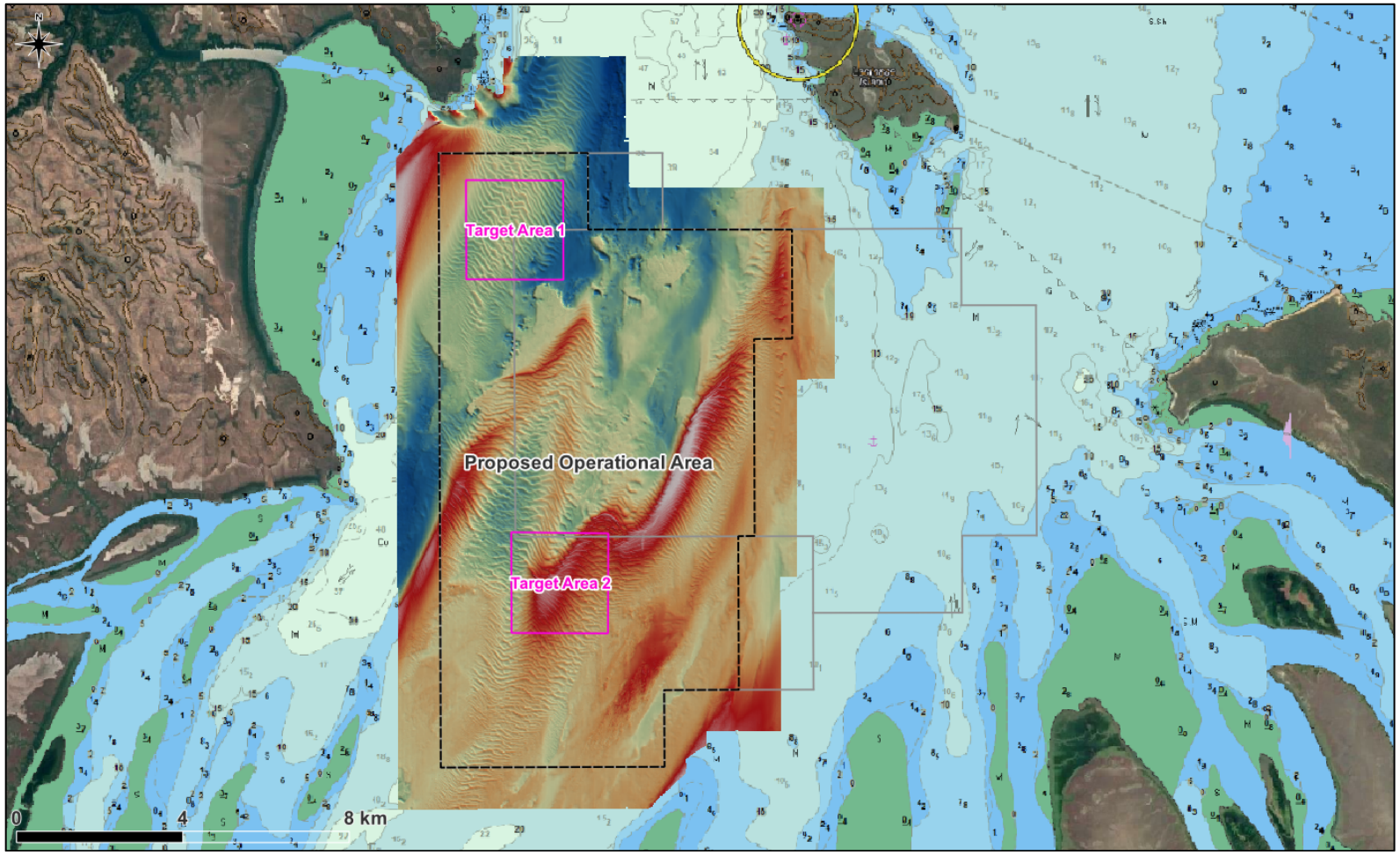

FIGURE A.1.3: *Multi-beam Hydrographic survey of the proposed operational area and 1 km buffer undertaken during the Wet Season Environmental Survey in Feb-Mar 2024. The resulting high resolution digital elevation model of the seabed allows definition of seabed morphology and habitat types. Repeat surveys in the two Target Areas over a lunar tidal cycle also allowed assessment of seabed movement.*

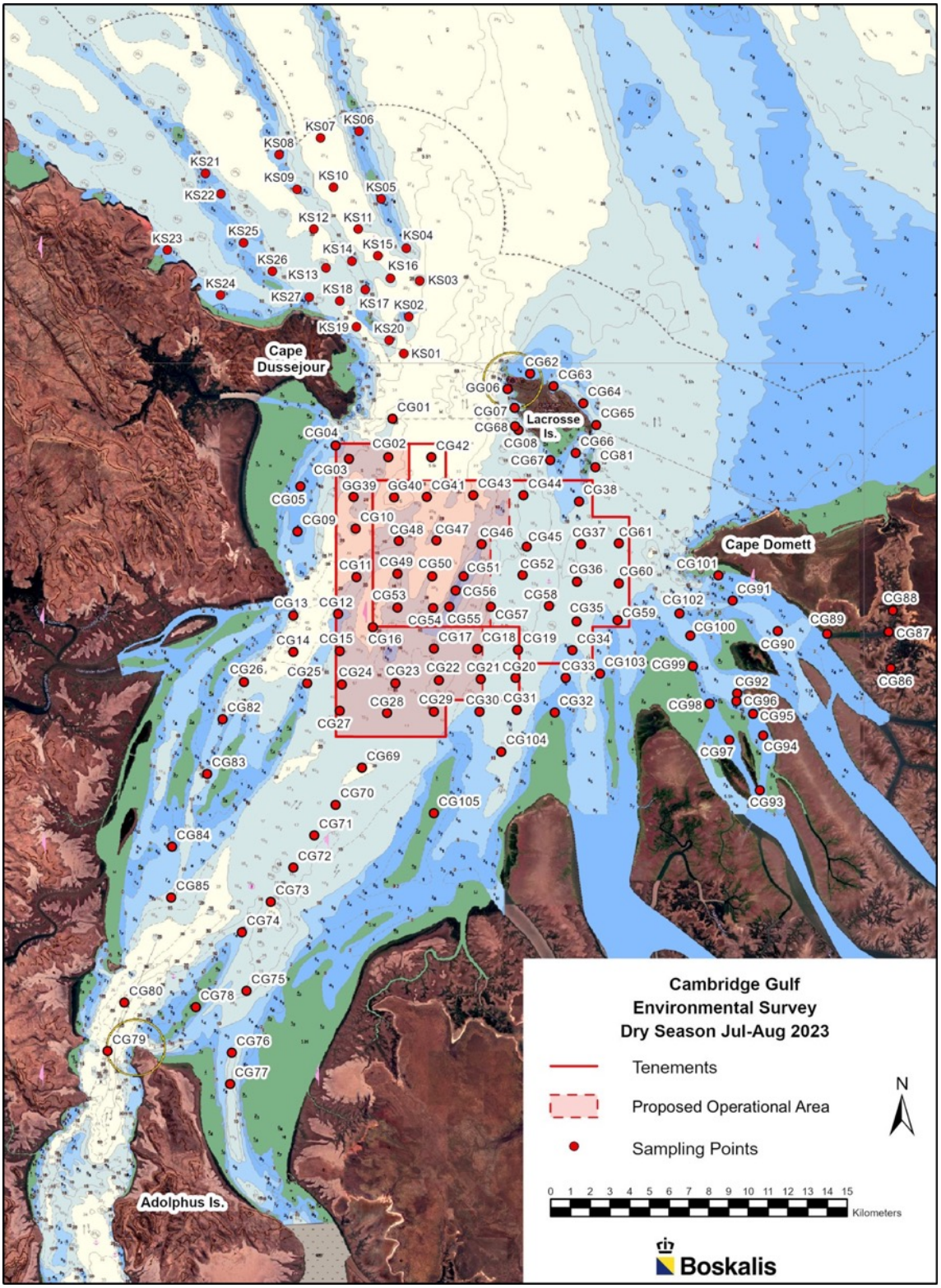

FIGURE A.1.4: *Benthic grab and drop camera sites sampled during the Dry Season Environmental Survey in Jul-Aug 2023.*

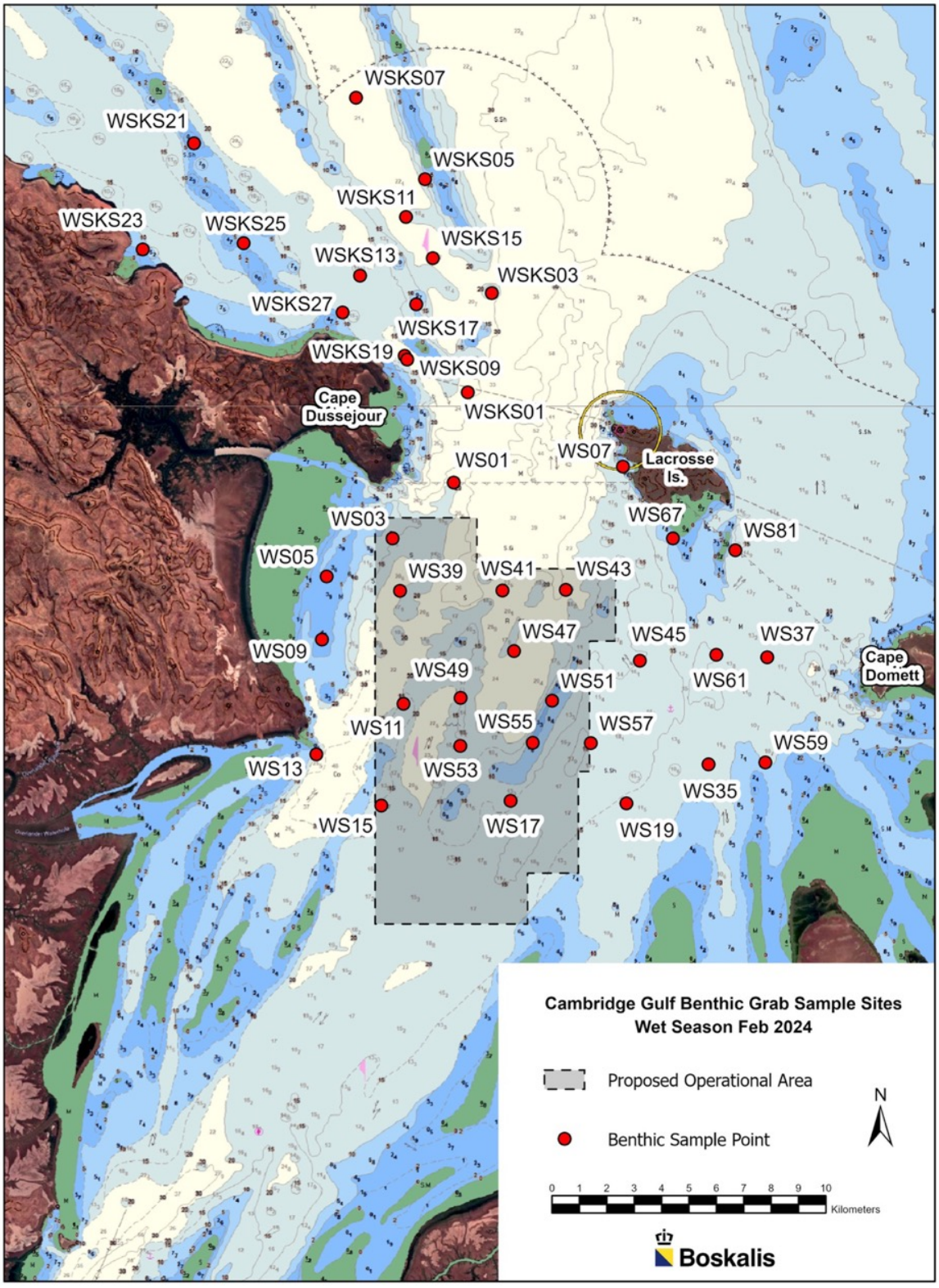

FIGURE A.1.5: *Benthic grab sites sampled during the Wet Season Environmental Survey in Feb 2024.*

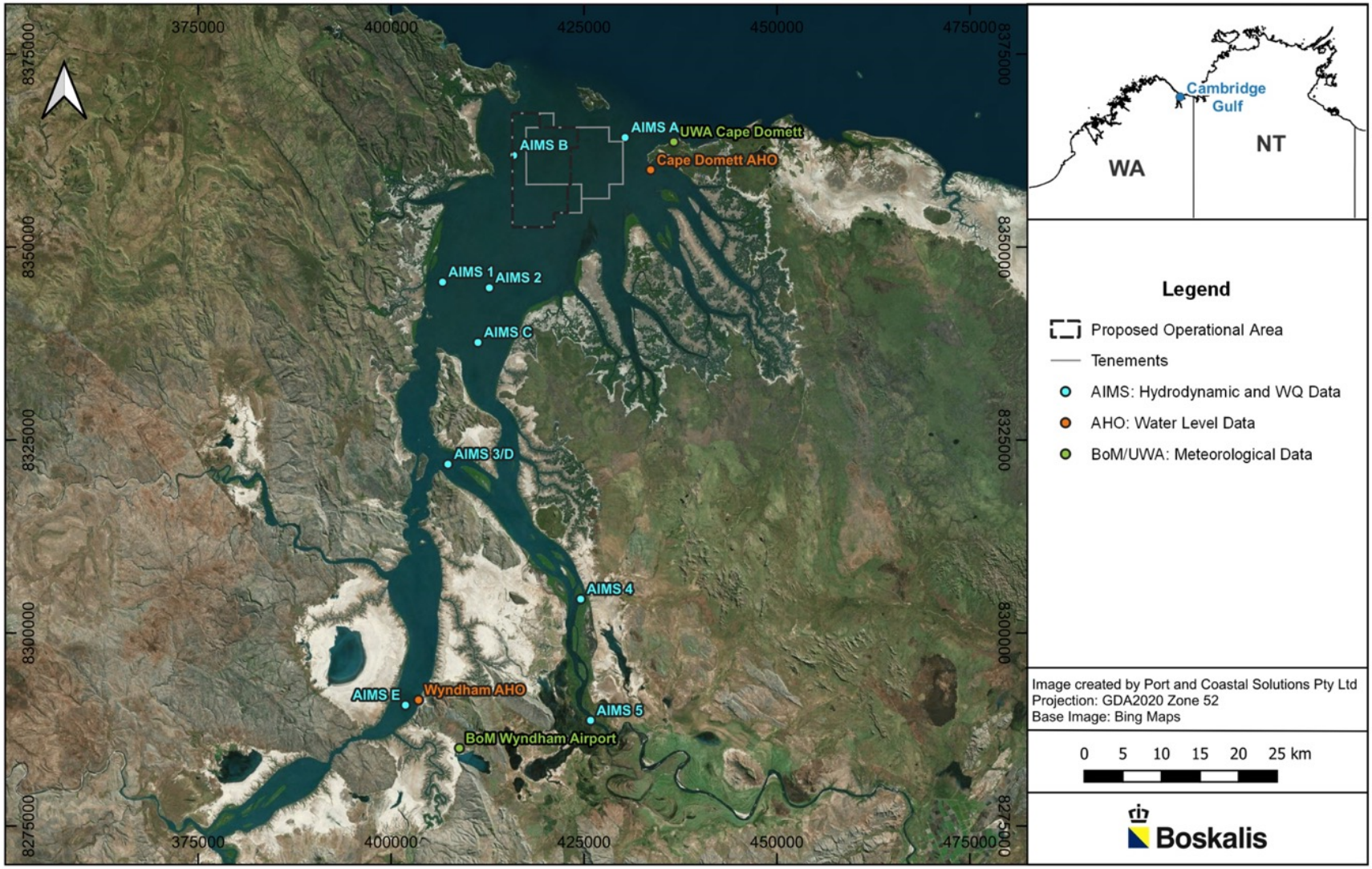

FIGURE A.1.6: *Location of AIMS, AHO, BoM and UWA data collection sites in CG.*

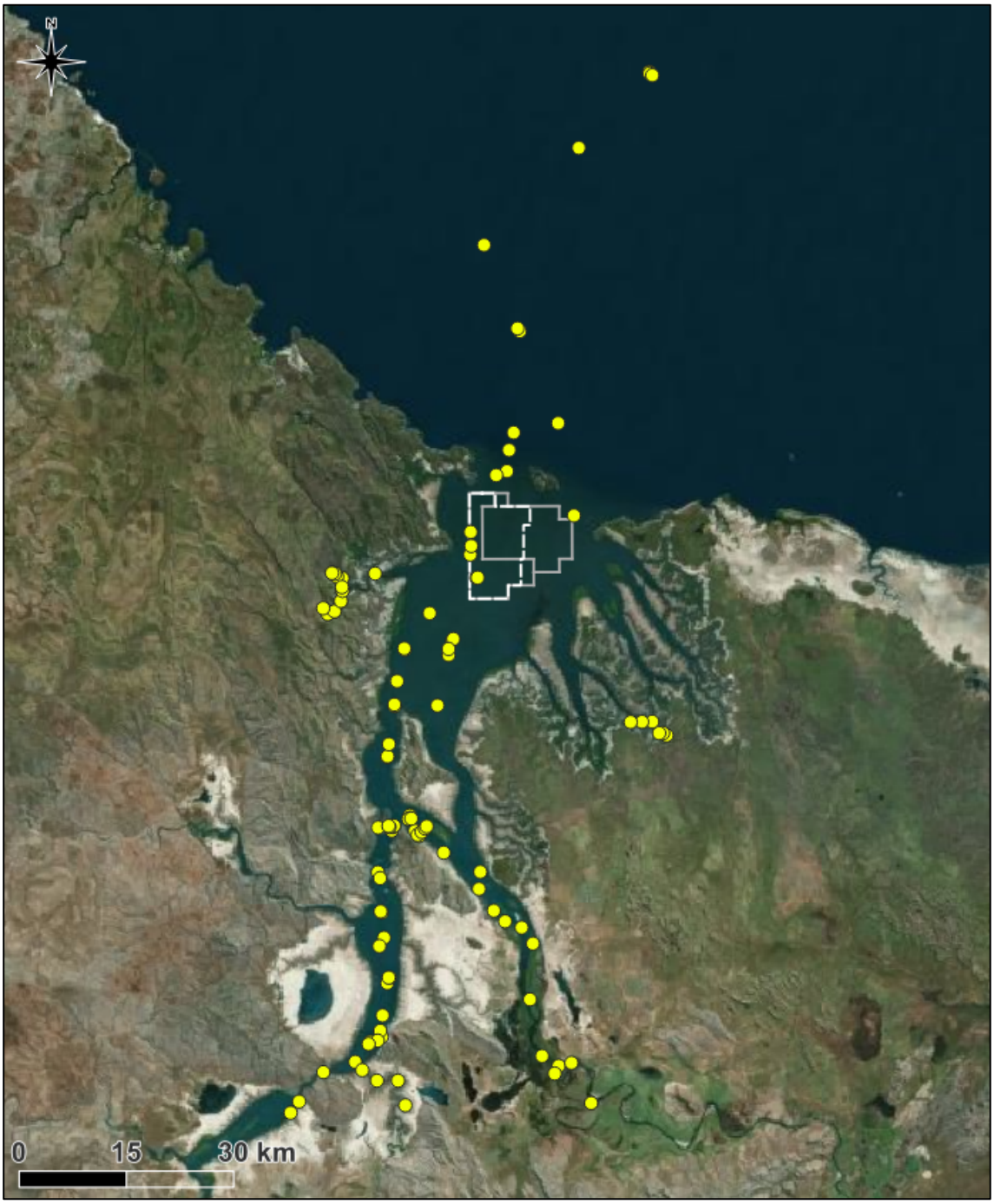

FIGURE A.1.7: *Location of the AIMS water quality profile sites 1999 to 2004.*

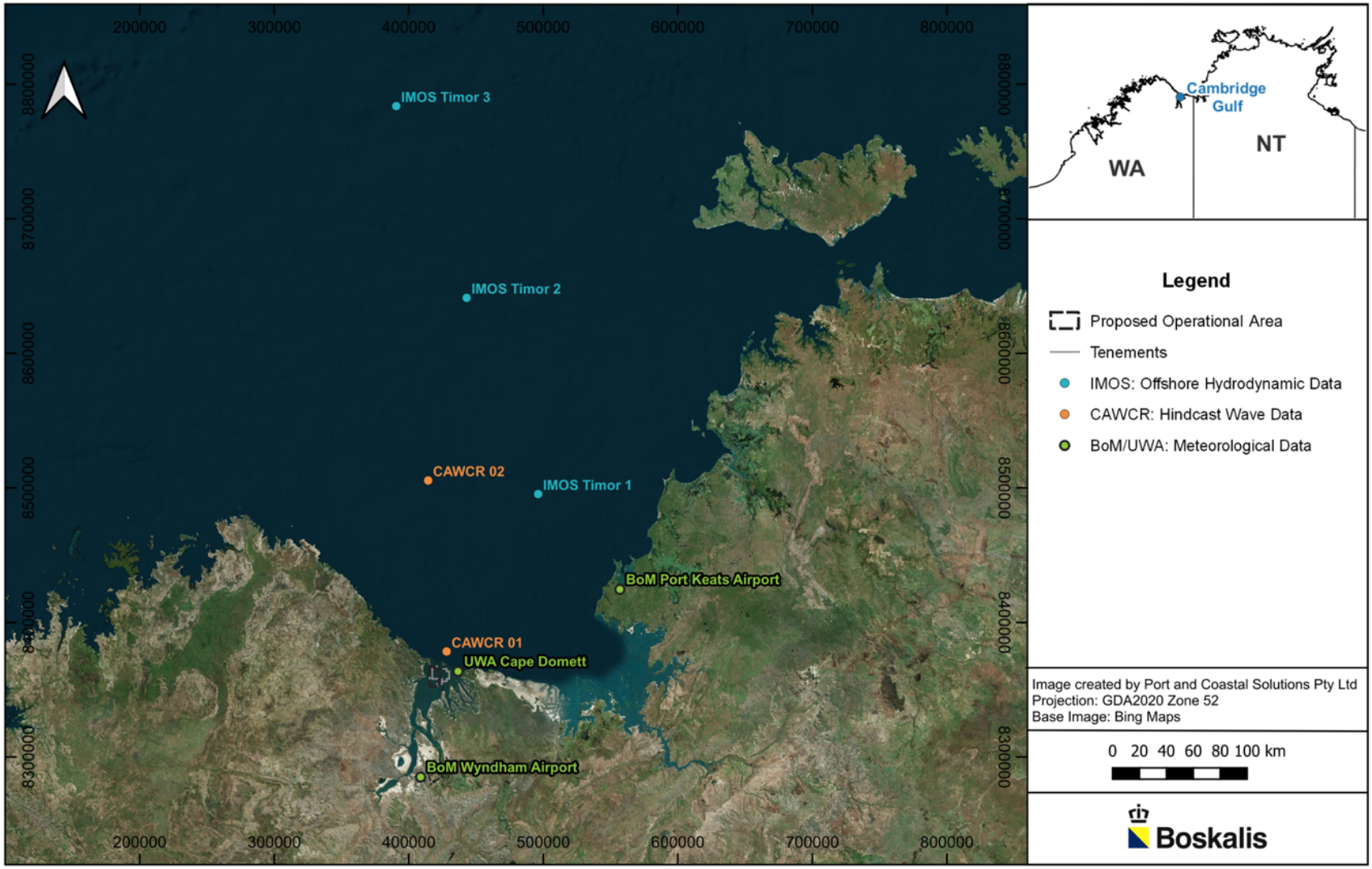

FIGURE A.1.8: *Locations of IMOS, CAWCR, BoM and UWA sites in vicinity of CG.*

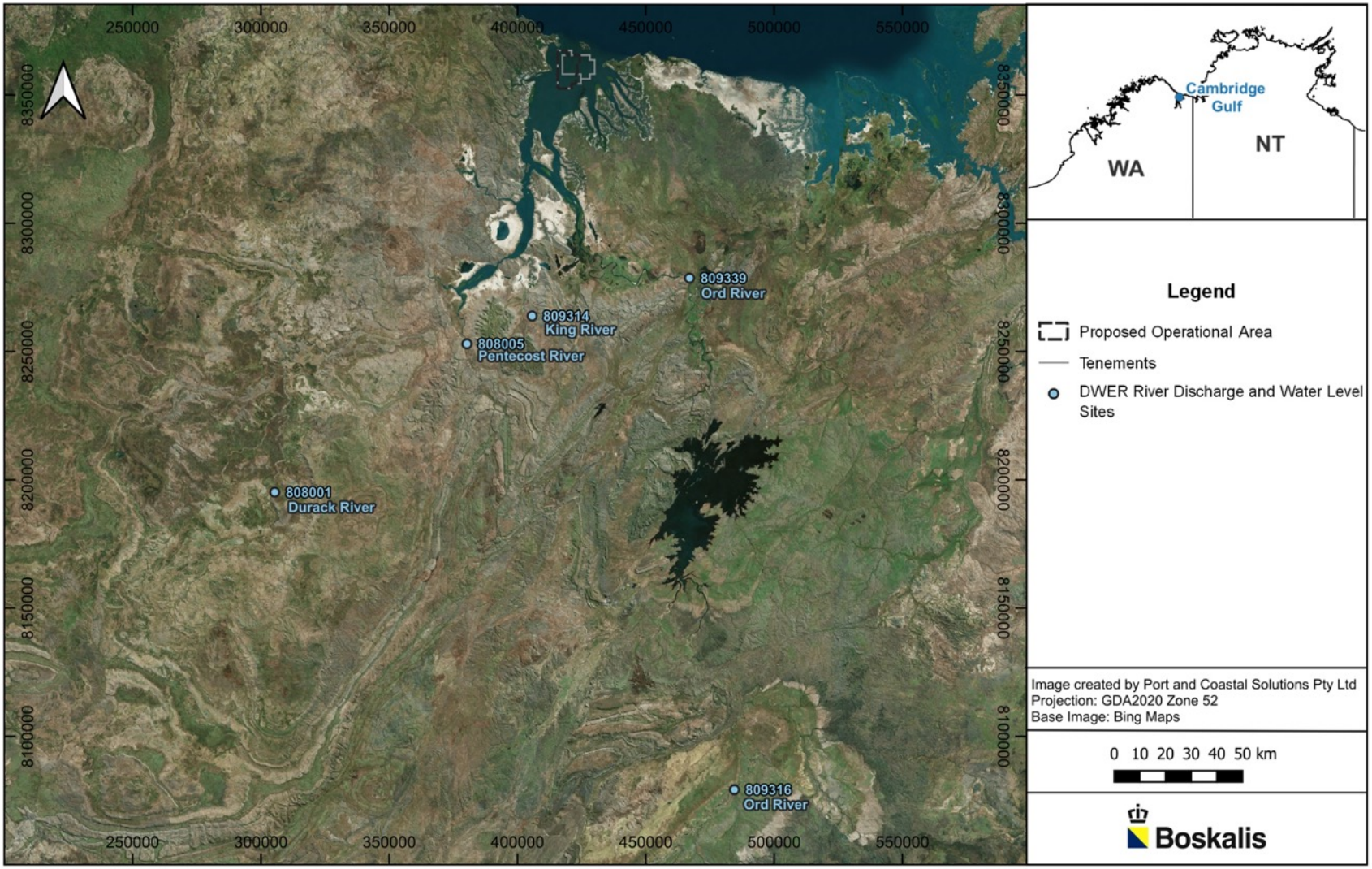

FIGURE A.1.9: *Locations of DWER river monitoring stations upstream from CG.*

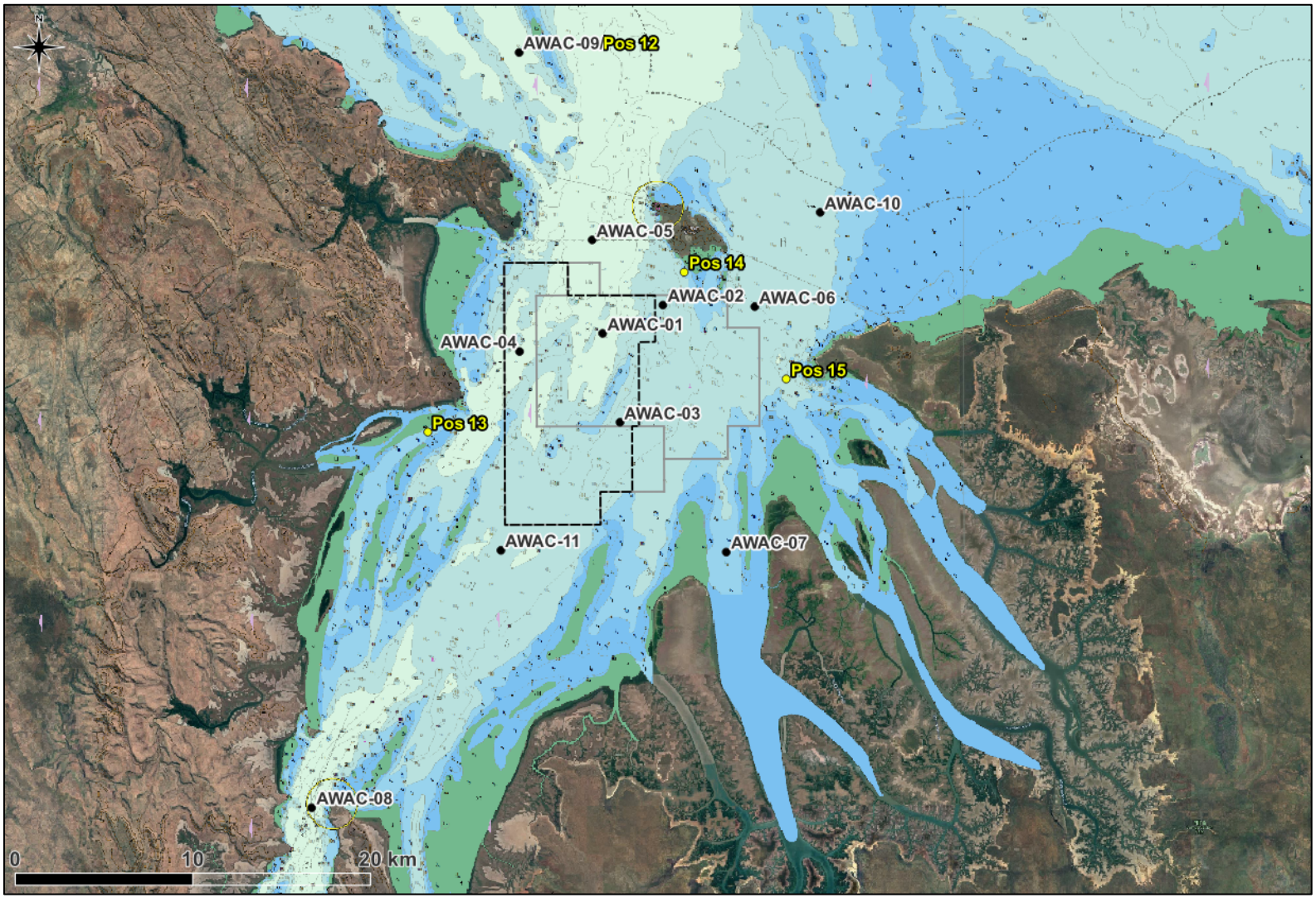

FIGURE A.1.10: *Locations of BKA's In-situ Seabed ADCPs / AWACS (sites marked 'Pos' are in-situ light meter / water quality sites listed in Annex 1.3)*

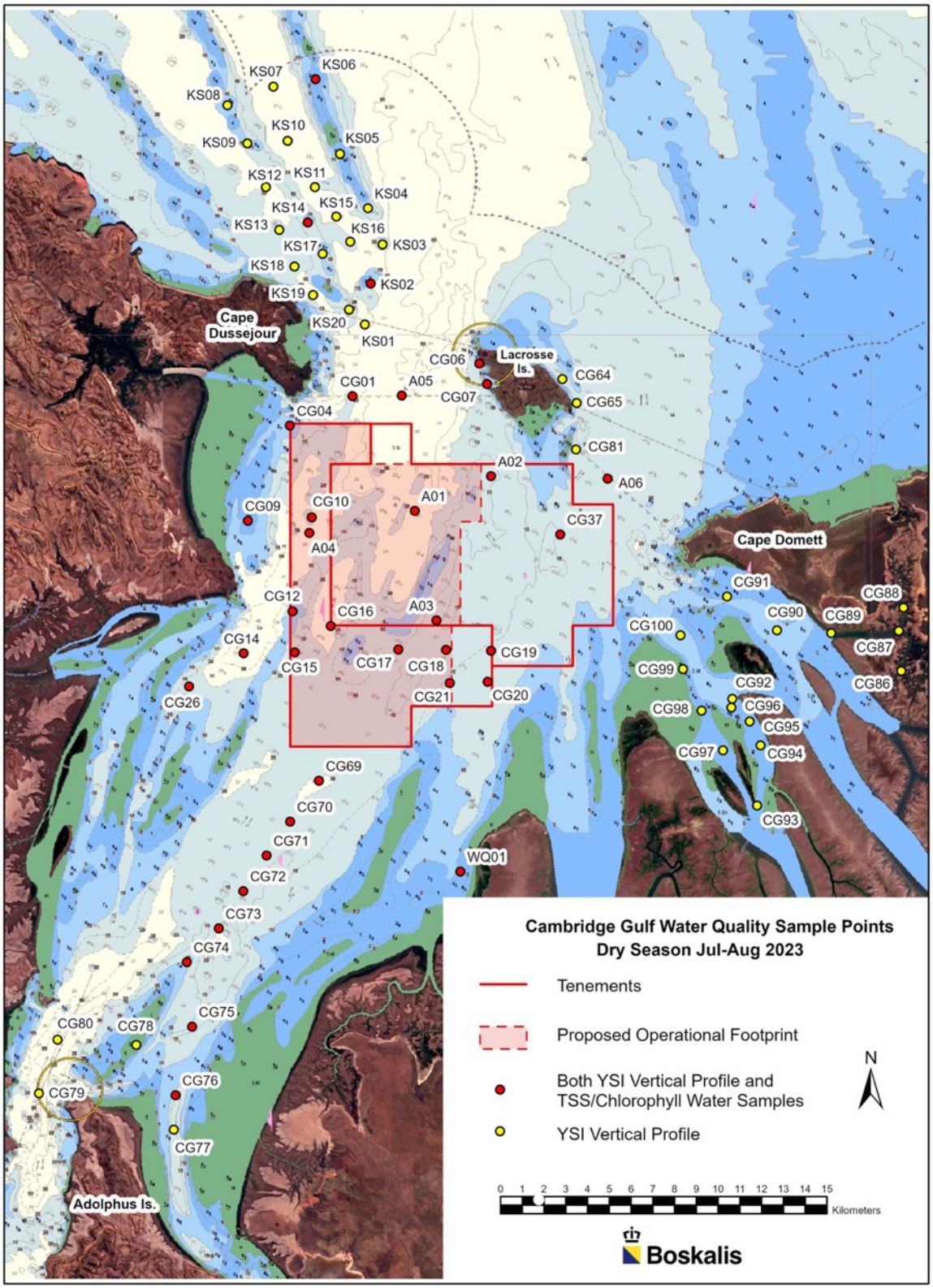

FIGURE A.1.11: *Locations of Vertical Water Quality Profile sites in CG and at King Shoals dry-season July 2023. Also referenced in Annex 1.3.*

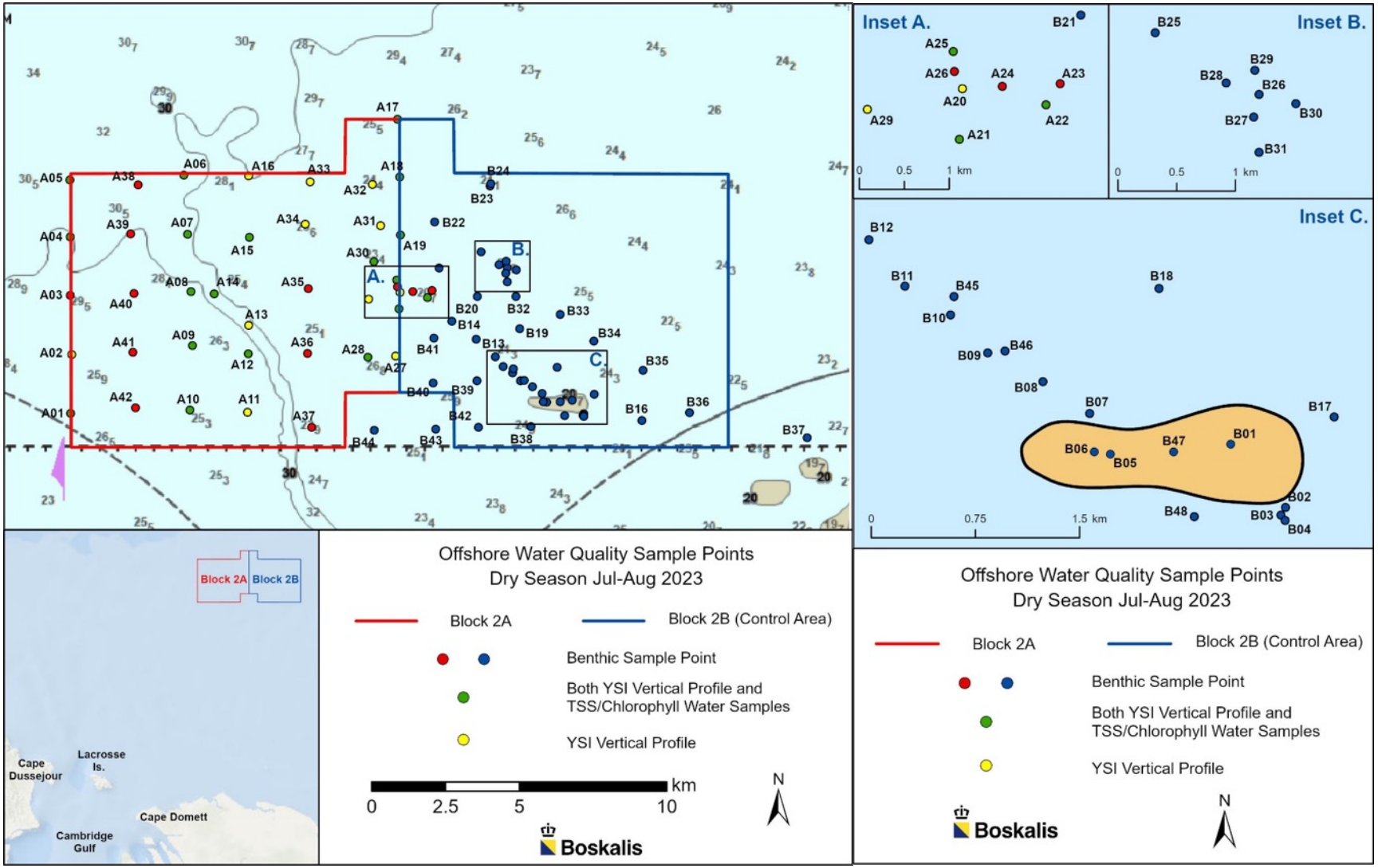

FIGURE A.1.12: *Locations of Vertical Water Quality Profile sites offshore in Joseph Bonaparte Gulf dry-season July 2023. Also referenced in Annex 1.3.*

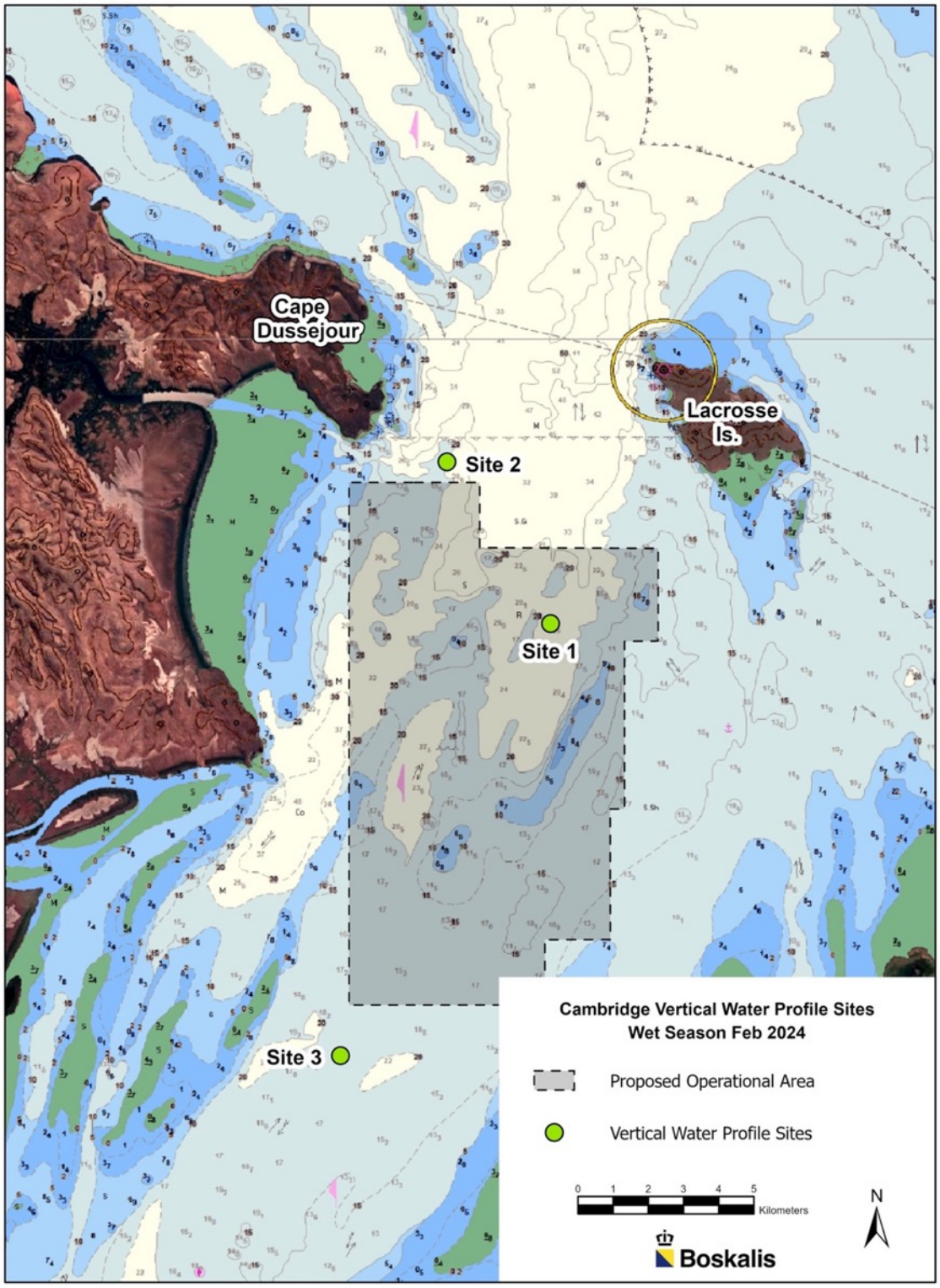

FIGURE A.1.13: *Locations of Vertical Water Quality Profile sites in CG wet season Feb 2024. Also referenced in Annex 1.3.*

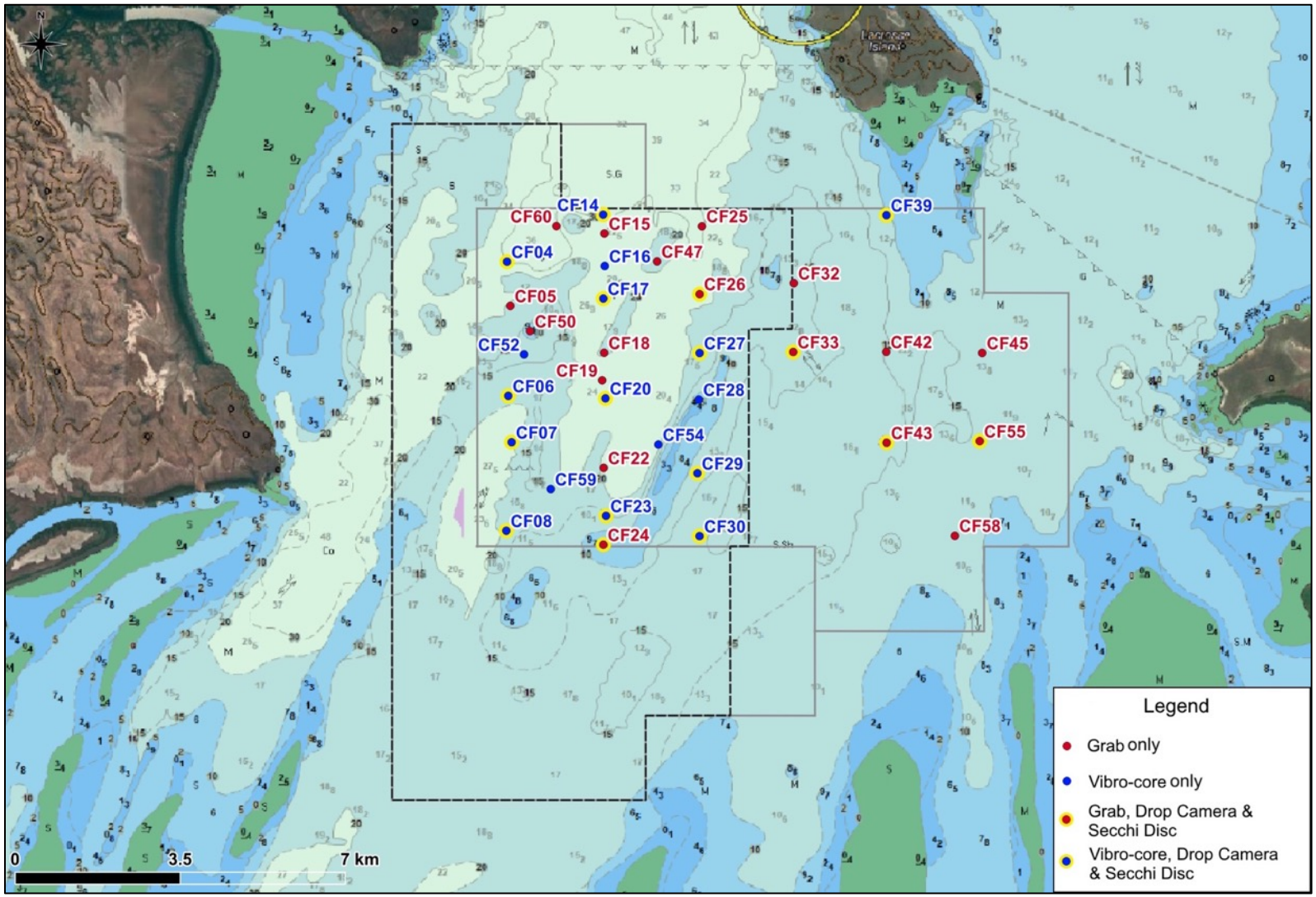

FIGURE A.1.14: *Locations of vibro-core & Van Veen Grab sediment samples as well as drop camera and Secchi disc sites during sand exploration survey March 2023.*

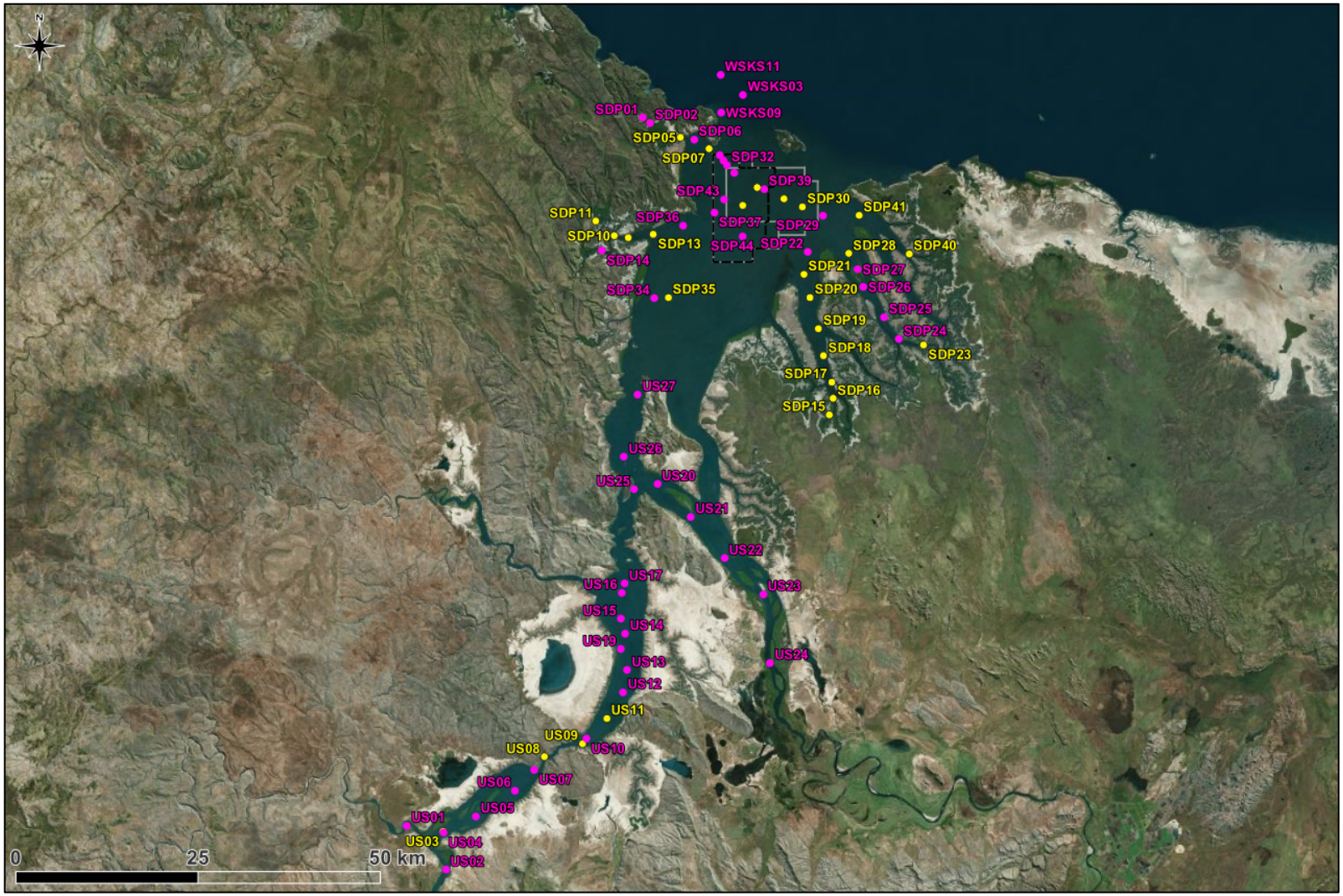

FIGURE A.1.15: *Locations of Van Veen Grab sediment samples wet season Feb 2024. Purple sites analysed or PSD and SEM elemental features and yellow sites for PSD only.*

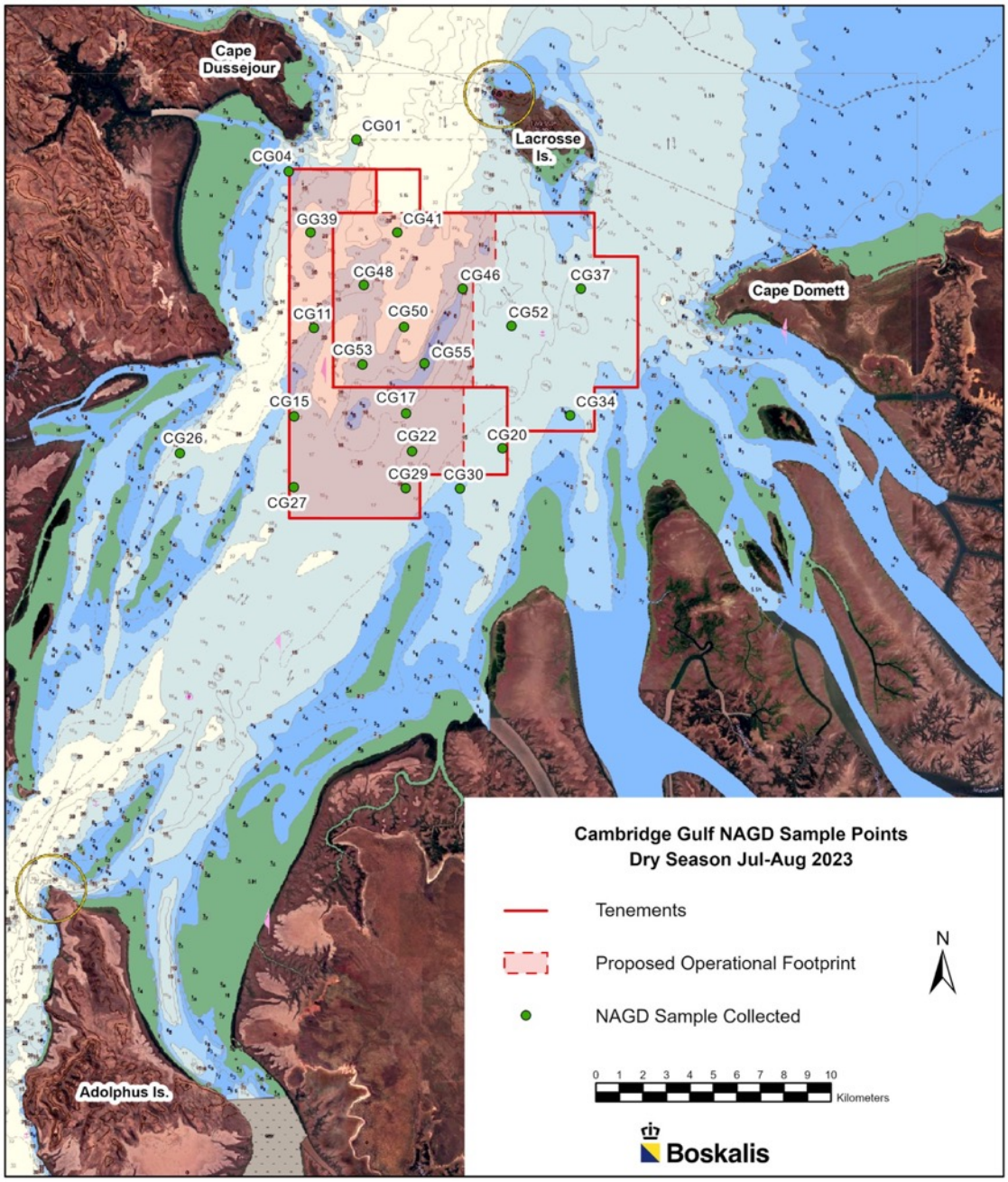

FIGURE A.1.16: *Locations of sediment quality sampling sites assessment against NAGD 2009 – dry-season July 2023.*

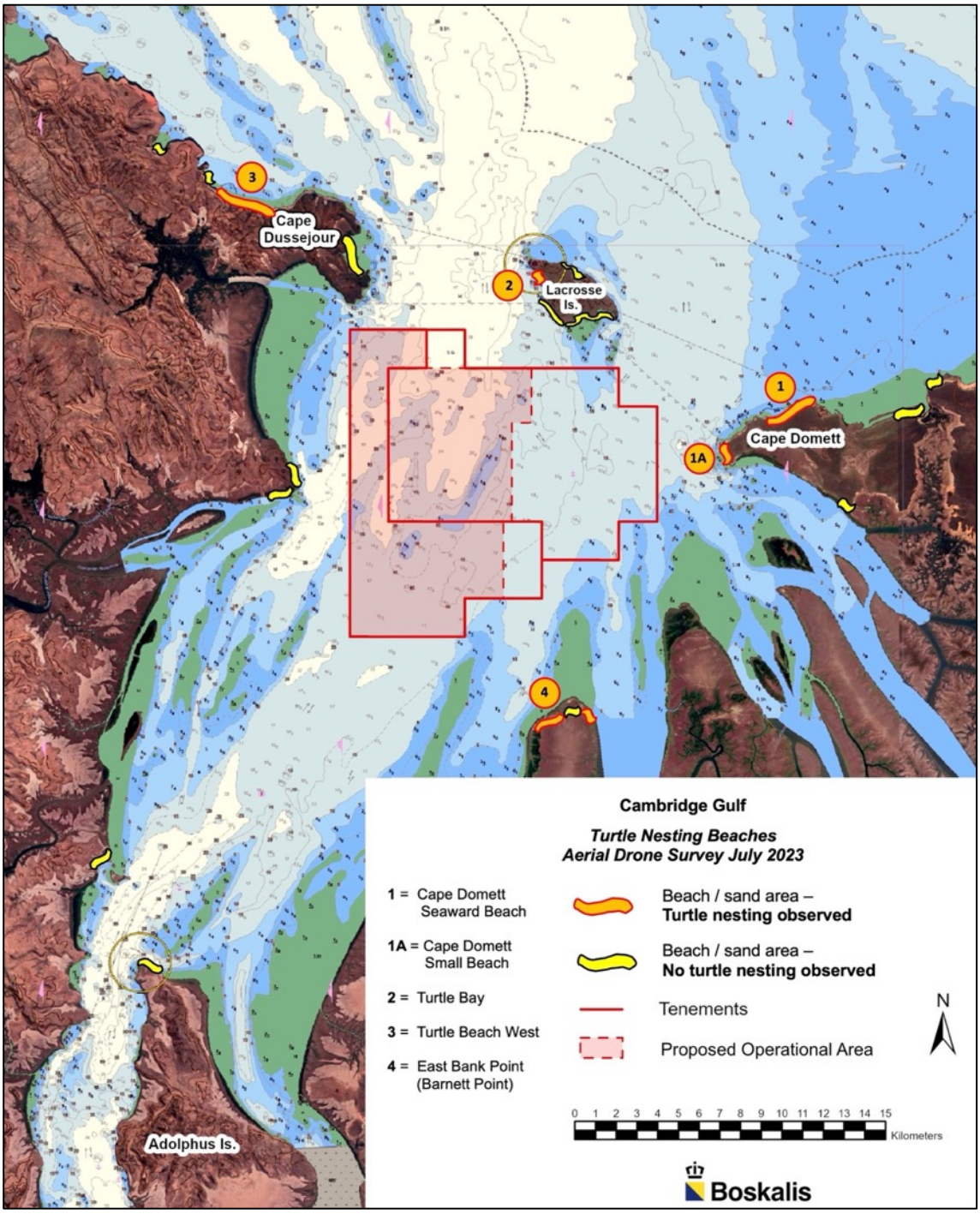

FIGURE A.1.17: *Supra-tidal sand areas surveyed for turtle nesting with aerial drone - dry-season July 2023.*

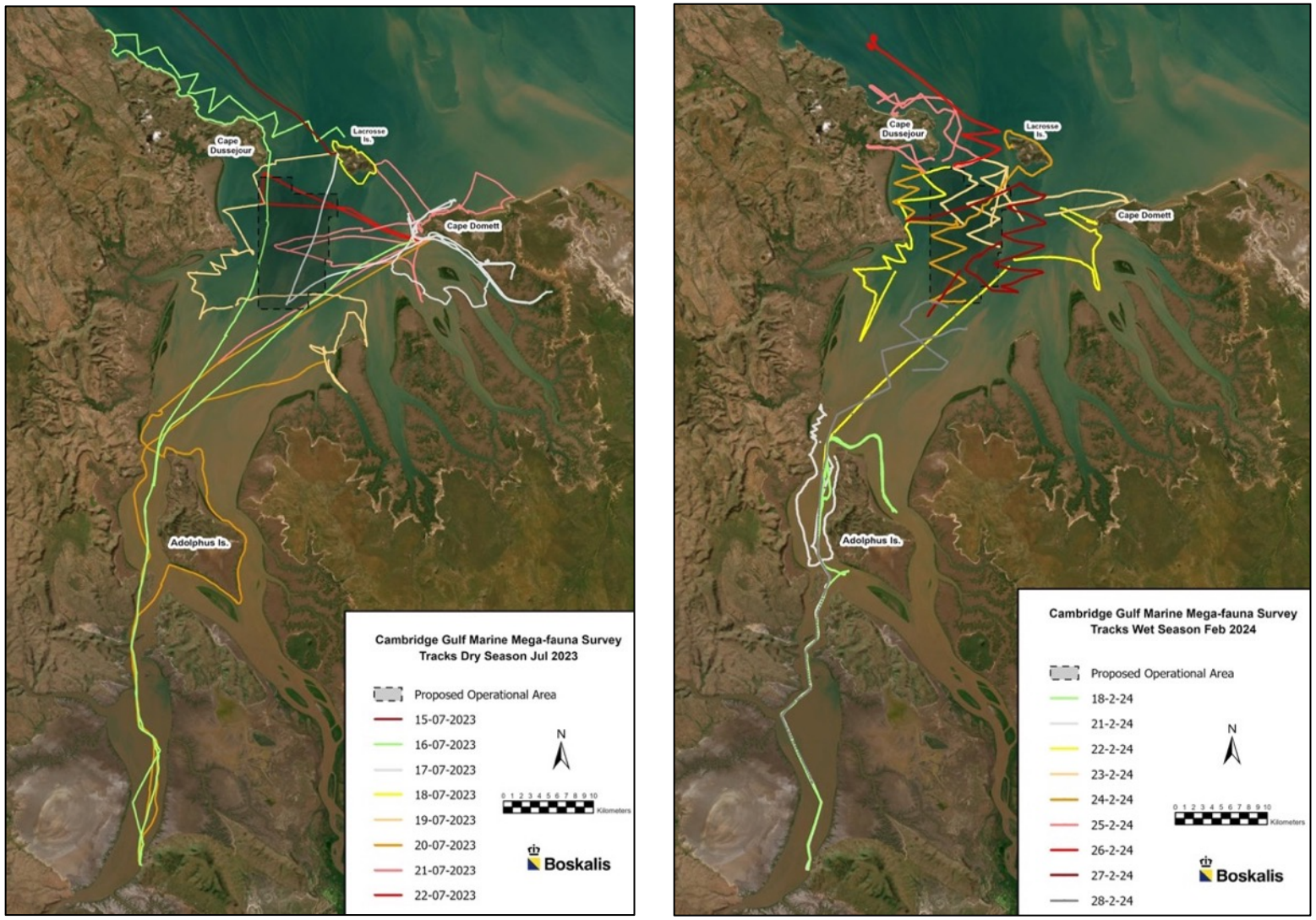

FIGURE A.1.18: *Dedicated Marine Mega-Fauna (MMF) survey tracks. Left: Dry-season / Right: Wet-season.*

ANNEX 2: SHIPPING & OIL SPILL RISK ASSESSMENT

A.2.1: Shipping Through CG & Port of Wyndham

1. The Port of Wyndham is located ~80 km upstream from Cambridge Gulf (CG) (Figure A.2.1). Vessels that enter and depart the Port of Wyndham must pass through CG, entering and departing via West Entrance between Lacrosse Island and Cape Dussejour, and pass directly through the proposed operational area of BKA's proposed sand-sourcing operation, as shown on Figures A.2.1 and A.2.2.

2. While it is a small port with a low frequency of ship visits (an average of 1.15 per week over 19 years 2005 to 2023 inclusive), it has and does receive a variety of ship types, including:

   - tankers that deliver diesel and other oil products, especially to supply mining operations in the East Kimberley,
   - bulk carriers that deliver nitrate (fertilizer) for the farms in the Ord River irrigation area,
   - bulk carriers that export nickel, iron ore, maize, scrap metal and other commodities,
   - cattle carriers that export cattle to SE Asia, and
   - small cruise ships that come in for fueling, resupply and to change out passengers after cruising the Kimberley coast,
   - amongst others.

3. Trade in the different products is quite variable, with gaps occurring in the shipment of different cargoes in response to market conditions. For example, in recent years from time-to-time crude oil was produced at the Buru terrestrial oil field ~90 km east of Broome and transported to Wyndham by road tanker, where it was stored and loaded onto crude oil tankers for shipping to a refinery in either Singapore or Papua New Guinea, although shipments have currently halted.

4. The port is operated by Cambridge Gulf Limited (CGL) under lease from the Kimberley Ports Authority (KPA). The KPA has regulatory oversight of the port including for all safety of navigation and vessel-sourced pollution issues. The proposed operational area is seaward of the declared Port Area as shown on Figures A.2.1 and A.2.2, and is therefore not under the jurisdiction of KPA. The maritime authority for State waters outside of declared Port Areas is the Maritime Division of the WA Department of Transport (DoT Maritime).

5. Port pilotage is compulsory unless the vessel master holds an exemption, and the pilots are provided by CGL. The Pilot Boarding Ground is located outside of the Port Area near the West Entrance to CG, although the Pilots will vary the location depending on prevailing weather conditions.

6. Figure A.2.3 shows some examples of typical vessel types and sizes that service Wyndham. A picture of shipping traffic through the Port of Wyndham, and thus through CG, is provided by the graphs in Figures A.2.4 to A.2.7 based on data provided by CGL. In summary these show:

   a) Figure A.2.4 - No. Visits per Year: This shows the number of piloted vessel visits per year for 19 years from 2005 to 2023 inclusive. This shows that the number of visits per year ranged from a low of 29 in 2017 to a high of 96 in 2012, with an average of 60 vessels visiting per year over the 19-year period.

   b) Figure A.2.5 - Vessel Types: This shows the number of piloted vessel visits by vessel type for the years 2005 - 2023 combined. This shows that the top four types of vessels in terms of frequency of visits were bulk carriers (all cargo types combined), with 372 visits, cruise ships with 228 visits, cattle carriers with 220 visits and diesel tankers with 147 visits over the 19-year period,

   c) Figure A.2.6 - Vessel Lengths: This shows the average vessel length overall (LoA) each year for 19 years from 2005 to 2023 inclusive. This shows that the LoA of vessels that visit Wyndham (excluding small local vessels) ranged from 34 m to 200 m, with an average vessel LoA over the 19-year period of 135 m.

   d) Figure A.2.7 - Vessel GRT: This shows the average vessel size in Gross Registered Tonnes (GRT) each year for 19 years from 2005 to 2023 inclusive. This shows that the GRT of vessels that visit Wyndham (excluding small local vessels) ranged from 436 GRT to 227,457 GRT, with an average vessel size over the 19-year period of 13,631 GRT.

FIGURE A.2.1: *Shipping traffic in and out of the Port of Wyndham passes through CG and the proposed operational area. Vessel AIS tracks from AMSA via Digital Earth Australia.*

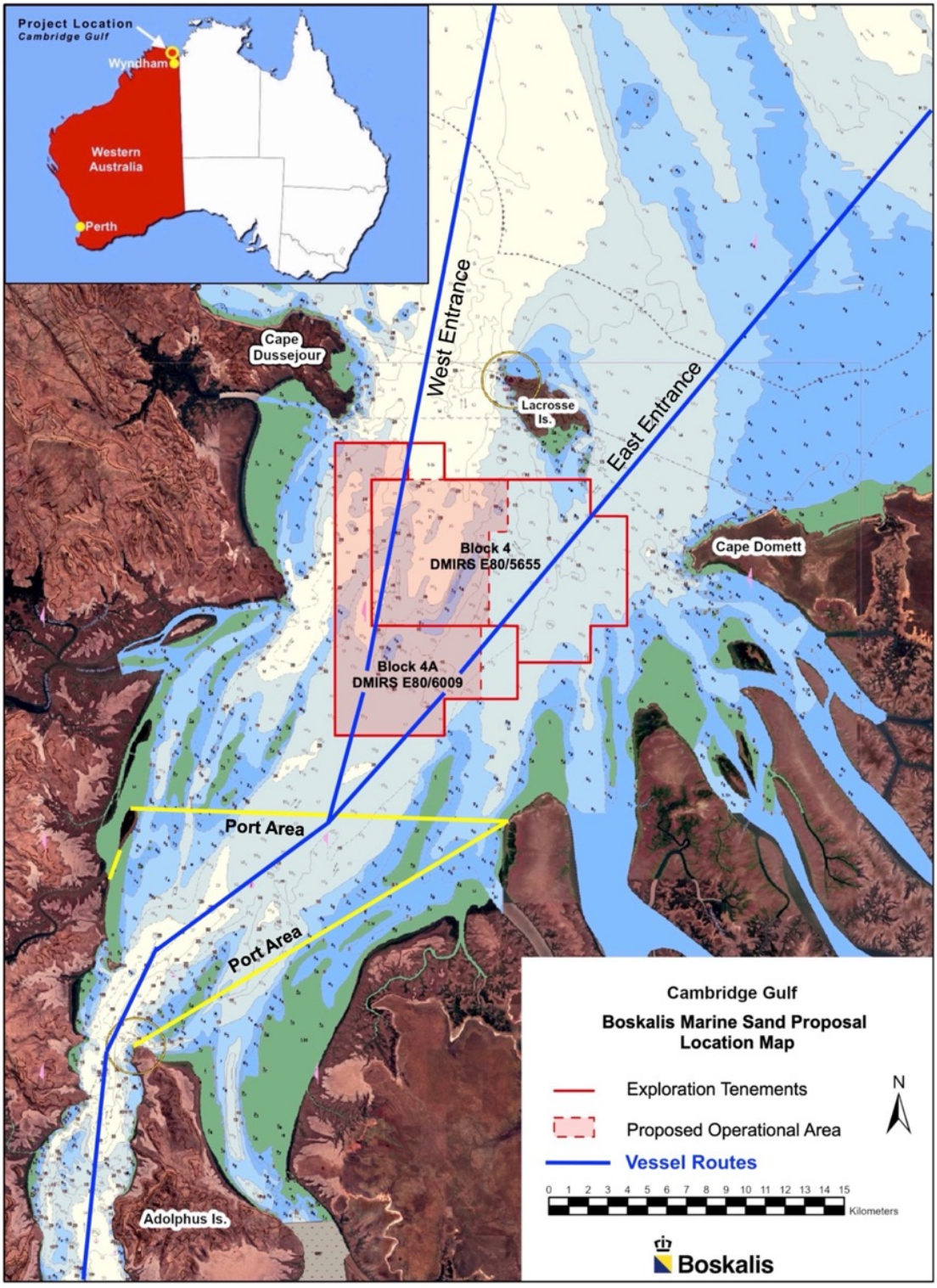

FIGURE A.2.2: *The main vessel routes through CG pass through the proposed operational area. Most vessels tend to use West Entrance as shown by the AIS tracks on Figure A.2.1. It should be noted that the proposed operational area is 100 km^2 in area, so there is significant scope to achieve vessel separation.*

FIGURE A.2.3: *Examples of typical vessel types and sizes that service Wyndham.* Top *- A small bulk carrier entering the Port of Wyndham through BKA's proposed operational area in March 2023 (Raaymakers).* Middle *- Three vessels alongside the wharf in Wyndham – two cruise vessels on the left and an offshore utility vessel on the right (CGL).* Bottom *- A larger bulk carrier being loaded with iron from a barge in Wyndham (CGL).*

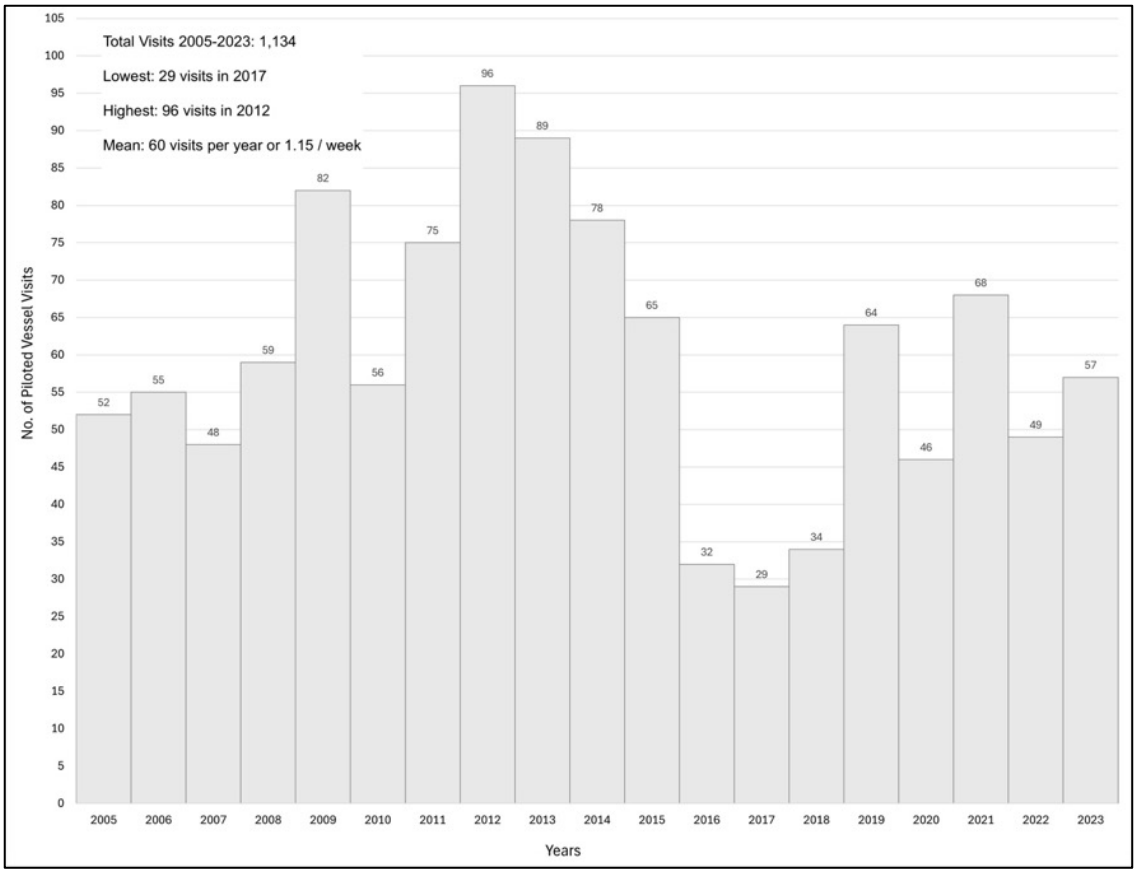

FIGURE A.2.4: *Port of Wyndham – Number of piloted vessel visits per year 2005 - 2023 (CGL)*

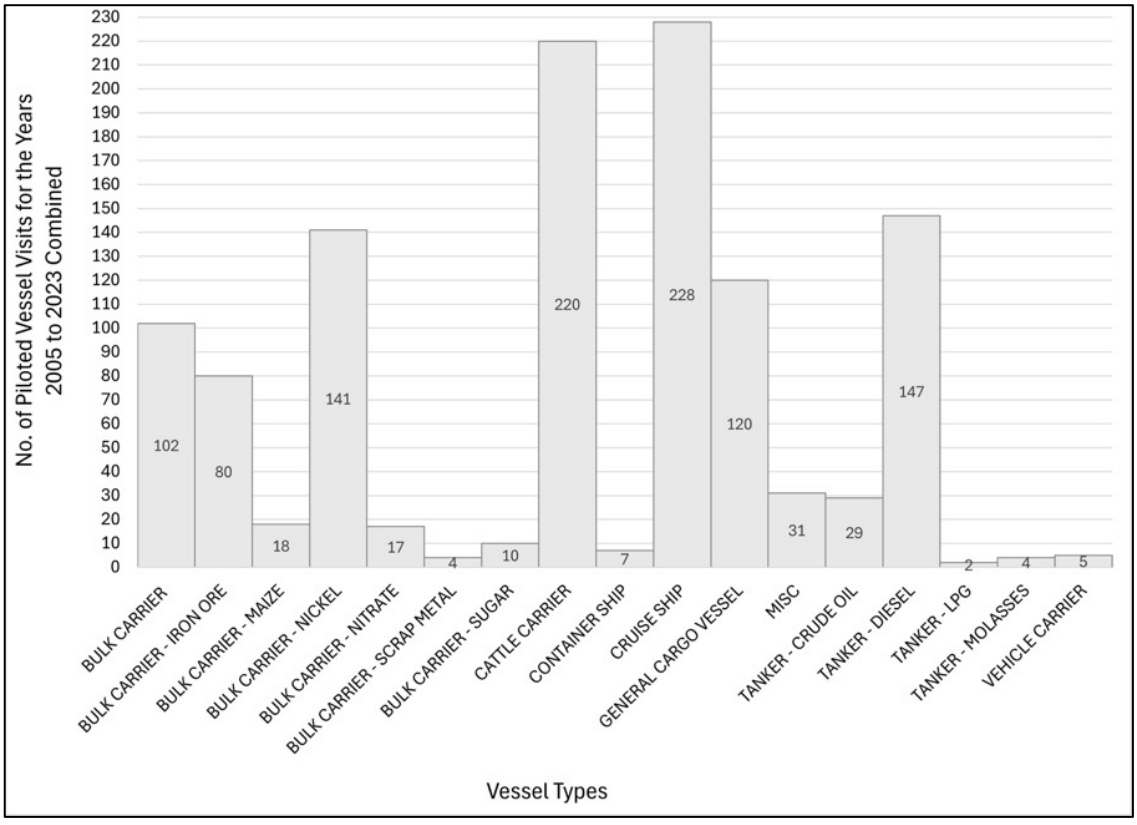

FIGURE A.2.5: *Port of Wyndham – Number of piloted vessel visits by vessel type for the years 2005 - 2023 combined (CGL)*

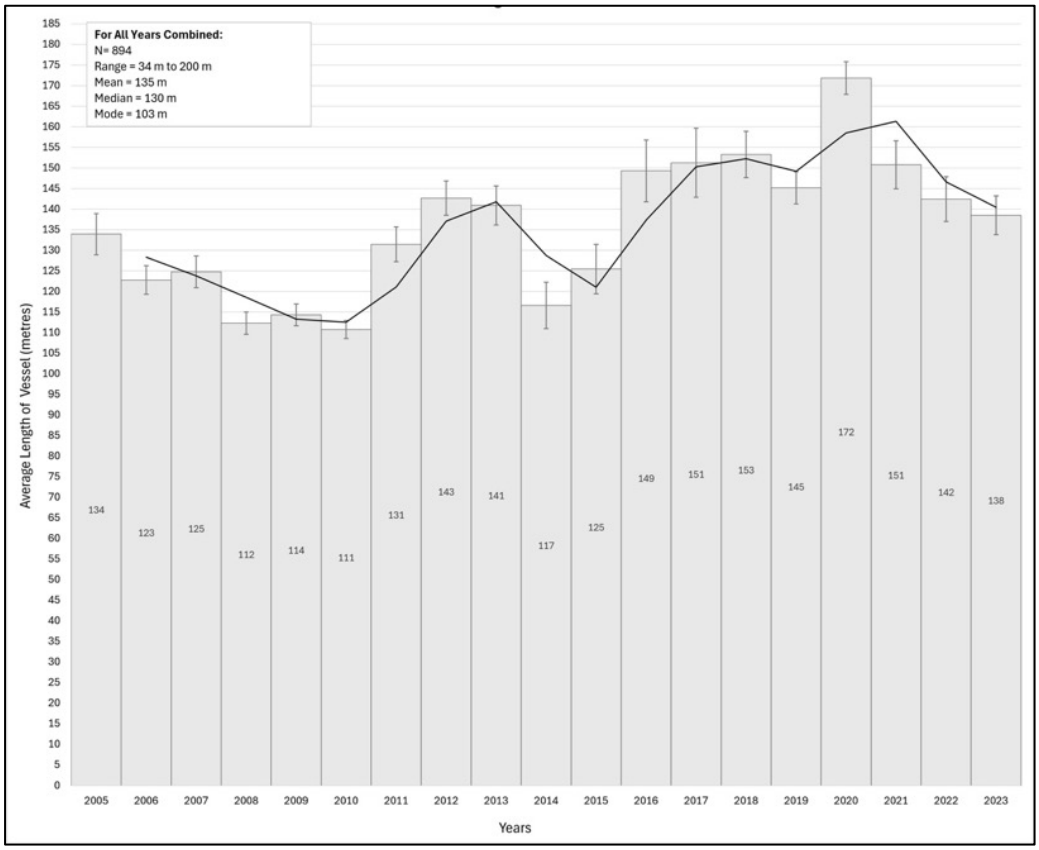

FIGURE A.2.6: *Port of Wyndham – Average Length Overall (LoA) of vessels visiting per Year 2005 - 2023 (CGL)*

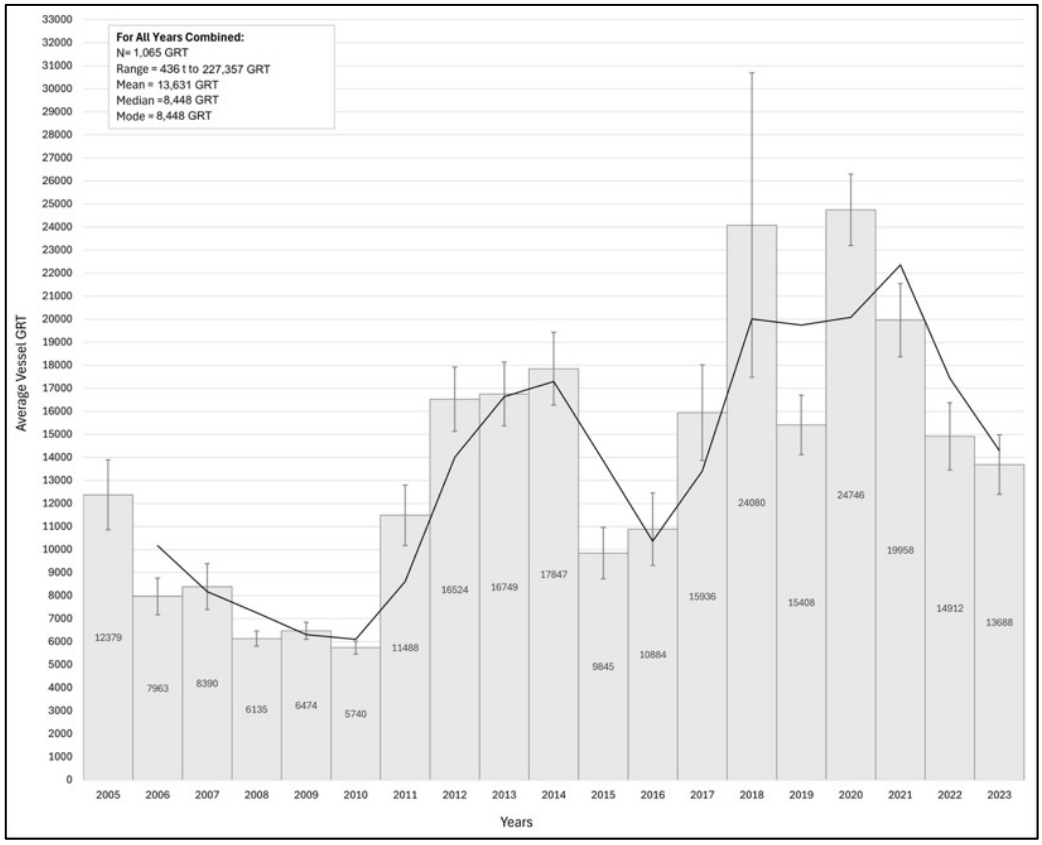

FIGURE A.2.7: *Port of Wyndham – Average Vessel Size in GRT that visited each year 2005 - 2023 (CGL)*

A.2.2: Potential Interactions Between Shipping Traffic & SPV

1. As outlined in section A.3.1 and shown on Figures A.2.1 and A.2.2, vessels that enter and depart the Port of Wyndham must pass through CG, and pass directly through the proposed operational area of BKA's proposed sand-sourcing operation.

2. This raises the potential for interactions between the Sand Production Vessel (SPV) and vessels transiting through the proposed operational area, including potential collisions.

3. As outlined in section A.3.1 vessels that transit through CG can be quite large, with an average LoA of 135 m and a maximum LoA to date of 200 m, and an average GRT of over 13,000 and a maximum GRT to date of over 220,000.

4. Vessels of these size ranges, including the bulk carriers that are the most frequent visitors to Wyndham, can carry several thousands and even more than 10,000 tonnes of fuel oil, albeit divided amongst separate tanks.

5. Diesel tankers are the fourth most frequent visitor to Wyndham, and these can carry several tens of thousands of tonnes of diesel as cargo – depending on the specific vessel, also divided amongst separate tanks.

6. Given these volumes of fuel oil and oil products being carried through CG, in the unlikely event of a collision between vessels, including the SPV, there is a risk of an oil spill.

7. The likelihood of a collision is driven by the frequency of vessel traffic through CG. As outlined in section A.2.1, based on 19-years of data there is an average of 60 vessel visits to the Port of Wyndham each year. If divided by 52 weeks in a year, this gives an average of 1.15 vessel visits per week. Given that each vessel visit involves both an arrival and a departure transit through CG, 1.15 visits per week is doubled to an average of 2.3 vessel movements through CG per week. This is a very low frequency of vessel movements.

8. It should be noted that this is an average value and there can be periods when vessel movements are higher or lower per week. During BKA's dry-season environmental survey in July-August 2023 only one vessel movement through CG was observed in a three-week period (the vessel shown at the top of Figure A.2.3). During BKA's wet-season environmental survey in February-March 2024 only two vessel movements through CG were observed in a four-week period.

9. Never-the-less, an average of 2.3 vessel movements through CG per week is used for assessment and planning purposes.

10. The other major parameter that influences the likelihood of a collision is the frequency and duration of the presence of the SPV in CG. The The SPV will load sand in CG for one to two days every two weeks, and will then sail to the sand delivery port in SE Asia and return to CG two weeks later to repeat the cycle. This means that the SPV will only operate in CG for 52 days per year, or 14% of the time. There will be zero operational activity in CG for 86% of the time during the project's lifespan of up to 15 years.

11. If an average of 2.3 vessel movements per week is combined with a cyclical presence of the SPV of one to two days every two weeks, there is a low likelihood that the presence of the SPV in CG will actually coincide with a transit by another vessel.

12. Because both the SPV's presence and the transits by other vessels are predictable and known in advance, including through vessel AIS tracking and advance reporting to the relevant port and maritime authorities, and because it typically takes less than an hour for an arriving or departing vessel to pass through CG, it will be a very straight forward to implement a simple traffic control and separation scheme.

13. If vessel tracking and advance reporting identify a potential overlap in the presence of the SPV in CG with a transiting vessel, the SPV can move to distant part of the operational area until the vessel passes (the proposed operational area is 100 km^2 in area, so there is significant scope to achieve vessel separation). This will largely eliminate the risk of collision.

14. The SPV will comply with all relevant maritime and navigational safety laws, including the *International Regulations for Preventing Collisions at Sea* (COLREGS). The SPV will operate at very low speeds (~2 knots) in CG and despite being a large vessel (LoA ~ 350 m) will be quite manoeuvrable with a bow-thrusters, further reducing the likelihood of collision.

15. In the highly unlikely event of a collision occurring and resulting in a breach of the SPV's hull, the likelihood of a fuel tank being breached and oil released is even lower. The SPV will comply with the vessel design and construction requirements of Annex I of the *International Convention for the Prevention of Pollution from Ships* (MARPOL), including on the placement and protection of fuel tanks, to prevent breaching and loss of fuel.

16. Overall, given these factors, the likelihood of a collision of the SPV with another vessel resulting in an oil spill is assessed to be negligible.

17. These and other measures to avoid and prevent incidents that could potentially result in an oil spill are discussed further in section A.2.6.

A.2.3: Potential Grounding of the SPV

1. Apart from a potential collision between vessels, possible grounding of the SPV is also a potential incident that could result in an oil spill. Water depths within the proposed operational average -25 m MSL, and are much deeper on high tide with a tidal range of 8 m. The draft of the SPV will be ~19 m, providing significant under-keel clearance and thus meaning that the likelihood of a grounding is very low.

2. The seabed in CG comprises sand and other soft sediments, so in the highly unlikely event of a grounding, there is an extremely low probability that the SPV's steel hull would be breached. In the even unlikelier event of a grounding occurring and resulting in a breach of the SPV's hull, the likelihood of a fuel tank being breached and oil released is even lower. The SPV will comply with the vessel design and construction requirements of Annex I of MARPOL, including on the placement and protection of fuel tanks, to prevent breaching and loss of fuel.

3. The SPV will operate at very low speeds (~2 knots) in CG and despite being a large vessel (LoA ~ 350 m) will be quite manoeuvrable with a bow-thrusters, further reducing the likelihood of grounding.

4. Overall, given these factors, the likelihood of a grounding of the SPV resulting in an oil spill is assessed to be negligible.

5. This and other measures to avoid and prevent incidents that could potentially result in an oil spill are discussed further in section A.2.6.

A.2.4: Potential Spills from Bunkering the SPV

1. International statistics show that the most frequent cause of oil spills from vessels is accidents during bunkering (refueling) and oil transfer operations. This risk will be eliminated for the BKA proposal in CG and Australian waters overall as there will be zero bunkering in Australian waters. All bunkering will be undertaken at the SE Asian sand delivery port under controlled port conditions.

A.2.5: Coordination with Port & Maritime Authorities

1. As outlined in Referral Report No. 6 - *Stakeholder Consultations*, BKA has consulted closely with CGL, KPA and DoT Maritime. BKA will continue to consult with these parties including, should the proposal be approved and proceed, to develop necessary navigational safety and maritime incident prevention, preparedness and response arrangements.

2. The SPV will be an internationally-registered vessel subject to all relevant regulatory requirements of the International Maritime Organization (IMO) and the Australian Maritime Safety Authority (AMSA). If the proposal proceeds, BKA will also consult with AMSA regarding vessel compliance with relevant requirements.

A.2.6: Shipping Incident & Oil Spill Prevention, Preparedness & Response Measures

1. Considering the points outlined in the sections above, Table A.2.1 integrates the shipping incident and oil spill prevention and response measures that BKA proposes to apply to the operation.

2. Additionally, section 7.3.6 of the main body of the report on potential impacts of marine pollution on benthic communities, and section 7.4 outlining the impact management hierarchy for benthic communities, also describes relevant measures.

TABLE A.2.1: *Proposed shipping incident and oil spill prevention and response measures.*

Potential Incident	Prevention Measures	Preparedness & Response Measures	Outcome
Collison of the SPV with another vessel transiting CG resulting in an oil spill.	Low likelihood of coincident vessel presence: There is a low likelihood that the presence of the SPV in CG will actually coincide with a transit by another vessel. This is due to an average of only 2.3 vessel movements per week combined with a cyclical presence of the SPV of only one to two days every two weeks. Traffic control and separation scheme: If vessel AIS tracking and advance port arrival and departure reporting identify a potential overlap in the presence of the SPV in CG with a transiting vessel, the SPV can move to a distant part of the operational area until the vessel passes (the proposed operational area is 100 km^2 in area, so there is significant scope to achieve vessel separation). This will largely eliminate the risk of collision. Compliance with COLREGS: The SPV will comply with COLREGS which are the international 'rules of the road' to avoid vessel collisions. Low speed & high manoeuvrability: The SPV will operate at very low speeds (~2 knots) in CG and will be manoeuvrable with a bow-thrusters, further reducing collision likelihood. Fuel tank protection: The SPV will comply with the vessel design and construction requirements of Annex I of MARPOL, including on the placement and protection of fuel tanks, to prevent breaching and loss of fuel.	SOPEP: The SPV will have an IMO- and AMSA-compliant Shipboard Oil Pollution Emergency Plan (SOPEP) and equipment for responding in the highly unlikely event of a spill, with a program of regular training and exercises, in cooperation with relevant agencies. Integration with Port, State & National Plans: The SPV's SOPEP will integrate with the relevant port-, state- and national-level plans. Rehabilitation: In the highly unlikely event of an accidental oil spill occurring from the SPV and causing impacts on the coastal environment, BKA would implement an appropriate rehabilitation program, in consultation with relevant stakeholders	The likelihood of a collison of the SPV with another vessel in CG resulting in an oil spill is negligible. In the highly unlikely event of such a spill, potential impacts will be minimized and mitigated through the preparedness and response measures.
Grounding of the SPV in CG resulting in an oil spill.	Adequate Under-keel Clearance: Water depths within the proposed operational average -25 m MSL, and are much deeper on high tide with a tidal range of 8 m. The draft of the SPV will be ~19 m, providing significant under-keel clearance and thus meaning that the likelihood of a grounding is very low. Soft seabed sediments: The seabed in CG comprises sand and other soft sediments, so in the highly unlikely event of a grounding, there is an extremely low probability that the SPV's steel hull would be breached. Low speed & high manoeuvrability: The SPV will operate at very low speeds (~2 knots) in CG and will be manoeuvrable with a bow-thrusters, further reducing grounding likelihood. Fuel tank protection: The SPV will comply with the vessel design and construction requirements of Annex I of MARPOL, including on the placement and protection of fuel tanks, to prevent breaching and loss of fuel.	As above.	The likelihood of a grounding of the SPV resulting in an oil spill is negligible. In the highly unlikely event of such a spill, potential impacts will be minimized and mitigated through the preparedness and response measures.
Accident during bunkering resulting in an oil spill:	This risk will be eliminated for the BKA proposal in CG and Australian waters overall, as there will be zero bunkering in Australian waters. All bunkering will be undertaken at the SE Asian sand delivery port under controlled port conditions.	Not required as risk does not exist.	No risk of such an incident.

ANNEX 3: PLUME MITIGATION CAPABILITY STATEMENT

Please see next page.

NOTE: Sediment dumping / disposal does not apply to BKA's proposed operation in CG.

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CAPABILITY SHEET

OVERFLOW PLUME
PREVENTION & MITIGATION

INTRODUCTION

Dredging operations by Trailing Suction Hopper Dredgers (TSHDs) can generate suspended sediment plumes from a number of sources, including the action of the draghead on the seabed, the release of overflow water containing sediment back into the sea, the disturbance of the overflow plume by the vessel's propeller, and disposal of the dredged material at sea (in cases when disposal applies).

In certain circumstances under certain conditions, especially when dredging is carried out in close proximity to sensitive benthic habitats and communities such as coral reefs, seagrass meadows, sponge beds and macroalgae communities, suspended sediment plumes dispersed by the prevailing currents can cause environmental impacts by increasing turbidity (and thus reducing light availability in the water column and at the seabed), and by causing sedimentation on the benthic habitat.

In accordance with Boskalis' stringent corporate environment and social policy, as well as the various environmental laws and regulations in the wide range of jurisdictions where Boskalis operates globally, Boskalis applies the following environmental management hierarchy, in descending order of priority:

- Prevent (avoid) impacts.
- Mitigate (minimize) impacts.
- Monitor and manage impacts.
- Offset impacts.
- Rehabilitate impacts.

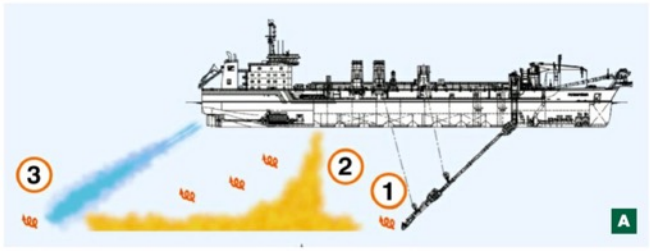
With many decades of global experience Boskalis has developed deep expertise in preventing, mitigating, monitoring, and managing suspended sediment plumes from dredging operations, particularly those caused by the discharge of overflow water, as relatively this constitutes the most significant potential source of suspended sediment from dredgers.

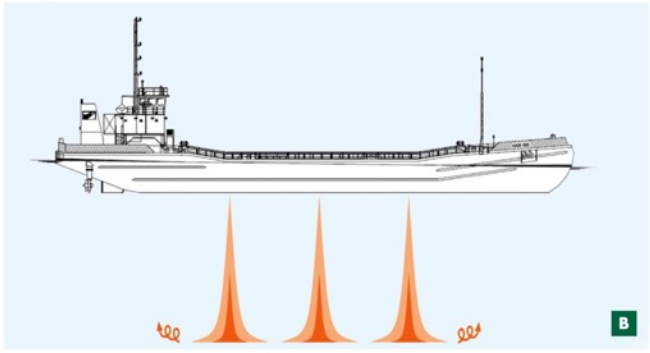
This capability sheet provides insights into Boskalis' experience, advancements, and best practices on this topic. These include state of the art capabilities in modelling and forecasting sediment plume generation and dispersal and their potential ecological impacts, and practical engineering measures to significantly reduce sediment plumes such as the 'green valve' fitted to the overflow water intakes on TSHDs.

THEORY / DETERMINATION OF SOURCE TERMS

During dredging operations with a TSHD, sediment is released at different locations (Figure A:

1. The action of the draghead on the seabed.
2. A small fraction of the hopper mixture through overflow into the water column.
3. The disturbance of the overflow plume through the action of the propellor.
4. Disposal of the dredged material at sea (in cases when disposal applies) (Figure B).





A Sediment plume sources for a TSHD during dredging.
B Sediment plume source for a TSHD during disposal.

As input for sediment plume dispersion models, Boskalis calculates source terms for each sediment source (dredging activity) and type of dredger.

The source term is calculated as:

$$S\left[\frac{kg}{s}\right] = Production\left[\frac{m^3}{s}\right] \times \rho\,(dry)\left[\frac{kg}{m^3}\right] \times fines\ content\ [\%] \times sourceterm\ fraction\ (\sigma)[-]$$

Where S = source term in kg/s and ρ (dry) is the dry density in kg/m³. Typical ranges of source term fractions can be found in *Dredging for Sustainable Infrastructure* (CEDA, 2018). These ranges are derived from literature (amongst others Becker et al. 2015) and are based on empirical data. For example, for TSHD overflow, the recommended source term fraction by Becker et al. is 0 – 20 %.

In some jurisdictions where Boskalis operates there can be specific guidelines for dredging sediment plume modelling and management, for example in the

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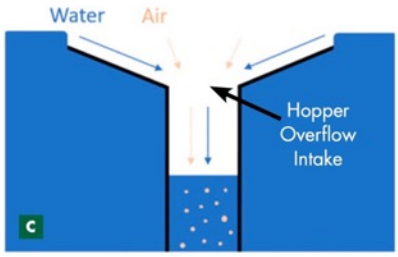
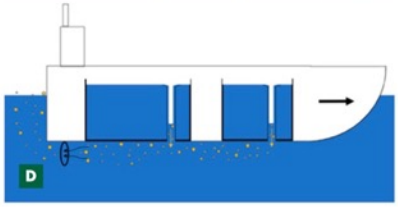
OVERFLOW PLUME
PREVENTION & MITIGATION

Great Barrier Reef region of Australia there are the *Guidelines on the use of hydrodynamic numerical modelling for dredging projects in the Great Barrier Reef Marine Park* (GBRMPA 2012), and in Western Australia (WA) there are the *WAMSI/CSIRO Guideline on dredge plume modelling for environmental impact assessment* (Sun et al 2020) and the WA EPA *Technical Guidance on environmental impact assessment of marine dredging proposals* (WA EPA 2021). In these areas Boskalis will ensure that modelling also complies with such requirements.

INTERACTION OF OVERFLOW PLUME AND PROPELLOR WASH

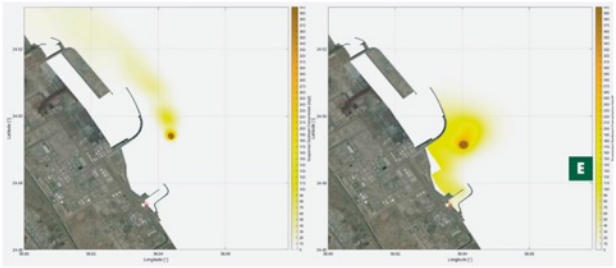
Without the inclusion of mitigation measures such as a 'green valve' as outlined below, sediment plumes can form when water and sediment overflowing from the dredger's hopper, are discharged into the sea. The process of regular overflow introduces air, creating turbulence that stirs up sediment beneath the vessel, as illustrated in Figure C. This disturbance can be further agitated by the vessel's propellers, resulting in a visible plume at the stern of the vessel, shown in Figure D.





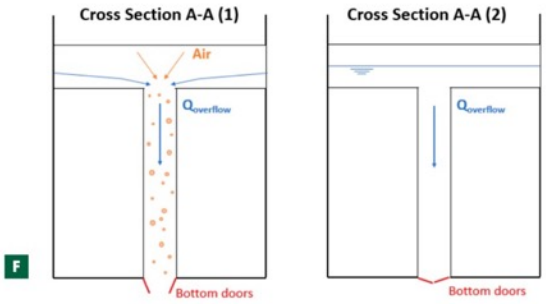
MODELLING

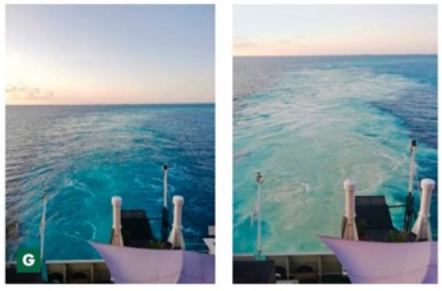
During any dredging project proposal phase, Boskalis sets up sediment plume generation and dispersion models (1D, 2D or 3D) with the calculated source terms as the starting point. These models can predict suspended sediment / turbidity values and plume dispersal scenarios that might be caused by the planned operations under a range of possible operational conditions and assess any potential environmental impacts. Based on these assessments, preventive and mitigation measures can be identified. See Figure E.



PREVENTION & MITIGATION OF SEDIMENT PLUMES - GREEN VALVES

In accordance with the environmental management hierarchy outlined above, Boskalis' priority is to prevent (avoid) and mitigate (minimize) the generation and dispersal of sediment plumes from the dredging operation. The primary measure for achieving significant reductions in sediment plumes from the dredge overflow is the installation of a 'green valve' in the overflow water intake. This is an innovative and proactive technique that minimizes sediment plumes by drowning the overflow, thus reducing air entrainment which causes sediment buoyancy, and allowing the sediment to settle more quickly (see Figure F and Figure G).





C The principle of water and air entrainment in an overflow without green valve.
D The interaction of the overflow sediment plume and the vessel's propellors.
E Examples of suspended sediment plume modelling to inform planning of dredging operations.
F The principle of a green valve: drowning the overflow to prevent air entrainment in the overflow.
G The effectiveness of a 'Green Valve' during dredging works. Left: Overflow plume with the use of a Green Valve. Right: Overflow plume without the use of a Green Valve.

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OVERFLOW PLUME
PREVENTION & MITIGATION

Boskalis' vessels are equipped with various types of Green Valves, including Dobber, Bottom Doors, Plumigator and Anti-turbidity valves. These valves are assessed based on technical performance, maintenance requirements, flexibility, and automation capabilities.

RESEARCH & DEVELOPMENT ON GREEN VALVES

Boskalis is dedicated to enhancing its environmental performance. Recent investigations into the operational effectiveness of different types of Green Valves have enriched the understanding of their relative effectiveness in different settings. Boskalis is now initiating a measurement campaign to precisely evaluate the comparative efficacy of Green Valves. This will also improve sediment plume model predictions, enabling more accurate impact assessments and mitigation strategies.

PREVENTION & MITIGATION OF SEDIMENT PLUMES – OTHER MEASURES

Other measures to avoid and minimize the generation and dispersal of sediment plumes from TSHD operations include adaptive management to the dredging, supported by modelling and real-time reactive monitoring.

ENVIRONMENTAL OUTCOMES

Based on Boskalis' extensive global experience, pro-active application of the measures outlined above are effective at preventing and mitigating potential environmental impacts from dredging-generated sediment plumes, and there is usually no requirement to move to the lower levels of the environmental management hierarchy of offsetting or rehabilitating impacts. The measures are effective at achieving the priority levels of the environmental management hierarchy.

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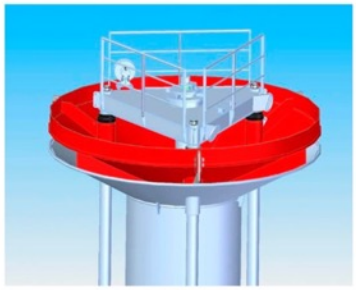

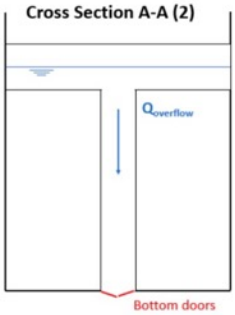

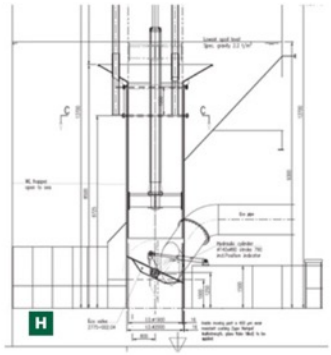

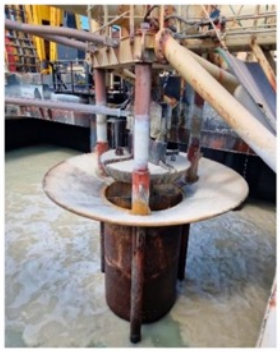

H Figures of the four different types of Green Valve overflow systems. (a) Top left: Plumigator, (b) Top right: Bottom Doors, (c) Bottom left: Anti -turbidity Valve, (d) Bottom right: Dobber System.

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ANNEX 4: MARINE MEGA-FAUNA CAPABILITY STATEMENT

Please see next page.

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CAPABILITY SHEET

MARINE MEGA-FAUNA
OBSERVATION & IMPACT PREVENTION

A Humpback whale (*Megaptera novaeangliae*) at Barrow Island, Western Australia
B Mating Sea turtles near Barrow Island, Western Australia
C Short-beaked dolphin (*Delphinus delphis*) observed during MMF observation procedures (source: Gardline)

INTRODUCTION

Boskalis' vessels, including dredgers and other work vessels, often operate in areas that host populations of marine mega-fauna (MMF) species, including, depending on the location, marine mammals (whales, dolphins, dugong, manatees and seals), marine turtles, crocodiles and sharks and rays. In certain countries some of these species may be protected under national laws.

MMF observation and impact prevention procedures during vessel operations are therefore a critical component of Boskalis' environmental protection efforts, aimed at preventing and minimizing potential vessel strikes on MMF and potential impacts of vessel-generated underwater noise on MMF.

As part of the company's values, which emphasize sustainability and biodiversity in every project, Boskalis applies extensive mitigation requirements, especially in the presence of important and protected MMF.

MMF observation involves the systematic monitoring for MMF in their natural habitats. Exclusion zones around the working vessel that are appropriate to the MMF species in the area are established, and these are continuously monitored for MMF activity. Avoidance procedures are followed to ensure that the vessel remains clear of MMF during operations. In some jurisdictions exclusion zones and observation and avoidance procedures are specified in guidelines or mandated by law.

PRACTICES AND PROTOCOLS

In general, as a minimum Boskalis applies the following MMF prac tices and protocols during dredging and other relevant vessel operations:

- Pre-operations Surveys: Before operations begin, surveys are conducted to identify the presence of MMF in the area. This helps in planning the dredging activities to avoid critical habitats or times when MMF is most likely to be present.
- Monitoring During Operations: Trained observers, either on board the vessels or on nearby platforms, monitor the presence of MMF throughout the dredging other relevant vessel operation. The use of both visual and acoustic monitoring techniques allows for the detection of marine life even under poor visibility conditions or underwater.
- Implementing Mitigation Measures: If MMF is/are observed in the vicinity of vessel activities, specific mitigation measures are implemented. These can include changing the vessel's speed and/or direction, pausing operations, reducing vessel noise levels, or adjusting the location or timing of the activities to minimize disturbance.
- Reporting and Documentation: Observations and any mitigation actions taken are meticulously documented and reported to relevant authorities. This data contributes to the understanding of MMF behavior and the impact of dredging and other vessel operations, informing future guidelines and best practices.

TECHNOLOGIES AND TECHNIQUES

MMF observation can employ a variety of technologies to ensure effectiveness and minimize impacts. These technologies are designed to detect the presence of MMF in and around dredging and other marine work sites, enabling timely implementation of mitigation measures. Considering the variation in project requirements across clients and geographical locations, Boskalis adapts its MMF observation technologies accordingly.

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MARINE MEGA-FAUNA
OBSERVATION & IMPACT PREVENTION


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As outlined above, often a combination of acoustic and visual monitoring is applied.

1. Visual observation of surfacing MMF species. Marine fauna observers (MFOs) use binoculars and thermal imaging cameras. The latter can detect marine mammals and some other MMF based on their body heat, which is particularly useful during low visibility conditions or at night.
2. Passive acoustic monitoring to detect vocalizations of marine mammals. Hydrophones and passive acoustic monitoring systems are used to detect marine mammal vocalizations. This is especially useful for species that are difficult to spot visually. Usually, these systems are mounted on a buoy.

INNOVATIONS – AUTOMATED MMF OBSERVATION

Boskalis is working on an innovation that allows for the automatic detection of certain MMF, and especially marine mammals, using AI technology. The aim of the system is more efficient and reliable MMF observation, with fewer interfaces and increased safety for MFO personnel.

The automated MMF observation system intends to automatically detect MMF and especially marine mammals using a set of visual and acoustic sensors. The data from these sensors is processed real-time through an algorithm using AI technology. This allows for real-time MMF detections and high accuracy species localization and identification. Imagery and data are transmitted in real-time to onshore office(s) and verification of the detections can be done onshore by a qualified MFO. Imagery and data is also backed-up to provide a permanent record of observations and can be further analysed for research and learning purposes.

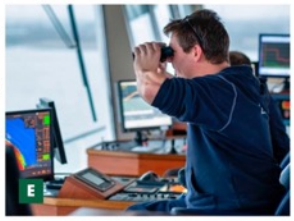
In future when the automatic system is fully proven it can reduce the need for MFOs on site / on vessels, thus improving safety, simplifying logistics and reducing greenhouse gas emissions through a reduced need for auxiliary vessels, as well as a reduced need to travel to and from work sites.

EXPERIENCES / EXAMPLE PROJECTS

Boskalis has extensive experience with MMF observation and impact prevention procedures on its marine projects, and below are some examples.

OFFSHORE WIND PROJECT - CHANGFANG XIDAO, TAIWAN

Between 2021 and 2023, Boskalis installed 62 pre-piled jackets for the 589 MW offshore wind farm Changfang Xidao in Taiwan, an area inhabited by the endangered Chinese White Dolphin (Sousa chinensis). To mitigate the potential impact of underwater noise from piling operations on these marine mammals, Boskalis employed surface-based visual observation and underwater passive acoustic monitoring (PAM) methods. These measures ensured compliance with environmental regulations, aiming to protect the dolphins from potential hearing damage by preventing their proximity to the piling location during operations.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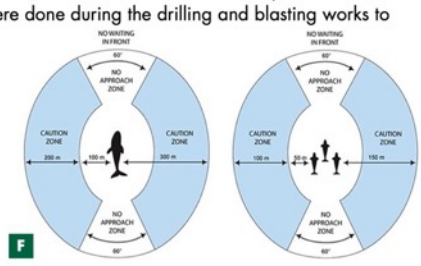
DREDGING PROJECT – KITIMAT, CANADA

Between 2018 and 2021, Boskalis worked on the dredging and remediation of a port basin in Kitimat, Canada, an area inhabited by Humpback Whales (*Megaptera novaeangliae*) and Killer Whales (*Orcinus orca*). The dredging scope involved sailing to and from an offshore disposal area with a Trailing Suction Hopper Dredger (TSHD). To mitigate the potential for vessel strikes in these animals, especially during sailing, 10 MFO's were employed.

Six Observers were stationed around the port basin, two on board of the bridge of the dredger, and another two on smaller vessels patrolling the port and following the dredger to the offshore disposal area. In case of any sightings, the dredging would be paused to avoid and minimize disturbance.

DREDGING PROJECT – DUQM, OMAN

As part of the development of a liquid bulk port facility in Duqm, Oman, Boskalis conducted extensive dredging works with a Cutter Suction Dredger (CSD) and several TSHD's between 2017 and 2019. To protect the local population of Humpback Whales, it was required to have a dedicated MFO on board each of the TSHDs to prevent collisions when the vessels were in transit between the port basin and offshore borrow and disposal areas. Inside the port, observations were done during the drilling and blasting works to remove a small area of rocky material. For this activity, another three MFOs were stationed on board the drilling and blasting barge, on the nearest jetty, and at the entrance to the port basin.



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D Passive Acoustic Monitoring during dredging works, Gabon.
E Trained crew observing from the bridge of the Boskalis dredger Causeway.
F Example of safe distances for whales and dolphins (source: www.dbca.wa.gov.au - Western Australia Department of Biodiversity Conservation & Attractions)

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