Auckland Marine Dredging

Economic Assessment of Disposal Options

27 November 2018 –final

m.e consulting

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Contents

Tables

Figures

1 Introduction

Coastal Resources Limited (CRL) have an application for consent to dispose up to 250,000m^3 annually at the Northern Disposal Area (NDA), before the Environmental Protection Agency. The Agency has asked CRL to provide a more detailed assessment of demand and alternatives in response to a Sapere Research Group review of the initial demand assessment. This report provides that assessment.

1.1 Application for Consent and the EPA

CRL have lodged an application for consent with the Environmental Protection Agency (EPA) to increase the quantity of marine sediment that it disposes of at the NDA. The NDA is an existing marine sediment disposal area that is located 25km east of Great Barrier Island, whereby marine sediment is disposed of using a bottom dump barge.

CRL dredge marine sediment from a number of locations and dispose a share of it at the NDA. It currently has consent to dispose of up to 50,000m^3 of sediment per annum at the NDA for the next 17 years (till the end of 2032). It is seeking consent to increase the annual limit to 250,000m^3 for the next 35 years (till the end of 2050).

The EPA, when assessing the application, must consider a number of factors, including:

> *"any alternative methods of disposal of the waste, other matter, or pipeline that could be used; and (Clause 59(2B)(c)) whether there are practical opportunities to reuse, recycle, or treat the waste, other matter, or pipeline (Clause 59(2B)(d))[1]".*

It must refuse an application for a marine dumping consent if it

> *"...considers that the waste or other matter may be reused, recycled, or treated without (ii) imposing costs on the applicant that are unreasonable in the circumstances; or (Clause 62(1A)(a)(ii)) the marine consent authority considers that dumping the waste or other matter or abandoning the pipeline is not the best approach to its disposal in the circumstances (Clause 62(1A)(c)".*

1.2 Context of Report

CRL initially commissioned Property Economics Ltd (PEL) to provide an economic analysis (the "PEL report")[2] to understand the costs and benefits of the different disposal options for marine sediment related to the proposal. The report was submitted as part of the consent application. Sapere Research Group undertook a peer review (the "Sapere review")[34] of the PEL report for the EPA. It identified a number of

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[1] Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012.

[2] Property Economics Limited, 2018 *Economic Assessment of Deep Sea Dredging Disposal in Auckland,* prepared for Coastal Resources Limited, April 2018.

[3] Murray, K. 2018 *Review of economic analysis submitted in support of Coastal Resources Limited marine dumping consent application,* prepared for the Environmental Protection Agency, Sapere Research Group, 1 November 2018.

[4] A further addendum (on the review of the PEL report) was provided by Sapere: Murray, K. 2018 *Addendum to: Review of economic analysis submitted in support of Coastal Resources Limited marine dumping consent application,* prepared for the Environmental Protection Agency, Sapere Research Group, 15 November 2018.

areas where further economic analysis was required for the EPA to understand the effects of the proposal. These are outlined in the following section.

CRL have now commissioned M.E to undertake further economic analysis to respond to the key matters raised in the Sapere review.

1.3 Key Matters Raised in the Sapere Review

The Sapere review has recommended the EPA seeks further economic analysis that:

- "assesses the questions asked in the survey which informed the CRL prediction of future demand for disposing of dredged material, and evaluates the results obtained and the quantum of the contingency[5] added by CRL.
- tests how sensitive the predicted quantities are to the assumptions supporting those predictions, including assumptions as to the price that would be charged for the Northern Disposal Area relative to other options.
- considers the geographical source of the material, and the composition of the dredged material from that source, and the (sic) hence the alternatives for that dredged material (p5)".

In addition, the Sapere review makes the following assertions:

- The total cost of sediment dumping at the NDA to society is higher than the price paid by CRL given the presence of externalities associated with dumping in the marine environment.
- The cost of dumping at the NDA is likely to increase from the current cost with an increase in volume due to:
    - an increase in scarcity of the dump site as a location to dispose of large volumes of material.
    - an increase in infrastructure costs to up a dumping operation of a larger scale.
- The demand for dumping is a derived demand from a combination of benefits from dredging and the cost of dumping at sea relative to other options.

1.4 Structure of Report

The remainder of the report is structured as follows. Section 2 outlines and assesses the costs of the different options for sediment disposal. Section 3 provides M.E's evaluation of the demand for sediment disposal from each of the sub-components of demand. Section 4 applies the truck movements identified in each option to the total estimated demand from each sediment source to calculate the total truck movements likely to be generated from the land-based sediment disposal options. It then quantifies the environmental externalities of air pollution arising from these options. A summary and synthesis of the demand and costs of sediment disposal to meet the future needs of marinas and other port activity across the wider area is provided in Section 5.

[5] Approximately 60% of the demand (1,500,000m3 of sediment) for dredging in the PEL report is allocated to 'other capital' and 'other maintenance', with the remainder allocated to specific locations.

2 Assessment of Alternative Marine Sediment Disposal Options

M.E have assessed the costs associated with four alternative options for sediment disposal. The assessment has been undertaken on a disaggregated basis by sediment source location, as well as a disaggregation of costs by each component of the process. The intent is to provide further information to the EPA on the alternative options and greater certainty around the overall cost estimates (to the user) of each option.

2.1 Sediment Disposal Options

There are four options for disposal of sediment that is dredged from the different locations (marinas and the Ports of Auckland Ltd (POAL)). These are:

- **Dry and landfill option** – sediment is dredged from the source location, dried out at/near the source location, then transported by truck and disposed of at a landfill.
- **Cement mixing and landfill option** – sediment is dredged from the source location, transported by barge to POAL, mixed with cement to a 'spadeable' consistency, then transported by truck and disposed of at a landfill.
- **Cement mixing and reuse option** – sediment is dredged from the source location, transported by barge to POAL, mixed with cement, then reused in another application, which may require transport by truck.
- **Northern Disposal Area (NDA) option** – sediment is dredged from the source location then transported by barge to the NDA and disposed of via bottom dump barge.

The costs of each option are outlined in the following sub-section. The cost estimates exclude the cost of the dredging itself as this is common across all options.

2.2 Dry and Landfill Option Costs

Under this option, sediment is dredged from the source location, then dried out on land at or close to the source location. Once it reaches a certain consistency, it is loaded and then transported by truck and disposed at the landfill.

The first stage of this option – drying the sediment – requires a land area adjacent to the source[6] to dry the sediment prior to transport to a landfill. CRL have estimated the land cost component to equate to $50 per m^3 of sediment, based on applying this option at Pine Harbour Marina. Specifically, this is based on an estimated land value of $500 per m^2, with 2ha of land required for 6 months to dry 7,000m^3 of sediment

[6] This analysis primarily considers a land area adjacent to the source location. An alternative land area would require transport of wet sediment via sealed truck units from the source to the land drying area. This is seldom undertaken as it involves considerable cost (for sealed truck units) and higher levels of environmental risk (if the sediment were to leak during transport).

at a land rent yield of 7% per annum. If different land costs are applied, ranging from $200 to $1,000 per m^2 across the different source locations, then the cost per m^3 of sediment ranges from between $20 and $100 (with an average of $54 per m^2).

Establishing a drying area also incurs a resource consent cost. For the same Pine Harbour Marina example, CRL have estimated this at $200,000 for 70,000$m^3$ of sediment (i.e. 7,000m^3 for 10 years of the consent), equating to $2.86 per m^3. CRL also estimate further cost to establish, process and disestablish the sediment bund and loading and unloading the sediment (at $58 per m^3).

In total, the costs associated the land drying component of the process equate to between $80 and $160 per m^3 of sediment. The variation in costs for this component reflects the difference in land value at each source location.

If sediment were instead transported to cheaper land at a different location, this would result in land costs of around $70 (assuming a land value of $100 per m^2), a difference of $10 to $90 per m^3. However, this would require higher numbers of truck movements and use of sealed truck units/tankers, which are likely to outweigh the cost difference. It is noted that in many cases appropriate land is not available at the sediment source location – making this not a practicable option.

Once the sediment has dried, it is then transported to a landfill. The landfill options for sediment disposal include Redvale and Hampton Downs, and the same disposal costs (at the landfill site) have been assumed for each. These equate to $129 (as advised by CRL). We note that a disposal cost of $250 per m^3, as outlined in Mr Male's evidence, is seen as reasonable within the Sapere review (para 42: p16).

This analysis considers each of these options (Redvale and Hampton Downs) in relation to the location of the sediment source area[7] as there are likely to be significant differences in transport costs for each option, and consequent differences by location between using each landfill.

Transport costs have been assumed to equate to $12.00 per truck kilometre travelled (for each truck)[8], with each truck carrying 21m^3 of sediment. A further $18 per m^3 of sediment has been assumed for the Redvale landfill to take into account timing and access volume constraints at this location (as advised by CRL).

Overall, transport costs equate to between $32 and $110 per m^3 of sediment from each location.

Table 1 provides a summary of the cost ranges involved at each stage of this process, and the overall range of total costs. These have been expressed on a per m^3 of sediment basis. In total, disposal via this option ranges from $256 to $325 per m^3. Importantly, these costs have been estimated on the basis that the

[7] The shortest road network distance between the sediment source location and the landfill forms a conservative estimate of the transport costs in this respect as, if the drying area were located away from the source area, then the total transport cost (i.e. to the drying area, then to the landfill) would be equal to or greater than the distance between the sediment source location and the landfill.

[8] CRL advise that smaller truck units cost $54 to transport each m^3 of sediment from Pine Harbour to Hampton Downs landfill. At 7m^3 per truck (based on the smaller truck units), this equates to a per kilometre rate of $5.25 for a truck (or $0.75 per m^3). This is within a similar range to the 2011 value of $4 per truck kilometre stated in the Sapere review (para 42: p16) when taking into account cost increases through time and changes to pricing structures (a shift to time-based pricing to better reflect the costs of congestion). The larger truck units (21m3 or 30 tonnes) are more efficient (as advised by CRL), and have been used in this analysis to produce conservative estimates, equate to $0.57 per m^3 per kilometre.

option would be available to undertake. In many cases, this alternative is unable to occur as resource consent is unable to be obtained for the sediment drying process. This constraint occurs on the basis of effects of the proposed consent as distinct from a constraint in relation to cost – in many cases consent is not granted on the basis of adverse effects of the proposal[9].

Table 1: Sediment Disposal Costs for Drying and Landfill Option

Process	Cost Category	Cost per m3 of sediment Min	Max	Average
Put dredged sediment on land next to marina to dry	Land costs	$ 20.00	$ 100.00	$ 54.00
	Resource consent			$ 3.00
	Decant Areas			$ 15.00
	Processing costs (e.g. rotary hoe + est bund)			$ 43.00
Truck to landfill	Truck transport costs	$ 32.00	$ 110.00	$ 47.00
Dispose at landfill	Landfill cost			$ 107.00
	Margin (15-20%)			$ 21.00
TOTAL		**$ 256.00**	**$ 325.00**	**$ 290.00**

2.3 Cement Mixing and Landfill

Under this option, sediment is dredged from each location. It is then transported by barge to POAL at Auckland's CBD waterfront. At POAL, cement is then added to the sediment on the barge, with both components mixed together, which sufficiently dries it to a consistency able to be transported to and accepted at landfill. The mixed sediment is then transported via trucks from the POAL to landfill.

The stage of transporting the dredged sediment to POAL incurs costs of barge hire and transport, and berth hire at POAL. Each barge can transport up to 337m^3 of sediment, with each trip requiring 2 days of berth hire at a cost of $6,500 per day. Barge hire and transport costs have been estimated to equate to $0.31 per kilometre travelled based off the estimated cost of barge transport to the NDA[10]. Together, this stage of the process costs between $39 and $84 per m^3, depending upon the distance between the sediment source location and the POAL.

The second stage of the process – adding cement and mixing the sediment – incurs the costs of cement and mixing. CRL have advised that cement costs $220 per tonne, with 100kg of cement required for every m^3 of sediment (equating to $26 per m^3 of sediment). A further $16 per m^3 is the cost for a digger to mix

[9] M.E understand that the land drying process involves potential environmental risks and reverse sensitivities to surrounding land uses. A core component of the risk associated with this process is the potential run-off and leaching of material from the sediment into local hydrological systems and water catchments. The often extensive requirements in relation to containing sediment run-off through sediment settling ponds and other sediment traps reflects this environmental risk.

[10] CRL states that the cost of transporting and disposing of sediment at the NDA (approximately 142 km away from the sediment source) is $50 per m3. Approximately $6 per m3 of this cost relates to administrative costs, with the remaining $44 per m3 assumed to be the cost of barge hire and transport. Assuming a distance of 142 km, this implies a cost of $0.31 per km travelled. The same cost rate has been applied to barge transport under the other options.

the cement with the sediment. Together, this amounts to $42 per m^3 of sediment for the second stage of this option.

Disposal of the mixed sediment to landfill forms the final stage of this option. It has been assumed that the material will be transported to Redvale landfill as it is located closer to POAL than Hampton Downs. The same cost estimates of $36 per m^3 have been assumed as that under the first option, which reflect the cost of transport from the POAL to Redvale landfill. Road transport costs are the same for all sediment source locations as the final stage of the process all occurs from the location of POAL.

Table 2 provides a summary of the cost ranges involved at each stage of this process, and the overall range of total costs. These have been expressed on a per m^3 of sediment basis. In total, disposal via this option ranges from $245 to $291 per m^3.

Table 2: Sediment Disposal Costs for Cement Mixing and Landfill Option

Process	Cost Category	Cost per m3 of sediment		
		Min	Max	Average
Barge to POAL	Barge hire and transport	$ -	$ 46.00	$ 11.00
	POAL fee			$ 39.00
Add cement and mix	Cement costs			$ 26.00
	Mixing costs			$ 16.00
Truck to landfill	Truck transport costs			$ 36.00
Dispose at landfill	Landfill cost			$ 107.00
	Margin (15-20%)			$ 21.00
TOTAL		**$ 245.00**	**$ 291.00**	**$ 256.00**

2.4 Cement Mixing and Re-Use

A further alternative option occurs where sediment mixed with cement is re-used in various applications instead of being disposed of at landfill.

The first stages of this process are equivalent to the above option where sediment is transported from the source location to POAL, then mixed with cement at POAL. As such, the costs up to this point of the process are assumed to be the same, ranging from between $81 and $127 per m^3 (refer to Table 2 above).

After this stage of the process, the sediment is then transported to the location of re-use. This is likely to incur transport costs (at $12.00 per km travelled by a 30 tonne truck and trailer carrying $21m^3$ of sediment) and any loading/unloading costs associated with distributing the sediment to the location of use.

Further information is not currently available on specific options for sediment re-use as potential future options have not yet materialised. The previous substantive re-use options predominantly involve land reclamation at POAL. However, this activity is unlikely to continue into the future as the capacity has now been fully taken up at POAL, with agreement among Iwi and other stakeholders that no further reclamation will occur. This agreement is reflected in the Auckland Unitary Plan (AUP) where reclamation has a Non-Complying activity status.

If sediment is reused in other locations, resource consents are a further cost that will incurred. Use of dredged sediment in built structures has a full Discretionary activity status under the AUP.

2.5 Northern Disposal Area (NDA) Option

Under this option, sediment is dredged from each source location, then transported to the NDA by barge. It is then disposed of at the NDA using a bottom dump barge.

This process incurs the cost of barge hire and travel to the NDA, which has been estimated at $0.31 per barge kilometre travelled for each m^3 of sediment. This cost component ranges from between $27 and $46 per m^3 of sediment, depending upon the sediment source location.

An administration cost of an average of $6 per m^3 of sediment is then charged by CRL to dispose of sediment at this location. CRL have also advised that resource consent costs for this option equate to around $0.81 per m^3 of sediment. This includes both the base resource consent cost and the ongoing monitoring requirements. This cost estimate reflects the cost of the current consent and it is anticipated that this will fall within a similar range in the future[11].

CRL have advised that sufficient capacity currently exists across a range of operators within the barge transport and dredging sector to cater for the increased sediment transport requirements. As such, no further investment in infrastructure is required for this option and therefore has not been included as an additional cost.

Table 3 provides a summary of the cost ranges involved at each stage of this process, and the overall range of total costs. These have been expressed on a per m^3 of sediment basis. In total, disposal via this option ranges from $34 to $52 per m^3.

Table 3: Sediment Disposal Costs for the Northern Disposal Area Option

		Cost per m3 of sediment		
Process	**Cost Category**	**Min**	**Max**	**Average**
Barge to NDA	Barge hire and transport	$ 27.00	$ 46.00	$ 40.00
Disposal costs	CRL administration cost			$ 6.00
Resource consent costs	Cost of obtaining resource consent			$ 1.00
TOTAL		**$ 34.00**	**$ 52.00**	**$ 47.00**

2.6 Summary of Sediment Disposal Options

The above sub-sections have outlined the overall disposal costs and their component parts for each of the sediment disposal options. These are summarised in Table 4.

[11] Although the future costs of the consent are not yet known, M.E consider this will have a very minor impact on the estimation of the cost of this option given the small share of total costs which are accounted for by the consent.

Table 4: Summary of Sediment Disposal Costs by Disposal Option

Disposal Option	Notes	Cost per m3 of sediment		
		Min	Max	Average
Dry and Landfill		$ 256	$ 325	$ 290
Cement Mix and Landfill		$ 245	$ 291	$ 256
Cement Mix and Re-Use	Partial costs only	$ 81	$ 127	$ 92
Northern Disposal Area		$ 34	$ 52	$ 47

Large cost differences for the disposal of sediment have been demonstrated between the different options. Overall, drying the sediment and then transporting it to landfill incurs an average cost of $290 per m^3 of sediment, some six times the cost of disposing sediment at the NDA. Similarly, mixing the sediment with cement, then disposing it at landfill incurs an average cost of $256 per m^3 of sediment, around five and a half times the cost of disposal at the NDA.

The cost of mixing the sediment with cement and then re-using it has only able to be partly estimated as re-use options are not currently available. However, only a sub-component of these costs are approximately double the cost of disposal at the NDA. The total costs of the re-use option, if an application becomes available, are likely to be substantively higher than the partial costs identified in the initial stages of this option.

Consequently, this analysis considers that the substantive differences in cost between the options means that the sediment is unable to be disposed of in an alternative way (to the NDA) without a much larger cost to the applicant.

Moreover, in many instances the possibility of undertaking the alternative disposal options does not exist due to constraints that occur irrespective of cost. As outlined in Section 2.2, it is often not possible to undertake the sediment drying option due to the refusal of resource consent to undertake the sediment drying process. Similarly, the cement mixing options assume sufficient capacity at the POAL to undertake this option, which may become a constraint or adversely affect the efficient functioning of the port, which is an additional cost not captured by the private cost of sediment disposal assessed here. As outlined in Section 2.4, the potential for the cement mixing and re-use option further relies on capacity at the port as well as the emergence of opportunities for re-use and successfully obtaining resource consent for these activities (which may be declined on the basis of effects).

The costs outlined in this section relate to the cost of disposal to the applicant. Differences to the total cost (i.e. including social and environmental factors) are discussed in Section 4. Potential changes to these costs are addressed in the following section (Section 2.7).

2.7 Potential Changes to Disposal Costs

The Sapere Review (paras 26 to 28) considers that the cost of disposal at the NDA may increase if resource consent is granted. This is due to a combination of the following factors:

i. Additional transport infrastructure required to meet the increased demand in sediment disposal at this location.
ii. Additional costs in obtaining resource consent.
iii. Economic theory would predict a price increase for access to the NDA as a scarce resource for disposing of large volumes of sediment.

This sub-section considers the above points together with the changes in prices that would be required to change the status of the NDA as a sediment disposal option relative to other options.

As outlined above, CRL have advised that the marine transport industry currently has sufficient capacity, across a number of different operators, to cater for an increase in demand. Consequently, no further investment in infrastructure is required.

Section 2.5 already includes the additional costs of obtaining a further resource consent. At around \$0.81 per m^3 of sediment, this contributes only a small share of the overall cost (average of \$47 per m^3).

If any cost increases were to occur with this disposal option, it is important to understand the required scale of changes to make the NDA disposal option a comparable cost to the alternative disposal options. The above sections have shown that the costs of sediment disposal among the alternative options differ in order of magnitude to that of the NDA option (alternative options are approximately 5.5 to 6 times the cost). Therefore, any change in disposal costs at the NDA would correspondingly have to change in order of magnitude to result in costs occurring within similar ranges to the alternative disposal options.

Moreover, when considering any potential changes to this cost, it is important that the dominant share (around 85%) of the cost of the NDA option is generated by barge travel to the NDA. As such, any change in this cost component would also apply to the next cheapest option, albeit with a smaller relative effect. The presence of multiple operators, together with the required use of barges in an alternative option, mean that any changes in price due to scarcity of access to the NDA can occur to this remaining component of cost. This means that the remainder of the cost of this option would have to increase by between 7 and 37 times (760% to 3,700%) for the NDA disposal option to become a similar disposal cost to other options.

M.E consider that there is limited scope for substantial changes in cost across these components. This is because there are a sufficient number of other operators (in addition to CRL) within the market that could also potentially establish an operation. Large cost increases would encourage the entry of other providers, which would in turn create competition within the market to limit any potential cost increases.

In addition, there is potential for scale economies to occur reducing the overall cost of this disposal option. The cost estimates have been prepared based on the application of a 337m^3 barge volume. Larger barges of up to 1,200m^3 sediment volume could potentially be used in the future. CRL have advised that the likely cost of this option (on a per m^3 basis) would be around 20% cheaper than the current barge volumes.

The potential for scale economies through using larger barges is greater for the NDA option than the cement mixing and landfill option as it makes up a much larger share of the cost. Barge transport accounts for 86% of the cost of the NDA disposal option, and around 19% of the cost of the cement mixing and landfill option.

3 Demand for Sediment Disposal

The requirement for dredging is formed from a combination of dredging at marinas and other areas (including the Ports of Auckland Ltd (POAL)). Within each of these, there is the requirement for capital works dredging (i.e. the creation of new dredged areas, such as new berths), and maintenance dredging to maintain the depths in previously dredged areas.

This analysis has assessed the likely demand for sediment disposal based on demand for the above activities. Across most areas, the calculations have been undertaken independently of the total demand volumes provided by CRL in the initial report. This approach has been taken in order to verify the scale of dredging demand contained in the initial report.

The following sub-sections consider the different factors in driving demand for each component of the overall sediment disposal demand.

3.1 Marina Demand and Capacity

M.E have considered information on the current market situation for marinas in the wider Auckland area. Information on the currently existing number of marinas in Auckland have been obtained from different reports, together with our own estimates of the number of berths at all marinas across Auckland and the Whangarei and Thames-Coromandel districts[12]. It is important to understand growth in demand for marina berths as it is a key driver of capital dredging demand for marinas.

3.1.1 Current and Future Marina Demand

Overall, M.E estimate there are currently around 6,800 marina berths in the wider Auckland region and the Whangarei and Thames-Coromandel districts[13]. It is also important to include any latent demand in a current estimate of demand for marina berths in Auckland. There has been a reduction in new capacity at Auckland marinas over recent years due largely to resource consenting issues. Based on existing marina occupancy rates and waiting lists, the total latent demand has been estimated at 10%. Together, the total demand for marina berths in Auckland and the Whangarei and Thames-Coromandel districts has been estimated at 7,480 berths.

[12] The EPA have requested an analysis of demand across the wider Auckland-Whangarei-Thames-Coromandel area to reflect the wider geographic catchment of demand for sediment disposal at the NDA.

[13] This figure has been estimated based on a combination of reports (Beca, 2012 *Auckland Recreational Boating Study,* prepared for Auckland Council, 12 April 2012; Comer, 2018 *Marina Berth Supply & Demand Trends,* prepared for Panuku Development Auckland, Updated Report, April 2018; Research New Zealand, 2016 *Summary of Recreational Boating Research,* prepared for Maritime New Zealand, September 2016) and M.E's own estimates of berths by marinas.

The estimated current and future demand is set out in Table 5. The current demand compares to a total existing household base of 626,400 households. The combined number of households across this wider area is expected to increase by 19% over the 2019 to 2029 period. If boat ownership rates remain constant, then growth in households will result in a demand for around 9,100 marina berths by 2029[14]. This equates to an increase in demand for around 2,100 berths between 2019 and 2029, including estimated existing latent demand for berths.

Table 5: Additional Demand for Marina Berths in Auckland and the Whangarei and Thames-Coromandel districts, 2019-2029

	Year			Change 2019-2029	
	2018	2019	2029	Percentage	Net
Auckland, Whangarei, Thames-Coromandel Households	626,400	639,400	759,700	19%	120,300
Existing marina berths	6,800				
Latent demand for marina berths	680				
Total current demand for marina berths	7,480				
Future demand for marina berths					
No change in boat ownership rates		7640	9070	19%	1,430
0.2% pa increase in rate of boat ownership		7650	9270	21%	1,620
Additional berth demand (from 2019 estimated berths) - incl. latent demand					
No change in boat ownership rates			2,110	30%	2,110
0.2% pa increase in rate of boat ownership			2,300	33%	2,300

Longer-term trends in New Zealand and Auckland suggest boat ownership rates are increasing through time. A report by BECA (2012) estimates that the rate of household boat ownership is projected to increase by 0.4% per year over the long-term from 2011 to 2031[15].

The analysis in this report has adopted a conservative estimate of a 0.2% annual change in the rate of boat ownership over the medium-term[16]. It has consequently assumed that marina berths as a percentage of households (across the wider area) will increase from 1.19% in 2018 to 1.22% in 2029. This represents a net increase in demand for around 2,300 marina berths from 2019 to 2029, including meeting latent demand.

3.1.2 Marina Capacity

M.E have analysed the capacity to accommodate growth in marina berth demand across existing and planned marinas in Auckland and the wider area served by the NDA (i.e. greater Auckland and the Whangarei and Thames-Coromandel districts). It has been assumed that capacity does not exist within

[14] That is, a 19% increase from a base demand of 7,600 berths (where latent demand has been included). The base year has been adjusted to 7,600 berths (from 7,480 berths) to account for growth between 2018 and 2019.

[15] It has estimated that 25% of Auckland households own boats (all types of boats, not only marina boats) in 2011, with this share increasing to 27% in 2031.

[16] Meeting latent demand has not been included as a factor driving increases in boat ownership rates. It has been assumed that latent demand is instead currently being met through a combination of other boat storage mechanisms such as swing and pile moorings and dry-stack storage.

existing marinas due to the reported high occupancy rates and low rates of new capacity over recent years – the factors driving latent demand.

The capacity for expansion of existing marinas has been identified in Auckland through comparing the Auckland Unitary Plan (AUP) zoned areas for marinas with the current spatial extent of each marina[17][18]. This shows the further water area that each marina is able to expand into under the AUP provisions. Where present, this additional surface area has been translated into additional capacity for each marina by applying the average surface area estimates for each berth (including fairway and accessway contributions) of each marina.

These capacity estimates are contained in Table 6. It shows that capacity (under the AUP) for marina expansion in the Half Moon Bay, Hobsonville, Pine Harbour, Gulf Harbour and Hobsonville Point marinas. In total, it is estimated that the additional zoned areas for expansion can accommodate an additional 1,350 marina berths.

[17] The capacity estimated for Half Moon Bay Marina has instead been informed by the resource consent application.

[18] Similar information was not available within the Whangarei and Thames-Coromandel districts. In these cases, capacity information was obtained through a desktop search of any marina expansion plans.

Table 6: Estimated Additional Capacity for Marina Berths by Auckland/Whitianga Marina, 2018

Marina	Existing Water Surface Area (ha)	Estimated Berths	Average Water Area per Berth (m2)	Additional Zoned Water Surface Area (ha)	Estimated Additional Capacity (berths)
Westhaven (1)	51.1	1,492	343	-	-
Half Moon Bay/Bucklands Beach	10.7	600	178	3.7	90
Hobsonville (2)	12.9	592	218	19.7	740
Pine Harbour	12.0	554	217	6.8	310
Gulf Harbour	32.0	1,033	310	1.3	40
Bayswater	10.4	394	263	-	-
Orakei	7.0	179	390	-	-
Milford	2.6	220	118	-	-
Outboard Boating Club	5.8	213	273	-	-
Silo Superyacht Marina (3)	2.8	10	2,820	-	-
Pier 21 Marina	1.3	48	269	-	-
Viaduct Harbour Marina	12.2	132	922	-	-
Sandspit Marina (1)	3.1	131	240	-	-
Whitianga	4.0	191	210	-	30
Mahurangi	0.4	16	280	-	-
Hobsonville Point (4)	-	-	-	4.2	140
TOTAL	**168.3**	**5,805.0**	**302**	**35.6**	**1,350**

(1) The AUP zoned area extends slightly beyond these marinas, but has been excluded as capacity. CRL have advised that no further expansion will occur at Westhaven, and the expansion at Sandspit would block the
(2) It has been assumed that 3.7ha of the additional zoned area is excluded to maintain access to the Henderson Creek channel as advised by CRL.
(3) The water area per berth at this marina has been excluded from the total estimate.
(4) The estimated capacity is based off the total marinas average space per berth (excluding the Silo Superyacht Marina).

In addition, estimates of capacity have been derived for the other items of marina capital dredging demand advised by CRL. These are set out in Table 7. Here, it has been assumed that the average digging depth equates to 2.5m, providing estimates of total water surface area for each marina (based off the capital works dredging demand stated by CRL). Overall average water space per berth (302m2) has then been applied to these estimates to estimate the total capacity.

Based on these averages, it is estimated that these additional marinas contain capacity for a further 860 berths. Together, this equates to a capacity for an additional 2,210 marina berths. This is similar to the estimated additional demand (2,300) for marina berths in Auckland and Whangarei and Thames-Coromandel districts.

Table 7: Estimated Additional Capacity for Marina Berths – Marinas and Other Identified Areas of Capital Dredging Demand

Item of Capital Dredging Demand	Capital Dredging Demand (m3)	Estimated Marina Water Surface Area (ha)	Estimated Additional Berths
Coromandel	100,000	-	130
Tonkin Taylor	300,000	12.0	400
Confidential - Auckland	250,000	10.0	330
SUB-TOTAL	**650,000**	**22.0**	**860**
Existing Marinas		35.6	1,350
TOTAL		**57.6**	**2,210**

M.E note that the estimates of additional capacity (in terms of numbers of additional berths) within existing marinas and newly identified areas of capital dredging demand may be over-stated, and consequently the demand for dredging estimates may be conservative. This is because trends in boat ownership suggest the average boat size has increased through time and is likely to continue to increase, resulting in a higher space requirement per berth.

3.1.3 Capital Dredging Demand from Additional Marina Capacity

M.E have found from the above analysis that the likely capacity from marinas in Auckland and the Whangarei and Thames-Coromandel districts broadly corresponds to the estimated demand over the next 10 years (including an allowance to meet existing latent demand).

Lastly, M.E have assessed the marina capital dredging demand stated by CRL with estimates of the dredging required to achieve the above marina expansions using an average digging depth of 2.5m. This is set out in Table 8. The level of capital dredging stated by CRL is lower than the estimates of dredging at an average of 2.5m across all marinas, with the exception of Hobsonville Point. It is noted that the total dredging volume for Hobsonville Point is the total consented dredging volume and there is not a separate consented volume for annual maintenance dredging. Consequently, M.E have assumed that this total volume includes any annual maintenance dredging demand.

It may be the case that smaller amounts of dredging is required for a number of marina expansions (than the average rate at 2.5m depth) as the chart datum is likely to be lower (and therefore, require less dredging) at the edges of the marina that are already near the deeper areas of the water.

Table 8: Comparison of M.E Estimated Marina Dredging Demand with CRL Stated Capital Dredging Demand

Marina	CRL Stated Capital Dredging Demand (m3)	Estimated Additional Marina Water Surface Area (ha)	Estimated Capital Digging Demand based on Average 2.5m Dredging Depth
Half Moon Bay/Bucklands Beach	40,000	3.7	92,000
Hobsonville	350,000	19.7	400,000
Pine Harbour	100,000	6.8	169,000
Gulf Harbour (not incl. in CRL estimates)	-	1.3	32,000
Hobsonville Point	214,900	4.2	105,000
TOTAL (excl. Gulf Harbour)	**704,900**	**34.3**	**766,000**
Coromandel	100,000	4.0	
Tonkin Taylor	300,000	12.0	
Confidential - Auckland	250,000	10.0	
COMBINED	**1,354,900**	**60.3**	

Overall, M.E consider that the volumes for capital dredging demand at marinas stated by CRL are within a reasonable range. They correspond to the potential expansion for marina activities, which corresponds to the likely level of demand for marina berths within Auckland and Whitianga over the 2019 to 2029 period. As such, the marina capital dredging requirements as stated by CRL have been used going forward in the remainder of M.E's analysis. The exception is Hobsonville Point where it has been assumed that the capital dredging component of demand equates to 215,000m^3 (i.e. the total consented value less the estimated maintenance dredging demand)[19].

Consequently, in total, M.E consider that there is likely to be a total demand for disposal of 1.35 million m^3 of sediment from capital dredging at marinas that potentially could be disposed of at the NDA.

3.2 Maintenance Dredging Demand at Marinas

Maintenance dredging at marinas forms a significant share of the annual demand for sediment disposal. M.E have analysed the demand for maintenance dredging across the marinas identified within the initial CRL submission. At the request of the EPA, we have also estimated the total demand for maintenance dredging sediment disposal across the rest of the marinas in Auckland, the Thames-Coromandel District and Whangarei District to understand the wider potential demand for sediment disposal at the NDA.

The first part of this section (Section 3.2.1) begins by analysing the past volumes of sediment dredging at the marinas identified within the initial CRL report, then estimating their likely future maintenance demand. The remainder of the section (Section 3.2.2) then estimates the additional demand arising from other marinas within Auckland, and the Thames-Coromandel and Whangarei District's.

[19] M.E note that the total consented dredging demand for Hobsonville Point Marina exceeds the range of our own estimates based on the application of average digging depths. During discussions with CRL it has been agreed to use the consented value in our demand estimates as the resource consenting process is more likely to better reflect the sediment characteristics unique to the local environment and therefore form a more accurate estimation of dredging demand. The total consented volume of 230,000m^3 is identified in para 4 of Mr Thompson's Statement of Evidence (1 November 2018).

3.2.1 Past and Future Maintenance Dredging Demand at CRL-Served Marinas

Information has been provided on the past maintenance dredging at marinas served by CRL. M.E have calculated annual average rates of maintenance dredging across these marinas if the dredging were spread evenly across the 6-year period. These are displayed in Table 9. In total, annual average maintenance dredging across these marinas has equated to an annual average 17,500m^3 of sediment per year across this period[20].

Table 9: Historic Rates of Maintenance Dredging at CRL-Served Marinas, 2013-2018

Marina	Previous Annual Average Maintenance Dredging Demand	Estimated Past Annual Average Dredging Depth (m)	Advised Future Annual Average Dredging Depth (m)
Half Moon Bay/Bucklands Beach	1,279	0.01	0.01
Hobsonville	5,120	0.04	0.12
Pine Harbour	7,587	0.06	0.08
Hobsonville Point	-	-	0.12
Coromandel	-	-	0.04
Tonkin Taylor	-	-	0.04
Confidential - Auckland	-	-	0.04
Bayswater	-	-	0.03
Sandspit Marina	860	0.03	0.10
Whitianga	2,652	0.07	0.07
TOTAL CRL MARINAS (1)	**17,498**		
AVERAGE		**0.04**	

(1) Sandspit and Whitianga Marinas differ to the totals in the Sapere Addendum as CRL advises that information relating to these marinas does not represent a 6 year time period.

M.E have mapped the water surface area of each marina and have equated the dredging volumes into average dredging depths. CRL have assessed these depths and provided updated information on the future dredging depths of each marina (also displayed in Table 9). These have also been applied to existing and future marinas where no information has been available on past dredging. Dredging volumes for 'Coromandel', 'Tonkin Taylor' and 'Confidential-Auckland', as advised, are based on the average past dredging depth (0.04m) for marinas.

The future dredging depths are based on CRL's estimate of the rate of sedimentation of each marina. This is determined by their knowledge of the local sediment environment, rates of tidal movement and water currents, and location of the marinas. The advised rates of dredging reflect the required sediment volume

[20] We note that this differs to the Sapere Addendum. This is because CRL have advised that the Whitianga Marina represents only 1 year of data. A total of 5 years of data of partial dredging has also been added to the Sandspit Marina (excluding any capital dredging).

to be removed to enable the marinas to effectively operate. In some cases, future dredging rates differ to past dredging for the following reasons:

i. Past dredging rates may not be well established where a marina is relatively new and has not yet experienced sediment build-up. This is the case for Sandspit Marina, where future dredging rates have been advised based on future volumes for removal estimated by the marina.

ii. The calculation of maintenance dredging volumes from Hobsonville Marina are conservative when expressed on an annual average basis over the six-year period as dredging up to 2015 was previously disposed of at the AEDG.

iii. Capital dredging (excluded from these rates) may have also simultaneously involved maintenance dredging. Maintenance dredging of the marina may have occurred at the same time as capital works to achieve scale economies based on the overall larger volumes of dredging occurring at the time.

iv. A redistribution of future operational expenditure has allocated a higher share of funding to dredging. This has occurred across a number of marinas where previous other maintenance requirements prevented sufficient funding being available for dredging (e.g. Pine Harbour Marina). Lower rates of past dredging have consequently resulted in greater future dredging requirements to maintain effective operation of the marina.

The future rates of dredging have been applied to the current and future marina sizes to estimate future dredging volumes for each marina (see Table 10). The table shows that the future annual average and total ten-year dredging volumes across the marinas based on future rates identified in Table 9.

Table 10: Estimated Future Maintenance Dredging Volumes by CRL-Served Marinas, 2019-2029

Marina	Estimated Marina Water Area Coverage (ha)			Estimated Annual Dreding Volumes (m3)			Estimated Total Dredging Volume (m3) (10 years)
	Current Size	Future Size	Development Year	Current Size (future depth)	Future Size (future depth)	Future Size (previous depth)	
Half Moon Bay/Bucklands Beach	10.7	14.3	2019	1,300	1,700	1,700	17,200
Hobsonville	12.9	28.9	2022	15,500	34,700	11,500	289,200
Pine Harbour	12.0	18.8	2025	9,600	15,000	11,800	117,900
Hobsonville Point	-	4.2	2026	-	5,000	1,800	15,100
Coromandel	-	4.0	2021	-	1,700	1,700	13,300
Tonkin Taylor	-	12.0	2024	-	5,000	5,000	25,000
Confidential - Auckland	-	10.0	2023	-	4,200	4,200	25,000
Bayswater	10.4	10.4		3,100	3,100	3,100	31,100
Sandspit Marina	3.1	3.1		3,100	3,100	900	31,400
Whitianga	4.0	4.0		2,800	2,800	2,700	28,100
TOTAL CRL MARINAS	**53.1**	**109.7**		**35,400**	**76,400**	**44,200**	**593,300**

When the future dredging depths are applied to the existing marina sizes, it amounts to an overall annual average dredging volume of 35,400m^3 (including an allowance of 3,100m^3 for Bayswater Marina). In comparison, the past rates of dredging across these marinas was 17,500m^3 (Table 9).

The previous section (Section 3.1.2) shows that capacity across a number of these marinas is projected to increase to meet future boating demand. In total, these marinas are projected to cover an increase of 56.6ha in water surface area to meet this demand. When existing marinas area expanded (Half Moon Bay/Bucklands Beach, Hobsonville and Pine Harbour) and new marinas area constructed (Hobsonville Point, Coromandel, Tonkin Taylor and Confidential-Auckland) to meet future boating demand, then the annual average dredging volume will equate to 76,400m^3 once the full expansion and construction has occurred. This volume has been calculated based off the advised annual average future dredging depth.

Table 10 also demonstrates the effect of capital works alone on marina maintenance dredging volumes. If past rates are applied to the increased marina areas, and the average past rate (0.04m) applied to new marinas (and Bayswater Marina, 0.03m[21]), then the annual average dredging volume increases to 44,200m^3.

In total, the future dredging volume across these marinas across the 2019 to 2029 period equates to 593,300m^3 of sediment. This is calculated from applying the advised future rates of dredging across the current and anticipated future sizes of the marinas, taking into account time of construction.

3.2.2 Future Maintenance Dredging Demand at Other Marinas

Maintenance dredging has also been estimated for other marinas within the Auckland region and Whangarei and Thames-Coromandel Districts that could potentially contribute to demand for sediment disposal at the NDA. A conservative assumption of an annual average dredging depth of 0.01m has been applied to these marinas, and no capital dredging has been assumed.

Applying these assumptions, Table 11 estimates that there is likely to be a further 115,200m^3 of sediment volume from maintenance dredging at other Auckland marinas, and a further 72,500m^3 from other Marinas in the Thames-Coromandel and Whangarei District's. The estimate total marina maintenance dredging volume demand across all marinas from 2019 to 2029 is 781,100m^3.

[21] We note that the resulting maintenance dredging volumes for Bayswater Marina at this depth (31,1000m3) are less than the consented volume of 50,000m3.

Table 11: Estimated Maintenance Dredging Demand for Other Marinas, 2019-2029

Marina	Estimated Total Dredging Volume (m3) (10 years)
CRL-Served Marinas	**593,300**
Other Auckland Marinas	
Westhaven	51,100
Gulf Harbour	32,000
Orakei	7,000
Milford	2,600
Outboard Boating Club	5,800
Silo Superyacht Marina	2,800
Pier 21 Marina	1,300
Viaduct Harbour Marina	12,200
Mahurangi	400
TOTAL OTHER AUCKLAND MARINAS	**115,200**
Other Marinas	
Pauanui Waterways	17,700
Whitianga Waterways	23,100
Whangamata Marina	6,800
Whangarei Marina	7,200
Marsden Cove	17,700
TOTAL OTHER MARINAS	**72,500**
TOTAL ALL MARINAS	**781,100**

3.3 Change in Marina Demand with Change in Sediment Disposal Prices

The previous sub-sections have identified the required future volumes of dredging that are required to enable the recreational and commercial boating sector to continue to effectively operate into the future and accommodate future growth in demand. A change in the price of sediment disposal may result in a change in the level of sediment able to be disposed from marinas. It is important to consider the cost that occur as a result of a change in the level of sediment deposition. This sub-section outlines our consideration of a change in the levels of sediment disposal and the costs likely to be experienced as a result of these changes.

Sediment disposal costs have a direct impact on the cost of marina berths. Capital dredging is required to generate marina capacity, with the cost of disposal having a direct impact on the cost of producing the berth, and therefore the price at which they are supplied. This is compounded by ongoing maintenance dredging requirements and associated costs which also have an effect on the cost of the berth (where berth owners have ongoing fees).

Ongoing maintenance costs are factored into the initial price paid for a berth (if berths are bought rather than rented) as consumers make a judgement on the price paid by combining the initial purchase price and likely ongoing maintenance costs. This associate change in the value of berths will have a corresponding change in the quantity of new marina capacity supplied by the market.

To understand the probability of this effect, it is important to identify the relative contribution of dredging sediment disposal costs to the overall cost of berths. Current market information suggests a wide range of berth prices (from $30,000 to $140,000) and correspondingly wide range of ongoing maintenance fees (ranging from $400 to $2,000 per month). CRL have advised that dredging currently equates to around 40% of the berth maintenance fees – a significant proportion. A future redistribution of operational expenditure, to undertake the necessary dredging to enable marinas to continue to operate, means that dredging is likely to account for a higher share of the cost of berths in the future.

If in the future dredging accounted for 50% of the berth costs, then a change in the dredging costs from the NDA disposal option to one of the alternative options would result in a 400% to 550% increase in this component of the operation costs. This would correspondingly flow through to a cost increase of around 325% to 350%. The magnitude of these cost changes are significant relative to the total cost of marina space.

There are significant costs associated with a change in the level of marina activity. It is important that these are taken into account when considering any change in demand for sediment disposal. A reduced ability to dispose of sediment through an order of magnitude cost change of sediment disposal will effectively constrain the ability of the marine sector to effectively operate as the required dredging may not be able to be undertaken.

A reduction in resulting marina activity directly corresponds to a reduction in the benefit consumers experience from recreational boating in New Zealand. Demand for marina capacity (and therefore, dredging) will remain, but will be unmet, existing as a latent demand.

Reductions in boating activity have substantial further costs that extent beyond the reduction in benefit from consumers of marina services. These are likely to be changes in employment and expenditure associated with the boating sector, as well as in other industry sectors that supply the industry. Further flow-on effects will occur from a reduction in wages (from lost employment) spent in other household sectors of the economy.

These changes in the boating sector are potentially significant for Auckland in particular given the higher relative contribution of the marine industry to the regional economy. Previous studies[22] show that the marine sector contributed 4.4% of the region's total exports and 0.7% of its GRP, with this share projected to increase into the future. Auckland attracted a disproportionate share of the national marine sector (64%), with even higher shares in sub-components of the sector (e.g. superyachts).

[22] Murray, C. 2009 *Industry Snapshot for the Auckland Region: The Marine Sector,* prepared by the Social and Economic Research & Monitoring Team at Auckland Regional Council, October 2009.

3.4 Maintenance Dredging at Ports of Auckland Ltd (POAL)

The POAL has an annual maintenance dredging demand to enable it to operate. The initial CRL report has stated a dredging demand for 30,000m^3 of sediment per annum. However, the Sapere Review Addendum has identified a higher annual demand of 38,800m^3. This is based off dredging volumes identified within the POAL Annual Review that have occurred over the last five years. Sapere (para 17 of the Addendum) note that this is consistent with a 1995 Parliamentary Commissioner for the Environment finding.

M.E agree with the Sapere Addendum that an annual volume of 38,800m^3 forms a better estimate of the POAL annual maintenance dredging requirement. Consequently, we have adopted this demand figure within our assessment in place of the initial 30,000m^3 identified by CRL.

It is likely that the 38,800m^3 will form net additional demand for sediment disposal (to the NDA or another disposal option) as previously the sediment has been used for land reclamation. Further land reclamation is unlikely as this capacity has been reached, with further reclamation a Non-Complying activity under the AUP.

M.E consider that demand for maintenance dredging at the POAL will arise irrespective of the cost of sediment disposal. This is because it is a fundamental requirement for continual operation of the port, which is a core piece of infrastructure in both the Auckland regional and national economies. If sediment disposal at the NDA was not able to occur, then disposal would consequently occur via one of the alternative options. The cost differences between these options (as set out in Section 2) means this would therefore result in unreasonable costs to the POAL in the circumstances.

The location of the POAL, within Auckland's CBD, is also an important consideration in assessing the impacts of alternative disposal options. Disposal of 38,800m^3 of sediment would result in around 5,500 truck movements per year at a bottleneck point in Auckland's key arterial road transport network.

M.E believe that it is also important to consider the impacts of not disposing of POAL sediment (and therefore not dredging the ports). The POAL is a major component of regional and national infrastructure, playing a core role in the economy. If operations were constrained at the port, then the cost of not dredging would substantially exceed the cost of reduced activity faced only by POAL.

Various studies have examined the role of the POAL in Auckland's economy. A 2011 report[23] estimated the port to have a total direct output of $207.6m, with a direct value-added component of $109.1m (653 jobs). A further $138.5m in value-added (1,375 jobs) occurs through indirect and induced impacts. The total impact is $247.6m (2,027 jobs). In addition, the cruise industry, which relies on the port, generates a further $184m value-added (3,144 jobs) within the Auckland economy (as estimated in 2017/18). Auckland is crucial for the cruise industry at the national level as it is the primary exchange port and key to local provisioning. Therefore, the impact stretches to the national level. In the 2017/18 season the Cruise

[23] Market Economics Ltd, 2011 *Economic Impacts of the Ports of Auckland Limited 2010, 2021 and 2031,* prepared for Ports of Auckland Limited, 11 October 2011.

industry generated total value added of $491m (sustaining 9,100 job equivalents) across New Zealand. This is expected to rise to over $690m in the 2018-19 season (12,800 job equivalents)[24].

The POAL has a wider role in facilitating trade within Auckland. The 2011 report estimates that if the port were removed (and taking account of any redirected trade to other ports), then “the economic impact would be over $741 million per annual (or 9,600 jobs) in the Auckland economy, through its core activity and the trade it handles (p4)”.

Strategic planning objectives for Auckland suggest that future growth in the POAL is expected to occur at a faster rate, increasing the role of the POAL in the economy. Future growth in the cruise industry is also expected to be strong, with M.E’s research into the sector showing faster past growth rates relative to the economy overall, which are expected to occur into the future.

3.4.1 Auckland Explosives Dumping Ground (AEDG) Disposal Option

The AEDG is one of 5 sites identified in regulations as authorised sites for accepting dredged spoil. POAL are progressing a separate application to dispose their maintenance dumping at the AEDG instead of reclamation which they have previously undertaken. Currently, any dumping at the AEDG is a discretionary activity and is subject to the same assessment criteria as the NDA (albeit being able to be processed non-notified). The AEDG is a deep site (600m – 1200m) which means it is too deep for effective environmental monitoring. This led to the view in the 1990’s that continued dumping there was in breach of New Zealand’s obligations under the 1996 Protocol to the London Convention (that prohibits dumping in locations where environmental monitoring of the effects of dumping cannot occur).

Maritime New Zealand allowed dumping at the AEDG (up to 50,000m^3 per year), issuing permits in 10,000m^3 tranches to encourage parties to find alternative locations. The POAL application is likely to be subject to the same issues that led to a cessation of dumping at the AEDG in the first place.

For that reason, we have included the POAL maintenance dredging of 38,000m^3 annually as being part of the demand that is most likely to be faced by consent holders at the NDA. It is important to note that should POAL be successful in their bid for AEDG consent, then the 38,000m^3 will need to come off the total available to operators of the NDA for the duration of the AEDG consent.

For the purposes of this consent hearing, it is important to include the POAL as part of the ongoing demand picture given the more appropriate environmental outcomes from the ability to monitor the NDA as opposed to the AEDG and the consenting risks associated with the POAL bid.

3.5 Capital Dredging for America’s Cup

CRL have estimated a total sediment disposal demand of 70,000m^3 from the America’s Cup capital dredging works to host the event in 2021.

[24] *Cruise Tourism’s Contribution to the New Zealand Economy 2018*, (October 2018) Market Economics for New Zealand Cruise Association.

The resource consent technical report[25] identifies a total capital dredging volume of 78,000m^3 of sediment. It also identifies a potential further 9,000m^3 of sediment, from borehole corings, that will be temporarily deposited on the seabed for later dredging.

The report recommends that highly contaminated dredged material is either disposed of as fill for port reclamation or in a sanitary landfill. It recommends that other dredgings are disposed of either as fill for port reclamation or in water deeper than 100m.

The report states that ongoing maintenance dredging of the capital works area will be covered within the POAL existing resource consent for annual dredging.

Similar to the POAL dredging demand, M.E consider that dredging for America's Cup will occur irrespective of the sediment disposal option (and their associated costs). Auckland has already committed to hosting the America's Cup and therefore need to undertake the dredging capital works. If sediment disposal at the NDA was not able to occur, then disposal would consequently occur via one of the alternative options. The cost differences between these options (as set out in Section 2) means this would therefore result in unreasonable costs in the circumstances.

Similar to the POAL, the location of the America's Cup, within Auckland's CBD[26], is also an important consideration in assessing the impacts of alternative disposal options. Disposal of 70,000m^3 of sediment would result in around 10,000 truck movements (assuming no further reclamation at the POAL as explained in Section 2.4) at a bottleneck point in Auckland's key arterial road transport network.

M.E believe that it is also important to consider the impacts of not disposing of America's Cup capital works sediment (and therefore not dredging). The America's Cup generates significant economic impact within the wider Auckland (and national) economies. If dredging were constrained, then the cost of not dredging would substantially exceed the cost of reduced activity faced only by the event hosts.

The America's Cup economic assessment report[27] estimates that the event generates a total of $763m in value-added[28] for the national economy (6,433 jobs). The analysis suggests the infrastructure development will also enable future growth opportunities within Auckland's marine sector, with associated GDP effects of $123m annually when developed to full capacity.

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[25] Beca Ltd and Tonkin & Taylor Ltd, 2018 *America's Cup, Wynyard Hobson Coastal Processes & Dredging Technical Report: Resource Consent Application, Wynyard Hobson,* prepared for Panuku Development Auckland and Ministry for Business, Innovation and Employment, April 2018.

[26] This assessment assumes that the CBD forms the most appropriate location for the America's Cup activities (rather than another potential location that may require different dredging volumes). This is due to the co-location of other major marine activity infrastructure, other transport and social infrastructure, the accommodation sector and people within the CBD, as well as the concentration of other economic activity that is likely to experience greater direct and indirect flow-on effects through the concentration of America's Cup activity at this location. Therefore, any relocation to another location with a lower dredging requirement would also involve potential costs in a lower value of economic activity.

[27] Market Economics Ltd, 2017 *36th America's Cup: High Level Economic Assessment Evaluation (Amended),* prepared for Ministry of Business, Innovation and Employment, 18 December 2017.

[28] This has been generated through Computable General Equilibrium (CGE) modelling, which takes into accounts constraints within the economy.

3.6 Summary of Demand for Sediment Disposal

The total estimated demand for sediment disposal for the ten-year period from 2019 to 2029 is summarised in Table 12. In total, there is estimated to be demand for around 2.8m m^3 of sediment disposal across the ten-year period.

Table 12: Combined Total Demand for Sediment Disposal, 2019-2029

Source of Demand	Sediment Disposal Demand (m3) Capital	Maintenance	Combined	Share of Total Demand Capital	Maintenance	Combined
MARINAS						
CRL-Served Marinas	1,354,900	593,300	1,948,200	48%	21%	70%
Other Auckland Marinas	-	115,200	115,200	0%	4%	4%
Other Marinas	-	72,500	72,500	0%	3%	3%
TOTAL MARINAS	***1,354,900***	***781,100***	***2,135,900***	***48%***	***28%***	***76%***
OTHER						
POAL	-	388,000	388,000	0%	14%	14%
America's Cup	70,000	-	70,000	3%	0%	3%
Contingency	100,000	100,000	200,000	4%	4%	7%
TOTAL OTHER	***170,000***	***488,000***	***658,000***	***6%***	***17%***	***24%***
TOTAL DEMAND	**1,524,900**	**1,269,100**	**2,793,900**	**55%**	**45%**	**100%**

It is estimated that marinas contribute just over three-quarters (76%; 2.14m m^3) of the demand. Over half (63%; 1.35m m^3) of the marina demand is contributed by capital works, driven by growth in demand for marina berths predominantly in the recreational boating sector. This capital dredging demand may be conservative as it is assumed to entirely occur within the CRL-served marinas. However, it is noted that, with the exception of a minor area at Gulf Harbour, no other marinas within Auckland were identified to contain additional capacity under the existing AUP provisions.

The remaining 37% (781,100m^3) of marina demand is driven by maintenance dredging. Over three-quarters of this demand is estimated to occur within the CRL-served marinas as a function of both their current and future sizes and dredging depths. It is likely that the maintenance dredging demand estimated for other marinas (i.e. Other Auckland, and Thames-Coromandel and Whangarei District's marinas) is conservative as only a small annual average dredging depth (as set out in Section 3.2.2) has been applied to these marinas. Furthermore, it has been applied to their existing size and assumes no further expansion.

The remaining quarter (24%; 658,000m^3) of sediment disposal demand is estimated to arise from other sources. Annual maintenance dredging at the POAL accounts for over half (388,000m^3) of this demand, with a further 70,000m^3 from the capital dredging for America's Cup.

A contingency of 100,000m^3 demand from capital dredging and 100,000m^3 demand from maintenance dredging (10,000m^3 annually) has been applied. Combined, the contingency value accounts for 7% of the total sediment disposal demand. Contingency demand includes additional sources of demand that are not currently known, but that may arise during the estimation period (2019-2029). CRL have advised that this is likely to be a conservative estimate.

4 Wider Transport Environmental Costs of Sediment Disposal

Significant volumes of truck transport are required to dispose of sediment on land under the 'Landfill Drying' and 'Landfill Cement Mixing' options. It is important to understand the aggregate level of truck movements generated at each location to transport the volumes of sediment required. These have impacts on the road network through additional traffic volume and road usage, as well as environmental impact through the emission of air pollutants.

M.E have quantified the overall level of demand on the road network to dispose of the volumes of sediment under each of the land-based options. These are expressed in terms of the total truck movements required and the total truck kilometres travelled. Environmental impacts of air pollution generated by the truck movements travelled have also been quantified.

4.1 Truck Movements

The previous sections have outlined our estimate of the volume of demand for sediment disposed by location. These have been translated into the total number of truck trips required to transport the volumes of sediment and the total kilometres travelled by the trucks.

CRL have advised that each truck and trailer can carry approximately 21m^3 of sediment (30 tonne total). Based on this volume, Table 13 estimates the total required truck movements required to transport the sediment for disposal from each location. The total truck movements are equivalent across both land-based disposal options as the total volume of sediment for disposal remains the same.

Table 13: Estimated Total Truck Movements and Kilometres Travelled for Sediment Disposal, 2019-2029

Source of Demand		TOTAL TRUCK MOVEMENTS	TOTAL TRUCK KMS TRAVELLED		TRUCK KMS PER M3	
			LANDFILL DRYING OPTION	LANDFILL - CEMENT MIXING OPTION	LANDFILL DRYING OPTION	LANDFILL - CEMENT MIXING OPTION
CRL Marinas	Half Moon Bay/Bucklands Beach	2,700	347,100	168,800	6.1	3.0
	Hobsonville	30,400	1,473,200	1,887,100	2.3	3.0
	Pine Harbour	10,400	1,452,100	643,400	6.7	3.0
	Hobsonville Point	11,000	617,800	679,200	2.7	3.0
	Coromandel	5,400	2,068,100	334,600	18.2	3.0
	Tonkin Taylor	15,500	1,136,200	959,500	3.5	3.0
	Confidential - Auckland	13,100	961,400	811,900	3.5	3.0
	Bayswater	1,500	80,100	91,700	2.6	3.0
	Sandspit Marina	1,500	122,400	92,800	3.9	3.0
	Whitianga	1,300	512,700	82,900	18.2	3.0
	TOTAL CRL MARINAS	**92,800**	**8,771,100**	**5,751,800**	**4.5**	**3.0**
Other Auckland Marinas	Westhaven	2,400	150,900	150,900	3.0	3.0
	Gulf Harbour	1,500	70,100	94,500	2.2	3.0
	Orakei	300	23,300	20,600	3.3	3.0
	Milford	100	5,400	7,700	2.1	3.0
	Outboard Boating Club	300	18,900	17,200	3.2	3.0
	Silo Superyacht Marina	100	7,500	8,300	2.7	3.0
	Pier 21 Marina	100	3,400	3,800	2.7	3.0
	Viaduct Harbour Marina	600	32,400	35,900	2.7	3.0
	Mahurangi	-	1,500	1,300	3.3	3.0
	TOTAL OTHER AUCKLAND MARINAS	**5,500**	**313,400**	**340,200**	**2.7**	**3.0**
Other Marinas	Pauanui Waterways	800	179,100	52,400	10.1	3.0
	Whitianga Waterways	1,100	422,300	68,300	18.2	3.0
	Whangamata Marina	300	75,000	20,000	11.0	3.0
	Whangarei Marina	300	10,300	21,300	1.4	3.0
	Marsden Cove	800	45,400	52,100	2.6	3.0
	TOTAL OTHER MARINAS	**3,500**	**732,000**	**214,100**	**10.1**	**3.0**
	TOTAL ALL MARINAS	**101,700**	**9,816,500**	**6,306,200**	**4.6**	**3.0**
Other	POAL	18,500	1,145,500	1,145,500	3.0	3.0
	Americas Cup	3,300	206,700	206,700	3.0	3.0
	Contingency	9,500	699,200	590,500	3.5	3.0
	TOTAL OTHER	**31,300**	**2,051,400**	**1,942,700**	**3.1**	**3.0**
TOTAL		**133,000**	**11,868,000**	**8,248,900**	**4.2**	**3.0**

In total, it is estimated that around 133,000 truck movements would be generated across the 2019 to 2029 ten-year period from moving the estimated volumes of sediment. The share across different components of demand are directly proportional to their share of overall sediment disposal volumes outlined in Section 3.6.

Over-three quarters (76%) of the demand arises from marinas, with most (91%) coming from the marina's currently served by CRL. The share from these marinas is higher due to the demand generated from capital dredging (which does not form a component of demand from other marinas), as well as the conservative assumptions applied around annual average dredging requirements.

It is important to consider the location of these truck movements as it has a major bearing on their effect on the transport network. The total truck movements across the ten-year period under each option are displayed by location in Figure 1 and Figure 2.

Figure 1: Distribution of Estimated Truck Movements by Point of Origin Under the 'Landfill Drying' Option, 2019-2029

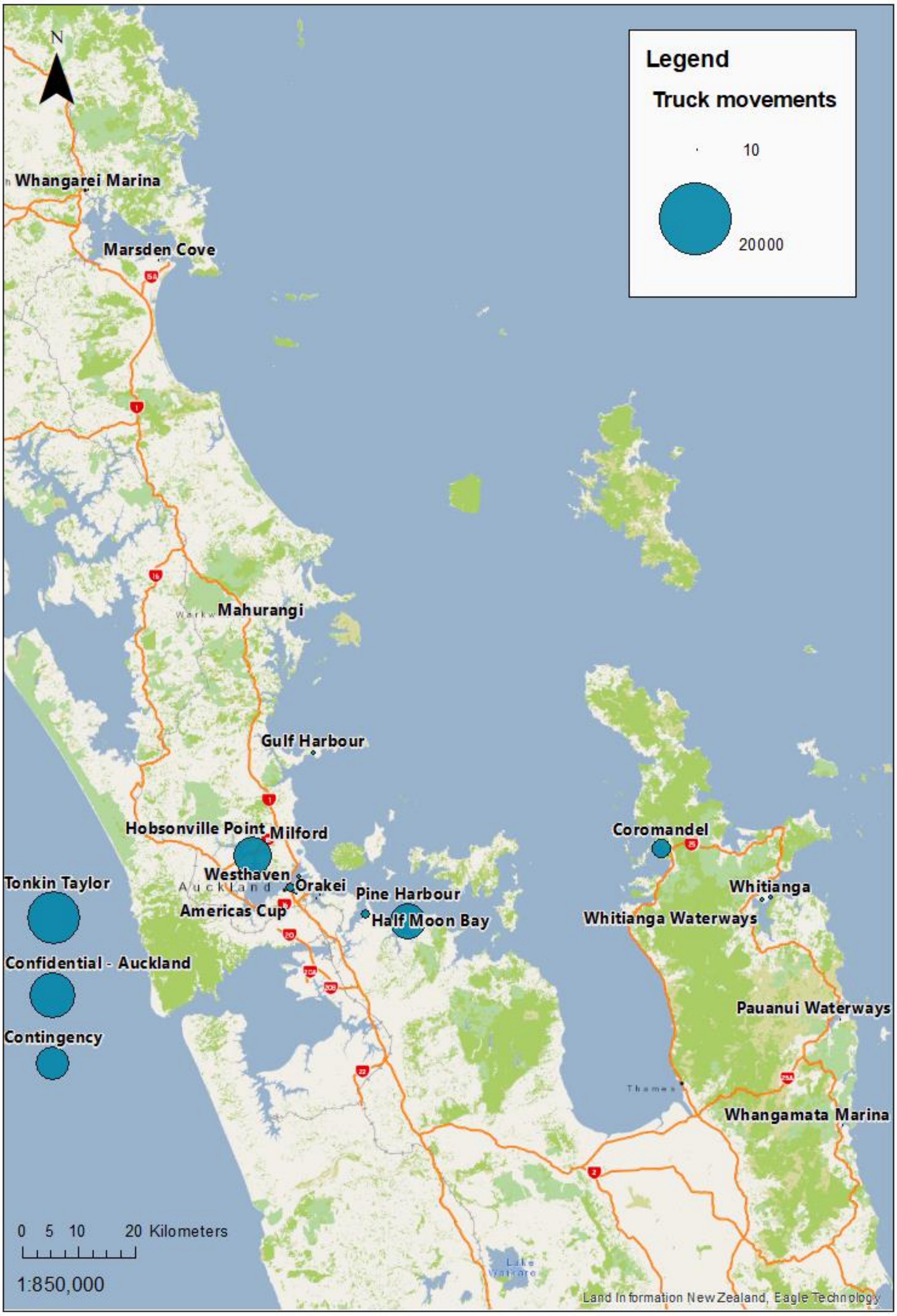
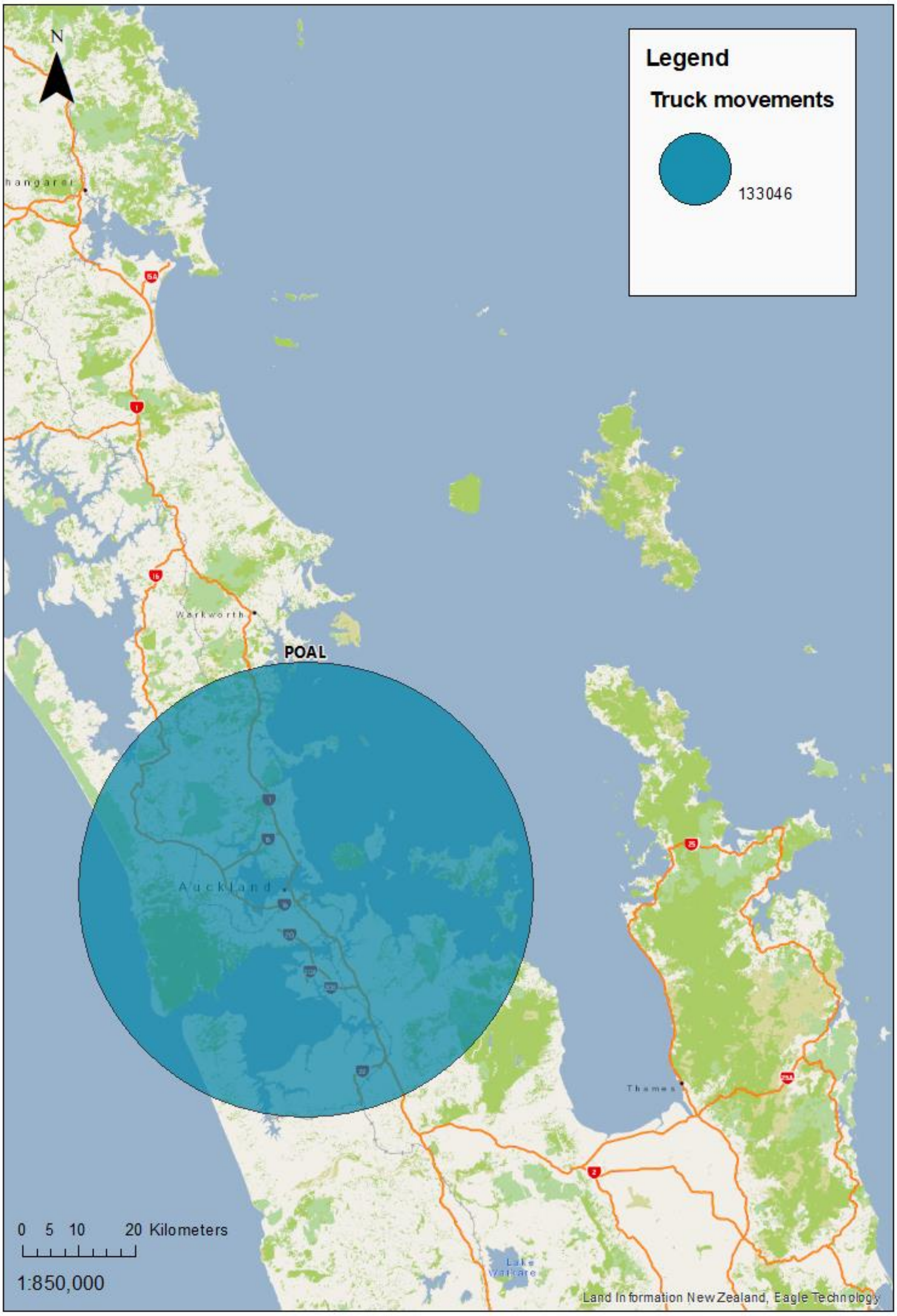


Figure 2: Distribution of Estimated Truck Movements by Point of Origin Under the 'Landfill Cement Mixing' Option, 2019-2029



Under the 'Landfill Cement Mixing' option, all of these truck movements will occur from the CBD as they occur subsequent to the cement mixing, which occurs at the Port of Auckland. This may have an effect on congestion at the port and surrounding transport network given it's location in Auckland CBD. If the total truck movements are spread evenly across the ten-year period, and occur evenly throughout the year, then this equates to an average of around 35 to 40 additional truck movements from the port per day. However, it is unlikely that truck movements will occur on an evenly spread basis, and it is likely there will be higher volumes of truck movements concentrated into particular time periods.

Under the 'Landfill and Drying' option the same number of total truck movements will occur. However, these will be spread across the wider area where truck movements occur from each sediment source location. This option will still generate a high volume of truck movements from Auckland's CBD area given the location of dredging demand from this area. Under this option, approximately one-fifth (19%) of the truck movements will occur from sediment source locations within Auckland's CBD.

4.2 Truck Kilometres Travelled

The total number of kilometres travelled by truck has also been calculated for the each of the options. These are displayed in Table 13. These have been calculated by multiplying the total number of truck movements by the distance to the nearest landfill, as outlined in Sections 2.2 and 2.3[29]. For the total traffic effect calculation, the total distance travelled has been multiplied by 2 to take account of the required return journey.

In total, the 'Landfill and Drying' option would generate around 11.9 million truck kilometres travelled, and the 'Landfill Cement Mixing' option around 8.2 million truck kilometres. Marinas would generate a higher share of the total kilometres under the 'Landfill and Drying' option given the larger road distances (on average) between their location and the landfill sites than the distance from the port and the Redvale landfill. Although the total road distance travelled is less under this option, there is also a component of barge travel to the port from each sediment source location, which may also contribute to potential congestion at the port.

4.3 Travel Externalities

The total cost of the land-based travel required under these options is likely to exceed the cost of the travel paid for the transport of sediment. This is due to the externalities of traffic congestion and environmental effects of travel (which are not fully captured by the price paid for travel)[30].

M.E have quantified the effect of vehicle emissions into the environment arising from the required truck travel. The dollar value impact of a quantity of the vehicle emission pollutants[31] have been obtained from

[29] With the further analysis beyond the Auckland region, alternative landfill locations were researched. A further landfill able to take commercial volumes of marine sediment was identified within Whangarei (at Puwera). It was assumed that sediment disposal from the Thames-Coromandel District would be most likely to occur at Hampton Downs with the closure and rehabilitation of the landfill at Thames.

[30] It has been assumed that the cost of the additional physical use of the road infrastructure is captured by the road user charges paid by the transport operators.

[31] These include the following pollutants: PM2.5, PM10, NOx, CO, HC, CO2.

the NZTA Economic Evaluation Manual (EEM)[32]. These have been converted into dollar value impacts of pollutants per kilometre travelled by each truck and applied to the estimates of total truck kilometres to provide an overall dollar value impact of the emissions externality. In total, the cost of emissions equates to $0.299 per kilometre travelled by a truck at 80 kilometres per hour, and $0.302 per kilometre at 60 kilometres per hour[33]. An average of these values ($0.301 per kilometre) has been applied in the analysis to reflect a combination of driving speeds[34][35].

Table 14 provides a disaggregation of the total estimated cost of travel emissions from each sediment source location under each of the land-based disposal options. These are directly proportional to the total truck kilometres travelled under each option, and therefore maintain the same relativities between locations as the analysis of total kilometres travelled.

In total, it is estimated that the total cost of emissions amounts to $3.6 million under the 'Landfill Drying' option and $2.5 million[36] under the 'Landfill Cement Mixing' option. This equates to an average of $1.28 per m^3 of sediment under the former option, and $0.89 per m^3 under the latter. The price remains constant by sediment source location under the 'Landfill Cement Mixing' option as all sediment is transported from the POAL. However, the costs per m^3 range from between $0.43 to $5.49 per m^3 under the 'Landfill and Drying' option.

Overall, the cost of emissions equates to an additional 0.4% of the paid cost of disposal under both the 'Landfill and Cement Mixing' and 'Landfill and Drying' options. Under the former option, this share ranges from 0.3% to 0.4%. Under the latter, it ranges from 0.2% up to 1.7%.

[32] NZTA, 2018 *Economic Evaluation Manual,* 1 July 2018.

[33] These are likely to represent conservative estimates of the total cost as they are expressed in 2016 dollar values.

[34] Although further information is not available to more definitively calculate the distribution of this value by truck speed, the similarities of these values at different speeds means that it does not affect the overall order of magnitude of this effect relative to other costs.

[35] The calculated values of emissions externalities are likely to represent a conservative estimate as they are the average of commercial trucks provided in the EEM. The disposal costs in this analysis are based off large trucks (of above average size) which also contain a trailer unit.

[36] These are not expressed as net present values as no discount rate has been applied.

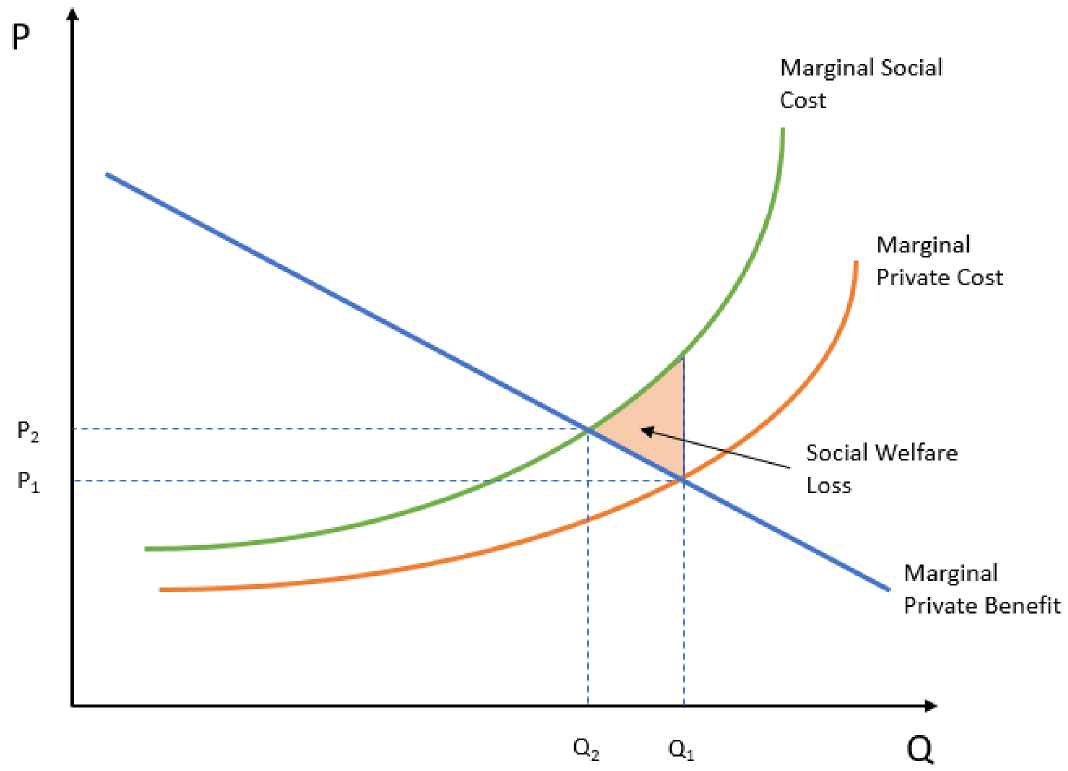
Table 14: Estimated Cost of Emissions from Truck Transport from Sediment Disposal, 2019-2029

Source of Demand		TOTAL COST OF EMISSIONS LANDFILL DRYING OPTION	TOTAL COST OF EMISSIONS LANDFILL - CEMENT MIXING OPTION	EMISSIONS COST PER M3 LANDFILL DRYING OPTION	EMISSIONS COST PER M3 LANDFILL - CEMENT MIXING OPTION	% OF PAID DISPOSAL COSTS LANDFILL DRYING OPTION	% OF PAID DISPOSAL COSTS LANDFILL - CEMENT MIXING OPTION
CRL Marinas	Half Moon Bay/Bucklands Beach	$ 104,400	$ 50,800	$ 1.83	$ 0.89	0.7%	0.4%
	Hobsonville	$ 443,100	$ 567,600	$ 0.69	$ 0.89	0.3%	0.4%
	Pine Harbour	$ 436,700	$ 193,500	$ 2.00	$ 0.89	0.7%	0.4%
	Hobsonville Point	$ 185,800	$ 204,300	$ 0.81	$ 0.89	0.3%	0.4%
	Coromandel	$ 622,000	$ 100,600	$ 5.49	$ 0.89	1.7%	0.3%
	Tonkin Taylor	$ 341,700	$ 288,600	$ 1.05	$ 0.89	0.4%	0.4%
	Confidential - Auckland	$ 289,100	$ 244,200	$ 1.05	$ 0.89	0.4%	0.4%
	Bayswater	$ 24,100	$ 27,600	$ 0.78	$ 0.89	0.3%	0.4%
	Sandspit Marina	$ 36,800	$ 27,900	$ 1.17	$ 0.89	0.5%	0.3%
	Whitianga	$ 154,200	$ 24,900	$ 5.49	$ 0.89	1.7%	0.3%
	TOTAL CRL MARINAS	**$ 2,638,000**	**$ 1,729,900**	**$ 1.35**	**$ 0.89**	**0.5%**	**0.4%**
Other Auckland Marinas	Westhaven	$ 45,400	$ 45,400	$ 0.89	$ 0.89	0.3%	0.4%
	Gulf Harbour	$ 21,100	$ 28,400	$ 0.66	$ 0.89	0.2%	0.3%
	Orakei	$ 7,000	$ 6,200	$ 1.00	$ 0.89	0.3%	0.4%
	Milford	$ 1,600	$ 2,300	$ 0.63	$ 0.89	0.2%	0.4%
	Outboard Boating Club	$ 5,700	$ 5,200	$ 0.97	$ 0.89	0.3%	0.4%
	Silo Superyacht Marina	$ 2,300	$ 2,500	$ 0.80	$ 0.89	0.2%	0.4%
	Pier 21 Marina	$ 1,000	$ 1,100	$ 0.80	$ 0.89	0.2%	0.4%
	Viaduct Harbour Marina	$ 9,800	$ 10,800	$ 0.80	$ 0.89	0.2%	0.4%
	Mahurangi	$ 400	$ 400	$ 1.00	$ 0.89	0.4%	0.3%
	TOTAL OTHER AUCKLAND MARINAS	**$ 94,300**	**$ 102,300**	**$ 0.82**	**$ 0.89**	**0.3%**	**0.4%**
Other Marinas	Pauanui Waterways	$ 53,900	$ 15,800	$ 3.04	$ 0.89	1.1%	0.3%
	Whitianga Waterways	$ 127,000	$ 20,500	$ 5.49	$ 0.89	1.7%	0.3%
	Whangamata Marina	$ 22,500	$ 6,000	$ 3.32	$ 0.89	1.2%	0.3%
	Whangarei Marina	$ 3,100	$ 6,400	$ 0.43	$ 0.89	0.2%	0.3%
	Marsden Cove	$ 13,700	$ 15,700	$ 0.77	$ 0.89	0.3%	0.3%
	TOTAL OTHER MARINAS	**$ 220,200**	**$ 64,400**	**$ 3.04**	**$ 0.89**	**1.1%**	**0.3%**
	TOTAL ALL MARINAS	**$ 2,952,400**	**$ 1,896,600**	**$ 1.38**	**$ 0.89**	**0.5%**	**0.3%**
Other	POAL	$ 344,500	$ 344,500	$ 0.89	$ 0.89	0.3%	0.4%
	Americas Cup	$ 62,200	$ 62,200	$ 0.89	$ 0.89	0.3%	0.4%
	Contingency	$ 210,300	$ 177,600	$ 1.05	$ 0.89	0.4%	0.4%
	TOTAL OTHER	**$ 617,000**	**$ 584,300**	**$ 0.94**	**$ 0.89**	**0.3%**	**0.4%**
TOTAL		**$ 3,569,400**	**$ 2,480,900**	**$ 1.28**	**$ 0.89**	**0.4%**	**0.4%**

The increased volume of truck movements required under the land-based disposal methods may also generate externalities of road congestion. Congestion occurs where the marginal private cost of each trip is exceeded by the marginal social cost of the trip. This is because each additional vehicle on the road also has an effect (cost) which is spread across all other vehicles. This marginal cost across other vehicles in aggregate is larger than the private cost of the vehicle making the trip. Consequently, more vehicles are added to the road network than is socially optimal, resulting in congestion.

This is demonstrated conceptually in Figure 3 where the social cost curve intersects the demand curve at a higher price (P_2) than the private cost curve (P_1). These prices correspond with different quantities of travel demand on the demand curve, where the social cost has a lower quantity (Q_2) of travel demanded than the private cost curve (Q_1). The orange triangle identifies the area of externality (social welfare loss) generated by this effect.

Figure 3: Stylised Illustration of the Travel Congestion Externality



M.E have recognised, but not quantified this effect as insufficient information is available on the timing and distribution of trips to be able to undertake the required transport modelling to calculate this effect.

5 Conclusions

CRL has made an application to the EPA for resource consent to increase the disposal of dredged marine sediment at the NDA. A consent to dispose of 50,000m^3 per annum currently exists, but is insufficient to meet future needs. Consent is sought to increase this amount to 250,000m^3 per annum to meet the future needs of the POAL, America's Cup and marinas in Auckland, Whangarei and Thames-Coromandel districts.

M.E has undertaken an assessment of the likely demand for disposal of dredged material over the next ten-years at the NDA. It has estimated a total volume of around 2.8 million m^3 of sediment from 2019-2029. This arises through a combination of maintenance dredging of existing marina capacity to enable their continued operation, capital dredging to expand marina capacity to meet the future projected demand for marina space, maintenance dredging at the POAL, capital works for the America's Cup, and an other contingency allocation of around 7%.

The calculation of demand occurred independently from the initial estimates provided by CRL. It does confirm the appropriateness of a number of the components of the initial demand estimates, and provides greater information on the allocation of demand estimates across different sediment sources.

The demand assessment has found that future demand for sediment disposal at the NDA is likely to significantly exceed past disposal volumes. This is due to a combination of factors, including:

i. Capital works dredging of marinas to provide additional capacity to meet future growth in marina space demand (and consequently higher ongoing maintenance dredging volumes across these expanded areas).
ii. A change in dredging depths across existing maximum capacity to enable future effective operation of marinas.
iii. A ceasing of capacity to dispose of sediment dredged from the POAL through land reclamation.
iv. Additional capital works required to host the America's Cup.

The calculated future demand volumes reflect the dredging requirement to enable the marine sector to operate effectively in the future and meet future growth in demand. It is required to enable POAL to continue to function, whilst meeting New Zealand's obligations under the 1996 London Convention on the prevention of marine pollution by dumping, and to enable Auckland to host the America's Cup.

M.E has conducted an assessment of the different options for marine sediment disposal. The following options for sediment disposal have been investigated:

- Disposal of sediment at the NDA via a bottom dump barge, transported directly from the sediment sources.
- Drying of sediment at the sources, then transporting to landfill.
- Transporting the sediment to the POAL, then mixing with cement, then transporting to landfill.
- Transporting the sediment to the POAL, then mixing with cement, then re-using in other applications.

Costs for these options have been calculated across the different sediment source locations currently served by CRL. Overall, disposal at the NDA is estimate at approximately \$47 per m^3. Disposal via the alternative options equate to approximately 5.5 to 6 times the cost of this option – the drying and landfill option at $290 per m^3, and the cement mixing and landfill option at $256 per m^3. A partial costing of the cement mixing a re-use option has also been undertaken, equating to $92 per m^3.

The large cost differences in these options mean that sediment disposal via one of the alternatives would result in the user facing unreasonable costs in the circumstances.

The alternative options also generate significant volumes of travel demand on the road network. Across the ten-year period, they are estimated to result in around 133,000 truck movements and 8 million to 12 million truck kilometres travelled.

The travel demand generates externalities of vehicle emissions into the environment (estimated at $2.5 million to $3.7 million) and congestion on the road network. The latter is especially pertinent under the cement mixing and landfill option where all truck movements would originate from the POAL, along with significant volumes of barge trips to deliver the sediment.

Importantly, these options also may not be available for sediment disposal. The land drying requires the availability of suitable land and infrastructure at appropriate locations. It also requires resource consent to be obtained, which may not be granted on the basis of the range of adverse effects associated with this process.

The re-use of sediment option is also of limited availability due to no further land reclamation able to occur. It relies on currently unidentified potential options that may or may not become available in the future. These also require acceptance through the resource consent process.

Consequently, this leaves the availability of the cement mixing and landfill option. This option concentrates all the significant sediment transport volumes at the POAL (on both land and water).

As considered within this assessment, if sediment disposal were to occur in an alternative option, then underlying demand is unlikely to change as it reflects the needs for continued effective operation of the POAL and marinas. It is required for the marina sector to meet the anticipated future growth within the sector.

Sediment dredging would still need to occur at the POAL as a fundamental core piece of regional and national infrastructure. The cost of not dredging the POAL – the constraints on the regional and national economies – is likely to be much greater to the wider economy than the cost of any loss in revenue to the POAL. A similar situation is true for the America's Cup through the wider economic contribution to the economy generated by this event. The continued disposal via an alternative option, at 5.5 to 6 times the cost, would therefore mean that these operators would face an unreasonable cost in the circumstances.

Alternative disposal methods would be likely to result in a constraint to activities at marinas. The recreational boating sector, as the key driver of demand, would face high relative increases in costs, reducing the ability to utilise marina's and result in a switch to latent (unmet) demand.

Constraints in this sector would well exceed the loss of consumer benefit from participation in boating activities. It would result in flow-on effects (costs) to a wide range of sectors and employees that serve the marine sector.

Lastly, the assessment has considered potential cost rises at the NDA itself and how this may affect demand for disposal. The cost differences between the NDA and other options are very large, meaning the disposal costs of this option would need to increase by around 450% to 500% to become comparable to other options.

Moreover, nearly all of the cost components of this option are common to other options, meaning that this increase would need to be generated predominantly from the CRL administration cost area – approximately 14% of the cost. As such, even a large relative increase in the cost of this component would have only a minor effect on the demand for this option. Cost increases of this component itself would be limited by competition within the marketplace from other potential operation.

There is however the potential for transport cost reductions to occur within this option with scale economies through the use of larger barges in the future. Barger transport scale economies are likely to have a larger relative impact on the NDA disposal option than the cement mixing and landfill option as barge transport accounts for a much larger share of the cost components of the NDA option.