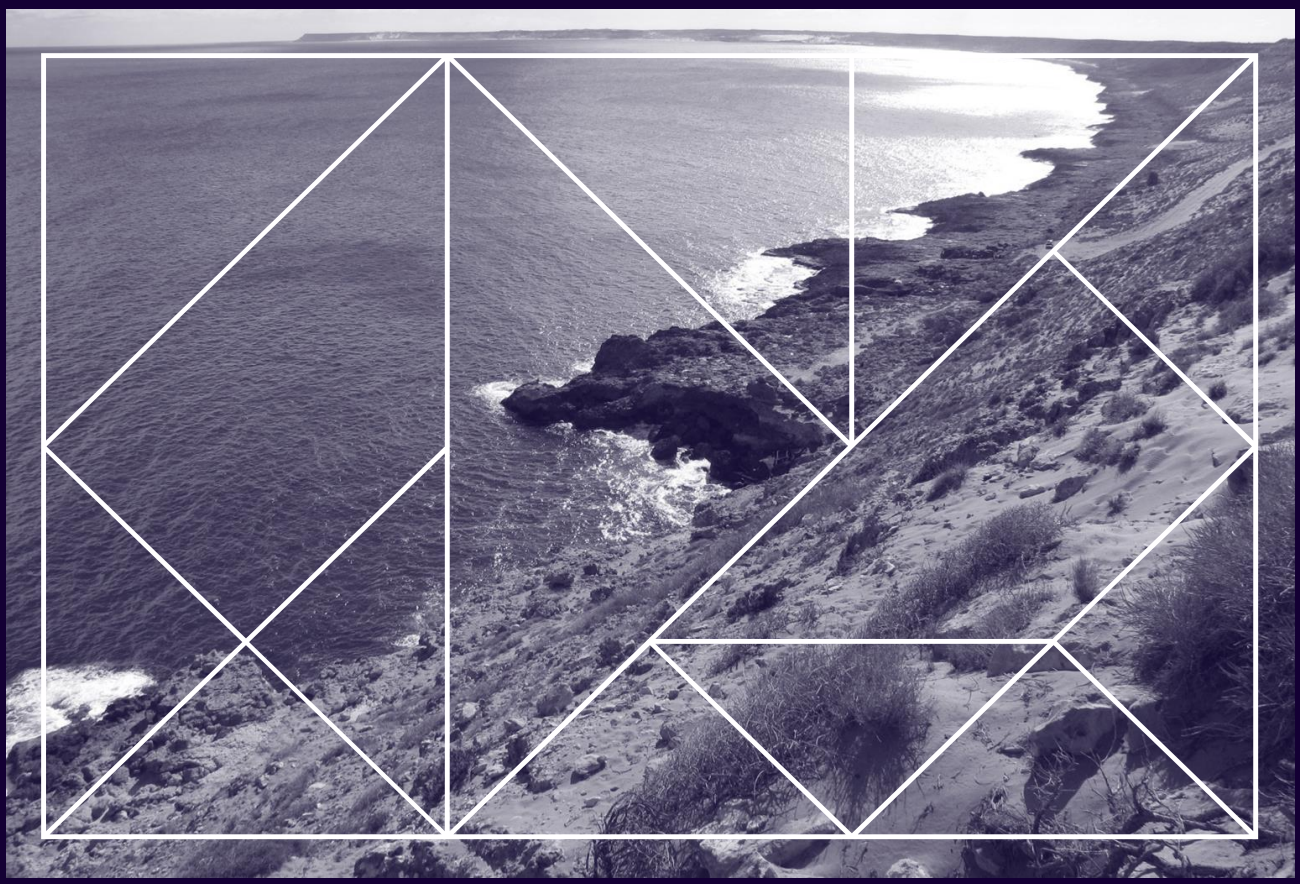
ACIL ALLEN

July 2023

Report to Gascoyne Development Commission

Gascoyne Barge Loading Facility Study

Initial Feasibility Assessment Report



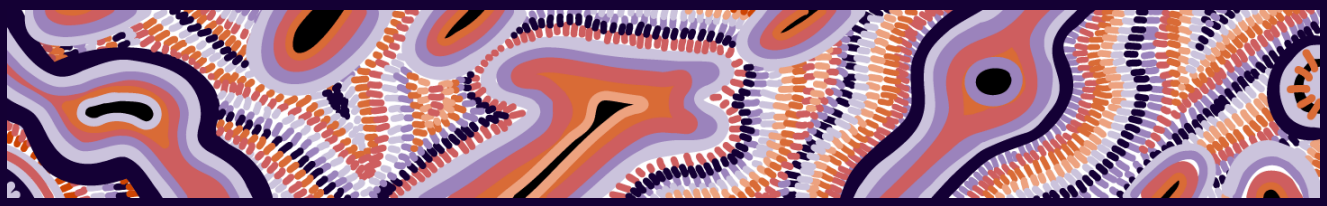
About ACIL Allen

ACIL Allen is a leading independent economics, policy and strategy advisory firm, dedicated to helping clients solve complex issues.

Our purpose is to help clients make informed decisions about complex economic and public policy issues.

Our vision is to be Australia's most trusted economics, policy and strategy advisory firm. We are committed and passionate about providing rigorous independent advice that contributes to a better world.

ACIL Allen acknowledges Aboriginal and Torres Strait Islander peoples as the Traditional Custodians of the land and its waters. We pay our respects to Elders, past and present, and to the youth, for the future. We extend this to all Aboriginal and Torres Strait Islander peoples reading this report.



Goomup, by Jarni McGuire

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Overview

Identification and development of fit for purpose marine infrastructure has been a strategic priority for the Gascoyne Development Commission ('GDC') for some time, reflecting the importance of the creation of a pathway to market for major projects. In this environment, the GDC engaged ACIL Allen and its engineering partner BMT Group to undertake a pre-feasibility study centred on the development of a **barge loading facility** on the western coast of the Gascoyne region.

The scope of the study called for an investigation into the specific infrastructure associated with a barge loading facility, reflecting the views of a number of proponents in the region that a barge facility would be beneficial to some prospective trades. Development of a barge loading facility has been associated with the Gascoyne region's potential to host the mining and export of renewable river sands.

During the study it emerged that a barge loading facility may not be the most appropriate infrastructure solution for the region given the evolving outlook for major projects. ACIL Allen and BMT presented this perspective to the Project Steering Group in April 2023, and sought advice on the way forward to ensure the study delivered value for money for the State.

This report presents a summary of the research, analysis and feedback which led to this outcome, as a means to demonstrate why a barge loading facility is not the most appropriate solution.

Study outcomes

The conclusions of the Initial Feasibility Assessment are provided below.

Summary of findings

Overall, it is clear from the work undertaken by the project team to date that the need for marine infrastructure in this part of the Gascoyne region is strong. There are a number of major project development opportunities which would benefit from the provision of fit for purpose marine infrastructure, to facilitate the movement of goods into and out of the region. For the two most significant opportunities (by trade volume and economic development opportunity respectively) in river sand and renewable energy production, success relies upon an ability to get product in and out via a local marine infrastructure solution.

However, it is evident from the work undertaken throughout the study that a barge loading facility is not the most appropriate marine infrastructure solution for the region, particularly given the emerging opportunities in renewable energy and renewable hydrogen. A barge loading facility can only meet part of the trade task, in part because it is physically constrained by barging, but more substantially because a barge is not an appropriate solution for many trades.

A barge loading facility may be adequate to serve the needs of river sands exporters, and to serve some additional trade activity around the margins. If the infrastructure solution meets the needs of these trades, at a cost which is feasible given the global market for these products, the infrastructure should be able to be financed and built by these industries.

The opportunity presented to the Gascoyne region by renewable energy and renewable hydrogen demands that the needs of these major projects be given substantial weighting when determining a way forward. It is clear, from the work of BMT Group on material handling and the feedback of major project developers in these industries, that a barge loading facility is not the way forward. The project team is bound by the terms of the study, which is to consider a barge loading facility only.

Meanwhile, the initial feasibility assessment of the barge loading facility conceived as part of the work undertaken to date is unfavourable. Financial modelling indicates that at comparative rates for similar services provided at other ports around Western Australia the proposed infrastructure would only recover between 53% and 70% of its costs (including the cost of capital / rate of return). This would mean the facility would struggle to be financed. This analysis includes the handling of some renewable energy cargoes, which may not materialise given the limitations of a barge loading facility.

Study recommendation: Finding a pathway to fit for purpose infrastructure

Considering the above, and the findings of the report, ACIL Allen made a recommendation to the Project Steering Group in April 2023 to pause the pre-feasibility study and to consider a change to the scope of the assessment. The change in scope would permit the project team with the resourcing and direction to investigate alternative marine infrastructure solutions to a barge loading facility, which would permit direct access to berth for ocean going vessels.

A further direction provided by stakeholders was the importance of developing a pathway for the infrastructure to become a major export terminal for renewable hydrogen-based products in the future. This would involve the creation of specific and specialised product handling infrastructure, and a bulk liquids berthing solution as an addition to the capacity to facilitate ocean going vessels.

In discussions with the GDC, ACIL Allen provided a series of options to continue the study at the current point but with the change in infrastructure concept for investigation. This would also provide ACIL Allen and BMT Group with the resources to re-engage with major project owners and other stakeholders to seek their views on the new infrastructure concept and the services that could or should be available.

The re-scoped study would also re-examine the potential trade demand considering the outlook for renewable hydrogen-based product exports, and additional trade and services opportunities such as offshore wind project construction and maintenance services. These trades could not be facilitated at a barge loading facility and so were not examined.

The output of this revised study will be able to be used by GDC or other relevant State Government stakeholders to complete an Application for Concept Approval, the first step in the Western Australian Government's *Strategic Asset Management Framework* for major infrastructure proposals. This approach will allow the State to carry forward the analysis and directions of the study and seek funding to prepare a business case, or to provide an independent perspective on any private sector proposals which may be active in the region.

Additional analysis, findings and directions

While the overall outcome of the study was to recommend alternative concept is considered as the starting point for a solution to the region's need for marine infrastructure, the work undertaken by ACIL Allen and BMT uncovered a range of additional findings and directions which are relevant and will be carried forward to the new study. These are introduced below, with the remainder of the report presenting the underlying analysis used to form the findings and directions.

Stakeholder perspectives

ACIL Allen and BMT Group met with and engaged a number of stakeholders with interests in the area of focus in the study. A summary of their perspectives is provided below.

The study area is highly prospective for renewable energy and hydrogen projects. All proponents engaged – including those not directly exposed to the renewable energy and hydrogen industries – have noted the strong interest in the region from a renewable energy and hydrogen perspective. There are a range of proponents at various stages of development, although most are at pre-concept stage (ie are undertaking preliminary studies). It is evident there remains significant work to be done to prove up the potential of this industry in the region, but interest is strong and centred on observed and expected data with respect to the quality of the renewable energy resource.

A barge loading facility would be welcomed by industry. All industry proponents engaged suggest development of a barge loading facility would be a useful piece of infrastructure for their projects if it was made available. In all cases this is due to the relatively limited options for proponents seeking to establish projects in the northern Mid West and western Gascoyne regions which are the focus of the study. However, stakeholders (particularly renewable energy developers) were clear and consistent with advice that a barge loading facility would only be useful to a certain extent, with a larger and more multi-purpose facility required once early construction works were completed. This infrastructure would allow for project developers to bring Ocean Going Vessels ('OGVs') directly to berth. Barging would be an inefficient and costly solution for a range of imports, including wind turbine blades and towers.

Sites to the north of Carnarvon are preferred by stakeholders. Stakeholders identified that Met-ocean conditions and landside constraints were more accommodating for development in the region to the north of the Carnarvon town site, which would help reduce costs and improve the deliverability of the project. The location was also identified as being more closely associated with renewable energy and renewable hydrogen project proponents, reducing the need for additional landside investments to support the facilitation of trade. Stakeholders who have been investigating the region in recent years have also noted the challenges associated with ocean and landside conditions to the south and far north of the site area.

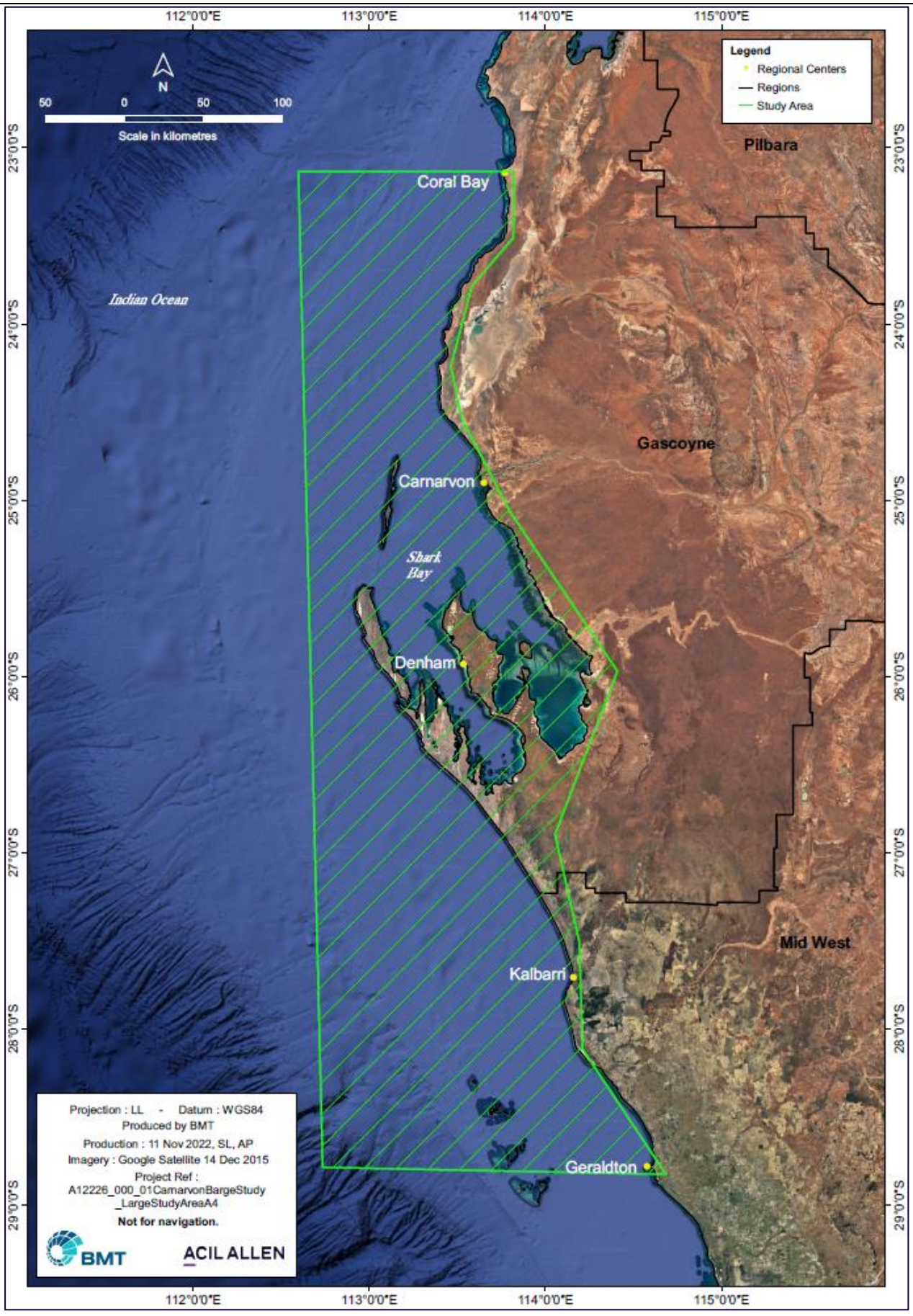
River sands projects are unlikely to provide adequate demand in isolation. The project team understands the potential for river sand exports from the region was one of the catalysts behind the commissioning of the study. The project team engaged with Tremor, Cauldron Energy and Transhipment Services Australia as project proponents seeking to develop river sands projects. The project team formed the view during these engagements that river sand exports were unlikely to be a reasonable basis for underwriting an infrastructure development in their own right. This has ultimately borne out in the initial feasibility screening (see Section 4).

Proponents are interested in an "end to end" maritime solution. Finally, while proponents expressed positive views on a barge loading facility, there was also interest in the potential for this to be further developed into a larger facility which could accommodate export of clean energy products (ie ammonia and / or liquid hydrogen). It was noted specialised facilities are required for these products, and a barge-loading facility was not fit for purpose.

Identification of a location

The initial study area considered in scope for the pre-feasibility study is identified in **Figure ES 1** (overleaf). The study area encompassed the entire western Gascoyne region through the southern border of the Ningaloo Marine Park to approximately Coral Bay, and the northern Mid West region from the Port of Geraldton as the nearest port facility.

Figure ES 1 Gascoyne Barge Loading Facility Study Area



Source: BMT, ACIL Allen

As part of its initial desktop review BMT Group narrowed the broad site area down to two coastal zones.[1] These were:

1. the area bound by the Shark Bay Marine Park to the south through to southern border of Quobba Station
2. a pocket of coastal area centred on Cape Cuvier, bound by the southern border of the Ningaloo Marine Park

The fatal flaws analysis centred on the removal of areas subject to protection under the *Conservation and Land Management Act 1984*, and areas subject to extreme Met-ocean conditions which would make vessel operations complex and challenging (particularly for a barging operation). Other initial site screening criteria are identified below. While progressing a marine infrastructure development within a marine park may be technically feasible, the additional environmental approvals and ongoing compliance requirements were deemed to be a fatal flaw given there were alternative locations within the study area not subject to these constraints.

This analysis rapidly narrowed the focus of the study to the area of the Gascoyne coastline immediately to the north and south of the Carnarvon town centre. This conformed with the views of stakeholders regarding the need for a solution to centre on this part of the region due to the expected location of future major projects.

The sites considered as part of the study are:

— Cape Cuvier
— Boolathana/Bejailing Station
— Babbage Island
— Carnarvon Boat Harbour
— Massey Bay
— Grey Point

The multicriteria analysis has clearly identified a site in or around Boolathana Station as the most appropriate location to consider an investment in marine infrastructure, due to its capacity to host a larger facility in the future, its location relative to the most important demand nodes, and its relatively limited impact on the marine environment (given the options available).

Review of trade opportunities

The study identified the following economic development opportunities in the region surrounding the proposed location of the infrastructure.

Table ES 1 Economic development opportunities in the Gascoyne region

Opportunity	Description
Production and export of river sand	The Gascoyne region hosts a number of deposits of sand deposits which are high in Silica Dioxide (SiO_2), and are considered renewable due to the natural processes in and around the Gascoyne River. Sand is exported to support construction industry activities (principally concrete) in South East Asia.
Production of renewable energy	The Gascoyne region hosts some of the most prospective diurnal wind-solar renewable energy generation resources in Australia – and the world. According to the CSIRO / Monash University's National Renewable Energy Capacity Factor map, areas of the Gascoyne region can achieve combined wind-solar capacity factors of in excess of 50%, which is amongst the highest in Australia. This would allow for

[1] Further details are provided in Appendix A.

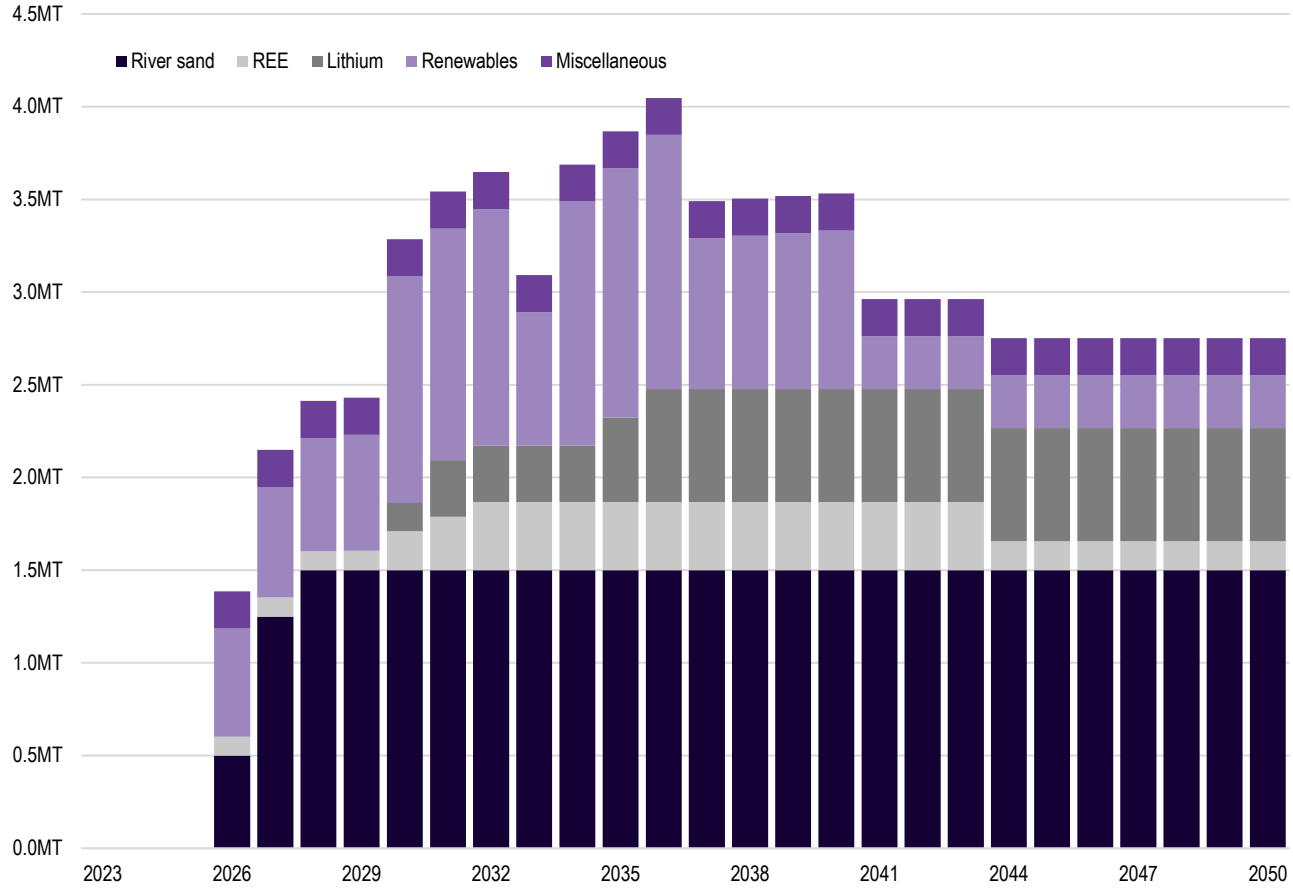
Opportunity	Description
	the production of renewable energy from these sources at a relatively low cost compared to locations with lower capacity factors.
Production and export of renewable hydrogen	The production of renewable hydrogen is based on electrolysis of water using renewable electricity. The existence of high quality renewable energy resources could result in the capacity of the Gascoyne region to host significant renewable hydrogen projects, producing molecular hydrogen and related products for export.
High value mineral production and export	The Gascoyne region is thought to host significant rare earth element ('REE') and lithium mineral resources. One project, the Hastings Rare Earths Project, is currently in development, while a range of ASX-listed and private companies are undertaking significant exploration activity targeting these minerals.
General cargo and containerised trade	The north west coastal regions of Western Australia are currently not served by a port facility between the Port of Ashburton and the Port of Geraldton. Access to a marine facility in the region would support greater use of direct shipping of cargo into and out of these regions, supporting economic development generally.
Agriculture product export (horticulture & packaged products)	The Gascoyne region is one of Western Australia's major food producing regions, but has limited access to large scale export market opportunities due to the lack of capacity to access marine infrastructure. Opportunities to scale and ship horticulture products produced in the Carnarvon region, and packaged protein products (ie beef and aquaculture) could be unlocked if shipping options were available.
Vessel services to support offshore industries	The coastal areas of the Gascoyne are heavily exposed outside of the Port of Carnarvon area (currently served by the Carnarvon Boat Harbour), leaving limited options for vessels supporting emerging offshore industries to berth. *During the engagement process it emerged there was significant interest in the Gascoyne region's potential to host offshore wind generation infrastructure. This was not captured in the initial scan.*

Source: ACIL Allen, from various sources

ACIL Allen has prepared an initial overview projection of trade demand for major projects within the Gascoyne region, making use of information provided by stakeholders and the outcomes of the desktop review into project needs. The profile has been developed as an initial estimate, based on analogous trades and past experience projecting major project import and export requirements.

The trade projection is based on four primary trade demands which could theoretically or technically be served by the barge loading facility, plus an additional volume of trade to reflect the various non-major project trades which could use the facility. The unconstrained trade demand profile is summarised below (**Figure ES 2**).

Figure ES 2 Unconstrained Trade Demand Projection



Source: ACIL Allen, from various sources

Summary of findings

The nine individual findings of the study are provided below.

Summary of findings

Finding 1

The existence of a number of marine side constraints – principally marine parks and challenging Met-ocean conditions – means there is a relatively limited area of the Gascoyne coastline which is suitable to investigate the provision of marine infrastructure.

Finding 2

The opportunities scan has identified a number of diverse trade facilitation opportunities for the Gascoyne, linked the region's current and emerging competitive advantages. The diversity of this demand for trades is a positive for the provision of infrastructure as it provides diversification. However, this also presents risks for the provision of a barge loading facility as not all trades are likely to be best served by this kind of infrastructure.

Summary of findings (cont.)

Finding 3

The stakeholders engaged during the first phase of the study were universally supportive of an investment in the provision of marine infrastructure on the western Gascoyne coast. Many stakeholders suggested without this infrastructure their projects would be unlikely to proceed. A number of stakeholders were unclear as to the merits of a barge loading facility for their needs, although some believed this was an appropriate solution given their own needs.

Finding 4

The initial feasibility assessment has identified river sand exports as the primary short term trade opportunity for the region, though in the medium to long term there are significant additional industries and opportunities in the form of renewable energy, renewable hydrogen, minerals and agriculture.

Finding 5

In discussing the multicriteria assessment criteria and their weightings, the Project Steering Group identified the need to find an appropriate site for the infrastructure, with the capacity to grow and develop in line with the needs of industry. The Project Steering Group also expressed a strong preference to find a location with minimal environmental impact.

Finding 6

The multicriteria analysis has clearly identified a site in or around Boolathana Station as the most appropriate location to consider an investment in marine infrastructure, due to its capacity to host a larger facility in the future, its location relative to the most important demand nodes, and its relatively limited impact on the marine environment (given the options available).

Finding 7

ACIL Allen and BMT Group have identified demand for up to 4.2 million tonnes of trade facilitation in the study area when constrained by the services provided over a barge. Based on BMT's analysis of operability and other constraints, the barge loading facility could not meet this need, with a maximum facilitation capacity of 3.5 million tonnes per annum in the Heavy infrastructure option.

Finding 8

BMT Group estimates the total cost of service provision for the three shortlisted options is in the order of $600 million to $650 million depending on the option, with a clear trade-off between higher capital costs and higher operating costs based on the operating parameters of the infrastructure. However, the costing is highly sensitive to future trade volumes, meaning the gross cost of the infrastructure is also a significant consideration.

Finding 9

A comparison of the cost of services per tonne of trade facilitated by the shortlisted options versus rates at existing Western Australian ports suggests the proposed infrastructure is between $2.77 / tonne and $6.72 / tonne more expensive. Applying the comparative rates to the shortlisted options would result in a cost recovery rate of between 53% and 70%, deeming the facility financially unviable.

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Main Report

1 Overview

This section of the report provides an overview of the engagement and the purpose of this report, in the context of the overall objectives of the pre-feasibility study.

1.1 Introduction

The Gascoyne region is Western Australia's smallest (by population and economy) region, located in the north western most parts of the State. The region has been identified as prospective for a range of new economic development opportunities by the Western Australian Government, including large-scale renewable energy and renewable hydrogen projects.[2] However, without a pathway to market – both to import the materials, equipment and infrastructure required to establish projects, and to export the finished product – the prospect of these developments coming to fruition is diminished.

Identification and development of fit for purpose marine infrastructure has been a strategic priority for the Gascoyne Development Commission ('GDC') for some time,[3] reflecting the importance of the creation of a pathway to market for major projects. In this environment, the GDC engaged ACIL Allen and its engineering partner BMT Group to undertake a pre-feasibility study centred on the development of a **barge loading facility** on the western coast of the Gascoyne region. The project is overseen by a Project Steering Group, comprising representatives of the following organisations:

- Gascoyne Development Commission
- Department of Transport
- Mid West Ports

The scope of the study calls for an investigation into the specific infrastructure associated with a barge loading facility, reflecting the views of a number of proponents in the region that a barge facility would be beneficial to some prospective trades. Development of a barge loading facility has been associated with the Gascoyne region's potential to host the mining and export of renewable river sands.

During the study (see below for an overview of the approach and methodology) it emerged that a barge loading facility may not be the most appropriate infrastructure solution for the region given the evolving outlook for major projects. ACIL Allen and BMT presented this perspective to the Project Steering Group in April 2023, and sought advice on the way forward to ensure the study delivered value for money for the State.

This report presents a summary of the research, analysis and feedback which led to this outcome, as a means to demonstrate why a barge loading facility is not the most appropriate solution.

[2] Infrastructure WA. 2022. *State Infrastructure Strategy: Regional Strategy*. Accessed online at http://www.infrastructure.wa.gov.au/

[3] Gascoyne Development Commission. 2022. *Gascoyne Strategic Plan 2022-2026*. Accessed online at http://www.gdc.wa.gov.au/

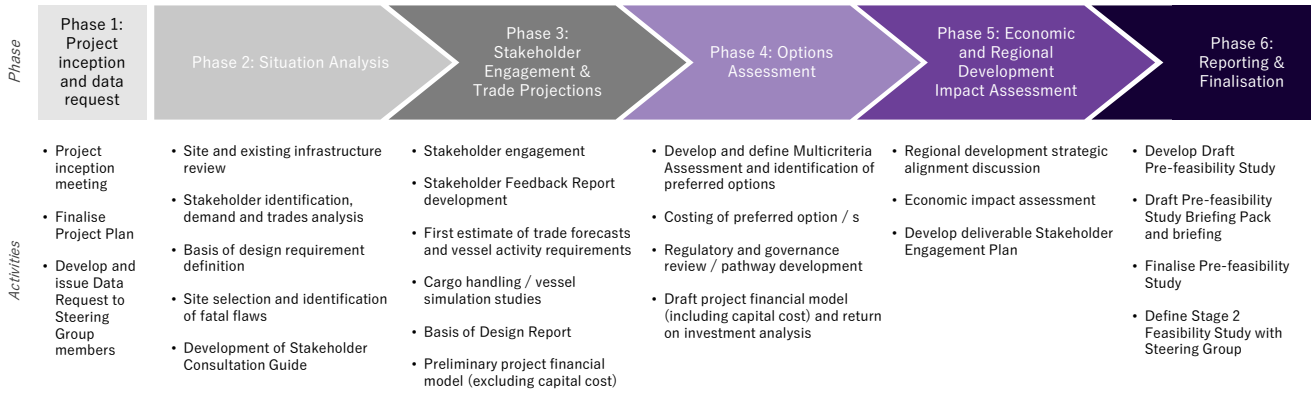
1.2 Approach and methodology

ACIL Allen and BMT Group are undertaking this study at arms length of Government, to provide a level of independence in the investigation and directions from the study. The project team reports through to the GDC as project manager, and the Project Steering Group as the strategic body setting the direction and providing feedback on study outputs.

The study is based on five phases of work, which are designed to culminate in the creation of a comprehensive pre-feasibility study for a selected infrastructure concept at an identified location. The output of the study – the pre-feasibility report and associated attachments – is designed to provide either Government or a private sector proponent with adequate information to commence a detailed feasibility study to progress the selected infrastructure concept at the selected location.

ACIL Allen and BMT's methodology is summarised below.

Figure 1.1 Gascoyne Barge Loading Facility Study Methodology Summary



Source:

In summary, the project team:

- Reviewed the outlook for major projects and their need for marine services within the Gascoyne region
- Identified a study area, and associated sites where marine infrastructure could be established
- Engaged with the market and other stakeholders to further investigate and formulate the needs assessment, and a perspective on the potential timing and quantum of trade demand
- Conducted a Fatal Flaws analysis to remove sites where it was assessed there were physical (ie geographic, environmental, social, cultural) constraints that could not be reasonably overcome
- Developed and shortlisted a series of infrastructure concepts which could meet the identified needs, noting the study was constrained by its consideration of a barge loading facility
- Conducted initial feasibility screening by analysing the cost of infrastructure and potential trade volumes.

It was at this point (during Phase 4) the project team reported to the Project Steering Group the prospect that a barge loading facility was unlikely to be the most appropriate mode of marine infrastructure delivery for the region in the context of its emerging major project outlook. This triggered the request to complete this report.

1.3 Study objectives

As part of the project inception phase of the engagement, ACIL Allen and BMT Group worked with the Project Steering Group to define a series of objectives for the study. The objectives are intended to guide decision-making on methodological matters, and provide a common understanding of what the study outputs are intended to achieve.

The study objectives were initially agreed as below.

Objective 1: The pre-feasibility study will identify the need for marine infrastructure in the study area, and assess the costs and benefits of establishing infrastructure

Objective 2: The pre-feasibility study will identify sites which could serve the need, and appropriate infrastructure solutions at these sites

Objective 3: The project team will prepare a study output which provides new data and information relevant to addressing the need, and presents a pathway for development of a solution

These objectives were made in the context of the direction of the study which is to focus on a barge loading facility as the infrastructure concept as part of the investigation. This means the study will at all times give regard to infrastructure which is designed primarily to facilitate the use of a barge as a means to move goods into and out of the region.

1.4 About this report

This report presents a summary of the work undertaken to reach the conclusion that a barge loading facility is not the most appropriate marine infrastructure solution to meet the objectives of the study, and to deliver on the GDC's Strategic Plan in relation to infrastructure and logistics. The report is intended to act as a cover report for a series of more detailed interim reports prepared throughout the engagement, including:

1. The Desktop Study on sites and infrastructure concepts, prepared by BMT Group (included in Appendix A)
2. The Options Analysis Briefing, where a long list of options was shortlisted through a Multicriteria Assessment (included in Appendix B).

The report includes four sections, as outlined below.

— **Section 2: Study Area and Needs Assessment.** This section identifies the major trades and associated attributes of marine services required or that could be facilitated utilising a barge loading facility as the infrastructure concept. This section also provides a summary of market and stakeholder engagement activities completed as part of the study to date.

— **Section 3: Shortlisted Options.** This section summarises the Desktop Study and Options Analysis components of the work, and discusses the attributes (including indicative costing) of three shortlisted options.

— **Section 4: Initial Feasibility Assessment.** This section presents the initial financial analysis of the shortlisted options under two analytical frames of reference (a bottom up costing, and comparative analysis to alternative ports outside of the region). This section also discusses the conclusions associated with the suitability of a barge loading facility to address the trade needs of the identified major projects and users.

— **Section 5: Summary and Directions.** This section provides a summary of the study to date, and presents ACIL Allen and BMT's suggested path forward to progress the study.

1.5 Terms and abbreviations

The following terms and abbreviations are used throughout this report.

Table 1.1 Glossary of terms and acronyms

Term / acronym	Description
$m	Millions of Australian dollars
$/t	Dollars per tonne (typically of trade)
BLF	Barge Loading Facility
BMT	BMT Group (technical study partner)
CAPX	Capital expenditure
GDC	Gascoyne Development Commission
MCA	Multicriteria Assessment
MT	Million tonnes
mtpa	Million tonnes per annum
OGV	Ocean Going Vessel
PV / NPV	Present Value / Net Present Value
REE	Rare earth elements
Renewable hydrogen	Molecular hydrogen produced through electrolysis of water utilising renewable energy resources
UKC	Under Keel Clearance

Study Area and Needs Assessment 2

This section of the Interim Report provides a summary of the identified need for marine infrastructure in the Gascoyne region. This is based on a combination of a desktop review and stakeholder engagement. The Needs Assessment is a critical input into the identification of appropriate sites and infrastructure options, and the associated Options Assessment criteria and weightings.

2.1 Identification of study area and fatal flaws

The initial study area considered in scope for the pre-feasibility study is identified in **Figure 2.1** (overleaf). The study area encompassed the entire western Gascoyne region through the southern border of the Ningaloo Marine Park to approximately Coral Bay, and the northern Mid West region from the Port of Geraldton as the nearest port facility.

The Exmouth cape was not considered in scope due to:

- its geographic isolation,
- sensitivities associated with the Ningaloo Marine Park on the western side of the cape,
- current State Government policy investigations into the environmental impacts of development and industrialisation in the Exmouth Gulf, on the eastern side of the cape, and
- the presence of the Gascoyne Gateway development, located 10 kilometres south of the Exmouth townsite.

As part of its initial desktop review BMT Group narrowed the broad site area down to two coastal zones.[4] These were:

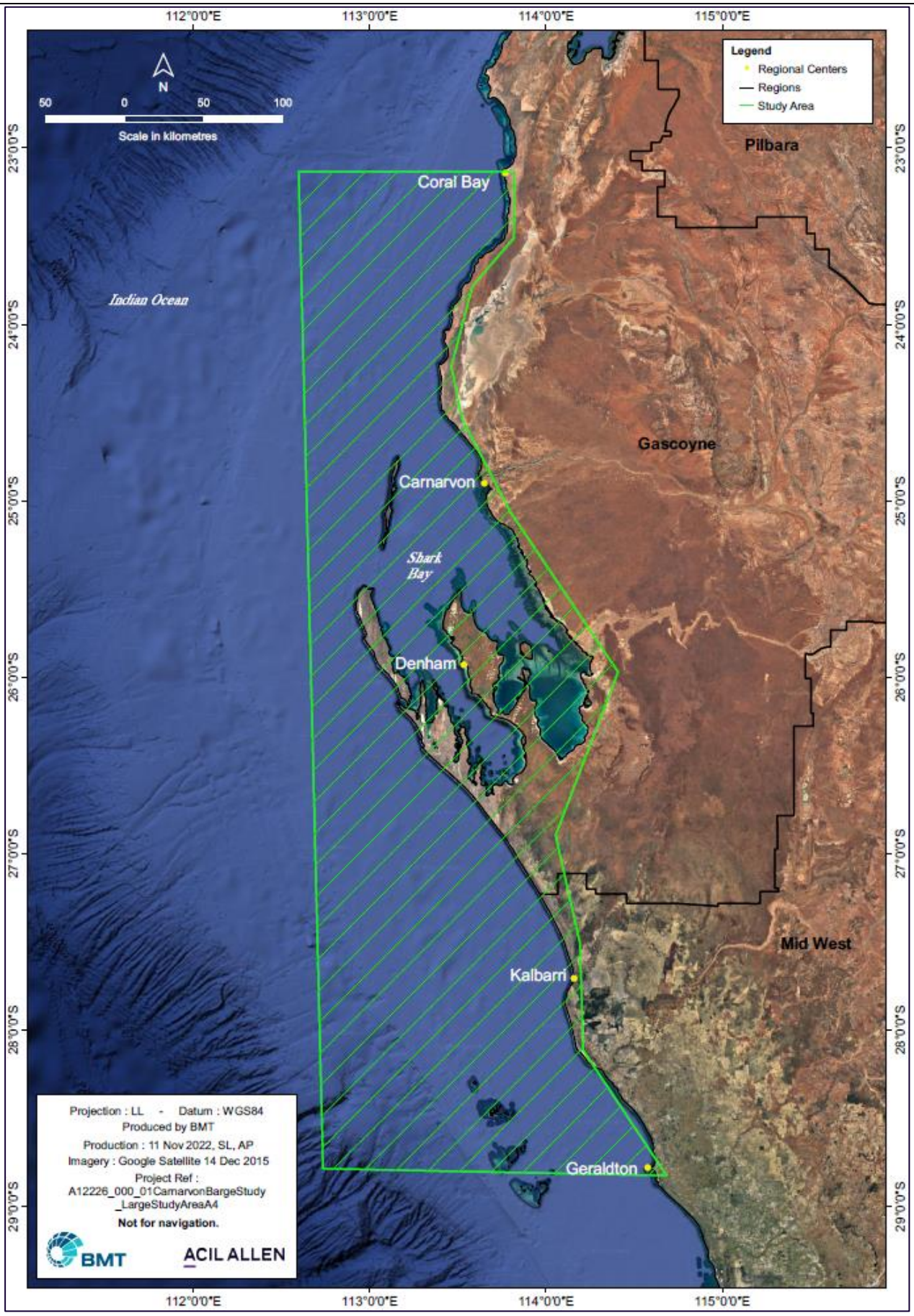
1. the area bound by the Shark Bay Marine Park to the south through to southern border of Quobba Station
2. a pocket of coastal area centred on Cape Cuvier, bound by the southern border of the Ningaloo Marine Park

The fatal flaws analysis centred on the removal of areas subject to protection under the *Conservation and Land Management Act 1984*, and areas subject to extreme Met-ocean conditions which would make vessel operations complex and challenging (particularly for a barging operation). Other initial site screening criteria are identified below. While progressing a marine infrastructure development within a marine park may be technically feasible, the additional environmental approvals and ongoing compliance requirements were deemed to be a fatal flaw given there were alternative locations within the study area not subject to these constraints.

This analysis rapidly narrowed the focus of the study to the area of the Gascoyne coastline immediately to the north and south of the Carnarvon town centre. This conformed with the views of stakeholders regarding the need for a solution to centre on this part of the region due to the expected location of future major projects. Further details of site selection and options formation are provided in Section 3.

[4] Further details are provided in Appendix A.

Figure 2.1 Gascoyne Barge Loading Facility Study Area



Source: BMT, ACIL Allen

Finding 1 Narrowing focus

The existence of a number of marine side constraints – principally marine parks and challenging Met-ocean conditions – means there is a relatively limited area of the Gascoyne coastline which is suitable to investigate the provision of marine infrastructure.

2.2 Economic development opportunities within the Gascoyne region

Through the first stage of the study, ACIL Allen identified a number of economic development opportunities in the Gascoyne region. These were based on a combination of past research[5], review of major projects currently operating and / or targeting the region, and a desktop review of policy and other relevant documents produced by Commonwealth, State and Local Government agencies.

In this review, the following economic development opportunities were identified.

Table 2.1 Economic development opportunities in the Gascoyne region

Opportunity	Description
Production and export of river sand	The Gascoyne region hosts a number of deposits of sand deposits which are high in Silica Dioxide (SiO_2), and are considered renewable due to the natural processes in and around the Gascoyne River. Sand is exported to support construction industry activities (principally concrete) in South East Asia.
Production of renewable energy	The Gascoyne region hosts some of the most prospective diurnal wind-solar renewable energy generation resources in Australia – and the world. According to the CSIRO / Monash University's National Renewable Energy Capacity Factor map, areas of the Gascoyne region can achieve combined wind-solar capacity factors of in excess of 50%, which is amongst the highest in Australia. This would allow for the production of renewable energy from these sources at a relatively low cost compared to locations with lower capacity factors.
Production and export of renewable hydrogen	The production of renewable hydrogen is based on electrolysis of water using renewable electricity. The existence of high quality renewable energy resources could result in the capacity of the Gascoyne region to host significant renewable hydrogen projects, producing molecular hydrogen and related products for export.
High value mineral production and export	The Gascoyne region is thought to host significant rare earth element ('REE') and lithium mineral resources. One project, the Hastings Rare Earths Project, is currently in development, while a range of ASX-listed and private companies are undertaking significant exploration activity targeting these minerals.
General cargo and containerised trade	The north west coastal regions of Western Australia are currently not served by a port facility between the Port of Ashburton and the Port of Geraldton. Access to a marine facility in the region would support greater use of direct shipping of cargo into and out of these regions, supporting economic development generally.
Agriculture product export (horticulture & packaged products)	The Gascoyne region is one of Western Australia's major food producing regions, but has limited access to large scale export market

[5] This review was based on ACIL Allen's past work on the *Exmouth Marine Infrastructure Project*, and a recently completed investment prospectus prepared for the Shire of Carnarvon on major projects in and around the Town of Carnarvon.

Opportunity	Description
	opportunities due to the lack of capacity to access marine infrastructure. Opportunities to scale and ship horticulture products produced in the Carnarvon region, and packaged protein products (ie beef and aquaculture) could be unlocked if shipping options were available.
Vessel services to support offshore industries	The coastal areas of the Gascoyne are heavily exposed outside of the Port of Carnarvon area (currently served by the Carnarvon Boat Harbour), leaving limited options for vessels supporting emerging offshore industries to berth. *During the engagement process it emerged there was significant interest in the Gascoyne region's potential to host offshore wind generation infrastructure. This was not captured in the initial scan.*

Source: ACIL Allen, from various sources

This initial scan of economic development opportunities culminated in the creation of a long list of potential stakeholders to meet with to discuss the prospects of a barge-loading facility in the region. As discussed in Section 1, the potential production and export of river sand was the primary economic development opportunity which underpinned the desire to investigate a barge loading facility.

Finding 2 Demand for trade facilitation

The opportunities scan has identified a number of diverse trade facilitation opportunities for the Gascoyne, linked the region's current and emerging competitive advantages. The diversity of this demand for trades is a positive for the provision of infrastructure as it provides diversification. However, this also presents risks for the provision of a barge loading facility as not all trades are likely to be best served by this kind of infrastructure.

2.3 Stakeholder perspectives

As part of the Needs Assessment ACIL Allen and BMT Group met with a number of interested parties with major projects planned in the Gascoyne region. A list of stakeholder meetings completed to support this initial feasibility assessment is provided below.

Table 2.2 Stakeholders Engagement Summary

Organisation	Interests	Meeting date / s
Province Resources	– Renewable energy / renewable hydrogen – Development of marine infrastructure	4 January 2023
Rio Tinto (Dampier Salt)	– Existing project (salt production / export)	19 October 2022 (Steering Group meeting)
Fortescue Future Industries	– Renewable energy / renewable hydrogen	13 December 2022
Vestas	– Renewable energy / renewable hydrogen	19 December 2022
Tremor	– River sands – Existing proposal to develop marine infrastructure	20 December 2022
Department of Jobs, Tourism, Science and Innovation	– Lead agency for renewable energy / renewable hydrogen projects	14 December 2022

Organisation	Interests	Meeting date / s
Krakatoa Resources	– Critical minerals project developer (exploration)	3 February 2023
Cauldron Energy	– River sands – Critical minerals project developer (exploration)	22 February 2023
Provaris	– Vessel services provider (renewable hydrogen)	2 February 2023
Transhipment Services Australia	– Vessel services provider (barge / bulk commodities)	7 February 2023

Source: ACIL Allen

The following stakeholder themes emerged during conversations with the stakeholders listed above.

2.3.1 The study area is highly prospective for renewable energy and hydrogen projects

All proponents engaged – including those not directly exposed to the renewable energy and hydrogen industries – have noted the strong interest in the region from a renewable energy and hydrogen perspective. There are a range of proponents at various stages of development, although most are at pre-concept stage (ie are undertaking preliminary studies). It is evident there remains significant work to be done to prove up the potential of this industry in the region, but interest is strong and centred on observed and expected data with respect to the quality of the renewable energy resource.

However, it is critical to note these projects are all at a very early stage of the development cycle. Many proponents are working through land access, and are yet to begin the process of obtaining firm data on renewable resource potential. Vestas, the only proponent engaged to date which has previous experience developing renewable energy projects, believes its project will enter commissioning **in at least seven years time**, on account of the time required for approvals, project offtake agreement development, financial close and construction. Other proponents engaged are less experienced in the development of these projects and are more optimistic with their project timelines.

2.3.2 A barge loading facility would be welcomed by industry

All industry proponents engaged suggest development of a barge loading facility would be a useful piece of infrastructure for their projects if it was made available. In all cases this is due to the relatively limited options for proponents seeking to establish projects in the northern Mid West and western Gascoyne regions which are the focus of the study.

In particular, hydrogen / renewable energy project proponents see a strong use case for a barge loading facility as enabling infrastructure for the early construction works associated with their projects. As it stands there is no firm pathway for proponents in this sector to import the components required to develop projects – they are early stage, and constructability is yet to be a major consideration for them. When pressed, stakeholders indicated they would likely make use of facilities at the Port of Geraldton and then truck infrastructure to their sites, a pathway which is likely to add substantial costs to development versus sites which are more closely located to ports infrastructure.

However, renewable energy developers were clear and consistent with advice that a barge loading facility would only be useful to a certain extent, with a larger and more multi-purpose facility required once early construction works were completed. This infrastructure would allow for project

developers to bring Ocean Going Vessels ('OGVs') directly to berth. Barging would be an inefficient and costly solution for a range of imports, including wind turbine blades and towers.

River sands proponents and associated vessel services providers believe a facility would be useful for the region. In the case of Tremor and Cauldron Energy, their export projects are contingent on the development of marine infrastructure to facilitate exports, with a barge solution ideal given the relatively low volumes and need for relatively low capital costs to ensure their projects are economic.

2.3.3 Sites to the north of Carnarvon are preferred by stakeholders

Industry stakeholders were consistent in suggesting sites adjacent to or north of the Carnarvon townsite are likely to be the most beneficial to industry. Stakeholders who have been investigating the region in recent years have also noted the challenges associated with ocean and landside conditions to the south and far north of the site area.

Stakeholders identified that Met-ocean conditions and landside constraints were more accommodating for development in the region to the north of the Carnarvon town site, which would help reduce costs and improve the deliverability of the project. The location was also identified as being more closely associated with renewable energy and renewable hydrogen project proponents, reducing the need for additional landside investments to support the facilitation of trade.

2.3.4 River sands projects are unlikely to provide adequate demand in isolation

The project team understands the potential for river sand exports from the region was one of the catalysts behind the commissioning of the study. The project team engaged with Tremor, Cauldron Energy and Transhipment Services Australia as project proponents seeking to develop river sands projects. Through these engagements it emerged that:

— River sand projects would be expected to produce relatively low volumes (ie Tremor is targeting one million tonnes per annum of sustainable production), with sporadic production depending on the capacity to enter into time-limited offtake agreements with customers in South East Asia

— River sand is a relatively low value product, meaning project proponents have limited capacity to pay and are very sensitive to changes in the market price,

— There are significant risks and uncertainties with respect to land tenure and native title claims, particularly centred on upstream areas of the Gascoyne River.

The project team formed the view during these engagements that river sand exports were unlikely to be a reasonable basis for underwriting an infrastructure development in their own right. This has ultimately borne out in the initial feasibility screening (see Section 4).

2.3.5 Proponents are interested in an "end to end" maritime solution

Finally, while proponents expressed positive views on a barge loading facility, there was also interest in the potential for this to be further developed into a larger facility which could accommodate export of clean energy products (ie ammonia and / or liquid hydrogen). It was noted specialised facilities are required for these products, and a barge-loading facility was not fit for purpose.

Proponents often spoke of the need for an "end to end" maritime solution. Given the number of interested parties in the region, there was a consistent line of thought that a common user export facility could be viable, and a more efficient means to finding a pathway to market via marine-based export than individual project-by-project solutions (such as single point moorings and subsea pipelines).

This issue has been considered throughout the study to date, and has culminated in the recommendation to discontinue the study with a barge loading facility as the infrastructure concept. Further discussion and analysis of this is included in the remainder of the document.

Finding 3 Stakeholders support a fit for purpose marine infrastructure solution

The stakeholders engaged during the first phase of the study were universally supportive of an investment in the provision of marine infrastructure on the western Gascoyne coast. Many stakeholders suggested without this infrastructure, their projects would be unlikely to proceed. A number of stakeholders were unclear as to the merits of a barge loading facility for the region's needs, although some believed this was an appropriate solution given their own needs.

2.4 Review of opportunities

ACIL Allen and BMT prepared a summary of the opportunities identified, and an initial assessment of these under a series of categories relevant to the objectives of the scope of services. This process was designed to provide guidance to the Project Steering Group when developing the Options Assessment, and considering the outcomes of the study as they emerged.

The summary is provided below, with further discussion contained in the remainder of this section.

Figure 2.2 Review of opportunities and infrastructure needs summary

Opportunity	Prospect Likelihood of development	Demand Potential trade volumes	Suitability Barge facility is appropriate	Timing When will demand arise	Need Extent of need for solution	Impact Regional development
River sands						
Renewable energy						
High value minerals						
Other bulk commodities						
Agriculture & food (containerised)						
General cargo (containerised)						
General cargo (breakbulk)						
Vessel services			N/A			

Source: ACIL Allen

Prospect

This is the project team's judgement of the prospect of industry development occurring should there be an appropriate marine infrastructure solution developed within the Gascoyne region. In general, the team identified that agriculture and food was a near-certain development opportunity given the existing agriculture and food production in the region, while river sands, general cargo trade, and vessel services were highly likely. The development of renewable energy and renewable hydrogen projects were seen as less prospective, due to the relatively early stage of these industries and the complexities associated with their development.

Demand

This is the project team's judgement is the potential trade volume that the particular trades could deliver for a barge loading facility. It was assessed that renewable energy and bulk commodities had the potential to provide significant trade volumes, while other trades were less prospective from a volumes point of view. This is an important consideration as the facility would require trade volumes to recover costs and deliver a return.

Suitability

This is the project team's judgement on the suitability of a barge loading facility to the marine services requirements of major projects within the opportunity. As suggested by the table, it is the team's judgement that a barge loading facility is highly suited to the river sand opportunity, but is less appropriate for all other trades. In practice, this means major projects would only be able to realise part of their need for marine services at a barge loading facility. Further details are provided in Appendix B.

Timing

This is the project team's assessment on when demand for trades from the industry development opportunity will arise. This is predominately based on the feedback of stakeholders consulted during the study. In general there are opportunities which are clear and present (river sand, general trade, vessel services), and opportunities which are more long lead and will take time to develop (renewable energy, high value minerals). This is an important consideration when selection infrastructure concepts and considering how best to meet the needs of industry.

Need

This is the project team's judgement of how contingent the economic development opportunity is on the provision of marine infrastructure. This is based on the feedback of stakeholders and an assessment of the alternative options for the facilitation of imports and exports into the target market area. It was assessed the two highest profile opportunities – river sands and renewable energy – are highly contingent on marine infrastructure, while others are less contingent due to the relatively low volumes or capacity to shift trade to facilities outside of the Gascoyne.

Impact

This is the project team's initial assessment of the regional development implications of the successful realisation of major projects within the opportunity. This is based on the project team's understanding of the employment and local business opportunities associated with each opportunity, and the feedback of stakeholders. It is judged renewable energy and renewable hydrogen projects represent the best opportunity for economic development, while river sands projects are less prospective due to their sporadic nature and relatively low level of employment.

Finding 4 All in the timing

The initial feasibility assessment has identified river sand exports as the primary short term trade opportunity for the region, though in the medium to long term there are significant additional industries and opportunities in the form of renewable energy, renewable hydrogen, minerals and agriculture.

3 Shortlisted Options

This section of the report summarises the shortlisted options for the barge loading facility pre-feasibility study, and the process for identifying these from an initial long list. The section summarises a range of materials prepared and presented in the Options Assessment workshop, which are provided in Appendix B.

3.1 Introduction

As part of its methodology ACIL Allen undertook a multicriteria assessment ('MCA') utilising a tailored framework and assessment of an initial long list of options against a set of criteria.

MCA is a commonly used technique as part of an options assessment process, as it seeks to introduce a logical framework for first determining preferences and then assessing how well options meet preferences compared to all other options on balance across the suite of preferences. An MCA is a two step process. The first step involves the development of a series of weighted selection criteria, which are intended to reflect the balanced priorities and/or outcomes an investment is seeking to foster. The second step involves scoring each option against each criteria, and then determining an overall score by multiplying the scores by the weights of the criteria.

The long list options were developed by ACIL Allen and BMT Group, and presented to the Project Steering Group for confirmation in March 2023. The options assessment criteria and weightings were developed by the Project Steering Group at a meeting in March 2023. The scoring of the options against the options assessment criteria was completed by ACIL Allen and BMT Group in April 2023. This process of client-led criteria development but advisor-led scoring results in additional independence in the assessment as neither party has full control over the process.

The remainder of this section discusses the outcomes of the long list, MCA and shortlisting process. Further details, including the basis of the development of the long list of options, are provided in the Options Assessment Briefing Pack in Appendix B.

3.2 Long list options

The creation of a long list of options to address the objectives of the study by narrowing down the broad area of the study (following the fatal flaw analysis) to a series of locations where marine infrastructure could be established. Following the site identification process, infrastructure concepts are proposed which meet the needs of the proposed major projects and their trade requirements – noting the requirement of the study to focus on a barge-based solution.

The sites considered as part of the study are introduced in the table below (**Table 3.1**). Further details are provided in Appendix A.

Table 3.1 Overview of sites for marine infrastructure

Site name	Description
Cape Cuvier	The Cape Cuvier port facility is located approximately 30 kilometres north of Carnarvon. The facility primarily services the oil and gas industry, with facilities including a deep-water jetty, a tank farm for storing crude oil and condensate, and an airstrip for personnel transport. Additionally, the facility has a range of workshops and support infrastructure to support oil and gas operations in the region. It is part of the Port of Carnarvon as dictated by the Shipping and Pilotage Act (1967).
Boolathana/Bejailing Station	Boolathana Station is a ~150,000 hectare pastoral lease in Western Australia, located in the western Gascoyne. The lease is located around 25 kilometres north of the Carnarvon Town Centre. The land itself largely alternates between sand dunes and salt flats, with some 23 kilometres of direct coastal frontage. It was historically a working sheep and cattle station.
Babbage Island	Babbage Island is a small uninhabited island located about 3 kilometres north-west of Carnarvon. It is accessible via Babbage Island Rd from the mainland. It is a relatively small sand island covering approximately 5 square kilometres. The island is largely undeveloped with walking tracks, minor roads, historical jetties and several buildings including Carnarvon Beach Holiday Resort. The area has previously been used as a deep-water port, with the One-mile Jetty constructed in 1897 to provide shipping for the agricultural goods from the region. The historic wooden jetty is currently now a tourist attraction and a popular spot for recreational activities including swimming, snorkelling and diving. The vegetation in this area is characterized by scrubland and low shrubs, with occasional stands of trees, such as eucalypts and acacias. The area surrounding the jetty is also home to a variety of wildlife, including seabirds, marine life, and land-based animals. An environmental impact assessment would need to be completed to ensure minimal impact is achieved.
Carnarvon Boat Harbour	Carnarvon Boat Harbour is a small harbour located in the town of Carnarvon. It is primarily used for recreational boating, fishing, and tourism. The facilities available at the harbour include boat ramps, jetties, a fuel station, toilets, showers, and a small car park. There are also several commercial fishing boats and a few charter boats operating from the harbour. The harbour is surrounded by restaurants, cafes, and shops, making it a popular spot for tourism.
Massey Bay	Massey Bay is located approximately 10 kilometres to the south of Carnarvon. Massey Bay is known for its sandy beaches, clear waters, and great fishing spots. The bay is also home to a variety of marine life, including dolphins, turtles, and whales, and is a popular tourist destination for snorkelling and diving. The area has a groin which extends 1km off the coast with approximately 50m in available width onshore. There are minor tracks extending to the end of this area where an old rubbish dump used to be.

Site name	Description
Grey Point	Grey Point is situated 30km south of Carnarvon townsite and is accessible by the North West Coastal Highway and then via several tracks using a four-wheel drive vehicle. It is characterised by sandy beaches, dunes and rocky outcrops. It is a popular tourist spot for fishing, swimming and snorkelling. There is limited infrastructure in the area with just a small car park area, public toilet and picnic area. The current access could make it difficult to transport equipment and personnel to and from the site. Limited road access could result in delays, increased transportation costs, and potentially hazardous conditions for personnel. Significant front end costs would be required to build suitable infrastructure for larger vehicles to access the site. Grey Point is a relatively remote location, which could limit access to essential infrastructure, such as power and water. This could result in increased operational costs and potentially hazardous conditions for personnel.

Source: ACIL Allen and BMT Group

Two infrastructure concepts were considered as part of the long list development: a "light" infrastructure solution and a "medium to heavy" infrastructure solution. The light option would primarily centre on import and export of volumes of bulk materials and small shipments of other cargoes (such as a limited number of fully laden containers per movement). The "medium to heavy" option would facilitate larger parcels of bulk materials, and have some capacity to move heavier or larger breakbulk cargoes such as wind turbine towers.

Conceptual diagrams for each of the infrastructure concepts are provided in **Figure 3.1**

Figure 3.1 Conceptual diagrams of infrastructure concepts

Source: BMT Group

In the "light" option, the concept was based on the ability to facilitate transfer of materials to a barge of between 60 and 80 metres LOA, with an under keel clearance ('UKC') of around four metres. In the "medium to heavy" option, the concept was based on barges of 100 metres LOA and a UKC of at least eight metres, and up to eight metres depending on the nature of trades. In both cases

advice received from BMT Group was two medium sized tug vessels would be adequate to manoeuvre the barge from an offshore anchoring point to the berth, however larger tugs were considered for the heavy facility option.

When formulating the options BMT Group gave regard to both landside and marine side investment requirements, including the need to create a channel and / or berth pocket to facilitate the movement of barges and support vessels during vessel operations. The concepts also considered the extent to which one or more breakwater structures may be required to address Met-ocean conditions in the Heavy options given the size of the barge vessel and the operability requirements.

In all, 12 options were considered, as a matrix of the sites and infrastructure concepts. The options are summarised, with indicative capital costs, in the table below (**Table 3.2**).

Table 3.2 Long list options summary

Option number	Site	Infrastructure concept	Indicative capital cost
Option 1	Cape Cuvier	Light	$20.5m
Option 2	Boolathana/Bejailing Station	Light	$26.7m
Option 3	Babbage Island	Light	$25.9m
Option 4	Carnarvon Boat Harbour	Light	$28.3m
Option 5	Massey Bay	Light	$37.9m
Option 6	Grey Point	Light	$32.8m
Option 7	Cape Cuvier	Medium to Heavy	$51.2m
Option 8	Boolathana/Bejailing Station	Medium to Heavy	$59.8m
Option 9	Babbage Island	Medium to Heavy	$61.9m
Option 10	Carnarvon Boat Harbour	Medium to Heavy	$62.4m
Option 11	Massey Bay	Medium to Heavy	$76.0m
Option 12	Grey Point	Medium to Heavy	$67.6m

Source:

A breakdown of the indicative capital cost for each of the options is provided in **Figure 3.3**. As indicated by the capital cost breakdown, the major cost lines include dredging (for sites which are depth constrained), protective structures (for the Medium to Heavy options), and civil works on the landside to establish appropriate berthing and stockpile infrastructure areas.

Capital costs range from just over $20 million for the Light Option and Cape Cuvier, through to $76 million for a Medium to Heavy Option at Massey Bay. The analysis highlights the significant influence of site location on matters such as the need for dredging at site and to create a channel.

Figure 3.2 Capital Expenditure for Long List Options (Light Options, 1-6)

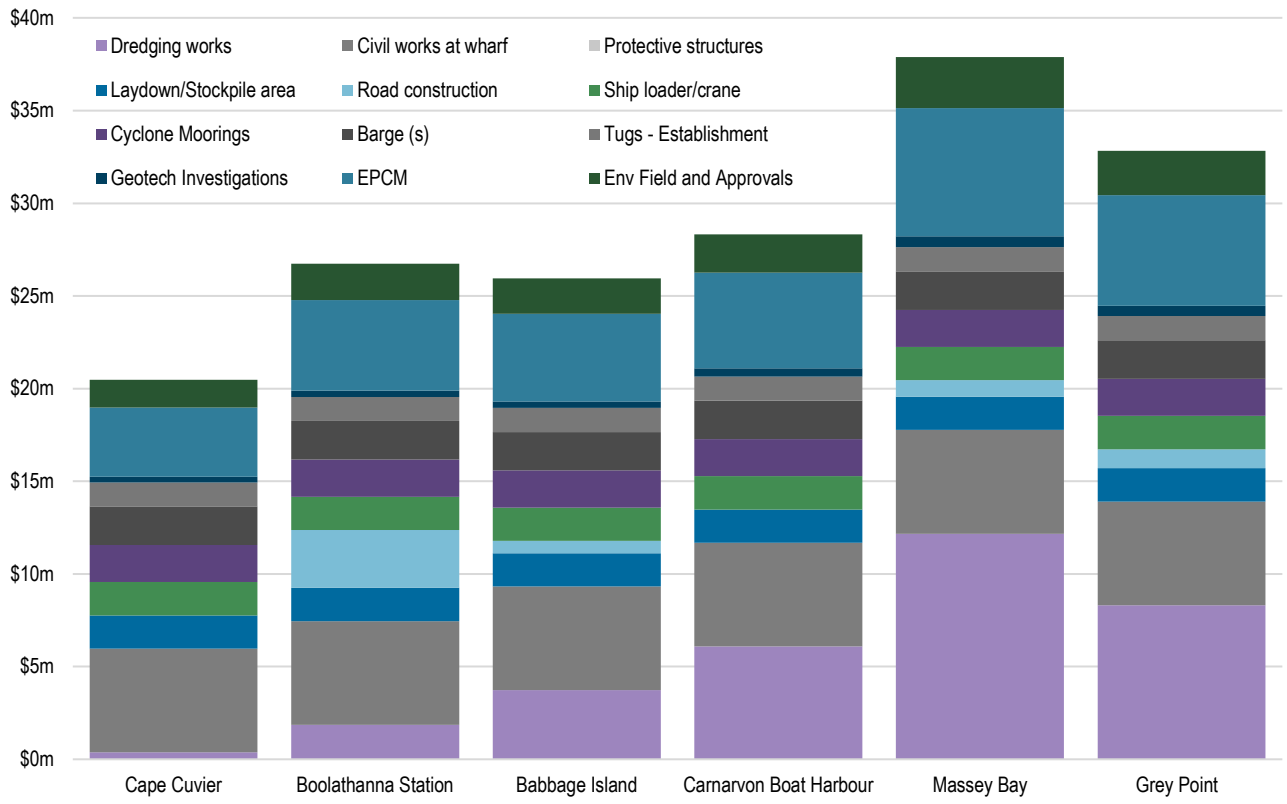
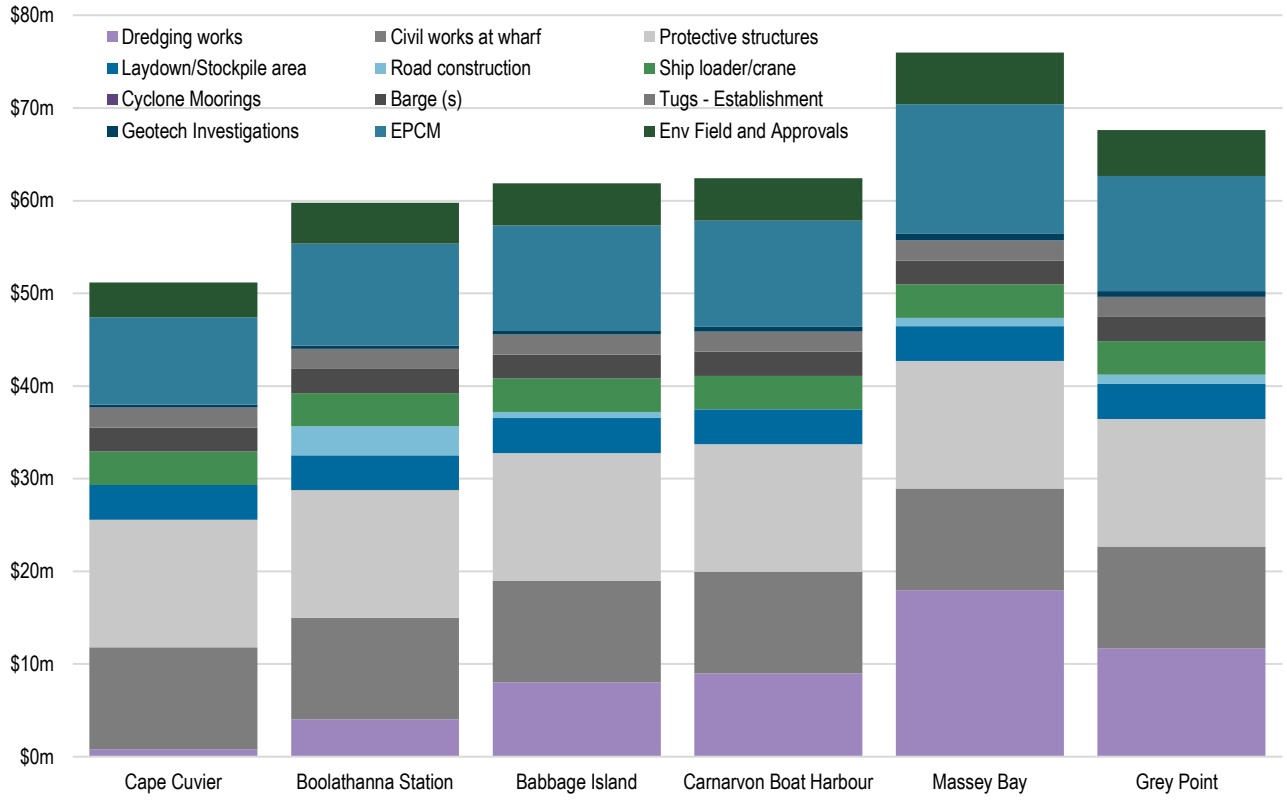


Figure 3.3 Capital Expenditure for Long List Options (Medium to Heavy Options, 7-12)



Source: BMT Group, ACIL Allen

3.3 Multicriteria assessment

To narrow down the long list to a short list of options for further consideration, ACIL Allen and BMT Group worked with the Project Steering Group to develop an MCA framework. The MCA is based on a series of criteria, weighted to reflect the relative importance of the criteria to achievement of the objectives of the study – principally the provision of fit for purpose marine infrastructure for the identified use cases.

There are three broad groupings of criteria, being:

- cost and complexity (denoted in purple below), to reflect the expected financial impost and foreseeable challenges with delivery of the selected option,
- social and environmental (blue), to reflect the social and environmental impacts, both positive and negative, of the selected option, and
- economic and commercial (green), to reflect the economic development outcomes and expected commercial aspects of the facility.

This is used to provide greater control over the calibration of criteria weightings. The high level categories are weighted against each other (to total 100%), with the individual criteria within each of the categories then weighted against each other (to total 100% within the category). The category weight is then multiplied by the criteria weight, with the total summing to 100% across the individual criteria.

The MCA criteria are introduced in the table below (**Table 3.3**).

Table 3.3 MCA Criteria Description

Category	Criteria	Description
Cost and complexity	1. Capital cost	The upfront cost of building the infrastructure. The higher the cost, the less preferred the option.
	2. Operating cost	The ongoing expected operational cost of the infrastructure, including long run maintenance requirements (ie dredging). The higher the expected operating cost, the less preferred the option.
	3. Construction complexity & deliverability	The anticipated challenges which would need to be overcome to develop the infrastructure concept at a particular site. The more complex, the less preferred.
	4. Marine operability	The expected risks to operability versus theoretically benign metocean conditions, as this impacts throughput and economic outcomes. The less operable the less preferred.
	5. Availability and tenure of adjacent land	Land tenure on the land side of the facility location, to facilitate cargo transfer, laydown and other services. The more complex / uncertain, the less preferred.
	6. Land side infrastructure development needs	The prospect of additional land side investment to fully unlock the infrastructure option at the assessed site. The more infrastructure required, the less preferred.
	7. Uncertainty with respect to local conditions	The study is designed to make use of the best available information to inform initial options analysis. Where there is limited information on a site, this site is less preferred.
Social and environment	8. Regulatory and approvals pathway complexity	The number of challenges and barriers which would need to be overcome to develop infrastructure at the selected site, noting the Desktop Review has already knocked out sites which are generally unfeasible. The more complex a site's pathway, the less preferred it will be.

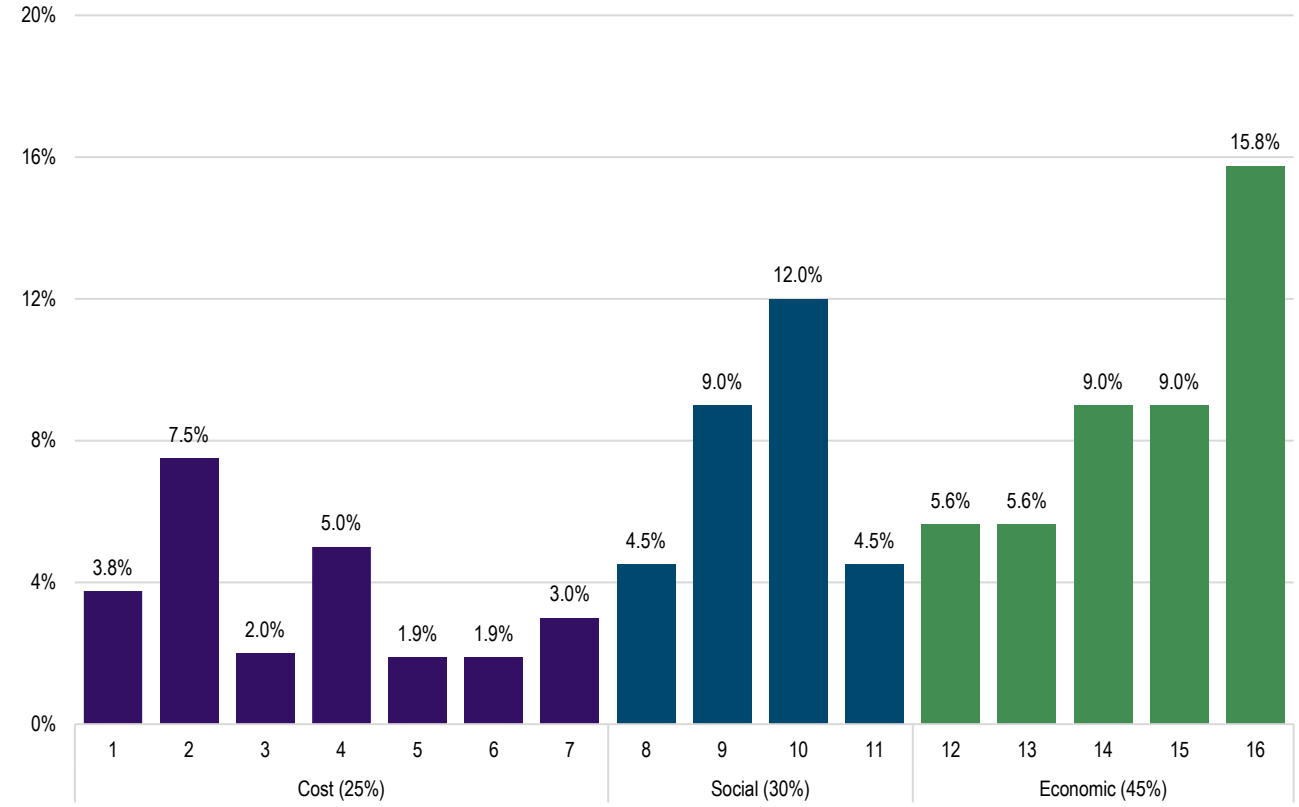
Category	Criteria	Description
	9. Land side environmental impact	The anticipated landside environmental impacts which would be expected to occur. The more land side impacts which are known in advance, the less preferred a site / infrastructure option will be.
	10. Marine side environmental impact	The anticipated marine side environmental impacts which would be expected to occur. The more land side impacts which are known in advance, the less preferred a site / infrastructure option will be.
	11. Proximity to Carnarvon Town Centre	The proximity of the option to the Carnarvon Town Centre could be perceived as advantageous or detrimental. At this stage it has been included in social / environmental as a negative influence on the MCA, as close proximity to the Carnarvon Town Centre would create noise, dust, traffic and other hazards for residents and businesses. The closer to the Carnarvon Town Centre, the less preferred an option will be.
Economic and commercial	12. Proximity to renewable hydrogen centre	The option's proximity to the geographic centre of proposed renewable energy and renewable hydrogen developments is a measure of its capacity to efficiently service this trade. The closer an option, the more it will be preferred.
	13. Proximity to river sands centre	The option's proximity to the geographic centre of river sand tenements and leases is a measure of its capacity to efficiently service this trade. The closer an option, the more it will be preferred.
	14. Potential for local economic impact / benefits	The option's proximity to the Carnarvon Town Centre represents the facility's potential capacity for local economic benefits to be felt directly as a result of the facility. This is perceived to be an important driver given current conditions in Carnarvon.
	15. Flexibility to facilitate multiple trades	Given the long run potential of the Gascoyne region, a facility and location combination with the flexibility to service multiple trades will be preferred over a facility with less flexibility.
	16. Potential to be intensified / developed in the future	This important criteria is one of the ways the project will take into account the feedback provided by stakeholders to date regarding the long run need for a more intensive marine infrastructure solution in the region. A site or infrastructure option which presents more future pathways for development will be preferred over a more static solution.

Source: ACIL Allen, BMT Group

3.3.1 Criteria weightings

The individual MCA criteria weightings were discussed and agreed at a meeting of the Project Steering Group in March 2023. The weightings are summarised in the chart below (**Figure 3.4**).

Figure 3.4 MCA Criteria Weightings (note: criteria are as per the order in Table 3.3)



Source: ACIL Allen, BMT Group]

Overall, the criteria weightings reflect the directions provided by major project stakeholders, balanced against prioritisation of options which are judged as having the lowest environmental impact (particularly on the marine side). It was the view of the Project Steering Group that cost and complexity criteria should have a more limited influence on the MCA outcomes given the study is at a pre-feasibility stage and further work would be required to firm up costings.

Finding 5 Importance of a lasting solution

In discussing the multicriteria assessment criteria and their weightings, the Project Steering Group identified the need to find an appropriate site for the infrastructure, with the capacity to grow and develop in line with the needs of industry. The Project Steering Group also expressed a strong preference to find a location with minimal environmental impact.

3.3.2 MCA scoring

ACIL Allen and BMT scored each of the options against each of the individual criteria on a Liekert scale of 1 to 5, utilising a structured approach of positive and negative points against an initial starting position of '3' out of 5. A score of 1 out of 5 indicates the option is not at all aligned to the MCA criteria, while a score of 5 out of 5 indicates the option was strongly aligned to the MCA criteria.

Details of the positive and negative point allocation methodology are provided in Appendix C.

The scoring of each of the options against the MCA criteria is provided on the following page.

Table 3.4 MCA Scoring

Criteria	Criteria name	Weighting	Cape Cuvier Light Option 1	Boolathana Station Light Option 2	Babbage Island Light Option 3	Carnarvon Boat Harbour Light Option 4	Massey Bay Light Option 5	Grey Point Light Option 6	Cape Cuvier Heavy Option 7	Boolathana Station Heavy Option 8	Babbage Island Heavy Option 9	Carnarvon Boat Harbour Heavy Option 10	Massey Bay Heavy Option 11	Grey Point Heavy Option 12
1	Capital cost	3.8%	5	4	5	4	3	3	4	3	3	2	1	2
2	Operating cost	7.5%	5	4	3	4	3	3.5	3	2	1	2	1	1.5
3	Construction complexity & deliverability	2.0%	4	4	4	3.5	4	3.5	3	3	3	2.5	3	2.5
4	Marine operability	5.0%	2.5	3.5	4	4	4	3.5	1.5	2.5	3	3	3	2.5
5	Availability and tenure of adjacent land	1.9%	2	4	3	3	3	4	2	4	3	3	3	4
6	Land side infrastructure development needs	1.9%	3	3	4	4	4	3	2.5	2.5	3.5	3.5	2.5	2.5
7	Uncertainty with respect to local conditions	3.0%	3	2.5	2.5	3	3	2.5	2.5	2	2	2.5	2.5	2
8	Regulatory and approvals pathway complexity	4.5%	4.5	2.5	3	4	3.5	1.5	4.5	2.5	3	4	3.5	1.5
9	Land side environmental impact	9.0%	3	3	2.5	3.5	3.5	3	3	3	2.5	3.5	3.5	3
10	Marine side environmental impact	12.0%	4	3.5	3.5	3.5	3	2.5	3	2.5	2.5	2.5	2	1.5
11	Proximity to Carnarvon Town Centre	4.5%	4	4	2	2	2	4	4	4	2	2	2	4
12	Proximity to renewable hydrogen centre	5.6%	2	4	3	3	3	2	2	4	3	3	3	2
13	Proximity to river sands centre	5.6%	1	3	3	3	3	3	1	3	3	3	3	3
14	Local economic opportunities	9.0%	2	3	3	3	3	3	2.5	3.5	3.5	3.5	3.5	3.5
15	Flexibility to facilitate multiple trades	9.0%	2.5	2.5	2.5	2.5	2.5	2.5	4	4	4	4	4	4
16	Potential to be intensified / developed in the future	15.8%	1	3.5	2.5	2.5	2.5	3.5	2	5	3.5	3.5	3.5	5
	Weighted score		**2.82**	**3.33**	**3.00**	**3.17**	**2.99**	**2.97**	**2.75**	**3.35**	**2.89**	**3.07**	**2.87**	**2.99**
	Rank (/12)		**11**	**2**	**5**	**3**	**6**	**8**	**12**	**1**	**9**	**4**	**10**	**7**

3.4 Overview of shortlist options

The MCA resulted in a cluster of scoring between 2.5 and 3.5 out of 5, reflecting the inherent trade-offs built into the criteria. It is evident the options which are most suitable from an economic perspective are also those which are the most costly and / or risky. Notwithstanding, the MCA identifies the Boolathana Station site as the most preferred, with the Carnarvon Boat Harbour scoring the highest overall due to the potential for lesser environmental impacts, and its less complex regulatory and approvals pathway.

A summary of the shortlisted options, including the positive and negative attributes of the options according to the MCA, is provided below.

3.4.1 Shortlisted Option #1: Boolathana Station (Medium to Heavy)

MCA scoring assessment

Positive	Negative	Overall perspective
– Single highest score on economic criteria, due to location and infrastructure. – Location outside of Carnarvon provides boost versus other Heavy options.	– One of the weakest scores on cost to due channel creation and heavier berthing infrastructure build. – Uncertainty regarding local conditions and environmental impacts the most significant hurdle.	Presents the option which is mostly likely to service the highest proportion of prospective trades, with flexibility to meet future development needs. May be the most costly however this is less of a concern at this stage of the project.

Site summary[6]

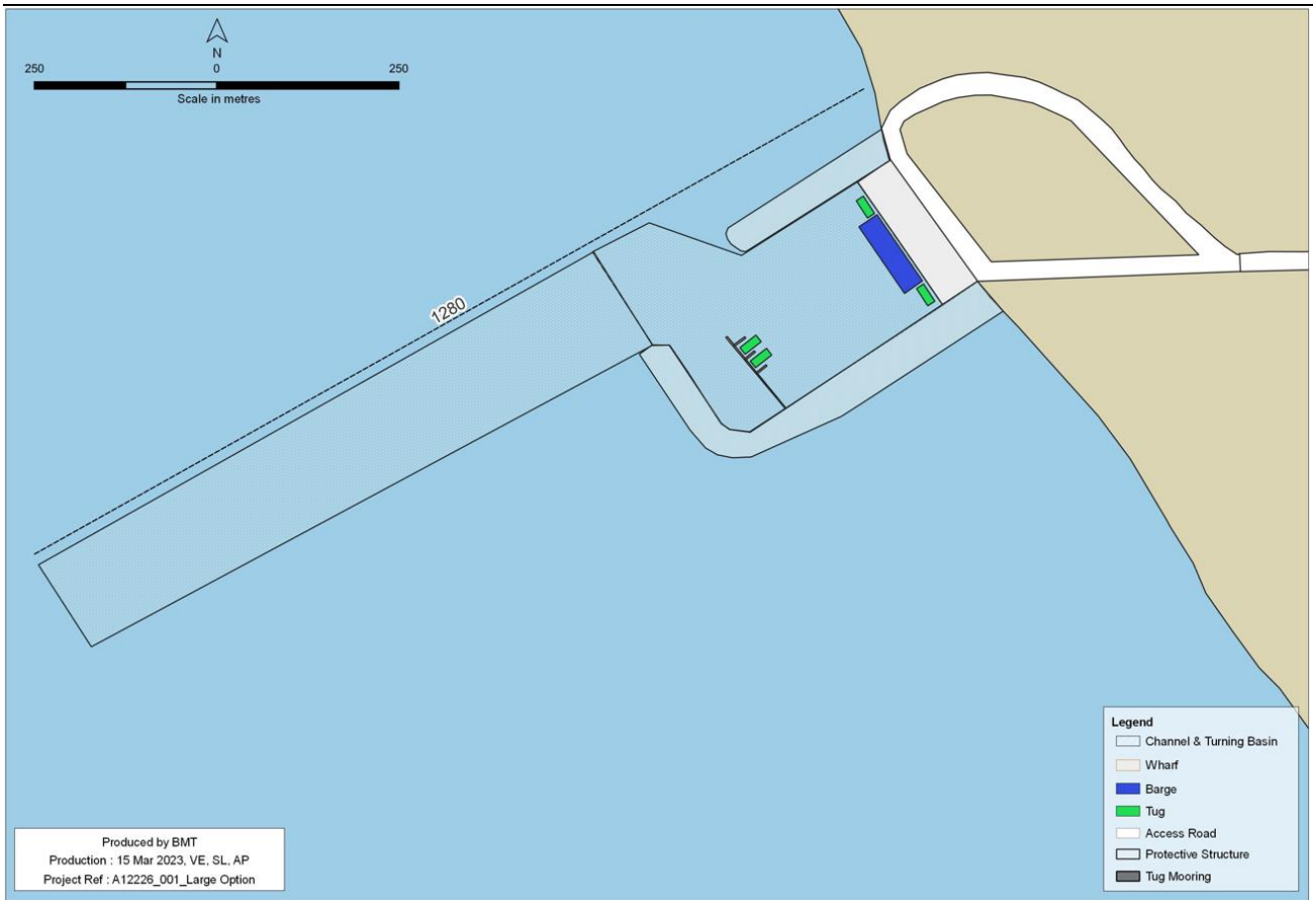
The Boolathana Station (Medium to Heavy Option) is a greenfield site with no existing onshore facilities and is characterized by its rugged and natural landscape, with limited infrastructure or urban development nearby. The site is accessible by a dirt access track off Bibbawarra Road, with Carnarvon located approximately 50 kilometres south-east, and has no existing industrial or commercial operations in the vicinity. The location's isolation and lack of existing infrastructure make it an ideal candidate for a barge facility, which could be used to transport goods, materials, and equipment to and from the site. The construction of a barge facility would have a minimal impact on the surrounding environment and could provide economic benefits for the local community.

A larger multiuser maritime facility would require a protective structure to ensure the safety and security of both the facility and its users and helps to ensure the longevity and sustainability of the facility. This site has no marine or terrestrial restrictions. This greenfield coastal location offers ample opportunities for development due to the large onshore areas that are free for construction. The availability of the onshore area for development also opens up opportunities for ancillary industries, such as logistics, transportation, and large-scale storage for things such as wind turbine blades. Therefore, the possibility of developing a multiuser maritime facility at Boolathana is very promising, and it could become a significant contributor to the local economy.

[6] See Appendix A for further details.

Initial option sketch

Figure 3.5 Shortlisted Option #1: Site and infrastructure overview



Source: BMT Group

3.4.2 Shortlisted Option #2: Boolathana Station (Light)

MCA scoring assessment

Positive	Negative	Overall perspective
– Clearly strongest site for economic criteria, including potential for future development, noting this infrastructure would not cater to heavy lift tasks. – Relatively strong on cost due to limited need for dredging in this infrastructure mode.	– As per Shortlisted Option #1, the site scores relatively poorly due to uncertainty and potential regulatory complexity. – Fairly balanced scoring otherwise, no other clear weaknesses.	Presents a "middle ground" option between the localised focus of Preferred Option #3 and the more costly, risky but flexible Preferred Option #1. However could be rolled into Preferred Option #1 with scenario testing.

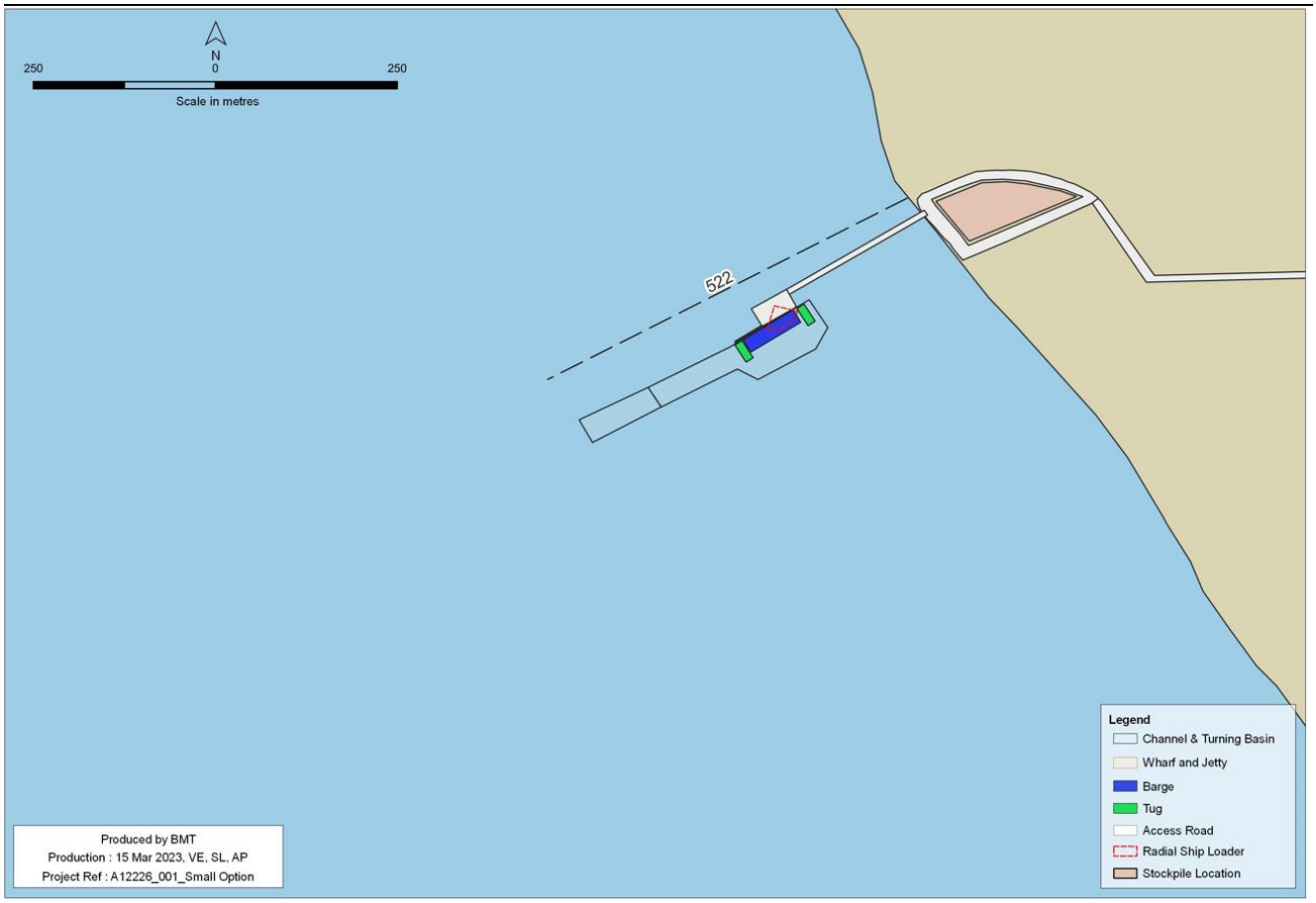
Site summary[7]

See Section 3.4.1 for an overview of the Boolathana Station site key attributes.

[7] See Appendix A for further details.

Initial option sketch

Figure 3.6 Shortlisted Option #2: Site and infrastructure overview



Source: BMT Group

3.4.3 Shortlisted Option #3: Carnarvon Boat Harbour (Light)

MCA scoring assessment

Positive	Negative	Overall perspective
– Strong score on cost, noting some construction complexity to be expected. – Relatively strong score on social impact, with only detriment the physical location in Carnarvon.	– Relatively weak score on economic criteria due to limited potential for future expansion and inability to cater to broad range of trades – Uncertainty: some landside constraints may emerge on further investigation.	Merit in exploring this option as it represents delivery of a localised infrastructure solution which could be of benefit to the region. However, it is unlikely to address stakeholder feedback on the need for a pathway to a multi-user port for the region.

Site summary[8]

Carnarvon Boat Harbour is a small marina located in the town of Carnarvon. It is primarily used for recreational boating, fishing, and tourism. The facilities available at the harbour include boat ramps, jetties, moorings, a fuel station, toilets, showers, and a small car park. There are also several

[8] See Appendix A for further details.

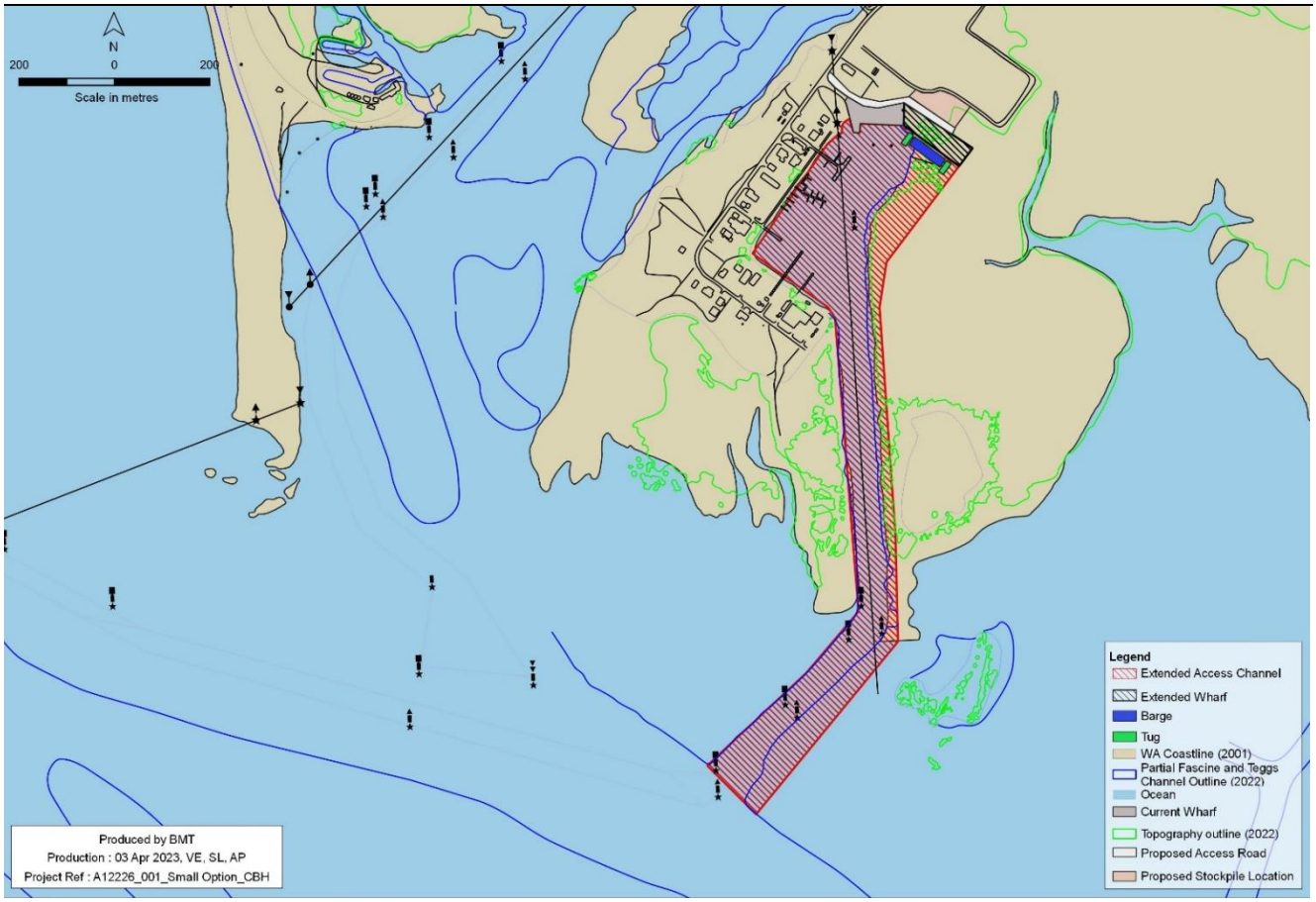
commercial fishing boats and a few charter boats operating from the harbour. The harbour is surrounded by restaurants, cafes, and shops, making it a popular spot for tourism.

The harbour is a man-made structure built in the 1960s to provide safe anchorage for fishing vessels and other boats. The harbour's tenure is owned and managed by the Western Australian Government through the Department of Transport, who oversees its day-to-day operations. The land type around the harbour is primarily made up of coastal wetlands and sand dunes.

The future development capabilities of Carnarvon Boat Harbour are limited by several factors, including its relatively small size and its location within a sensitive environmental area. The harbour has limited space for expansion and cannot accommodate larger vessels, which limits its potential as a commercial port. Furthermore, the surrounding environment is home to a variety of marine species and other sensitive ecosystems that must be protected. As a result, any future development plans must be carefully considered and designed to minimize environmental impact.

Initial option sketch

Figure 3.7 Shortlisted Option #3: Site and infrastructure overview



Source: BMT Group

Finding 6 Boolathana Station

The multicriteria analysis has clearly identified a site in or around Boolathana Station as the most appropriate location to consider an investment in marine infrastructure, due to its capacity to host a larger facility in the future, its location relative to the most important demand nodes, and its relatively limited impact on the marine environment (given the options available).

Initial Feasibility Assessment 4

This section of the report provides the initial feasibility assessment of the barge loading facility under the three shortlisted options. The initial feasibility assessment is conducted using a bottom up and top down financial modelling approach, and a qualitative assessment of the suitability of the shortlisted options to meet the needs of major projects in the region. This section of the report identifies the challenges of a barge loading facility to meet financial feasibility thresholds, and the limited capacity of the infrastructure to meet the needs of major projects.

4.1 Initial feasibility assessment overview

As part of Phase 4 of the methodology for the pre-feasibility study, ACIL Allen and BMT Group prepared an initial financial feasibility assessment based on the shortlisted options identified during the MCA. The initial financial feasibility assessment is designed to present a perspective on the prospect of the infrastructure being able to meet relevant financial return benchmarks.

The analysis is undertaken through two frames of reference, which are outlined below.

Test 1: Bottom up costing

The first test is to consider the aggregate capital and operational costs associated with facilitating a given volume of trade, and identify the cost per unit of trade that would be required to achieve full cost recovery and realise a rate of return. This is based on the analysis of capital costs, a high level funding strategy, and the assessment of operational costs for a given volume of trade. The bottom up costing identifies the fees and charges that would be required, and assesses whether this is reasonable given the market prices for trades facilitated.

Test 2: Comparative rate card assessment

The second test is to consider the aggregate capital and operational costs associated with facilitating a given volume of trade, and comparing this to the revenue which would be generated if the fees and charges which apply at an alternative operating port were applicable to the infrastructure. The revenue generation is compared to the cost of the infrastructure, with the assessment designed to identify the extent to which an alternative facility would represent better value for money for users.

The remainder of this section presents the results of the initial financial feasibility assessment.

4.1.2 Trade demand used for assessment

ACIL Allen has prepared an initial overview projection of trade demand for major projects within the Gascoyne region, making use of information provided by stakeholders and the outcomes of the desktop review into project needs. The profile has been developed as an initial estimate, based on analogous trades and past experience projecting major project import and export requirements.

The trade projection is based on four primary trade demands which could theoretically or technically be served by the barge loading facility, plus an additional volume of trade to reflect the various non-major project trades which could use the facility. The projections are based on ACIL Allen's internal estimates, informed by the following sources:

— **River sand:** Direct feedback from project proponents on target volumes and availability to commence operations

— **Rare earth elements:** Hastings Mineral Technology's April 2023 Market Update, and Definitive Feasibility Study. It is assumed an additional rare earth element project emerges towards the end of the decade with a similar production profile to the Yangibana Project.[9]

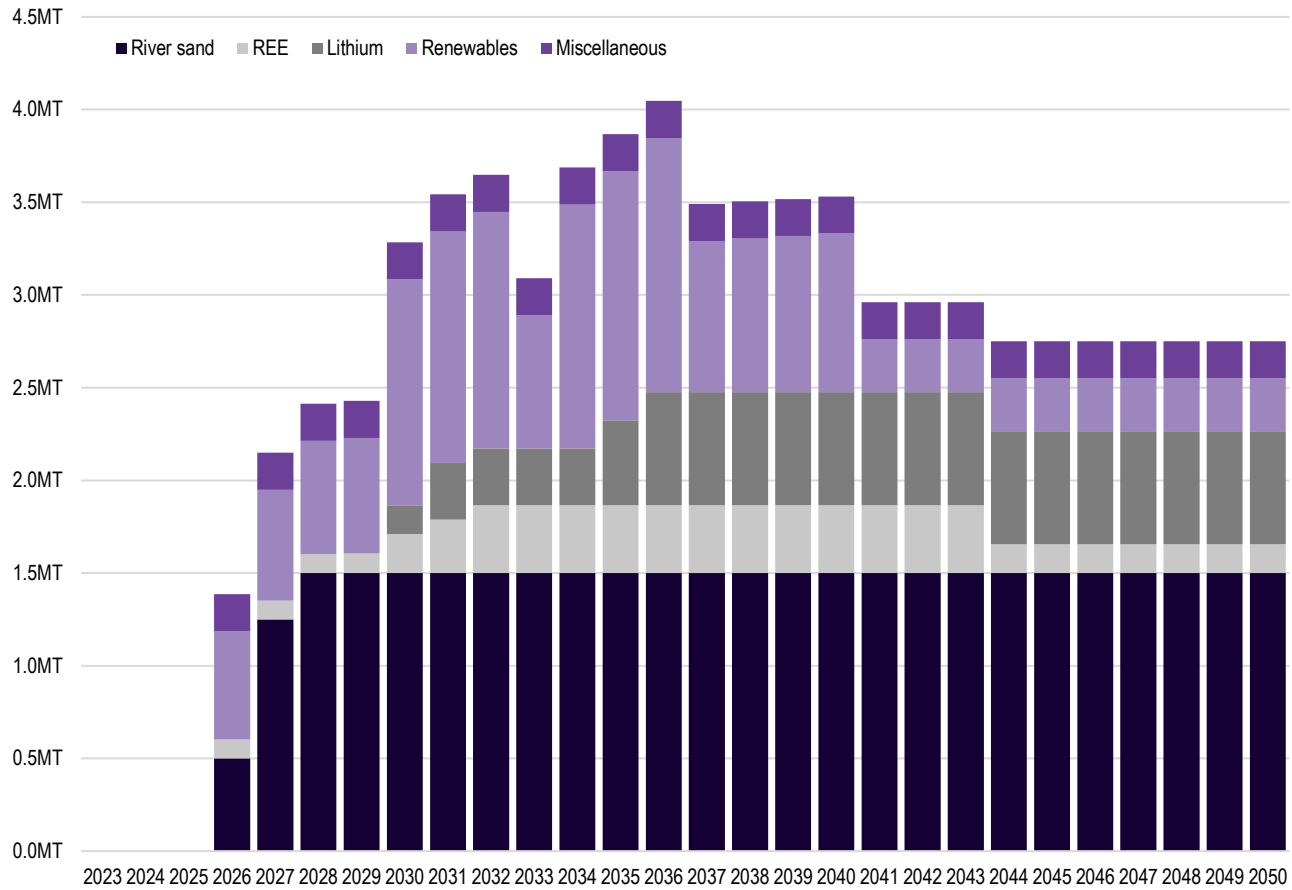
— **Lithium:** Based on Mineral Resources'/Albemarle Wodinga Project, assuming single lithium spodumene production train and commencement date of post-2030. Based on stakeholder feedback and review of ASX-listed company announcements.[10]

— **Renewable energy:** Based on ACIL Allen internal data on wind turbine and associated infrastructure import volumes per asset, and application of development profile of the Uaroo Renewable Generation Project (sourced from Public Environmental Review report).[11]

— **Miscellaneous:** A technical modelling assumption to reflect additional demand for trade in the region which cannot be readily linked to a major project or existing activity from publicly available data.

The unconstrained trade demand profile is summarised below (**Figure 4.1**).

Figure 4.1 Unconstrained Trade Demand Projection



Source: ACIL Allen, from various sources

[9] Rare earth elements are exported via containers, with an assumed 20.5 tonnes per container exported. The actual throughput presented is based on a bottom up estimate of the number of containers required to facilitate the projected volume multiplied by the weight of a full container (22.5 tonnes).

[10] Lithium exports are based on the same methodology as rare earth elements.

[11] Renewable energy import cargoes are based on a cubic metre, rather than tonne, rate, as the cubic metre value of trade is greater than weight and is better reflective of the real constraint on the trade task.

The financial analysis is based on a series of operational assumptions with respect to the barges and other vessels and infrastructure required to facilitate trade. For the Light options, trade is constrained at two million tonnes per annum, serviced by a fleet of two barges which operate throughout the year. For the Medium to Heavy options, trade is constrained at 3.5 million tonnes per annum, with three larger barges operating throughout the year.

These constraints mean not all of the volumes presented in the projection can be serviced. Where this occurs ACIL Allen removes trades starting with Renewable Energy, then Lithium, then Rare Earths and finally Miscellaneous. It is assumed River Sand volumes will persist and receive priority given the strong link between project development and provision of this infrastructure.

Technical details used to assess infrastructure capacity are provided in Appendix D.

Finding 7 Meeting the trade task

ACIL Allen and BMT Group have identified demand for up to 4.2 million tonnes of trade facilitation in the study area when constrained by the services provided over a barge. Based on BMT's analysis of operability and other constraints, the barge loading facility could not meet this need, with a maximum facilitation capacity of 3.5 million tonnes per annum in the Heavy infrastructure option.

4.2 Financial analysis

The financial analysis to support the initial feasibility assessment is prepared through two frames of reference: a bottom up costing, and a comparative assessment of similar services at other facilities in Western Australia. The results of the analysis are presented in the remainder of this section.

4.2.1 Feasibility test 1: Bottom up costing

ACIL Allen worked with BMT Group to prepare a bottom up costing of each of the options based on a series of parameters around vessel capacity, throughput, target volume of trade, and cost of services provided. This was added to a schedule of maintenance capital expenditure, and an estimate of the required return on invested capital for the project to be commercial. The costing differs for each option, both in terms of the actual cost of services and capital invested, and the individual rate per unit of trade facilitated, due to differences in the cost profile and throughput.

An overview of the costing methodology is provided below.

Bottom up costing of infrastructure and services

BMT prepared a series of vessel operational parameters centred on the throughput, loading / unloading rates, and days of availability for each of the shortlisted infrastructure options. Details of this operational model are provided in Appendix D.

The cost of infrastructure operations was built up using a series of day rates for personnel, vessels and fuel, plus overarching assumptions for general facility maintenance, maintenance dredging, insurance, and mobilisation costs. Operational costs are split into fixed and variable charges, with the extent of variable charges determined based on a modelled number of operational days required to fulfill the trade demand for the given year.

Costs can be further split into operational and maintenance costs, however for the initial feasibility assessment a fixed versus variable regime is used.

For the capital line, the modelling is based on a simple vanilla return on capital estimate based on an upfront capital expenditure requirement, required rate of return, and asset life. This is used to

derive an annual payment, in real terms, which both returns the capital to the owner and provides a rate of return.

The assessment is based on a real 12% pre-tax Weighted Average Cost of Capital (or discount rate), with an asset life of 30 years. This approach balances the relatively risky nature of the asset (at a greenfield site with no existing marine infrastructure of this kind, and relatively unknown trade based on major projects) with the early stage nature of the modelling.

Results of the bottom up costing are provided below. The analysis is presented in terms of the real cost of services over the 30 year projection period, with a single rate then determined based on the present value of costs divided by the present value of trade facilitated. This approach is comparable to the way new infrastructure is costed and priced in other contexts, as it allows for the identification of a real price which would allow the asset owner to recover all of its costs (including cost of capital / rate of return) for a given level of trade.

In effect, the cost of services identified in the modelling are the cost to load cargoes onto a barge, tranship the barge to an ocean going vessel, and load the cargoes onto the ocean going vessel (or vice versa for imported goods). The costs exclude any logistics costs to ship goods to the facility, and further costs associated with the hire and use of an ocean going vessel to move goods from the region to their end destination. This makes the costing similar to a wharfage charge.

Shortlist Option 1 (Boolathana Station Heavy)

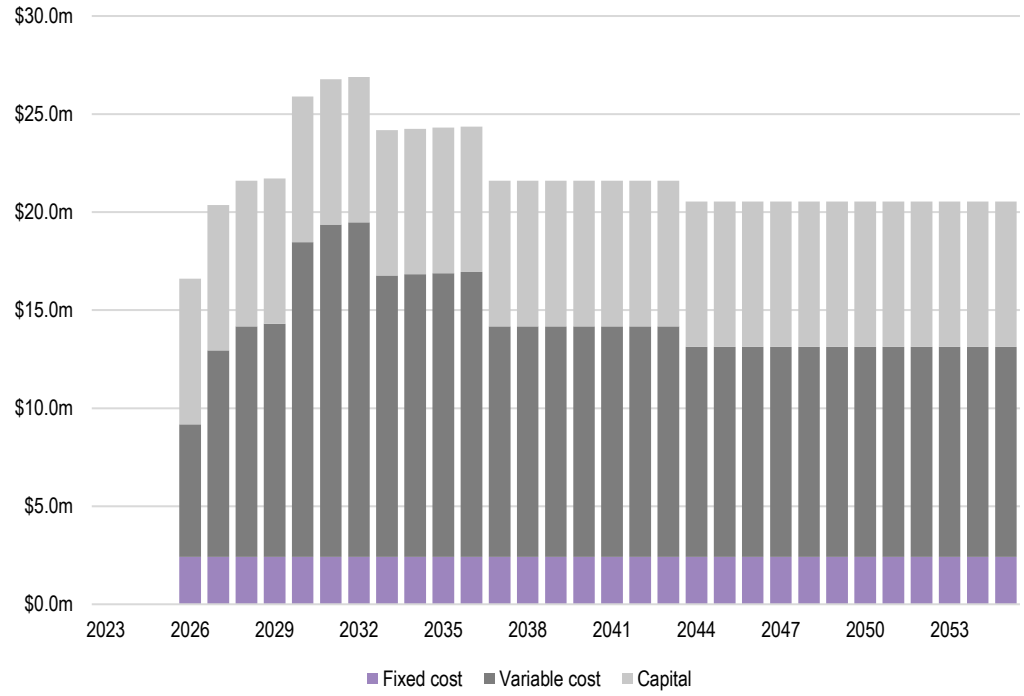
In this scenario, the infrastructure has a maximum capacity of 3.5 million tonnes of trade per annum based on three barges being in operation. Based on the trade demand profile this means the infrastructure is able to facilitate all river sand, the initial rare earth elements project (but not the second), one lithium project (but not the second), two renewable energy import projects (but not the third), the associated renewable maintenance, and the miscellaneous trade demand. Under this set of parameters the infrastructure reaches its nameplate capacity in FY2030 and FY2031.

The cost of services is presented below (**Figure 4.2**).

Overall ACIL Allen estimates the infrastructure services would require a cost of $8.77 per tonne in real 2023 dollars to recover costs and deliver a rate of return. This is based on the following cost blocks and aggregate trade volumes over the 30 year life of the asset:

- Total trade facilitated: 73.6MT (16.3MT in PV terms)
  - River sand: 43.8MT
  - Rare earth elements: 3.4MT
  - Lithium: 7.8MT
  - Renewable energy infrastructure: 12.7MT
  - Miscellaneous: 6.0MT
- Fixed costs: $72.3m ($15.5m in PV terms)
- Variable costs: $359.7m ($79.5m in PV terms)
- Capital costs including return: $222.6m ($47.6m in PV terms)

Figure 4.2 Cost of services analysis: Option 1 (real 2023 dollars by item)



Source: ACIL Allen, from BMT Group

Shortlist Option 2 (Boolathana Station Light)

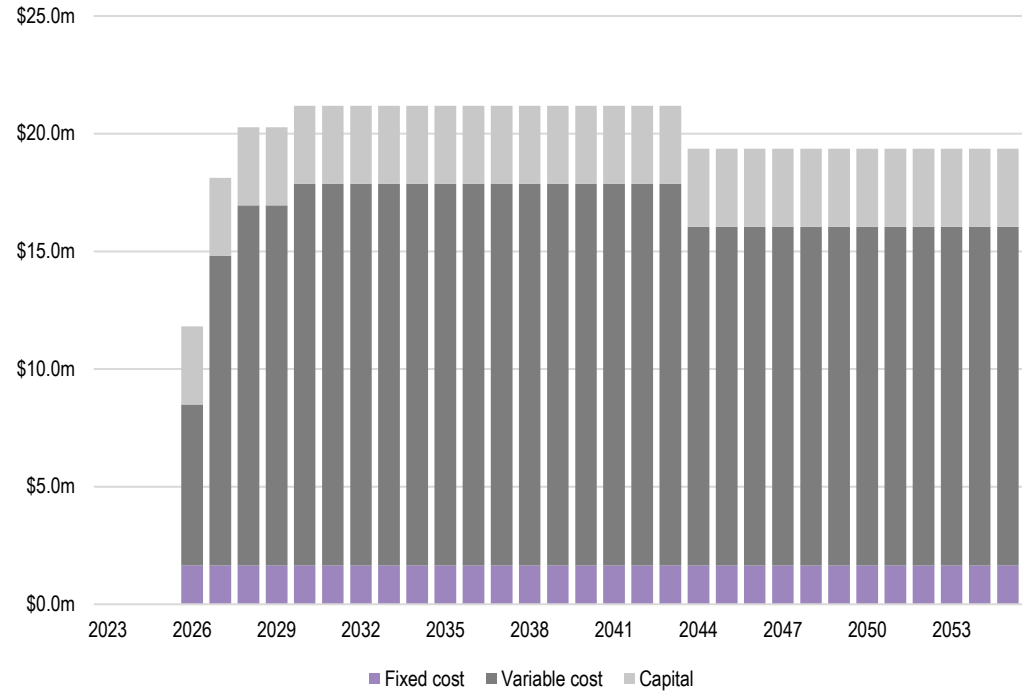
In this scenario, the infrastructure has a maximum capacity of 2 million tonnes of trade per annum based on two barges being in operation. Based on the trade demand profile this means the infrastructure is able to facilitate all river sand, the initial rare earth elements project (but not the second), and the miscellaneous trade demand. There is no capacity available to deliver additional containerised minerals trade, while the Light infrastructure option cannot cater for renewable energy imports. Under this set of parameters the infrastructure facilitates a maximum of 1.9MT of trade per annum.

The cost of services is presented below (**Figure 4.3**).

Overall ACIL Allen estimates the infrastructure services would require a cost of $11.39 per tonne in real 2023 dollars to recover costs and deliver a rate of return. This is based on the following cost blocks and aggregate trade volumes over the 30 year life of the asset:

- Total trade facilitated: 53.1MT (11.0MT in PV terms)
  - River sand: 43.8MT
  - Rare earth elements: 3.4MT
  - Lithium: 0
  - Renewable energy infrastructure: 0
  - Miscellaneous: 6.0MT
- Fixed costs: $49.3m ($10.5m in PV terms)
- Variable costs: $450.6m ($93.4m in PV terms)
- Capital costs including return: $99.6m ($21.3m in PV terms)

Figure 4.3 Cost of services analysis: Option 2 (real 2023 dollars by item)



Source: ACIL Allen, from BMT Group

The reason for the higher variable cost versus Shortlist Option 1 is the infrastructure runs at a higher utilisation rate for longer, resulting in a greater number of operational days and a higher number of individual campaigns to facilitate the projected volumes.

Shortlist Option 3 (Carnarvon Boat Harbour Light)

In this scenario, the infrastructure has a maximum capacity of 2 million tonnes of trade per annum based on two barges being in operation. Based on the trade demand profile this means the infrastructure is able to facilitate all river sand, the initial rare earth elements project (but not the second), and the miscellaneous trade demand. There is no capacity available to deliver additional containerised minerals trade, while the Light infrastructure option cannot cater for renewable energy imports. The location is also constrained on the landside, which would make facilitation of renewable energy imports impossible. Under this set of parameters the infrastructure facilitates a maximum of 1.9MT of trade per annum.

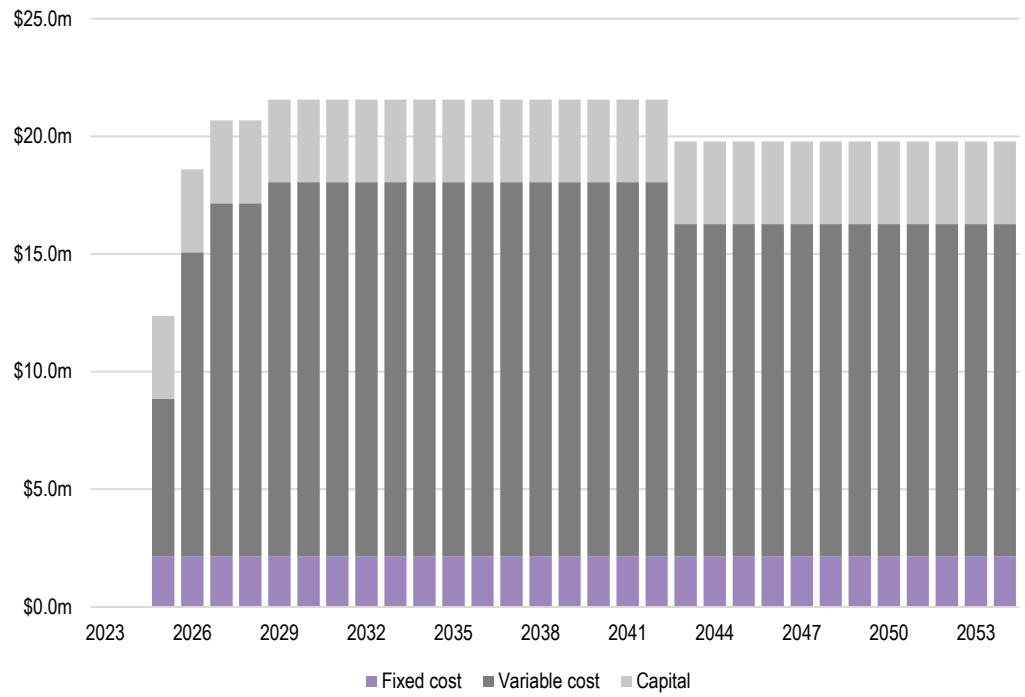
The cost of services is presented below (**Figure 4.4**).

Overall ACIL Allen estimates the infrastructure services would require a cost of $11.63 per tonne in real 2023 dollars to recover costs and deliver a rate of return. This is based on the following cost blocks and aggregate trade volumes over the 30 year life of the asset:

- Total trade facilitated: 53.1MT (11.0MT in PV terms)
  - River sand: 43.8MT
  - Rare earth elements: 3.4MT
  - Lithium: 0
  - Renewable energy infrastructure: 0
  - Miscellaneous: 6.0MT
- Fixed costs: $64.3m ($13.8m in PV terms)
- Variable costs: $441.8m ($91.6m in PV terms)

— Capital costs including return: $105.5m ($22.6m in PV terms)

Figure 4.4 Cost of services analysis: Option 3 (real 2023 dollars by item)



Source: ACIL Allen, from BMT Group

The higher fixed costs in this option versus the other two options reflects the requirement for substantially larger dredging to be undertaken to provide appropriate access – even for the Light infrastructure option. This results in the maintenance dredging cost estimate for this option being over three times the estimate for options at Boolathana Station.

Finding 8 A costly infrastructure solution

BMT Group estimates the total cost of service provision for the three shortlisted options is in the order of $600 million to $650 million depending on the option, with a clear trade-off between higher capital costs and higher operating costs based on the operating parameters of the infrastructure. However, the costing is highly sensitive to future trade volumes, meaning the gross cost of the infrastructure is also a significant consideration.

4.2.2 Feasibility test 2: Comparative rate card assessment

As discussed above, the provision of this infrastructure and the services provided are akin to the "wharfage" charges levied by a more developed, multi-user port facility. These charges are typically based on a per-tonne or per unit of activity rate (such as a rate per container), and reflect the costs and asset deployed to service the physical movement of goods from a cargo vessel on to the shore.

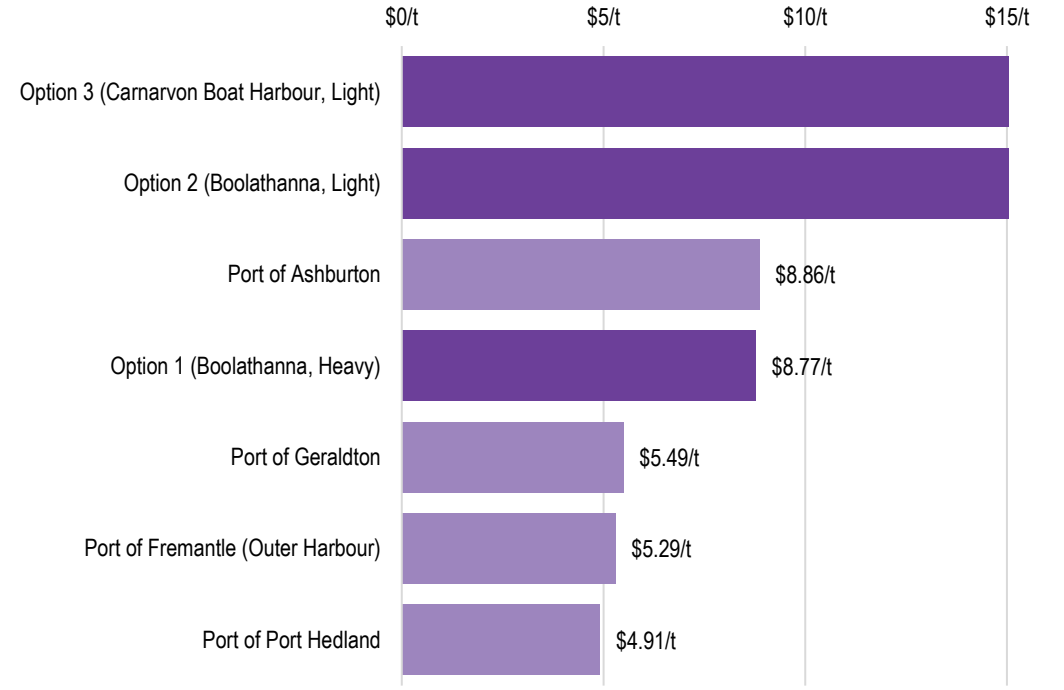
Therefore, to test the financial feasibility of the proposed infrastructure options, it is reasonable to compare the derived costs to the wharfage rates available at other facilities in Western Australia. If the wharfage charges at these facilities are broadly aligned to the cost of the infrastructure (including the cost of capital / rate of return), then the modelling would suggest the infrastructure is competitive.

To complete this comparison ACIL Allen reviewed the wharfage rates at the following ports, which would provide similar services to the proposed barge loading infrastructure:

— Port of Fremantle (Outer Harbour), Fremantle Port Authority
— Port of Ashburton, Pilbara Ports Authority
— Port of Port Hedland, Pilbara Ports Authority
— Port of Geraldton, Mid West Ports

The wharfage rates for these facilities for the 2023 financial year are provided below (**Figure 4.5**).

Figure 4.5 Comparative analysis of wharfage-equivalent charges, $/t (2023 values)



Source: ACIL Allen, from Port Authorities & GBLF Financial Model

The comparative analysis shows the estimated wharfage-equivalent charge associated with the three shortlisted options is substantially above the most mature comparator port facilities in Geraldton, Fremantle and Port Hedland. The comparison suggests the wharfage-equivalent charge associated with Option 1 is broadly aligned to the fees payable to make use of the Port of Ashburton (in Onslow, some 400 kilometres north east of Carnarvon), but is still substantially cheaper than Option 2 and Option 3. It is important to note the industries and use cases – predominately the oil and gas industry – at the Port of Ashburton are less sensitive to the cost of infrastructure and therefore may have a higher capacity to pay.

In effect, the analysis suggests an importer / exporter would be required to pay between $2.77 and $6.72 per tonne more for the services in the proposed infrastructure versus an alternative location.

Alternatively, if the infrastructure was required to meet a benchmark fee for the provision of its services versus like facilities across Western Australia, the fee would only permit the recovery of between 53% and 70% of costs – which would result in the infrastructure being deemed unviable.

As discussed throughout this section, it is important to note this is only one part of the logistic chain required to move goods into and out of the region via a barge loading infrastructure solution. This is relevant to the comparative analysis as it is possible the higher cost of wharfage-like services

presented by this infrastructure could be made up for through lower landside logistics costs, such as the cost of moving goods from one of the alternative ports into the region.

Finding 9 Unfavourable cost comparisons

A comparison of the cost of services per tonne of trade facilitated by the shortlisted options versus rates at existing Western Australian ports suggests the proposed infrastructure is between $2.77 / tonne and $6.72 / tonne more expensive. Applying the comparative rates to the shortlisted options would result in a cost recovery rate of between 53% and 70%, deeming the facility financially unviable.

Summary and Directions 5

This section of the report presents a summary of the work undertaken to date to inform this initial feasibility assessment report, and makes a recommendation to continue the investigation with an alternative infrastructure concept.

5.1 Summary of study findings

The findings which are made throughout this report are presented below. These findings have been informed by the work undertaken by ACIL Allen and BMT Group (as summarised in this report, and contained in the detailed attachments and appendices), and the feedback of stakeholders regarding the suitability of a barge loading facility for the needs of major projects in the region.

Summary of findings

Finding 1

The existence of a number of marine side constraints – principally marine parks and challenging Met-ocean conditions – means there is a relatively limited area of the Gascoyne coastline which is suitable to investigate the provision of marine infrastructure.

Finding 2

The opportunities scan has identified a number of diverse trade facilitation opportunities for the Gascoyne, linked the region's current and emerging competitive advantages. The diversity of this demand for trades is a positive for the provision of infrastructure as it provides diversification. However, this also presents risks for the provision of a barge loading facility as not all trades are likely to be best served by this kind of infrastructure.

Finding 3

The stakeholders engaged during the first phase of the study were universally supportive of an investment in the provision of marine infrastructure on the western Gascoyne coast. Many stakeholders suggested without this infrastructure their projects would be unlikely to proceed. A number of stakeholders were unclear as to the merits of a barge loading facility for their needs, although some believed this was an appropriate solution given their own needs.

Finding 4

The initial feasibility assessment has identified river sand exports as the primary short term trade opportunity for the region, though in the medium to long term there are significant additional industries and opportunities in the form of renewable energy, renewable hydrogen, minerals and agriculture.

Finding 5

In discussing the multicriteria assessment criteria and their weightings, the Project Steering Group identified the need to find an appropriate site for the infrastructure, with the capacity to grow and develop in line with the needs of industry. The Project Steering Group also expressed a strong preference to find a location with minimal environmental impact.

Finding 6

The multicriteria analysis has clearly identified a site in or around Boolathana Station as the most appropriate location to consider an investment in marine infrastructure, due to its capacity to host a larger facility in the future, its location relative to the most important demand nodes, and its relatively limited impact on the marine environment (given the options available).

Summary of findings (cont.)

Finding 7

ACIL Allen and BMT Group have identified demand for up to 4.2 million tonnes of trade facilitation in the study area when constrained by the services provided over a barge. Based on BMT's analysis of operability and other constraints, the barge loading facility could not meet this need, with a maximum facilitation capacity of 3.5 million tonnes per annum in the Heavy infrastructure option.

Finding 8

BMT Group estimates the total cost of service provision for the three shortlisted options is in the order of $600 million to $650 million depending on the option, with a clear trade-off between higher capital costs and higher operating costs based on the operating parameters of the infrastructure. However, the costing is highly sensitive to future trade volumes, meaning the gross cost of the infrastructure is also a significant consideration.

Finding 9

A comparison of the cost of services per tonne of trade facilitated by the shortlisted options versus rates at existing Western Australian ports suggests the proposed infrastructure is between $2.77 / tonne and $6.72 / tonne more expensive. Applying the comparative rates to the shortlisted options would result in a cost recovery rate of between 53% and 70%, deeming the facility financially unviable.

5.2 Directions and recommendations

5.2.1 Study directions: is a barge the right way forward?

Overall, it is clear from the work undertaken by the project team to date that the need for marine infrastructure in this part of the Gascoyne region is strong. There are a number of major project development opportunities which would benefit from the provision of fit for purpose marine infrastructure, to facilitate the movement of goods into and out of the region. For the two most significant opportunities (by trade volume and economic development opportunity respectively) in river sand and renewable energy production, success relies upon an ability to get product in and out via a local marine infrastructure solution.

However, it is evident from the work undertaken throughout the study that a barge loading facility is not the most appropriate marine infrastructure solution for the region, particularly given the emerging opportunities in renewable energy and renewable hydrogen. A barge loading facility can only meet part of the trade task, in part because it is physically constrained by barging, but more substantially because a barge is not an appropriate solution for many trades.

A barge loading facility may be adequate to serve the needs of river sands exporters, and to serve some additional trade activity around the margins. If the infrastructure solution meets the needs of these trades, at a cost which is feasible given the global market for these products, the infrastructure should be able to be financed and built by these industries.

The opportunity presented to the Gascoyne region by renewable energy and renewable hydrogen demands that the needs of these major projects be given substantial weighting when determining a way forward. It is clear, from the work of BMT Group on material handling and the feedback of major project developers in these industries, that a barge loading facility is not the way forward. The project team is bound by the terms of the study, which is to consider a barge loading facility only.

Meanwhile, the initial feasibility assessment of the barge loading facility conceived as part of the work undertaken to date is unfavourable. Financial modelling indicates that at comparative rates for similar services provided at other ports around Western Australia the proposed infrastructure would only recover between 53% and 70% of its costs (including the cost of capital / rate of return). This

would mean the facility would struggle to be financed. This analysis includes the handling of some renewable energy cargoes, which may not materialise given the limitations of a barge loading facility.

5.2.2 Study recommendations

Considering the above, and the findings of the report, ACIL Allen made a recommendation to the Project Steering Group in April 2023 to pause the pre-feasibility study and to consider a change to the scope of the assessment. The change in scope would permit the project team with the resourcing and direction to investigate alternative marine infrastructure solutions to a barge loading facility, which would permit direct access to berth for ocean going vessels.

A further direction provided by stakeholders was the importance of developing a pathway for the infrastructure to become a major export terminal for renewable hydrogen-based products in the future. This would involve the creation of specific and specialised product handling infrastructure, and a bulk liquids berthing solution as an addition to the capacity to facilitate ocean going vessels.

In discussions with the GDC, ACIL Allen provided a series of options to continue the study at the current point but with the change in infrastructure concept for investigation. This would also provide ACIL Allen and BMT Group with the resources to re-engage with major project owners and other stakeholders to seek their views on the new infrastructure concept and the services that could or should be available.

The re-scoped study would also re-examine the potential trade demand considering the outlook for renewable hydrogen-based product exports, and additional trade and services opportunities such as offshore wind project construction and maintenance services. These trades could not be facilitated at a barge loading facility and so were not examined.

The output of this revised study will be able to be used by GDC or other relevant State Government stakeholders to complete an Application for Concept Approval, the first step in the Western Australian Government's *Strategic Asset Management Framework* for major infrastructure proposals. This approach will allow the State to carry forward the analysis and directions of the study and seek funding to prepare a business case, or to provide an independent perspective on any private sector proposals which may be active in the region.

ACIL ALLEN

Attachments

Desktop Study A

GBLF Barge Feasibility Assessment Supporting Documents

Customer	Acil Allen
Project	A12226
Deliverable	2
Version	1
	28/09/2023

Document Control

Document Identification

Title	GBLF Barge Feasibility Assessment Supporting Documents
Project No	A12226
Deliverable No	2
Version No	1
Version Date	28/09/2023
Customer	Acil Allen
Classification	OFFICIAL

Author	Samantha Law
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Amendment Record

The Amendment Record below records the history and issue status of this document.

Version	Version Date	Distribution	Record
0	28 July 2023	External	Report
1	28 September 2023	External	Report

Contents

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Figures

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1 Introduction

This report presents a comprehensive combination of three short technical notes, each offering crucial supporting documentation to the Barge Feasibility Assessment. The following sections delve into each of the three technical notes, elaborating on their individual contributions to the assessment.

2 Site Options Long List

2.1 Introduction

2.1.1 Background

In October 2022, BMT (together with ACIL Allen) was appointed by the Gascoyne Development Commission (GDC) to perform a pre-feasibility study assessing viable options for a barge loading facility to service Carnarvon and the associated Region. An initial desktop review was completed to compile all relevant information to assist in site selection for Barge Loading Facility (hereafter; the Facility).

The Objectives met in this document include:

- Identify suitable sites for a facility (including existing facilities), including considerations of land availability and tenure, access to deep water for cargo vessels, and impacts on Carnarvon roads and marine traffic as identified in Tn-12226-1 (BMT 2023).
- Identification of options for where the facility could be located in the Carnarvon area, taking into consideration vessel access and movements, road traffic, and marine traffic among other matters at the Consultant's discretion, and a process for identifying a preferred or multiple preferred sites; In particular, the State is keen to provide information and data from this study to identify and develop solutions to any "fatal flaws" associated with the interface between a barging solution and metocean conditions, shoreline structures and other existing infrastructure in and around the identified site or sites.

2.1.2 Scope of Site Location Study

An initial broad area reduction was conducted to discount areas of the coastline that present unsuitable conditions for the development or operation of such a facility. From this reduced area six (6) options were analysed against the site selection criteria devised from the initial desktop review (BMT 2023). Key information reflecting the below criteria was summarised to inform a Multi-Criteria Assessment (MCA), led by ACIL Allen.

Table 2.1 Summary of Site Criteria

Screening criteria	Examples
Potential for future development	• Space for future extensions and a multi user facility. • Offshore depth (i.e. minimise the requirement for dredging).
Metocean conditions	• Avoid areas that experience extreme weather, looking for areas that are protected from the southerly swell events brought about by cold fronts in winter months. Likewise avoiding the northern extent of the study area as the risk for cyclones is higher. • Looking for areas that are naturally sheltered to avoid large additional costs for additional protective structures.
Environmentally sensitive areas (Marine Parks)	• Areas of extreme environmental sensitivity need to be avoided (i.e. Ningaloo Marine Park and Shark Bay Marine Park).
Bathymetry	• Significant depth required quayside (~4-5 m for the Barge option and ~14 m for heavy module loading and exports). • Suitable depth to allow passage to and from the Facility, to reduce the cost required for dredging of channels and basins etc.
Coastal processes	• Avoiding areas with intense dynamic coastal processes and alluvial soil to avoid high channel maintenance costs.
Proximity to infrastructure	• Reduce the distance between the Facility and required road infrastructure. Try to minimise the cost requirements for upgrading of local road infrastructure for the initial setup of the Facility. • Avoid locations where the land access is not suitable for haulage (i.e. Gascoyne River crossing is not load rated). • Reduce the distance from the Airport to allow for ease of commute of workers being flown to the area.

2.2 Broad Area Reduction

From the site criteria summarised in Table 2.1 marine parks were immediately deemed as unsuitable for the Facility. South of Shark Bay Marine Park was removed due to extreme metocean conditions experienced from the south. Likewise, the area south of Cape Cuvier was deemed unsuitable due to it's location not being protected from the extreme southerly metocean conditions. Figure 2.1 depicts the extent of the study area reduction.

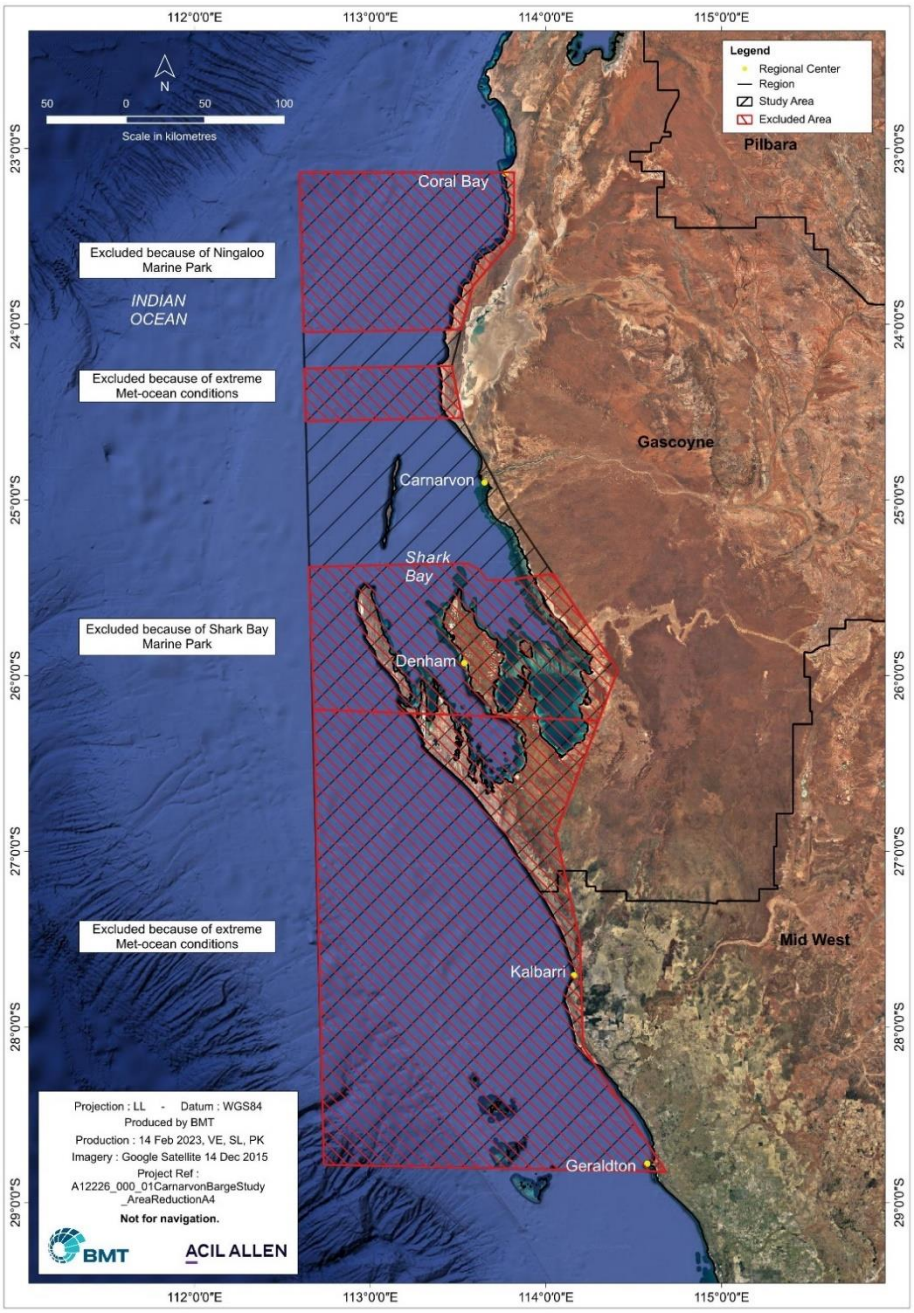


Figure 2.1 Excluded Areas (depicted as red marked areas) from the initial study area scope (black marked out area)

2.3 Onshore Sites Overview

To determine suitable sites, several potential options were explored at a feasibility level. Table 2.2 summarises the sites and their results against the site criteria. It should be noted that a proposal of this complexity is expected to potentially have a significant impact on the environment (without appropriate mitigations and management) and will be referred to the Department of Water and Environmental Regulation (DWER) – Environmental Protection Authority (EPA) services for formal assessment of the following Onshore Potential Sites (Section 2.3.1).

2.3.1 Potential Sites

Cape Cuvier

The Cape Cuvier Port Facility (CCPF) is located approximately 30 km north of Carnarvon. The CCPF primarily services the oil and gas industry, with facilities including a deep-water jetty, a tank farm for storing crude oil and condensate, and an airstrip for personnel transport. Additionally, the CCPF has a range of workshops and support infrastructure to support oil and gas operations in the region. It is part of the Port of Carnarvon as dictated by the *Shipping and Pilotage Act 1967*.

The bathymetry in the region indicates depths at the port range from -13 m to -15 m directly adjacent to the jetty and dropping to ~-30 m within 100 m offshore. The port is located within the Quobba Pastoral Lease and is privately owned by Rio Tinto. The site would require detailed and successful land use negotiations with Dampier Salt / Rio Tinto. Anecdotally, Dampier Salt have stated previously that they would not share infrastructure with other salt or gypsum exporters. The site experiences significant land access constraints with entry via a minor unsealed road.

Geotechnical information in the area suggests that the location experiences sedimentary carbonate material. The area is described as marine and coastal limestone, lesser marine and coastal sandstone and local conglomerate (BMT 2023)

Cape Cuvier is highly exposed to metocean conditions with the predominate wave and wind direction coming from the south west (Figure 2.3). The closest previous cyclones were in 2000 (~3 km, category 2) and 2014 (~7 km, category 3). It is by far the most exposed site and would pose significant construction challenges and risks. Likewise, there would be constraints on suitable land area for stockyards and difficulty accessing the berth due to cliffs at the shore edge.

Under the Section 38 of the *Environmental Protection Act 1986* (EP Act), a Referral Supporting Document will be required to provide sufficient information for the EPA to assess the Proposal at the referral stage. Baseline surveys and technical studies would be required before the commencement of a Section 38 Referral Supporting Document (EPA 2021).

Other relevant legislation that will be considered to assess the key environmental factors and potential sensitive receptors and Matters of National Environmental Significance (MNES) are:

- *Commonwealth Environment Protection Biodiversity Conservation Act 1999* (EPBC Act)
- *Western Australian Biodiversity Conservation Act 2016* (BC Act).

Under the *Native Title Act 1993* (NT Act), Native Title determination was granted in 2019 to the claimant group Gnulli, Gnulli #2 and Gnulli #3 – Yinggarda, Baiyungu and Thalanyji People (NNTT 2023a). The Determination Area is divided into two geographical areas, being Baiyungu and/ or Thalanyji Area in the north of the Determination Area and the Yinggarda Area in the south of the Determination Area (FCA 2019). CCPF is located within the Baiyungu and/ or Thalanyji Prescribed Body Corporate (PBC) boundary and within the Nganhurra Thanardi Garrbu Aboriginal Corporation Registered Native Title Body Corporate (RNTBC) boundary (NNTT 2023a). A search of the Department of Planning, Lands and Heritage (DPLH) Aboriginal Cultural Heritage Inquiry System (ACHIS) showed one Registered Aboriginal Sites [Site 6060] within the 5 km radius from the proposed site (DPLH 2023a; Annex A).

On 1 July 2023, the *Aboriginal Cultural Heritage Act 2021* (ACH Act) replaced the *Aboriginal Heritage Act 1972* (AHA Act) which provides stronger protection to and greater involvement of Aboriginal people in Aboriginal Cultural Heritage (DPLH 2023b). The ACH Act establishes a new system which will replace the existing Section 18 process. The new tiered system will help determine the level of due diligence and approvals required based on the level of impact a project has on aboriginal cultural heritage (DPLH 2023b). No approval is required for Tier 1 activities (low amount of disturbance) and exempt activities (DPLH 2023b). A notification to aboriginal parties and a permit is required for Tier 2 activities (medium amount of impact) (DPLH 2023b). Consultation with aboriginal parties and an aboriginal cultural heritage management plan (to be agreed with local aboriginal organisation) is required for Tier 3 activities (DPLH 2023b).

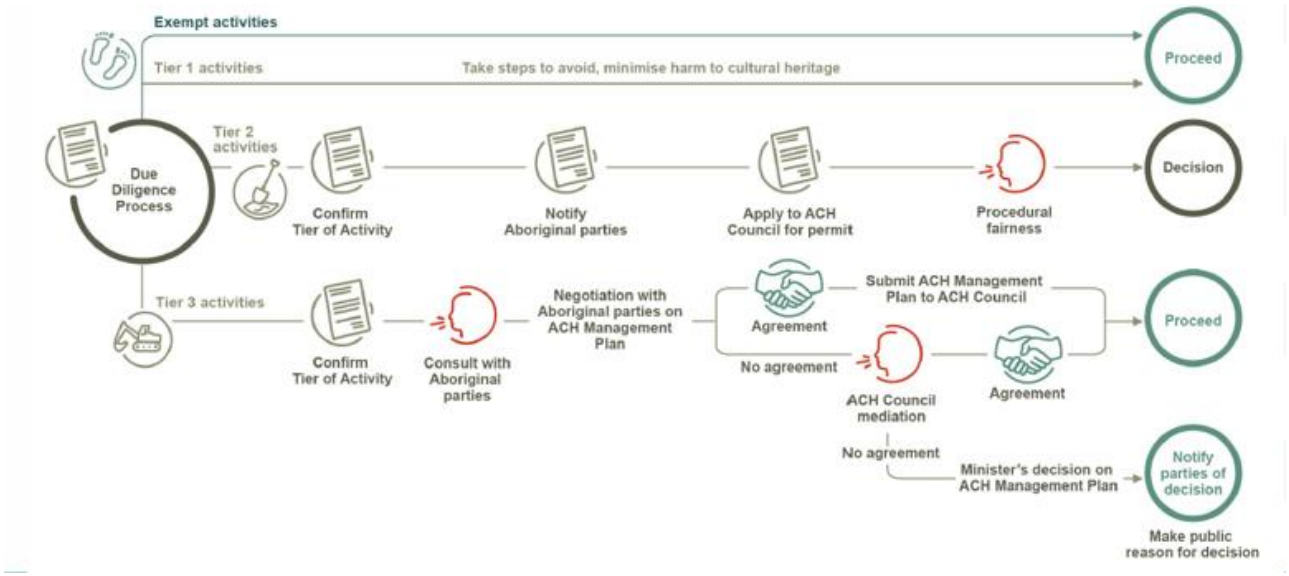


Figure 2.2 Flowchart showing the tiered system of the Aboriginal Cultural Heritage Act 2021 (DPLH 2023b)

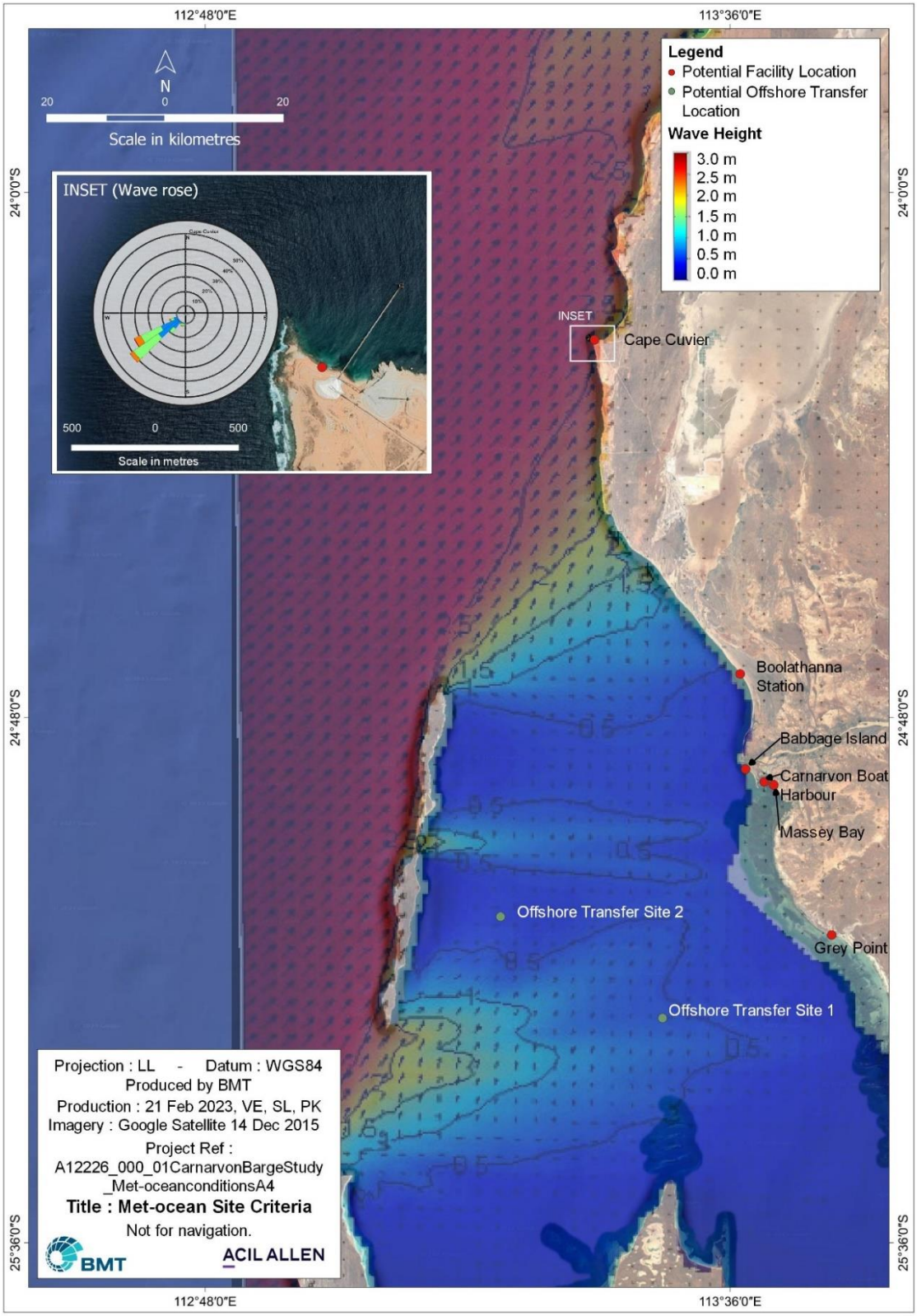


Figure 2.3 Metocean site criteria conditions for all sites in the initial study area scope (Data extracted from (AECOM, 2010) and overlain over sites)

Boolathanna/Bejailing Station

Boolathanna Station is a pastoral lease in Western Australia, located in the state's Pilbara region. The area is currently part of an exploration licence owned by Province Resources. It is situated approximately 120 km southeast of the town of Port Hedland and 120 km east of the coastal town of Karratha. The station covers an area of around 3,073 km^2 and is bordered by the Coongan River to the west and the Oakover River to the east. The terrain in the area is generally flat, with low hills and ranges in some areas.

The Facility would be located approximately at the point shown in Figure 2.3, with land-based access via an unsealed track off the Great Northern Highway, which passes to the west of the property. The Facility would be approximately 16 km from the heavy haulage route already utilised. It is also approximately 41 km (driven route) from the local Carnarvon Airport. There are no marine facilities located there currently. The area is part of the Carnarvon Port Area as dictated by the *Shipping and Pilotage Act 1967*.

The area is protected from the extreme southerly and south westerly metocean conditions by Bernie Island. The waves are diffracted around the north of the island and the wave height is reduced ~500% (~0.5 m). The site has not experienced a cyclone directly with the closest previous episode in 1995 (15 km, Category 4). The area is very shallow with the -20 m contour sitting approximately 23 km off the coast. Significant dredging would be required for expansion of the Facility to include other methods of exporting. Onshore rock type is sedimentary carbonate, the area is described as marine and coastal limestone, lesser marine and coastal sandstone and local conglomerate (BMT 2023). The area has sand and sandy silts directly offshore with sections of turf algae and sparse seagrass scattered throughout. The area is a wave dominated arid zone delta, in which the northwards longshore drift, under the influence of waves, has produced a major beach ridge complex, the Bejaling beach ridges in this area (BMT 2023).

Under the Section 38 of the EP Act, a Referral Supporting Document will be required to provide sufficient information for the EPA to assess the Proposal at the referral stage (EPA 2021). The Boolathanna Large Facility is located near no existing infrastructure and there is minimal disturbance related to human activities in the receiving terrestrial and marine environment (BMT 2023). Baseline surveys and technical studies would be required before the commencement of a Section 38 Referral Supporting Document (EPA 2021).

Other relevant legislation that will be considered to assess the key environmental factors and potential sensitive receptors and MNES (DCCEEW 2023) are:

- Commonwealth EPBC Act 1999
- Western Australian BC Act 2016.

Under the NT Act, Native Title determination was granted in 2019 to the claimant group Gnulli, Gnulli #2 and Gnulli #3 – Yinggarda, Baiyungu and Thalanyji People (NNTT 2023a). The Determination Area is divided into two geographical areas, being Baiyungu and/ or Thalanyji Area in the north of the Determination Area and the Yinggarda Area in the south of the Determination Area (FCA 2019). Boolathanna station is located at the southern Determination Area within the Yinggarda PBC boundary and within the most southern boundary of the Yinggarda Aboriginal Corporation RNTBC boundary (NNTT 2023a). A search of the DPLH ACHIS showed no Registered Aboriginal Sites within the 5 km radius from the proposed site (DPLH 2023a).

On 1 July 2023, the ACH Act replaced the AHA Act which provides stronger protection to and greater involvement of Aboriginal people in Aboriginal Cultural Heritage (DPLH 2023b). The ACH Act establishes a new system which will replace the existing Section 18 process (DPLH 2023b). As described in Figure 2.2 a determination will need to be made whether Tier 1, 2 or 3 approval is required under the ACH Act.

Babbage Island (near One Mile Jetty)

Babbage Island is a small uninhabited island located about 3 km north-west of Carnarvon. It is accessible via Babbage Island Rd from the mainland. It is a relatively small sand island covering approximately 5 km^2. The island is largely undeveloped with walking tracks, minor roads, historical jetties and several buildings including Carnarvon Beach Holiday Resort.

The area has previously been used as a deep-water port, with the One Mile Jetty constructed in 1897 to provide shipping for the agricultural goods from the region. The historic wooden jetty is currently now a tourist attraction and a popular spot for recreational activities including swimming, snorkelling and diving. The terrestrial vegetation is characterised by scrubland and low shrubs, with occasional stands of trees, such as eucalypts and acacias. The area surrounding the jetty is also home to a variety of wildlife, including seabirds, marine life, and terrestrial fauna (BMT 2023).

At One Mile Jetty, the shoreline has been moving seaward at an average rate of 4.5 m / year between 1949 and 2020. The area displays massive deposition of alluvial deposits associated with stream avulsion events and large-scale channel migration of the Gascoyne River.

The land is under the Shire of Carnarvon, listed as Freehold. There is a mining lease pending with Onslow Resources for the Gascoyne River, depending on the specific site chosen on Babbage Island, tenure discussions may be required.

The soil depth is commonly greater than 1 m and the profile consists of a thin layer (10-45 cm) of sand, loamy sand or sandy loam, over sandy clay loam or sandy clay.(BMT 2023). The rock type in this location is sedimentary carbonate. The location is protected from the southwest and westerly wave conditions which are diffracted around the Islands offshore. There was one cyclone offshore in 1995 (~4 km adjacent, category 4).

The area has been covered by DoT survey previously and does not currently provide access to deep water. Significant dredging would be required to create a channel that could accommodate large barges. The area is close to infrastructure including Carnarvon Airport, ~8 km from the heavy haulage road and ~4 km from the current boat harbour facilities.

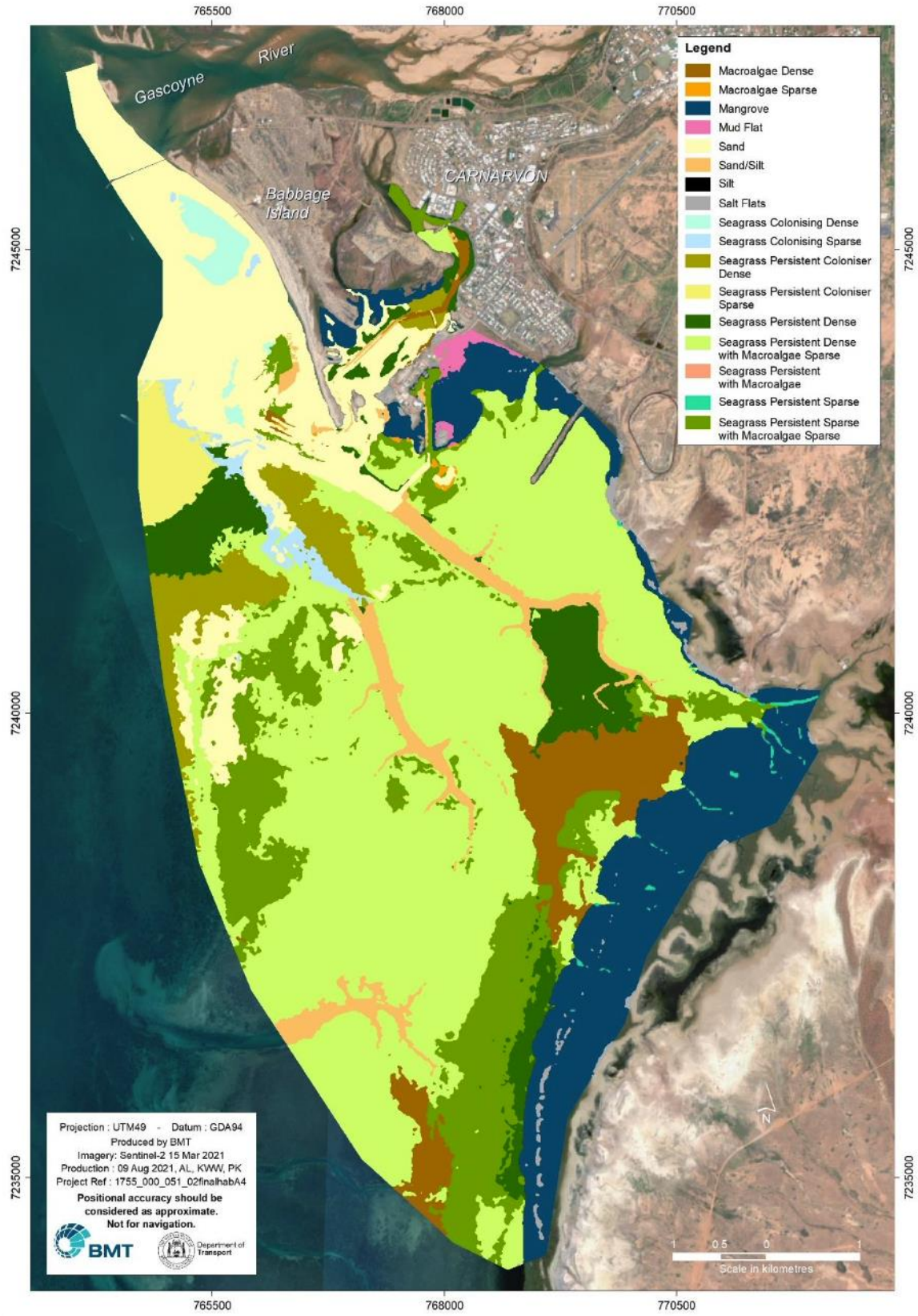
Under the Section 38 of the EP Act, a Referral Supporting Document will be required to provide sufficient information for the EPA to assess the Proposal at the referral stage (EPA 2021). The Babbage Island is located near no existing infrastructure and there is minimal disturbance related to human activities in the receiving terrestrial and marine environment (BMT 2023). The distribution and extent of Benthic Communities and Habitat in the Carnarvon Boat Harbour region (including the area of Babbage Island) have been previously mapped in March 2021 for the purposes of Department of Transport's Maintenance Dredging campaigns (BMT 2021). There is a meadow of colonising seagrass present within the expanse of bare sandy habitat offshore from the middle of Babbage Island Spit (Figure 2.4; BMT 2021). However, it may still be a requirement to update the benthic habitat map when proposal is under assessment by DWER (EPA Services) in the referral stage (EPA 2021).

Other relevant legislation that will be considered to assess the key environmental factors and potential sensitive receptors and MNES (DCCEEW 2023) are:

- Commonwealth EPBC Act 1999
- Western Australian BC Act 2016

Under the NT Act, Native Title determination was granted in 2019 to the claimant group Gnulli, Gnulli #2 and Gnulli #3 – Yinggarda, Baiyungu and Thalanyji People (NNTT 2023a). The Determination Area is divided into two geographical areas, being Baiyungu and/ or Thalanyji Area in the north of the Determination Area and the Yinggarda Area in the south of the Determination Area (FCA 2019). Babbage Island is located within the Yinggarda PBC boundary of the Determination Area. The area of land where the site is located (near one mile jetty) falls partly within the Yinggarda Aboriginal Corporation RNTBC boundary (NNTT 2023a). A search of the DPLH ACHIS showed 13 Registered Aboriginal Sites within the 5 km radius from the proposed site (Annex A) and two Register Aboriginal Sites in close proximity (1 km radius) to the proposed site [Site 874 and Site 39200] (DPLH 2023a).

On 1 July 2023, the ACH Act replaced the AHA Act which provides stronger protection to and greater involvement of Aboriginal people in Aboriginal Cultural Heritage (DPLH 2023b). The ACH Act establishes a new system which will replace the existing Section 18 process (DPLH 2023b). As described in Figure 2.2 a determination will need to be made whether Tier 1, 2 or 3 approval is required under the ACH Act.



Source: BMT (2021)

Figure 2.4 Distribution and extent of Benthic Communities and Habitat in the Carnarvon region

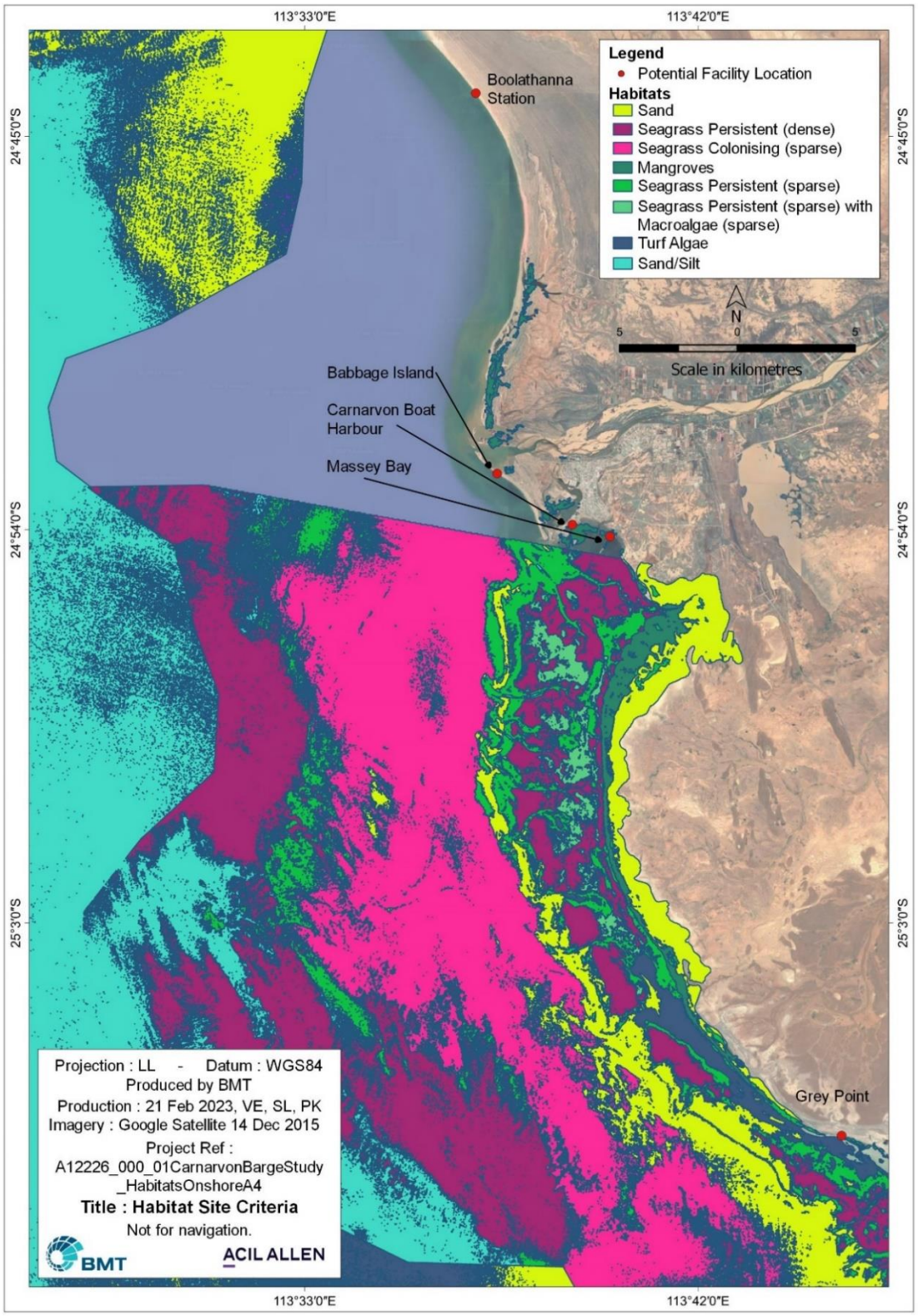


Figure 2.5 Benthic Habitat Map for Potential Onshore Sites (Data extracted from (BMT, 2021) and overlaid on the study area)

Carnarvon Boat Harbour

Carnarvon Boat Harbour is a small harbour located in the town of Carnarvon. It is primarily used for recreational boating, fishing, and tourism. The facilities available at the harbour include boat ramps, jetties, a fuel station, toilets, showers, and a small car park. There are also several commercial fishing boats and a few charter boats operating from the harbour. The harbour is surrounded by restaurants, cafes, and shops, making it a popular spot for tourism.

Access to the Boat harbour is via Teggs Channel (design depth of -3.5 m CD and 40 m width) into the Access Channel (design depth -3 m CD and 30 m wide). Some dredging would be required to expand this channel and the boat harbour to allow for access and manoeuvrability of larger width vessels. Surrounding the harbour and access channel is mangroves limiting the area available for future development. Suitable undeveloped land around the harbour is limited, and the construction of a barge loading facility would need to be carefully planned to avoid impacting other harbour users or infringing on sensitive environmental areas. This could limit the size of the facility and its potential throughput capacity.

The land-based access is via the township of Carnarvon which would require community consultation on the effect of transporting exports (increased traffic) through the town to the Boat Harbour. Transporting ore to the harbour would require significant investment in maintenance of current transport infrastructure, and the added cost of transportation could make the site less attractive to potential customers.

Carnarvon Boat Harbour and Teggs Channel is periodically dredged as part of DoT's Maintenance Dredging Program. Therefore, this area has significantly more data available including annual survey depths, geotechnical boreholes and previously submitted environmental approvals. This knowledge would limit the additional studies required before detailed design of the facility could proceed.

Under the Section 38 of the EP Act, a Referral Supporting Document will be required to provide sufficient information for the EPA to assess the Proposal at the referral stage (EPA 2021). The distribution and extent of Benthic Communities and Habitat in the Carnarvon Boat Harbour region have been previously mapped in March 2021 for the purposes of Department of Transport’s Maintenance Dredging campaigns (BMT 2021). The Boat Harbour and Entrance Channel seabed comprise of primarily of bare sands and silt, and sparse persistent seagrass and macroalgae (BMT 2021). Mangroves dominate the intertidal zone and cover is particularly extensive along the coastal fringes (Figure 2.4; BMT 2021). Mud flats and *Sarcocornia* spp. samphire salt flats were identified closer to Carnarvon town site (LEC 1990, DALSE & JFA 2003, BMT 2021), and are only inundated during high spring tides. Grazing molluscs (*Cerithid* sp. and *Terebralia* sp.) inhabit the base of mangroves (LEC 1990). However, it may still be a requirement to update the benthic habitat map when proposal is under assessment by DWER (EPA Services) in the referral stage (EPA 2021).

Other relevant legislation that will be considered to assess the key environmental factors and potential sensitive receptors and MNES (DCCEEW 2023) are:

- Commonwealth EPBC Act 1999
- Western Australian BC Act 2016

Under the NT Act, Native Title determination was granted in 2019 to the claimant group Gnulli, Gnulli #2 and Gnulli #3 – Yinggarda, Baiyungu and Thalanyji People (NNTT 2023a). The Determination Area is divided into two geographical areas, being Baiyungu and/ or Thalanyji Area in the north of the Determination Area and the Yinggarda Area in the south of the Determination Area (FCA 2019). Carnarvon Boat Harbour is located in the Yinggarda boundary (south of the Determination Area). A search of the DPLH ACHIS showed 14 Registered Aboriginal Sites within the 5 km radius from the proposed site (Annex A) and no Registered Aboriginal Sites within close proximity (1 km radius) to the proposed site (DPLH 2023a).

On 1 July 2023, the ACH Act replaced the AHA Act which provides stronger protection to and greater involvement of Aboriginal people in Aboriginal Cultural Heritage (DPLH 2023b). The ACH Act establishes a new system which will replace the existing Section 18 process (DPLH 2023b). As described in Figure 2.2 a determination will need to be made whether Tier 1, 2 or 3 approval is required under the ACH Act.

Massey Bay

Massey Bay is located approximately 10 km to the south of Carnarvon. Massey Bay is known for its sandy beaches, clear waters, and great fishing spots. The bay is also home to a variety of marine life, including dolphins, turtles, and whales, and is a popular tourist destination for snorkelling and diving.

The existing bed elevations and controlling depths within the Massey Bay proposed Facility area currently does not provide sufficient navigational water depth to achieve planned vessel production targets. To allow sufficient navigation across these shallow areas significant dredging would be required to make the site viable, which could be both costly and time consuming. Dredging approvals will also be required to lower the bed elevations to a target depth of -4 m LAT. This area is susceptible to sedimentation and therefore large maintenance costs would be required to maintain the required channel width and depth.

The area has a groin which extends 1 km off the coast with approximately 50 m in available width onshore. There are minor tracks extending to the end of this area towards a historic rubbish dump. It is proposed to place the Facility at the end of this spit and the stockpile locations would be placed further northeast behind the mangrove. The land is unallocated crown land, and the area has a pending miscellaneous license with Stratland Investments Pty Ltd, potential tenure discussions may be required if this licence is approved.

Land base access is via Massey Bay Drive which connects to Carnarvon Road to the south of Carnarvon Township. There is currently no infrastructure in the immediate surrounding area and therefore significant front-end capital would be required. This site would require conveyor infrastructure to allow for transportation of large volumes of export material along the rock groin. Carnarvon Airport is approximately 2 km away and the area provides some possibility for future expansion of the facility, though substantial dredging of the area would be required.

The area is protected from large south/south-west wave conditions; however, the site is located in an area that is prone to cyclones and heavy weather conditions, which could significantly disrupt operations. Barges may not be able to operate safely during these periods, leading to delays and increased costs. In addition, severe weather conditions could damage the loading infrastructure, requiring expensive repairs.

Soft clays are expected to be present within the prospective dredged approach channel and basin area. This material is too weak to be used as fill and will need to be disposed. Underlying stiff clays and sand layers are more suitable for beneficial reuse as general fill across the site and for bund walls around any settlement basins that may be required. Potential Acid Sulphate Soils (ASS) may be present (BMT 2023).

Under the Section 38 of the EP Act, a Referral Supporting Document will be required to provide sufficient information for the EPA to assess the Proposal at the referral stage (EPA 2021). The distribution and extent of Benthic Communities and Habitat in the Carnarvon Boat Harbour region (including the area of Massey Bay) have been previously mapped in March 2021 for the purposes of Department of Transport's Maintenance Dredging campaigns (BMT 2021). The benthic habitat adjacent to Massey Bay consisted primarily of persistent dense seagrass meadows with small patches of sparse macroalgae present (Figure 2.4). However, it may still be a requirement to update the benthic habitat map, as well as other technical reports, when the proposal is under assessment by DWER (EPA services) in the referral stage.

Other relevant legislation that will be considered to assess the key environmental factors and potential sensitive receptors and MNES are:

- Commonwealth EPBC Act 1999
- Western Australian BC Act 2016

Under NT Act, Native Title determination was granted in 2019 to the claimant group Gnulli, Gnulli #2 and Gnulli #3 – Yinggarda, Baiyungu and Thalanyji People (NNTT 2023a). The Determination Area is divided into two geographical areas, being Baiyungu and/ or Thalanyji Area in the north of the Determination Area and the Yinggarda Area in the south of the Determination Area (FCA 2019). Massey Bay is located within the Yinggarda PBC boundary of the Determination Area. There are parts of Massey Bay near the proposed site within the Yinggarda Aboriginal Corporation RNTBC boundary. A search of the DPLH ACHIS showed 13 Registered Aboriginal Sites (Annex A) within the 5 km radius from the proposed site and two Registered Aboriginal Sites [Site 874 and Site 39200] in close proximity (1 km radius) to the proposed site (DPLH 2023a).

On 1 July 2023, the ACH Act replaced the AHA Act which provides stronger protection to and greater involvement of Aboriginal people in Aboriginal Cultural Heritage (DPLH 2023b). The ACH Act establishes a new system which will replace the existing Section 18 process (DPLH 2023b). As described in Figure 2.2 a determination will need to be made whether Tier 1, 2 or 3 approval is required under the ACH Act.

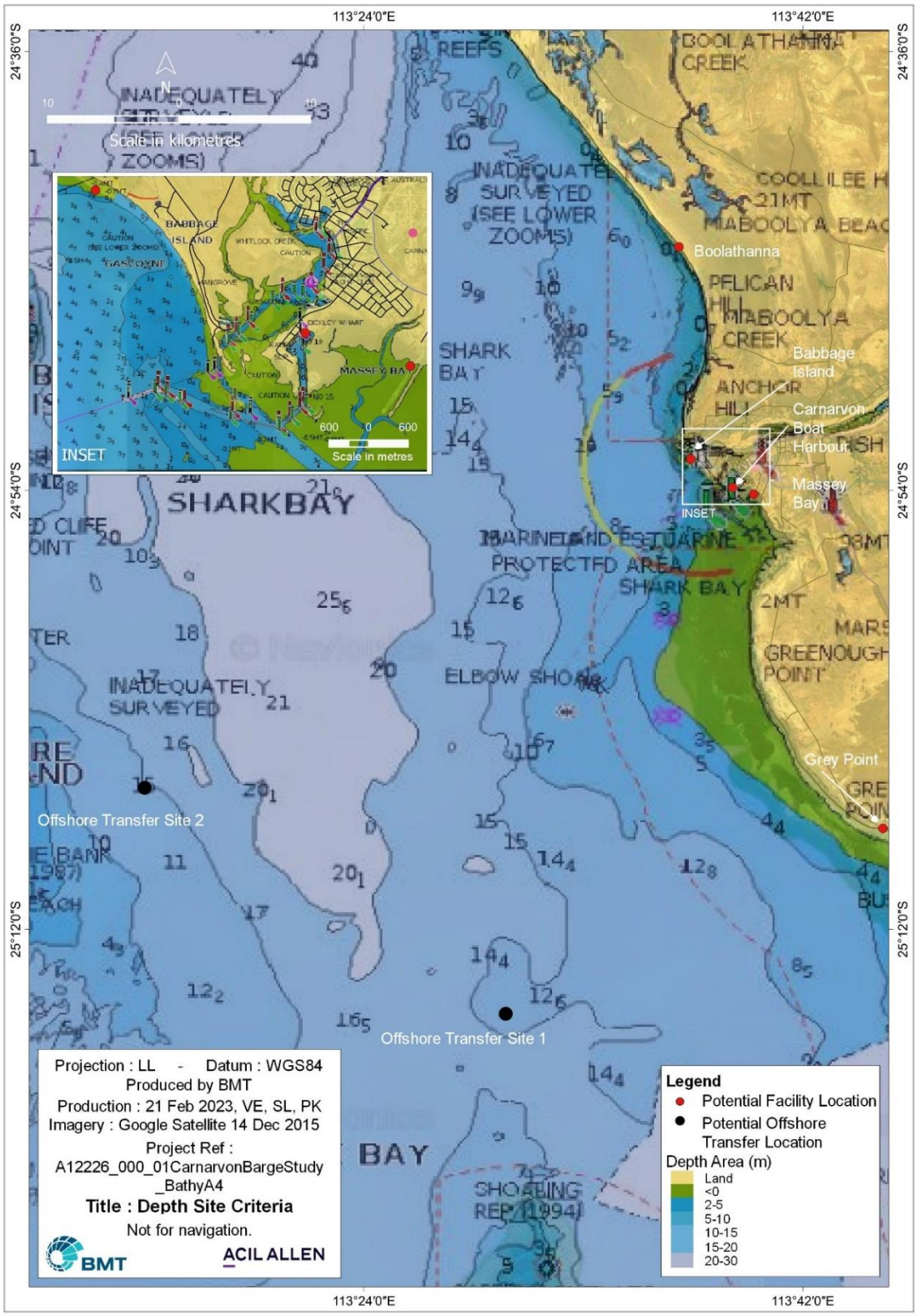


Figure 2.6 Depth Site Criteria for Onshore Sites (Data extracted from (Navionics, Chart Viewer, 2023) and overlaid on the sites)

Grey Point

Grey Point is situated 30km south of Carnarvon townsite and is accessible by the North West Coastal Highway and then via several tracks using a four-wheel drive vehicle. It is characterised by sandy beaches, dunes and rocky outcrops. It is a popular tourist spot for fishing, swimming and snorkelling. There is limited infrastructure in the area with just a small car park area, public toilet and picnic area. The current access could make it difficult to transport equipment and personnel to and from the site. Limited road access could result in delays, increased transportation costs, and potentially hazardous conditions for personnel. Significant front end costs would be required to build suitable infrastructure for larger vehicles to access the site. Grey Point is a relatively remote location, which could limit access to essential infrastructure, such as power and water. This could also result in increased operational costs.

Grey Point is relatively shallow, with approximate depths of ~5m extending 3 km offshore and then gradual increase in depth to 12 m approximately 14 km offshore. Significant dredging would be required to provide a channel and basin for barge access and manoeuvrability. The area around Grey Point is known for its high winds and wave conditions, particularly during the winter months. Also, the possibility for cyclonic conditions during the summer months. It is slightly protected from the southerly wave conditions from Shark Bay; however, the location is still exposed to high wind conditions. These conditions could make it unsafe to operate barges and potentially result in equipment damage and hazardous conditions for personnel. The area has potential for future development both landside and on the coast, although substantial dredging would be required to expand the facilities capabilities. It is also noted that the surrounding area is limestone, dominantly aeolian calcarenite and siliciclastic sandstone (BMT 2023).

The land is part of a pastoral lease under the name Brick House. The Brick House Pastoral lease is a large grazing property covering an area of approximately 495,000 hectares (1.2 million acres). The Brick House Pastoral lease is owned by the Indigenous Land Corporation (ILC), which is a Commonwealth Government agency that works to support the economic and social development of Indigenous communities through land acquisition and management. The ILC acquired the lease in 1998 as part of its efforts to support Indigenous participation in the pastoral industry and promote sustainable land management practices. Today, the Brick House Pastoral lease is operated by the ILC and managed by Indigenous rangers from the local Wilunyu community. The lease is used for a range of activities, including grazing, conservation and land management, and cultural activities. Discussions with the ILC would be required to arrange use of the coastline.

Under the Section 38 of the EP Act, a Referral Supporting Document will be required to provide sufficient information for the EPA to assess the Proposal at the referral stage (EPA 2021). Grey Point is located near no existing infrastructure and there is currently minimal disturbance related to human activities in the receiving terrestrial and marine environment (BMT 2023). Baseline surveys and technical studies would be required before the commencement of a Section 38 Referral Supporting Document (EPA 2021). The satellite imagery indicated that the benthic habitat adjacent to Grey Point is predominately comprised of turf algae and sparse patches of persistent seagrass increasingly more dense offshore (Figure 2.5).

Grey Point area is located in the Wooramel Special Purpose Zone (seagrass protection) of the Shark Bay Marine Park (DBCA 2018). The proposal site at Grey Point is located within the Shark Bay Marine Park that is managed by Department Biodiversity Conservation Attractions (DBCA) under the *Conservation and Land Management Act 1984* (CALM Act). A Regulation 4 Lawful Authority (Reg4LA) application is required to authorise a person to undertake or perform an activity in CALM waters. The Reg4LA application requires details of the location in which the Activity will occur, including name of DBCA Marine Park, DBCA district and the purpose and duration of the proposed activity. The Reg4LA application is required to be supported by environmental documentation outlining the proposed Activity and potential environmental impacts and a monitoring and management framework to mitigate the risks to marine park values. There is no statutory timeframe for turnaround of applications/amendments, and it is likely the DBCA assessment timeline for an approval to the Reg4LA and supporting environmental management plan would be ~1–2 years. This timing is based on previous experience and consideration that the approval is also subject to assessment by the Conservation and Parks Commission, a senior body cooperate established under the CALM Act to assess complex Activity's occurring with marine parks.

Other relevant legislation that will be considered to assess the key environmental factors and potential sensitive receptors and MNES (DCCEEW 2023) are:

- Commonwealth EPBC Act 1999
- Western Australian BC Act 2016

Under NT Act, Native Title determination was granted in 2019 to the claimant group Gnulli, Gnulli #2 and Gnulli #3 – Yinggarda, Baiyungu and Thalanyji People (NNTT 2023a). The Determination Area is divided into two geographical areas, being Baiyungu and/ or Thalanyji Area in the north of the Determination Area and the Yinggarda Area in the south of the Determination Area (FCA 2019). Grey Point is located within the Yinggarda PBC boundary of the Determination Area. A search of the DPLH ACHIS showed that there is no Registered Aboriginal Sites within the 5 km radius from the proposed site (DPLH 2023a). Grey Point is located inside the Brickhouse and Yinggarda Aboriginal Corporation Indigenous Land Use Agreement (ILUA) (Tribunal No. WI2021/003; NNTT 2023b). The ILUA covers ~2,196 km^2 of the Brickhouse pastoral lease and binds the following parties: Forrest and Forrest Pty Ltd and Yinggarda Aboriginal Corporation RNTBC (NNTT 2023b).

On 1 July 2023, the ACH Act replaced the AHA Act which provides stronger protection to and greater involvement of Aboriginal people in Aboriginal Cultural Heritage (DPLH 2023b). The ACH Act establishes a new system which will replace the existing Section 18 process (DPLH 2023b). As described in Figure 2.2 a determination will need to be made whether Tier 1, 2 or 3 approval is required under the ACH Act.

2.3.2 Site Summary

Table 2.2 presents a summary of the information provided in this technical note based on the assessed criteria at each site.

Table 2.2 Criteria summary of all possible Sites

Criteria	Cape Cuvier	Boolatharna	Babbage Island	Carnarvon boat Harbour	Massey Bay	Grey Point
Tenure and Land Type	**	✓	*	**	✓	*
Existing Infrastructure	✓	✖	✓	✓	✖	✖
Bathymetry	✓	**	**	**	✓	✓
Metocean conditions	***	✓	✓	✓	✓	✓
Coastal processes	✓	✓	✖	✖	✓	✓
Geotechnical	✓	✓	**	✖	✓	✓
Environmental	✓	✓	*	**	***	✖
Heritage	✓	✓	**	✓	✓	***
Regulatory Pathways and Requirements	✓	**	?	✓	**	***
Potential for Future Development	✓	✓	✓	✖	✖	✓

✓ Meets Requirement ✖ Does not meet requirement * Possible minor issues **Possible medium issues ***Possible severe issues (defined by approval process complexity)

2.4 Offshore Transhipment Sites Overview

2.4.1 Potential Sites

A fatal flaw assessment of the Southern and Northern offshore transhipment locations for barge shipments (see Figure 2.7) involved identifying the potential risks and hazards associated with the site and determining whether they pose a significant threat to the safety of personnel, equipment and/or the environment.

Option 1 (Southern)
For the Southern Option location (see Figure 2.7) the following factors were identified:

- Water depth: The depth at the southern option is approximately 14 m which is deemed suitable for this initial assessment. Specific vessel dimensions are required to determine if the water depth at the transhipment location is insufficient.
- Weather conditions: This offshore transhipment location is protected from the harsh weather conditions of the region as it sits north-east of Cape Peron in Shark Bay. Thereby minimising the possibility of operations being stood down due to weather. The wave height is approximately ~0.5 m in the extreme south/south-westerly conditions which is suitable for barge operations to function.
- Access: The site is located closest from the onshore facility locations which will decrease transit times. It is located furthest from the access into Shark Bay which will increase the transit time of the vessel into the offshore transhipment point (OTP). If the OTP is difficult to access, it can lead to delays in cargo transfer, increased transportation costs, and potentially hazardous conditions for personnel.
- Mooring facilities: If the OTP lacks adequate mooring facilities, it can make it difficult to safely dock and secure the barge. This can lead to equipment damage, cargo loss, and potentially hazardous conditions for personnel. Mooring facilities will need to be designed at the concept design stage.
- Environmental risks: The OTP is located in environmentally sensitive areas and surrounded by benthic habitat including dense patches of seagrass. The initial desktop study deemed the risk of impacts to the surrounding environment to be high (BMT 2023). It should be noted that a proposal of this complexity is expected to potentially have a significant impact on the environment and will be referred to the DWER – EPA services for a determination regarding formal assessment under the EP Act (EPA 2021).

Option 2 (Northern)
For the Northern Option location (see Figure 2.7) the following factors were identified:

- Water depth: The depth at the northern option is approximately 15 m which is deemed suitable for this initial assessment. Specific vessel dimensions are required to determine if the water depth at the transhipment location is insufficient.
- Weather conditions: This offshore transhipment location is partially open to the harsh weather conditions of the region as it sits 15 km east of Dorre Island. There is the possibility of operations being stood down due to weather. The wave height is approximately ~0.75 m in the extreme south/south-westerly conditions which is at the maximum range suitable for barge operations to function. This increase in wave height is due to the diffraction through the stretch of ocean between Bernier and Dorre Islands.

- Access: The site is located farthest away from the onshore facility locations which will increase transit times. It is located closest to the access into Shark Bay which will increase the transit time of the vessel into the offshore transhipment point (OTP). If the OTP is difficult to access, it can lead to delays in cargo transfer, increased transportation costs, and potentially hazardous conditions for personnel.
- Mooring facilities: If the OTP lacks adequate mooring facilities, it can make it difficult to safely dock and secure the barge. This can lead to equipment damage, cargo loss, and potentially hazardous conditions for personnel. Mooring facilities will need to be designed at the concept design stage.
- Environmental risks: The OTP is located in an environmentally sensitive area and surrounded by benthic habitat including dense patches of seagrass. The initial desktop study deemed the risk of impacts to the surrounding environment to be high (BMT 2023). It should be noted that a proposal of this complexity is expected to potentially have a significant impact on the environment and will be referred to the DWER – EPA services for determination regarding formal assessment under Section 38 of the EP Act (EPA 2021).

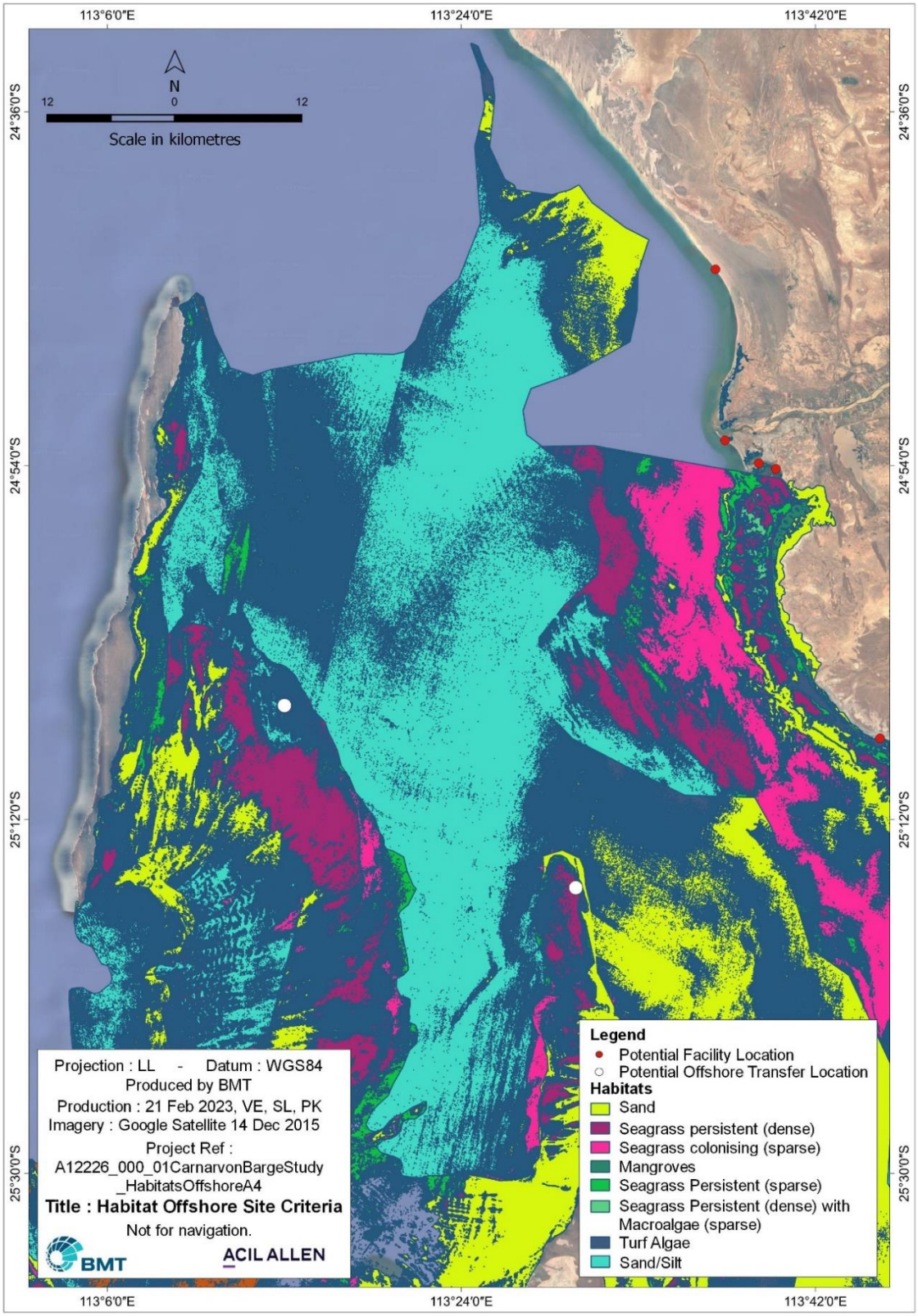


Figure 2.7 Benthic Habitat Map for Potential Offshore Sites, white points depict potential Northern and Southern Offshore Options. (Data extracted from (BMT, 2021) and overlaid on the study area)

2.4.2 Site Summary

Table 2.3 presents a summary of the information provided in this technical note based on the assessed criteria at each offshore transfer site.

Table 2.3 Summary of Offshore Transfer Location Options

Criteria	Option 1 (Southern)	Option 2 (Northern)
Bathymetry	✓	✓
Habitat	**	**
Transfer Distance	✓	✓
Met-ocean Conditions	✓	*

(Meets Requirement (Does not meet requirement * Possible minor issues **Possible medium issues ***Possible severe issues.

The decision regarding which offshore transfer site will be based on which onshore location is chosen.

3 Technical Inputs and Handling Methods

3.1 Introduction

3.1.1 Project Scope

In October 2022, BMT (together with Acil Allen) was appointed by the Gascoyne Development Commission (GDC) to perform a pre-feasibility study assessing viable options for a barge loading facility (BLF) to service Carnarvon and the associated Region.

3.1.2 Background

The Gascoyne region is Western Australia's regional development area encompassing the northwest cape of the State. It is Western Australia's smallest region from both an economic output and population perspective, but hosts significant land, renewable energy, minerals, energy, and other natural resources.

In recent years there has been an increase in private sector interest in the Gascoyne, on account of its natural and renewable resources, proximity to key trading partners, and close co-location with the Pilbara and Mid-West regions to the northeast and south respectively. These projects include mineral sands, renewable energy, agriculture, and tourism developments, among others. In addition, existing businesses have identified opportunities for growth and expansion through tapping into export markets to the north.

One of the most significant barriers to the growth and development of Carnarvon, the broader Gascoyne region, and extending into the western parts of the Pilbara region, is access to reliable, cost-effective marine infrastructure to facilitate the movement of goods into and out of the region.

3.1.3 Document Purpose

Stakeholder engagement is lead by ACIL Allen. BMT has been included in the stakeholder engagement process in both preparation and execution, ensuring technical aspects of proposed projects are ascertained. This document summarises stakeholder needs from a technical perspective, deducing an appropriate or likely handling method for the identified trade requirement and defining the likely required infrastructure to support the facility function.

The document concludes likely vessels, cranage and infrastructure requirements for the identified trade needs, based on proponent supplied information, BMT experience and other interested parties such as Transhipping Services Australia (TSA), who could potentially be involved as a barge shipment operator.

3.2 Trades Technical Requirements

3.2.1 Process

The current stakeholder engagement is focused on a barge loading facility only. A number of proponents advised that their plans would require the construction of a larger facility in the region to support the development and offloading or export of goods. The identified trade options continue up to where a barge loading facility would be beneficial to the proponents use.

3.3 Technical summary

Details	Renewable Energy Component Import	Sand Mining	Rare Earths Mining
Pathway	Import	Export	Export
Product	Windfarm components	Construction sand and aggregates	Rare earth ore
Volume	Up to 1000 turbines total	1 Million tonnes per annum	30,000-50,000 tonnes
Method	Break bulk lifting	Bulk material handling	Break bulk; placed in custom containers with radiation protection
Transfer at OGV	Crane off OGV	Hydraulic clamp bucket lift - crane on OGV	Crane off OGV
Transfer at quayside	Crane on Quayside	Shiploader, fixed or mobile/dump method	Crane on Quayside
Weight/density	50t – 105t (individual component)	1.7t/m^2	20ft or 40ft containers - extra weight for radiation protection
Size of items	Up to 90m in length	Granular (less than 4mm)	-

3.4 Typical Handling Techniques

3.4.1 Barge options

A number of barge vessels are available for use on transhipment projects. Additional functionality can be incorporated to increase operability figures, reduce loading time and make use of smaller weather windows. The additional functionality of course comes with additional CAPEX and OPEX requirements. As such, the suitability of the barge and its function depend upon the overall volume of trade, vessel sizing.

Whilst a detailed logistics study would be required to derive the optimum solution, local site conditions identified within the desktop study can be combined with typical or reference case projects to guide or identify the likely best method and provide initial concept definition.

The following subsections include a range of available barging options, increasing in functionality and associated costs.

Flat top (dumb barge)

Flat top barge is the lowest CAPEX option, with numerous barges available to be adapted to project needs. Flat top barges are available in a range of sizes, generally up to 100m in length. Depending on wind conditions at transhipment location and the property of the material, dust dispersion/emissions for the flat top barge may trigger some environmental concerns. Tug assistance is required to move a dumb barge.

Figure 3.1 Flat-top barge (https://www.fodico.com.au/wb3/)

Hopper barge

Hopper barges are specifically designed for the transport of bulk material. Due to the shape of the hull and in-built hopper, additional volume can be transferred in comparison to a flat top barge. These

barges are available with or without self-propulsion. In the case they are self-propelled, the need for tug assistance can be avoided.

Figure 3.2 Split hopper barge (Spanopoulos Group)

Contained/closed-top barge

The hatch of some hoppers can be closed by use of mechanical equipment after loading. Other closed-top barges have a relatively small hopper feed in conjunction with an internal loading system which has the capability of distributing the load evenly on the hold using a conveyor or a gantry system. This type of transhipper categorises as single point loading which does not need warping along the berth for loading.

Self-unloading barge (SUB)

Self-unloading barges include an unloading system to extract and transfer bulk material from the deck or hopper. These systems themselves range in complexity and transfer rate and can include bucketwheels and conveyors.

Self-unloading vessels reduce transfer and turnaround times which can reduce overall delivered cost

per tonne and labour expenses, although higher upfront costs are incurred. A self-unloading barge is not suited to large/complex transfers such as windfarm components.

Figure 3.3 Self-unloading barge (CSL Ships)

Self-propelled, self-unloading

The most complex option would be a self-propelled, self-unloading barge. This option would also require the highest level of CAPEX, with the vessel likely to be custom designed and constructed for the project.

3.4.2 Bulk materials handling

A number of options are available for the transfer of bulk material through a maritime facility for both import and export. Conveyors and mechanical systems such as ship loaders exist in a range of sizes and applications, some of which are bespoke to the project, in addition to other small-scale options which can be deployed to site as mobile units. Barge unloaders can be continuous, such as a conveyor/stacker and reclaimer system; or intermittent, such as a mechanical grab. Clamshell grabs are commonly used for transferring loose materials such as sand, and have reduced production rates.

Figure 3.4 Shiploader for sand (https://solidground.sandvik/shiploader-safety/)

Figure 3.5 Grab bucket unloader (Richmond Engineering)

3.4.3 Break bulk handling

Break bulk goods or containerised goods are typically handled via crane. Cranes can be quayside, either mobile or fixed; as well as floating or attached to a vessel. Crane operations are limited by the crane's reach, and environmental conditions at site. Larger structures may be transferred through roll-on, roll-off (RO-RO) methods however, these would not be typically suited to a barge facility as the depth requirement would typically increase for such operations.

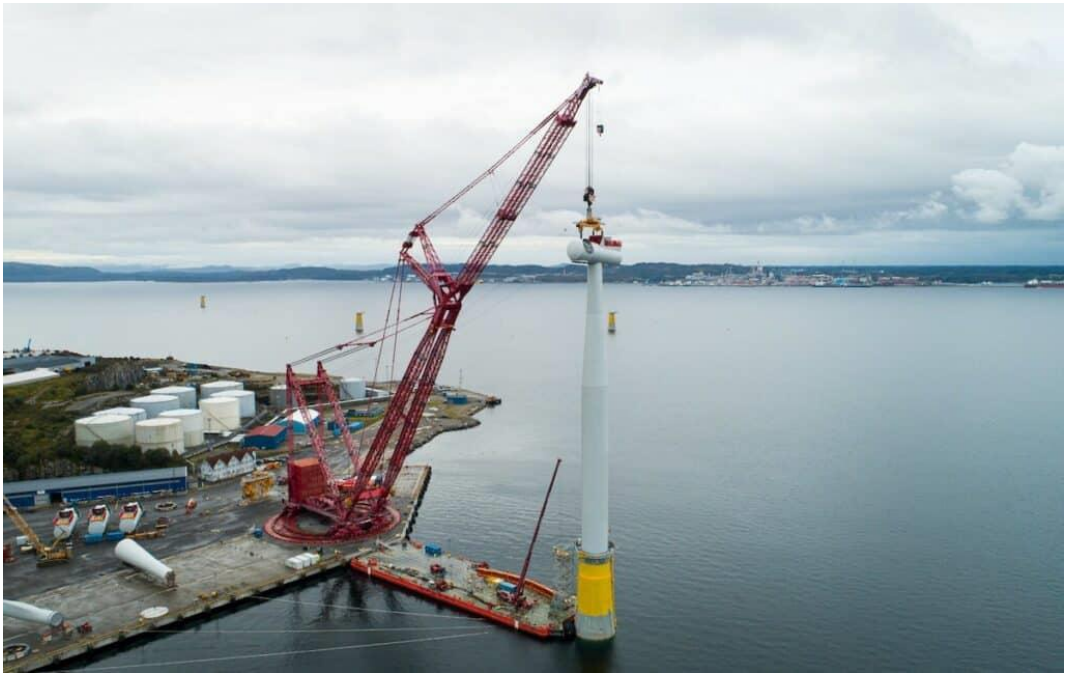


Figure 3.6 Quayside crane (https://www.cranesandlifting.com.au)

3.5 Sand Mining (Export)

3.5.1 Project description

In initiation of this study, sand mining proponents had been in discussion with a number of potential purchasers of product in South-East Asia, particularly in Singapore. The product of the Gascoyne river mining leases contributes to beneficial structural or mechanical properties when utilised as part of a concrete mix. The resulting early strengths reached are particularly beneficial to the construction of high-rise buildings. Some locations have also experienced a supply shortage of construction sand, leading them to seek alternatives, such as the importation of sand.

Two sand mining proponents were contacted through the stakeholder engagement, Tremor and Cauldron Energy. Feedback included specific trade details in terms of material volume and properties, which is outlined in the following subsections.

3.6 Specific Trade requirements

Item	Value	Notes
Product	Fine Aggregate River Sand	
Weight/Density	1.8 t/m^2	
Volume	1 million tonnes per annum	Per proponent
Maximum loading rate	850 t/h	

3.6.1 Identified handling method

Transport to site

Delivery to the facility would be via road haulage. With the majority of roads in the Carnarvon region being suitable for heavy haulage, it is envisaged that only a small CAPEX would be required to enable road haulage. Sand could be dumped directly from road haulage via side tipping mechanism.

Figure 3.7 Side dump truck

Stockpile requirements

For this fairly low value, high volume product, it is anticipated a stockpile would be required for efficient transfer to the OGV when needed. Some losses of stockpile volume may occur due to wind driven erosion between the export events. Earthmoving equipment, such as dozers/excavators or loaders may be required, as well as a dust suppression or stabilisation system (water spraying).

Sand mining proponents have indicated that approximately 60,0000 tonnes capacity stockpile would be required. This would cover a footprint of approximately 10,000m^2.

Figure 3.8 Stockpile conveyor (Superior Ind)

Quayside infrastructure

To minimise losses and increase transfer rates, it is envisaged that some form of ship loader would ideally be utilised. Due to the low volume of production per annum, it is likely that a low-cost mobile conveyor or a radial loader (no travelling or luffing) would be well suited.

Mobile transfer conveyors, often referred to as grasshopper conveyors are not typically material specific and may be acquired through a mining equipment service provider.

Figure 3.9 Grasshopper conveyor (SKE Industries)

Barge specifics

Such an operation would likely be established with minimal CAPEX. The resulting suitable barge would be a readily available flat top barge, to which a hopper can be welded to the deck. To allow efficient loading of the OGV, it is likely 2 off barges would be required.

Figure 3.10 Damen unrestricted hopper barge (Damen)

Barge specifics:
-Damen Stan Hopper Barge 6016 Unrestricted
-Length of 59.5 metres
-Breadth 16.5 metres
-Depth 4.5 metres

Approximately 8 trips per day required to fulfill the 20000t per day target.

Tug specifics

-Damen ASD Tug 2111
-Length 21m
-Breadth 11.13m
-Draft 4.9m

Figure 3.11 Azimuth 2111 tug (Damen)

Offshore transfer/OGV

-CSL Tawaki- 39,855 DWT Handymax Logs and Grab Fitted Bulk Carrier
-Length 180m
-Breadth 30m
-Draft 15m

Figure 3.12 CSL Tawaki Handymax (CSL)

3.7 Rare Earth Elements (Export)

3.7.1 Project description

Rare earth elements (REE) are becoming increasingly in demand for their unique properties which are utilised in alloys forming part of complex electronics such as computer, phones and batteries. A number of REE exploration lease holders have tenements within the Gascoyne and Mid-West regions. These projects are at various stages of development and some proponents have advised their interest in the use of a facility with an export function. Whilst the product can be transported via road to typical container ports, there are specialist needs for which a dedicated port facility may provide benefit.

3.7.2 Specific Trade requirements

REE is a high value, low volume product. It is typically placed in bulker bags and containerised. It can be calls as hazardous and radioactive, therefore containers are specialised and heavy.

Krakatoa resources provided indication that they would be looking to export 30,000-50,000 tonnes of REE oxide. Assuming fully laden containers and assuming away bulker bag weight, this would be 1,360 (low grade) to 2,270 (high grade) containers a year. With tare weight considered, weight per container would be approximately 40 tonnes.

Figure 3.13 REE containers, usually include concrete for radioactive protection (www.rotainer.com)

3.7.3 Identified handling method

Transport to site

Containers would typically be transported to site via road haulage. Special considerations and permits would be required due to the hazardous nature of the goods.

Laydown area requirements

Due to the hazardous nature of the material it is anticipated that only a small laydown area would be utilised, to avoid radioactive risks quayside. However, to ensure transfer efficiency, at least some laydown are would be required for temporary stacking of containers.

Export frequency would not be limited by OGC size in this case. It is likely export planning would be driven by economic return. As such, it is anticipated a load would be sent approximately every 2 months, totalling around 360 containers per load out. Assuming a portion of the load out would be

delivered directly to site during load out, space for approximately 200 containers is considered. These could be stacked up to 3 high, resulting in a required laydown area of approximately 8,000m^2.

Quayside infrastructure

Craneage would be required at quayside to transfer containers. To increase efficiency, a dedicated container crane or at least a hydraulic lifting tool would be ideally incorporated.

Vessel specifics

Barge:
-80 metre barge
-Containers can be stacked 2 high

Tug :
-Engage Challenger
-Length 27.9m
-Breadth 9m
-Draft 4.7m
-Bollard pull 50t

Figure 3.14 Engage Challenger tug (Engage Marine)

Offshore Transfer/OGV

A geared OGV would be required to transfer the containers, limiting its size to handymax.

-Spliethoff H-Type
-Length 138m
-Breadth 21m
-Cranes 2x 180 mt SWL, 2x 150 mt SWL
-664 TEU

Figure 3.15 Spliethoff H-Type OGV (Spliethoff)

3.7.4 Operability and production

The goods being completely enclosed in containers, plus the nature of the material being robust, operability limits are higher than normal container operations. It can be expected operations could continue up to windage limits of around 25 to 30-knots.

Additional time is required to engage and disengage rigging from the containers both at the quayside and offshore transfer site.

3.8 Onshore Hydrogen Developments (Import)

3.8.1 Project description

The Gascoyne region has been identified as having high capacity for renewable energy production, and has attracted the initial stages of major project development. A barge loading facility has drawn interest from three different proponents to facilitate the development of onshore green hydrogen, solar and wind energy installations, with proposed investments of upwards of $10 billion. The facility would be used to import large components, equipment and materials over a multi-year construction period, as well as enabling the export of green hydrogen during the plant operation phase with a minimum duration of 25 years.

3.8.2 Specific Trade requirements

Construction materials

- Refer to bulk materials section

Accommodation units

Potentially through barge facility and cranes, likely loaded in SW. Otherwise, may be satisfied via road haulage.

3.8.3 Wind farm components

Item	Estimated total weight (kt)	Notes
Tower modules	2988	- Based on 1000 turbines - Heaviest individual component 105t - Longest component 90m
Nacelle modules	90	
Powertrains	105	
Hubs	60	
Blades	120	
Cables	50	
Foundations	50	
Total	4313	

Hydrogen production facility components
Not addressed as part of this study due to the increased weight – not feasible to transfer such items through a barging facility.

3.8.4 Identified handling method

This section discusses wind farm components only, construction materials and accommodation units are considered to be addressed through the previous sections.

Transport to barging location (HLV)
For ocean transport, a heavy lift vessel is required with sufficient capacity to lift components of up to 90m in length and weighing up to 105 tonnes each.

Figure 3.16 Spliethoff SL2-Type HLV (Spliethoff)

Vessel specifics:
- Spliethoff SL2-Type HLV
- Length of 185.40 metres, breadth of 25.30 metres
- 3 x 120mt SWL cranes
- Approximately 150 trips required

Barge specifics

Driven by the 90-metre turbine blade length, a large barge would be required for transportation of components between the shore and ocean-going vessel. Due to the significant size of individual components, multiple trips would be necessary for transportation of the wind farm components. The available deck area for a dumb barge of 90m length would necessitate approximately 600 trips. Trip time is dependent on selected location and limitations due to weather conditions.

-TSA 3002 (dumb barge)
-Length 91.5 metres and breadth 24.4 metres
-Design draft of 4.295 metres
-Approximately 600 trips required to transport all windfarm components, based on component sizing supplied by Vestas and scaled up to a farm size of 1000 turbines.

Figure 3.17 TSA 3002 Barge (Transhipment Services)

Tug specifics

A powerful tug, or series or tugs, would be required to tow the barge and it is anticipated that dredging would be required in some locations to accommodate the tug draft.

- Damen ASD Tug 2811
- 60 t bollard pull
- Draft of 4.65 metres
- Length 28.57metres, breadth 11.43 metres

Figure 3.18 Damen ASD tug 2811 (Damen)

Quayside infrastructure

A quayside crane of 250 tonnes lifting capacity is anticipated for transfer of components between the loading facility and barge, to accommodate for the greatest individual windfarm component weight of 105 tonnes. The crane must have sufficient reach and space underneath for the lifting of large components.

Crane specifics:
-250 Tonne Kobelco CKE2500-2 Crawler Crane
-Maximum boom length 91.4 metres

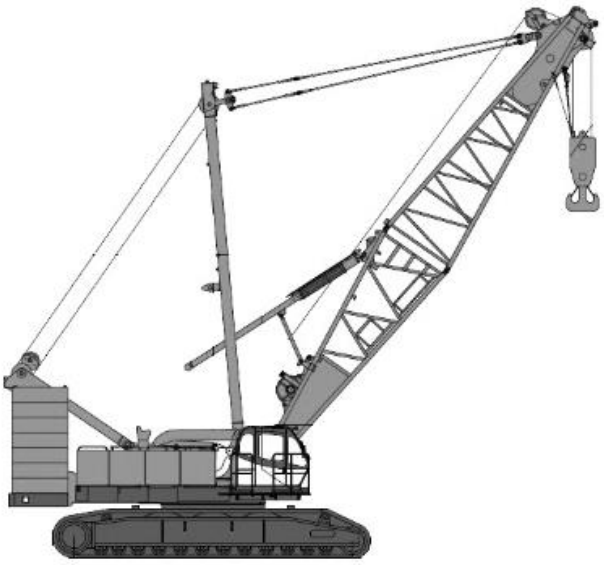


Figure 3.1 (Kobelco Construction Machinery)

Laydown area requirements
A large laydown area would be required for temporary storage of components. It is anticipated that the area would need to accommodate a significant number of components at a time, due to a lengthy road transport process from port to site and a typical turbine erection rate of 1 per week.

Allowing for laydown area accommodating 2 OGV loads worth of components to minimise demurrage charges, the estimated required laydown size is 1 hectare.

Transport to site
Transport to the site would be by road, with relevant permits and escorts required for specialist vehicles. Components for each turbine generally require between 12-14 over-size over-mass (OSOM) deliveries.

Specialist vehicles typically required:

- Book end trailer for large diameter tower components
- Heavy load platform for gearboxes, nacelle, shorter tower segments
- Beam trailer for long tower segments
- Telescopic trailer for blades

Issues with obtaining permits are not envisaged for the main roads, however road upgrades could be required for unsealed roads, and roads with limited width or sharp corners to accommodate oversize vehicles.

3.8.5 Operability or production

To shorten operation times, two barges at a time could be used to load the OGV as it has the capacity to fit approximately 4 barge loads of components per trip.

Quayside crane transfer operations would be constrained by wind speed, particularly when lifting the blades. The current limit placed on lifting a singular blade is a wind speed of 20 knots.

Transfer operations from the barge to OGV are expected to be more wind-limited, with the significant wave height capped at 1 metre for the transfer of containers and other robust components, and 0.75 metres for turbine blades. Fetch distances from the proposed offshore transfer locations to the nearest land in Shark Bay are 96km and 67km for locations 1 and 2 respectively, based on the predominant wind direction (south-westerly). Corresponding wind limits are 12 knots for containers and 10 knots for blades, to remain below the recommended significant wave height limits.

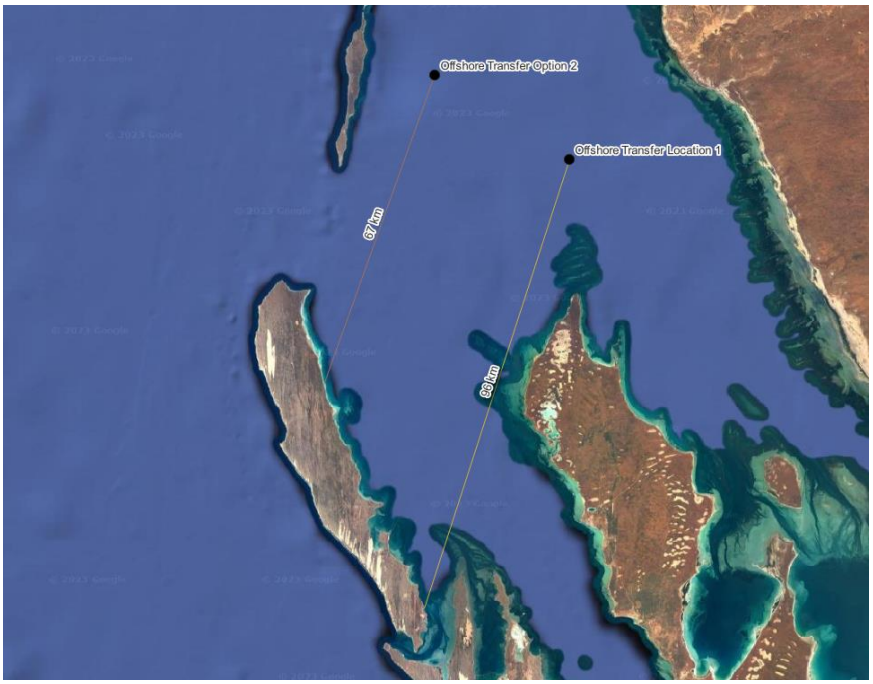


Figure 3.2 Distances to offshore transfer locations

Further Considerations

3.8.6 Cyclone response planning

The desktop review conducted as part of this feasibility study identifies cyclones as a risk to operations. The facility would require the development of a cyclone response plan, containing the necessary precautions to avoid damage to infrastructure.

In terms of onshore infrastructure, this can be covered through securing mechanisms for cranes and cyclone rated protection structure or garage for mobile plant. It would likely be difficult to protect any stockpile against loss during a cyclone.

On the marine side, any barge would likely require cyclone moorings to be established at a location reasonably close to operations. Tugs and smaller vessels may find safe harbour close to Carnarvon or, may have to travel outside of the region to seek protection. Otherwise, protective structures such as break walls should be introduced to mitigate the risk of damage.

4 Site Options Short List

4.1 Background

Acil Allen along with BMT and the steering committee completed the multi criteria assessment (MCA) of the 6 onshore sites with two facility options at each. The MCA provided the following as the top three options:

1. Boolathanna Large Facility (Section 4.2)
2. Boolathanna Small Facility (Section 4.3)
3. Carnarvon Boat Harbour Small Facility (Section 4.4)

All necessary information provided in the initial desktop review (BMT, 2023a) has been compiled for these three options. Design inputs and other assumptions relevant to the two sites have been summarised for use in the initial concept sketches.

4.2 Boolathanna Large Facility Specifics

Boolathanna Station (hereafter; Site 1) is a pastoral lease in Western Australia, located ~16 km from Carnarvon town, in the Pilbara region. The Facility would be located approximately at the point shown in Figure 4.1, with land-based access via an unsealed track off the Great Northern Highway, which passes to the west of the property.

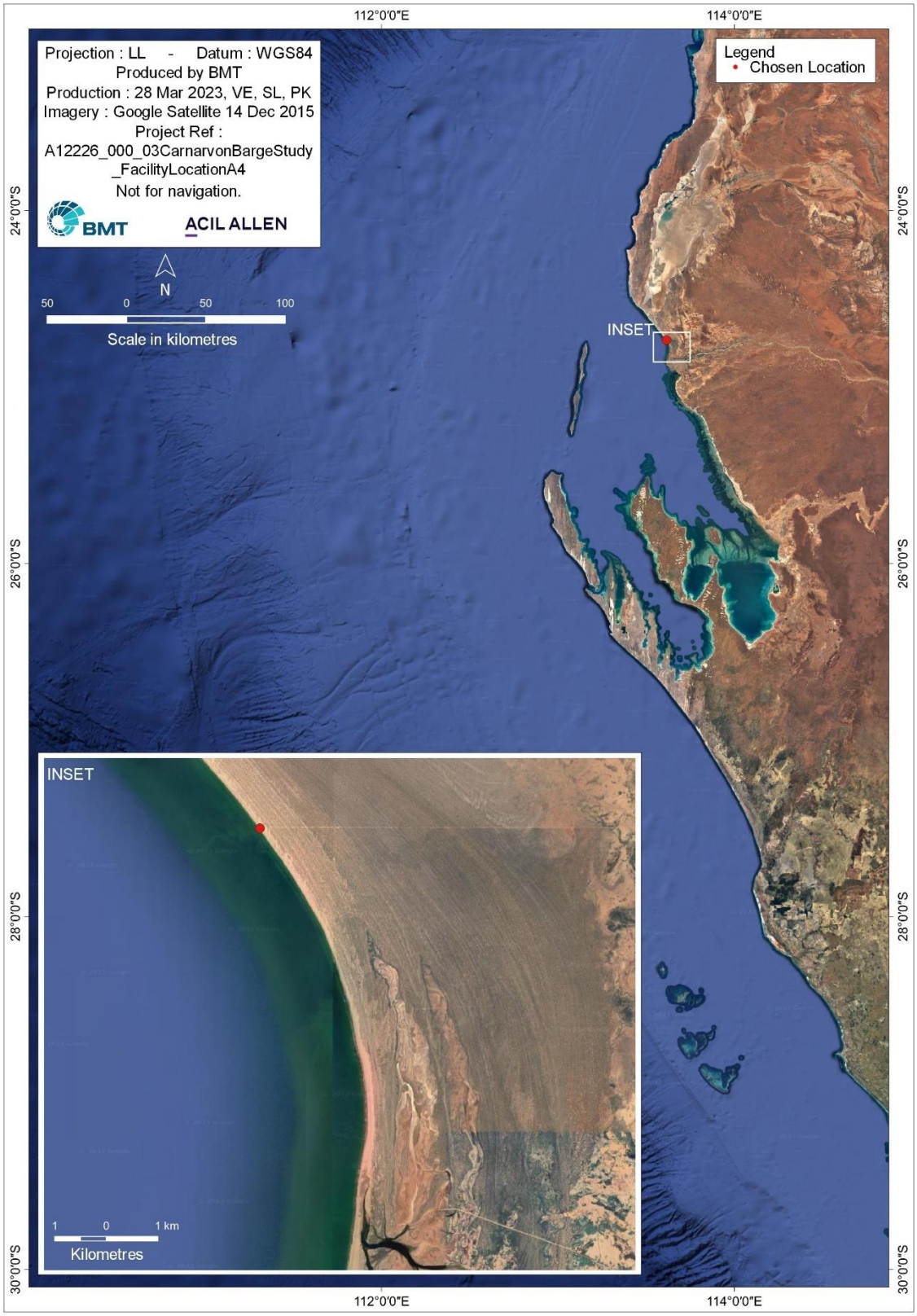


Figure 4.1 Boolathanna Large Facility (Site 1)

4.2.2 Tenure and land type/usage

The land immediately adjacent to the coast is unallocated crown land (UCL). This thin strip (~50 m in width) is land owned by the state government but has not been allocated for any specific purpose (Landgate, 2022). The Department of Planning, Lands and Heritage (DPLH) is responsible for managing UCL and determining its appropriate use. UCL can be leased, sold, or reserved for specific purposes, such as conservation or cultural heritage protection. The process of allocating UCL involves consultation with stakeholders and may involve environmental and cultural heritage assessments. Further inland, Site 1 has Boolathanna Station which is a long-term pastoral lease overseen by DPLH (DPLH 2022). This station is also located in an area ear marked as Land Act Type 2. This refers to a category of land tenure that is used for residential, commercial or industrial purposes. These leases are often used for the development of urban or industrial land, including the construction of buildings and other structures. Further south east there is a regional reserve. Regional reserves are established to protect and manage significant natural and cultural values such as wildlife habitats, biodiversity, geological formations, and areas of cultural importance. These reserves may also be used for recreational activities, such as hiking and camping, as long as they do not compromise the conservation values of the area. Discussions would be required with the current land owners to determine if an arrangement could be made.

4.2.3 Existing infrastructure

Site 1 is a greenfield site with no existing onshore facilities and is characterised by its rugged and natural landscape, with limited infrastructure or urban development nearby. Site 1 is accessible by a dirt access track off Bibbawarra Road, with Carnarvon located approximately 50 km south-east, and has no existing industrial or commercial operations in the vicinity. The location's isolation and lack of existing infrastructure make it an ideal candidate for a barge facility, which could be used to transport goods, materials, and equipment to and from the site. The construction of a barge facility may potentially have limited impacts on the surrounding environment and could provide economic benefits for the local community.

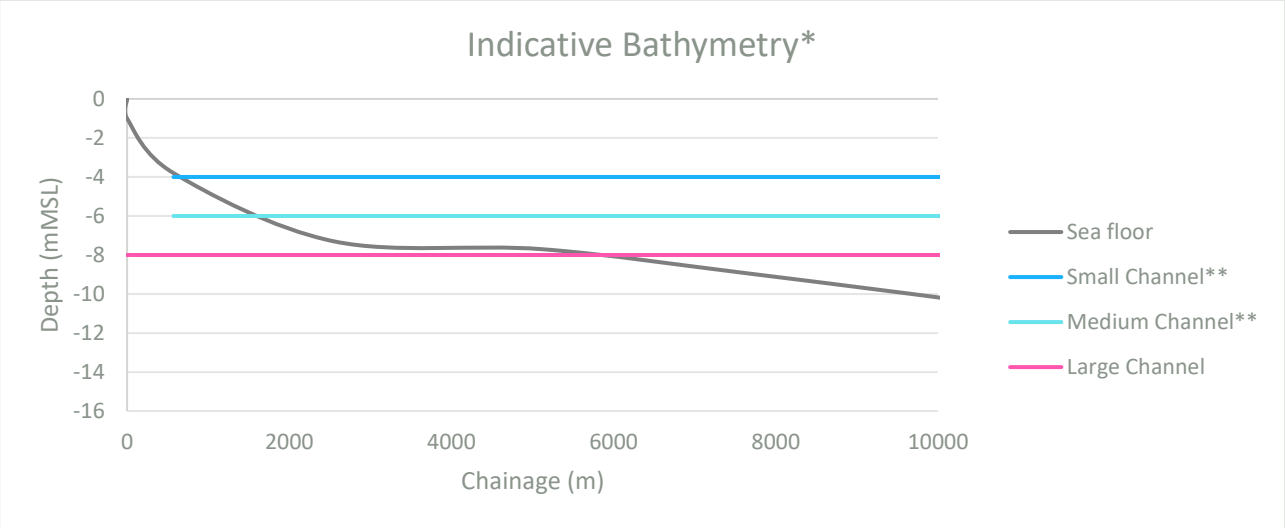
Figure 4.2 Entry to the access track, looking west. (GoogleMaps, 2022)

The Facility would be approximately 16 km from the heavy haulage route already utilised. It is also approximately 41 km (driven route) from the local Carnarvon Airport. There are no marine facilities located there currently. The area is part of the Carnarvon Port Area as dictated by the *Shipping and Pilotage Act 1967*.

4.2.4 Bathymetry and topography

From initial high level site suitability research, it was deemed that the small channel option would require approximately 4 m depth, the medium a depth of 6 m and the large a channel depth of 8 m for the barges to be able to navigate. The area offshore of this location is inadequately surveyed and indicative depths have been used only (Navionics, Chart Viewer, 2023). Further multibeam surveys would need to be completed to obtain accurate depths in the area. There are also no known navigational issues or exclusion zones in this area. Figure 4.3 displays the indicative depth as the crow flies offshore south westerly.

The topography of the area is relatively flat ranging from 11 m from mean sea level (MSL) at the start of the access track to a slope of 0.007 over the last km to MSL the max height is ~14 m MSL. This data is based World Geodetic System 1984 which has a limited accuracy of at best 2 m (GEBCO, 2022).



*Data sourced manually from Navionics showing a profile in a south westerly direction
**Assuming that both the small and medium options include a ~500m long trestle structure offshore and therefore depth required begins from 500m

Figure 4.3 Indicative Bathymetry directly offshore from Site 1

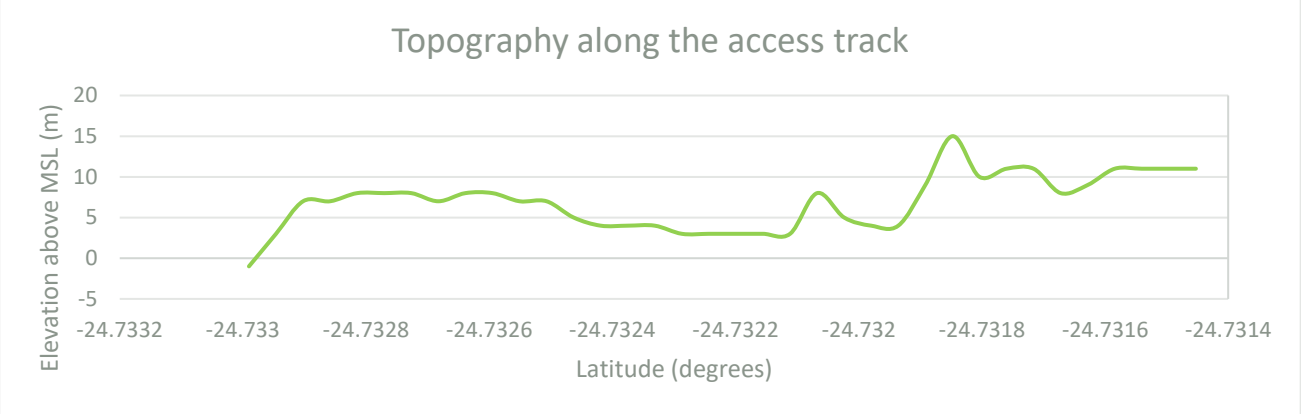


Figure 4.4 Indicative Topography along the access to the Site 1

4.2.5 Metocean conditions and coastal processes

The North Carnarvon coast where site 1 is situated, is in the tropical cyclone belt and is prone to severe storms from November to April. These storms can bring high winds, heavy rainfall, and large waves to the region, causing significant coastal erosion and flooding. Site 1 has not experienced a cyclone

directly with the closest previous episode in 1995 (15 km, Category 4). The region experiences a semi-arid climate with low and highly variable rainfall. The temperature ranges from an average low of 13°C in winter to an average high of 33°C in summer.

The Leeuwin Current is a major oceanic feature off the Western Australian coast, bringing warm tropical waters southward along the coast. The current's strength and temperature can vary seasonally and inter-annually, affecting the coastal water temperature and the distribution of marine species (Feng, Weller, & Hill, 2009). The region is also influenced by the southward flowing Ningaloo Current, which brings cooler waters from the tropics. There is no current open-source water level data in this area. Assuming that the area experiences similar values to Carnarvon Boat Harbour which is 16 km south. Therefore, the area experiences an overall tidal range of ~2 m (LAT to HAT). During the winter months a small increase in mean tidal levels can be seen. The mean tidal level reduces during autumn and increases in summer. The current regime at Carnarvon is predominately tide driven with a significant component from the persistent southerly wind pattern. Currents are likely to be in the order of 1 to 2 knots (AECOM, 2010).

Carnarvon airport is the closest location with weather data, coverage is from December 1993 to May 2022 (at site #006011). Site 1 has a southerly aspect which means it is susceptible to larger wind swell action. The data indicated the wind speed was greater during summer and spring months but demonstrated more directionality during winter. In particular the values from AWCAR01 have significant wave height of ~0.5 m and generally remains below 0.8 m in height and is dominated by wind-sea. The SWAN model shows the diffraction of the waves around the top of Bernier Island and reaching the location normal (west) to shore with influence from swell diffracted through the break in the islands from the south west. The waves are diffracted around the north of the island and the wave height is reduced ~500% (~0.5 m).

Coastal erosion is a significant process that affects the region, primarily driven by storm waves, tides, and sea-level rise. The region's sandy beaches, dunes, and cliffs are continuously reshaped by these processes. Using the DEA coastal mapping software, the coastline at this location has retreated by 0.7 m per year on average since 1988.

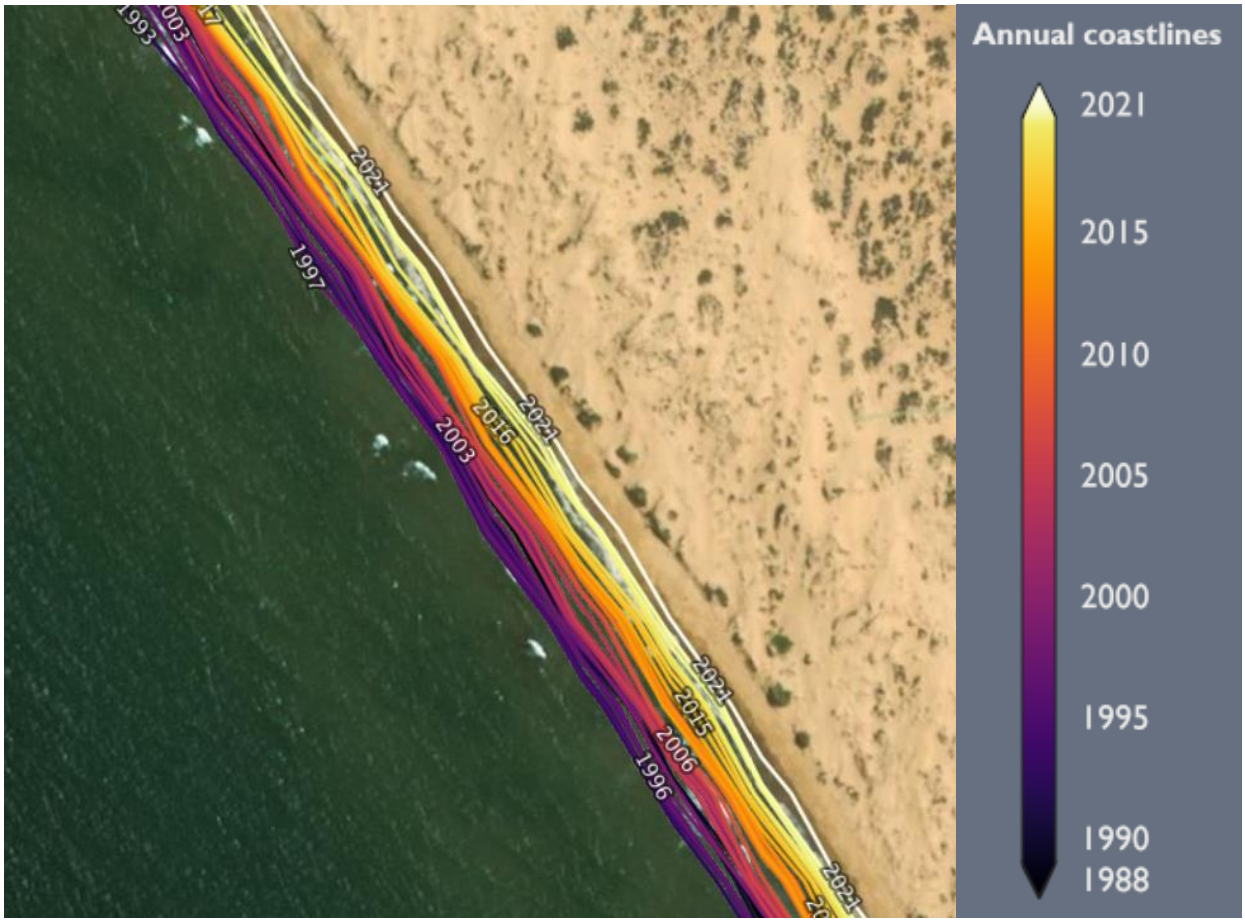


Figure 4.5 Annual coastline movement at the Site 1 proposed location (DEA, 2021)

The shoreline is dynamically influenced by river floors, aeolian transport and wave-driven transport (BMT, 2023a). The shoreline may accrete before eroding over time. The dynamic shoreline requires a solution that can accommodate the shoreline variations, the long-piled jetty solves this problem. Likewise, a causeway/breakwater structure would disrupt the transport enough to provide appropriate navigational safety. However, there are higher initial capital and ongoing maintenance costs associated with a large facility.

There is limited available sand in this region, primarily supplied by the Gascoyne river. Because this section of coast is effectively unrestricted landform changes are highly variable and this needs to be taken into consideration for when designing the facility. This location is part of the Gascoyne Primary Coastal Compartment and the secondary compartment which extends from Grey Point to South Bejaling Hill. The area is low-lying and therefore susceptible to inundation from storm surges and fluctuations in sea level (BMT, 2023a). The sea level rise on the Australian coast is planned to be ~0.9m over a 100-year timeframe. If planning the structures life after 2110, 0.01 needs to be added every year (BMT, 2023a).

4.2.6 Geotechnical data

The onshore rock type is sedimentary carbonate, with the area being described as marine and coastal limestone, lesser marine and coastal sandstone and local conglomerate (BMT 2023). The area has sand and sandy silts directly offshore with sections of turf algae and sparse seagrass scattered throughout (BMT, 2023a). The area is a wave dominated arid zone delta, in which the northwards longshore drift, under the influence of waves, has produced a major beach ridge complex, the Bejaling beach ridges in this area.

4.2.7 Heritage sites

No registered Aboriginal or European heritage sites are located within the vicinity of Boolanthanna Large Facility feasibility area. A search of the WA Museum Shipwrecks Database (WA Museum 2023) showed no shipwrecks of significant maritime heritage within the vicinity of site 1.

4.2.8 Aboriginal heritage

Native Title determination was granted in 2019 to the claimant group Gnulli, Gnulli #2 and Gnulli #3 – Yinggarda, Baiyungu and Thalanyji People (NNTT 2023). A search of the DPLH Aboriginal Cultural Heritage Inquiry System (ACHIS) showed no Registered Aboriginal Sites within the 5 km radius from Site 1(DPLH 2023).

4.2.9 Environmental regulatory pathways and requirements

The required regulatory pathways are complex and will require further investigation if a feasibility study is to be completed for Site 1. It is expected that this proposal may potentially have a significant impact on the environment (without appropriate mitigations and management) and will need to be referred to the Department of Water and Environmental Regulation (DWER) – Environmental Protection Authority (EPA) services for formal assessment (Table 4.1). In Western Australia, the *Environmental Protection Act 1986* (EP Act) is the primary legislative instrument for environmental assessment. Under the Section 38 of the EP Act, a Referral Supporting Document will be required to provide sufficient information for the EPA to assess the Proposal at the referral stage (EPA 2021). It describes the baseline studies and investigations conducted by the Proponent in relation to the key environmental factors. The EPA provides advice to the Minister on referrals assessed under Part IV of the EP Act (Table 4.1).

Site 1 is located near no existing infrastructure and minimal disturbance related to human activities in the receiving terrestrial and marine environment. Baseline surveys and technical studies would be required before the commencement of a Referral Supporting Document. The terrestrial onshore area could potentially require a Native Vegetation Clearing Permit (NVCP) for the construction phase of this proposal (potential road and infrastructure upgrades).

Other relevant legislation that will be considered to assess the key environmental factors, potential sensitive receptors and Matters of National Environmental Significance (MNES) are (EPBC 2023):

- Commonwealth Environmental Protection Biodiversity Conservation Act 1999 (EPBC Act)
- Western Australian *Biodiversity Conservation Act 2016* (BC Act).

See Table 4.1 for the potential decision-making authorities, legislation and approvals relevant to the Proposal within Site 1.

Table 4.1 Potential decision-making authorities, legislation and approvals relevant to the Site 1 proposal area

Agency / Decision-Making authority	Legislation or agreement regulating the activity	Approval required	How statuary decision-making process can mitigate impacts on the environment
State			
Department Water Environmental Regulation (DWER)	*Environmental Protection Act 1986* (EP Act) (Part IV) (Primary environmental impact assessment and approvals mechanism) [Environmental Protection Authority Services]	Environmental Protection Authority (EPA) Approval (Ministerial Statement) Relevant proposal elements: - Construction (onshore and offshore) - Transhipment operations	The relevant EPA objectives will need to be identified in the referral document and its subsequent review and assessment by the EPA
DWER	EP Act (Part V)	Native Vegetation Clearing Permit (NVCP) Relevant proposal elements: - Construction and Transportation (onshore)	A NVCP application will need to be completed to describe the following aspects of the vegetation clearing: - Objectives - Reason - Location - Area (m^2) and its assessment by DWER native vegetation clearing services
DWER / Chief Executive Officer of DWER	*Environmental Protection Act Amendment 2020* (EP Amendment 2020) (Part V) [Regulatory Services]	Works Approval (Licence) Relevant proposal elements: - Transhipment operations	The EPA objective for example, Air Quality, will need to be met. The potential impacts to Air Quality are initially assessed as part of the referral document. A Works Approval and subsequent License will be required under Part V of the EP Act in order to monitor emissions from operations.
Commonwealth			
Department of Climate Change, Energy, the Environment and Water (DCCEEW)	*Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)	DCCEEW Relevant proposal elements: - Berth construction - Transhipment operations	The EPBC Act factors for Matters of National Environmental Significance (MNES) will be met. The potential impacts from construction and transhipment operations on marine fauna will be mitigated through the strategies outlined in the referral document

Agency / Decision-Making authority	Legislation or agreement regulating the activity	Approval required	How statuary decision-making process can mitigate impacts on the environment
			prepared for approval under Part IV of the EP Act 1986

Notes:
1. It should be noted the process and timeframe is subject to change depending on a range of different factors including the complexity of the project, the key environmental factors within the proposal area, potential amendments to referral and locality of the project.

The Western Australian Department of Transport (hereafter; DoT) has previously completed Environmental Impact Assessment documentation for maintenance dredging campaigns of the Carnarvon Boat Harbour region. For example, the terrestrial onshore area could potentially require a Native Vegetation Clearing Permit (NVCP) for the construction phase of this proposal (Table 4.2). Table 4.2 provides a comprehensive list of the potential applicability of regulatory instruments that may be required in Site 1 proposal area based on regulation pathways required for maintenance dredging campaigns.

Table 4.2 Applicability of other regulatory instruments and frameworks to the Carnarvon Barge Facility in Site 1 proposal area based on previous maintenance dredging environmental documentation (BMT 2023)

Guideline/legislation	Applicability to project
Aboriginal Cultural Heritage Act 2021 (ACH Act)	Native Title determination was granted in 2019 to the claimant group Gnulli, Gnulli #2 and Gnulli #3 – Yinggarda, Baiyungu and Thalanyji People (NNTT 2023). Boolathanna station is located at the southern Determination Area within the Yinggarda Prescribed Body Corporate (PBC) boundary and within the most southern boundary of the Yinggarda Aboriginal Corporation Registered Native Title Body Corporate (RNTBC) boundary (NNTT 2023). A search of the DPLH ACHIS showed no Registered Aboriginal Sites within the 5 km radius from the proposed site (DPLH 2023a). On 1 July 2023 the ACH Act established a new system replaced the existing Section 18 process (DPLH 2023b). The new tiered system will help determine the level of due diligence and approvals required based on the level of impact a project has on aboriginal cultural heritage (DPLH 2023b). No approval is required for Tier 1 activities (low amount of disturbance) and exempt activities (DPLH 2023b). A notification to aboriginal parties and a permit is required for Tier 2 activities (medium amount of impact) (DPLH 2023b). Consultation with aboriginal parties and an aboriginal cultural heritage management plan (to be agreed with local aboriginal organisation) is required for Tier 3 activities (high amount of impact) (DPLH 2023b). If there no disturbance to Aboriginal Cultural Heritage in the Site 1 proposal area then no approval will be required under the ACH Act.
Acid Sulfate Soils (ASS) Guideline Series	The Site 1 proposal area is not located in an ASS risk area (DWER 2023).
Australian and New Zealand Guidelines (ANZG) for Fresh and Marine Water Quality	Sediment and water sampling can assess the contamination concentrations within the potential dredging and disposal areas to ensure they meet NAGD Screening Levels (CA 2009). Elutriate analysis will show if sediments meet the relevant ANZG (2018) DGVs and ANZECC/ARMCANZ (2000) default trigger values for PC stressors. Based on maintenance dredging campaigns, the elutriate metals and nutrients data were scaled to account

Guideline/legislation	Applicability to project
	for initial dilution at the Disposal Areas, and the resultant concentrations can show if the relevant ANZECC/ARMCANZ (2000) marine water quality trigger values for PC stressors and ANZG (2018) DGVs for 95% and 90% species protection level are met.
Conservation and Land Management Act 1984	The proposal will potentially impact terrestrial or marine conservation areas; therefore, the *Conservation and Land Management Act 1984* may apply.
Contaminated Sites Act 2003 (WA) and Contaminated Sites Guidelines	A search of DWER's contaminated sites database showed that Site 1 has no contaminated sites (DWER 2023).
Environmental Protection Act 1986 (EP Act)	If the proposal requires native vegetation to be cleared, then a NVCP application will be required to be submitted to DWER for assessment. Therefore, the EP Act may apply.
Environment Protection (Sea Dumping) Act 1981	If the proposal does involve dumping of dredged material (or any material) at sea and *the Sea Dumping Act 1981* may apply.
Environmental Protection (Noise) Regulations 1997	Noise will be required to be managed and if it is anticipated to cause an impact during the proposal the Environmental Protection (Noise) Regulations 1997 may apply (DEP 1997).
Heritage Act 2018	There are no known European heritage sites within or immediately adjacent to Site 1 proposal area; therefore, the *Heritage Act 2018* may not apply.
Maritime Archaeology Act 1973	A search of the Western Australian Museum Shipwreck Database (WA Museum 2023) showed no shipwrecks of significant maritime heritage within the vicinity of the Site 1 proposal area. Therefore, the *Maritime Archaeology Act 1973* is not applicable.
Underwater Cultural Heritage Act 2018	A search of the Australasian Underwater Cultural Heritage Database (DCCEEW 2023c) showed no known historical shipwrecks or relics in the vicinity of the Site 1 proposal area and therefore the *Underwater Cultural Heritage Act 2018* is not applicable.
Landfill Waste Classification and Waste Definitions 1996	The Site 1 proposal area may potentially involve the disposal of material to landfill; therefore, the Landfill Waste Classification and Waste Definitions 1996 does apply (DWER 2019).
WA Biodiversity Conservation Act 2016	The Site 1 proposal areas are potentially within an/or adjacent to critical habitat and/or feeding grounds of protected species. The potential implications and triggers that could occur as a result of the proposed activity will need to be reviewed and concluded the anticipated impacts to protected species or threatened ecological communities therefore the *WA Biodiversity Conservation Act 2016* may be applicable.

Notes:
1. It should be noted the regulatory instruments within this table subject to change depending on a range of different factors including the complexity of the project, the key environmental factors within the proposal area, potential amendments to referral and locality of the project. This table should be used as a guide only.

4.2.10 Future development

A larger multiuser maritime facility would require a protective structure to ensure the safety and security of both the facility and its users and helps to ensure the longevity and sustainability of the facility. This site has no marine or terrestrial restrictions. This greenfield coastal location offers ample opportunities for development due to the large onshore areas that are free for construction. The availability of the onshore area for development also opens up opportunities for ancillary industries, such as logistics, transportation, and large-scale storage for things such as wind turbine blades. Therefore, the possibility of developing a multiuser maritime facility at Boolathanna is very promising, and it could become a significant contributor to the local economy.

4.3 Carnarvon Boat Harbour Specifics

Carnarvon Boat Harbour (hereafter; Site 2) is a small marina located in the town of Carnarvon. It is primarily used for recreational boating, fishing, and tourism. The facilities available at Site 2 include boat ramps, jetties, moorings, a fuel station, toilets, showers, and a small car park. There are also several commercial fishing boats and a few charter boats operating from the harbour. Site 2 is surrounded by restaurants, cafes, and shops, making it a popular spot for tourism.

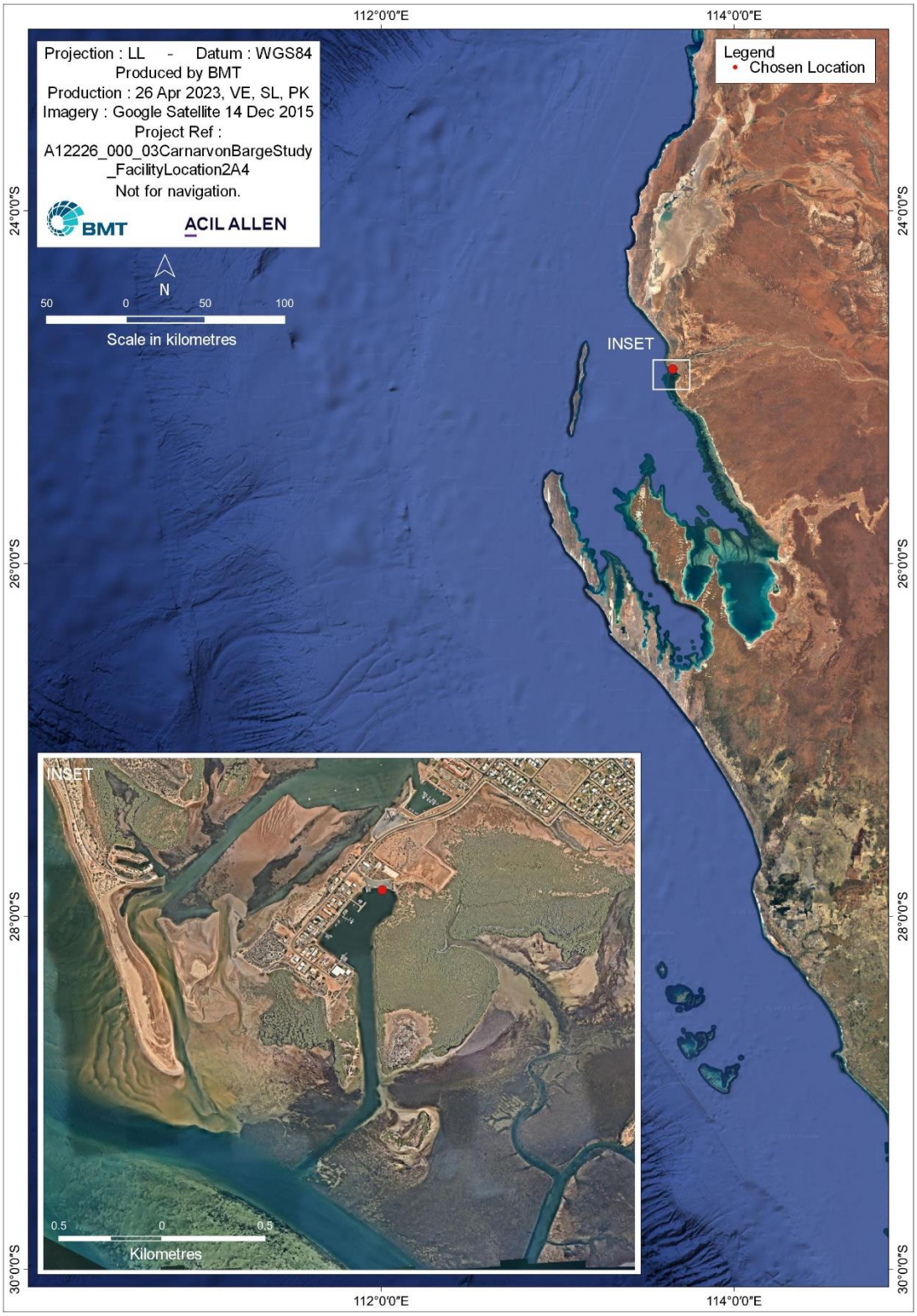


Figure 4.6 Carnarvon Boat Harbour location (Site 2)

4.3.2 Tenure and land type/usage

The boat harbour is a man-made structure built in the 1960s to provide safe anchorage for fishing vessels and other boats. The boat harbour's tenure is owned and managed by the Western Australian Government through the Department of Transport, who oversees its day-to-day operations. The land type around the harbour is primarily made up of coastal wetlands and sand dunes.

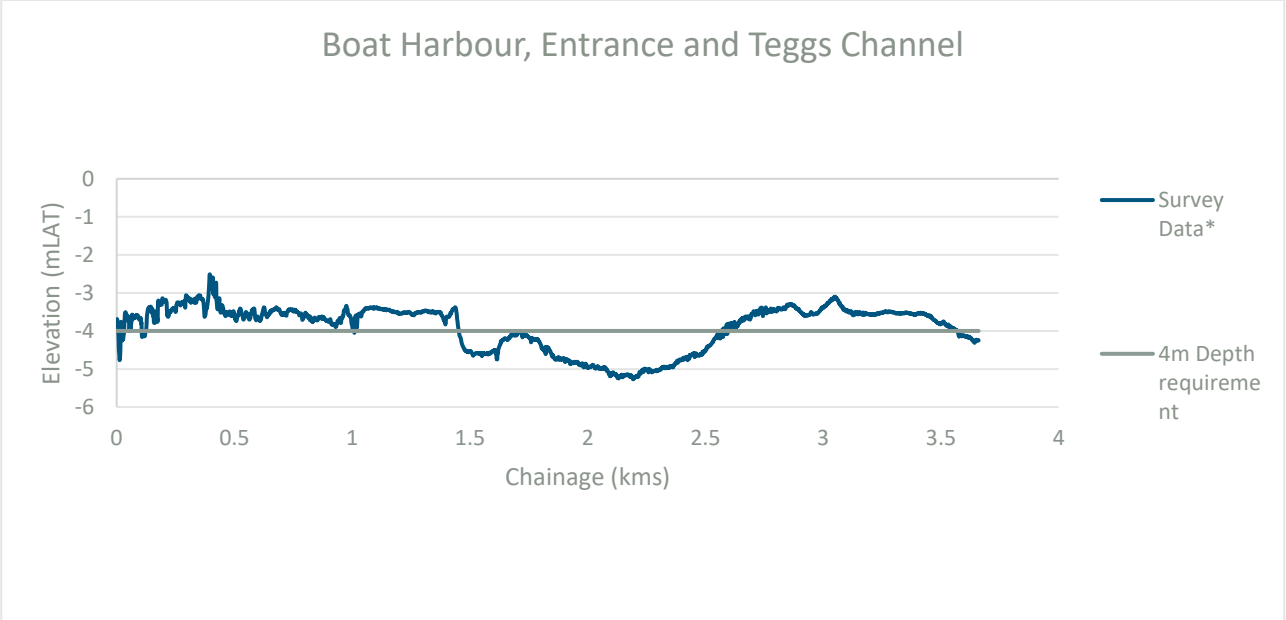
4.3.3 Existing infrastructure

The land-based access is via the township of Carnarvon which would require community consultation on the effect of transporting exports (increased traffic) through the town to the harbour. Transporting ore to the harbour would require significant investment in maintenance of current transport infrastructure, and the added cost of transportation could make the site less attractive to potential customers.

Figure 4.7 Carnarvon Boat Harbour Aerial Image (DoT, Carnarvon Boat Harbour, 2023)

4.3.4 Bathymetry and Topography

Access to Site 2 is via Teggs Channel (design depth of -3.5 m CD and 40 m width) into the Access Channel (design depth -3 m CD and 30 m wide). Some dredging would be required to expand this channel and the boat harbour to allow for access and manoeuvrability of larger width vessels. Surrounding the boat harbour and access channel is mangroves limiting the area available for future development. Suitable undeveloped land around the boat harbour is limited, and the construction of a barge loading facility would need to be carefully planned to avoid impacting other harbour users or infringing on sensitive environmental areas. This could limit the size of the facility and its potential throughput capacity.



*Data is a combination of surveys including September 2016, November 2019, February 2020, July 2020, September 2020, November 2020, January 2021, November 2021 and May 2022.

Figure 4.8 Bathymetry of the access to Site 2 (DoT, Survey Data, Various)

4.3.5 Metocean conditions and coastal processes

Site 2 is located on the western coast of Australia, near the mouth of the Gascoyne River. The Metocean conditions at this location are influenced by the prevailing winds, tides, and ocean currents. The area experiences a semi-arid climate with hot summers and mild winters. The prevailing winds in the region are the south-westerly sea breezes, which typically blow during the afternoon and evening. These winds can be gusty and variable, with wind speeds typically ranging from 10 to 20 knots (18 to 37 km/h). These winds can cause choppy sea conditions and increased wave heights, which can make navigation in and out of the boat harbour more challenging.

The tidal range for Site 2 is ~2 m (LAT to HAT) with Figure 4.9 showing the submergence curve.

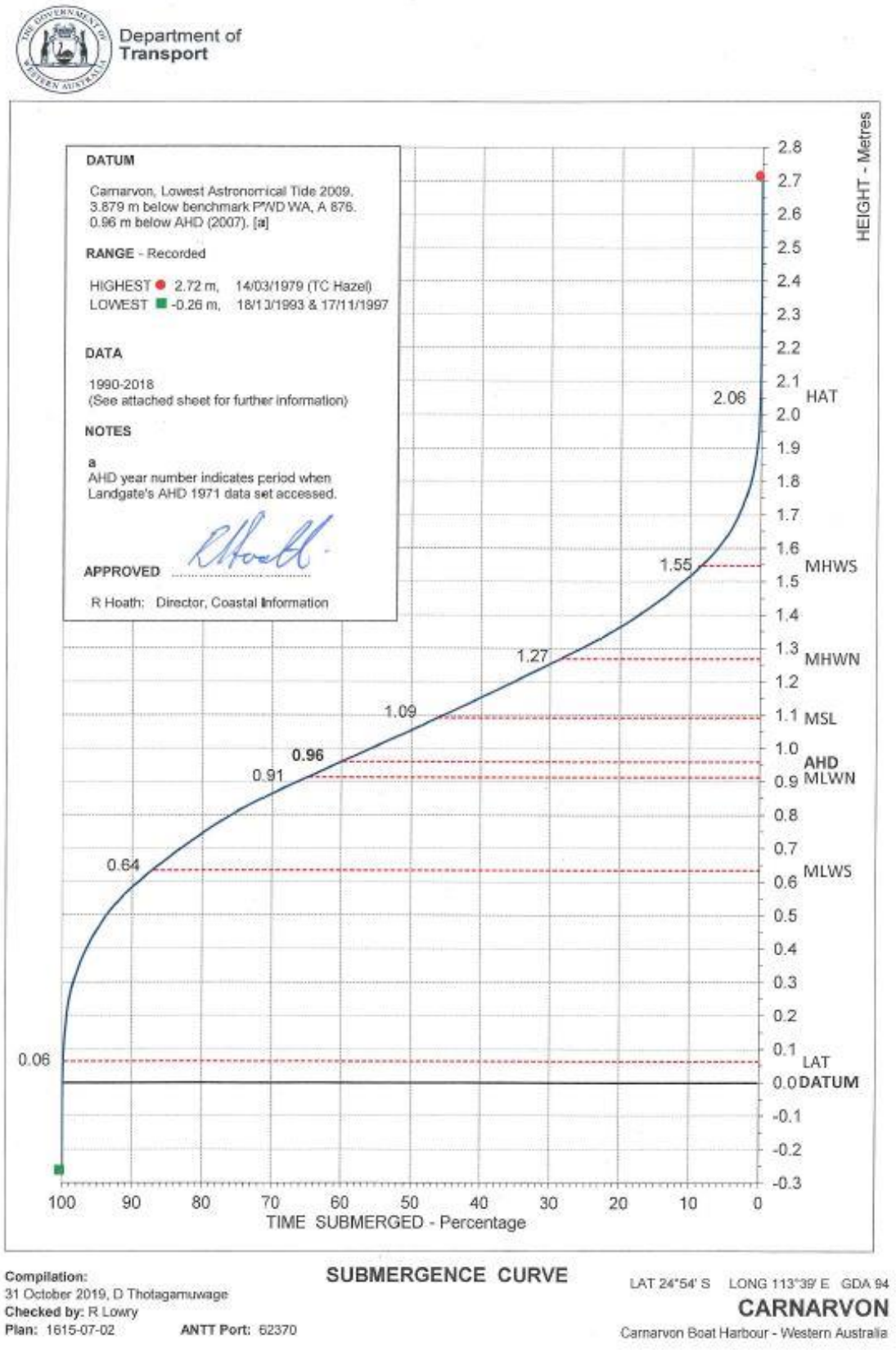


Figure 4.9 Submergence curve for Site 2

In addition to wind and wave conditions, the harbour is also subject to coastal processes such as erosion and sediment transport. The area is characterized by sandy beaches and dunes, which are constantly shaped by the actions of wind and water. The Gascoyne River also contributes to sediment transport in the area, as it carries large volumes of sediment downstream towards the coast. As a result, sediment deposition and erosion can be highly variable along the coastline. To mitigate the effects of these processes, the harbour features a breakwater that helps to reduce wave energy and protect vessels. The harbour is used for cyclone mooring and provides shelter for some larger vessels.

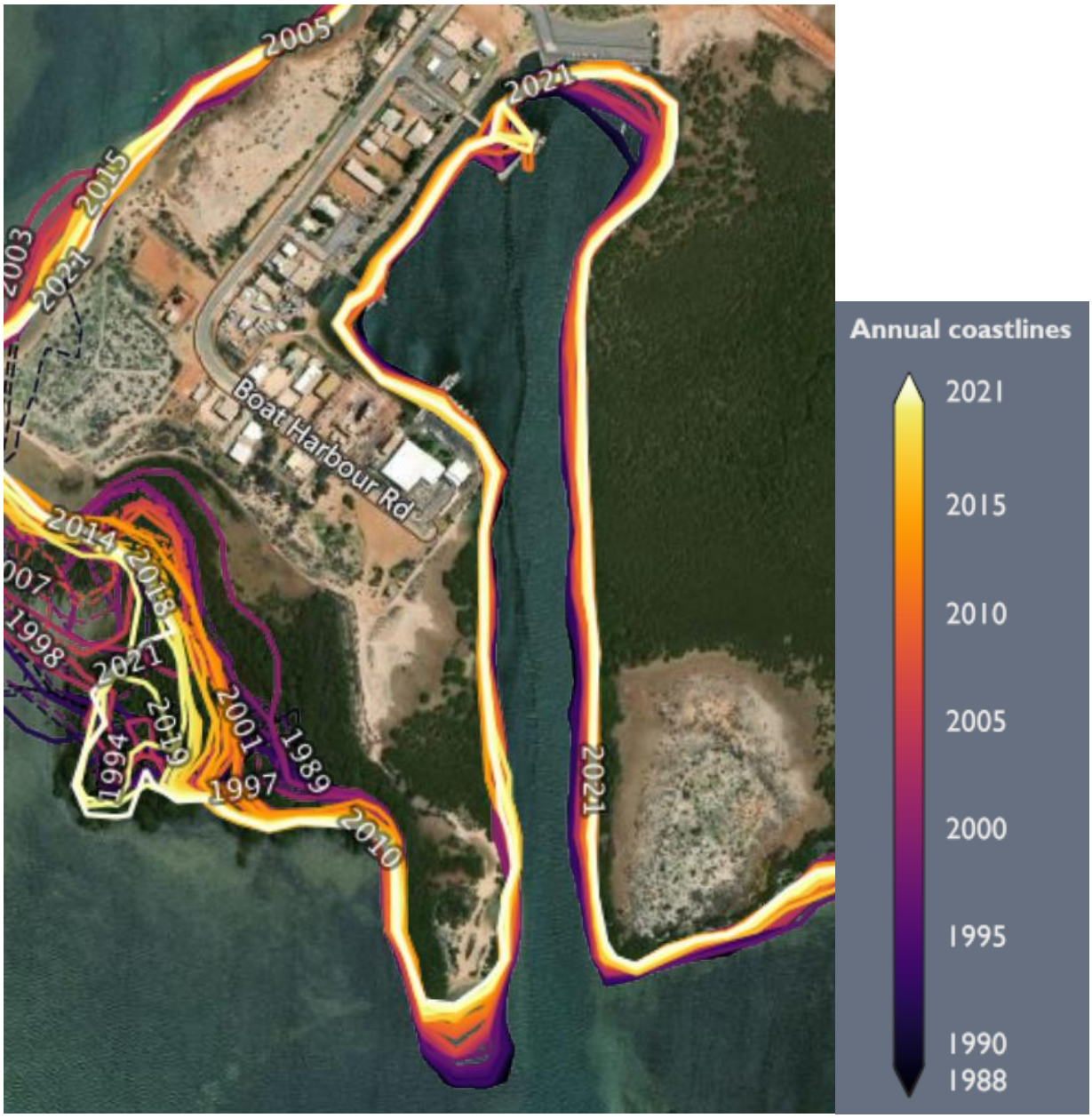


Figure 4.10 Shoreline changes over the years at Site 2 (DEA, 2021)

4.3.6 Geotechnical data

The harbour and Teggs Channel is periodically dredged as part of DoT's Maintenance Dredging Program. Therefore, this area has significantly more data available including annual survey depths, geotechnical boreholes and previously submitted environmental approvals. This knowledge would limit the additional studies required before detailed design of the facility could proceed.

Sediment sampling undertaken in January 2023 (BMT, 2023b) showed sediments from Teggs Channel dredge area and Pelican Point renourishment disposal area were largely characterised by fine to medium sand (125–500 µm) with small portions of silt/clay (0-63 µm).

Site 2 has known contaminated material within the harbour and the upper entrance channel (BMT, 2023b). If considerable dredging is required within the harbour a new disposal option would be required as the current onshore bunded area used for contaminated disposal previously has at limited remaining capacity.

4.3.7 Aboriginal heritage

Native Title determination was granted in 2019 to the claimant group Gnulli, Gnulli #2 and Gnulli #3 – Yinggarda, Baiyungu and Thalanyji People (NNTT 2023). A search of the DPLH ACHIS showed 14 Registered Aboriginal Sites within the 5 km radius from Site 2 proposal area and no Registered Aboriginal Sites within close proximity (1 km radius) to the Site 2 proposal area (DPLH 2023).

4.3.8 European and maritime heritage

A search of the Heritage Council State Heritage Office InHerit Database identified 88 European heritage places in the Carnarvon region, however, none of the European heritage places are in the habour proposal area (GWA 2023). A search of the Australasian Underwater Cultural Heritage Database (DCCEEW 2023) showed no known historical shipwrecks or relics in the vicinity of Site 2 proposal area. A search of the WA Museum Shipwrecks Database (WA Museum 2023) found two shipwrecks of significant maritime heritage in the vicinity of Site 2 proposal area. Fascine Unidentified Nellie? is a shipwreck located in the middle of the Fascine, and Carnarvon Jetty shipwreck is ~2.3 km north-west of Pelican Point (WA Museum 2023).

4.3.9 Environmental regulatory pathways and requirements

This proposal is expected to potentially have a significant impact on the environment (without appropriate mitigations and management) and would need to be referred to the DWER – EPA services for formal assessment (EPA 2021). In Western Australia, the EP Act is the primary legislative instrument for environmental assessment. Under the Section 38 of the EP Act, a Referral Supporting Document will be required to provide sufficient information for the EPA to assess the Proposal at the referral stage (EPA 2021). It describes the baseline studies and investigations conducted by the Proponent in relation to the key environmental factors. The EPA provides advice to the Minister on referrals assessed under Part IV of the EP Act (EPA 2021).

Site 2 proposal area has existing infrastructure and maintenance dredging is routinely completed within the boat harbour to restore navigable depths. The boating facilities are utilised by recreational boating, commercial and tourism industries.

The distribution and extent of Benthic Communities Habitats (BCHs) in the Carnarvon region have been previously mapped in March 2021 (BMT 2021). The boat harbour and Entrance Channel seabed comprise of primarily of bare sands and silt, and sparse persistent seagrass and macroalgae (BMT 2021). Mangroves dominate the intertidal zone and cover is particularly extensive along the coastal fringes (BMT 2021). Mud flats and *Sarcocornia* spp. samphire salt flats were identified closer to Carnarvon town site (LEC 1990, DALSE & JFA 2003, BMT 2021), and are only inundated during high spring tides. Grazing molluscs (*Cerithid* sp. and *Terebralia* sp.) inhabit the base of mangroves (LEC 1990). However, it may still be a requirement to update the benthic habitat map in the Referral Supporting Document. The terrestrial onshore area could potentially require a Native Vegetation Clearing Permit (NVCP) for the construction phase of this proposal (potential road and infrastructure upgrades).

Other relevant legislation that will be considered to assess the key environmental factors, potential sensitive receptors and MNES (EPBC 2023) are:

- Commonwealth EPBC Act
- Western Australian BC Act

As described in Section4.2.9, Table 4.1 and Table 4.2 similar environmental pathways and requirements would need to be considered for Site 2.

4.3.10 Future development

The future development capabilities of Carnarvon Boat Harbour are limited by several factors, including its relatively small size and its location within a sensitive environmental area. The harbour has limited space for expansion and cannot accommodate larger vessels, which limits its potential as a commercial port. Furthermore, the surrounding environment is home to a variety of marine species and other sensitive ecosystems that must be protected. As a result, any future development plans must be carefully considered and designed to minimise environmental impact.

4.4 Offshore location

The northern offshore transfer location (hereafter; Site 3 (offshore)) is located 57 km southwest from Boolathanna station and was chosen as it was the closer option to the two proposed facility locations.

4.4.1 Bathymetry and topography

The depth at the northern option is approximately 15 m which is deemed suitable for this initial assessment. Specific vessel dimensions are required to determine if the water depth at the transhipment location is insufficient.

4.4.2 Metocean conditions and coastal processes

Site 3 is partially open to the harsh weather conditions of the region as it sits 15 km east of Dorre Island. There is the possibility of operations being stood down due to weather. The wave height is approximately ~0.75 m in the extreme south/south-westerly conditions which is at the maximum range suitable for barge operations to function. This increase in wave height is due to the diffraction through the stretch of ocean between Bernier and Dorre Islands.

4.4.3 Regulatory pathways and requirements

The required environmental regulatory pathways are complex and will require further investigation if a feasibility study is to be completed for Site 3 (offshore) proposal site. It is expected that this proposal may potentially have a significant impact on the environment (without appropriate mitigations and management) and will need to be referred to the DWER – EPA services for a determination regarding

formal assessment (EPA 2021). In Western Australia, the EP Act is the primary legislative instrument for environmental assessment (EPA 2021). Under the Section 38 of the EP Act, a Referral Supporting Document will be required to provide sufficient information for the EPA to assess the Proposal at the referral stage (EPA 2021). It describes the baseline studies and investigations conducted by the Proponent in relation to the key environmental factors. The EPA provides advice to the Minister on referrals assessed under Part IV of the EP Act (EPA 2021).

The Site 3 (offshore) is located in an area of no existing infrastructure and minimal prior disturbance related to human activities. The offshore areas of this proposal would require an array of baseline surveys to map the existing environmental values.

Other relevant legislation that will be considered to assess the key environmental factors and potential sensitive receptors are:

- Commonwealth EPBC Act 1999
- Western Australian BC Act 2016

As described in Table 4.1 and Table 4.2 similar environmental pathways and requirements would need to be considered for Site 3.

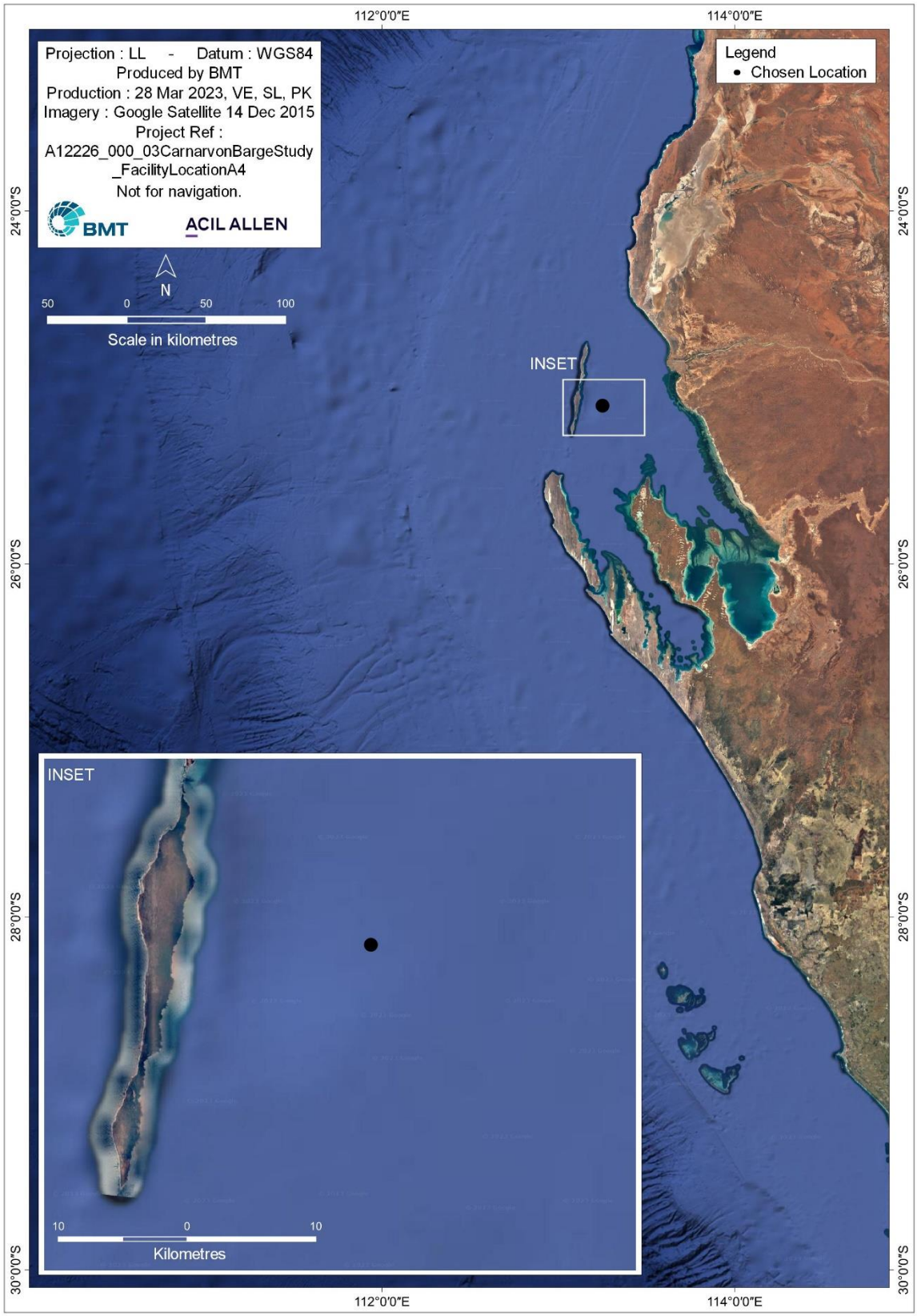


Figure 4.11 Offshore Location

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Annex A Aboriginal Cultural Heritage Inquiry System Search Reports

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Directory

Search Criteria

1 Aboriginal Cultural Heritage (ACH) Directory in Custom search area - Point with 5000m buffer - 113.394302403605°E, 24.2247389718834°S (GDA94)

Disclaimer

The *Aboriginal Cultural Heritage Act 2021 (Act)* recognises, protects, conserves, and preserves Aboriginal cultural heritage (ACH), and recognises the fundamental importance of ACH to Aboriginal people and its role in Aboriginal communities past, present and future. The Act recognises the value of ACH to Aboriginal people as well as to the wider Western Australian community.

Aboriginal cultural heritage in Western Australia is protected, whether or not the ACH has been reported to the ACH Council or exists on the Directory.

The information provided is made available in good faith and is predominately based on the information provided to the Department of Planning, Lands and Heritage by third parties. The information is provided solely on the basis that readers will be responsible for making their own assessment as to the accuracy of the information. If you find any errors or omissions in our records, including our maps, it would be appreciated if you email the details to the Department at AboriginalHeritage@dplh.wa.gov.au and we will make every effort to rectify it as soon as possible.

Copyright

Terminology

ID: Reported ACH is assigned a unique ID by the Department of Planning, Lands and Heritage using the format: ACH-00000001. For ACH places on the former Register the ID numbers remain unchanged and use the new format. For example the ACH ID of the place Swan River was previously '3536' and is now 'ACH-00003536'.

Access and Restrictions:

- **Boundary Reliable (Yes/No):** Indicates whether the location and extent of the ACH boundary is considered reliable.
- **Boundary Restricted = No:** ACH location is shown as accurately as the information submitted allows.
- **Boundary Restricted = Yes:** To preserve confidentiality the exact location and extent of the place is not displayed on the map. However, the shaded region (generally with an area of at least 4km²) provides a general indication of where the ACH is located. If you are a landowner and wish to find out more about the exact location of the place, please contact the Department of Planning, Lands and Heritage.
- **Culturally Sensitive = No:** Availability of information that the Department of Planning, Lands and Heritage holds in relation to the ACH is not restricted in any way.
- **Culturally Sensitive = Yes:** Some of the information that the Department of Planning, Lands and Heritage holds in relation to the ACH is restricted if it is considered culturally sensitive information. This information will only be made available if the Department of Planning, Lands and Heritage receives written approval from the people who provided the information. To request access please contact AboriginalHeritage@dplh.wa.gov.au.
- **Culturally Sensitive Nature:**
  - **No Gender / Initiation Restrictions:** *Anyone* can view the information.
  - **Men only:** Only *males* can view restricted information.
  - **Women only:** Only *females* can view restricted information.

Status:

- **ACH Directory**: Aboriginal cultural heritage place or cultural landscape.
- **Pending**: Aboriginal cultural heritage place or cultural landscape with information in a verification stage.
- **Historic**: Aboriginal heritage places determined to not meet the criteria of Section 5 of the Aboriginal Heritage Act 1972. Includes places that no longer exist as a result of land use activities with existing approvals.

ACH Type:

- **Cultural Landscape:** a group of areas interconnected through the tangible elements of Aboriginal culture heritage present.
- **Place**: an area in which tangible elements of Aboriginal cultural heritage are present.

Place Type: The type of Aboriginal cultural heritage place. For example an artefact scatter place or engravings place.

Legacy Place Status: A status determined under the previous *Aboriginal Heritage Act 1972*:

- **Registered Site:** the place was assessed as meeting Section 5 of the *Aboriginal Heritage Act 1972.*
- **Lodged:** Information was received in relation to the place, but an assessment was not completed to determine if it met section 5 of the *Aboriginal Heritage Act 1972.*
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Legacy ID: This is the former unique number that the former Department of Aboriginal Sites assigned to the place.

Coordinates

Map coordinates are based on the GDA 94 Datum.

Basemap Copyright

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Directory

ID	Name	Boundary Restricted	Boundary Reliable	Culturally Sensitive	Culturally Sensitive Nature	Status	ACH Type	Place Type	Knowledge Holders	Legacy Place Status	Legacy ID
6060	CAPE CUVIER	No	Yes	No	No Gender / Initiation Restrictions	ACH Directory	Place	Artefacts / Scatter; Midden	*Registered Knowledge Holder names available from DPLH	Registered Site	P07053

Department of Planning, Lands and Heritage

Aboriginal Cultural Heritage Inquiry System

Map of Aboriginal Cultural Heritage (ACH) Directory

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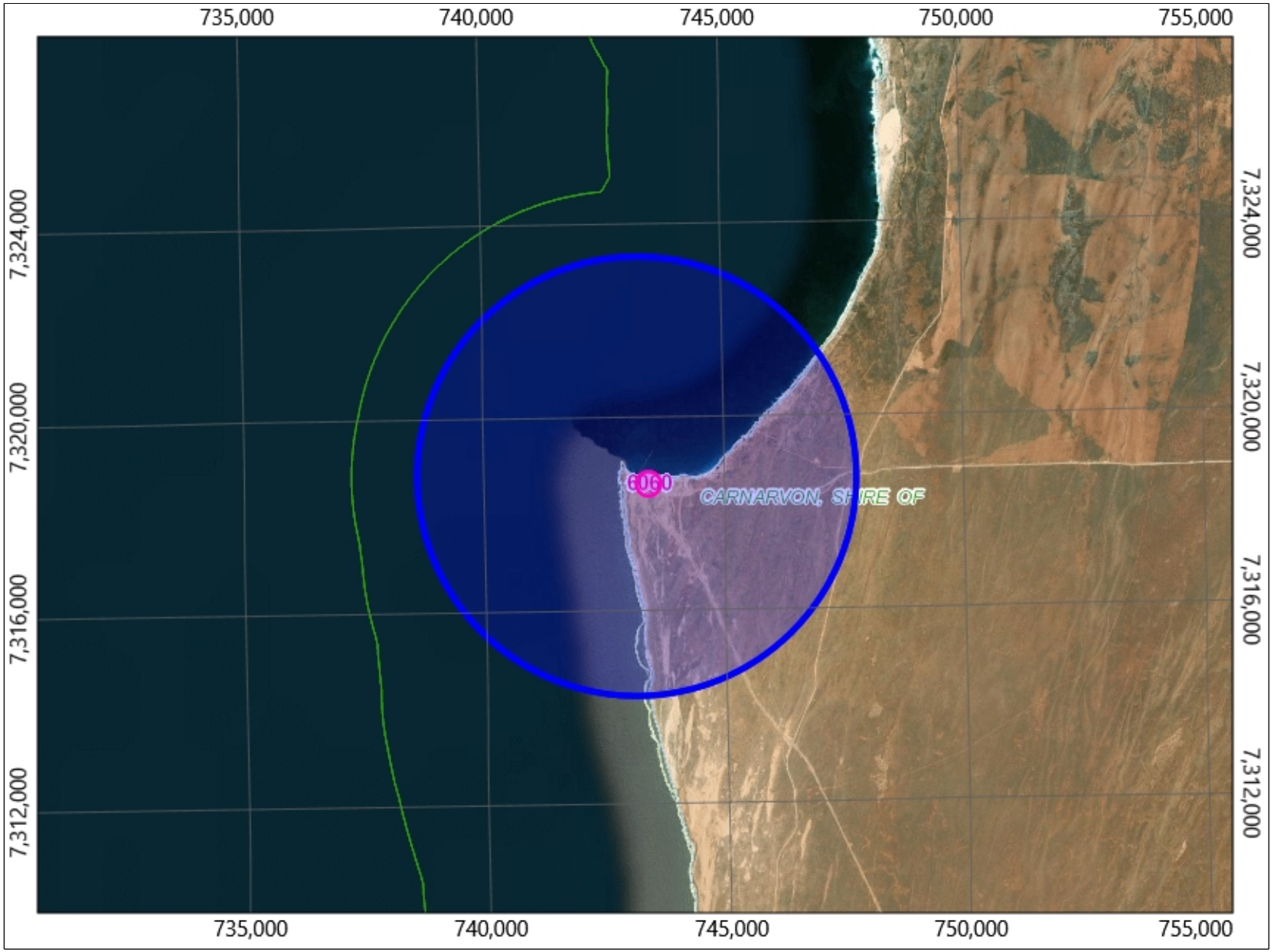

Legend

- Aboriginal Cultural Heritage (ACH) Directory
- Search Area
- Aboriginal Community
  - *Permanent*
  - *Seasonal*
  - *Town Based*
- Town
- Road
- River
- Local Government Authority

4.35 kilometres

Map Scale 1 : 132,000

MGA Zone 49 (GDA94)

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Directory

Search Criteria

12 Aboriginal Cultural Heritage (ACH) Directory in Custom search area - Point with 5000m buffer - 113.623373782697°E, 24.8781459551463°S (GDA94)

Disclaimer

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Coordinates

Map coordinates are based on the GDA 94 Datum.

Basemap Copyright

ID	Name	Boundary Restricted	Boundary Reliable	Culturally Sensitive	Culturally Sensitive Nature	Status	ACH Type	Place Type	Knowledge Holders	Legacy Place Status	Legacy ID
874	CARNARVON FASCINE	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Artefacts / Scatter; Midden	*Registered Knowledge Holder names available from DPLH	Registered Site	P07288
7129	LEWER ROAD RESERVE.	No	Yes	No	No Gender / Initiation Restrictions	ACH Directory	Place	Camp; Historical	*Registered Knowledge Holder names available from DPLH	Lodged	P05795
7130	LEWER ROAD WATERSNAKE	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	Registered Site	P05796
7131	LEWER ROAD LAW GROUND	Yes	Yes	Yes	Men only	ACH Directory	Place	Ritual / Ceremonial; Repository / Storage Place	*Registered Knowledge Holder names available from DPLH	Registered Site	P05797
7132	BREAKWATER No. 2.	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Artefacts / Scatter; Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	Registered Site	P05798
7232	MOBURN TREE.	Yes	No	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Ritual / Ceremonial; Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	Registered Site	P05684
7233	NJUNI TALU	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Ritual / Ceremonial	*Registered Knowledge Holder names available from DPLH	Registered Site	P05685
7234	KUWINWARDU SOAK.	Yes	No	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Camp; Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	Registered Site	P05686
7235	WATERHOLE	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Ritual / Ceremonial; Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	Registered Site	P05687
10355	CHINAMAN'S POOL	No	No	No	No Gender / Initiation Restrictions	ACH Directory	Place	Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	Registered Site	P01827
21676	Babbage Island	No	Yes	No	No Gender / Initiation Restrictions	ACH Directory	Place	Artefacts / Scatter; Camp; Ochre	*Registered Knowledge Holder names available from DPLH	Lodged	
39200	Gascoyne and Lyons River	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Ritual / Ceremonial; Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	Registered Site	

Department of Planning, Lands and Heritage

Aboriginal Cultural Heritage Inquiry System

Map of Aboriginal Cultural Heritage (ACH) Directory

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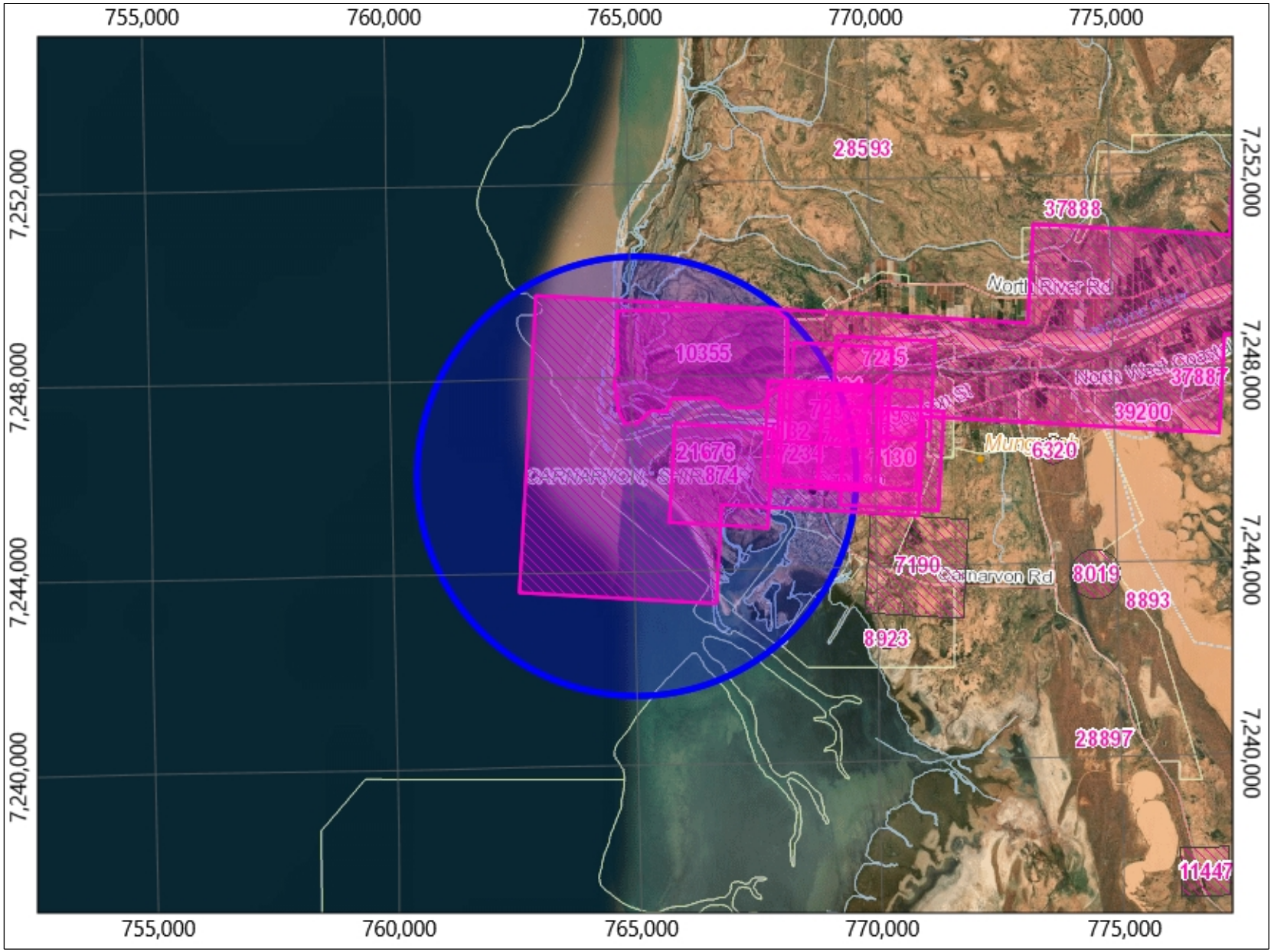

Legend

- Aboriginal Cultural Heritage (ACH) Directory
- Search Area
- Aboriginal Community
  - *Permanent*
  - *Seasonal*
  - *Town Based*
- Town
- Road
- River
- Local Government Authority

4.35 kilometres

Map Scale 1 : 132,000

MGA Zone 49 (GDA94)

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Directory

Search Criteria

14 Aboriginal Cultural Heritage (ACH) Directory in Custom search area - Point with 5000m buffer - 113.650474823°E, 24.8989928143614°S (GDA94)

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Coordinates

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Basemap Copyright

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7129	LEWER ROAD RESERVE.	No	Yes	No	No Gender / Initiation Restrictions	ACH Directory	Place	Camp; Historical	*Registered Knowledge Holder names available from DPLH	Lodged	P05795
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7131	LEWER ROAD LAW GROUND	Yes	Yes	Yes	Men only	ACH Directory	Place	Ritual / Ceremonial; Repository / Storage Place	*Registered Knowledge Holder names available from DPLH	Registered Site	P05797
7132	BREAKWATER No. 2.	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Artefacts / Scatter; Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	Registered Site	P05798
7190	TITIWARRA SOAK.	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	Registered Site	P05747
7232	MOBURN TREE.	Yes	No	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Ritual / Ceremonial; Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	Registered Site	P05684
7233	NJUNI TALU	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Ritual / Ceremonial	*Registered Knowledge Holder names available from DPLH	Registered Site	P05685
7234	KUWINWARDU SOAK.	Yes	No	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Camp; Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	Registered Site	P05686
7235	WATERHOLE	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Ritual / Ceremonial; Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	Registered Site	P05687
8923	CARNARVON GOLF COURSE	No	Yes	No	No Gender / Initiation Restrictions	ACH Directory	Place	Burial	*Registered Knowledge Holder names available from DPLH	Registered Site	P03566
10355	CHINAMAN'S POOL	No	No	No	No Gender / Initiation Restrictions	ACH Directory	Place	Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	Registered Site	P01827

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Directory

ID	Name	Boundary Restricted	Boundary Reliable	Culturally Sensitive	Culturally Sensitive Nature	Status	ACH Type	Place Type	Knowledge Holders	Legacy Place Status	Legacy ID
21676	Babbage Island	No	Yes	No	No Gender / Initiation Restrictions	ACH Directory	Place	Artefacts / Scatter; Camp; Ochre	*Registered Knowledge Holder names available from DPLH	Lodged	
39200	Gascoyne and Lyons River	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Ritual / Ceremonial; Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	Registered Site	

Department of Planning, Lands and Heritage

Aboriginal Cultural Heritage Inquiry System

Map of Aboriginal Cultural Heritage (ACH) Directory

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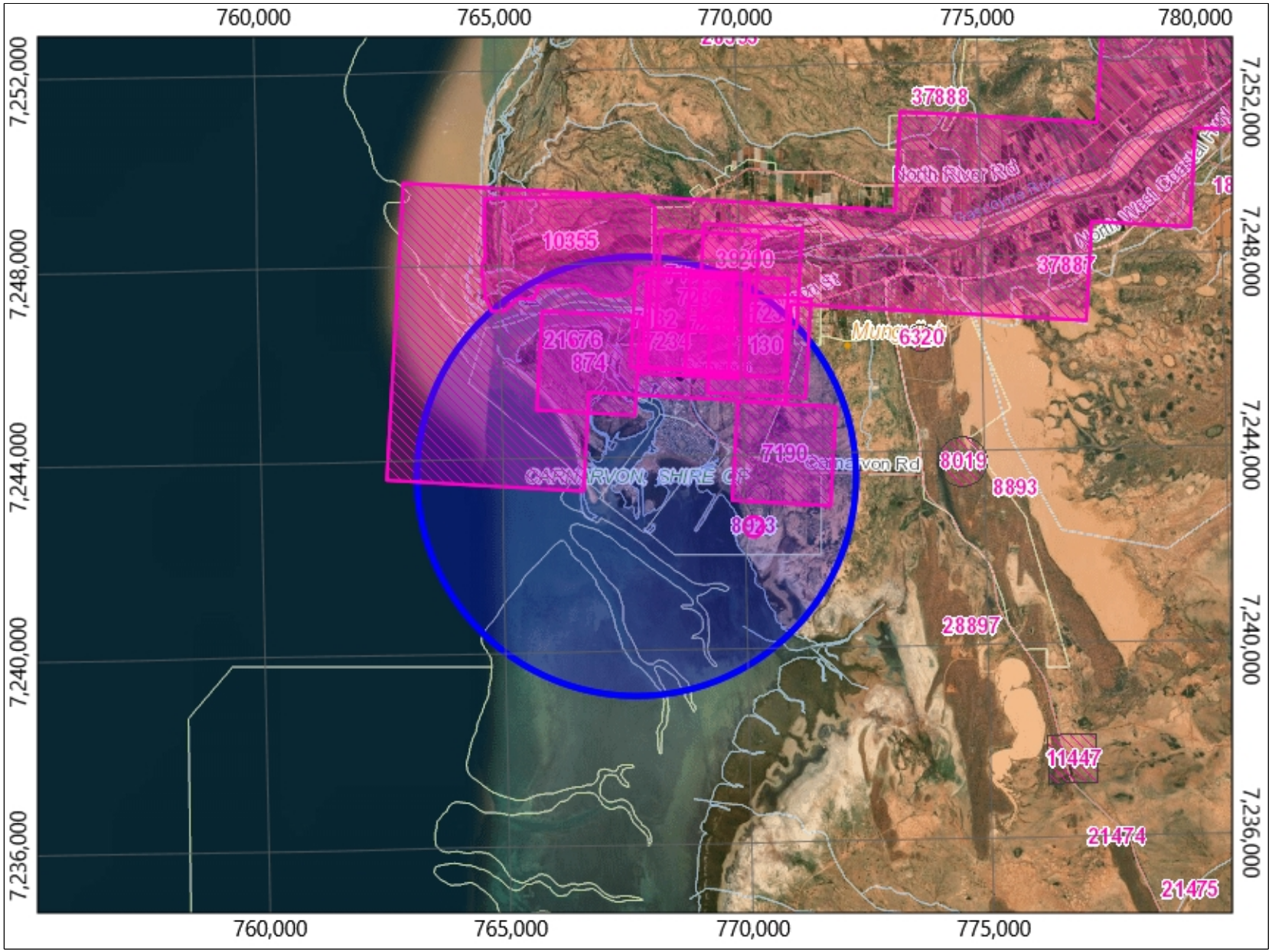

Legend

- Aboriginal Cultural Heritage (ACH) Directory
- Search Area
- Aboriginal Community
  - *Permanent*
  - *Seasonal*
  - *Town Based*
- Town
- Road
- River
- Local Government Authority

4.35 kilometres

Map Scale 1 : 132,000

MGA Zone 49 (GDA94)

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Directory

Search Criteria

13 Aboriginal Cultural Heritage (ACH) Directory in Custom search area - Point with 5000m buffer - 113.671417511347°E, 24.9050262626505°S (GDA94)

Disclaimer

The Aboriginal Cultural Heritage Act 2021 (Act) recognises, protects, conserves, and preserves Aboriginal cultural heritage (ACH), and recognises the fundamental importance of ACH to Aboriginal people and its role in Aboriginal communities past, present and future. The Act recognises the value of ACH to Aboriginal people as well as to the wider Western Australian community.

Aboriginal cultural heritage in Western Australia is protected, whether or not the ACH has been reported to the ACH Council or exists on the Directory.

The information provided is made available in good faith and is predominately based on the information provided to the Department of Planning, Lands and Heritage by third parties. The information is provided solely on the basis that readers will be responsible for making their own assessment as to the accuracy of the information. If you find any errors or omissions in our records, including our maps, it would be appreciated if you email the details to the Department at AboriginalHeritage@dplh.wa.gov.au and we will make every effort to rectify it as soon as possible.

Copyright

Terminology

ID: Reported ACH is assigned a unique ID by the Department of Planning, Lands and Heritage using the format: ACH-00000001. For ACH places on the former Register the ID numbers remain unchanged and use the new format. For example the ACH ID of the place Swan River was previously '3536' and is now 'ACH-00003536'.

Access and Restrictions:

- Boundary Reliable (Yes/No): Indicates whether the location and extent of the ACH boundary is considered reliable.
- Boundary Restricted = No: ACH location is shown as accurately as the information submitted allows.
- Boundary Restricted = Yes: To preserve confidentiality the exact location and extent of the place is not displayed on the map. However, the shaded region (generally with an area of at least 4km²) provides a general indication of where the ACH is located. If you are a landowner and wish to find out more about the exact location of the place, please contact the Department of Planning, Lands and Heritage.
- Culturally Sensitive = No: Availability of information that the Department of Planning, Lands and Heritage holds in relation to the ACH is not restricted in any way.
- Culturally Sensitive = Yes: Some of the information that the Department of Planning, Lands and Heritage holds in relation to the ACH is restricted if it is considered culturally sensitive information. This information will only be made available if the Department of Planning, Lands and Heritage receives written approval from the people who provided the information. To request access please contact AboriginalHeritage@dplh.wa.gov.au.
- Culturally Sensitive Nature:
  - No Gender / Initiation Restrictions: Anyone can view the information.
  - Men only: Only males can view restricted information.
  - Women only: Only females can view restricted information.

Status:

- ACH Directory: Aboriginal cultural heritage place or cultural landscape.
- Pending: Aboriginal cultural heritage place or cultural landscape with information in a verification stage.
- Historic: Aboriginal heritage places determined to not meet the criteria of Section 5 of the Aboriginal Heritage Act 1972. Includes places that no longer exist as a result of land use activities with existing approvals.

ACH Type:

- Cultural Landscape: a group of areas interconnected through the tangible elements of Aboriginal culture heritage present.
- Place: an area in which tangible elements of Aboriginal cultural heritage are present.

Place Type: The type of Aboriginal cultural heritage place. For example an artefact scatter place or engravings place.

Legacy Place Status: A status determined under the previous Aboriginal Heritage Act 1972:

- Registered Site: the place was assessed as meeting Section 5 of the Aboriginal Heritage Act 1972.
- Lodged: Information was received in relation to the place, but an assessment was not completed to determine if it met section 5 of the Aboriginal Heritage Act 1972.
- Stored Data/Not a Site: The place was assessed as not meeting Section 5 of the Aboriginal Heritage Act 1972.

Legacy ID: This is the former unique number that the former Department of Aboriginal Sites assigned to the place.

Coordinates

Map coordinates are based on the GDA 94 Datum.

Basemap Copyright

ID	Name	Boundary Restricted	Boundary Reliable	Culturally Sensitive	Culturally Sensitive Nature	Status	ACH Type	Place Type	Knowledge Holders	Legacy Place Status	Legacy ID
874	CARNARVON FASCINE	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Artefacts / Scatter; Midden	*Registered Knowledge Holder names available from DPLH	Registered Site	P07288
7129	LEWER ROAD RESERVE.	No	Yes	No	No Gender / Initiation Restrictions	ACH Directory	Place	Camp; Historical	*Registered Knowledge Holder names available from DPLH	Lodged	P05795
7130	LEWER ROAD WATERSNAKE	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	Registered Site	P05796
7131	LEWER ROAD LAW GROUND	Yes	Yes	Yes	Men only	ACH Directory	Place	Ritual / Ceremonial; Repository / Storage Place	*Registered Knowledge Holder names available from DPLH	Registered Site	P05797
7132	BREAKWATER No. 2.	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Artefacts / Scatter; Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	Registered Site	P05798
7190	TITIWARRA SOAK.	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	Registered Site	P05747
7232	MOBURN TREE.	Yes	No	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Ritual / Ceremonial; Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	Registered Site	P05684
7233	NJUNI TALU	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Ritual / Ceremonial	*Registered Knowledge Holder names available from DPLH	Registered Site	P05685
7234	KUWINWARDU SOAK.	Yes	No	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Camp; Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	Registered Site	P05686
7235	WATERHOLE	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Ritual / Ceremonial; Creation / Dreaming Narrative	*Registered Knowledge Holder names available from DPLH	Registered Site	P05687
8019	BROWN RANGE DEFLATION	No	No	No	No Gender / Initiation Restrictions	ACH Directory	Place	Artefacts / Scatter; Grinding areas / Grooves	*Registered Knowledge Holder names available from DPLH	Registered Site	P04670
8923	CARNARVON GOLF COURSE	No	Yes	No	No Gender / Initiation Restrictions	ACH Directory	Place	Burial	*Registered Knowledge Holder names available from DPLH	Registered Site	P03566

Aboriginal Cultural Heritage Inquiry System

List of Aboriginal Cultural Heritage (ACH) Directory

ID	Name	Boundary Restricted	Boundary Reliable	Culturally Sensitive	Culturally Sensitive Nature	Status	ACH Type	Place Type	Knowledge Holders	Legacy Place Status	Legacy ID
39200	Gascoyne and Lyons River	Yes	Yes	Yes	No Gender / Initiation Restrictions	ACH Directory	Place	Ritual / Ceremonial; Creation / Dreaming Narrative; Water Source	*Registered Knowledge Holder names available from DPLH	Registered Site	

Department of Planning, Lands and Heritage

Aboriginal Cultural Heritage Inquiry System

Map of Aboriginal Cultural Heritage (ACH) Directory

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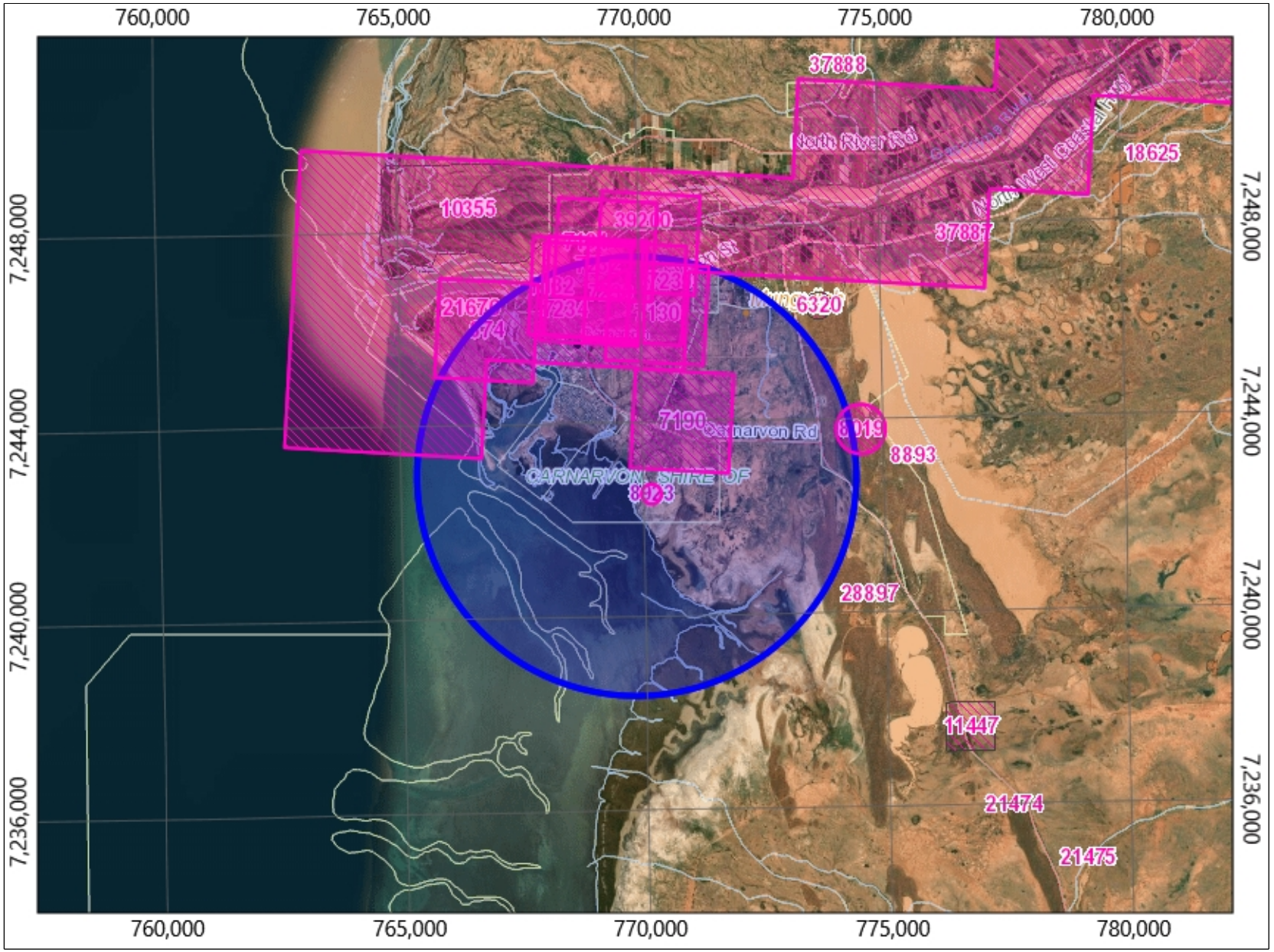


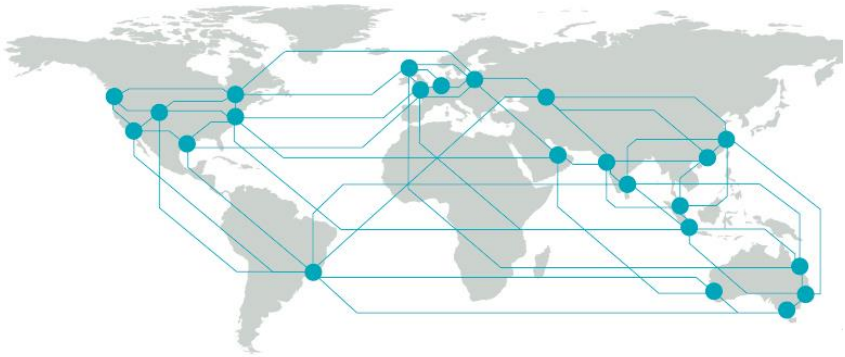
Legend

- Aboriginal Cultural Heritage (ACH) Directory
- Search Area
- Aboriginal Community
  - *Permanent*
  - *Seasonal*
  - *Town Based*
- Town
- Road
- River
- Local Government Authority

4.35 kilometres

Map Scale 1 : 132,000

MGA Zone 49 (GDA94)



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Site Selection and Options Analysis

B

13 March 2023

Gascoyne Barge Loading Facility Study

Options Analysis

ACIL ALLEN

About this Briefing Pack

ACIL Allen and technical partner BMT Group have been engaged by the Gascoyne Development Commission to undertake a pre-feasibility study for a barge loading facility in the Gascoyne region of Western Australia. This Briefing Pack contains the Options Assessment, presenting the sites and options developed, the assessment and scoring, and identification of preferred options.

Introduction

ACIL Allen and BMT Group have been working with the Gascoyne Development Commission and a Project Steering Group to undertake an assessment of the potential to establish a barge-loading facility in the Gascoyne region.

About this Briefing Pack

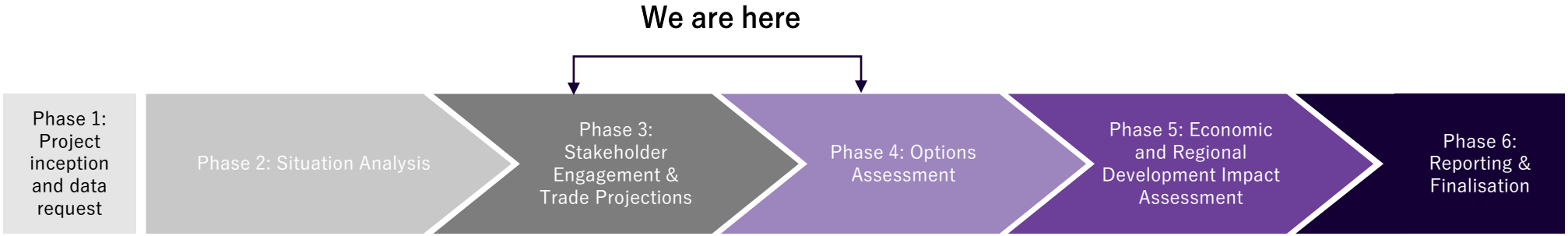
The study has progressed through to the Options Assessment, where a series of site and infrastructure delivery combinations are assessed for their capacity to meet a range of objectives and principles. This is bought together in a **Multicriteria Assessment ('MCA') framework**, the components of which are presented in the remainder of this Briefing Pack.

Prior to the presentation of the MCA, there is a range of background content provided for information and to assist in understanding the underlying rationale for the options, the criteria, and their weightings. This includes:

- A recap of the Objectives and Directions of the study (pg 3), which articulate the outcomes an investment is seeking to achieve
- A summary of the use cases for marine infrastructure in the Gascoyne (pg 4), based on stakeholder views and research
- A summary of the sites assessed as part of the study (pg 5), with pins dropped at approximate locations where infrastructure establishment has been investigated
- A summary of the long list of options considered in the MCA (pg 6), principally on the dimensions of site / location and capacity of the infrastructure to provide services (ie light infrastructure or heavy infrastructure).

The end of the report contains the Desktop Study summary material for reference. This should be read in conjunction with the Desktop Study and Annexures prepared by BMT Group.

Following the Options Assessment, BMT Group and ACIL Allen will begin drafting the pre-feasibility study itself, starting with the Basis of Design document and preparing trade projections and financial model.



Study objectives and directions

Objectives

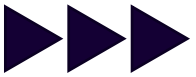
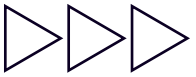
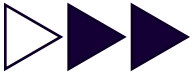
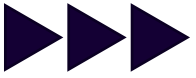
1	Identify the need for marine infrastructure in the study area, and assess the costs and benefits of establishing infrastructure
2	Identify sites which could serve the need, and appropriate infrastructure solutions at these sites
3	Prepare a study output which provides new data and information relevant to addressing the need, and presents a pathway for development of a solution

Directions

A	The study is centred on investigation of a barge loading facility, capable of facilitating barge and / or transhipment services in the region
B	Infrastructure solutions should give regard to the potential servicing of a broader array of trades within the scope of what is principally a barge-loading facility
C	The study should consider a pathway for phased development towards a more broad-ranging, multi-user infrastructure solution when considering sites and infrastructure

Industry development opportunities scan

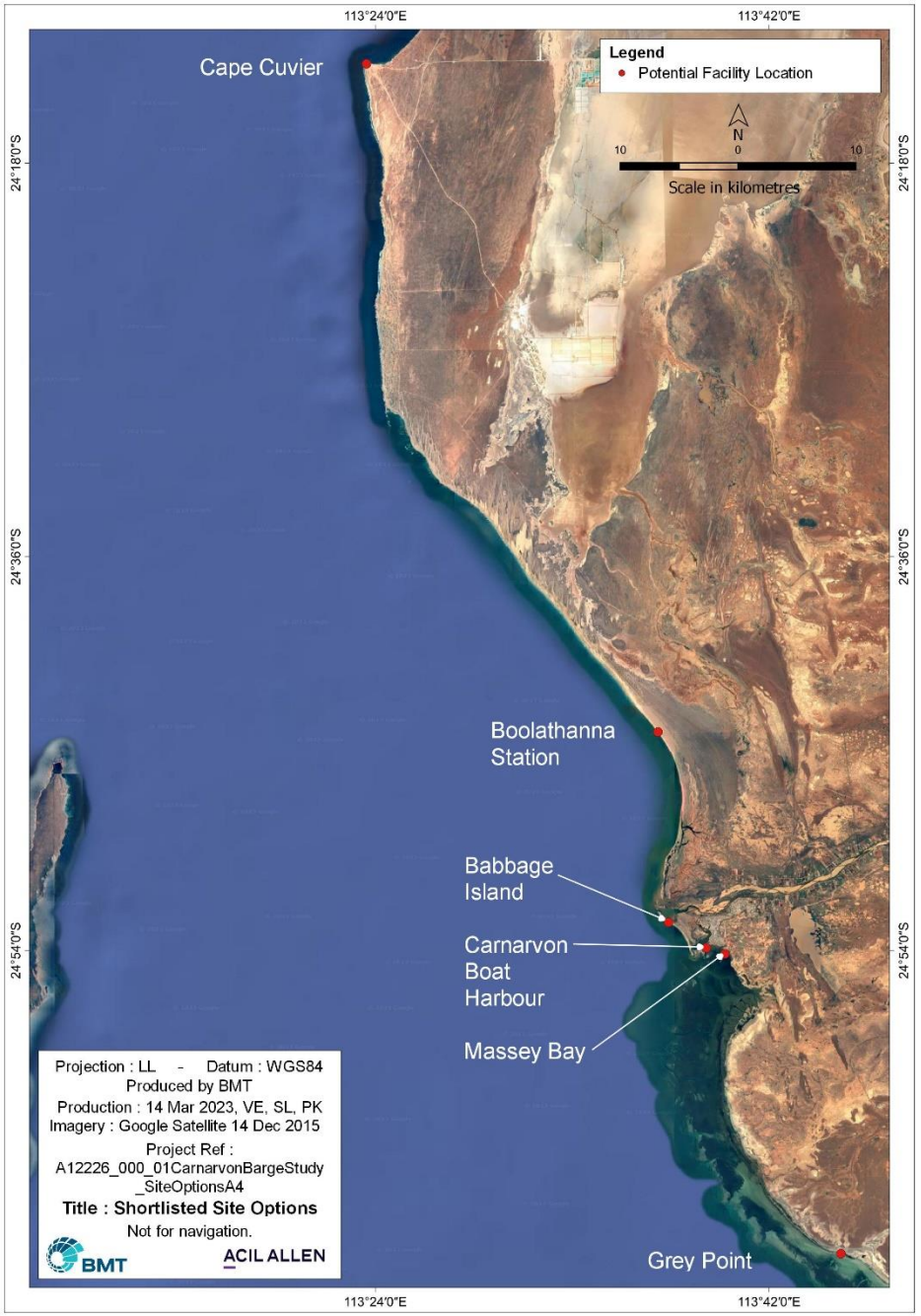
ACIL Allen and BMT have sought broad engagement with industry within the target region. To date discussions have centred on renewable energy / hydrogen, river sands, and high value minerals. Other industry stakeholders have been less forthcoming to date but their needs are broadly understood from past studies.

Opportunity	Prospect Likelihood of development	Demand Potential trade volumes	Suitability Barge facility is appropriate	Timing When will demand arise	Need Extent of need for solution	Impact Regional development
River sands						
Renewable energy						
High value minerals						
Other bulk commodities						
Agriculture & food (containerised)						
General cargo (containerised)						
General cargo (breakbulk)						
Vessel services			N/A			

Note: The fuller the graphic, the better from the perspective of the infrastructure or trade attribute. This does for the timing as well – a higher number of dark triangles means the opportunity is here now / in the short term.

Site selection: Summary

- Fatal flaw analysis performed across study area
- Broad area reduction achieved, revealing 6 sites for assessment in long list
- Local considerations for each summarised based on information presented within the desktop review



Infrastructure Options - light to moderate or heavier multifunctional

Two non site specific functional options developed to approximate qualitative value for assessed criteria at identified locations

- Light to moderate – single function

- Heavier multifunctional facility

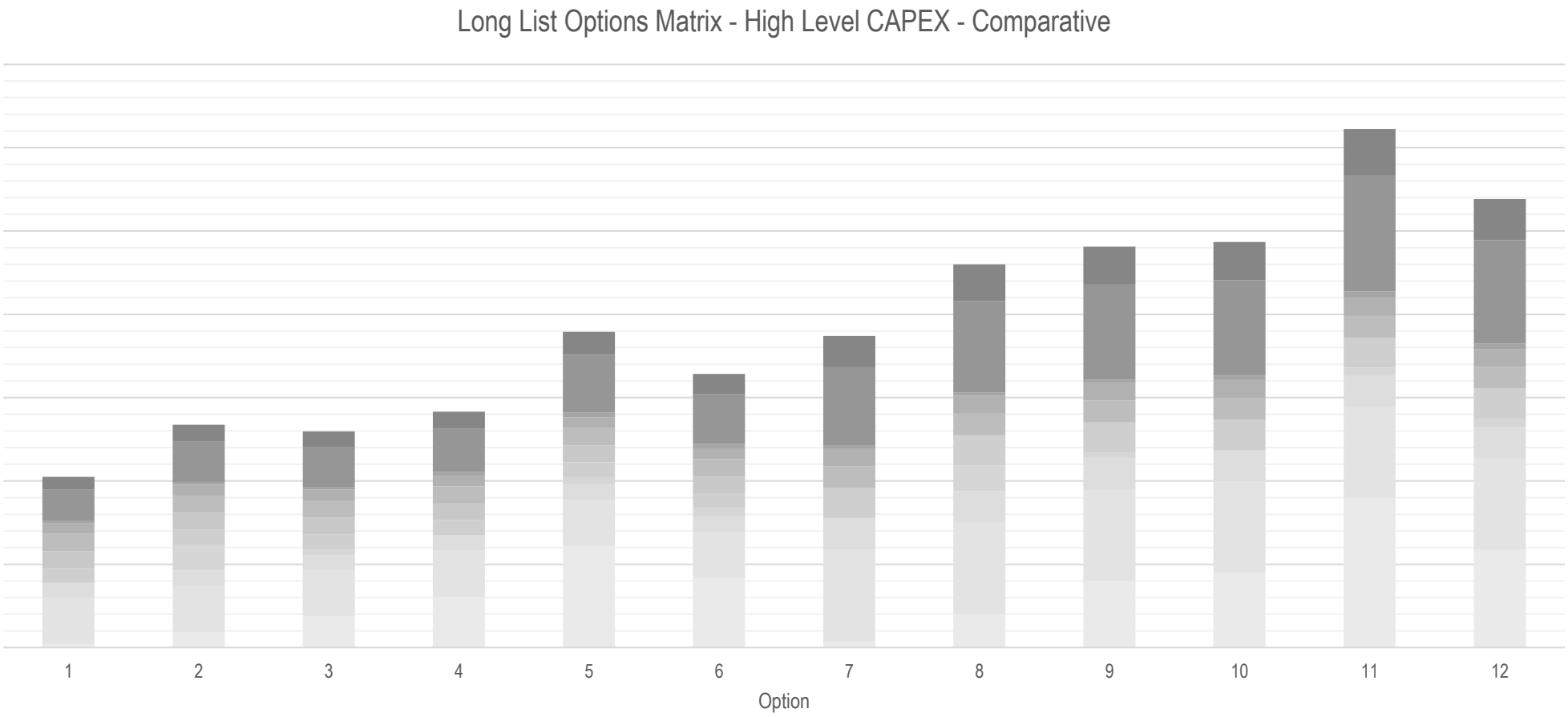
Long list of options

There are 12 options in the long list, taking the option dimensions of site and intensity of infrastructure option. The assessment is based on carrying 1-3 (ideally 2) options through to the impact analysis phase.

Infrastructure	Site					
	Babbage Island	Boolathanna Station	Cape Cuvier	Carnarvon Boat Harbour	Grey Point	Massey Bay
Barge with light to moderate capacities, and limited landside loading infrastructure	Option 1	Option 3	Option 5	Option 7	Option 9	Option 11
Heavier barge with extensive landside loading infrastructure, possible multi-function capability	Option 2	Option 4	Option 6	Option 8	Option 10	Option 12

CAPEX Comparison

To qualify one of the key criteria, capital costs, approximate CAPEX for each option was drafted. Considerations included dredging works, land and marine based civil works, protective structures, laydown and stockpile requirements, access road construction, ship loader or craneage costs, EPCM and regulatory approvals. An establishment cost was included for vessels, considering they would likely be procured through charter arrangements.



Multicriteria Assessment: Criteria to assess options

ACIL Allen, BMT and GDC have prepared a series of criteria for the MCA for discussion. This is considered a “long list” and will need to be refined prior to use in the MCA. The criteria will be used to assess what matters most for a development in this region, and determine which option or options best meet the criteria.

Cost / complexity criteria

1. Capital cost
2. Operating cost
3. Construction complexity and deliverability
4. Marine operability
5. Availability and tenure of adjacent land
6. Land side infrastructure development needs
7. Uncertainty with respect to local conditions

Social / environmental criteria

1. Regulatory and approvals pathway complexity
2. Land side environmental impact
3. Marine side environmental impact
4. Proximity to Carnarvon Town Centre

Economic / commercial criteria

1. Proximity to renewable hydrogen centre
2. Proximity to river sands centre
3. Flexibility to facilitate multiple trades
4. Potential for local economic impact / benefits
5. Potential to be intensified / developed in the future

MCA: Cost & complexity criteria

The following criteria are proposed to form part of the assessment, from a cost and complexity perspective. In general, the more costly, complex or uncertain the option is, the lower it is expected to score in the MCA.

Criteria	Description
Capital cost	The upfront cost of building the infrastructure. The higher the cost, the less preferred the option.
Operating cost	The ongoing expected operational cost of the infrastructure, including long run maintenance requirements (ie dredging). The higher the expected operating cost, the less preferred the option.
Construction complexity & deliverability	The anticipated challenges which would need to be overcome to develop the infrastructure concept at a particular site. The more complex, the less preferred.
Marine operability	The expected risks to operability versus theoretically benign metocean conditions, as this impacts throughput and economic outcomes. The less operable the less preferred.
Availability and tenure of adjacent land	Land tenure on the land side of the facility location, to facilitate cargo transfer, laydown and other services. The more complex / uncertain, the less preferred.
Land side infrastructure development needs	The prospect of additional land side investment to fully unlock the infrastructure option at the assessed site. The more infrastructure required, the less preferred.
Uncertainty with respect to local conditions	The study is designed to make use of the best available information to inform initial options analysis. Where there is limited information on a site, this site is less preferred.

MCA: Social / environmental criteria

The following criteria are proposed to form part of the assessment, from a social / environmental perspective. In general, the more impacts which can be foreseen, either in terms of the expected complexity of the approvals pathway or in physical impacts on the environment or social amenity of the region, the less preferred an option will be.

Criteria	Description
Regulatory and approvals pathway complexity	The number of challenges and barriers which would need to be overcome to develop infrastructure at the selected site, noting the Desktop Review has already knocked out sites which are generally unfeasible. The more complex a site's pathway, the less preferred it will be.
Land side environmental impact	The anticipated landside environmental impacts which would be expected to occur. The more land side impacts which are known in advance, the less preferred a site / infrastructure option will be.
Marine side environmental impact	The anticipated marine side environmental impacts which would be expected to occur. The more land side impacts which are known in advance, the less preferred a site / infrastructure option will be.
Proximity to Carnarvon Town Centre	The proximity of the option to the Carnarvon Town Centre could be perceived as advantageous or detrimental. At this stage it has been included in social / environmental as a negative influence on the MCA, as close proximity to the Carnarvon Town Centre would create noise, dust, traffic and other hazards for residents and businesses. The closer to the Carnarvon Town Centre, the less preferred an option will be.

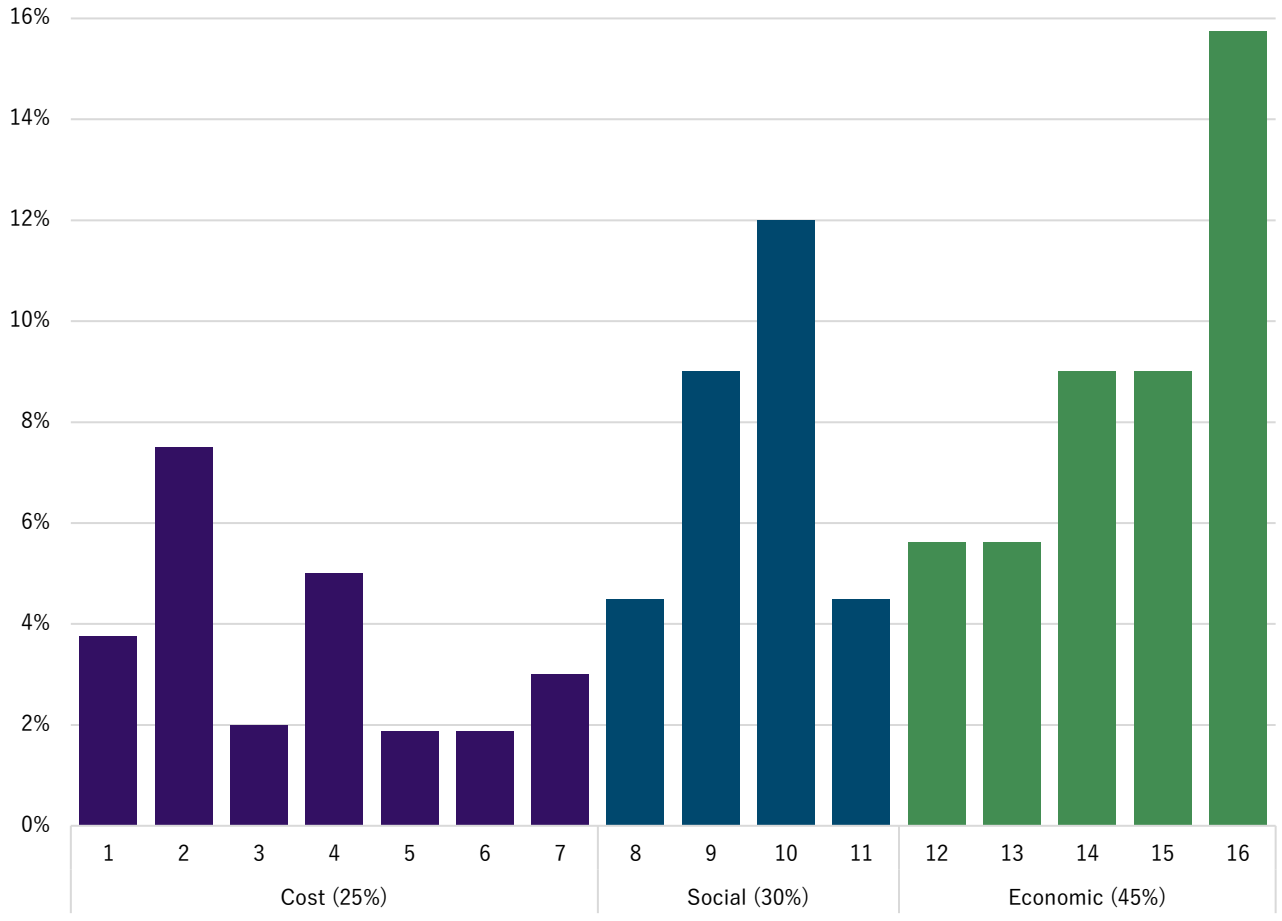
MCA: Economic / commercial criteria

The following criteria are proposed to form part of the assessment, from an economic / commercial perspective. In general, the more trades an option can service, and the more proximate it is to where the expected sources of trade demand lie, the more preferred it will be. This options set includes consideration of the future development options enabled by the chosen option.

Criteria	Description
Proximity to renewable hydrogen centre	The option's proximity to the geographic centre of proposed renewable energy and renewable hydrogen developments is a measure of its capacity to efficiently service this trade. The closer an option, the more it will be preferred.
Proximity to river sands centre	The option's proximity to the geographic centre of river sand tenements and leases is a measure of its capacity to efficiently service this trade. The closer an option, the more it will be preferred.
Potential for local economic impact / benefits	The option's proximity to the Carnarvon Town Centre represents the facility's potential capacity for local economic benefits to be felt directly as a result of the facility. This is perceived to be an important driver given current conditions in Carnarvon.
Flexibility to facilitate multiple trades	Given the long run potential of the Gascoyne region, a facility and location combination with the flexibility to service multiple trades will be preferred over a facility with less flexibility.
Potential to be intensified / developed in the future	This important criteria is one of the ways the project will take into account the feedback provided by stakeholders to date regarding the long run need for a more intensive marine infrastructure solution in the region. A site or infrastructure option which presents more future pathways for development will be preferred over a more static solution.

MCA: Criteria weightings

The following MCA weightings were developed and adopted at a meeting of the Project Steering Group on 28 February. The weightings reflect the category weightings (sum to 100% across the three categories), and individual criteria weightings (sum to 100% across each category), with the applicable weighting being a function of the category and individual criteria weightings.



Criteria	
1.	Capital cost
2.	Operating cost
3.	Construction complexity and deliverability
4.	Marine operability
5.	Availability and tenure of adjacent land
6.	Land side infrastructure development needs
7.	Uncertainty with respect to local conditions
8.	Regulatory and approvals complexity
9.	Land side environmental impact
10.	Marine side environmental impact
11.	Proximity to Carnarvon Town Centre
12.	Proximity to renewable hydrogen centre
13.	Proximity to river sands centre
14.	Potential for local economic benefits
15.	Flexibility to facilitate multiple trades
16.	Potential to be developed in the future

Note: Values presented in the chart are the overall weightings (ie category x individual). These values sum to 100% and are the values used to drive the MCA.

MCA: Options Scoring

The scoring of the MCA was undertaken by ACIL Allen and BMT Group on 9 March, independently from the Project Steering Committee. Scoring was based on a Likert scale of 1-5, where '1' meant the option was not at all aligned and '5' meant the option was strongly aligned to fulfilling the intent of the criteria. The scoring was based on a series of structured attributes of each option against the criteria, with scores starting at '3' and 0.5 to 1 point being added or deducted based on these attributes.

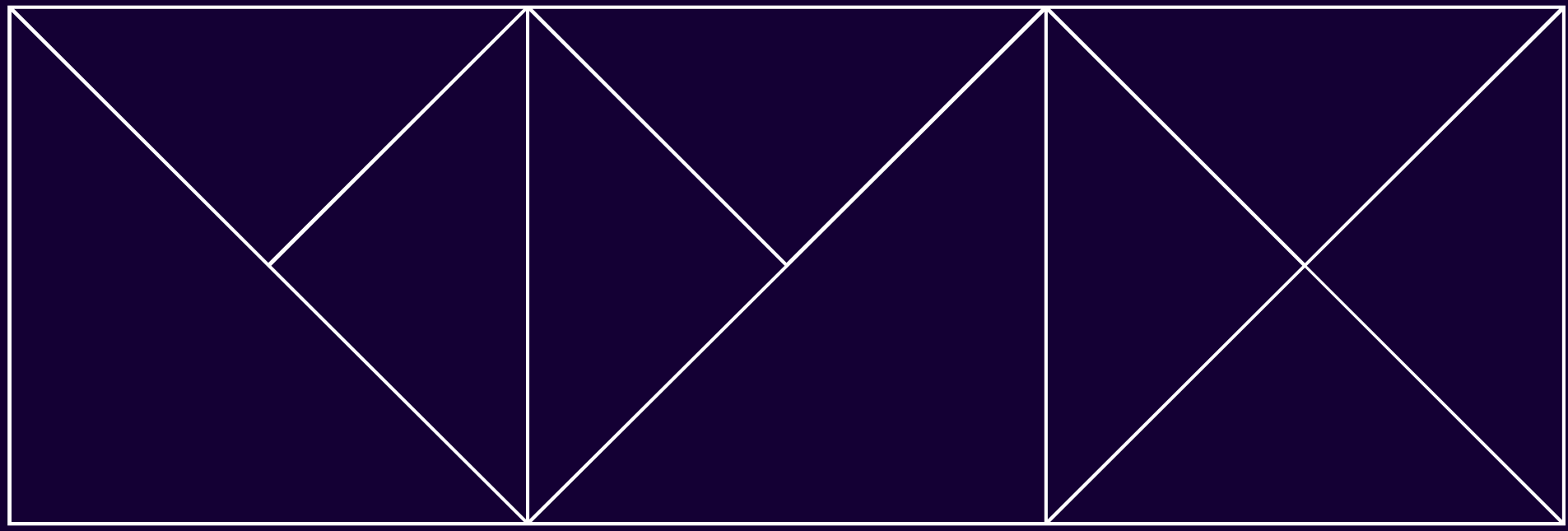
Site	Babbage Island	Babbage Island	**Boolathanna Station**	**Boolathanna Station**	Cape Cuvier	Cape Cuvier	**Carnarvon Boat Harbour**	Carnarvon Boat Harbour	Grey Point	Grey Point	Massey Bay	Massey Bay
Capacity	Moderate	Heavy	**Moderate**	**Heavy**	Moderate	Heavy	**Moderate**	Heavy	Moderate	Heavy	Moderate	Heavy
Option number	Option 1	Option 2	**Option 3**	**Option 4**	Option 5	Option 6	**Option 7**	Option 8	Option 9	Option 10	Option 11	Option 12
Capital cost	5	3	**4**	**3**	5	4	**4**	2	3	2	3	1
Operating cost	3	1	**4**	**2**	5	3	**4**	2	3.5	1.5	3	1
Construction complexity & deliverability	4	3	**4**	**3**	4	3	**3.5**	2.5	3.5	2.5	4	3
Marine operability	4	3	**3.5**	**2.5**	2.5	1.5	**4**	3	3.5	2.5	4	3
Availability and tenure of adjacent land	3	3	**4**	**4**	2	2	**3**	3	4	4	3	3
Land side infrastructure development needs	4	3.5	**3**	**2.5**	3	2.5	**4**	3.5	3	2.5	4	2.5
Uncertainty with respect to local conditions	2.5	2	**2.5**	**2**	3	2.5	**3**	2.5	2.5	2	3	2.5
Regulatory and approvals pathway complexity	3	3	**2.5**	**2.5**	4.5	4.5	**4**	4	1.5	1.5	3.5	3.5
Land side environmental impact	2.5	2.5	**3**	**3**	3	3	**3.5**	3.5	3	3	3.5	3.5
Marine side environmental impact	3.5	2.5	**3.5**	**2.5**	4	3	**3.5**	2.5	2.5	1.5	3	2
Proximity to Carnarvon Town Centre	2	2	**4**	**4**	4	4	**2**	2	4	4	2	2
Proximity to renewable hydrogen centre	3	3	**4**	**4**	2	2	**3**	3	2	2	3	3
Proximity to river sands centre	3	3	**3**	**3**	1	1	**3**	3	3	3	3	3
Local economic opportunities	3	3.5	3	3.5	2	2.5	3	3.5	3	3.5	3	3.5
Flexibility to facilitate multiple trades	2.5	4	**2.5**	**4**	2.5	4	**2.5**	4	2.5	4	2.5	4
Potential to be intensified / developed in the future	2.5	3.5	**3.5**	**5**	1	2	**2.5**	3.5	3.5	5	2.5	3.5
Weighted score	**3.00**	**2.89**	**3.33**	**3.35**	**2.82**	**2.75**	**3.17**	**3.07**	**2.97**	**2.99**	**2.99**	**2.87**
Rank	5	9	2	1	11	12	3	4	8	7	6	10

MCA: Preferred options

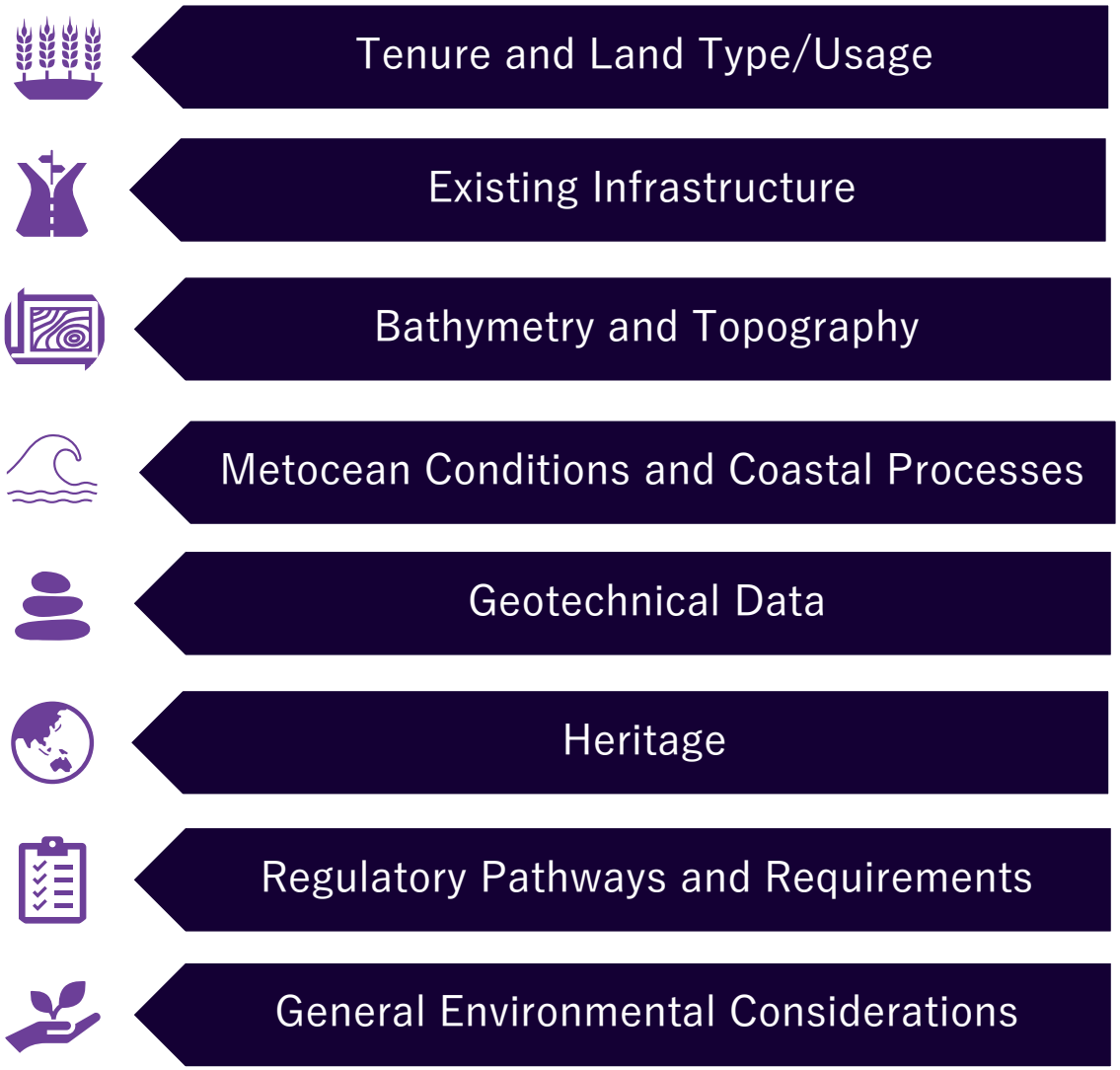
The MCA resulted in a cluster of scoring between 2.5 and 3.5 out of 5, reflecting the inherent trade-offs built into the criteria. It is evident the options which are most suitable from an economic perspective are also those which are the most costly and / or risky. Notwithstanding, the MCA identifies the Boolathanna Station site as the most preferred, with the Carnarvon Boat Harbour scoring the highest overall due to the potential for lesser environmental impacts, and its less complex regulatory and approvals pathway.

Option	Site	Infrastructure	Positive	Negative	Overall view
Preferred Option #1	Boolathanna Station	Heavy Infrastructure Capacity	▪ Single highest score on economic criteria, due to location and infrastructure. ▪ Location outside of Carnarvon provides boost versus other Heavy options.	▪ One of the weakest scores on cost to due channel creation and heavier berthing infrastructure build. ▪ Uncertainty regarding local conditions and environmental impacts the most significant hurdle.	Presents the option which is mostly likely to service the highest proportion of prospective trades, with flexibility to meet future development needs. May be the most costly however this is less of a concern at this stage of the project.
Preferred Option #2	Boolathanna Station	Moderate Infrastructure Capacity	▪ Clearly strongest site for economic criteria, including potential for future development, noting this infrastructure would not cater to heavy lift tasks. ▪ Relatively strong on cost due to limited need for dredging in this infrastructure mode.	▪ As above, the site scores relatively poorly due to uncertainty and potential regulatory complexity. ▪ Fairly balanced scoring otherwise, no other clear weaknesses.	Presents a “middle ground” option between the localised focus of Preferred Option #3 and the more costly, risky but flexible Preferred Option #1. However could be rolled into Preferred Option #1 with scenario testing.
Preferred Option #3	Carnarvon Boat Harbour	Moderate Infrastructure Capacity	▪ Strong score on cost, noting some construction complexity to be expected. ▪ Relatively strong score on social impact, with only detriment the physical location in Carnarvon.	▪ Relatively weak score on economic criteria due to limited potential for future expansion and inability to cater to broad range of trades ▪ Uncertainty: some landside constraints may emerge on further investigation.	Merit in exploring this option as it represents delivery of a localised infrastructure solution which could be of benefit to the region. However, it is unlikely to address stakeholder feedback on the need for a pathway to a multi-user port for the region.

Appendix: Site and Infrastructure Assessment and Fatal Flaws Analysis (Desktop Study Summary)

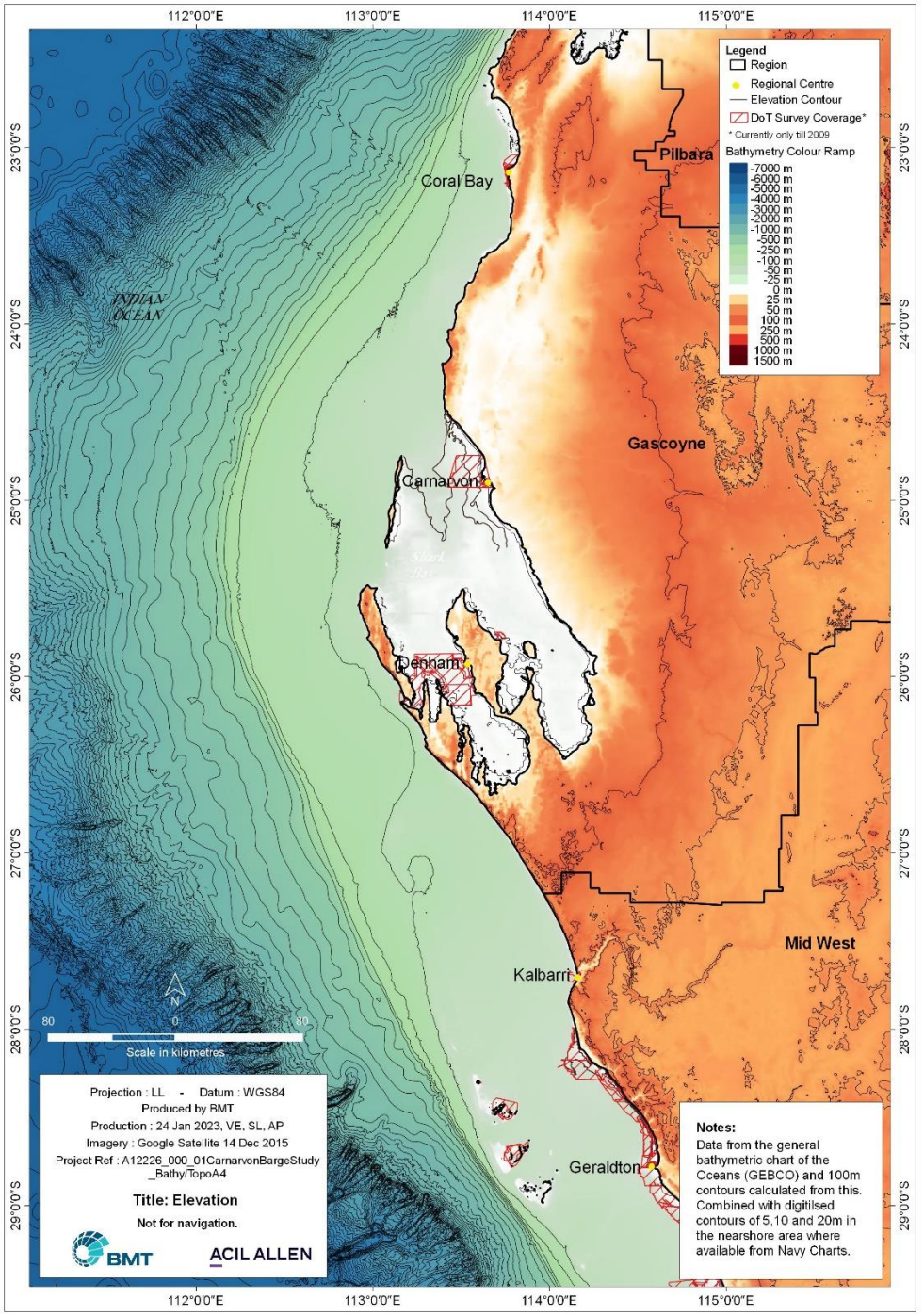


Desktop Study

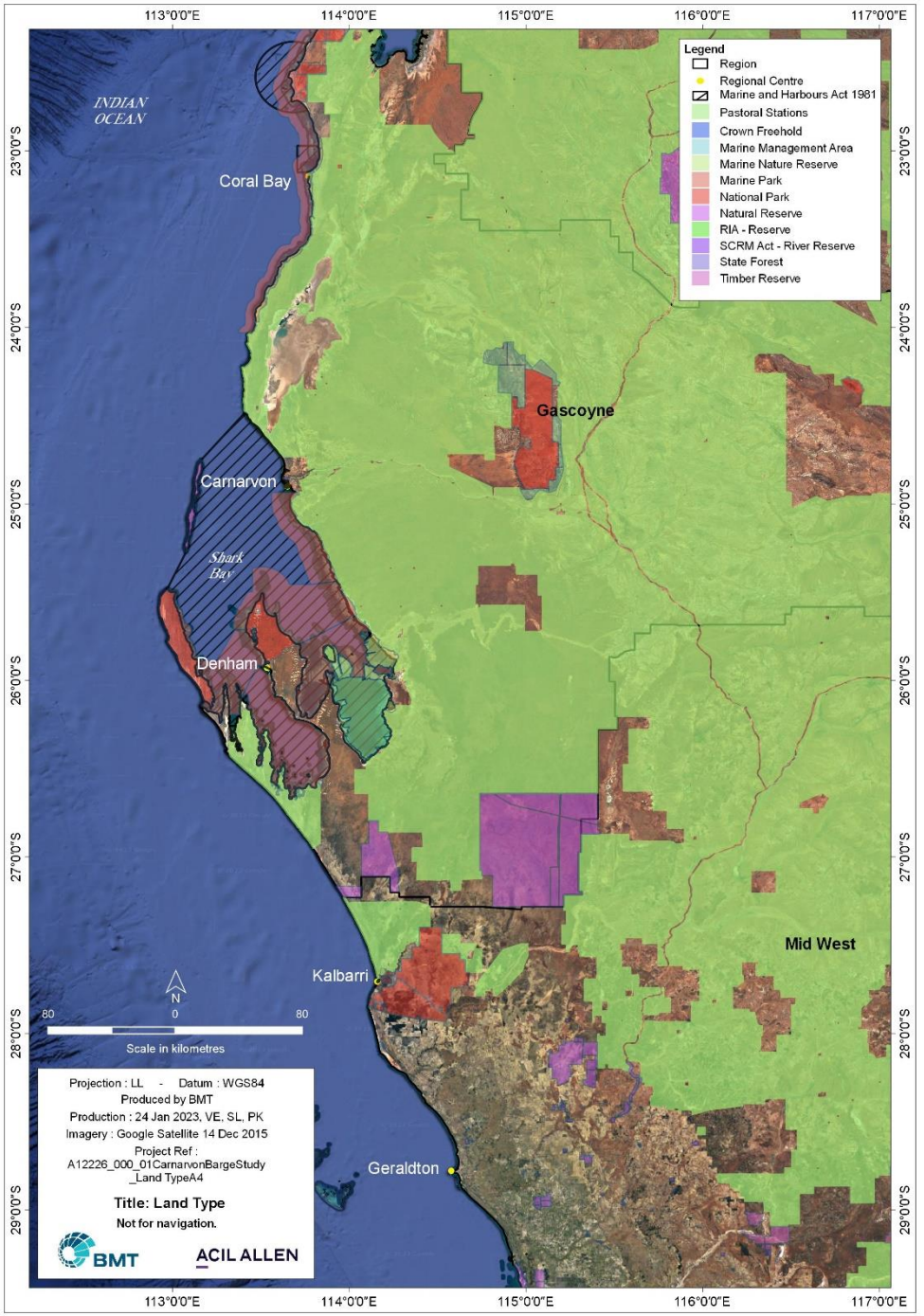


Desktop study findings

Bathymetry



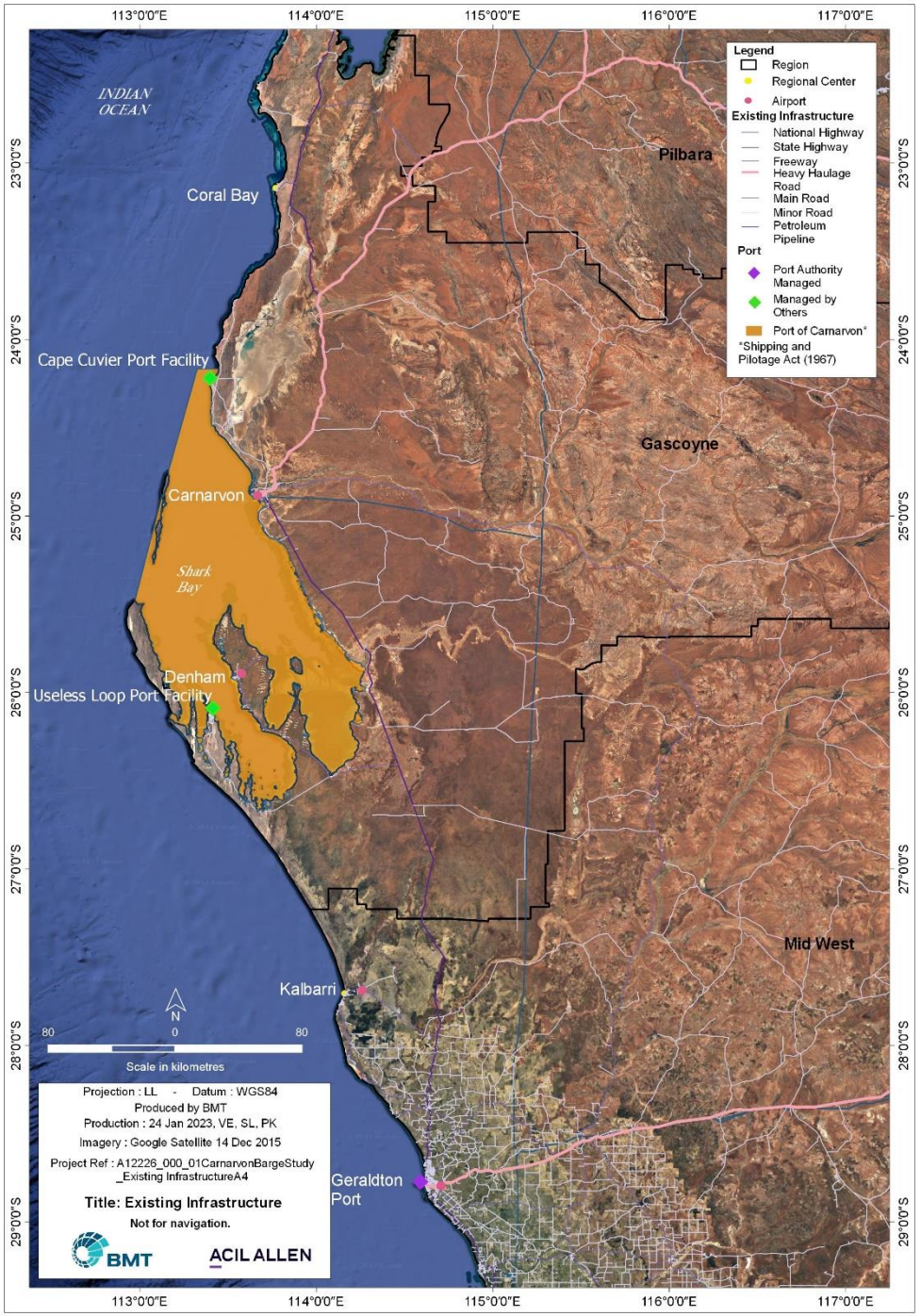
Desktop study findings
Land Type



Data obtained from Landgate

Desktop study findings

Infrastructure

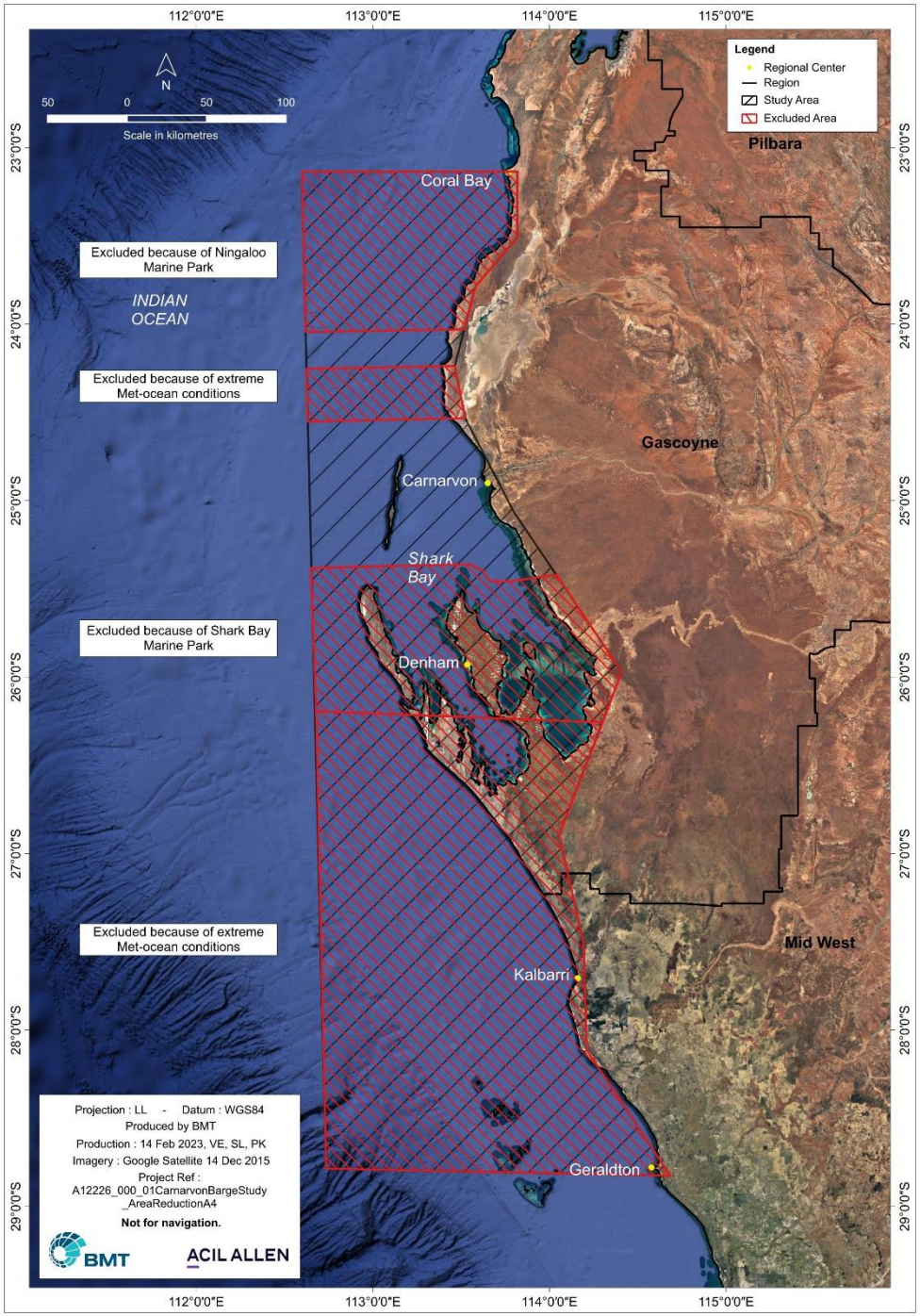


Data obtained from DataWA

Site Selection Key Considerations

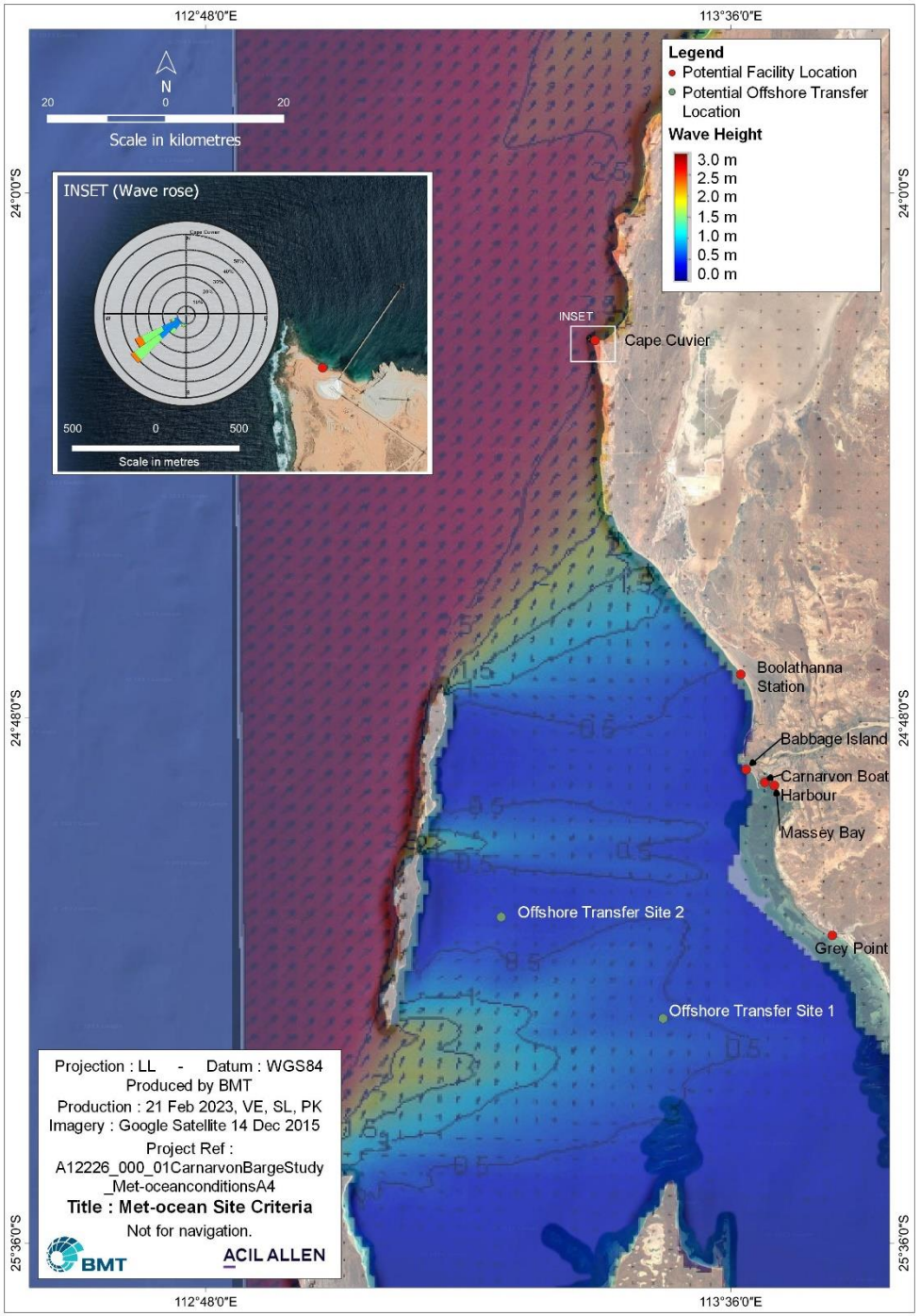
Screening criteria	Examples
Potential for future development	▪ Space for future extensions and a multi user facility ▪ Proximity to deep water access (12m) (i.e., minimise the requirement for dredging)
Metocean conditions	▪ Avoid areas that experience extreme weather, looking for areas that are protected from the southerly swell events brought about by cold fronts in winter months. Likewise avoiding the northern extent of the study area as the risk for cyclones is higher. ▪ Looking for areas that are naturally sheltered to avoid large additional costs for additional protective structures.
Bathymetry	▪ Under Keel Clearance (UKC) required quayside (~4-5m for the Barge option and up to ~14m for heavy module loading and exports). ▪ Suitable depth to allow passage to and from the Facility, want to reduce the cost required for dredging of channels and basins etc.
Coastal Processes	▪ Avoiding areas with intense dynamic coastal processes and alluvial soil to avoid high channel maintenance costs.
Environmentally sensitive areas (Marine Parks)	▪ Areas of extreme environmental sensitivity need to be avoided (i.e., Ningaloo Marine Park and Shark Bay Marine Park, due to additional regulatory requirements ▪ MNES (EPBC)

Fatal Flaw/ Area Reduction



Sites

Met-Ocean Criteria



Data obtained from:
AECOM (2010) Bejaling Deepwater Port Study. Prepared for Gascoyne Development Commission by AECOM Australia Pty Ltd, 15 October 2010

Sites

Depth Criteria

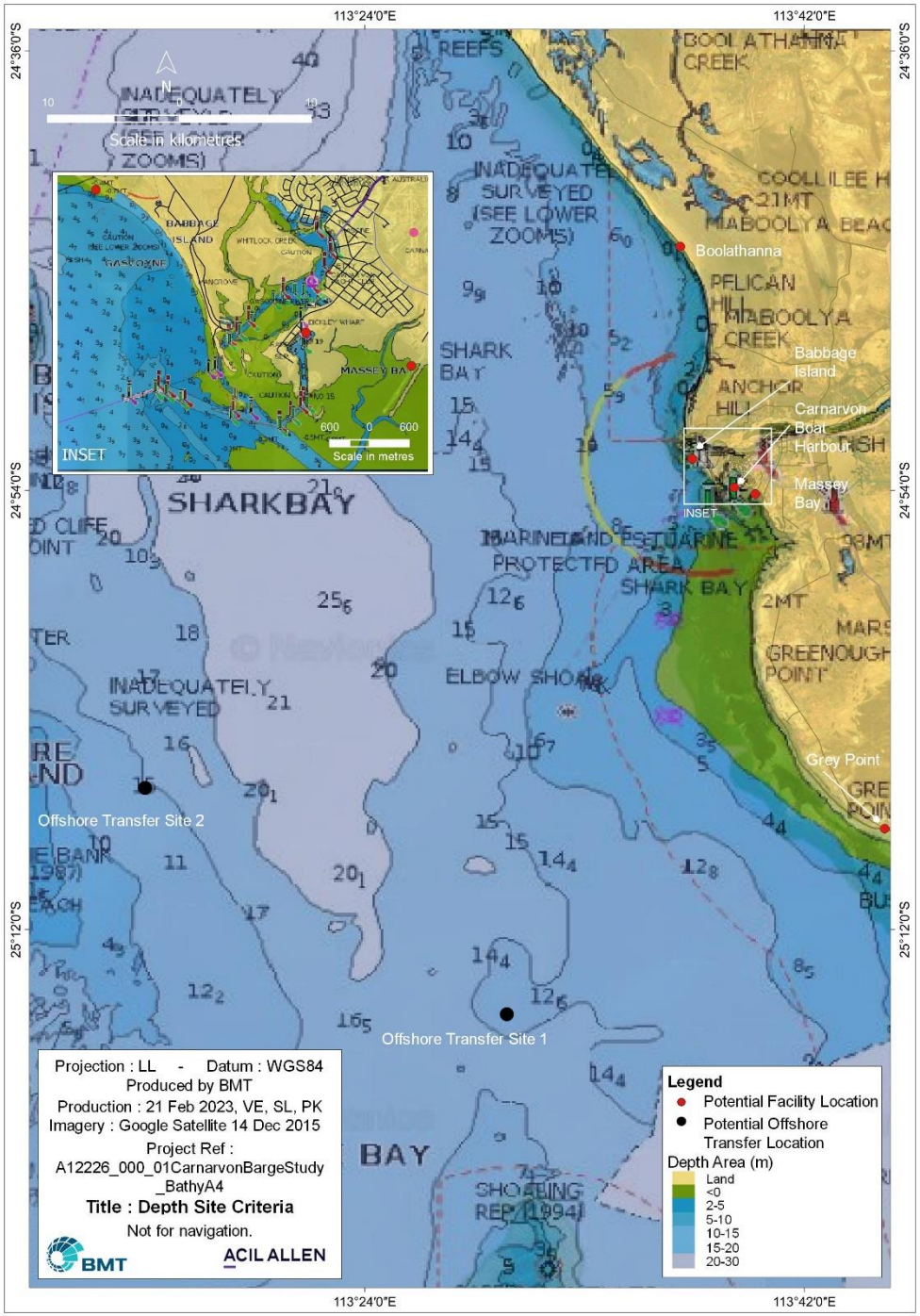
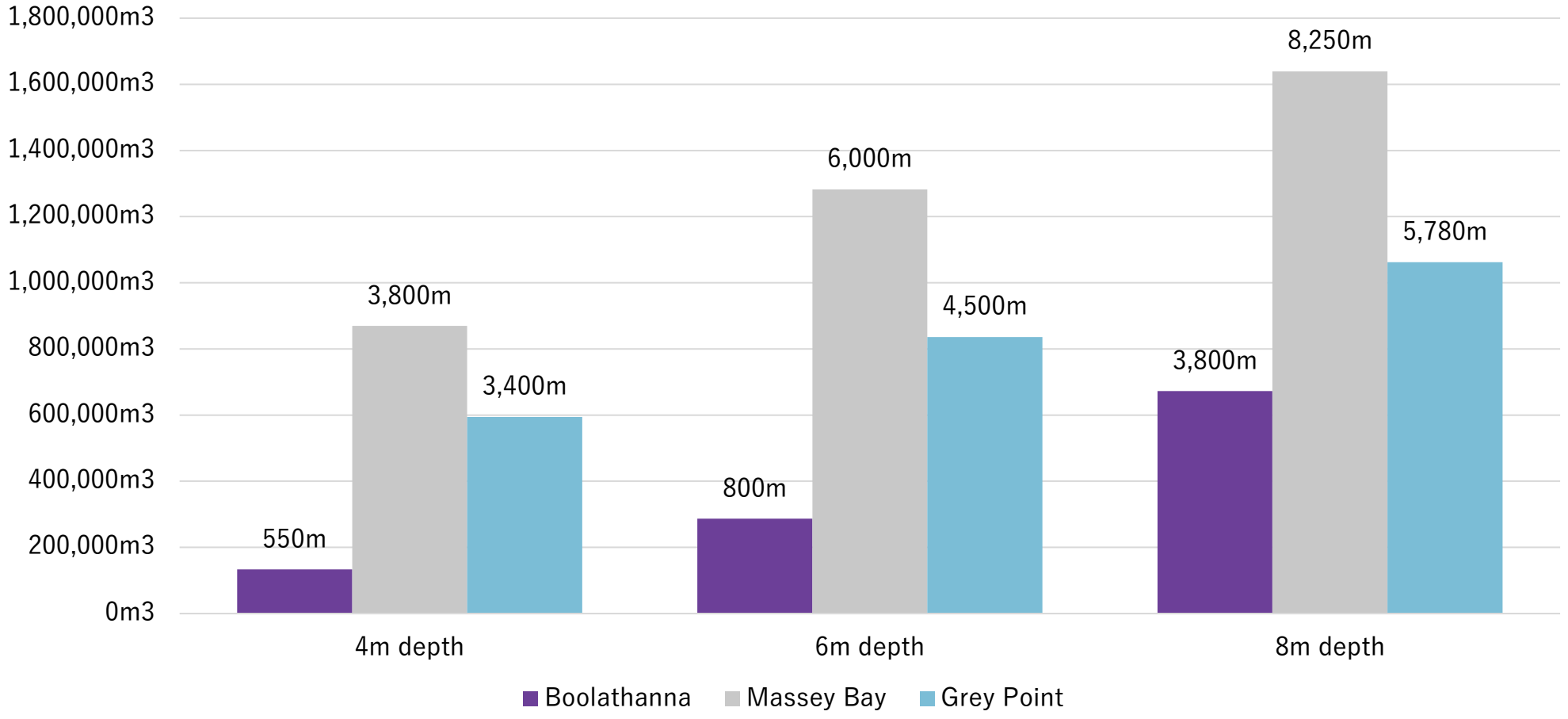


Image courtesy of Navionics

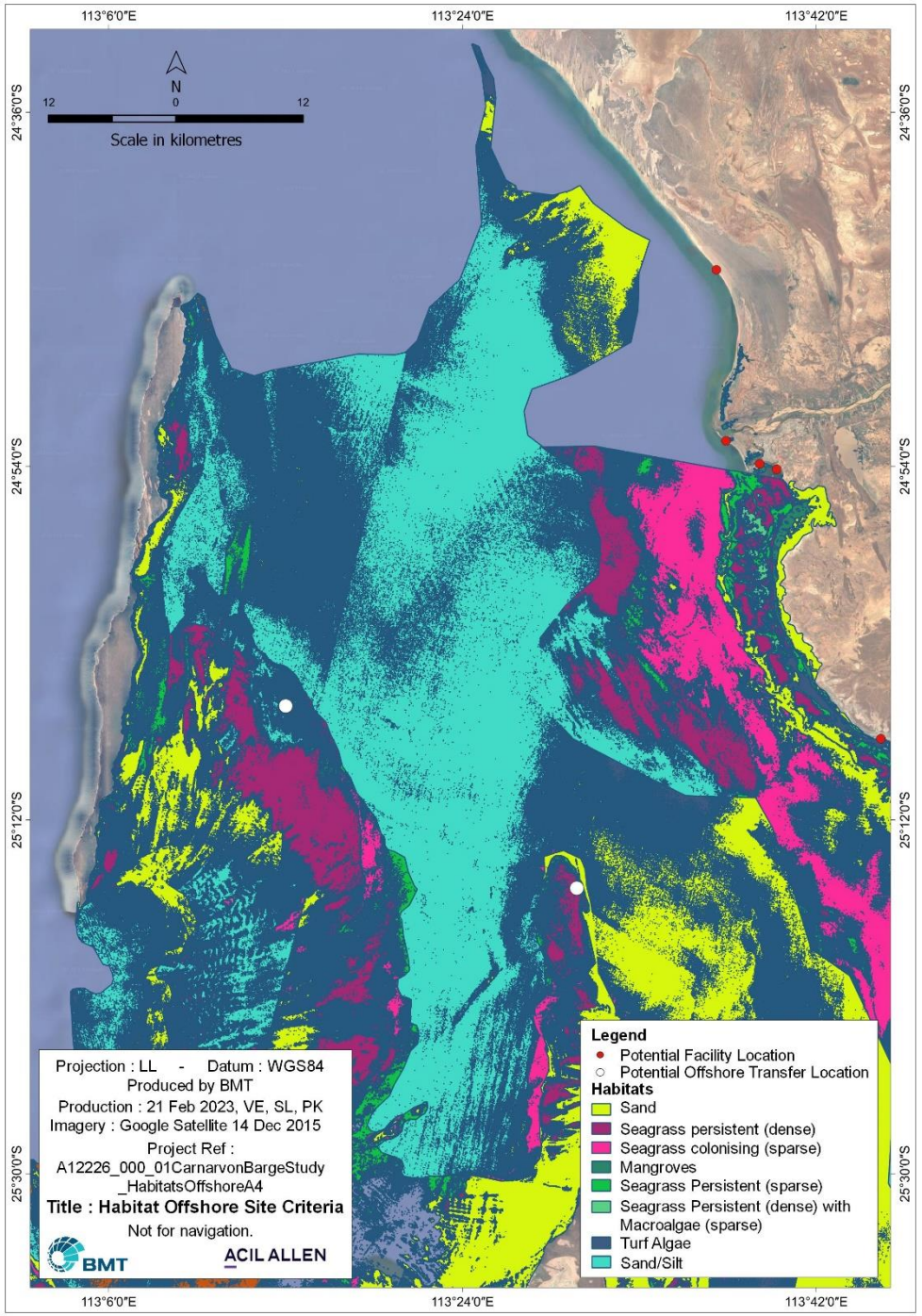
Future development optionality: Dredge requirements for selected options

Access to appropriate depth to facilitate a broader array of trades beyond the initial barge task is expected to require significant volumes of dredging at certain sites. An initial estimate of the volume of dredging required (in cubic metres) is provided below. Approximate channel length requirement is included above each column.



Sites

Benthic Habitat Map - OTL



Data obtained from:
BMT (2021) Carnarvon Fascine Entryway Benthic Habitat Mapping. Prepared for Department of Transport by BMT Commercial Australia Pty Ltd, Report No. R-1755_00-15, Perth, Western Australia, September 2021

Matters of National Environmental Significance (EPBC)

MNES	Relevant to Study Area
World heritage properties	▪ Shark Bay World Heritage Area ▪ Ningaloo Coast World Heritage Area
National Heritage places	▪ Batavia Shipwreck Site and Survivor Camps Area [1629] ▪ Dirk Hartog Landing Site [1616]
Nationally threatened species and ecological communities	▪ The Initial Desktop Review Study Area is within and adjacent to critical habitat and/or feeding grounds to threatened marine fauna species
Migratory species	▪ The Initial Desktop Review Study Area is within and adjacent to critical habitat and/or feeding grounds to migratory marine birds, fauna, terrestrial and wetland species
Commonwealth marine areas	▪ EEZ and Territorial Sea

Sites (Long List Consideration)

Devised Site criteria

- Depth to minimise dredging
- Avoid environmentally sensitive areas
- Suitable protection from harsh south/south west Met-ocean conditions
- Potential for future development
- Avoid dynamic coastal areas
- Reduce the distance between current infrastructure and the chosen site

Onshore:
• Cape Cuvier • Boolathanna Station • Babbage Island • Carnarvon Boat Harbour • Massey Bay • Grey Point

Offshore Transfer Location:
• Northern Option • Southern Option

Functional Options – Technical Outputs from Stakeholder Consultation

River Sands

- Bulk export
- Approx 1 million tonnes per annum per proponent (2 identified)
- Identified market in Singapore

High Value Minerals

- Containerised export
- Currently small market (2,000 containers per year – likely to continue to grow
- Hazardous materials (radioactive), heavy non-standard containers

Other Bulk Commodities

- Higher volume lower value in comparison to REE.
- Export
- Significant number of exploration leases in the region, market may increase

Agriculture and food

- Containerised export
- Market expected to continue to grow

Renewable Energy

- Import construction materials (3 million tonnes of concrete per proponent (3))
- Import wind and solar farm components (7 to 9GW), up to 1000 turbines
- Import processing facility modules (Heavy Lift)

Functional Option – Construction Sand Bulk Handling (Export)

Functional Option – Containerised Rare Earth Elements (Export)

- Hazardous/Radioactive material
- Stored in concrete lined containers (additional tare weight (up to 40 tonne total)
- Road haulage to site
- Temporary laydown for efficiency

- Craneage would be required at quayside to transfer containers.
- Dedicated container crane or at least a hydraulic lifting tool would be ideally incorporated

- Mid-size barge likely suitable (80m), similar mid size tug with draft requirement approx. 5m
- Temporary Seafastening required on barge
- Craneage required on OGV

Functional Option – Major Onshore Power to X Projects – Construction Support (Import)

Future Consideration – Major Onshore (or Offshore) Power to X Projects – Construction Support, RO-RO, MOF Outside of Current Scope

Functional Options – Summary of Technical Requirements

Technical Requirement	River Sands	High Value Minerals	Other Bulk Commodities	Agriculture and Food	Renewable Energy
UKC	4 m	4 m	4 - 5 m	4 - 5 m	4-5 m initially, 8 to 10 for RO-RO, 12-14 for HLV
Quayside Infrastructure	Area for stockpile Ship loader, fixed or mobile	Area for laydown and container stacking. Crane, approx. 100t	Area for stockpile Ship loader, fixed or mobile	Carenage suitable for container lift, approx. 100t	Mobile crane initially (200t) for accom units. Ro-Ro berth and heavy load capacity for modules – lift from vessel
Barge and tug requirements	60 to 80 m flat top barges with hopper (2). Medium, sized tug in support	60 to 80 m flat top barge, seafastening with container lock system, stack 2 high. Medium sized tug	100m flat top barges (2), 2 tugs in support, one large one small	60 to 80 m flat top barge, seafastening with container lock system, stack 2 high. Medium sized tug	100m flat tope barge may suffice for wind/solar farm components, otherwise, deep water access required
OGV requirements	Geared, handymax size or less, hydraulic clam shell grabs	Geared, handymax size or less, container lifting tools. Likely dedicated due to value and route.	Geared, handymax size or less, hydraulic clam shell grabs	Geared, handymax size or less, container lifting tools	GCV initially, RO-RO and HLV for later functions

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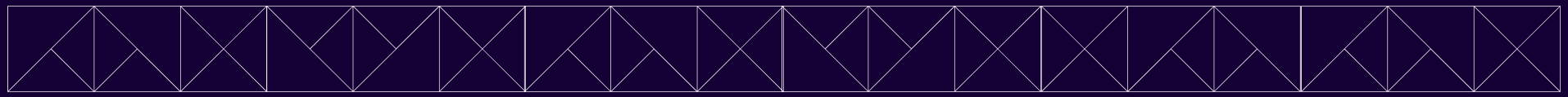

Options Assessment Scoring Approach

C

The approach to scoring each of the long list options on the criteria in the Multicriteria Assessment is introduced below.

Table C.1 MCA Scoring System

Criteria	Scoring approach
Capital cost	– Starting value of 3 for all options – Options penalised / boosted by 1 point for every 0.2pt of Standard Deviation away from the average capital cost
Operating cost	– Options start at 4 for all options – Options deduct 1-2 points for subjective assessment of maintenance dredge costs – Options deduct 1 point for larger barge operations – Options deduct 1 point for expected channel length and width requirements
Construction complexity & deliverability	– Options start at 3 – Small infrastructure benefits 1 point – Known build risks at sites deduct 0.5 points
Marine operability	– Options start at 3 – Smaller barges benefits 1 point (more flexibility) – Deduct 0.5-1 point for exposure to coastal processes – Cape Cuvier penalised additional point due to competing uses
Availability and tenure of adjacent land	– Options start at 3 – Deduct 1 point for each additional land tenure matter to overcome – Greenfield sites (away from Carnarvon) benefit due to isolation
Land side infrastructure development needs	– Options start at 4 – Deduct 0.5 points for every road access investment requirement – Deduct 1 point for heavy haul road / laydown requirement of larger facility
Uncertainty with respect to local conditions	– Options start at 3 – Deduct 0.5 points for every unknown aspect of site / access
Regulatory and approvals pathway complexity	– Options start at 3 – Deduct 0.5 points for every additional environmental approval, Native Title negotiation and other planning / approval hurdle to overcome – Existing “port” sites gain 2 points due to capacity to undertake port operations being approved
Land side environmental impact	– Options start at 3 – Deduct 0.5 points for every known major terrestrial environmental impact to be mitigated – Sites with existing landsite environmental impacts benefit 0.5 points

Criteria	Scoring approach
Marine side environmental impact	– Options start at 3 – Deduct 0.5 points for every known major marine environmental impact to be mitigated – Sites with depth / direct ocean access benefit 1 point – Heavy infrastructure options deduct 1 point due to increased depth requirements and associated seabed impacts
Proximity to Carnarvon Town Centre	– Options start at 3 – Sites in Carnarvon lose 1 point – Sites outside of Carnarvon gain 1 point
Proximity to renewable hydrogen centre	– Options to North West of Carnarvon score 4 – Options in Carnarvon score 3 – Options South or Far North of Carnarvon score 2
Proximity to river sands centre	– All options score 3 due to presence of dispersed river sand licences – Except Cape Cuvier due to isolation (score 1)
Local economic opportunities	– Inverse of Proximity to Carnarvon Town Centre
Flexibility to facilitate multiple trades	– Options start at 3 – Heavy infrastructure options gain 1 point – Light infrastructure options lose 0.5 points
Potential to be intensified / developed in the future	– Options start at 3 – Heavy infrastructure options gain 1 point (due to lower incremental cost) – Light infrastructure options penalised 0.5 points – Sites with pathway to establishing deepwater port gain 0.5 points – Greenfield sites gain 0.5 points

Source: ACIL Allen. BMT Group

Barge Operations Parameters

D

Table D.1 BLF Operating Parameters

Parameter	Option 1	Option 2	Option 3	Notes / units
OVERALL PARAMETERS				
Target annual capacity	3.5	2	2	Mt/year
OGV load	62,000	62,000	62,000	t
Number of loads per year	56	32	32	
Density	2200	2200	2200	kg/m3
Distance to Offshore Transfer Loc	20	20	20	nm
RATES				
Transit speed	6	6	6	knots
Maximum loading rate at quayside	850	850	850	t/h
Average loading rate at quayside	600	600	600	t/h
Design discharge rate at OGV	600	600	600	t/h
Average discharge rate at OGV	500	500	500	t/h
SCENARIOS				
Transhipment load size	7500	6000	6000	t
Loading method	single	single	single	
Discharge booms	none	none	none	
Number of transhipment vessels	3	2	2	
OPERATING TIMES				
Days per year	365	365	365	
Major Maintenance days	-20	-20	-20	d
Weather lost days	-30	-30	-30	d
OGV delay days	-15	-15	-15	d
crew and other lost days	-10	-10	-10	d
CYCLE TIMES				
Loading time at wharf	12.50	10.00	10.00	h
Repositioning during loading	1.25	1	1	h
mooring / un- mooring time at wharf	0.5	0.5	0.5	h
Mooring /unmooring at OGV	1	1	1	h
number of hatch changes(/7500)	1.0	0.8	0.8	
hatch change time each	0.25	0.25	0.25	h
hatch change time total	0.25	0.20	0.20	h
Discharge time at OGV	15	12	12	h
Transit time to anchorage Z	3.3..	3.3..	3.3..	h

Parameter	Option 1	Option 2	Option 3	Notes / units
Transit time from anchorage Z	3.3..	3.3..	3.3..	h
travel time per cycle	6.66..	6.66..	6.66..	h
ANNUAL PERFORMANCE				
Maximum tonnes per day per vessel	4716	4449	4449	
number vessels	3	2	2	
Maximum tonnes per year	4.10	2.31	2.49	Mt/year
Target annual capacity	3.5	2	2	Mt/year

Source: BMT Group (with ACIL Allen adjustments to reflect trade requirements)

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