Causeway Lake Dredging - Engineering Feasibility Evaluation Summary Report

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Synopsis:

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1 Introduction

Livingstone Shire Council intends to revitalise the Causeway Lake area with the goal of optimising recreational use opportunities on the lake and facilitating supportive development along the lake's north and south shores. Restoration of the lake system is also desired to preserve the present-day environmental values that could be impacted by ongoing sedimentation. Long-term local efforts to identify a revitalisation path have consistently identified the lake's shallowing to be a major limitation.

Lake revitalisation will require the removal of accumulated sediments via dredging. This report summarises an engineering evaluation for determining the feasibility of dredging the lake. The evaluation was delivered in four key stages, including:

(1) Site investigations to determine the present-day depth within the lake, sediment quality, and seagrass coverage

(2) Dredge and material placement area concepts with consideration to the lake depth required to support various recreational activities, evaluation of environmental factors that may limit the extent of dredging, and potential dredging methods

(3) Risk assessment of the feasible dredging and disposal placement options

(4) Order of magnitude costs to undertake the dredging works.

The study area and locations referred to in this report are shown in Figure 1-1 and the key findings of the project are summarised in the following sections.

Title: **Study Area**

Figure: **1-1**

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2 Site Investigations

Site investigations completed in April 2021 had the following objectives:

- To establish present-day depths within the lake. This information was required to calculate the volume of material to be removed by dredging.
- To establish the extent of seagrass throughout the lake. Seagrass is considered a 'marine plant' under the *Queensland Fisheries Act*. In situations where marine plant removal cannot be avoided an offset must be either paid or delivered through restoration works.
- Obtain sediment samples to be analysed for sediment type (gravel, sand, silt or clay) and contaminants. This information was needed for evaluating potential dredging methods and material placement options.

Present-day Lake Depth

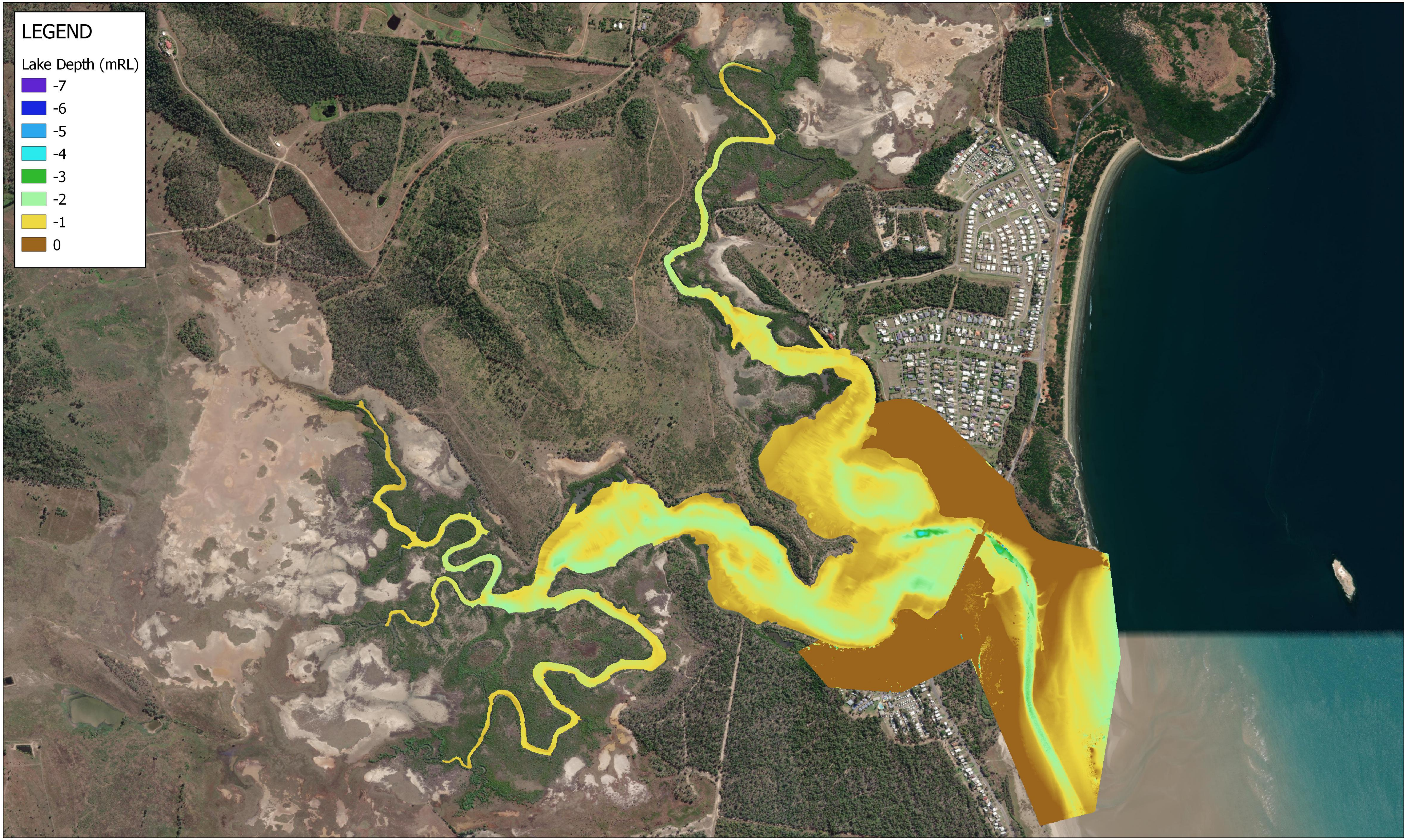
The depths in Figure 2-1 are shown in metres relative to the height of the causeway sill, which is approximately 1.4m above Australian Height Datum (AHD). Except for the deeper channel that aligns with the concrete sill beneath the causeway road bridge, the lake depths are typically less than 2 m and much shallower across vast areas, as indicated by the yellow and brown colours in Figure 2-1. It is noted that the top of the sill acts to maintain the lake water level at a similar height. During the higher high tides that reach levels above 1.4m AHD, seawater flows over the sill and into the lake, causing the lake water level to increase temporarily.

Seagrass Coverage

The map of seagrass coverage is shown in Figure 2-2. If the lake is dredged it will not be possible to completely avoid impact to seagrass and therefore it is expected that an environmental offset would need to be paid to the State Government. Payment would be required if the seagrass meadows did not return to their former (i.e. before dredging) condition within 5 years of the works.

Sediment type

Several sediment samples (up to 1.2m below the lakebed surface) were collected at the locations shown in Figure 2-2. The samples were visually inspected to note the material appearance and the presence of different sediments per borehole. The samples were also sent to a laboratory for analysis of sediment particle size and contamination. Most samples were dominated by sands, with a lower contribution of finer sediments (silt and clay) and occasional gravel pieces. Most sites had a lighter coloured silt layer in the upper 2 cm, with muddy sands below. A summary of the laboratory results for particle size distribution (PSD) is shown in Figure 2-3. The material was reported as 'clean' with some minor contamination in some areas but not at levels of concern.



Title:

Causeway Lake Depths Relative to the Sill Level at 1.4m AHD

Figure: 2-1

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Title:

Seagrass Coverage and Sediment Sample Locations

Figure: 2-2

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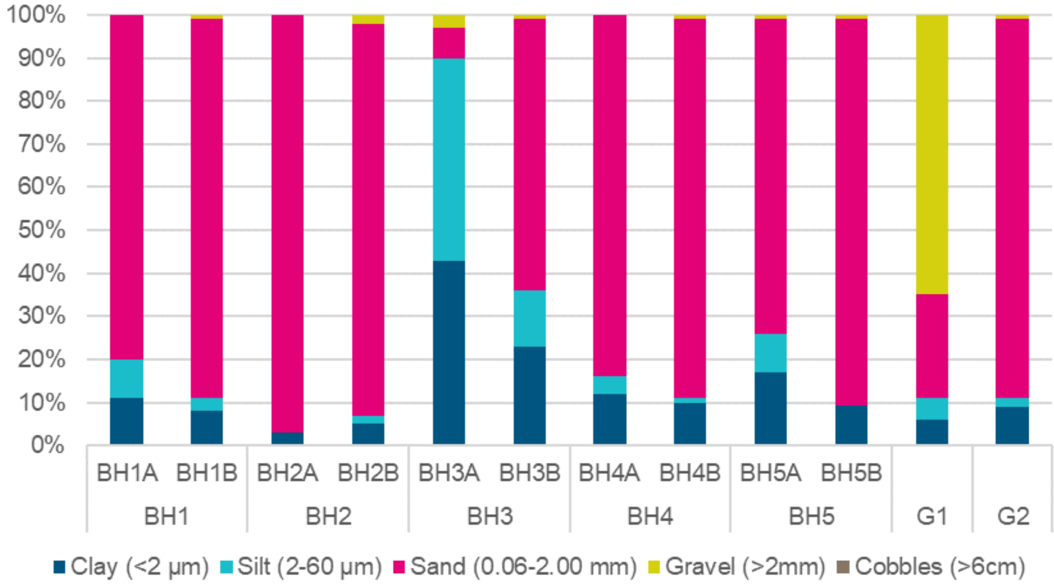

Figure 2-3 Sediment Sample Particle Size Distribution (locations shown in Figure 2-2)

3 Dredge & Placement Area Concepts

Several dredging and placement area concepts were developed in consultation with Livingstone Shire Council during May and June 2021. This process relied on the site investigation data described above and a previous masterplan for the lake and its surrounds. The design and planning had the following broad objectives:

- To achieve lake depths to suit desired recreational uses
- Reduce dredge volumes to minimise the duration and cost of project delivery
- Minimise environmental impact, such as to seagrass meadows.

Dredge Area

The optimised dredge area concept is shown in Figure 3-1, this is the 'preferred' concept because it provides:

- Two Zones: one for motorised boating activities (Zone 1) and one for non-motorised activities including swimming (Zone 2). An operational and navigational management plan would be needed to manage the safety of different lake activities, such as navigational markers to separate swimming and motorised boating areas.
- A minimum depth of 1.9m (lakebed level at -0.5 mAHD) when tidal waters do not exceed the causeway sill level, with greater depths during periods of tidal exchange.
- In Zone 1, a channel width ranging from 75-100m to provide safe navigation for motorised boating activities.
- Gradual lakebed slopes between dredging and non-dredging areas to provide a smooth transition for safe water access.
- A volume that allows dredging works to be completed within a 12-month period, assuming suitable dredging equipment is available (this is discussed further below)
- A reduced impact to seagrass and the cost of environmental offsets.

Figure 3-1 indicates a dredging depth to -0.5 mAHD, which is roughly equivalent to 1.9m depth of water when the lake water level is being maintained by the causeway sill (the typical condition). The dark shaded areas in Figure 3-1 indicate the impact to seagrass based on the coverage in April 2021, with a total area of approximately 46,000 square metres. This dredge area concept assumes the removal of 165,000 m^3 of lakebed sediments.

Siltation of the lake will continue after dredging and the need for additional future dredging campaigns (maintenance dredging) was also assessed. It was estimated that maintenance dredging would be needed every 30 years to maintain the intended functionality of the lake. Comprehensive surveys of the lakebed will be required immediately after the first dredging campaign and at regular intervals (minimum of every 5 years) to monitor the actual sedimentation rate and assess the requirement for maintenance dredging.

Title:

Dredge Area Concept

Figure: 3-1

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Placement Areas

Beneficial reuse of the dredged material for foreshore reclamation within the lake was assessed as the preferred placement option. The sediment is considered suitable for this use based on the sediment sample analysis described above. This option is also economically favourable due to the relatively short distance from the dredging location to placement area. During operations the dredged material would be pumped as a slurry via a pipeline to the placement location (see Figure 3-2). Three sites were selected as suitable placement areas, based on existing or potential future shore-based infrastructure, the alignment of the proposed dredging footprint, the extent of seagrass coverage, and the previous masterplan for the lake and its surrounds. These potential sites are shown in Figure 3-3 and have a combined capacity estimated at 110,000 m^3.

Placement of material along North Kinka Beach was identified as a secondary location for the remaining dredge material, following reclamation of nearshore locations within the lake. Only clean sandy material could be placed at the beach. The area around Pinnacle Point experienced substantial change following the construction of the causeway in 1939 and now features a large sand spit extending southwards from Pinnacle Point. Erosion of this area has historically presented a risk to the Scenic Highway and private properties along the beach and required management intervention in late 1980s. Although the erosion threat to the road and properties is presently low, dredged material could still be used for beach nourishment to increase the available sandy buffer and improve amenity on North Kinka Beach. It is estimated that this area has capacity for 50,000 m^3 to 100,000 m^3 of dredge material and is shown in Figure 3-4.

If State and Federal approvals cannot be obtained for the lakeshore and/or North Kinka Beach placement areas, another option is to transport the material to a parcel of land near the lake owned and operated by Barlow's Earthmoving, who have confirmed their interest in receiving the dredged material. This option would require pumping of the material over a longer distance and the works would be more expensive.

Figure 3-2 Dredge with Floating Pipeline Supported by Plastic Floats (left) and Pipeline Outlet at a Beach Nourishment Site (right)

Title:

Potential Beneficial Reuse Placement at Lake Shoreline (clean marine sands or finer sediments)

Figure: 3-3

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Title:

Potential Beneficial Reuse Placement at North Kinka Beach (clean marine sands only, pipeline to extend below bridge)

Figure: 3-4

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4 Dredging Methods & Costs

The following dredges are suitable for use in the lake in terms of access and production rate are (listed in order of preference):

- Small cutter suction dredge (CSD)
- Amphibious excavator with both backhoe and cutter / pump capability
- Mini auger dredge or mini CSD.

These dredge types are illustrated in Figure 4-1 and share the following benefits and opportunities:

- Well suited to dredging in shallow water and nearshore areas. The cutter heads on the CSDs and auger dredges can be used to excavate a passage in front of the dredge. This technique is also applicable for an amphibious excavator using a cutter head. Additionally, the excavator can work from shore with backhoe attachment.
- Able to accommodate pumping of the dredged material as a slurry to the placement areas. This is the most cost-effective method when compared to transport by trucks, as it does not require additional mechanical equipment. Pipeline transport also presents less risk to the environment and community, as it is predominantly a closed system.
- The flow and production of sediments being pumped to the placement site can be controlled.
- The dredge equipment can be transported to site by truck (as shown in Figure 4-2), assembled on site provided a suitable laydown area and launched to the lake using ramps or cranes. The amphibious excavator has the advantage of moving autonomously from shore to water without any ramp or crane support.

Figure 4-1 Dredge Types Suitable for use in the Lake: Small Cutter Suction Dredge (left); Auger Dredge (middle); Amphibious Excavator (right)

Figure 4-2 Small Cutter Suction Dredge being Transport by Truck

Several risks associated with the proposed dredging activities have been identified, including:

- Inaccessibility to the lake site by heavy dredging machinery due to unsuitable roads and ramps leading to additional scope, time and cost associated with enabling the roads and ramps.
- Limited availability of the preferred small CSD dredging equipment delaying project commencement, leading to additional time and cost associated with using other dredge types.
- Disruption to the community during the construction phase of the project, including temporary closure of roads, partial closure of lake, high levels of noise, etc.
- Direct impacts to seagrass that cannot be avoided.
- Difficulty accessing material placement sites beyond the lake shoreline. For example, potential issues include: logistical challenges with transporting (pumping) material over longer distances, land tenue along the temporary pipeline corridor, and the need to clear vegetation.
- Challenges gaining State and Federal environmental approvals for dredging, transport and placement of the material.

It's expected that these risks can be managed through a combination of early and ongoing engagement with:

- Dredging contractors to discuss fleet availability and scheduling, mobilisation/de-mobilisation requirements and pipeline alignment options.
- Stakeholders and the community about the expected disruption associated with the works.
- State and Federal regulators to confirm the approvals pathway and approach to managing unavoidable environmental impacts (such as an offset payment for the loss of seagrass).

A Rough Order of Magnitude Cost Estimate (ROM Estimate) was developed for six feasible dredging scenarios. The ROM Estimates are illustrated in Figure 4-3 and were broadly categorised into four streams: preliminaries, costs associated with dredging activities, costs associated with the transportation and placement of dredged material, and costs associated with environmental offsets.

- The small CSD was assessed as the most cost-effective option at $7-9M, depending on the material placement option. This is also the most efficient option with estimated completion within 12 months. Accessibility to the lake is a key risk associated with the small CSD.
- The Amphibious Excavator is the intermediate solution in terms of cost ($8-10M) and efficiency (completion within 18 months). A key risk with this option is the limited availability in the market.
- The highest cost ($13-15M) and longest duration is associated with the Mini (Auger) Dredge option. Two of the mini dredge plants would be required to operate in parallel to complete the dredging within 24 months.

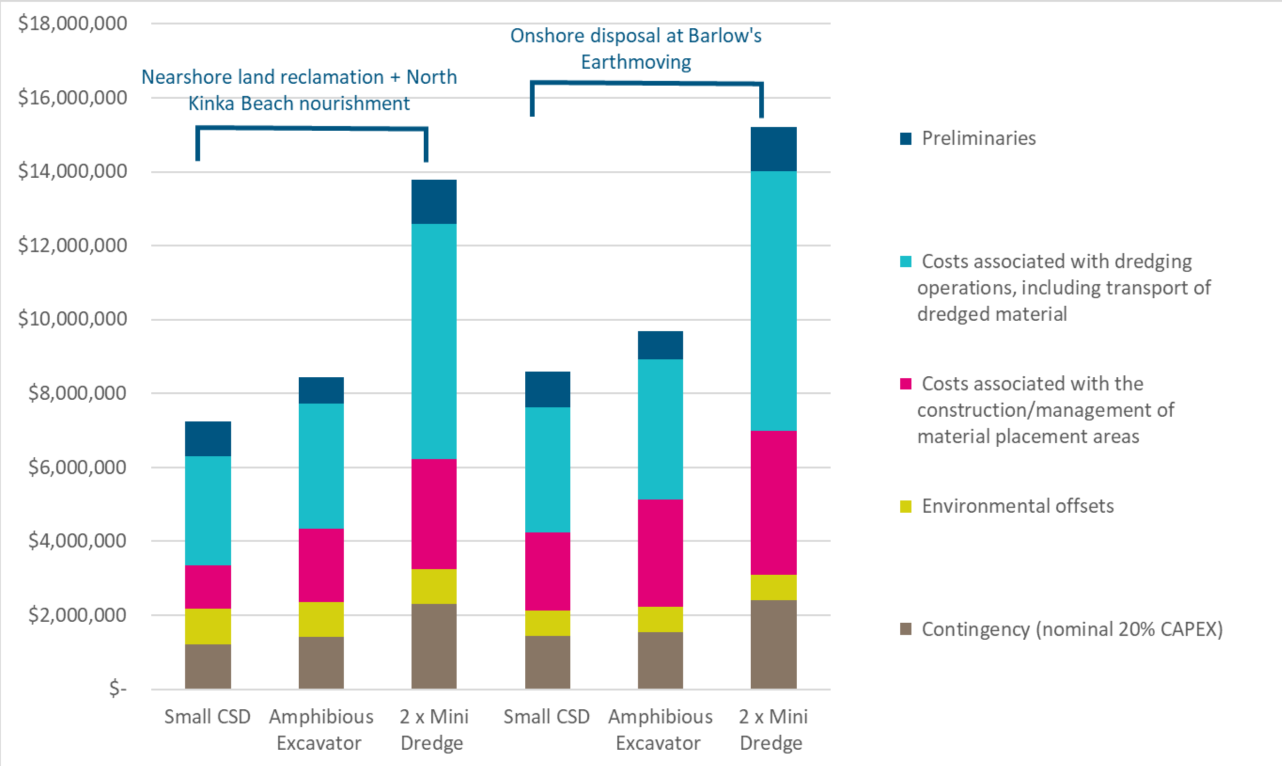

Figure 4-3 ROM Estimate for Six Dredging Scenarios ($AUD in 2021)

5 Key Findings

Dredging the lake was assessed as feasible with the following conditions:

- Only a small Cutter Suction Dredge (CSD), amphibious excavator, or mini dredge (auger dredge) can access the site and deliver the production rates required to remove the estimated 165,000 m^3 of lakebed sediments.
- Transport of the dredged material as slurry via a pipeline to the placement areas is the recommended method based on cost and practicality.
- The preferred dredge material placement areas include shoreline reclamation within the lake and beach nourishment of North Kinka Beach. Another potential placement option is on land near the lake owned by Barlow's Earthmoving.
- The potential impact to seagrass within the dredge footprint can be minimised but not completely avoided and, if approved, will require the payment of an environmental offset to the Queensland Government.
- Infrequent maintenance dredging (estimated every 30 years) will be required to manage ongoing sedimentation and maintain the functionality of the Lake. Comprehensive bathymetric surveys will be required immediately after dredging and at regular intervals (minimum of 5 years) to monitor the actual sedimentation rate and assess the requirement for maintenance dredging.
- Supported catchment management measures to reduce the rate of sedimentation in the Lake include increasing vegetation cover and improving stormwater management in adjacent urban areas.

Further planning and design studies are required to progress the option of dredging the Lake. An outline of the proposed workflow and timing is provided in Table 5-1 and suggests 2-3 years is required to finalise the planning, design and approvals for the dredging. A minimum of 12 months is then required for construction, depending on the dredge type. It is important to note that additional time and hold points between these activities may be needed for consultation with stakeholders and dredging contractors.

Table 5-1 Proposed Workflow for Progressing the Planning and Design for Dredging the Lake

Activity	Description	Indicative Timing
Engagement & Master Plan Review/Update	• State agency engagement to discuss the outcomes of the dredging feasibility evaluation and development application requirements. • Considering the outcomes of the dredging feasibility assessment in the context of broader planning for Causeway Lake, including the opportunities and constraints associated with the proposed lakeshore reclamation footprints. • Stakeholder engagement.	6 months
Dredge and Placement Area Concept Design Phase	Building on the basis of assessment developed for this project and the proposed Master Plan Review/Update outcomes, refine the dredge and placement area design. The Concept design package to include: • Basis of Design report • Concept drawings • Outcomes from engagement with dredging contractors to confirm the availability of preferred equipment	6 months
Preliminary Design Phase (50%)	Preliminary design package to include: • Further geotechnical investigations • Design Drawing set including dredging and placement area general arrangement plans and cross sections • Technical Specifications • Proposed construction methodology (including engagement with dredging contractors) • Functional requirements such as shoreline access, amenity, drainage, vegetation management • Safety in Design report • Cost estimates	3 months
Environmental Approvals Phase *(State approvals requirements based on pre-lodgement advice in 2018; to be confirmed through further engagement)*	Undertake studies to support a development application for tidal work and work in a coastal management district, marine plant removal, material change of use for an Environmental Relevant Activity to gain the relevant state and federal approvals, including: • Environmental impact assessment, reviewing impacts to the Great Barrier Reef World Heritage Area, wetland values and protected species • Impact assessment to coastal processes and water quality, likely to require monitoring data and numerical modelling • Detailed sediment sampling and analysis to National Assessment Guidelines for Dredging (NAGD) standard • Offset Agreement for any residual impacts on marine plants (e.g. seagrass and mangrove) • Detailed terrestrial vegetation survey if removal cannot be avoided during placement activities	12 months
Detailed Design Phase (90% and 100%)	• 90% detailed design package to include (issued for client review) to include updated Basis of Design Report, Design Drawings, Technical Specification and Cost Estimate. • 100% detailed design package to include Issued for Construction (IFC) Drawings, Bill of Quantities, Approvals Documentation and final versions of the design reports.	3 months
Tendering Phase	For construction tendering	2 months
Construction Phase *(timing dependent on dredge type and production rate)*	• Small Cutter Suction Dredge • Amphibious Excavator • 2 x Mini (Auger) Dredge	12 months 18 months +24 months

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