Request for a pre-application meeting for resource consents

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Fields marked with an asterisk (*) are mandatory

General location of proposal* (this helps us determine which council area office should process your request)

✓ Auckland CBD/Isthmus/Gulf Islands | North Shore | Rodney/Hibiscus Coast

Waitakere | Manukau | Papakura | Pukekohe/Franklin

1 Contact details

Name:* Luke Gaving

Company name (if applicable): Argo Environmental Ltd

Landline:* 09 367 0631 Mobile: 021 323310

E-mail: lgaving@argoenv.com

In providing email contact details, you consent to being contacted by Auckland Council or agents for the purpose of customer satisfaction or other research. If you would like to opt-out of this contact please tick here ☐

Preferred method of contact (please tick):

☐ Landline ☑ Mobile ☑ E-mail

I am the (please tick):

☐ Property owner ☐ Prospective purchaser ☐ Lessee ☑ Agent or consultant ☐ Other (please specify)

Please indicate whether you have previously discussed your application with council and, if so, who.

Yes, Sarah McCarter

If you are not the prospective applicant for any consents, permits or licenses (if they are required), please enter the applicant's details below.

Name of prospective applicant (if applicable): Joe Griffin (Community Leisure Management Ltd)

Landline: — Mobile: 0274 677041

E-mail: JG@clmnz.co.nz

2 Other attendees

Please indicate who will be attending the meeting with you. This may include your client, agent, or consultant(s) with particular expertise.

Attendee name	Area of expertise/profession/title
Joe Griffin	Director
Garry Venus	Planner
Luke Gaving	Environmental Scientist

3 Meeting preferences

Please indicate which dates and times over the next two weeks you and all of your party are available to meet.*

The more dates and times you are able to indicate the easier it will be for us to fulfil your meeting request. (Please note that in most cases, meetings are held at the Auckland Council area office closest to the location of your proposal.)

Date | Times on that day

any time later this week (14-16/3/2012) if possible please.

4. Site details

Site address of proposal*

Street number and name: Coastal marine area located between the road & rail bridges at the point where Hobson Bay joins the Waitemata Harbour beneath Tamaki Drive at the northern end of Hobson Bay.

Suburb, town or locality: Auckland.

Legal description of property: —

5 Proposal

Please provide an outline of your proposal below and, if known, a list of consent, permit and licensing requirements.*

Please attach all available information. This may include any conceptual plans, drawings, photos or draft assessments of environmental effects.

In providing an outline, consider whether there are specific matters you would like addressed at the meeting.

(Please note: the information you provide in this section will help us determine which council staff should attend the meeting and what we need to do to prepare for it.)

Following are examples of matters you may wish to discuss:

- resource consent requirements or the information needed to support consent applications;
- traffic, heritage, urban design, ecological, tree, archaeological, storm water or roading issues;
- the rules associated with discharges to water, air or land, or activities in the coastal environment;
- people who may be affected by your proposal;
- building code or building consent requirements;
- licensing and compliance requirements in terms of food premises, health, noise, contaminated land, or liquor.

Please see draft AEE attached.

Having completed the previous question, please indicate the main area to which your proposal relates.*
(Please note: this information will help us determine which team will handle your meeting request.)

___ Resource Consents – district issues (eg land use, subdivision and development)

✓ Resource Consents – regional issues (eg coastal permits, air permits, water permit, etc)

Please note that 'Resource Consents – regional issues' include discharges to land, air or water; the taking, using, damming or diversion of water; activities in the coastal marine area; industrial trade processes; contaminated land; works in the beds or lakes or rivers.

What other consents, permits or licenses, if any, have you already obtained with respect to this proposal?

6 Terms, conditions and fees

The purpose of a pre-application meeting is to facilitate communication between applicants and the council so that the applicant can make informed decisions about applying for consents, permits or licenses.

The views expressed by council staff in or following a pre-application meeting are those officers' preliminary views, made in good faith, on the applicant's proposal. The council makes no warranty, express or implied, nor assumes any legal liability or responsibility for the accuracy, correctness, completeness or use of any information or views communicated as part of the pre-application process.

The applicant is not required to amend their proposal to accommodate the views expressed by council staff, nor to comply with any suggestions made by council staff. Further, it remains the applicant's responsibility to get their own professional planning and legal advice when making any application for consents, permits or licences, and to rely solely on that advice, in making any application for consents, permits or licenses.

To the extent permissible by law, the council expressly disclaims any liability to the applicant (under any theory of law including negligence) in relation to any pre-application process. The applicant also recognises that any information it provides to the council may be required to be disclosed under the Local Government Official Information and Meetings Act 1987 (unless there is a good reason to withhold the information under that Act).

The cost of the pre-application meeting depends on whether the proposal under discussion is considered to be a standard or complex proposal by the council.

Standard proposals incur a fixed fee. Standard proposals are those that require only one pre-application meeting of up to one hour, and attendance by no more than four council staff. There will be no further charge unless the applicant asks the council to do further work in relation to the proposal.

Complex proposals are those that:

- require more than one meeting; or
- attendance by more than four council staff; or
- are estimated to be valued in excess of $5 million; or
- are proposed subdivisions that involve the creation of 50 lots or more.

The council will require a deposit and otherwise charge for complex proposals based on the number and hourly rate of council staff attending the meeting, and any related work undertaken by council staff.

Information on fees and charges are available on the council website www.aucklandcouncil.govt.nz or can be obtained via our call centre on 09 301 0101 or from our service centres.

The fee or deposit should be paid in advance of, or at, the first meeting.

7 Declaration

I have read, understood, and accept the terms and conditions set out above. I agree to pay Auckland Council the applicable fee and the actual and reasonable costs of the work the council undertakes in response to this request.

Signature: Luke Cairns

Date: 12 March 2012

All correspondence (excluding invoices) sent to:

Address: Argo Environmental Ltd, P.O.Box 105774, Auckland

Postcode: 1143

Invoices, if applicable, sent to:

Address: CLM NZ, P.O.Box 14110 Panmure, Auckland Attn: Joe Griffin.

Postcode:

✓ Please indicate whether you would like an estimate of costs for pre-application engagement. Please note however, that standard proposals are subject to a fixed fee. Any estimate that the council provides with respect to complex proposals will be based on the information you have provided in support of your request.

Office use only

Area office	Officer(s) allocated to meeting
File #	Specialist advisers required
Proposal type (complex or standard)	Meeting date and time
Indicate if request made by key account client	Location
Meeting lead	Invoicing complete (if required)

CLM Limited

Parnell Baths
Marine Energy Project

APPLICATION FOR RESOURCE CONSENTS

AND

ASSESSMENT OF
ENVIRONMENTAL EFFECTS

FINAL DRAFT

March 2012

APPLICATION FOR RESOURCE CONSENTS PURSUANT TO SECTION 88, RESOURCE MANAGEMENT ACT 1991

To: Auckland Regional Council
21 Pitt Street
Private Bag 92-012
Auckland 1142

COMMUNITY LEISURE MANAGEMENT (CLM) NEW ZEALAND LIMITED applies for a resource consent for part of the Coastal Marine Area located adjacent to the Parnell Baths facility as described below.

The location to which the application relates:

Coastal Marine Area located between the road and rail bridges at the point where Hobson Bay joins the Waitemata Harbour beneath Tamaki Drive at the northern end of Hobson Bay.

The name and address of the owner(s) and occupier of the land to which the applications relate are:

Ontrack (land adjacent to railway)

The types of resource consent being sought:

CLM New Zealand Limited is applying for the following resource consent for a term of 35 years:

- **Coastal permit for coastal occupation;**

  Occupation by three tidal turbines suspended in the water column at or about NZMS 260 R11: 799703 (see Figure 1).

- **Coastal permit to erect a structure on the foreshore**

  The erection of a turbine - supporting gantry structure across the channel beneath Tamaki Drive located between the Tamaki Drive road and rail bridges.

- **Coastal permit to take, use or divert open coastal water**

  The turbines require the diversion of water around the structures in order to spin thereby generating electricity.

- **Coastal permit for a mooring**

  As the turbine location is outside of a Mooring Management Area, a permit is required to moor the structure.

- **Land use consent associated with shoreline structures and shore based cable laying**

  Land use activities associated with the electrical connection of the turbine array to the Parnell Baths, including cable trenching over a distance of around 150m through the rail corridor from the turbine array to the footbridge adjacent to the Baths complex.

[Refer attached Assessment of Environmental Effects (AEE) document, for a more detailed description of the activities for which consent is sought].

Assessment of Environmental Effects:

An Assessment of Effects on the Environment (AEE) of the proposed activities, including ways in which any adverse effects may be mitigated, has been prepared in accordance with the Fourth Schedule of the Resource Management Act 1991, and is attached.

Are other resource consents required?

No.

Name and address for service of documents:

CLM New Zealand Limited

PO Box 14-643

Panmure

Attention: Joe Griffin

Signature of applicant:

____

[authorised representative CLM NZ Ltd]

Dated:

TABLE OF CONTENTS

1. Introduction

1.1 Background

Auckland Council owns and operates the Parnell Baths swimming facility located on the north-eastern edge of Hobson Bay, Auckland (Figure 1). Day - to - day operations are managed under a lease arrangement by Parnell Baths Limited, a wholly owned subsidiary of Community Leisure Management New Zealand Ltd (CLM) which operates some thirty-six public swimming pools and recreational facilities around New Zealand.

A significant annual business operations cost to the Parnell Baths is the purchase cost of compressed natural gas (used mainly for lido pool and spa water heating including wash showers heating) and electricity (mainly used for sea-water pump lifting, filtration and re-circulation).

CLM intends to, where practicable, implement renewable energy solutions for the Parnell Baths and, to this end, has evaluated available 'off-the-shelf' renewable energy technology options (including solar) capable of reducing the company's future energy demand from the national grid. CLM has identified marine energy as viable solution to their energy needs.

CLM proposes to construct and commission a small scale tidal energy electricity generation plant ("the Project") to harness the flows into and out of Hobson Bay into the Waitemata Harbour, to be located beneath Tamaki Drive to the northeast of the Baths (see Figure 1).

Under the provisions of Sections 9, 12, 13 and 15 of the Resource Management Act 1991 (RMA), resource consents are needed for activities associated with the Project. Applications for resource consents are set out in Part 1 of the present document, and as required by the Act, the applications are supported by this Assessment of Effects on the Environment ("AEE"), provided as Part 2 of this document.

1.2 Activities Overview

Proposed activities associated with the Project in the Coastal Marine area (CMA) below MHWS include the following:

- Occupation of Coastal marine area
- Use seawater for generation of electricity

Each of these project elements is described in detail in this AEE.

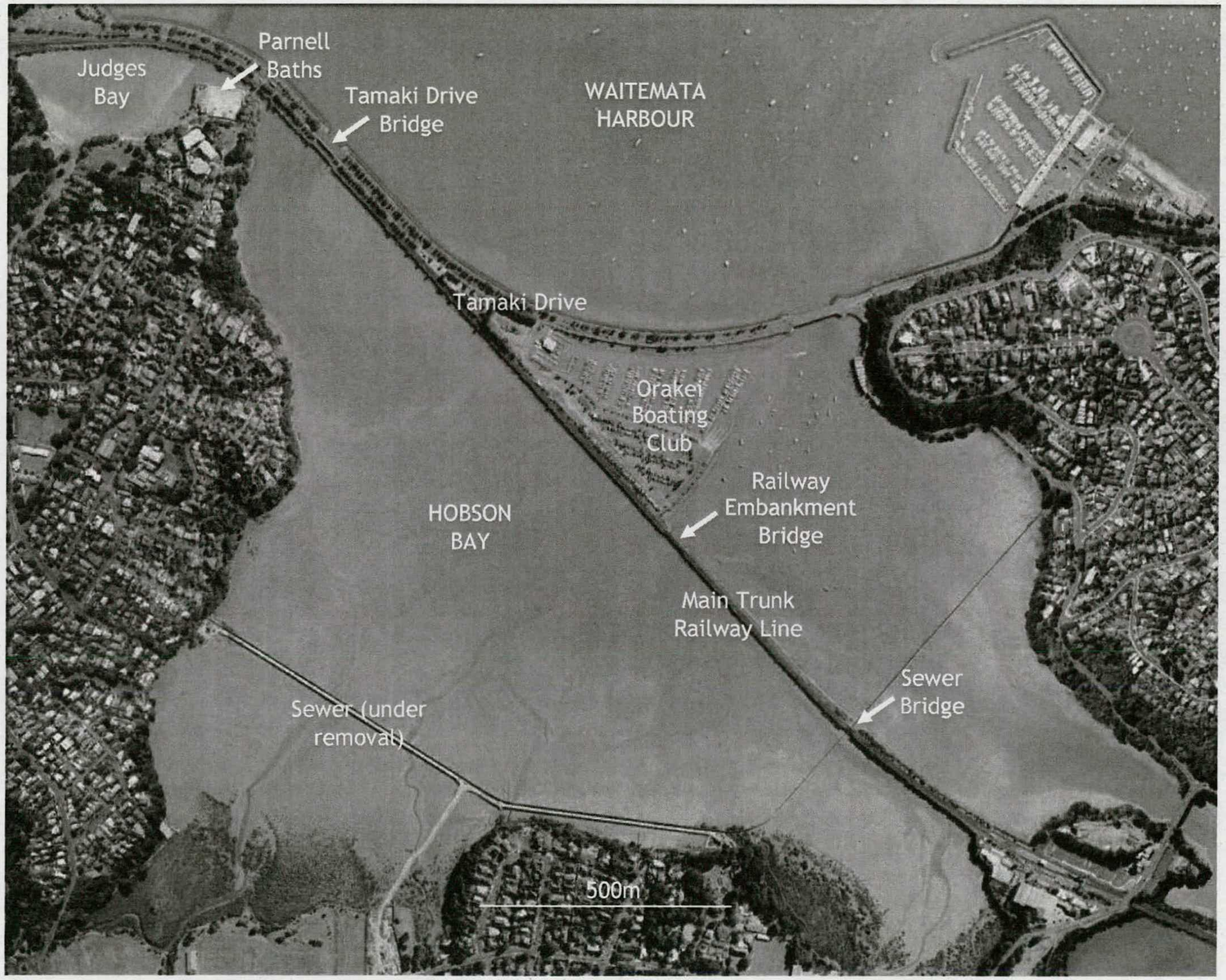

Figure 1: Location of the Parnell Baths in relation to Hobson Bay

1. Introduction

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2. Project Description

2.1 Project Location

As previously described the Project is to be located between the road and rail bridges at the point where Hobson Bay joins the Waitemata Harbour beneath Tamaki Drive (see Figure 2). Supporting both Bridges are a series of six aligned concrete piles which are unevenly spaced across the channel. This location is approximately 300 m southeast of the Parnell Baths complex. Ontrack owns the land either side of the Rail bridge up to Tamaki Drive.

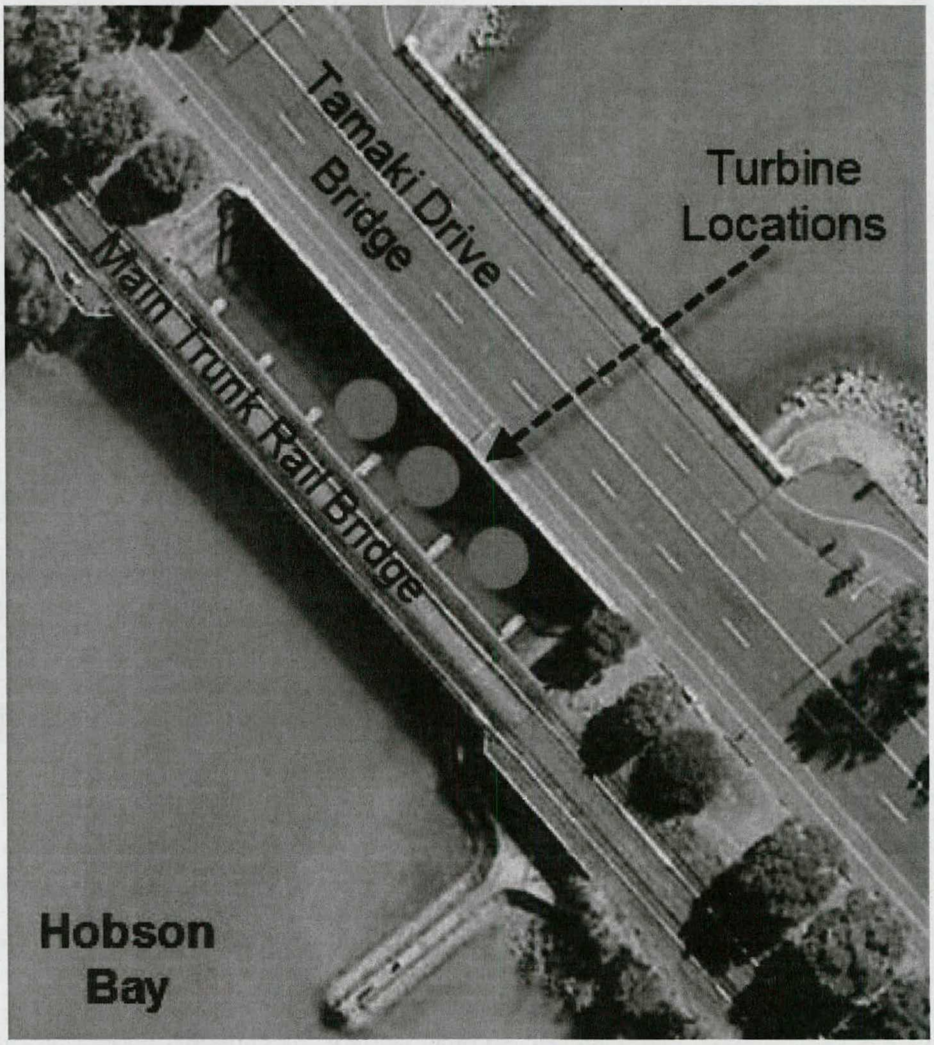

Figure 2: Google Earth image showing proposed deployment site located between the Tamaki Drive and Main trunk Railway Bridges.

2.2 Project Technology

The Project will (subject to agreement on commercial terms) utilise New Energy 'En-Current' hydro-marine submersible turbines to generate electricity to pump and recirculate treated seawater in the Parnell Baths and, in conjunction with solar heating, help the operators of the baths to reduce their reliance on grid electricity and gas.

The turbines are manufactured from stainless steel, aluminium alloy and coated alloy steel. They consist of a support cradle and pontoon for either overhung or floating operation, drive chain gear box, permanent magnet generator and safety brake.

The En-Current turbine design, based on the Darrieus Wind Turbine concept, consists of a series of aerodynamically shaped blades which are mounted parallel to the vertical shaft and positioned in a concentric arrangement (see Figure 3). The individual hydrofoils are connected via radial support arms to a central shaft which then transmits torque to a gear box and coupled AC generator. The blades are mounted rigidly to the arms at an optimum pitch angle designed to maximise power extraction efficiency in the desired range of flows. In this configuration the turbine rotor design is mechanically simple and robust. Typically three to five blades are utilised.

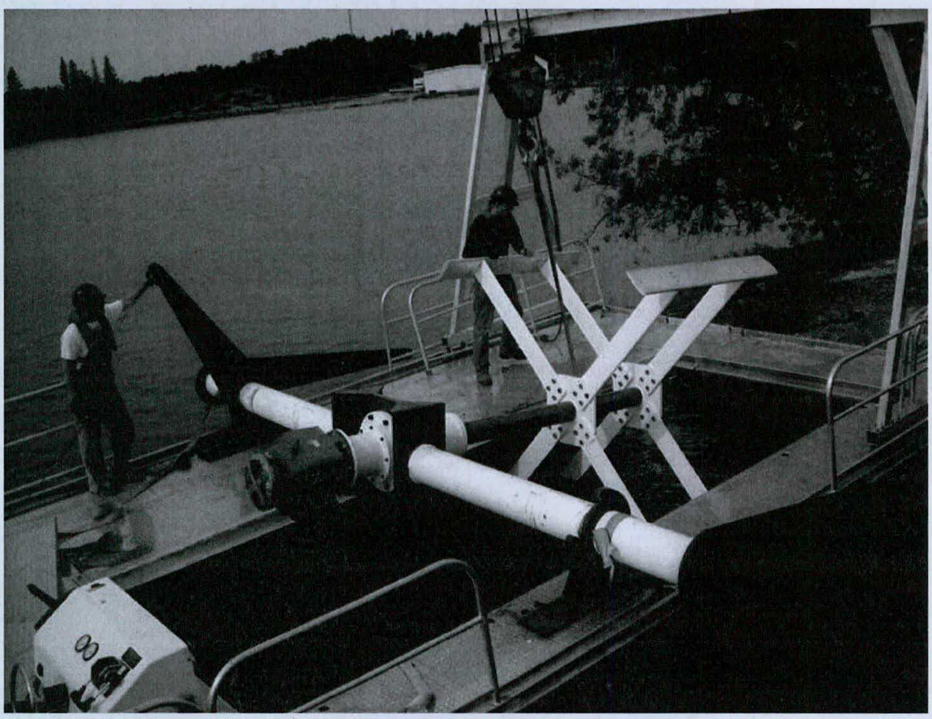

Figure 3: EnCurrent turbine configuration

The vertical axis turbine configuration is well suited to extract energy from flows such as rivers, tidal streams, man-made channels and weirs since the bladed rotor diameter to height aspect ratio can be tailored to maximise the swept cross-sectional area of the stream. Most streams encountered are relatively shallow compared to their width making a rotor with a 2:1 aspect ratio more practical to deploy.

This is the case for the Tamaki Drive road and rail bridge causeway leading into Hobson Bay estuary. In general, the En-Current turbine can be applied for any application where a slow moving stream of water with sufficient volume exists as is the case for the Hobson Bay estuary.

In free-stream applications, water is allowed to move freely around the turbine so no potential head can be developed, however energy can be extracted from the kinetic head of the flow passing through the system.

Access to all the mechanical and electrical equipment is relatively easy as it is located primarily above the water line allowing for the maintenance or safe removal of various sub-assembly components.

2.3 Project Layout and Installation

Figure 5 provides plan and elevation views of the possible placement of up to five En-Current marine turbines between the rail & road bridge water causeway. This Consent Application relates to two floating units only at positions G1, G2 or G3. Electricity cables will require burial back to and across underneath the pedestrian bridge crossing Tamaki Drive to the Baths complex.

The projected generator output is less for the incoming tides compared to the outgoing tides due to the nature of raised elevation of the Hobson Bay and Judges Bay beach fronts causing lower flows through the Tamaki Drive Road and Rail Bridge water causeway.

Discussion with New Energy Ltd engineers in Calgary, Canada recommends that the floating ‘low flow’ 25kW vertical axis turbines mounted on an overhung cradle support would in their opinion prove to be the best suited to the lower current Tamaki Drive causeway channel.

A number of options will be assessed for gantry and turbine installation but access will be required through Ontrack land which lies directly adjacent to Tamaki Drive. The options include:

- Fabrication of gantry on site.
- Off-site gantry fabrication and crane installation from the road bridge.
- Off-site gantry fabrication and crane installation from the rail bridge.

In order to minimise disruption to road and rail traffic the most appropriate installation method will be determined following consultation with key stakeholders.

Permission is required from Ontrack to allow burial of cables in the railway corridor for an approximate distance of 150m and for ongoing access across Ontrack land from Tamaki Drive to facilitate turbine maintenance.

Appendix 1 presents a specification sheet for the 25kW turbine.

2.4 Deployment History of the Technology

New Energy Corporation En-Current turbines are commercially available and have been deployed at a number of sites in Canada and Alaska for up to five years (Figure 4).

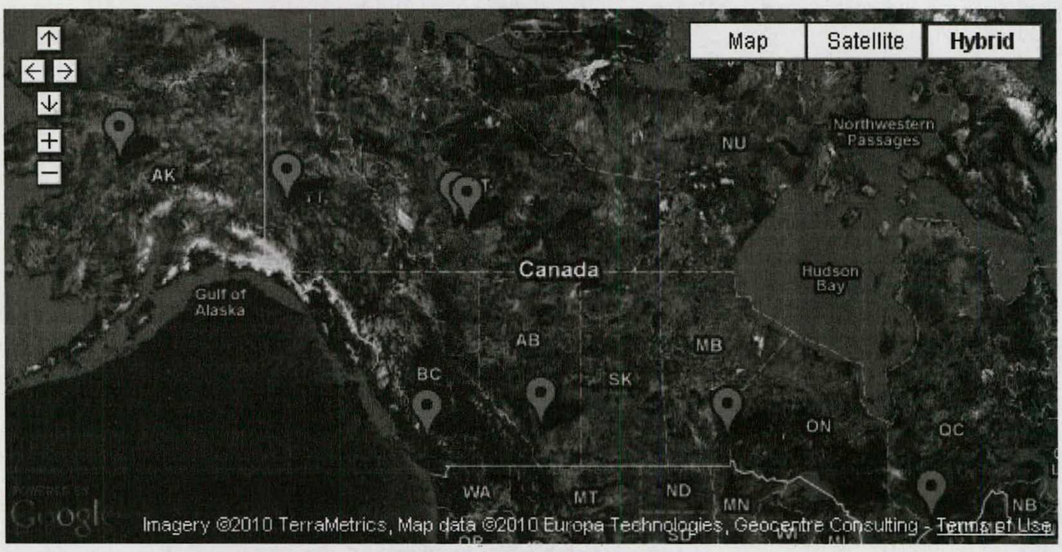

Figure 4: En-Current Turbines deployment sites

(http://www.newenergycorp.ca/OurClients/DeploymentMap/tabid/83/Default.aspx)

Many of these sites are located in isolated communities which rely on diesel generation and where rivers are only available for generation for part of the year.

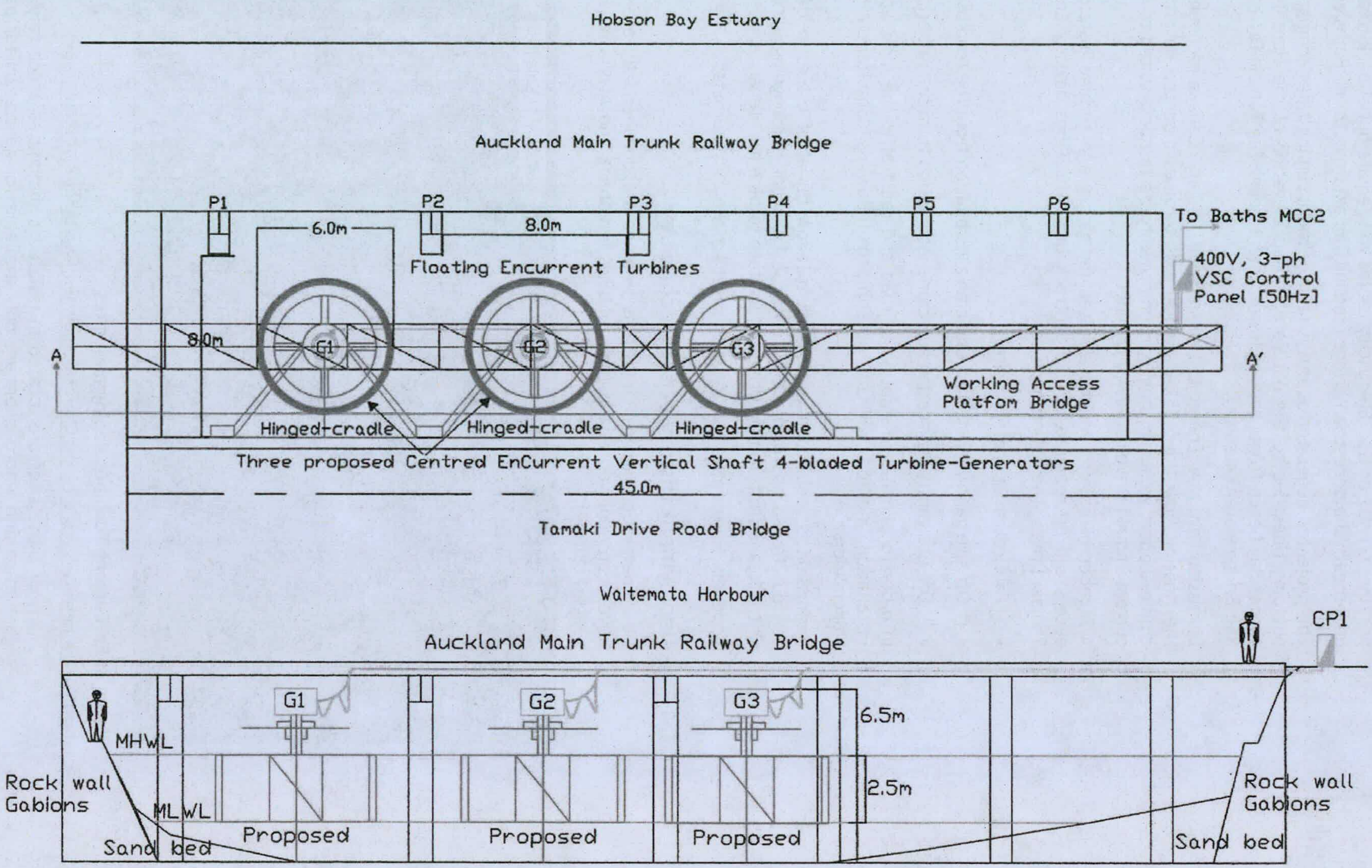

Figure 5: Elevation view of the proposed turbine arrangement in plan (top) and elevation (bottom) views

3. Physical Environment

3.1 Introduction

The physical characteristics of Hobson Bay have been described previously[1] as part of the Project Hobson consents for the replacement of the Orakei Main sewer. The sediment and water quality aspects of Hobson Bay have also been described[2].

Hobson Bay is the largest Bay in the Auckland Isthmus. The Bay is bounded by the Parnell Cliffs, Shore Road, Orakei Road and the railway embankment. The wider catchment area abuts the southern and western sides of Hobson Bay, the Orakei Basin surrounds and includes parts of Parnell, Newmarket, Meadowbank and St Johns (see Figure 1).

3.2 General Description

The Coastal Marine Area (CMA) within the Bay consists of wide intertidal flats with little or no defined beach system. Generally, the toe of the cliffs that abut the intertidal flats are situated between RL 0.75 to RL 1.5 m (approximate Mean High Water Springs). The seabed in the nearshore zone is typically comprised of fine silts, sands and shell turning to mud further offshore.

Hobson Bay is divided by the railway causeway into two interconnected coastal areas. For the purposes of this Report the CMA west of the railway causeway is referred to as the western embayment and the portion of the CMA east of the causeway, the eastern embayment.

The CMA area within the western embayment is generally flat, with seabed slopes ranging between 1(v):300(h) to 1(v):800(h). At low water the majority of the seabed is exposed, except for localised deep areas adjacent to the entrances at the north of the Bay to the Waitemata Harbour, and through the railway embankment at the centre of the Bay (see Figure 1). Two well defined channels within the intertidal flat have formed from the Newmarket Stream and stormwater/catchment discharge at Portland Road.

Prior to its removal, an above ground sewer dominated the southern shoreline of the Bay.

3.3 Morphology

Prior to construction of Tamaki Drive and the railway causeway in the 1930's, Hobson Bay was directly exposed to wave energy from the Hauraki Gulf. The closing of the Bay entrance changed the wave energy environment from an inshore wave climate with remnant swell to a fetch and depth limited wave environment. Overall, this change coupled with the reduced tidal exchange, created a sheltered environment that promotes sedimentation within the Bay and has reduced the rate of cliff erosion due to wave action.

Since the 1930's the shoreline margins have been modified through reclamation, development and natural erosion/slumping processes. These modifications/processes are particularly evident along the southern shoreline of the Bay. Examples of shoreline change include the following:

- Reclaimed areas such as the Shore Road reserve.
- Coastal protection structures along localised areas within the Bay.

[1]Tonkin & Taylor 2003. Hobson Bay Sewer Tunnel Coastal Processes. Technical Appendix 4. Report prepared for Watercare Services Ltd. October 2003.
[2]Tonkin & Taylor 2003. Hobson Bay Sewer Tunnel Ecological Technical Report. Technical Appendix 5. Report prepared for Watercare Services Ltd. Ref # 17802.100. September 2003.

- Deposition of construction fill and rubbish at the cliff toe.
- Natural creep and accumulation of embankment/cliff material at the toe of the cliffs that historically would have been removed by wave action.

3.4 Coastal Processes

Coastal processes within Hobson Bay have been significantly influenced by the construction of Tamaki Drive, railway causeway and prior to its recent removal, the existing sewer pipeline. This section presents a description of the coastal processes that operate within the Bay.

3.4.1 Water levels

Astronomical tidal water levels for the Port of Auckland, considered representative for Hobson Bay, are presented in Table 1. The tidal regime is semi-diurnal with a tidal range of 3.75 m.

Tidal levels are also affected by stochastic phenomena including storm surge which is the elevation of still water level over and above the astronomical tide due to barometric set-up, wind set-up, and wave set-up. Generally, the upper limit for open coast storm surge is approximately 1.0 m.[3]

Table 1: Tidal Levels

Tidal Levels	Chart Datum (m CD)	DOSLI (m RL)
Highest Astronomical Tide	3.65	1.91
Mean High Water Springs	3.31	1.57
Mean High Water Neaps	2.75	1.01
Mean Sea Level	1.81	0.07
Mean Low Water Neaps	0.88	-0.86
Mean Low Water Springs	0.32	-1.42
Lowest Astronomical Tide	-0.10	-1.84

Note: Tidal levels based on all tidal constituents[4]

3.4.2 Wind

Hobson Bay is exposed to winds from the northwest to northeast. Due to orographic and sheltering effects from the cliffs surrounding the Bay, the Bay is relatively sheltered from the predominant westerly and south-westerly winds typical of the Auckland region. Wind records for between 1975 to 2002 for Kohimarama Beach, calibrated to the Bean Rock wind gauge located east of Hobson Bay, indicate that winds from the northern sector occur approximately 27% of the time[5] (Figure 6). Although orographic effects are expected to modify the wind field within Hobson Bay from that recorded at Bean Rock, the data provides a useful guide to typical and extreme wind directions.

[3] Bell, R.G., Foreman, M.G.G., Goring, D.G. 2001. Tides and sea-surface variability in the SW Pacific from TOPEX/Poseidon. *In:* Coasts and Ports 2001, Proceedings of 15th Australasian Coastal & Ocean Engineering Conference, Gold Coast, September 2001.
[4] LINZ, 2003: New Zealand Nautical Almanac 2003/04 edition. NZ204.
[5] Beca 2003. Kohimarama Beach seawall protection project - coastal engineering report. Prepared for Auckland City Council.

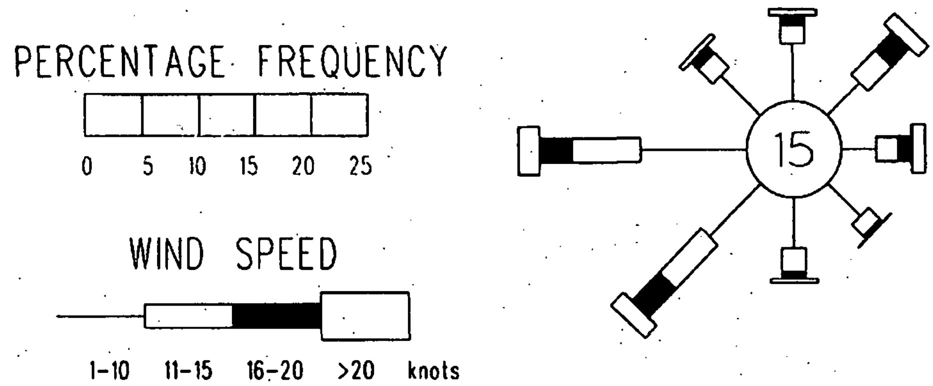

Figure 6: Wind Rose for Kohimarama Beach

Extreme 2% Annual Exceedence Probability (AEP) mean 10-minute wind speeds equivalent to a 1 in 50 year event are 24 m/s from the north, 26 m/s from the northwest, northeast and southeast and 27 m/s from the east[6].

3.4.3 Waves

Hobson Bay is classified as a "fetch and depth limited wind generated wave environment"[1]. The Bay is generally exposed to fetch, that being the over water distance, and depth limited wind-generated waves from the northwest to the northeast (clockwise). The distribution of wave energy is a function of the configuration of the Bay, available fetch, water depth and the predominant wind direction.

Significant Wave Heights (H_s), average of the largest 10% of the waves ($H_{1/10}$) and peak wave periods (T_P) for normal wind conditions (13 m/s) and for a 2% AEP event have been estimated[1] for seven locations located for the southern, eastern and western parts of the Bay. The results presented in Table 2 are derived at the shoreline and have been corrected to depth limited conditions using linear wave theory where appropriate to provide the maximum potential wave climate. As the data was calculated pre sewer pipeline removal the effect of its presence was also taken into account.

The wave energy at shoreline is ultimately dependent on nearshore bathymetry, the water level at the time and the location of the sewer. Typical H_s is generally less than 0.3 m with a peak period of 2 seconds.

3.4.4 Sediment transport

Considering the low energy hydrodynamic environment within the Bay the magnitude of sediment transport processes is considered to be low. The two main processes that have the potential to redistribute sediment are cross-shore and longshore sediment transport. These processes are likely to be most pronounced during infrequent storm events or periods of persistent high wave energy.

Sedimentation processes have been significantly affected as a result of the construction of Tamaki Drive and the railway causeway. Siltation has increased due to reduced tidal flows, tidal exchange and lower wave energy.

West of the railway causeway in the Western Embayment, sediment transport processes are likely to be dominated by wave induced cross-shore sediment transport in conjunction with ongoing erosion from wetting and drying of the embankment/cliff material and sediment supply from the catchment.

[6] Australian and New Zealand Standard, 2002. Structural design actions - Part 2: wind actions. AS / NZS 1170.2:2002. Published by Standards Australia International Ltd and Standards New Zealand.

Table 2: Maximum wave climate at selected locations within Hobson Bay

Site	Description	Typical Fetch (m)	Wind Speed (m/s)	Hs (m)	H1/10 (m)	Tp (s)
A*	Outboard Boating Club	1150	13	0.22	0.27	1.88
			26	0.43	0.54	2.56
B	Purewa Bridge (Orakei Train Station)	1150	13	0.22	0.27	1.88
			26	0.43	0.54	2.56
C	Shore Reserve East	2100	13	0.28	0.36	2.18
			26	0.30	0.39	2.93
D	Victoria Avenue	1600	13	0.25	0.32	2.05
			26	0.39 (max)	0.39 (max)	2.80
E	Shore Road Reserve	1400	13	0.24	0.30	1.98
			26	0.47	0.60	2.71
F	Adjacent to Elam Street	1050	13	0.21	0.26	1.84
			26	0.41	0.50 (max)	2.51
G	Logan Terrace	1050	13	0.21	0.26	1.84
			26	0.41	0.50 (max)	2.51

Due to the low wave climate and the absence of longer period waves, onshore transport of sediment is very low with a likely net offshore trend as demonstrated by the absence of defined beaches within the embayment. The absence of a well-defined beach system means there is no significant erosion buffer protecting backshore areas so that during storm events or periods of high wave energy at elevated water levels, waves impact directly on the base of the cliffs, resulting in cliff erosion.

3.5 Sediment Quality

Table 3 presents surficial sediment quality data for the Newmarket site located in Hobson Bay collected as part of the Auckland Councils SOE monitoring programme. Table 4 presents Auckland Council environmental response criteria (ERC) which correspond to internationally accepted sediment quality guideline values. The key points to note are:

- There are no exceedences of guideline concentrations for all parameters for the analysis of samples of particle sizes less than 500 µm.
- For the analysis of particle sizes less than 63 µm, mean copper concentrations are in the amber for all surveys; mean zinc concentrations are in the red zone in three of the six years; and mean lead concentrations are in the red zone in five of the six years i.e., the red level corresponds to the ERL guideline[7] concentration where the probability of effects on marine organisms are low. There were no exceedences of the blue ERC

[7] Long, E. R., Morgan, L. G. 1990. The potential for biological effects of sediment - sorbed contaminants tested in the National Status and Trends Program. National Oceanic and Atmospheric Administration, NOAA Technical Memorandum, NOSOMA52, Seattle, Washington. 175pp.
Long, E. R., MacDonald, D. D., Smith S. L., Calder, F. D. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19:81-97.

level. This concentration corresponds to the probable effects level (PEL)[8] i.e., the threshold where effects are probable.

Table 3: Hobson Bay sediment contaminant concentrations (mg/kg) at the Newmarket site for ARC surveys conducted between 1998 and 2007

Particle Size	Parameter	Year					
		1998	1999	2001	2003	2005	2007
<500 µm	Cu	5.6	8.4	6.6	4.0	6.0	5.2
	Pb	17.8	22.1	11.1	14.6	13.7	13.0
	Zn	46.0	53.4	47.5	39.0	39.5	42.0
	TPAH (H)[1]	-	-	-	-	0.05 ± 0.007	-
	TPAH (L)[2]	-	-	-	-	11 ± 3	-
	TPAH	681.1 ± 73.7	991.5 ± 23.1	693.5 ± 144.0	-	543 ± 53.6	-
<63 µm	Cu	22.6 ± 0.5	28.5 ± 0.6	28.9 ± 0.5	17.7 ± 2.3	30.9 ± 0.4	29.5 ± 1.8
	Pb	69.2 ± 1.4	77.3 ± 1.9	62.4 ± 0.7	48.2 ± 4.5	64.9 ± 2.0	61.4 ± 3.3
	Zn	118.0 ± 2.5	159.7 ± 4.1	155.0 ± 2.0	109.9 ± 10.1	145.8 ± 1.71	156.3 ± 9.2

Notes: [1]High molecular weight polycyclic aromatic hydrocarbons. [2]Low molecular weight polycyclic aromatic hydrocarbons.

Table 4: Auckland Council environmental response criteria (ERC)

Parameter	Environmental Response Criteria			
	Green	Amber	Red	Blue
Cu	<18	18-34	34-108	108
Pb	<30	30-50	50-112	112
Zn	<124	124-150	150-271	271
TPAH (H)[1]	<0.66	0.66-1.7	>1.7	-
TPAH (L)[2]	552	-	-	-

3.6 Water Quality

The Auckland Regional Water Board carried out water quality sampling in Hobson Bay periodically from December 1971 to January 1981[9]. Dissolved oxygen levels fell below 5 mg/L once out of 23 sampling occasions (or sites) and five day biological oxygen demand ranged between 0 and 3.4 mg/L.

Other relevant water quality data are available from ARC monitoring exercises carried out in the Hauraki Gulf and Waitemata Harbour, and from investigations carried out in relation to previous consent applications at nearby Okahu Bay.

The incoming tide is generally very low in suspended sediments. Samples collected from the main tidal channel south of Stanley Point had concentrations generally less than 10 mg/l. Higher concentrations tend to occur in inshore regions when significant wave action stirs up surface sediments on inter-tidal areas, particularly during windy conditions. Near-bed samples taken at Shoal

[8] MacDonald, D. D., Carr, R. S., Calder, F. D., Long, E. R., Ingersoll, C. G. 1996. Development and evaluation of sediment quality guidelines for Florida coastalwaters. Ecotoxicology5:253278.
[9] Bioresearches 1990. Assessment of the Natural Environment Implications of the Proposed Eastern Arterial Road: between Tamaki Drive and St Johns Road.

Bay during calm conditions had suspended sediment concentrations of 12-13 mg/l, while samples taken under conditions of 20-25 knot south-westerly winds had concentrations generally in the 11-27 mg/l range, with one sample reaching 121 mg/l. Median suspended sediment concentrations during four surveys carried out at nearby Okahu Bay[10] between 1981 and 1986 ranged between 23 and 38 mg/l. Dissolved oxygen concentration measured during these surveys was relatively high, at 98-110% of saturation.

Overall, it is likely that the water quality of Hobson Bay is largely influenced by its tidal nature and closely reflects conditions in the adjacent Waitemata Harbour. The shallow intertidal nature means that sediments can become suspended during windy conditions, and hence waters will tend to be more turbid than the adjacent harbour water.

3.7 Water Velocities

As part of a scoping study conducted in April 2010, water velocities beneath the Tamaki Road Bridge were determined through timing of the distance travelled by a series of drogues deployed at mid - tide on the ebb and flood tide at a number of points across the width of the channel. Velocities were largest where the channel is deepest during the ebb tide (ranging from 0.9 to 1.1 m/s). Peak velocity for flows on the flood tide was 0.6 m/s.

In December 2011, further more detailed evaluation of tidal velocities was undertaken using a flow meter (see Appendix 2). The study confirmed velocities are greatest at spring tide on the ebb where the channel is deepest and peaked at 2 m/s.

3.8 Summary

An investigation of the physical and biological resources present Hobson Bay and surrounding environs has shown the following:

- Hobson Bay has been highly modified as a result of past activities such as the construction of Tamaki Drive and railway embankments and various other coastal reclamations.
- The Coastal Marine Area (CMA) within the Bay consists of wide intertidal flats with little or no defined beach system. At low water the majority of the muddy seabed is exposed, except for localised deep areas adjacent to the entrances at the north of the Bay to the Waitemata Harbour, and through the railway embankment at the centre of the Bay.
- The closing of the Bay entrance coupled with the reduced tidal exchange, created a sheltered environment that promotes sedimentation within the Bay and has reduced the rate of cliff erosion due to wave action.
- Surficial sediment quality is reasonably with no exceedences of concentrations of key parameters which exceed thresholds where effects on marine organisms are probable. Water quality is largely influenced by its tidal nature closely reflecting conditions in the adjacent Waitemata Harbour.
- Tidal velocities beneath the Tamaki Road bridge are greatest at spring tide on the ebb where the channel is deepest and peaked at 2 m/s.

[10] Akarana Marinas Limited / DoC 1989. Proposed marina at Okahu Landing, Waitemata Harbour. Akarana Marinas Limited / Department of Conservation, Auckland Conservancy Office.

4. Biological Environment

4.1 Introduction

The wider Hobson Bay area has been the subject of a number of previous investigations including those undertaken in the 1950s[11] and 1970s[12]. More recent investigations looking at marine flora and fauna, water quality, bird use, etc, have been undertaken in association with other projects in the Bay including the Hobson Bay Walkway[13], the Eastern Corridor Project[9] and the Hobson Bay Sewer tunnel[2]. The relevant results of these investigations are presented below.

4.2 Setting

Hobson Bay comprises an extensive, relatively sheltered area of intertidal mudflat, bisected by low tidal channels. The Bay is bounded by the Parnell, Remuera and Orakei landforms to landward, by Tamaki Drive at its seaward extent, and is bisected by the rail embankment and previously, the Hobson Bay Sewer. The natural form of the Hobson Bay shoreline has been heavily modified by urban development, including a number of reclamations along the southern shoreline and at the Outboard Boating Club marina.

The closing of the Bay entrance when Tamaki Drive was constructed has reduced the amount of wave energy received. Overall, this change, coupled with the reduced tidal exchange, has created a sheltered environment that promotes sedimentation and reduces the rate of cliff erosion due to wave action.

4.3 Ecological Condition

The ecological condition[14] of a number of sites throughout the Auckland region, including four sites within the wider Hobson Bay, has been determined. An ecosystem health model has been developed which takes into account the levels of contamination (copper lead zinc) and sediment type to rank ecological condition from 1 (healthy) to 5 (degraded) (see Table 5). Overall, all sites rated 'average' to 'good' in terms of ecological ranking.

4.4 Habitat Types

4.4.1 Mangroves

Hobson Bay is fringed with mangroves in various locations. The largest areas of mangrove habitat are in Mataharehare Bay immediately adjacent to Thomas Bloodworth Park/Shore Rd reserve and in the South East Bay between Palmers Garden Centre and St Kentigerns lower playing field. The latter extends around the cliff line to the west towards Victoria Avenue. Further localised individual or small groups of mangrove trees can also be found scattered around the shoreline of the wider Bay, particularly beneath the Parnell cliff line, at the base of the Tohunga cliffs and around Burwood Peninsula.

[11]Cooper, R.C. 1950: The Ecology of Hobson Bay. Unpublished MA Thesis, University of Auckland.
[12]Chapman, V.J. & Larcombe, M.F. 1974: Ecological Report on the Hobson Bay Region. An Addendum to the Ecology Report on the Waitemata Harbour.
[13]Tonkin & Taylor 1996. Auckland City Council: Hobson Bay Walkway - Assessment of Environmental Effects.
[14]Auckland Regional Council 2007: Marine receiving environment stormwater contaminants: Status Report 2007. ARC Technical Publication 333.

Table 5: Overall ecological ranking for sites located in Hobson Bay based on combined contaminants in the <63µm (bioavailable), <500 µm (total sediment fractions) and ecological community structure.

Site	Bioavailable Metal Concentrations	Total Metal Concentrations	Overall Ecological Rank	Sediment Characteristics
Newmarket	5	2	2	C
Victoria Ave	3	2	2	F
Awatea Road	4	4	3	F
Purewa	4	4	3	F

As with any enclosed body of water, Hobson Bay is susceptible to sediment accumulation and the consequent changes this may bring to the ecology. The road and railway embankments are likely responsible for an increased rate of fine sediment deposition, and as a result the mangrove communities are steadily advancing into the Bay. Continued urban development in the catchments draining to the Bay is also thought to be responsible for contributing sediment loads.

An analysis of aerial photographs[15] shows that there has been an increase of about 50% in the coverage of mangroves in the South East Bay since 1960. Since the construction of the Shore Rd reclamation the mangrove coverage has also increased significantly on the western side of the Bay.

4.4.2 Soft Shores and Low-tidal channels

Inter-tidal sand/mud flats are the dominant habitat type within the wider Hobson Bay area. In Hobson Bay there is a general trend from firm fine sand inshore towards the where the sewer pipeline used to be, to fine-sand sediments towards the railway embankment and low water level. Accumulations of dead mollusc shells on the surface are present in some places and shells, debris and coarser sediments have accumulated beneath the cliffs near Victoria Ave and Logan Terrace.

Outside the mangroves, sediments in the south-east of Hobson Bay consist of fine sands and muds with softer regions near the drainage channels and, in particular, towards the western side of the Bay.

A number of low tide drainage channels cross the Bay and flow beneath the existing pipeline. Sediments near these channels are generally softer than on the surrounding flats.

4.4.3 Hard substrates

Hard substrates in Hobson Bay are limited to accumulations of boulders beneath the cliffs in upper inter-tidal zone, small sandstone outcrops at high tide levels and an area of outcropping sandstone that extends over the entire inter-tidal range near the north-western corner. Hard substrates of basalt and scoria retaining walls extend along the inside of the railway embankment in Hobson Bay and South-east Bay.

4.5 Biota

A survey of the ecological habitats of the southern part of Hobson Bay was conducted in 2000[16]. The survey consisted of a basic description of the habitats along the old Hobson Bay pipeline and core samples, surface quadrats and

[15] See reference #2.
[16] See reference #11

qualitative shellfish samples taken from six transects or sites in mudflat and mangrove habitats near Victoria Ave. The results of the field investigations are discussed below in relation to the findings of other marine ecology studies of Hobson Bay and the wider Waitemata Harbour[17].

4.5.1 Mangroves

The epifauna of the Hobson Bay mangrove habitat is dominated by gastropods *Turbo smaragdus* (catseye), *Diloma subrostrata*, *Notoacmea helmsi* and *Cominella glandiformis*. Infaunal abundances are generally lower than on the mudflats, although overall species diversity was similar. Mud crabs (*Helice crassa*) and nutshell bivalves (*Nucula hartvigiana*) are common. Other than the mangroves themselves, marine flora was limited to small patches of neptunes necklace (*Hormosira banksii*).

Overall, the epifaunal and infaunal assemblages are typical of that found in mangrove habitats throughout the Waitemata Harbour[17].

4.5.2 Soft shores

Mud/sand flat habitats support a healthy and diverse range of fauna both on and beneath the surface. On the surface the spire-shell *Zeacumantus lutulentus* and the mud snail *Amphibola crenata* are the most widespread gastropod; whelk *Cominella glandiformis* and top shell *Diloma subrostrata* are also present. Clumps of rock oysters (*Crassostrea glomerata*) are scattered over the mudflats, as are anemones (*Isactinia olivacea* and *Anthopleura aureoradiata*), estuarine limpet *Notocmea helmsi* and whelk *C. glandiformis*.

Beneath the surface several species of polychaete worm, amphipod, mud crab (*Helice crassa* and *Macrophthalamus hirtipes*) and bivalve mollusc (mainly cockle *Austrovenus stutchburyi* and nut shell *Nucula hartvigiana*) are present.

Marine flora is sparse with a patchy distribution of neptunes necklace amongst coarser sediments, where the occur on the upper inter-tidal.

The range of species identified is similar to that recorded previously in the wider Hobson Bay[12], and to that described for firm muddy fine sand flats and soft mud habitats throughout the Waitemata Harbour[17].

4.5.3 Low-tidal Channels

The low tidal channel areas of the eastern embayment[18] are considered to likely contain a range of biota including brittle star (*Amphiura aster*), tubeworm (*Pectinaria antipoda*), ghost shrimp (*Lysiosquilla spinosa*), hermit crab (*Pagurus* sp.), snail (*Struthiolaria vermis*), slug (*Bursatella leachii*), horse mussel (*Atrina zelandica*) and green-lipped mussel (*Perna canaliculus*).

4.5.4 Hard Substrates

Hard surfaces consist of the Waitemata stone shelves, larger rocks in the upper inter-tidal and placed rocks along the verge of the walkway at Logan Terrace. Marine fauna colonising this habitat include: rock oysters; the barnacle *Elminius modestus*; small black mussel *Xenostrobus pulex*; *Zeacumantus subcarinatus*; the green chiton *Amaurochiton glaucus*; the spotted top shell *Melagraphia aethiops*; and the smooth shore crab *Cyclograpsus lavauxi*.

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[17] Auckland Regional Council 1999. Intertidal and subtidal biota and habitats of the Central Waitemata Harbour. Technical Publication No. 127.
[18] Department of Conservation, 1988: Proposed Whakatakataka Bay Marina: Review of Environmental Impact Assessment. Outboard Boating Club of Auckland (Inc).

A number of common maritime plants are present along the littoral fringe at the base of the cliffs including the widely distributed glasswort *Salicornia australis* and buffalo grass *Stenotaphrum secundatum*. The sea primrose *Samolus repens*, *Juncus* sp. and *Carex* sp. are also patchily distributed. Mats of green algae *Enteromorpha* sp. are also present on the upper inter-tidal Waitemata stone shelves and on the concrete and placed stones surrounding stormwater pipe outlets.

Species identified previously in addition to those mentioned above include: isopods *Ligia* sp., *Talorchestia* sp., various polychaete worms, the estuarine limpet *Notoacmea helmsi*, the whelk *Cominella glandiformis*, the chiton *Spharochiton pelliserpentis*, and the hairy-handed crab *Hemigrapsus crenulatus*[7]; and *Nerita melanotraggus*, the small snail *Littorina unifasciata* and the slug *Onchidella nigricans*[19]

These species are commonly found on basalt walls and Waitemata sandstone reefs throughout the Waitemata Harbour[17].

4.5.5 Harvesting marine resources

During the 2000 study[13] the most abundant edible shellfish identified were the rock oysters *C. glomerata* (attached to mangroves, pneumatophores and small pieces of hard substrate or each other) and the cockle *A. stutchburyi* which are generally small (less than 20 mm shell width) and well below what is considered an attractive edible size. Other edible species are present including shrimp *Alpheus* sp., cats-eye *Turbo smaragdus* and wedge shell *Macomona liliana*, but these species were present in fairly low densities.

4.6 Fishery Resources

4.6.1 Marine Fishes

Fish species present in the upper[20] and wider Waitemata Harbour[21] are described in Table 6. The most abundant species found include yellow-eyed mullet (*Aldrichetta forsteri*), snapper (*Pagrus auratus*), dogfish (*Mustelus lenticulatus*) and yellow-bellied flounder (*Rhombosolea leporina*). Other common fish species include spotty (*Notolabrus celidotus*), parore (*Girella tricuspidata*), jack mackerel (*Trachurus declevis*), kahawai (*Arripis trutta*), sand flounder (*Rhombosolea plebeia*) and grey mullet (*Mugil cephalus*).

The wider Hobson Bay area is likely to provide feeding habitat for a wide variety of harbour fish species that typically use sheltered, shallow embayments that prevail throughout the Waitemata Harbour. Apart from the low tide channels, which provide access for fish entering and leaving the Bay with the tide, Hobson Bay is completely intertidal and would only be used by fish for diffuse feeding[19].

[19] Bioresearches 1990. Assessment of the natural environment Implications of the Proposed Eastern Arterial Road: between Tamaki Drive and St Johns Road. Prepared for Auckland City Council.
Boffa Miskell Ltd, 2002: Eastern Corridor Strategic Study: Ecological Considerations. Prepared for Auckland City Council.

[20] Briggs, I. 1980: Upper Waitemata Harbour - Interim Fish Survey. Upper Waitemata Harbour Catchment Study Working Report No. 17. Auckland Regional Authority.

[21] Larcombe M.F. 1973: Ecological Report on the Waitemata Harbour. Unpublished PhD thesis, Department of Zoology, University of Auckland.

Table 6: Waitemata Harbour fish species

Common name	Scientific name	Use of Harbour[1]	Feeding Area	Principal Food	Occupation[2]
Snapper	*Chrysophrys auratus*	f	widespread	invertebrates	p
John Dory	*Zeus japonicus*	f	outer hbr	fish	t
Trevalli	*Usacaranx lutesaens*	f	widespread pelagic	planktonic and benthic inverts	t
Kahawai	*Arripis trutta*	f	widespread pelagic	fish and inverts	p
Kingfish	*Sereola dorsalis*	f	widespread pelagic	fish	p
Koheru	*Decapterus koheru*	f,s?	widespread	plankton	p
Barracouta	*Thrysites atun*	f	outer harbour	fish	t
Piper	*Hyporhamphus ihi*	f,s?	widespread	plankton	t
Yellow-eyed mullet	*Aldrichetta forsteri*	f	widespread	plankton	p
Grey mullet	*Mugil cephalus*	f	upper hbr	small inverts	t,s
Blue maomao	*Scorpis violaceus*	f	outer hbr	planktonic inverts.	p
Paketi	*Notolabrus celidotus*	f,s	widespread	benthic inverts.	p
Banded parrotfish	*Pseudolabrus fucicola*	f,s	Outer hbr	benthic inverts	p
Paroro	*Girella tricuspidata*	f,s	widespread	algae and detritus	p
Red moki	*Cheilodactylus spectabilis*	f,s	outer hbr	algae	p
Blue cod	*Parapercis colias*	f	Outer hbr	Benthic inverts	p
Marble fish	*Aplodactylus arctidens*	f,s?	Outer hbr	Algae and inverts	p
Pilchard	*Sardinops neopilchardus*	f,s?	widespread	plankton	s
Anchovy	*Engraulis australis*	f,s	widespread	plankton	p
Jack mackeral	*Trachurus declevis*	f,s?	widespread	plankton	s
Hiwihiwi	*Chironemus marmoratus*	f,s	Outer hbr	Benthic inverts	s
Drummer	*Kyphosus sydneyanus*	f	Outer hbr	algae	t
Butterfish	*Odax pullus*	f,s	Outer hbr	algae	p
Stargazer	*Genyagnus monopterygius*	f,s	Sandflats	inverts	p
Spotty	*Notolabrus celidotus*	f,s?	Rocky reef	inverts	s
Gurnard	*Chelidonichthys kumu*	f	Sandy bottom	Benthic inverts	t
Seahorse	*Hippocampus abdominalis*	f,s	Rocky reef	crustacea	p
Eel	*Anguilla sp.*	f	widespread	Benthic inverts	p
Tommy cod	*Acanthoclinus quadridactylus*	f,s	Rocky reef	crustacea	p
Acentrogobius	*Acentrogobius lentiginosus*	f,s	widespread	Benthic inverts	p
Forsterygion	*Forsterygion nigripenne*	f,s	Rocky areas	Benthic inverts	p
Whitebait	*Galaxias maculatus*	f	Open water	plankton	t
Smelt	*Retropinna sp.*	f,s?	Mudflats and mangroves	Benthic inverts	t
Argentea	*Argentea sp.*	f,s?	Mudflats and mangroves	Benthic inverts	t
Yellow-bellied flounder	*Rhombosolea leporina*	f,s	Sand and mudflats	Benthic inverts	p
Sand Flounder	*Rhombosolea plebeia*	f,s	Sand and mudflats	Benthic inverts	p
Common sole	*Peltorhamphus novaezelandiae*	f	Sand and mudflats	Benthic inverts	t
Dab	*Rhombosolea plebeia*	f,s?	Sand and mudflats	Benthic inverts	p
Plaice	*Pleuronectes platessa*	f	Sand flats	Benthic inverts	t
Short-tailed stingray	*Dasyatis brevicuadatus*	f	Sand flats	Benthic inverts	p
Eagle ray	*Myliobatis tenuicaudatus*	f,s?	Sand and mudflats	Benthic inverts	p
Bronze Whaler	*Carcharhinus brachyurus*	f,s?	widespread	scavenger	t,s
Hammer Head	*Sphyrna zygaena*	f,s?	widespread	Carnivore scavenger	t,s
Dogfish	*Mustelus lenticulatus*	f,s?	widespread	Benthic inverts	t,s
School shark	*Galeorhinus australis*	f	widespread	Benthic inverts	t

Notes: [1]f = feeding s = spawning. [2]p = permanent t = temporary w = winter s = summer

4.6.1 Freshwater Fish

Few freshwater fish species are present in the watercourses that discharge into Hobson Bay. A total of 7 fish species have been identified in NIWAs freshwater fish database including both species of eel, two common diadromous galaxids and an introduced pest fish (Table 7). The likely reason for the low numbers of freshwater fish species is the lack of suitable fish habitat and the fact that watercourses have been highly modified through urbanisation.

The native fish species identified undergo migrations between fresh and saltwater as a necessary part of their lifecycle, and are widespread throughout New Zealand although some species have declined in range and abundance due to habitat degradation or fishing pressure. In terms of current conservation status, longfin eel is classified as being in 'gradual decline' nationally[22].

Table 7: Freshwater fish records for Hobson Bay watercourses

Common Name	Species Name	Newmarket Stream	Orakei Stream	Purewa Creek	Migratory
Shortfin eel	*Anguilla australis*		√	√	Y
Longfin eel	*Anguilla dieffenbachii*		√	√	Y
Unided eel	*Anguilla sp.*	√	√	√	Y
Common bully	*Gobiomorphus cotidianus*		√	√	Y/N
Yelloweye Mullet	*Aldrichetta forsterii*		√		
Banded kokopu	*Galaxias fasciatus*		√	√	Y/N
Inanga	*Galaxias maculatus*		√	√	Y
Mosquitofish	*Gambusia affinis*		√		N

4.7 Birds

Informal observations undertaken during the 2000 field surveys[13] identified a range of bird species feeding on the mudflats or channels or resting on the pipeline. These include duck *Anas* sp., black backed gull *Larus dominicanus*, white-faced heron *Ardea novaehollandiae*, kingfisher *Halycon sancta vagans*, pied stilt *Himantopus himantopus leucocephalus* and pied shag *Phalocrocorax varius*.

A formal survey of the birds inhabiting and frequenting the mangrove and the open sand-flat habitats of Mataharehare Bay, located at the eastern end of the old pipeline (Table 8), was conducted in early 2003[23] when wading birds are usually in their highest abundances.

In general, the number of bird species using the mangrove habitats was considered to be moderate but not exceptional, and the number of coastal bird species using the sand flat area was considered to be relatively high.

[22] Department of Conservation 2005. New Zealand threat classification lists 2005. Compiled by Hitchmough, R., Bull, L., & Cromarty, P.

[23] Bioresearches 2003. Auckland City Hobson Bay Walkway: The potential effects on wildlife of the Brighton Reserve to Elam Street steps section. Prepared for Auckland City Council.

Table 8: Bird Species recorded using mangrove and mud flat habitat in Mataharehare Bay

			Habitat Type	
Common Name	**Maori Name**	**Scientific Name**	**Mangrove**	**Sandflat**
Australasian harrier†	Kahu	*Circus approximans*	✓	-
Australasian pied stilt†	Poaka	*Himantopus himantopus leucocephalus*	-	✓
Blackbird	-	*Turdus merula*	✓	-
Caspian tern†	Taranui	*Hydroprogne caspia*		✓
Chaffinch	-	*Fringilla coelebs*	✓	-
Goldfinch	-	*Carduelis carduelis*	✓	-
Eastern bar-tailed godwit	Kuaka	*Limosa lapponica baueri*		✓
Grey warbler†	Riroriro	*Gerygone igata*	✓	-
House sparrow	-	*Passer domesticus*	✓	-
Little shag†	Kawaupaka	*Phalacrocorax melanoleucos brevirostris*	✓	✓
Mallard	-	*Anas platyrhynchos platyrhynchos*	✓	✓
NZ Kingfisher†	Kotare	*Halcyon sancta vagans*	✓	✓
Pied shag†	Karuhiruhi	*Phalacrocorax varius varius*	✓	✓
Pukeko†	-	*Porphyrio porphyrio melanotus*	✓	
Red-billed gull†	Tarapunga	*Larus novaehollandiae scopulinus*		✓
Silvereye†	Tauhou	*Zosterops lateralis lateralis*	✓	-
Song thrush	-	*Turdus philomelos*	✓	-
Southern black-billed gull†	Karoro	*Larus dominicanus dominicanus*	-	✓
NZ pied oystercatcher†	Torea	*Haematopus finschi*	-	✓
Spur-winged plover†	-	*Vanellus miles novaehollandiae*	-	✓
Starling	-	*Sturnus vulgaris*	✓	-
Variable oystercatcher*	Toreapango	*Himantopus unicolor*	-	✓
Welcome swallow†	-	*Hirundo tahitica noexena*	✓	
White-faced heron†	-	*Ardea novaehollandiae novaehollandiae*	✓	✓
White-fronted tern	Tara	*Sterna striata striata*	-	✓

Notes: † native species *endemic species

Of the total of 16 species observed in the mangroves, nine are native and seven introduced[24]. A total of 13 coastal bird species were recorded using the sand-flats of which 11 were native and one endemic.

A number of observed bird species are considered to be of conservation importance. Single pied shags were occasionally observed throughout the area roosting on stakes and the pipeline, feeding on the sand flats at high tide and in the main low tide channel of the eastern embayment during low tide periods. Pied shag is considered to be a threatened species classified as 'nationally vulnerable'[25] (Table 9). Caspian tern, seen on the sandflats, have similar status. Several other species are considered to be 'at risk' such as the little shag but it is naturally uncommon and its population is thought to be increasing.

[24] Heather, B., Robertson, H. 2000. Field Guide to the Birds of New Zealand. Auckland, New Zealand.
[25] Miskelly *et.al.* 2008. Conservation status of New Zealand birds, 2008. Notornis 2008, Vol 55: 117 - 135.

Suitable breeding habitat was identified in the mangroves for pukeko and mallard and in coastal trees and slopes for white-faced heron and kingfisher. The study concluded that the existing pipeline roost habitat was of greater significance to local coastal birds than the inter-tidal habitat within Mataharehare Bay but that this may change with the removal of the pipeline.

Table 9: Conservation status of bird species identified in Mataharehare Bay

Common Name	Status	Criteria	Qualifier
Pied shag	Threatened, Nationally vulnerable	1 - 5,000 mature individuals, 10-50% pop decline	-
Caspian tern	Threatened, Nationally vulnerable	1 - 5,000 mature individuals (unnatural), stable	-
New Zealand pied oystercatcher	At Risk, Declining	20,000 - 100,000 mature individuals, 10-50% pop decline	-
White-fronted tern	At Risk, Declining	20,000 - 100,000 mature individuals, 10-50% pop decline	Data poor
Little shag	At Risk, Naturally uncommon	-	Increasing
Variable oystercatcher	At Risk, Recovering	1 - 5,000 mature individuals, pop increase >10%	-

4.7 Recreational Activity

The western embayment of Hobson Bay is used for a range of water-based activities, however, amount of use is restricted due to the tidal nature of the area and the fact that access is from two key locations: the Tamaki Drive and the rail embankment entrances.

Boating activity associated with the Outboard Boating Club Marina and the mooring area in the Purewa channel off Ngapipi Road occurs within the eastern embayment area.

A number of parks and reserves fringe the Bay, and a foreshore walkway has been established around a large portion of the southern and western foreshore. The Frieda Kirkwood walkway at Logan Terrace, the boardwalk at Victoria Avenue, Thomas Bloodworth Park and the Shore Road Reserve are popular and well used public amenities.

Anecdotal evidence suggested that some recreational fishing is undertaken from the western side of Tamaki Drive road bridge on the outgoing tide.

4.8 Marine mammals

A number of marine mammal species are known to frequent the Waitemata Harbour and wider Hauraki Gulf waters. The most commonly observed species is the common dolphin *Delphinus delphis*.

Other species that frequent the Hauraki Gulf include bottlenose dolphin, spotted dolphin striped dolphin, orca, bryde's whale, fin/sei whale and minke whale. These species are rarely seen close to shore in the inner Gulf area.

Due to the limited access to Hobson Bay and the inter-tidal nature of Hobson Bay itself, it is considered highly unlikely that marine mammals would use the waters within Hobson Bay.

4.9 Conservation Values

Hobson Bay - Orakei Basin is defined as a Coastal Protection Area 2 (51a) in the Auckland Regional Plan: Coastal (see Figure 7) on account of the fact that the area is considered to be a feeding and breeding area for a variety of shag species, and a variety of other coastal and wading birds. CPA2 areas are those of regional, national or international significance which do not warrant CPA 1 status as they are more robust.

There are also two features of geological significance (Orakei Basin (51b) and a greensand exposure (51d)) which are located outside of the western embayment area. Purewa Creek has some of the largest mangroves in the ecological district and their value is enhanced as a result of gradation from mangrove forest into the coastal forest of Purewa Reserve.

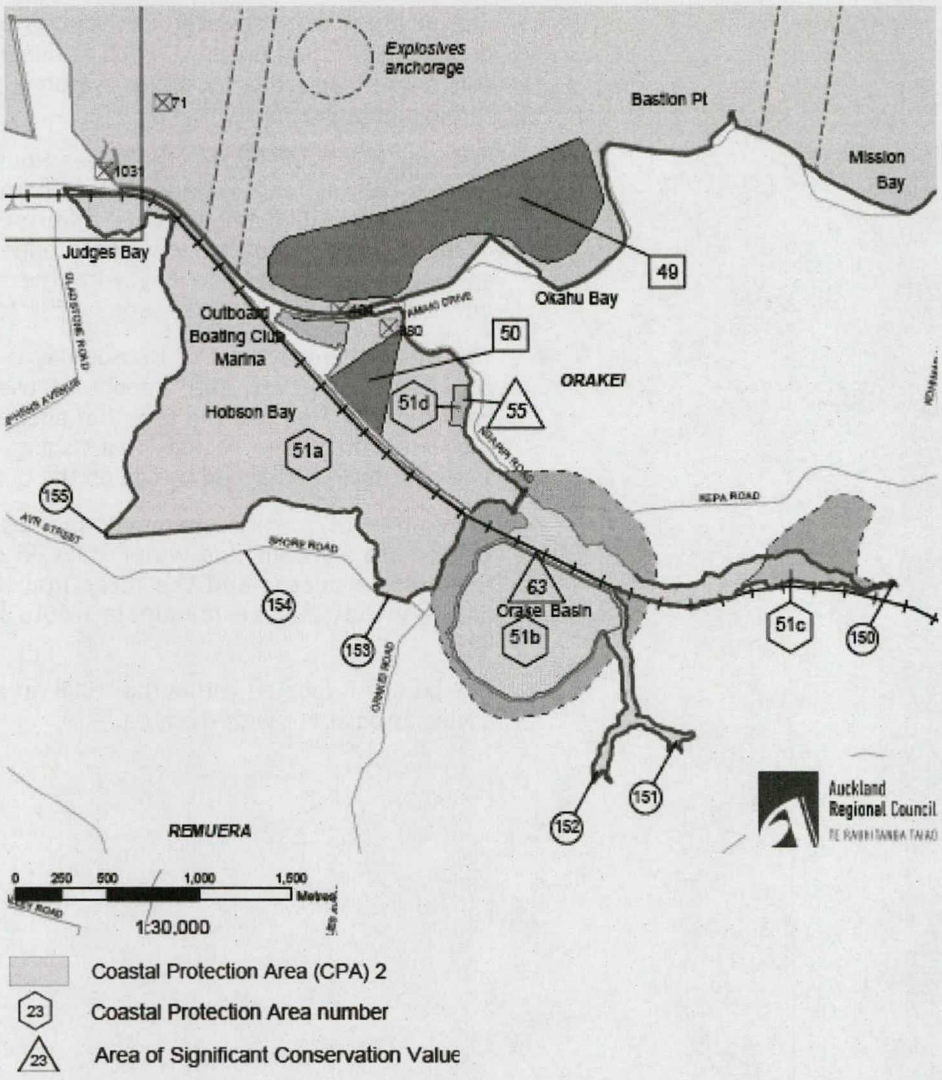

Figure 7: Auckland Regional Plan: Coastal Map Series 1 (Sheet 30) and legend

4.10 Tangata Whenua

Hobson Bay is located within the tribal area of Ngati Whatua, with other iwi having associations with the area.

4.11 Summary

An investigation of the physical and biological resources present Hobson Bay and surrounding environs has shown the following:

- Hobson Bay is a Coastal Protection Area due to it representing breeding and feeding habitat for a range of coastal and wading birds. Pied shag and Caspian tern are considered to be threatened species classified as 'nationally vulnerable' with several other species 'at risk' such as the little shag.
- A range of habitat types are present including mangroves, soft and hard shores all of which contain biological organisms that are generally typical of the wider Waitemata Harbour. A range of edible species are present but these are typically small and in low densities therefore less attractive from a harvesting point of view.
- The numbers of freshwater fish species present in the watercourses that drain into the Bay are low which is likely to be due to a lack of suitable fish habitat and the fact that watercourses have been highly modified through urbanisation.
- In terms of marine fishes, the wider Hobson Bay area is likely to provide feeding habitat for a wide variety of harbour fish species that typical use sheltered, shallow embayments that prevail throughout the Waitemata Harbour. Apart from the low tide channels, which provide access for fish entering and leaving the Bay with the tide, Hobson Bay is completely intertidal and would only be used by fish for diffuse feeding.
- The western embayment of Hobson Bay is used for a range of water-based activities. However, the amount of use is restricted due to the tidal nature of the area and the fact that access is limited. Anecdotal evidence suggested that some recreational fishing is undertaken from the western side of Tamaki Drive road bridge on the outgoing tide.
- A number of marine mammal species are known to frequent the Waitemata Harbour and wider Hauraki Gulf waters. However, due to the limited access and the intertidal nature, it is considered highly unlikely that marine mammals would use the waters within Hobson Bay.
- Hobson Bay is located within the tribal area of Ngati Whatua, with other iwi having associations with the area.

5. Assessment of Environmental Effects

5.1 Introduction

The RMA requires (Section 88) that in making an application for resource consent, an applicant must include an assessment of environmental effects in such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

This section of the report provides an assessment of the effects of the proposed cable reburial activities on the biological resources along and immediately adjacent to the proposed cable route.

A limited range of effects are anticipated as a result of turbine deployment. These are as follows:

- Effects on fish / bird species as a result of turbine operation.
- Water quality effects due to sediment deposition / resuspension as a result of a reduction in water velocities immediately downstream / upstream of the turbines.
- Occupation of coastal waters resulting in issues of access.

These effects are addressed in further detail below.

5.2 Biological Resources

Section 4 describes the biological resources present in Hobson Bay and the wider Waitemata Harbour. The key resources potential affected by the proposed turbine deployment include fish and birds, specifically shag species, and are discussed in further detail below.

Marine mammals, and other biological resources, are not addressed in any detail as they are not known to frequent the Hobson Bay western embayment.

5.2.1 Fish resources

Section 4.6 describes the fish resources likely to be present in the Hobson Bay and the wider Waitemata Harbour which are considered to be typical of this type of environment.

The potential effects of the deployment of turbines in the culvert beneath Tamaki Drive are as follows:

- Mechanical injury as a result of blade impingement.
- Avoidance resulting in fish refusing to pass a moving structure resulting in migratory delay[26]

New Energy Corporation commissioned research to evaluate the potential effects of EnCurrent turbine deployment on fish[27]. The information below is derived from this unpublished research and was provided to CLM by New Energy Corporation

Preliminary flume trialling was undertaken to determine the effects of the biological effects of the EnCurrent turbine on juvenile Atlantic salmon and adult American shad. Atlantic salmon smolts were selected to be representative of juvenile life stages, and shad was considered to be a good

[26] Castro-Santos,T. & Haro,A. 2003. Quantifying migratory delay: a new application of survival analysis methods. Can.J.Fish.Aquat.Sci. 60: 986-996.
[27] Castro-Santos,T. & Haro,A. 2010. Biological Testing of Effects of EnCurrent Model ENC-005-F4 Hydrokinetic Turbine On juvenile Atlantic salmon and adult American shad. *In Press*

indicator species as it is susceptible to handling so that any injury that would harm an adult salmonid would have a greater effect on shad. Shad are also known to be 'nervous' and easily deterred from passing obstacles or conditions that might be perceived as unnatural.

Studies were designed to assess the potential effects (i.e., mechanical injury, avoidance behaviours, and migratory delay) of fish passing the turbine in a large-scale, semi-controlled laboratory setting.

A 5kw turbine was used in the study which produced an 'affected' cross-sectional area of 50% (i.e., swept area of the turbine blades and the un-swept water above and below the turbine) in flow velocities averaging 2.25m/s.

No injuries to individual smolts migrating downstream were observed. Moreover, after 48 hours no significant difference could be determined between treatment smolt (98.3% survival) and smolt in the control (96.4%). In addition, no evidence of the avoidance of the turbine structure by smolt could be detected.

In terms of migrating shad there was no significant difference in the number of attempts made to swim upstream past the turbine between turbine in position and turbine removed treatments.

As with smolt, post - test assessment of shad yielded no evidence of strike injuries, and survival of treatment and control groups was comparable. The authors state that it is unlikely that shad incurred any additional mortality due to turbine exposure.

Overall, the effects of the Hobson Bay turbine units are expected to be no more than minor due to the following:

- Low tide Hobson Bay is almost completely empty, with water being confined to low tidal channels i.e., there is minimal habitat available at low tide.
- As the freshwater fish fauna of the watercourses surrounding Hobson Bay is depauperate there is likely to be low abundances of juveniles migrating back from coastal waters. In any event, the presence of the tidal turbines will not prevent migrations as juveniles tend to migrate in the slower flowing waters on the margins.
- At low tide, which is the worst case scenario, the total cross sectional area 'affected' with three turbines in place is approximately $21.8m^2$. This represents approximately 50% of the total cross sectional area of $42.2m^2$ available for fish passage which is the same as the flume testing conditions described above. The available evidence suggests that mortality due to fish strike on migrating juveniles and adult fish and avoidance resulting in fish refusing to pass a moving structure is negligible. In addition, the sides of the culvert, where water velocities would be less, would remain unaffected and available for fish passage. At higher water levels the increased cross-sectional area would provide additional room for fish passage.

5.2.2 Bird resources

Section 4.7 describes the bird resources likely to be present in Hobson Bay. Hobson Bay is identified as Coastal Protection Area 1 on account of the fact that the area is considered to be a feeding and breeding area for a variety of shag species, and a variety of other coastal and wading birds. Shags are water birds that forage by submerged swimming in search and pursuit of fish.

The potential effects of the deployment of turbines in the culvert beneath Tamaki Drive relating to birds are similar to fish: mechanical injury as a result of blade impingement; and avoidance resulting in swimming birds refusing to pass a moving structure.

Overall, the effects on swimming birds are expected to be no more than minor due to the following:

- Hobson Bay at low tide is almost completely empty, with water being confined to low tidal channels i.e., there is minimal foraging habitat available at this point of the tide.
- Shags are highly manoeuvrable[28], intelligent animals and are likely to avoid turbines better than fish. A large proportion of the cross sectional area of the channel would be available for any individual passing through the area.

5.3 Public Access and Use, Navigation and Safety

Section 4.7 of this AEE describes the recreational uses of Hobson Bay. The effects on recreational activity are expected to be no more than minor for the following reasons:

- Due to its highly tidal nature, Hobson Bay is not used extensively for recreational purposes. Our observations suggest water skiing and occasional sea kayakers use the Bay towards high tide. As only 50% of the channel width beneath Tamaki Drive in the northern part of Hobson Bay will be occupied, access will be maintained in the waters adjacent to the turbines. There will be no impediment to the other entrances to the Bay.
- Fishing from the Tamaki Drive Road Bridge is undertaken on the Waitemata Harbour side of the Bridge on an outgoing tide to prevent lines becoming entangled with support structures. As a result fishing effort will not be interrupted by turbine installation and operation.

A copy of the application has been forwarded to Maritime New Zealand (MNZ) as required by Section 395 of the RMA for comment, along with the Auckland Harbourmaster. It is unlikely that the proposals will have any effect on maritime navigation and safety.

5.4 Coastal Matters of Significance to Tangata Whenua

In assessing this application the relationship of Maori and their culture and traditions with their ancestral taonga must be recognised and provided for (see Policy 6.4.1 of the ARPC).

Consultation is ongoing with the Tangata Whenua for the Hobson Bay area. Preliminary concerns have been raised in relation to the potential effects of the turbines on kai moana in Hobson Bay, the ability to fish from the road bridge and Waka Ama access.

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[28] Ribak, G., Weihs, D., Arad, Z. 2008. Consequences of buoyancy to the manouervering capabilities of a foot - propelled aquatic predator, the great cormorant (*Phalcrocorax carbo sinensis*). Journal of Experimental Biologogy 211 3009 - 3019.

6. Consultation

CLM has initiated consultation with interested / affected parties and stakeholders by way of telephone conversations and meetings. A copy of this AEE report has been provided to those parties that have expressed an interest in the proposals. The applicant will receive further comments on the proposals in due course. The consultees are identified in Table 6.1.

Table 6.1: Key consultees

Organisation	Contact
Iwi	Bernadette Papa (Ngāti Whatua o Orakei's Heritage and Resource Manager)
DoC	Marilyn Fulham (Community Relations Officer-Coastal) / Kala Sivaguru (Coastal Scientist)
Outboard Boating Club	Lois Badham (Club Manager)
Auckland Harbourmaster	Andrew Hayton
KiwiRail	Pam Butler (Senior RMA Advisor) / Richard Greenfield (Senior Structures Engineer)
Sea Kayakers	Peter Townend (Sea Kayakers Association of New Zealand)

7. Resource Management Act 1991 - Statutory Framework

7.1 Introduction

The RMA provides the statutory framework for the consideration of resource consent applications, as part of which the applicant is required to provide information about the activity and an assessment of the activity's effects on the environment.

This section sets out the statutory and policy framework for assessing CLMs application for resource consents for the Parnell Baths marine energy project in terms of the requirements of the RMA. The objectives and policies from the relevant policy and planning documents have been assessed with reference to the information contained in the various technical sections in this report, which address the actual and potential environmental effects related to the proposals.

7.2 Resource consents required

Auckland Council

- **Coastal permit for coastal occupation;**

  Occupation by three turbines suspended in the water column at or about NZMS 260 R11 799703 (see Figure 1).

- **Coastal permit to erect a structure on the foreshore**

  The erection of a turbine - supporting gantry structure across the channel beneath Tamaki Drive located between the Tamaki Drive road and rail bridges.

- **Coastal permit to take, use or divert open coastal water**

  The turbines require the diversion of water around the structures in order to spin thereby generating electricity.

- **Coastal permit for a mooring**

  As the turbine location is outside of a Mooring Management Area, a permit is required to moor the structure.

- **Land use consent associated with shoreline structures and shore based cable laying**

  Land use activities associated with the electrical connection of the turbine array to the Parnell Baths, including cable trenching over a distance of around 150m through the rail corridor from the turbine array to the footbridge adjacent to the Baths complex.

7.3 Matters to be considered under the RMA 1991

7.3.1 Purpose of the Act

The Act's central purpose is *sustainable management of natural and physical resources* (s.5(1)). The RMA defines "sustainable management" to mean:

"... managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while -

(a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and

(b) Safeguarding the life-supporting capacity of air, water, soil and ecosystems; and

(c) Avoiding, remedying, or mitigating any adverse effect of activities on the environment." (s.5(2))

The "environment" is broadly defined and includes:

(a) Ecosystems and their constituent parts including people and communities; and

(b) All natural and physical resources; and

(c) Amenity values; and

(d) The social, economic, aesthetic, and cultural conditions which affect matters stated in paragraphs (a) to (c) of this definition or which are affected by those matters" (s.2)

In turn, "natural and physical resources" are defined as including "... land, water, air, soil, minerals, and energy, all forms of plants and animals (whether native to New Zealand or introduced)".

7.3.2 Fourth Schedule Assessment

As mentioned above, the RMA requires applicants to prepare an assessment of environmental effects (AEE) in support of their consent applications. The AEE must be prepared in accordance with the requirements of the Fourth Schedule to the RMA (refer s.88(6)(b)). The level of detail required in the assessment of effects must be commensurate with the scale and significance of those effects (s.88(6)(a)).

Clause 1 of the Fourth Schedule outlines a specific list of matters an AEE should include (subject to any additional information requirements of any relevant policy statement or plan). The Table below identifies the information to be provided, and the sections of this AEE which addresses each topic:

Matters to be included	*Section in this AEE*
(a) a description of the proposal	Section 2
(b) where significant adverse effects are likely, any possible alternative locations or methods for undertaking the activity	No significant adverse effects identified (see Section 5 for detail)
(c) (repealed)	N/A
(d) assessment of actual or potential effects	Section 5.
(e) hazards - environmental risk assessment	Section 5.3
(f) discharge of contaminants: nature of the discharge and sensitivity of the receiving environment to adverse effects and any possible alternative discharge methods	N/A
(g) mitigation measures to prevent or reduce the actual or potential effect	Section 7
(h) consultation	Section 6
(i) monitoring	Given the nature and scale of the proposed activities none is proposed

The Fourth Schedule (Clause 2) goes on to require applicants in their AEE to consider - in addition to any other information required by relevant policy statements or plans - the following matters:

(a) *any effect on the neighbourhood and wider community (including socio-economic and cultural effects)*

(b) *physical effects on locality (including landscape and visual effects)*

(c) *effects on ecosystems (including effects on plants, animals and physical disturbance of habitats)*

(d) *any effect on resources having aesthetic, recreational, scientific, historical, spiritual, cultural or other special value*

(e) *discharge of contaminants and options for treatment and disposal of contaminants*

(f) *risks to the neighbourhood, community or environment through hazards*

It is considered that the programme undertaken by CLM in preparation for the consents application and this AEE, meets these Fourth Schedule requirements.

7.3.3 Section 104 Assessment

In order to undertake a s104 assessment of the proposed activities, we have adopted the headings contained in s104 (i) of the RMA:

(a) *Any actual and potential effects on the environment of allowing the activity*

The following actual and potential adverse effects have been identified:

- Potential for adverse effects on marine life.

Each of these effects has been addressed in this AEE.

In addition, the following positive effects are associated with the CLM project as a whole:

- Generate power for use by the Parnell Baths, a Auckland Council owned facility, in a sustainable manner

(b)(i) Any relevant national policy statement,

There are no national policy statements relevant to this application.

(b)(ii) New Zealand coastal policy statement,

Refer to Section 8.4 below.

(b)(iii) Regional policy statement, or proposed regional policy statement

Refer to Section 8.6 below

(b)(iv)A plan or proposed plan

Refer to Sections 8.7 and 8.8 below.

(c) Any other matter the consent authority considers relevant and reasonably necessary to determine the application

It is considered there are no other relevant matters.

7.4 New Zealand Coastal Policy Statement

The purpose of the New Zealand Coastal Policy Statement (**"NZCPS"**) is set out in Section 56 of the Resource Management Act and states:

> *"The purpose of a New Zealand coastal policy statement is to state policies in order to achieve the purpose of this Act in relation to the coastal environment of New Zealand."*

The purpose of the Resource Management Act is set out in Section 5 of the Act which states:

(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.

(2) In this Act, 'sustainable management' means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while:

(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations;

(b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and

(c) avoiding, remedying, or mitigating any adverse effects of activities on the environment."

The New Zealand Coastal Policy Statement 2010 (NZCPS 2010) covers the coastal environment.

Local authorities are required to "give effect to" the NZCPS in their regional policy statements, regional plans and district plans "as soon as practicable" after the NZCPS comes into effect on 3 December 2010. A consent authority, when considering an application for a resource consent and any submissions received, must, subject to Part 2 of the Act, have regard to, amongst other things, any relevant provisions of the NZCPS 2010.

The NZCPS 2010 contains 7 objectives and 29 policies.

The following policies have been identified as relevant to the Hobson Bay Project:

NZCPS 2010 Policy	
Policy 2 The Treaty of Waitangi, tangata whenua and Māori heritage	CLM has initiated consultation with Tangata Whenua in regard to the Project.
Policy 3 Precautionary approach	
(1) Adopt a precautionary approach towards proposed activities whose effects on the coastal environment are uncertain, unknown, or little understood, but potentially significantly adverse.	The effects of this Project will not be potentially significantly adverse -effects if any are anticipated to be no more than minor.
Policy 6 Activities in the coastal environment	
(1) In relation to the coastal environment:	

(g) take into account the potential of renewable resources in the coastal environment, such as energy from wind, waves, currents and tides, to meet the reasonably foreseeable needs of future generations;	This Project involves renewable marine generation
(2) Additionally, in relation to the coastal marine area:	
(a) recognise potential contributions to the social, economic and cultural wellbeing of people and communities from use and development of the coastal marine area, including the potential for renewable marine energy to contribute to meeting the energy needs of future generations:	This Project involves renewable marine generation
(b) recognise that there are activities that have a functional need to be located in the coastal marine area, and provide for those activities in appropriate places;	The activities associated with the Project have a functional need for location on the coastal marine area.
Policy 19 Walking access	
(3) Only impose a restriction on public walking access to, along or adjacent to the coastal marine area where such a restriction is necessary:	
(d) to protect public health or safety	The Project will not hinder access other than in a very limited extent relating to public safety in the immediate vicinity of the turbine units.

Our analysis indicates that the Project is consistent with the NZCPS 2010 Policies, and in particular is specifically addressed under policy (6)(1)(g) which requires the consent authority to:

"take into account the potential of renewable resources in the coastal environment, such as energy from wind, waves, currents and tides, to meet the reasonably foreseeable needs of future generations."

This Project involves renewable marine energy generation and involves lees than minor adverse effects.

7.5 Hauraki Gulf Marine Park Act (2000)

The Hauraki Gulf Marine Park Act was passed in February 2000. The Act achieves integrated management across land and sea, so that the effects of urban and rural land use on the Gulf are given proper attention and the life supporting capacity of the Gulf is protected. The Act provides for integrated management of the Gulf across 21 statutes including the Resource Management Act, Conservation Act and Fisheries Act.

7.6 Auckland Regional Planning Documents

7.6.1 Auckland Regional Policy Statement

The Auckland Regional Policy Statement (ARPS) became operative in August 1999 and is a statement about managing the use, development and protection of the natural and physical resources of the Region. It sets in place the policy for promoting the sustainable management of these resources. It also clarifies the respective roles of the agencies with responsibilities under the Resource Management Act (RM Act) in the Auckland region.

Its aim is to achieve integrated, consistent and coordinated management of the region's resources. Its aim is also to provide greater certainty over the ways that natural and physical resources are to be managed and hence create an awareness of the constraints and opportunities in this region.

The key issues, objectives and policies contained in the ARPS relevant to the proposed activities and the effects of the activities proposed for CLM Project are set out below. Having assessed these objectives and policies, it is considered that the CLM Project is generally consistent with the objectives and policies of the Auckland RPS.

In particular, Chapter 5 of the ARPS outlines the ARC's long-term strategy for energy use and development in the Auckland Region. Particular emphasis is placed on the acknowledgement that the Auckland region produces little energy of their own, and rely heavily on other regions to satisfy a growing demand. The RPS also points out that the long-term economic viability of the region is reliant on a continued and reliable supply of energy.

Issue 5.2.2 of the RPS identifies the Auckland region's heavy reliance on fossil fuels, and a recognition that a transition needs to take place, moving from a dependence on non-renewable energy resources such as coal, to the use of renewable sources of energy such as wind, solar, tidal and bio-fuels.

Issue 5.2.2 states that the use of renewable forms of energy such as tidal energy should be encouraged, subject to local factors and environmental impacts.

Policy 5.4.1(2) of the RPS outlines the Regional Council's function in relation to encouraging renewable energy sources as follows:

(i) Promoting alternatives to the use of non-renewable fossil fuels

(ii) Promoting energy production from the regions renewable energy assets, if such production is consistent with the provisions of the RPS.

In summary, the ARPS explicitly acknowledges that a reliable and continuous supply of energy is required in order to secure the long term growth and development of the region, and that the current reliance on non renewable energy resources sourced from outside the region is not sustainable in the long term. Although the ARPS acknowledges that a shift to renewable energy sources is best achieved from a national government level, it has undertaken through the policies and objectives in the ARPS to promote and encourage this shift through education and ongoing support of the Energy Efficiency Conservation Authority.

The RPS acknowledges and states that the use of renewable forms of energy such as tidal energy should be encouraged, subject to local factors and environmental impacts. Clearly the Parnell Baths Project is consistent with this policy direction.

7.6.2 Auckland Plan: Coastal

The Auckland Regional Plan: Coastal, provides the framework to promote the integrated and sustainable management of the Auckland region's coastal environment. One of the functions of the Auckland Regional Council, as outlined in Section 30 of the Resource Management Act (RMA), is the control of the region's coastal marine area in conjunction with the Minister of Conservation.

The Coastal Plan contains objectives, policies and methods, including rules, which establish the framework within which certain uses are permitted and proposals for development can be assessed. The plan provides certainty for existing and potential users of the coastal marine area.

The ARPC covers the area around Auckland's coast from Mean High Water Springs (MHWS) to the 12 nautical mile (22.3 km) limit of New Zealand's territorial sea (Figure 1) including the air space above this area. This area is referred to in the Resource Management Act as the "coastal marine area".

In terms of rules or methods, the rules set out in the following Table are relevant to the consent application.

Rule	Topic	Activity
10.5.9	General - Occupation	Discretionary
11.5.5	Activities	Discretionary
12.5.18	Structures	Discretionary
19.5.2	Taking, use, or diversion of coastal water	Discretionary
24.5.5	Moorings	Discretionary

Having considered the objectives and policies included in the ARPC it is considered that the activities proposed by CLM are generally consistent with the objectives and policies of the Plan.

8. Concluding Statement

On the basis of analyses set out in Report, CLMs' Parnell Baths Marine Energy Project is found to be consistent with relevant Central Government policy directions, and with District and Regional Plan policies and objectives. The activities associated with the CLM Project are anticipated to result in adverse effects on the environment which will be no more than minor.

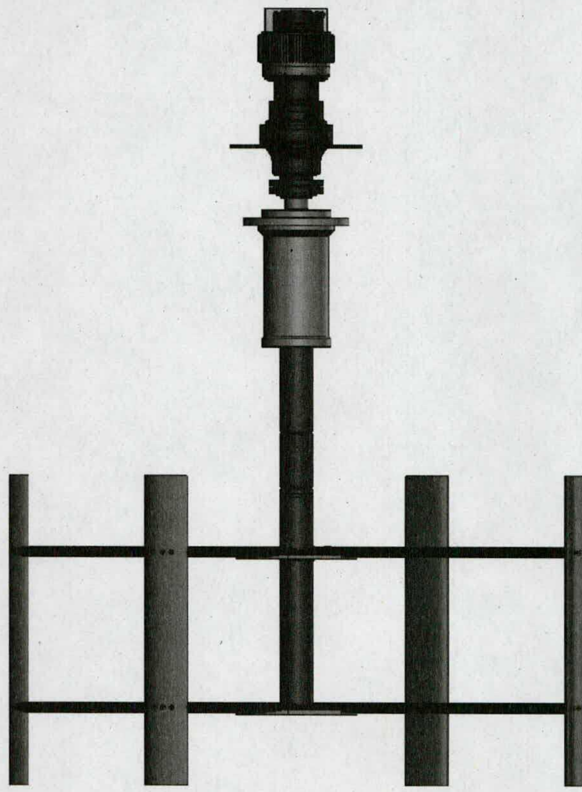
Appendix 1: Encurrent 25kW turbine - Specification sheet

EnCurrent Hydro Turbines
25 kW Specification

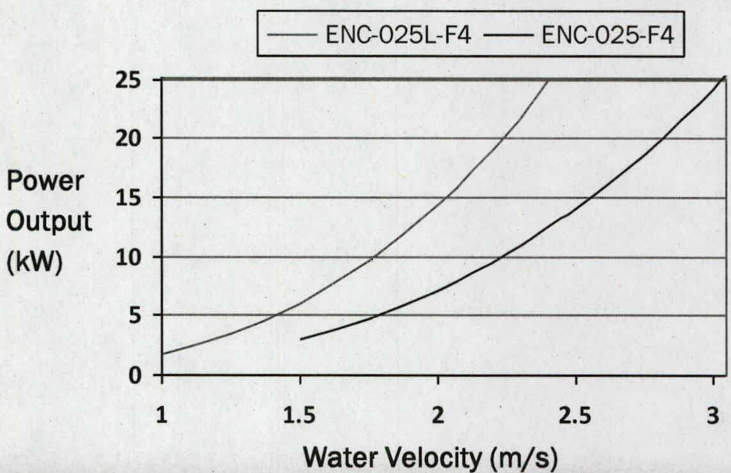
New Energy Corporation Inc.

ENC-025-F4, ENC-025-R5, ENC-025L-R4
EnCurrent Features and Benefits

- Generates electricity with no greenhouse gas emissions.
- Harnesses the energy from moving water without the need for dams, barrages or penstocks.
- Minimal civil works required w th installation.
- Low fish mortality rates due to slow rotational speed and open design.
- Grid connected or standalone operation.
- Permanent Magnet generator allows the turbine to run at peak performance in a wide range of water flows.
- Drive train and generator positioned above the waterline for system longevity and ease of maintenance.
- Safety brake for high water flow or low power conditions.
- Wetted materials made of aluminum or coated steel.

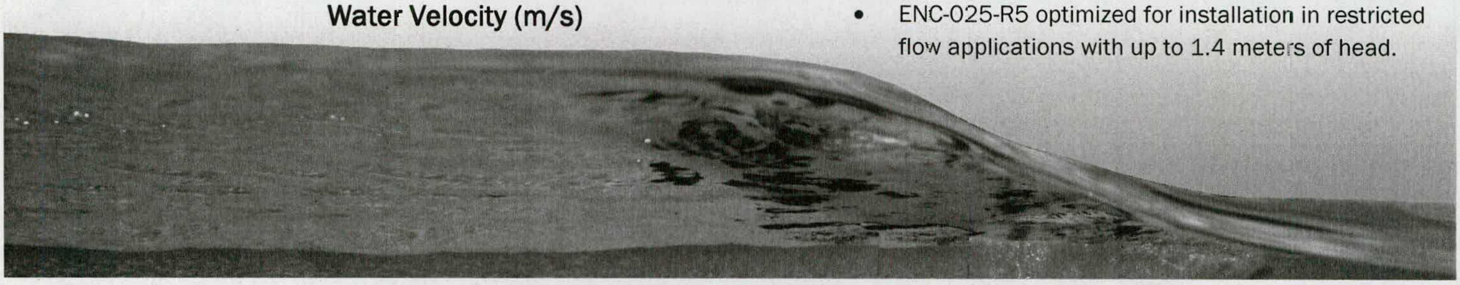


ENC-025-F4



EnCurrent Applications

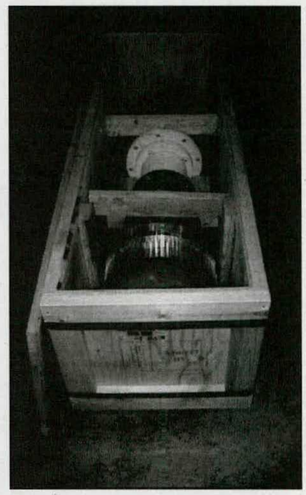
- Installs easily into controlled waterways such as irrigation and engineered canals.
- ENC-025-F4 and ENC-025L-F4 optim zed for instal-lat on in free flow applications.
- Installation on a floating platform for sites with widely varying water levels such as rivers.
- Multi-directional operation allows for installation into tidal currents. Tidal option available on request.
- ENC-025-R5 optimized for installation in restricted flow applications with up to 1.4 meters of head.



Sustainable Hydropower

New Energy Corporation Inc.

Characteristic	ENC-025-F4	ENC-025-R5	ENC-025L-F4
Maximum Power Output	25 kW	25 kW	25 kW
Water Velocity at Max Power	3 m/s	3 m/s*	2.4 m/s
Rotor speed at Max Power	40 RPM	33 RPM	22.4 RPM
Overall System Mass	1760 kg	1910 kg	2665 kg
Overall System Height	4.24 m	4.24 m	5.41 m
Rotor Diameter	3.40 m	3.40 m	4.33 m
Rotor Height	1.70 m	1.70 m	2.41 m
Number of Blades	4	5	4
Distance from top of rotor to:			
Center of Bottom Bearing	0.467 m	0.467 m	0 594
Mounting Surface	1.056 m	1.056 m	1.089 m
Gearbox Ratio	30.7:1	38.6:1	53.5:1
Generator Output	0–307 V	0–318 V	0–300 V

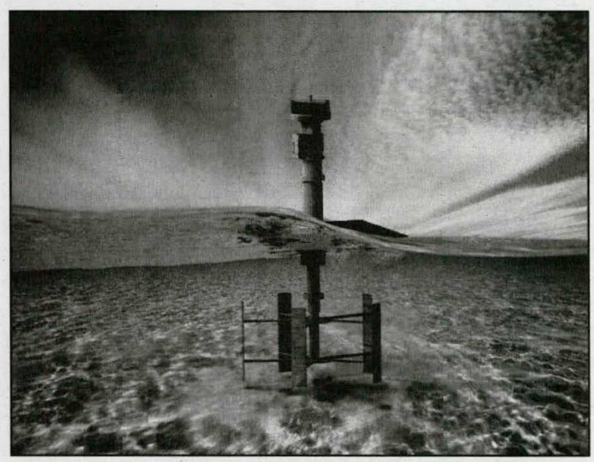


* For the ENC-025-R5 the water velocity is based on the ambient water velocity and head differential

Power Plants with 25 kW Turbines

The 25 kW Turbines can be deployed in single or multiple unit power plants. In a multiple-unit configuration, a single power plant is capable of providing generating capacities of 500 kW or more.

Multiple-unit power plants can be deployed in rivers or tidal flows by or in man-made canals. Within rivers and tidal flows, the turbines can be deployed either in series or parallel within the flow. For man-made canals, the turbines can be installed in series throughout the canal, with the possibility of inducing a minimal amount of head differential upstream of each turbine. For more information on multiple-unit power plants, contact sales at New Energy.



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Appendix 2: Tidal Resource Assessment

CLM Limited

Parnell Baths
Marine Energy Project

FINAL

Tidal Resource
Assessment

December 2011

EXECUTIVE SUMMARY

Community Leisure Management (CLM) Ltd operates the Auckland Council owned Parnell Baths facility located on the north eastern edge of Hobson Bay, Auckland. The public swimming pools are open from mid-November through to mid-April each year and consume around 330 MWh of electricity annually mainly for pump lifting and filter re-circulating of sea water through to the outdoor and indoor pools.

This Report has been prepared to fulfil the requirements of Milestone 1 of Schedule 3 which requires "completion of a more detailed assessment of tidal resource at the proposed site". In summary, the recent fieldwork indicates that tidal velocities are measured as largest on the spring tide on the ebb at where the channel is deepest peaking at 2 m/s.

In order to generate maximum electricity CLM are best suited to locate the turbines in the causeway channels where flow velocities are highest. The flows measured suggest that the installation of the two to three turbines should reasonably achieve the prospective annual electrical energy output of 77-115 MWh annually.

It is recommended that flow monitoring continue to define the available tidal resource over an entire year to provide 'range data' to allow optimised modelling of the overall ratings of the selected EnCurrent turbines, and to derive final design parameters including dimensions, fixed hydrofoil blade numbers, component materials and blade pitch.

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1. Introduction

1.1 Introduction

Auckland Council owns and operates the Parnell Baths swimming facility located on the north eastern edge of Hobson Bay, Auckland (Figure 1). Day to day operations are managed by CLMNZ.

CLMNZ was awarded a grant from EECA's Marine Energy Deployment Fund (MEDF) in early 2011 for a proposed marine turbine installation to be deployed at the entrance to Hobson Bay (see Figure 1) to generate electricity for Baths complex.

This Report has been prepared to fulfil the requirements of Milestone 1 of Schedule 3 which requires "completion of a more detailed assessment of tidal resource at the proposed site".

1.2 Previous Investigations

As part of a scoping study conducted in April 2010, water velocities were determined through deployment of a series of drogues from the Tamaki Road Bridge at mid - tide on the ebb and flood tide. The time taken for the drogue to travel a set distance was recorded at a number of points across the width of the channel.

Velocities are largest where the channel is deepest (Site B between Piles 2 and 3 - see Figure 2) during the ebb tide (ranging from 0.9 to 1.1 m/s). Peak velocity for flows on the flood tide was 0.6 m/s.

Astronomical tidal water levels for The Port of Auckland, which are considered to be representative for Hobson Bay, are presented in Table 1. The tidal regime is semi-diurnal with a maximum tidal range of 3.75 m.

Table 1: Tidal Levels

Tidal Levels	Chart Datum (m CD)	DOSLI (m RL)
Highest Astronomical Tide	3.65	1.91
Mean High Water Springs	3.31	1.57
Mean High Water Neaps	2.75	1.01
Mean Sea Level	1.81	0.07
Mean Low Water Neaps	0.88	-0.86
Mean Low Water Springs	0.32	-1.42
Lowest Astronomical Tide	-0.10	-1.84

Note: Tidal levels based on all tidal constituents (LINZ, 2003)

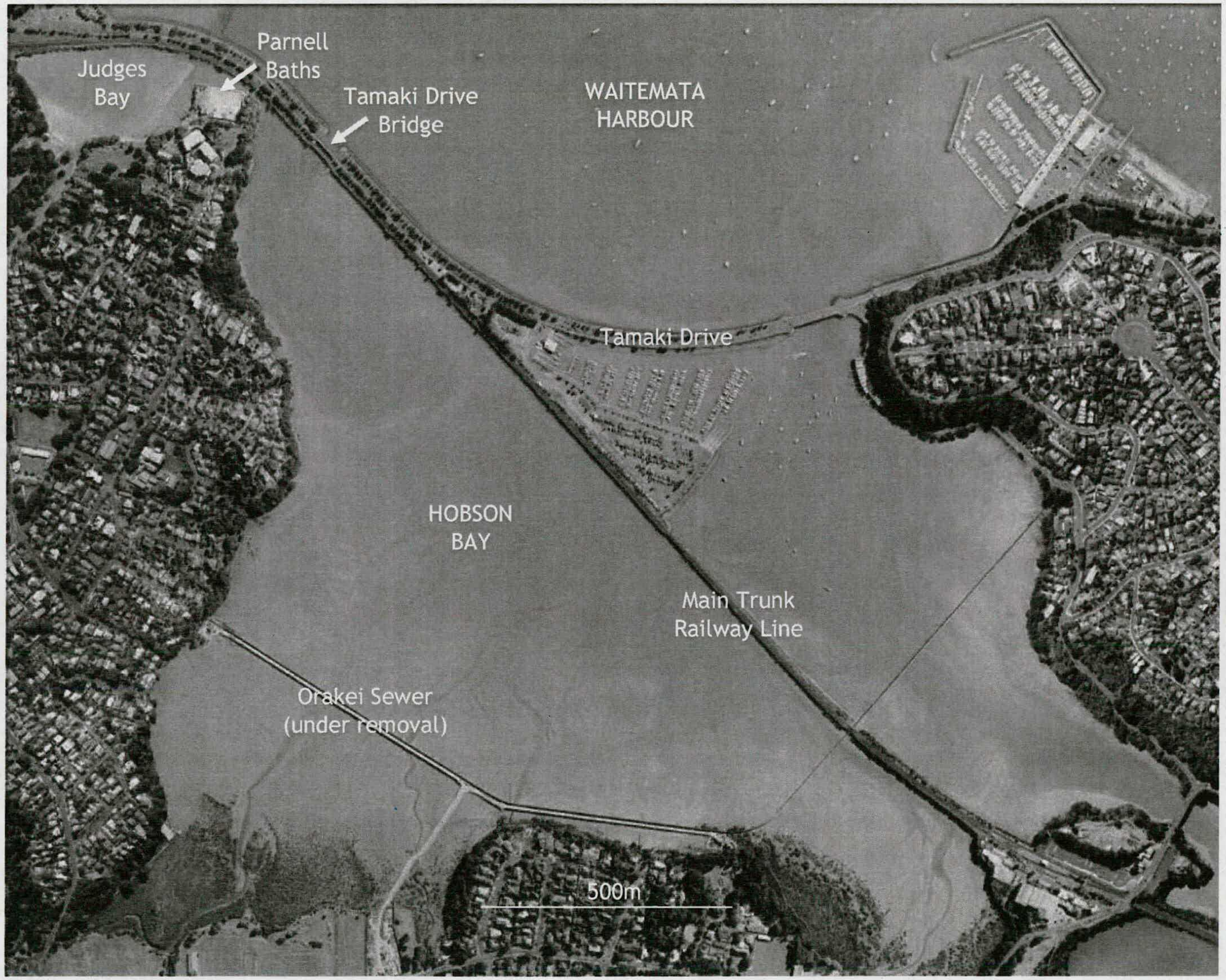


Figure 1: Location of the Parnell Baths in relation to Hobson Bay

2. Methodology

2.1 Introduction

This section of the report describes the methodology used to determine tidal flow velocities of water entering and exiting Hobson Bay underneath Tamaki Drive.

At this location there are two bridges: a four lane road bridge on the Waitemata Harbour side, and a rail bridge on the Hobson Bay side (see Figure 2). Supporting both Bridges are a series of six concrete piles which are in line with each other but unevenly spaced across the channel.

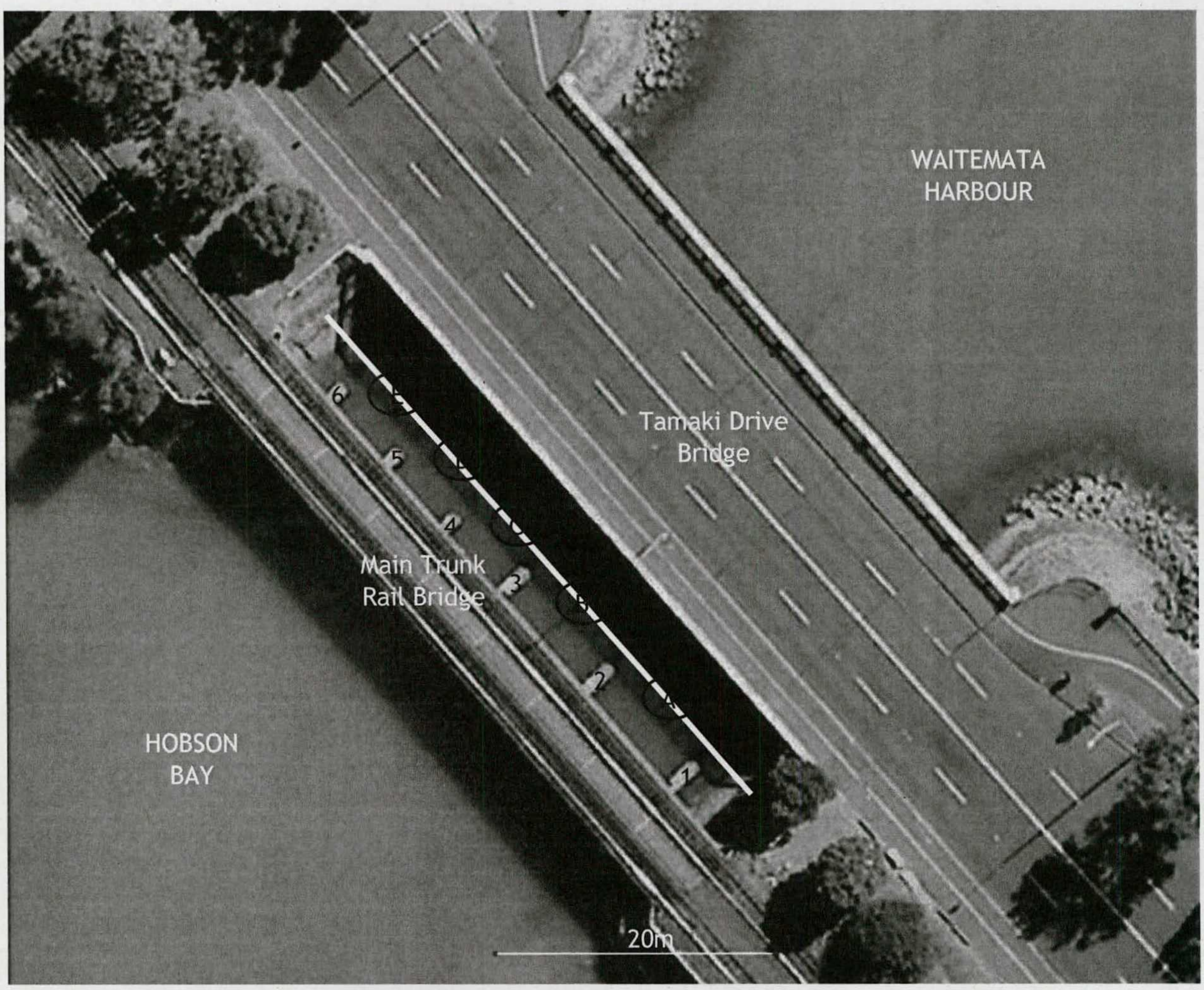


Figure 2: Google Earth image showing sites where water velocities were measured

2.2 Data Collection

Water velocities were determined at a number of sites across the channel corresponding to the midpoints between the concrete piles supporting the Bridge and where velocities were expected to be their greatest.

Table 2: Sampling dates and tidal predictions for the Port of Auckland

Date	Time	Height (m)
8/12/11	0639	2.8
	1238	1.0
	1852	2.8
16/12/11	0548	0.5
	1215	3.2
	1821	0.6

Measurements were undertaken in December 2011 on both a neap tide (8/12/11) and a spring tide (16/12/11) on a flood and ebb tide.

On 8/12/11 measurements were made at half tide on the ebb tide (every minute for 10 minutes) and flood tide (every minute for 5 minutes) at Sites A-D. On 16/12/11 more detailed hourly measurements were made on the ebb and flood tide at Sites A-E.

Water velocities were determined using a Global Flow Probe (FP211) 0.5m below the water surface at each site. Average and maximum water velocities were recorded every minute for 5 minutes.

The LINZ tide charts indicate low and high tidal heights of 1.0m and 2.8m respectively on 8/12/11, a range of 1.8m. On 16/12/11 a range of 2.6-2.7m was experienced which represents the difference between low (0.5-0.6m) and high tide (3.2m).

This corresponds with the LINZ recorded mean neap and spring ranges for the Waitemata Harbour of 1.87m and 2.99m respectively.

3. Results

Table 3-5 and Figures 3-5 present a summary of the neap and spring tidal velocity data for the ebb and flood tides measured. The raw data is presented in Appendix A. The key points to note are as follows:

- Average and maximum tidal velocities are largest on the spring tide (1.47 and 2.0 m/s respectively) compared with the neap tide (0.77 and 1.07 m/s respectively).
- Spring tide velocities are at their maximum at mid tide (3 hours post high tide) with average and maximum tidal velocities ranging from 1.06-1.47 m/s and 1.4-2.0 m/s respectively. Interestingly, on the flood tide velocities peak 4 hours after low tide with average and maximum tidal velocities ranging from 0.62 to 0.94 m/s and 1.0-1.4 m/s respectively.
- At mid tide velocities are typically greatest between Piles 2-4 (at Sites B-D) on both the incoming and outgoing tides where the channel is deepest.

Table 3: Summary of neap tide ebb and flood velocities (m/s) for 8/12/11

Date	Tide type	Site	Time	Average (m/s)	Maximum (m/s)	n
8/12/11	Ebb	A	0951	0.72	0.88	10
		B	1010	0.77	1.07	10
		C	1035	0.67	1.00	10
		D	1051	0.39	0.70	10
	Flood	A	1533	0.52	0.90	5
		B	1527	0.61	0.90	5
		C	1518	0.43	0.70	5
		D	1511	0.43	0.70	5

Table 4: Spring flood tide velocities (m/s) after low tide on 16/12/11

Hour post low tide	Site	Time	Average (m/s)	Maximum (m/s)
1hr	A	0643	0.24	0.3
	B	0651	0.40	0.5
	C	0700	0.36	0.6
	D	0707	0.39	0.6
	E	0715	0.48	0.6
2hr	A	0745	0.47	0.7
	B	0753	0.65	1.0
	C	0802	0.5	0.7
	D	0812	0.68	0.9
	E	0820	0.6	0.9
3hr	A	0846	0.53	0.9
	B	0854	0.84	1.2
	C	0903	0.64	1.0
	D	0911	0.70	1.1
	E	0920	0.72	1.0
4hr	A	0946	0.62	1.0
	B	0945	0.93	1.4
	C	1003	0.93	1.4
	D	1012	0.94	1.2
	E	1020	0.76	1.0
5hr	A	1049	0.70	1.0
	B	1102	0.71	0.9
	C	1110	0.70	1.0
	D	1118	0.58	0.7
	E	1126	0.22	0.5

Table 5: Ebb tide flow data (m/s) after high tide for 16/12/11

Hour post high tide	Site	Time	Average (m/s)	Maximum (m/s)
1hr	A	1253	0.25	0.5
	B	1301	0.41	0.8
	C	1310	0.42	0.8
	D	1318	0.49	0.7
	E	1327	0.68	0.9
2hr	A	1351	0.81	1.1
	B	1359	1.08	1.5
	C	1408	1.08	1.4
	D	1416	0.84	1.1
	E	1426	0.92	1.5
3hr	A	1504	1.11	1.4
	B	1513	1.47	2.0
	C	1522	1.36	1.7
	D	1531	1.25	1.7
	E	1540	1.06	1.4
4hr	A	1550	0.94	1.2
	B	1556	1.08	1.5
	C	1605	0.93	1.2
	D	1613	0.79	1.3
	E	1621	0.55	0.8
5hr	A	1645	0.52	0.9
	B	1653	0.71	1.0
	C	1701	0.65	1.0
	D	1709	0.53	0.8
	E	1717	0.23	0.4

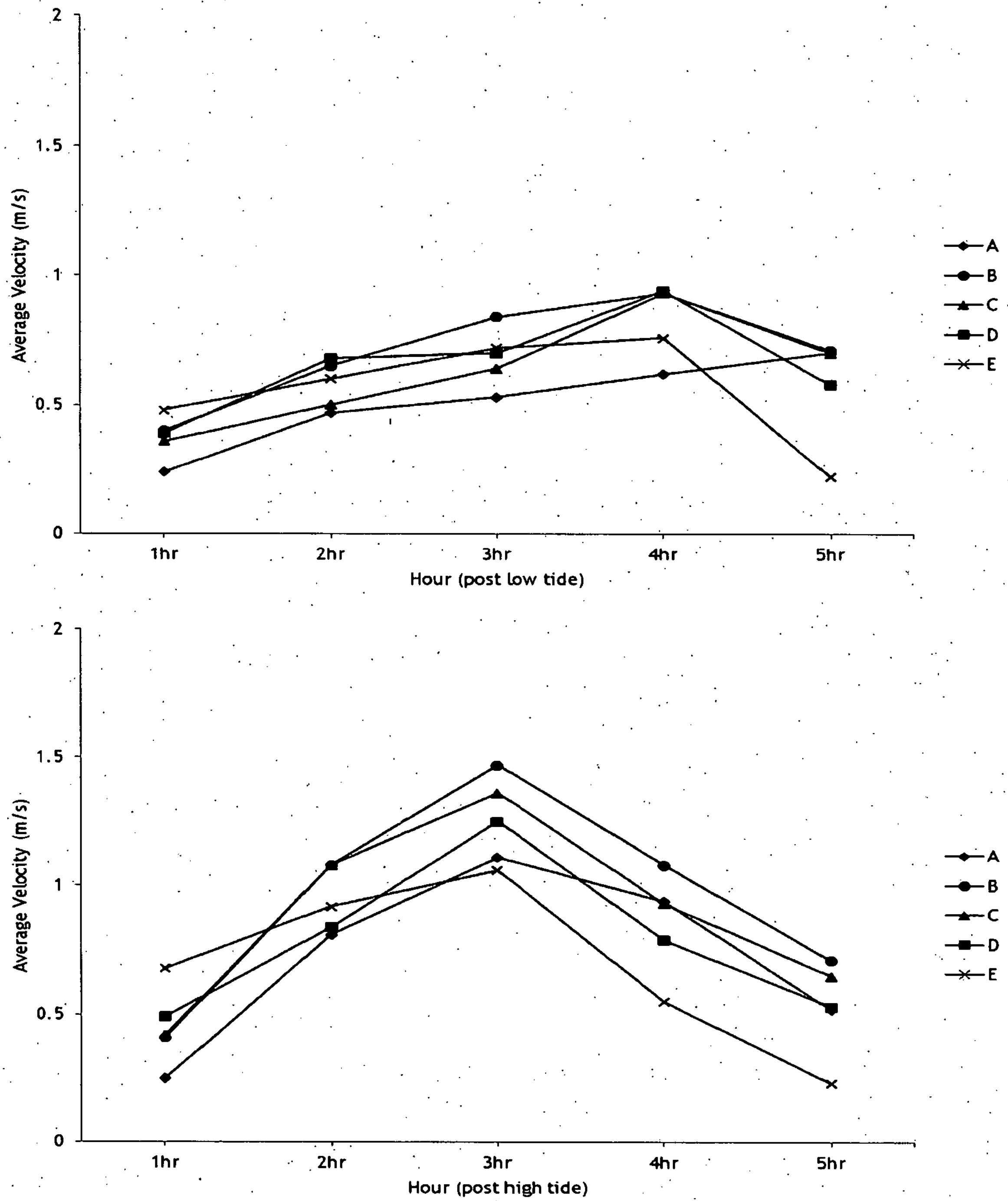
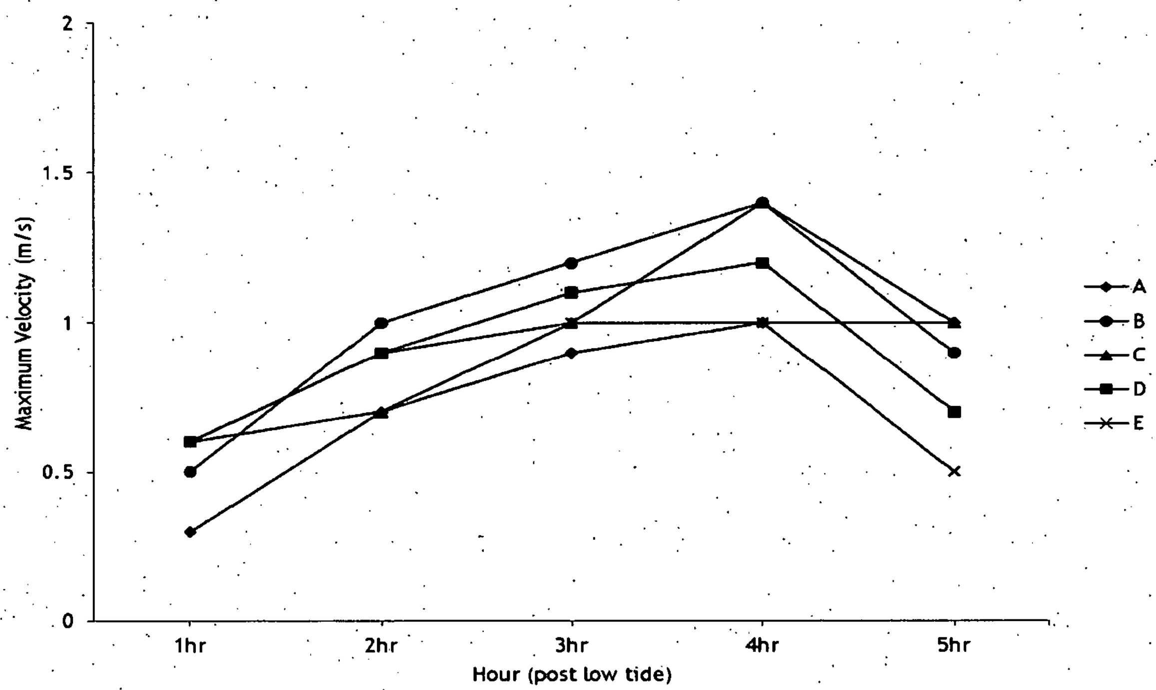


Figure 3: Average spring tide velocity data (m/s) for hours post low tide (top) and high tide (bottom)



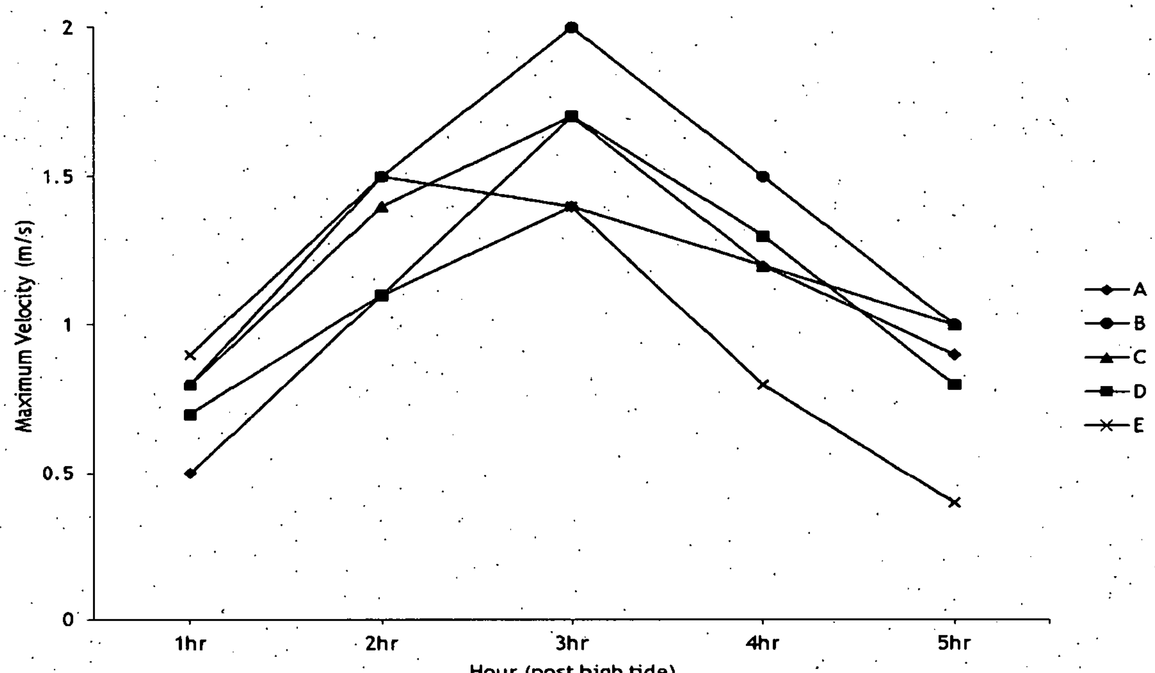


Figure 4: Maximum spring tide velocity data (m/s) for hours post low tide (top) and high tide (bottom)

4. Implications for Energy Generation

Based on the available tidal flows the estimated annual energy metered energy generation is 38.3 MWh for a single 25 kW EnCurrent turbine. Based on this, it is estimated that two or three turbines would generate 76.6 MWh and 114.9 MWh respectively.

The modelling assumptions are presented in Appendix B. These assume the use of a low flow, low head EnCurrent turbine consisting of: 4 blades attached to a vertical shaft with a fixed rotor; a 25:1 gear box (40 rpm to 1,000 rpm); safety brake; 0-415V permanent magnet generator and a 400V / 3-phase / 50 Hz synchronous inverter module.

The recorded flow velocities for the five causeway locations in the current survey suggest that the available spring and neap tidal spectral energy flux densities originally calculated for the site in April 2010 remains a conservative estimate.

The most favoured option is for the deployment of three tidal turbines for the Hobson Bay tidal energy project. Further collection of channel flow data would assist with optimising the EnCurrent turbine design to better suit the specific location, and the resulting electrical generation outputs are likely to increase substantially above the estimated annual output of 38 MWh.

The EnCurrent turbine uses a series of aerodynamically shaped blades mounted parallel to the vertical shaft in a concentric arrangement. The individual hydrofoils are connected via support arms to a central shaft which then transmits the torque to a permanent magnet generator. In the turbine's simplest form, the blades are mounted rigidly to the arms at an optimum pitch angle designed to maximize power extraction efficiency in the desired range of tidal flows. In this configuration the turbine rotor design is mechanically simple and robust.

The vertical axis configuration is well suited to extract energy from flows in tidal streams and causeway channels as the rotor diameter to height aspect ratio can be tailored to maximize the swept cross sectional area of the stream.

In general, the EnCurrent turbine can be applied to any application where a moving stream of water with sufficient volume exists. The two broad applications are 'free stream' which relies only on kinetic head in the flow and 'restricted flow' where a small potential head is allowed to be developed across the submerged turbine. Restricted flow applications are found in numerous NZ existing low head dams, very slow moving flows in irrigation systems and several industrial outflows as well as river systems where a small amount of flooding can be tolerated.

For restricted flows, such as in the current location, a potential head up to about 2 m is able be utilized for energy extraction above which cavitation may become an issue. Normally all the flow would be diverted through the turbine other than that required to prevent cavitation or flooding. However, as closely spaced turbines can produce a similar effect the proposed layout for this Project consists of an array of two to three turbines located perpendicular to the flow.

The peak efficiency for this type of layout is not governed by the Betz limit but falls somewhere between that of a more traditional hydro installation and that of a free stream turbine installation.

5. Concluding Statement

This tidal resource assessment has been undertaken to fulfil the requirements of Milestone 1 of EECA's NZMEDF Grant for the Parnell Baths marine energy project.

In summary, tidal velocities are largest on the spring tide on the ebb at Sites B to D where the channel is deepest peaking at 2 m/s.

These locations are the desired positions to establish an array of two to three vertical shaft turbines mounted on individual floating pontoon support assemblies and anchored to the existing bridge structures. The permanent magnet generator outputs are to be connected to the Parnell Baths internal switchboard via network synchronised AC inverters to be located near the tidal generator array.

New Energy's EnCurrent vertical axis turbines have been developed for use in a variety of applications including harnessing energy from ebb and flood tides. The proposed location is seen as a realisable and pragmatic opportunity to apply this type of renewable marine generation technology on a commercial basis to off-set the increasing cost of electricity purchases from the local distribution network.

Appendix A: Raw flow data

Table A1: Raw flow data for 8/12/11

Site	Time	Min	Av	Max	Site	Time	Min	Av	Max
2	0951	1	0.6	0.80	5	1511	1	0.41	0.5
		2	0.62	0.80			2	0.43	0.7
		3	0.63	0.80			3	0.43	0.7
		4	0.64	0.80			4	0.43	0.7
		5	0.65	0.80			5	0.43	0.7
	1002	6	0.66	0.82					
		7	0.68	0.82					
		8	0.70	0.88					
		9	0.71	0.88					
		10	0.72	0.88					
3	1010	1	0.68	1.07	4	1518	1	0.41	0.6
		2	0.77	1.07			2	0.41	0.6
		3	0.78	1.07			3	0.42	0.6
		4	0.78	1.07			4	0.43	0.7
		5	0.77	1.07			5	0.43	0.7
	1016	6	0.77	1.00					
		7	0.79	1.00					
		8	0.79	1.00					
		9	0.79	1.00					
		10	0.79	1.00					
4	1035	1	0.56	1.00	3	1527	1	0.58	0.8
		2	0.56	1.00			2	0.59	0.8
		3	0.58	1.00			3	0.6	0.8
		4	0.59	1.00			4	0.61	0.8
		5	0.6	1.00			5	0.61	0.9
	1041	6	0.66	0.76					
		7	0.66	0.76					
		8	0.66	0.79					
		9	0.67	0.94					
		10	0.67	0.94					
5	1051	1	0.52	0.70	2	1533	1	0.5	0.9
		2	0.53	0.70			2	0.49	0.9
		3	0.54	0.70			3	0.51	0.9
		4	0.53	0.70			4	0.51	0.9
		5	0.52	0.70			5	0.52	0.9
	1059	6	0.43	0.60					
		7	0.41	0.60					
		8	0.4	0.60					
		9	0.39	0.60					
		10	0.39	0.60					

Table A2: Raw flow data for 16/12/11

Site	Time	Min	Av	Max	Time	Min	Av	Max	Time	Min	Av	Max	Time	Min	Av	Max	Time	Min	Av	Max
2	0643	1	0.22	0.30	0745	1	0.49	0.7	0846	1	0.55	0.8	0946	1	0.56	0.8	1049	1	0.66	1
		2	0.22	0.30		2	0.48	0.7		2	0.58	0.8		2	0.6	0.8		2	0.69	1
		3	0.22	0.30		3	0.48	0.7		3	0.59	0.9		3	0.59	1		3	0.7	1
		4	0.22	0.30		4	0.47	0.7		4	0.6	0.9		4	0.61	1		4	0.7	1
		5	0.24	0.30		5	0.47	0.7		5	0.53	0.9		5	0.62	1		5	0.7	1
3	0651	1	0.37	0.40	0753	1	0.62	0.9	0854	1	0.8	1	0954	1	0.94	1.4	1102	1	0.7	0.9
		2	0.38	0.50		2	0.63	0.9		2	0.81	1		2	0.95	1.4		2	0.69	0.9
		3	0.39	0.50		3	0.63	0.9		3	0.8	1.1		3	0.94	1.4		3	0.71	0.9
		4	0.39	0.50		4	0.64	0.9		4	0.82	1.1		4	0.93	1.4		4	0.71	0.9
		5	0.4	0.50		5	0.65	1		5	0.84	1.2		5	0.93	1.4		5	0.71	0.9
4	0700	1	0.35	0.60	0802	1	0.5	0.7	0903	1	0.64	1	1003	1	0.93	1.4	1110	1	0.65	1
		2	0.36	0.60		2	0.48	0.7		2	0.64	1		2	0.86	1.4		2	0.67	1
		3	0.35	0.60		3	0.49	0.7		3	0.63	1		3	0.9	1.4		3	0.68	1
		4	0.35	0.60		4	0.5	0.7		4	0.63	1		4	0.92	1.4		4	0.69	1
		5	0.36	0.60		5	0.5	0.7		5	0.64	1		5	0.93	1.4		5	0.7	1
5	0707	1	0.28	0.30	0812	1	0.69	0.8	0911	1	0.71	1.1	1012	1	0.93	1.2	1118	1	0.61	0.7
		2	0.3	0.40		2	0.72	0.9		2	0.71	1.1		2	0.94	1.2		2	0.59	0.8
		3	0.33	0.40		3	0.7	0.9		3	0.71	1.1		3	0.94	1.2		3	0.58	0.8
		4	0.37	0.50		4	0.69	0.9		4	0.7	1.1		4	0.94	1.2		4	0.58	0.8
		5	0.39	0.60		5	0.68	0.9		5	0.7	1.1		5	0.94	1.2		5	0.58	0.8
6	0715	1	0.45	0.60	0820	1	0.59	0.8	0920	1	0.7	0.8	1020	1	0.69	0.9	1126	1	0.22	0.3
		2	0.46	0.60		2	0.6	0.8		2	0.71	1		2	0.72	0.9		2	0.23	0.3
		3	0.47	0.60		3	0.59	0.8		3	0.71	1		3	0.74	1		3	0.23	0.5
		4	0.47	0.60		4	0.59	0.8		4	0.72	1		4	0.75	1		4	0.23	0.5
		5	0.48	0.60		5	0.6	0.9		5	0.72	1		5	0.76	1		5	0.23	0.5

Table A2 (cont.): Raw flow data for 16/12/11

Site	Time	Min	Av	Max	Time	Min	Av	Max	Time	Min	Av	Max	Time	Min	Av	Max	Time	Min	Av	Max
2	1253	1	0.21	0.4	1351	1	0.79	1	1504	1	1.04	1.4	1550	1	0.94	1.2	1645	1	0.52	0.9
		2	0.21	0.4		2	0.79	1		2	1.07	1.4		2	0.94	1.2		2	0.53	0.9
		3	0.24	0.5		3	0.8	1.1		3	1.09	1.4		3	0.94	1.2		3	0.52	0.9
		4	0.24	0.5		4	0.8	1.1		4	1.1	1.4		4	0.94	1.2		4	0.52	0.9
		5	0.25	0.5		5	0.81	1.1		5	1.11	1.4		5	0.94	1.2		5	0.52	0.9
3	1301	1	0.35	0.6	1359	1	1.07	1.5	1513	1	1.42	1.7	1556	1	1.07	1.5	1653	1	0.71	1
		2	0.4	0.7		2	1.08	1.5		2	1.47	1.7		2	1.08	1.5		2	0.71	1
		3	0.41	0.8		3	1.08	1.5		3	1.47	2		3	1.08	1.5		3	0.71	1
		4	0.41	0.8		4	1.08	1.5		4	1.47	2		4	1.08	1.5		4	0.71	1
		5	0.41	0.8		5	1.08	1.5		5	1.47	2		5	1.08	1.5		5	0.71	1
4	1310	1	0.44	0.7	1408	1	1.04	1.3	1522	1	1.31	1.6	1605	1	0.93	1.1	1701	1	0.67	1
		2	0.41	0.7		2	1.06	1.4		2	1.35	1.6		2	0.94	1.2		2	0.67	1
		3	0.41	0.7		3	1.07	1.4		3	1.35	1.6		3	0.93	1.2		3	0.67	1
		4	0.41	0.7		4	1.08	1.4		4	1.36	1.7		4	0.93	1.2		4	0.66	1
		5	0.42	0.8		5	1.08	1.4		5	1.36	1.7		5	0.93	1.2		5	0.65	1
5	1318	1	0.53	0.6	1416	1	0.83	1.1	1531	1	1.3	1.5	1613	1	0.78	1.1	1709	1	0.55	0.7
		2	0.5	0.7		2	0.84	1.1		2	1.3	1.7		2	0.79	1.1		2	0.56	0.7
		3	0.48	0.7		3	0.85	1.1		3	1.23	1.7		3	0.8	1.1		3	0.55	0.7
		4	0.48	0.7		4	0.84	1.1		4	1.26	1.7		4	0.79	1.2		4	0.54	0.8
		5	0.49	0.7		5	0.84	1.1		5	1.25	1.7		5	0.79	1.3		5	0.53	0.8
6	1327	1	0.67	0.9	1426	1	0.73	1.5	1540	1	1.09	1.3	1621	1	0.58	0.7	1717	1	0.22	0.3
		2	0.67	0.9		2	0.84	1.5		2	1.06	1.3		2	0.57	0.8		2	0.23	0.3
		3	0.68	0.9		3	0.88	1.5		3	1.08	1.3		3	0.56	0.8		3	0.23	0.4
		4	0.68	0.9		4	0.92	1.5		4	1.07	1.4		4	0.55	0.8		4	0.23	0.4
		5	0.68	0.9		5	0.92	1.5		5	1.06	1.4		5	0.55	0.8		5	0.23	0.4

Appendix B: Modelling Assumptions

B1 Turbine Power versus Flow Characteristics

The following assumptions have been made in relation to turbine power versus flow characteristics:

1. Turbine Peak power = 25 kW @ 2.4m/sec [5.4 mph]
2. Turbine Average Power = 15 kW @ 1.25m/s [in summertime mean outgoing tidal flows]
3. Turbine Average Power = 12 kW @ 1.0m/s [in wintertime mean tidal outgoing flows]
4. Turbine Average Power = 6 kW @ 0.75m/s [in summertime mean incoming tidal flows]
5. Turbine Average Power = 4 kW @ 0.6m/s [in wintertime mean incoming tidal flows]
6. Turbine speed-no-load = ~0.4m/sec

B2 Electrical Losses

The following assumptions have been made in relation to electrical losses delivered to the 400V main switchboard [MSB] kWh meter =:

7. PMG motor losses = 3.5%
8. AC Inverter losses = 9%
9. DC & AC Cables losses = 2.5%
10. 400V Meter accuracy = +/-1%

This represents a total of approximately16% @ rated voltage and full load current.

B3 Availability

The following assumptions have been made in relation to availability:

- Summer period plant availability = 0.99% [allowance for unplanned outages only]
- Winter period plant availability = 0.95% [allowance for planned & unplanned outages]
- Useable averaged incoming tidal energy capacity factor in summer period = (3.6 hour/6.30 hours/tide change/24 hours) = 7.2 hours per generation day.
- Useable averaged incoming tidal energy capacity factor in winter period = (3.3 hour/6.15 hours/tide change/24 hours) = 6.6 hours per generation day.
- Useable averaged outgoing tidal energy capacity factor in summer period = (3.6 hour/6.30 hours/tide change/ 24 hours) = 7.2 hours per generation day.
- Useable averaged outgoing tidal energy capacity factor in winter period = (3.3 hour/6.15 hours/tide change/ 24 hours) = 6.6 hours per generation day.

B4 Energy Generation

B4.1 Summer Period 1st November to 30th April [181 days]:

Expected total generation = (181 days)*(7.2 hours/day)*(15 kW + 6 kW)*(0.99) = 27.094 MWh

Estimated energy losses - (27.094)*(0.16) = 4.335 MWh

Nett metered energy - (27.093 - 4.335) = **22.758 MWh**

B4.2 Winter Period 1st May to 31st October [184 days]

Expected total generation = (184 days)*(6.6 hours/day)*(12 kW + 4 kW)*(0.95) = 18.459 MWh

Estimated energy losses - (18.459)* (0.16) = 2.953 MWh

Nett metered energy - (18.459 - 2.953) = **15.506 MWh**

Estimated annual metered energy = 22.758 + 15.506 = **38.3 MWh** per 25 kW turbine

B5 Summary of Estimated Energy Analysis per Turbine Generator

Available tidal energy to each turbine = 165.2 MWh/yr [assuming free flow]

Generated electrical energy by each turbine = 45.6 MWh/yr [Mechanical η =27.6%]

Delivered metered energy by each turbine = 38.3 MWh/yr [Electrical η = 84.0%]

Lee-Ann Ronan

From: Sarah McCarter
Sent: Monday, 12 March 2012 4:12 p.m.
To: Lee-Ann Ronan; Alan Moore
Subject: FW: Parnell Baths Marine Energy Project
Attachments: Pre-Application - Parnell Baths Project.pdf; Parnell Baths Marine Energy Project AEE - CLMNZ (Final Draft) March 2012.pdf

Hi Lee-Ann

As discussed. Actually, this is a Council related application so I guess we can just invoice them.

Alan –this might be one for you and Sam rather than me?

Sarah

From: lgowing [mailto:lgowing@argoenv.com]
Sent: Monday, 12 March 2012 3:48 p.m.
To: Sarah McCarter
Cc: 'Joe Griffin'
Subject: Parnell Baths Marine Energy Project

Hi Sarah

Further to our conversation please find attached a copy of the pre-application form and the final draft AEE.

As discussed, it would be great to meet with you (or someone from your team) to discuss the application further later this week if possible.

Regards

Luke Gowing
Senior Environmental Scientist

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