Galway Harbour Company

Galway Harbour Extension

Environmental Impact Statement

Chapter 4

Description of Development

TABLE OF CONTENTS

TABLES & FIGURES

TABLES

FIGURES

4 DESCRIPTION OF PROPOSED DEVELOPMENT

4.1 INTRODUCTION

This section has been divided into sub sections as follows:

Section 4.2 describes the **Existing Galway Harbour,** its facilities and the physical constraints.

Section 4.3 presents a detailed description of the **proposed development areas**. The proposed site access and services are noted.

Section 4.4 details the **stages of the Galway Harbour Extension development** and the proposed works to be undertaken at each stage.

Section 4.5 details the **main construction elements** of the development.

Section 4.6 summarises the **Galway Harbour Extension development and the requirements met**.

Section 4.7 outlines the **consultations process** involved in the design of the development.

4.2 EXISTING GALWAY HARBOUR

4.2.1 Existing Harbour Facilities

Marine facilities are usually managed or expressed as metres Chart Datum (mCD), while land based facilities are normally expressed as metres Ordnance Datum (mOD) related either to Malin Head or Poolbeg. In this case Malin Head is adopted as the reference. Figure 4.2.1 shows the relationship between tidal variation; existing dock dredged level, proposed ship berth pockets and finished new Quay level in both mOD and mCD. Generally then reference to marine levels on finished land surfaces will be referenced to OD Malin.

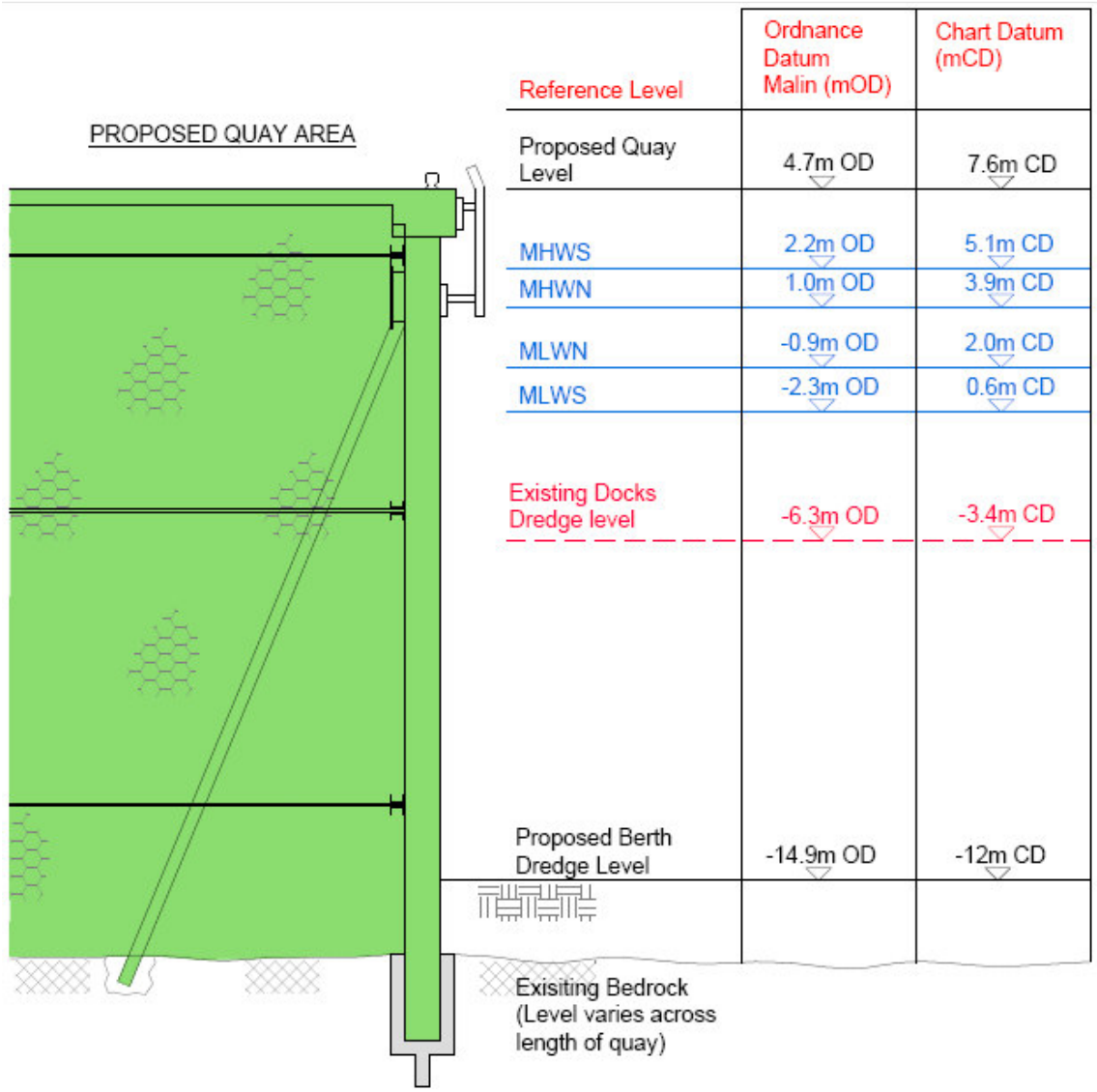

Figure 4.2.1- Relationship between Chart Datum (mCD) and Ordnance Datum Malin (mOD)

The depth of the existing dredged channel leading to the inner dock is 3.4m CD. It is 79 m wide and 1.1 km long. The width of the dock gates is approximately 20m. The inner dock has an approximate area of 2.8ha much of which is dredged to–3.4mCD. The existing dock's quay area is approximately 1.43hA. The overall total existing quay wall length is 860m, 530m of which has adequate depth to allow use as working quays i.e. the -3.4mCD.

At present the dock gates can only be opened for two hours before high tide twice daily. This means that there is only a four hour window every 24 hours when ships can enter and leave the docks.

Between 1996 and 2003, Galway Harbour Company developed 21.39 hectares of land to the east of the existing Galway docks, as part of the Galway Harbour Enterprise Park (G.H.E.P.) development. 2.7 hectares of the Galway Harbour Company lands were then reserved as an amenity area as part of a somewhat larger area of salt marsh and lagoon at the North of the Renmore Beach.

4.2.2 Physical Constraints of Existing Galway Harbour

At present the existing Galway docks are restricted by several factors:

The dock gates are approximately 20 meters wide and the dredged channel leading up to the dock gate is only 3.4m below Chart Datum. Both these factors limit the size of vessel which can enter the dock at high tide, to approximately 5,000 Tonne.

The dock facility is tide dependant, i.e. the gates can only be opened approaching high tide which leaves a two-hour window twice daily where ships can enter and leave the dock.

There is limited berthage for larger vessels in the inner docks due to its enclosed nature – approximately 530m of berthage is usable for commercial vessels.

Navigation into the docks is quite difficult due to the outflow of the River Corrib, requiring expert pilotage and navigation.

Currently there is very little serviced land available for harbour related industry, storage and facilities, as the adjacent lands are zoned for City rather than Harbour development and the vacant lands at the G.H.E.P. are largely required for relocation of existing harbour clients and business, access and rail link.

The above restrictions have led the Galway Harbour Company to propose the New Harbour Development detailed herein.

4.3 PROJECT DESCRIPTION

4.3.1 Proposed Planning Application

The **Site Layout Drg. No. 2139-2117** details the overall proposed planning application layout. The overall planning application development boundaries are outlined in Red.

The development areas are noted on the layout drawing as areas No.'s 1-3. The development proposed at each area is as follows:

- Area 1 – Galway Harbour Extension (GHE) 82.89 ha
- Area 2 – Galway Harbour Enterprise Park (GHEP) Road & Services Upgrade 1.21 ha
- Area 3 – Lough Atalia Road & Services Upgrade 1.29 ha

Hence, the Total Planning Development Area 85.39 ha

4.3.2 Proposed Development

The Galway Harbour Extension area of development consists of 82.89 ha broken down as follows:

- Land development area 28.07 ha
- Breakwaters and Revetment area 3.04 ha
- Dredged Area 46.48 ha
- Working Area (Dredge / Marine Construction) 5.30 ha

Land to be reclaimed from Sea 23.89 ha
Existing G.H.E.P. land to be redeveloped 4.18 ha
Total land development / redevelopment 28.07 ha

The development will provide the following:

- 660m of quay berth to –14.9m O.D. depth
- Port development serviced by a channel to -10.9m O.D.
- A 400m turning circle to -10.9m O.D.
- 28.07 ha of land development.
- 660m of sheltered quays.
- Western Marina with 216 No. berths.
- Fishing Pier
- Nautical Centre Slipway
- Freight rail link to enable freight and cargo to be efficiently transported to and from the harbour to allow positive road traffic and environmental benefits.

As noted above the land area to be developed is 28.07 ha. This will provide the following land use area breakdowns in yards, quays, open space etc:

- Commercial Port back up Yard Areas 6.45 ha
- Commercial Quay Areas 1.72 ha
- Harbour Company Warehouse Yards 1.53 ha
- Future Oil and Bitumen Yard Areas 1.86 ha
- ESB, Security Yard & Fire Water Storage Area 1.08 ha
- Marina Boat Yard, Quay and Village Area 1.83 ha
- Fishing Pier and Yard Area 0.55 ha
- Roads and Access Area 3.97 ha
- Rail Line and Embankment Area 2.20 ha

- Nautical Yard & Slipway Area 0.82 ha
- Passenger Terminal Yard Area 0.34 ha
- Landscaped Area 5.44 ha
- Wave Wall Area 0.28 ha

The development will provide for dry bulk cargos such as the following:

- Coal Yard
- Waste Export
- Steel Import Yard
- Scrap Metal Yard
- Ship Chandlers
- Roll on/Roll off Yard
- Container Yard
- Project Cargos – Ocean Energy Development & Servicing
- Biomass Storage & Handling

It will also allow for

- Parklands and landscaping areas
- Renmore Promenade
- Marina Promenade

4.3.3 Proposed Site Access & Services

Access

Harbour Access Junction improvements are proposed at the location highlighted in the proposed site layout map Drawing 2139-2117 (Area 2). Access to the proposed Harbour extension will be through the existing Galway Harbour Enterprise Park (GHEP). The GHEP is accessible via a bridge, which crosses the entrance channel to Lough Atalia.

It is also proposed to upgrade the road under Lough Atalia Bridge which is a protected structure (Area 3).

Services

Foul sewers will fall by gravity to a new pumping station. The pumping station will pump directly into the Galway city main drainage network via a separate rising main. Storm water collection pipes will discharge via six outfall points. The outfall pipes will be constructed to incorporate oil and grit interceptors, shut off valves and tideflex valves.

4.3.4 Description of Galway Harbour Extension Operations

In order to meet these projected demands as set out in Section 2.2 of the EIS, the harbour has been separated into key designated zones comprising commercial quay, liner berth, fishing pier, enclosed marina pontoon berths, and marine sports activity centre. Each one of these require different infrastructure and are designed to meet the security, safety and operational requirements particular to the zoned use. In particular, the separation of the different activities was a key Safety and Health consideration at concept design stage, which in addition to consideration of construction related Safety and Health design decisions, also featured in the operational safety, including day-to-day use and future routine maintenance, anticipated repair and element replacement. The zoned design also includes for access, utilities and other linkages to the variety of onshore facilities in the Galway Harbour Extension backup lands. The following is a summary of how the proposed new facilities will respond to the requirements in each of the main zones.

4.3.4.1 Commercial Quay

At the outer end of the GHE, the commercial quay will provide all of the necessary port facilities for the variety of projected commercial traffic. This zone is divided into three categories, namely the outermost 260metre quay facing North East, to take oil and bitumen, the adjacent 400metre liner berth facing South East to have the various commercial cargoes, cruise liners and passenger ferries, and the nearby 170metre pier to take lesser cargo and larger fishing vessels on the South Westerly Quay and with the lesser inshore fishing vessels on the North Easterly side. The proposed dedicated rail connection and port spine access road will provide easy access to this zone. The separated location of the outermost quay will facilitate safe and secure operation of the oil and bitumen offloading. Coal, steel and general cargo handling will take place on the adjacent 400 metre liner berth. This location will also minimise potential interfaces with persons using the remainder of the harbour facilities. The location of these commercial landings also facilitates the 24 hour operation planned. The liner berth is facilitated by easy access, deep water, a shielded turning circle, and its location will provide for control and transfer of the significant passenger numbers disembarking/embarking the large liners planned for the Galway harbour development. Similarly, passengers using ferries berthed at the South West facing pier will be able to gather in numbers and readily embark/disembark ferries, located to facilitate quick ferry turnaround. Transport connections will be provided via rail and coach links direct to the pier.

4.3.4.1.1 Ship Movement Parameters

The key parameters that fed into the design of the commercial zone are summarised as follows: -

- 260m dedicated fuel loading/discharge berth for Petroleum/Bitumen; separate and secure to exclude interface with other port users and the public
- 400m of multi modal quay for
    - Loading/discharge of Scrap Steel; Coal; Steel; Project Cargoes; Limestone
    - Berthing Large Cruise Liners and for servicing Research and Naval Vessels with direct rail and coach infrastructure
- 170m of Fishing Pier
- Vessel movements in the Commercial Port will operate on a 24 hr basis.
- Liquid bulk cargo operations will be conducted on a 24 hr basis as is the current practice.
- Dry Bulk and Project Cargoes will generally operate from 06:00 hrs to 20:00 hrs.
- Cruise liners will operate on a 24 hrs basis but generally these vessel types disembark/embark their passengers from 07:00 hrs to 20:00 hrs.
- Passenger Ferries will operate to a timetable to coincide with train time and coach time tables and also dictated by market conditions.
- Navigational Aids will continue to be maintained by the Harbour as the Local Lighthouse Authority.
- Assisted by new Navigational Aids, navigation into the commercial port section of the GHE will be via the existing approach from the inner bay, as far as the -10.9m O.D. contour, and from there through a new deepened channel.
- The new channel will be dredged to -10.9m O.D. and this channel will extend into and include the Inner Turning Circle. This will provide a minimum draft clearance in the channel and turning circle of approximately 8.6metres at Mean Low Water Springs which is -2.3m O.D.
- Adjacent to both the Petroleum/Bitumen quay and the Cruise Liner quay, the Berths will be dredged to -14.9m O.D. This will provide for the largest projected vessels to remain berthed with adequate draft clearance at the lowest possible tidal level.
- Adjacent to the Fishing Pier, the bottom will be dredged to -6.4m O.D., thus providing a minimum draft clearance of approximately 4.1metres at Mean Low Water Springs.
- Vessels using the commercial port will no longer be subject to difficulties of navigating across the current from the mouth of the River Corrib, nor will they be subject to navigating through the very narrow existing dock-gate entrance.
- Pilotage is compulsory for all ships in the harbour.

- Pilotage Exemption Certificates (PEC's) are issued on recommendation of the Superintendent of Pilots.
- PEC's are not issued to ships carrying petroleum.
- PEC's may be issued to ships masters of passenger ferries engaged on regular routes to/from the port after examination and assessment by the Superintendent of Pilots.
- Typical ship movements were assessed to understand the timing of all typical operations from ships entering port, loading/unloading and leaving port again. These were developed in consultation with the commercial users of the port and were a key input in the port design.
- Cruise vessel arrivals will be known well in advance. Oil/bitumen deliveries will be scheduled to be not generally in port at the same time as cruise vessels
- Oil will not be discharged when cruise vessels are in port.

4.3.4.1.2 Commercial Quay Operations

The operation of the GHE will be based on the existing infrastructure, albeit considerably expanded to deal with the larger volume of port traffic, yet simplified by the removal of the current port difficulties and restrictions arising from the tidal constraints, narrow dock-gate entrance, limited depth available, limited handling facilities, mixing of all different types of port traffic, and limited transport infrastructure and access.

The key principles controlling the safe, secure and systematic management of the new port operations are set out below: -

- Ship generated waste will be managed as per the Port's Waste Management Plan. This includes onboard waste and cargoes residues. The Port Waste Management Plan is contained in Appendix 4.1.
- Commercial Port Security will be managed in accordance with the ISPS Code and the Port Security Plan (Appendix 4.6)
- The GHE design includes detailed provision for emergency response, including personnel escape, emergency vehicle access, fire and oil control infrastructure. In the event of an oil spill, this will be managed in accordance with the Oil Spill Contingency Plan. Oil booms will be deployed while ships are in port. The Oil Spill Contingency Plan is attached in Appendix 4.3.
- In the event of a marine emergency, the 'Galfire Plan' will be activated. This is a coordinated plan, covering inner Galway Bay and including the Port, to deal with any marine emergency according to coordinated planned protocols, and includes all of the key emergency services and stakeholders, including Port Authorities, Galway Fire and Rescue Service, the Local Authorities, the key port commercial users in particular Oil and Bitumen Companies, Garda Siochána, Health and Safety Executive, and the Irish Coast Guard. The 'Galfire Plan' is attached in Appendix 4.4.
- In order to provide the Harbour Master and the commercial port with the necessary power, control and sanctions, Port Bye-Laws are available and used to operate the port, and will extend to cover the full extent of the harbour. The Port Bye-Laws are attached in Appendix 4.5.
- In order to maintain the necessary navigation channels and the safe operation of the port, dredging will be on a 10 year cycle as is currently the practice. This maintenance dredging will be by trailer suction dredgers and the licence to carry out this work will be in accordance with guidelines laid down by the EPA/Maritime Safety Division/Dept of Transport and will be disposed of as per the Foreshore Licence for same.
- The quay surfaces, roads, and pavements will all drain into a new drainage collection system. The system will incorporate oil interceptors, through which all drainage will filter prior to discharge.
- Ship Generated sewage will be discharged via the foul drainage system located at the quays which in turn discharges to Galway City Main Drainage System.
- Ships taking bunkers (fuel for main & auxiliary engines) is carried out in accordance with Marine Notice 2 of 2006.

- There will be a rail link from the adjacent existing Dublin to Galway rail line which will connect to the new commercial quay. This will be used to transport rail freight when viable.
- The RNLI will be incorporated into berthing facilities to enhance the operation of their rescue capability.
- As stated, cruise and oil vessels will be scheduled to be not generally in port simultaneously.

4.3.4.2 Fishing Pier

Smaller fishing vessels will be accommodated on the North Eastern face of the projecting pier adjacent to the liner berth. Larger fishing vessels will be accommodated on the South Western side of the pier. The location will provide a dedicated fishing quay, largely separated from other port operations. This location provides direct access to the adjacent rail link and the adjacent port spine access road, for ease of fish delivery.

4.3.4.2.1 Fishing Vessel Movement Parameters

The key parameters that fed into the design of the fishing zone are summarised as follows: -

- Navigation to the fishing pier is direct from the inner bay, through the new dredged channel, thus providing easy direct access to the fishing pier.
- The bottom adjacent to the North Eastern Side of the Fishing Pier will be dredged to -3.5m C.D., thus providing a minimum draft clearance of 4.1metres at Mean Low Water Spring which is +0.6m C.D The South Western side will be 2.5m deeper.
- Pilotage is not compulsory for local fishing vessels. Foreign registered fishing vessels are and will continue to be docked under the advice of a licensed pilot for the safety of navigation and for the protection of the marine environment.
- Fishing Vessels maintain a listening watch on VHF Ch12 and are available to receive a call from the Harbour Master or Licensed Pilot when manoeuvring within the confines of the port.
- The fishing vessels will moor at the dedicated fishing quay with 30 berths. These berths will have the facility for freshwater and electrical power provided by a metered utility kiosk.

4.3.4.2.2 Fishing Pier Operations

The location of the new fishing pier in the outer harbour will provide much enhanced access and facilities. Navigation to and from the new location will no longer be affected by tidal constraints and the pier will provide dedicated services, access and facilities, undisturbed by other port operations, from which the fishing pier is separated.

- Landing of fish is, and will continue to be, carried out on a 24 hr basis.
- Routine maintenance will be carried out at the quayside by marine engineers as is currently the practice, and there will be easy access from their premises in the Enterprise Park onto the pier where adequate space will be available to facilitate vehicular access for necessary support equipment.
- In addition, there is a yard adjacent to the fishing pier for the storage, maintenance and repair of fishing gear and equipment.

4.3.4.3 Marina

As described earlier, the marina development is based on projections following detailed assessment and consultation, but also based on Galway Harbour Company experience with its own new marina within the existing docks. There is considerable demand for berths there, and the new marina will respond not only to local demand, but also the tourist demand with Galway marina being another key link in the necklace of marina facilities around Ireland. It will be the

premier facility in the set of facilities around the Greater Galway Bay, so encouraging inter marina action for the benefit of that Galway Bay trade.

4.3.4.3.1 Marina Vessel Movement Parameters

- Navigation to the marina will be via a new channel dredged from the -3.5m C.D. contour, with a channel bottom of -3.5m C.D. This will provide a draft clearance of approximately 4.1metres at Mean Low Water Springs, enough to handle the largest yachts visiting Galway Harbour Extension Marina.
- Pilotage is not compulsory for marine leisure vessels. However, mega yachts are docked under the advice of a licensed pilot for the safety of navigation and for the protection of the marine environment.
- Marine Leisure craft maintain a listening watch on VHF Ch12 and are available to receive a call from the Harbour Master or Licensed Pilot when manoeuvring within the confines of the port.
- Allocation of berthage is under the control of the harbour office/marina office.

4.3.4.3.2 Marina Operations

- Water speed restrictions are governed by the marina rules which are periodically under review.
- The marina office will display local marina notices, weather forecasts and necessary information for the safety of navigation.
- Marine leisure craft will berth in the dedicated 216 berth western marina. These berths will have the facility for freshwater and electrical power provided by a metered utility kiosk.
- At the Southern end of the marina, there will a marina quay for all marina utilities, including refuelling, waste collection and access for launching of leisure craft into the marina and removal there from.
- There will be a dedicated fuel berth there for the refuelling of marine leisure craft, requiring double skin fuel oil tanks in the marina quay. See Drawing 2139-2161. This berth will have an oil absorbent boom facility.
- There will be strict waste management controls at the marina, and these will be facilitated by a solid waste disposal facility and a foul drainage station which will discharge sewage to Galway City Main Drainage System.
- The marina quay will be accessible to craft trucks/trailers and craneage to facilitate launching and removal. For safety reasons, access to the marina quay will be restricted during craft lifting operations.
- Car parking facilities will be available on the marina access road, directly facing the marina.
- Access to the marina will be controlled by the marina office for safety and security purposes.

4.3.4.4 Galway Harbour Extension Buildings

There will be 4 buildings included in the planning application as follows:

- Harbour Office
  - This will be the control centre for the new harbour including offices, boardroom, crisis management centre, Vessel Traffic Management, and general administration.
- Marina Office
  - This office will be for the management of the marina including security control and monitoring, management of facilities for the marina users and general administration. It will also provide services and facilities for the marina users.

- Passenger Terminal
    - This will be for disembarking/embarking of passengers and for the administration and management of this procedure.
- Harbour Company Warehouse
    - This warehouse will be used as a pollution equipment store, anchor chains for navigational buoyage, waste management, machinery, workshop, and general facilities and storage for harbour staff.
- Ancillary Buildings
  These comprise service/utility buildings incorporating: -
    - Pump house for fire fighting purposes
    - Security building at the main port access gate
    - ESB sub-stations.
- Future Buildings
    - All future building i.e. adjacent to the western marina and in yards will be subject to future planning applications.

It is expected that all buildings will require piled foundations. Therefore any removal of foundation material will be very limited and if required this material will be removed to a licensed facility.

For design details of all of these buildings, reference should be made to Appendix 13.1 and E.I.S. Volume 2D - Architectural Drawings No. 01-0110 to 05-0110

4.3.4.5 Galway Harbour Extension Yards

A significant area of the GHE development will comprise transit yard areas. Taking account of safety, security, and control considerations, the development has been designed to provide distinct separate areas, with discrete access. The main areas comprise:-

- Marina Yard
- Harbour Company Yard
- Future Oil Yard
- Limestone Yard
- Security Area
- Fire Water Retention Bund
- ESB Station
- Scrap/recyclables Yard
- Steel/construction Yard
- Project Cargo Yards
- Yardage for port expansion cargoes
- Nautical Centre Yard & Slipway

Drawing 2139-2127 details the proposed land use.

Galway Harbour Company will be the management company for the new port lands for the G.H.E.P.

All of these yards will be accessible by HGV for the movement of cargoes to/from the quayside.

These sites will be individually managed by the operators but all under the overarching control of the management company and in accordance with the management company procedures.

The common areas will be shared by all harbour users such as roads, paths, landscaping areas etc. These will be controlled directly by the management company.

The Nautical Centre and slipway will be operated and managed by the co-ordination of the local sea sport associations in conjunction with Galway Harbour Company and Galway City Council.

The centre will be for amenity use and the harbour company will control the operation of vessel movements for reasons of the safety of navigation.

There will open areas, landscaped areas and walkways which will be accessible to the public and will be under the control of the management company particularly in respect of safety, security and maintenance.

The entire Galway harbour extension development, land and quays, will be serviced with all utilities i.e. water main, sewer, broadband, telecom, electricity supply, gas main by connecting to existing services. These will be maintained by the harbour company in conjunction with the service providers.

The new quays will be connected to the existing fuel and bitumen terminals via new pipelines. These will be maintained by the Harbour Company in conjunction with the operators.

4.3.4.6 Commercial Port Operational Safety

General references to safety have been made in the above sections on commercial port operation. The safety of port operations in the past have been based on the advice of Frank Graham Meredith Evans BA, FNI, Grad I Fire E, Master Mariner, Cert Ed. Mr. Evans has been advising Galway Harbour Company in relation to the safety of its operations since 1980 and has carried out annual audits and provided reports and recommendations arising from those audits.

A Report on the Safety Protocols with regard to all commercial port operations is attached herewith in Appendix 4.6.

Typical Timing of Shipping Movements and Associated Operations

The Table 4.3.1 below illustrates the operation durations for each vessel type entering port, commencing from when pilot goes on board (Port Control). For the purposes of this table, the pilot is assumed to board all vessels at 06:00hrs, to match port working hours commencing at 07:00hrs. Where 16:00 + 1 is shown in the table means at 16:00hrs. on the following day.

Operation	Time (h+m)									
	Coal	Petroleum	Bitumen	Cruise Liner	Steel	Timber	Scrap Steel	Research	Limestone	Containers
Pilot on board	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00
Vessel Moored	07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00	07:00
Open Hatches	07:45				07:45	07:45	07:45		07:45	07:45
Connect Pipelines		08:00	08:00							
Pax Gangway Rigged				07:30						
Commence Cargo Ops	08:15	08:30	08:30		08:15	08:15	08:15		08:15	08:00
Complete Cargo Ops	18:00 +1	20:00	22:00	18:00	15:00 +1	15:00 +1	15:00 +1	NA	16:00 +1	22:00
Pilot Disembarked	19:00 + 1	21:00	23:00	19:00	16:00 +1	16:00 +1	17:00 +1	NA	17:00 + 1	23:00

Table 4.3.1 - Typical Timing of Shipping Movements and associated operations

Table Footnotes:

Coal Ships/Steel/Limestone/Timber – working hours are generally 07:00 hrs to 17:00 hrs daily but working time may be extended to finish a ship in order for her to sail. Where dry bulk cargoes are prone to suspended particles, these cargoes will be either bagged, baled or boxed to ensure no air blown dust to sea water.

Petroleum Ships – cargo transfer operations are carried out at all hours once the pipelines are connected. These ships will be surrounded by a containment boom during cargo and bunker transfer operations.

Bitumen Ships - cargo transfer operations are carried out at all hours once the pipelines are connected. These ships will be surrounded by a containment boom during cargo and bunker transfer operations.

Cruise Liner – Generally, these ships moor at 07:00 hrs and depart at 18:00 hrs. These ships will be surrounded by a containment boom at all times whilst moored in port.

Scrap Steel Ships – these ships are exporting cargo, therefore the cargo is loaded whilst all other vessels are discharged. These ships are to be surrounded by a containment boom during bunker transfer operations. Scrap Steel Cargoes will be in open topped container sized boxes.

Container Ships – These ships load and discharge containers at any hour. These ships will be surrounded by a containment booms during bunker transfer operations.

All vessels are going to have booms in position to trap any spillages while in Port.

All quay surface runoff will be to channels, to grit and oil interceptors to ensure no direct surface runoff to sea water of vehicular oil or cargo dusts.

All ships whilst moored alongside the quay will continue to operate auxiliary generators to provide electrical power to run onboard operations and machinery as necessary.

All other vessels such as fishing, marine leisure, pilot cutters, RNLI, line-handling, tugs and naval vessels may operate at all times.

4.3.4.7 NAVIGATION & VESSEL MANOEUVRING

The Harbour Master has statutory responsibility for vessel movements within the jurisdiction of the Galway Harbour Company. The Harbour Master is also the Superintendent of Pilots and has responsibility as a local lighthouse authority.

The Harbour Master has interacted fully with the design team from conception up to final design layout of the Galway Harbour Extension. This has included in assisting as the project has evolved to its current layout, and with the final layout details and facilities.

The navigation into the proposed harbour follows broadly the existing shipping transit routes to the current harbour using existing navigational aids. Landfall into the GHE has been designed to allow the ships master to make safe approach to the port before the port pilot boards the ship. Therefore the approach of vessels as far as Mutton Island is broadly the same as heretofore.

From Mutton Island, there is less navigation distance to the proposed commercial port; there is no dock gate beam restriction or tidal/river flow complexity while still following the present approach routes.

The final approaches in to the GHE commercial port will create a substantial risk reduction for the safety of navigation, particularly when considering the adverse affects of the River Corrib when approaching the existing harbour.

Departure of ships under the guidance of a licensed pilot from the Harbour extension will also have the same risk reduction benefits and corresponding improvements as for the approaches of ships described above.

The harbour will be able to accommodate vessels with a draft up to -7.5m including a safe under keel clearance at all stages of the tidal cycle. Vessels with a draft between -7.5 metres and 11.5 metres (including a safe under keel clearance) will be scheduled accordingly, in line with normal port operational practice to enter and leave with the benefit of additional tidal water draft.

The final layout has been studied extensively in terms of the expected vessel sizes that will moor at the new quays including oil tankers, cargo ships and cruise liners. The Oasis of the Sea (362m x 47m x 9.3m) or similar is the largest expected cruise vessel that can be accommodated at the Galway Harbour Extension. The approach channels, turning circles, quay depth and quay pocket widths has been studied for this vessel and other similar size of vessel for liquid and dry bulk cargoes.

The Harbour Master is satisfied that the GHE layout will be able to accommodate the above vessel types.

The shelter afforded for ships has been significantly improved with the southern breakwater. The Harbour Master is satisfied that the shelter it will provide from the prevailing winds and waves will allow for safe berthage and cargo working operations. Part of the breakwater also acts as a multifunction quay for the docking of oil tankers and bitumen carriers. This quay is 260 metres long and has a draft of – 14.9m O.D. and is the designated liquid bulk quay. It is designed to incorporate proper safety jetty systems necessary for these types of ship.

The remaining 400 metres of quay can accommodate the largest cruise vessels expected and will multifunction for working of other cargo vessels such as dry and break bulk as at 4.3.4.6 above.

It is therefore considered that the GHE has the necessary docking and working quays to be able to appropriately meet the shipping demands and to control future shipping needs in its environmentally designated location.

The overall scheme allows for much improved fishing facilities which will be accessed in the same routes as the commercial port. The new marina facility will have a separate leisure channel which will not interfere with commercial shipping, but will be shared with the Inner (Old) Port facility. This 216 berth marina is sheltered from the prevailing winds by the southern breakwater and allows for safe access and egress.

The overall scheme allows for an amenity slipway to the eastern side of the development in a very sheltered clean, sandy bedded area of the inner bay which will be made available for sail training for the various sea sports groups in Galway City as appropriately managed by the coordination of the local sea sport associations.

4.4 MAIN CONSTRUCTION ELEMENTS

4.4.1 Galway Harbour Extension Requirements Summary

The detailed requirements and their background are explained earlier and these are summarised as follows: -

- Safe and Secure Berths for Oil and Bitumen Tankers
- Berths for Coal, Steel and General Cargo with direct linkage to transport infrastructure
- Deep Water Berths for Large Cruise Liners with easy sea approach access
- Protected Berths for Fishing Vessels
- Land Based Areas for Storage, Buildings and associated Harbour Facilities
- Safe and Secure Berths for Yachts and Pleasure Craft
- Launching Facilities
- Facilities for Marine Sport and Leisure Activities
- Utilities, Transport and Services Infrastructure

4.4.2 Main Construction Elements Summary

In order to meet these requirements, the following is a summary of the main elements to be constructed: -

- Lagoon Walls to contain marine dredged materials and provide access roads to construction areas
- Lagoon Walls protected with breakwater revetment on sides exposed to sea climate
- New Approach Channels Dredged to provide safe easy access to all berths
- Dredged Materials Filled into confined Lagoons
- Reclamation of Land comprised by Lagoon Areas
- Creation of Defined Open Areas within Reclaimed Land
- Outer Port Protection Breakwater
- Quay Walls for Deepwater Berths for Liners, Oil and Bitumen Tankers, and Cargo Vessels
- Fishing Pier
- Nautical Centre Slipway
- Marina Protection Breakwater
- Marina Berths
- Dedicated Utilities and Services to Oil, Bitumen, and Marina Berths
- General Utilities and Services to All Areas
- Rail Transport Link to Outer Quays
- Individual Site Developments

4.4.3 Construction Elements Sequence Summary

The detailed construction methodology to deliver the elements summarised above and the sequence of the construction operations are described in detail in Section 4.5.The following is a summary of the sequence of delivery of the main elements:

- Stage 1: Berths for Cruise Liners, Oil and Bitumen Tankers, and Cargo Vessels
    - Provision of Enhanced Road Access from Lough Atalia Bridge and Harbour Hotel
    - Dredging of Inner Port and Outer Port Access Channels,
    - Dredging for Outer Port Turning Circle and Berths
    - Reclamation of 19.86ha of land
    - Construction of Quays for Oil and Bitumen Tankers
    - Construction of Quays for Cruise Liners and Cargo Vessels
    - Installation of Oil and Bitumen Utilities and Facilities
- Stage 2: Outer Port breakwater, rail embankment, lagoon bund and additional quays
    - Rail Embankment
    - Seaward Bund Wall for Lagoon 7
    - Construction of 60m of Quays
    - Construction of Outer Port Protection Breakwater
- Stage 3: Marina Protection Breakwater, Fishing Pier, Slipway and Rail Access
    - Dredging of Fishing Pier and Marina Areas
    - Construction of Marina Protection Breakwater
    - Reclamation of 3.09ha of land in Lagoon 7
    - Construction of Fishing Pier and Nautical Centre Slipway (0.7ha)
    - Construction of Rail Lines
- Stage 4: Marina Berths and Quay and Reclaimed Lands
    - Construction of Service Quay for Marina
    - Construction of Marina Berths
    - Consolidation of Reclaimed Lands

4.4.4 Construction Methodology Summary

A full and detailed description of construction methods is provided in Section 4.5. The following is a brief description of the influences and concepts behind the construction methodology:

- The Geotechnical Investigation (see Appendix 6.1) reports Soft Silts, above Gravels and Sands over Bedrock
- Dredging of these soils are required to provide Access Channels, Berths and Structure Foundations
- Re-use of Dredged Materials is a fundamental economic and sustainability principle underpinning the design
- The dredged materials will be filled into controlled lagoons to provide for land reclamation
- The materials will be contained by lagoon bund walls lined with geo-fabrics to contain the silts
- Over time, these soft materials will consolidate, accelerated by the installation of vertical drains and surcharging with dredged materials, and provide the areas for land based facilities
- Quay Walls will be provided by using Sheet Piling Systems driven through the overburden and keyed into pre-blasted trenches in the bedrock

- Rock-Armoured Breakwaters will be constructed to protect the outer harbour berths and the Marina.
- Where these breakwaters are located adjacent to navigable channels, sheet piling will be installed below mean tide levels to provide an unobstructed channel and protect the breakwater from scouring action. Channel markers will be positioned on top of the piling to define the channel at high tide.
- A Wave Wall will be constructed on top of exposed Quays to prevent wave overtopping

4.5 CONSTRUCTION METHODS

4.5.1 Design Considerations

The principles established earlier have provided the primary input into the integrated design process of the Galway Harbour Extension. We summarise below the key considerations that drove the design process to meet the key requirements: -

- Sufficient draft provided for all tide access to each berth area based on proposed use
- Sufficient land provided to support all necessary land-based facilities for a sustainable New Harbour.
- Configuration and individual berth locations positioned to minimise rock dredging.
- Port layouts, use and activity locations configured to optimise rail connectivity.
- Quays & breakwaters positioned and structured to provide sheltered berthing of cargo, passenger, fishing and amenity vessels.
- Western Marina and Promenades, Eastern Slipway and Eastern Promenade configured, positioned and structured for optimal use of natural amenity
- Layout configured and elements structured to provide aesthetically pleasing views from surrounding shoreline and to reduce the visual impact from the adjacent shore lines while availing of the shelter provided by those existing shorelines and the proposed development.
- Maximum efficient separation of commercial vessels from pleasure/sport/leisure craft achieved
- Maximum amenity access to Harbour Lands provided while preserving Port security and health and safety requirements.

4.5.1.1 Sustainability

The proposed development incorporates sustainability principles in its design, construction and operation.

The development is being designed to integrate these principles into all aspects of the decision making processes from pre feasibility through to construction completion.

The development is proposed in order to sustain harbour related industry in Galway, by relieving Galway Harbour of its present physical constraints.

The following key sustainability principles will be used to assess the impact of the development which in this case, we number as follows:

1. Protection of Natural Habitats
2. Low Carbon Emissions
3. Low Waste Production
4. Use of Sustainable Materials
5. Promotion of Sustainable Transport modes
6. Efficient Land Use
7. Promotion of the sustainable use of water
8. Promotion of Culture & Heritage

9. Promotion of Local Economy
10. Promotion of healthy and active living.

The development is being designed to fully incorporate the sustainable principles outlined above and to eliminate or reduce potential significant impacts on the sustainability of the development.

- Proposed layout is designed to have minimum impact on the existing pNHA, cSAC & SPA natural habitats e.g. layout orientated to minimise effect on path of salmonoids and eels from River Corrib to and from the open sea. In addition, other measures that are being taken for example to protect water quality will be beneficial for marine flora and fauna.

- Proposed construction methods have been selected to minimise carbon emissions.

- Location and layout chosen to ensure a balance of minimum rock dredging, sediment dredging and seaward projection, and will have a number of benefits including sustainable use of materials and minimising waste.

- Proposed construction methods designed to ensure minimum environmental impact, minimum cost and maximum construction efficiency.

- All dredged material will be reused for land reclamation therefore delivering on the principles of low waste production and sustainable use of materials.

- Rail Link and Sea transport will reduce the vehicular transport associated with product delivery to and from the port location; satisfying both the sustainability principles of low carbon emissions and of sustainable transport.

- Amenity areas are fully incorporated into the harbour design to encourage healthy and active living. This will also preserve and promote the local nautical traditions, enhance marine amenities and generate maximum enhancement of Galway's maritime and tourist status with provision of marina and cruise liner facilities, with benefits for sustaining the local economy.

- Rainwater harvesting and sustainable drainage systems are integrated into the design to promote sustainable water.

4.5.2 Construction Sequence & Methods

4.5.2.1 Sequence, Durations and Timeframes for Stages

The following Table 4.5.1 details the proposed sequence of construction for the development. This table is to be read in conjunction with Drawings 2139-2145 to 2153.

Construction Sequence			
STAGE	**ELEMENT**	**DURATION**	**TIMEFRAME**
Stage 1	**Access Channels; Land Filling; Outer Port Quays**	**43 months 1 - 43**	**Jan Year 1 - July Year 4**
1	Setting up of site compound and mobilisation of construction machinery (Drg. No. 2139-2145 – Element 1)	Month 1	Jan Year 1
2	Enabling works – upgrade of Lough Atalia Road and Galway Harbour Enterprise Entrance to improve access infrastructure (Drg. No. 2139-2145 – Element 2)	Month 1 & 2	Jan – Feb Year 1
3	Construction of Haul Road and Lagoon Wall in a southerly direction from the existing shoreline (Drg. No. 2139-2145 – Element 3)	Month 3	March Year 1
	No work in water	Months 4 - 7	April – July Year 1
4	Construction of Lagoons 1 & 2. (Drg. No. 2139-2146 – Element 4)	Months 8 - 10	Aug – Oct Year 1
5	Dredging of New Channel to existing docks by Trailer Suction Hopper Dredger. Dredged material pumped to Lagoons 1 & 2. Dredging and rock blasting at Marina and Breakwater Combiwall locations (Drg. No. 2139-216 – Element 5)	Months 10-11	Oct – Nov Year 1
6	Construction of part of Marina Wall Construction of Lagoons 3 & 4. (Drg. No. 2139-2146 – Element 6)	Months 11 - 15	Nov Year 1 – March Year 2

Table 4.5.1 - Construction Sequence

Construction Sequence			
STAGE	**ELEMENT**	**DURATION**	**TIMEFRAME**
	No work in water	Months 16 - 19	April – July Year 2
7	Dredging of soft upper seabed material at turning circle, berths and access channel locations using trailer suction hopper dredger. Dredged material pumped to Lagoons 3 & 4. (Drg. No. 2139-2147 – Element 7)	Months 20 – 23	Aug – Nov Year 2
8	Construction of Lagoons 5 & 6. Construction of part of deepwater quays to facilitate berthing of ships carrying construction and dredged materials. (Drg. No. 2139-2147 – Element 8)	Months 23 – 27	Nov Year 2 – March Year 3
	No work in water	Months 28 – 31	April – July Year 3
9	Dredging of firm lower seabed material at turning circle, berths and access channel locations using a backhoe type dredger Dredged material to be placed in Lagoons 1 – 6. (Drg. No. 2139-2148 – Element 9)	Months 32 – 34	Aug – Oct Year 3
10	Construction of 600m of Deepwater Quays Progression of land reclamation works including the construction of vertical band drains for land consolidation purposes Construction of Oil and Bitumen Lines (Drg. No. 2139-2148 – Element 10)	Months 34 - 39	Oct Year 3 – Year 4
	No work in water	Months 40 - 43	April – July Year 4

Table 4.5.1 contd/. - Construction Sequence

Construction Sequence			
STAGE	**ELEMENT**	**DURATION**	**TIMEFRAME**
Stage 2	**60m Deepwater Quay; Outer Breakwater; Lagoon 7 Seawall, Rail Embankment**	**12 Months 44 - 55**	**Aug Year 4 – July Year 5**
11	Construction of 60m of Deepwater Quays Construction of Outer Breakwater (Drg. No. 2139-2149 – Element 11)	Months 44 – 48	Aug Year 4 – Dec Year 4
12	Construction of Combiwall Type Lagoon Seaward Wall to form Lagoon 7. Construction of Rail Line Embankments Road Underpass to Eastern Enterprise Park and Eastern Harbour Access Road. Progression of Land Reclamation Works (Drg. No. 2139-2149 – Element 12)	Months 48 - 51	Dec Year 4 – March Year 5
	No work in water	Months 52 – 55	April – July Year 5

Table 4.5.1 contd/. - Construction Sequence

Construction Sequence			
STAGE	**ELEMENT**	**DURATION**	**TIMEFRAME**
Stage 3	**Marina Breakwater; Land Reclamation; Railway Line; Fishing Pier; Slipway; Harbour Support Buildings**	**26 months 56 - 81**	**Aug Year 5 – Sept Year 7**
13	Surplus Stage 1 consolidated material stripped and placed in Lagoon 7. Dredging of seabed material at Fishing Pier Marina Berths and Access Channel. Dredged material to be placed in Lagoon 7 along with surplus Stage 1 consolidated material. (Drg. No. 2139-2150 – Element 13)	Month 56	Aug Year 5
14	Construction of Marina Breakwater (Drg. No. 2139-2150 – Element 14)	Months 57 - 63	Sept Year 5 – March Year 6
15	Capping of Stage 1 lands including the provision of services Construction of finished roads and services on Stage 1 lands Progression of land reclamation works in Lagoon 7. (Drg. No. 2139-2151 – Element 15) **Note:** No works in water in this element	Months 63 - 67	March – July Year 6
16	Construction of Rail Underbridge Construction of Rail Line Construction of Nautical Centre Slipway Construction of Fishing Pier Progression of Land Reclamation Works in Lagoon 7. (Drg. No. 2139-2151 – Element 16)	Months 68 - 74	Aug Year 6 – Feb Year 7
17	Construction of Passenger Terminal Buildings and Harbour Warehouse Development of yards on Stage 1 lands Progression of Land Reclamation Works in Lagoon 7. (Drg. No. 2139-2152 – Element 17) **Note:** No works in water in this element	Months 74 - 81	Feb – Sept Year 7

Table 4.5.1 contd/. - Construction Sequence

Table 4.5.1 – Construction Sequence			
STAGE	**ELEMENT**	**DURATION**	**TIMEFRAME**
Stage 4	**Marina Berths, Quay and Support Buildings; Roads, Yards and Services**	**15 months 82 - 96**	**Oct Year 7 – Dec Year 8**
18	Capping of Stage 3 lands upon consolidation of lands. (Drg. No. 2139-2152 – Element 18)	Months 82 - 84	Oct – Dec Year 7
19	Development of yards on Stage 1 lands Construction of Marina Quay and the construction of Marina Berths (No works in water Apr – July year 8) Construction of finished roads and services on Stage 3 lands. Construction of Harbour Office and Marina Management Buildings (Drg. No. 2139-2153 – Element 19)	Months 85 - 96	Jan – Dec Year 8

Table 4.5.1 contd/. - Construction Sequence

The methods of construction of the various elements noted in the construction sequence above are described in the following sections.

4.5.2.2 Site Investigation Works

The following details the Site Investigation works carried out to date. Further Site Investigation work will be required, in accordance with normal practice, to fully inform potential contractors.

A marine site investigation survey was undertaken by Causeway Geotech Ltd. in March 2012 to provide information on the soil materials present in the general area of the proposed Galway Harbour Extension development.

The purpose of the survey was to investigate the following: -

The nature of underwater soil materials across the development site
The profile of the different materials across the development site
The profile of the bedrock across the development site

The surveys included 38 No. exploratory holes including cable percussion boring, rotary drilling, depth probing and cone penetration tests.

Soil and rock samples were recovered and laboratory testing carried out to describe the nature of the materials encountered. Causeway Geotech Ltd. prepared geotechnical reports on their findings which included comments on construction methods suited to the site in question.

The Causeway Geotech Ltd. Geotechnical Report is included in Appendix 6.1 of the EIS. The findings are reported on in the Soils Section at Section 6 of the EIS.

In summary, the investigations showed that the upper soils, comprising soft silts, could be removed by trailer suction hopper dredger and be pumped to the proposed Lagoon areas. These soft silts would consolidate over a period of time and were suited to acceleration of consolidation by a combination of dredged material surcharge and a system of vertical drains. The soil materials become firmer with depth, and these firmer materials will be suited to dredging with backhoe dredger, for removal by barge and dump truck into the Lagoons. In short, the proposed methodology for construction of the Lagoons and longer term Land Reclamation has been demonstrated by the investigations to be feasible.

The investigations also provided detailed information on the granitic bedrock and confirmed its suitability for re-use in the construction of embankments as part of the Harbour Extension development. The profile of the bedrock was used to further develop the harbour orientation and configuration to minimise the quantities of soils and rock to be removed.

The soils information also allowed the forms of construction to be developed which vary with distance from the existing shoreline. The depth and nature of overburden over rock increases with distance from shore and generally decreases in granular size.

Drawing 2139-2136 details the exploratory hole locations.

4.5.2.3 Lagoon Wall Construction (incl. Wall Revetment)

In order to provide for controlled and contained development of the land reclamation, the proposed land reclamation area will be subdivided into discrete Lagoons, each contained by robust wall systems. These proposed wall systems vary depending on their location, particularly related to the subsoil conditions. In total, seven discrete Lagoons will be provided.

It is proposed to deliver the rock armour materials to the site via sea on barges. The materials will be placed in position by a combination of methods depending on location, mainly by removing from the barges and placing in position using land based crane. Land based trucks will be used as necessary along the constructed and partly constructed lagoon walls to distribute rock armour for final placing by crane.

Figure 4.5.1 below details the location of Lagoons 1 – 6, all to be constructed during Stage 1

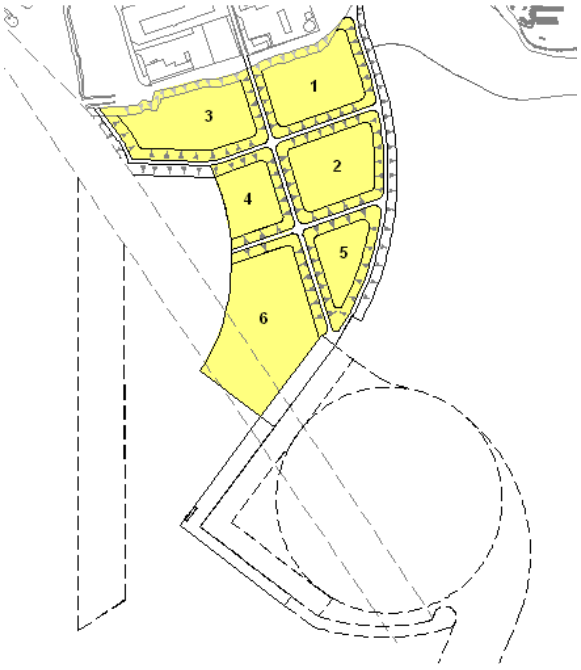

Figure 4.5.1 - Stage 1 Lagoons

Lagoon 7 will be filled as part of Stage 3, with the outer containment seawall for Lagoon 7 being constructed during Stage 2. Construction details of the outer containment seawall for Lagoon 7 will be described later as part of the description of Stage 2 works.

4.5.2.3.1 Lagoons 1, 2 & 5 - Eastern Seawall Construction

Section A-A of Drawing 2139-2142 as extracted and shown in Figure 4.5.2 below details a typical section of the wall construction proposed for Lagoons 1, 2 & 5.

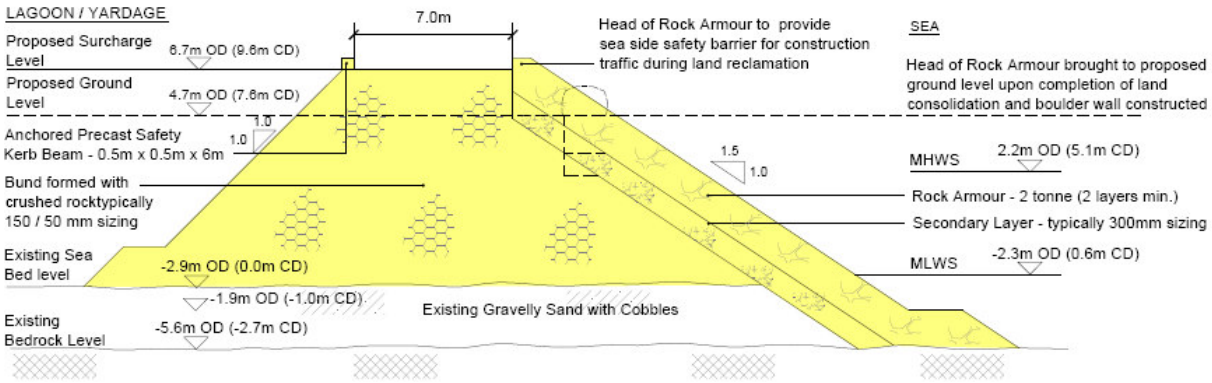

Figure 4.5.2 - Typical Lagoon Seawall construction for Lagoons 1, 2 & 5

Lagoons 1, 2 & 5 rock filled wall construction will consist of imported granular free draining rock fill, generally ranging in size from 150mm down to 50mm placed on the existing seabed. Should soft materials be encountered under the wall footprint, these will be excavated down to firm sub-soils prior to placement of the wall. Under the revetment section on the seaward face, the overburden soils will be excavated down to bedrock, so that the revetment toe foundation provides protection against risk of wave scour damage to the wall foundation. The walls will be lined internally with geo-membrane to facilitate drainage of the sediment pumped from the TSHD, while containing sediment entirely within the confines of the bunded Lagoons. This geo-membrane will comprise heavy duty non-woven geotextile and will be laid from the top of the wall down to the base and extend a minimum of 1metre beyond the toe of the wall to lap across the lagoon existing base material. The top of the geo-membrane will be anchored under the wall top kerb stone. To ensure the bottom of the geo-membrane stays in place and adequately laps across the lagoon base, weighting sand bags will be sewn onto the bottom end of the geo-membrane. The lagoon walls will be constructed to a level of 6.7m OD (9.6m CD) i.e. some 3.86m above highest astronomical tide (HAT) or 4.5m above MHWS thus allowing continuous gradual filtered release of dredged sediment transport water. This height of the lagoon walls above HAT has been designed to control the risk of wave overtopping, based on data provided by the wave climate study detailed in Chapter 8.

To protect the embankment against wave action, layers of rock armour revetment will be placed on the seaward face of the Lagoon Walls. The rock armour revetment has been designed to cater for the wave heights provided by the wave climate study detailed in Chapter 8. The primary rock armour on the seaward exposed faces of these lagoons will vary and be up to 2 tonnes in weight.

4.5.2.3.2 Lagoons 1, 2, 3, 4 and 5 – Common Wall Construction

Section B-B of Drawing 2139-2142 as extracted and shown in Fig. 4.5.3 below details a typical section of the wall construction proposed for use between Lagoons.

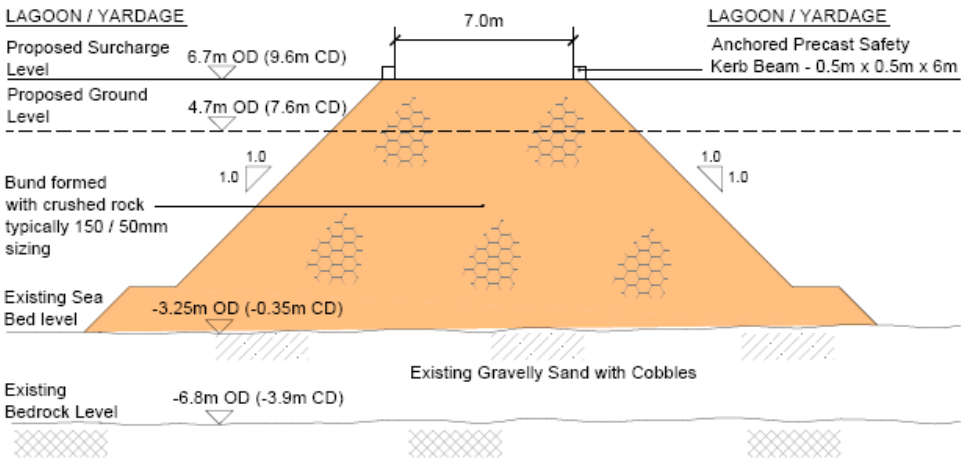

Figure 4.5.3 - Typical Lagoon Internal construction for Lagoons 1, 2, 3, 4 & 5

This Lagoon Wall construction provides separation between the discrete Lagoons to be filled with dredged materials. The walls are designed to withstand the Lagoon filling and will be lined with geo-membrane to contain the sediment entirely within the confines of each discrete bunded Lagoon, while allowing the release of the sediment transport water through the lagoon wall stone filling. These common Lagoon walls will provide temporary access for construction traffic during land reclamation. They will comprise granular free draining rock fill, generally ranging in size from 150mm down to 50mm placed on the existing seabed. Should soft materials be encountered under the wall footprints, these will be excavated down to firm sub-soils prior to placement of the walls.

4.5.2.3.3 Lagoon 3 – North Marina Wall Construction

Section C-C of Drawing 2139-2142 as extracted and shown in Figure 4.5.4 below details a typical section of the wall to the north of the proposed marina.

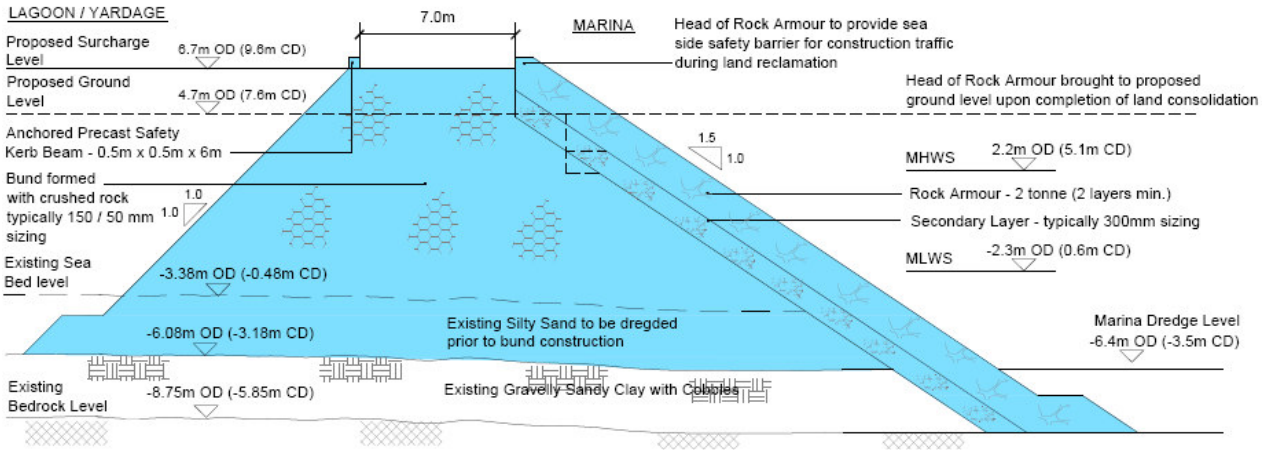

Figure 4.5.4 - C-C Lagoon 3 - typical wall construction to the north of the proposed marina

This comprises the North wall of the proposed marina. The construction of the core material is the same as the other Lagoon walls, namely imported granular free draining rock fill, generally ranging in size from 150mm down to 50mm placed on the existing seabed. Where soft materials are encountered under this wall footprint, these will be excavated down to firm sub-soils prior to placement of the wall. As the Southern face of the wall is exposed to the sea wave climate, rock armour revetment will be placed to this face of the wall. The revetment is designed to withstand the wave loadings identified in the wave climate study, and is carried down to bedrock level, to protect the wall foundations from risk of scour damage.

4.5.2.3.4 Lagoon 3 – West Seawall Construction Adjacent to Shipping Channel

Section D-D of Drawing 2139-2142 as extracted and shown in Figure 4.5.5 below details a typical section of the wall adjacent to the existing shipping channel.

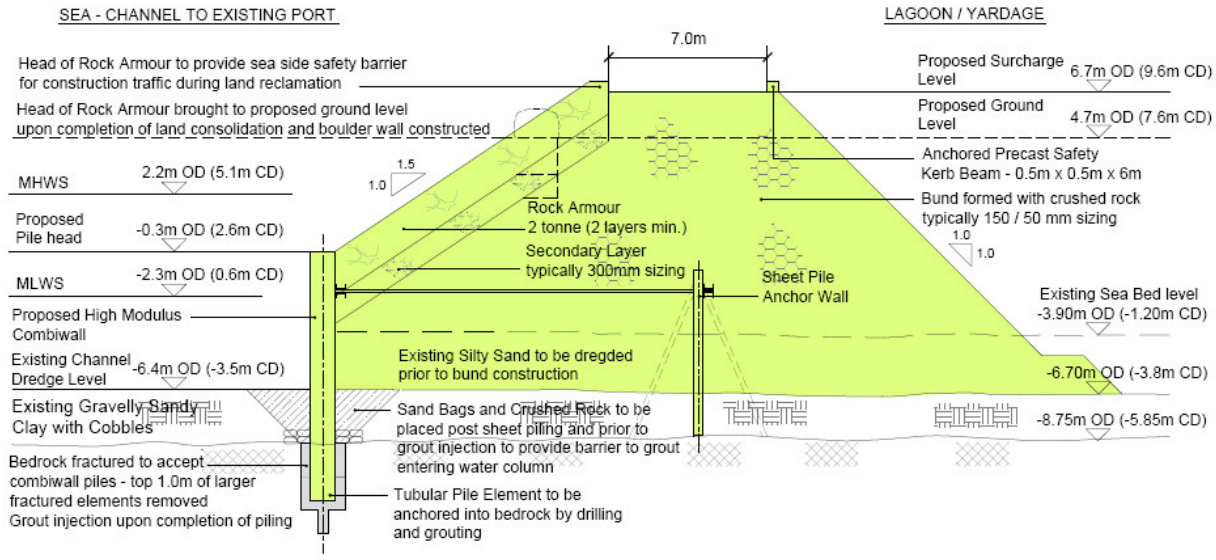

Figure 4.5.5 - Lagoon 3 – typical wall construction adjacent to existing shipping channel

The same principles apply to the construction of this Lagoon containment wall as others in relation to core material and foundation. As this Lagoon wall is to be constructed to a defined shipping channel, the bottom of the seaward revetment slope must be contained to the defined channel line, below mid tide level. To facilitate this, a steel sheet pile combiwall structure will be installed along the edge of the shipping channel. The top level of the sheet piled combiwall will be curtailed to mid tide level, in order to limit the aspect of the sheet pile system visible from the Claddagh, particularly from Nimmo's Pier, South Park and Claddagh Beach. The head of this combiwall toe will be at level of -0.3m OD (2.6m CD). In order to visibly indicate the edge of the navigable channel, channel markers will be fixed on top of the sheet piling.

The combiwall tubular piles and sheet piles, used to form the toe of the lagoon wall adjacent to the shipping channel, will eliminate the possibility of undermining of the lagoon wall from the scouring action of the flow from the existing river channel. In addition, the steel combi-wall will protect the embankment from propeller wash from ships as they navigate the bend in the channel and meet the river current. The combiwall system is an integrated steel retaining wall structure and comprises driven steel sheet piles with intermediate tubular steel piles. In this location, the design is based on 900mm diameter tubular steel piles with three intermediate LX 25 steel sheet piles.

A number of strategies have been considered with regard to the protection of the steel combi-wall system against corrosion. One component of the overall protection strategy is the installation of a passive cathodic protection system. These anodes (typically zinc) will act sacrificially and be most effective in protecting the steel in the areas where the steel is under the low water levels, not generally visible, but exposed to corrosion due to dissolved oxygen. The steel visible in the splash and intertidal zones will be monitored for corrosion on an ongoing basis. The design has provided for increased thickness of steel sections, above that required for structural capacity reasons, the additional sacrificial thickness providing extra corrosion capacity on the basis of recognised corrosion rates. In addition, the corrosion design has taken account of the extra capacity from high yield steels that will be used here, on the basis that the system is designed to be exposed only to the low stress levels used for normal strength steels. In addition, the system has taken account of the potential for strengthening in time to enhance the design life of the system.

The tubular piles will be installed approximately 2.5m into the existing bedrock. To facilitate the installation of the steel piling system, a trench approximately 2m wide by 2.5m deep will be pre-blasted along the proposed line of the toe of the sheet pile wall and the top layer of larger fractured rock will be excavated using a backhoe type dredger. The sheet piles will then be driven approximately 1.5m into the fractured bedrock but will also be provided with lateral support from the adjacent tubular sheet piles to which they will be clutched. Piling will comprise a mix of impact piling and vibratory piling (vibropiling) depending on ground conditions. The expected average rate of installation is 4 tubular piles and 12 sheet piles per day, a quantity that will vary depending on ground and weather conditions. Sand bags will be placed along the top of the trench, both sides of the pile wall. Once the sand bags are in place, granular fill will then be placed along and against both sides of the pile wall toe. Grout will then be injected through the tubular piles, to anchor into the rock, using grouted rock anchors. The grout will extend to a limited extent along the trench providing enhanced bottom restraint to the sheet piling. The grout will be designed as a colloidal grout mix using special proprietary additives, in order to provide a very cohesive grout. These grouts are typically employed in underwater situations to minimise separation of the mix and dispersion in the water. In addition to the specific grout design parameters, in terms of material mix and pressure head, the granular fill above the trench will provide a significant gravity and dispersion path barrier between the water column and the injected grout. To provide a further containment barrier to the injected grout, and to prevent any risk of grout entering the water column, the barrier layer of sand bags (minimum of two bags deep) will be placed along both faces of the sheet piling, extending from the face of the sheet pile wall out beyond the edge of the blasted trench. In order to provide a further assurance that the grout barrier system is effective in practice, divers will monitor for any signs of grout escape.

The delivery, handling and installation of the piling system will all be carried out from sea, using sea-going ships and barges for delivery, with jack-up pontoons with cranes and driving equipment mounted thereon for installation. Standard marine pile guide systems will be employed during installation/driving of the piling.

The top of the combi-wall will be tied back to a sheet pile anchor wall (know as a deadman anchor system). This deadman anchor is restrained by the passive pressure of the crushed rock core material.

The tie system, including walings, connections and protection is described in detail below.

4.5.2.3.5 Lagoons 4 and 6 - East Marina Wall Construction

Section E-E of Drawing 2139-2142 as extracted and shown in Figure 4.5.6 below details a typical section of the West wall of Lagoons 4 and 6 forming the East Wall of the Marina

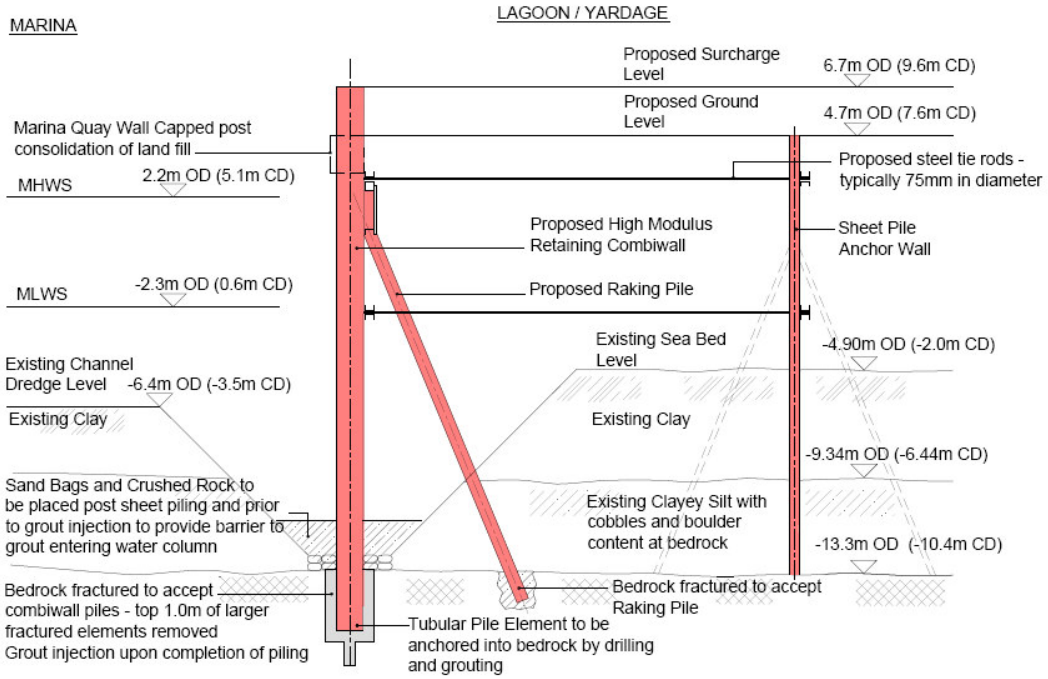

Figure 4.5.6 - Lagoon 4 and 6 - Typical combiwall construction details (East Marina Wall)

The wall of Lagoons 4 and 6 adjacent to the proposed marina will be constructed with tubular and sheet steel piles (combiwall). The tubular and sheet piles will be constructed in a similar manner to that of the wall adjacent to the existing shipping channel of Lagoon 3 detailed above.

Due to the height of this sheet pile combiwall, raking piles will be driven into blasted pockets in the bedrock, to provide lateral support for the proposed combiwall against the wave and current loadings. These raking piles will be driven in sequence with the main tubular piles, to provide lateral stability during the construction phase. In addition, a sheet pile anchor wall (deadman) will be driven as shown in the drawing. Before the fill behind the wall is placed, an anchor system, including ties, walings and connections will be installed to connect the combiwall back to the anchor wall, to restrain the wall against the fill material pressure.

It is proposed that the head of the combiwall be constructed to a level of 6.7m OD (9.6m CD) to facilitate the surcharge of the Stage 1 land reclamation. When settlement is complete and surcharge material is removed the combiwall will be cut down to allow a quay wall head level of 4.7m OD (7.6m CD) to suit the final proposed ground level. A reinforced concrete capping beam, typically some 1800mm wide by 1500mm deep will then be formed along the head of the

combiwall. The Combiwall will typically comprise tubular steel piles up to 1200mm diameter at 2.5m centres with intermediate steel sheet piling, typically Larssen 6 or similar. The diagonal bracing piles will typically comprise 500mm diameter tubular steel piles. Stainless Steel anchor ties, typically 75mm diameter, will be used to connect the main containment wall section back to sheet pile anchor walls. Steel walings, comprising pairs of galvanised steel channels, typically 432x102mm sections, will be used to distribute the loads between the combi-wall and anchor sheet pile wall sections. These steel waling systems, with a special bracketed assembly at the combi-wall raking pile junction, will also distribute the destabilising loads to the tubular steel bracing piles. As the wall extends southwards, the Site Investigation indicates that rock levels are gradually becoming deeper. Consequently, the construction details will change to those set out below for the South West Wall of Lagoon 6.

4.5.2.3.6 Lagoon 5 – Wall to Connect to Quay Wall

The southern wall of this lagoon where it forms part of the commercial quay will be constructed in a similar manner to the wall of lagoon 4 with the marina (as shown in Figure 4.5.6 above). It will have a combiwall face to form part of the commercial quay wall and be backed with stone to form the haul road access to the quay construction. The sheet pile face will be propped by raking props and tied back to a “dead man” steel sheet pile anchor wall to provide lateral stability to retain the stone fill. The installation process including blasting, pile driving, grouting etc. will be carried out as set out earlier. The top of pile will correspond with future quay level, 4.7mOD. This area will act as the initial quay to receive the firmer back hoe dredged material from barges, delivered into side tipping dump trucks, which will then deliver and discharge to Lagoons using the haul roads shown provided on top of the Lagoon walls.

4.5.2.3.7 Lagoon 6 – North and North-East Wall Construction

The walls of Lagoon 6 which are shared with Lagoons 5 and 4 will be constructed in the same manner as those proposed for Lagoons 1, 2 and 5 detailed above.

4.5.2.3.8 Lagoon 6 – South West Wall Construction

Section G-G of Drawing 2139-2143 as extracted and shown in Figure 4.5.7 below details the construction of the wall located to the North East of the proposed Stage 2 lands.

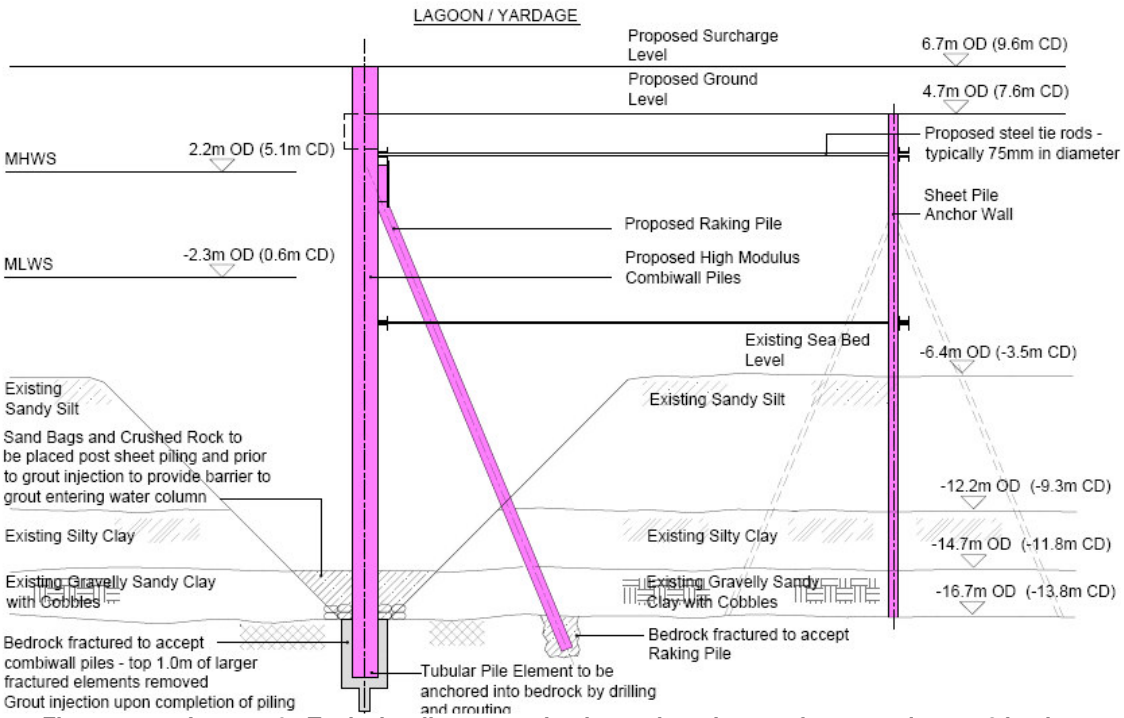

Figure 4.5.7 - Lagoon 6 - Typical wall construction located north east of proposed stage 2 lands

The South West Walls of Lagoon 6 will be constructed with combiwall tubular piles and sheet piles. The tubular and sheet piles will be installed in a similar manner and typically using the same structural members to that of the wall of Lagoons 4 and 6 adjacent to the proposed marina, as set out above. As noted earlier, the depth to bedrock gradually increases the more Southerly the section of wall.

This section of wall will eventually become redundant when, during Stage 3, Lagoon 7 South West of Lagoon 6 is filled with the later material, dredged from the Marina, and Fishing Pier sites, and boosted by surplus surcharge material removed from the consolidated Lagoons filled during Stage 1.

4.5.2.4 Revetment Construction

The Lagoon Walls generally comprise imported granular crushed rock material. Whereas this material will provide robust containment structure for the Lagoon filling, seaward exposed faces will require protection which will be designed to withstand wave loadings based on the data provided by the Wave Climate Study presented in Section 8 of the EIS. This protection comprises large heavy rocks (rock armour) capable of withstanding the wave disturbing forces, installed in an integrated way to provide a protection revetment to the Lagoon walls, in a similar fashion to the Outer Port Protection Breakwater and the Marina Breakwater, further described below.

The revetment system comprises two zones of Rock Armour which will be placed to the outside face of the lagoon walls. These are described as secondary and primary layers and are as detailed in the above lagoon wall figures 4.5.2 & 4.5.4 and as shown on the Drawing No. 2139-2142 and 2139-2143.

Rock Armour layers will provide protection from wave action. As noted above, the typical primary layer rock armour, on the lagoon embankment wall, will comprise 1 to 2 tonne boulders, typically a minimum of two boulder depths in each layer. As rock armour is a natural material and varies to some extent in size and shape, dependent on the size and shape of the particular rocks delivered in particular areas of the revetment, and the pattern of overlapping of the boulders, the

number of rocks in the each layer will vary; the minimum of two boulder depths specified will see that the smaller secondary layer boulders are adequately protected from wave action by adequate wave energy dissipation. Similarly, the core will in turn be protected by the specification of a minimum depth of two boulders in the secondary layer, so that the wave energy is dissipated further before it reaches the even smaller core material. Toe protection will be provided for the revetment by the provision of a rock toe berm, to minimise the risk of slippage/undermining of the revetment face at the base and restrain potential seaward displacement of the edge of the revetment. In order to protect the existing gravel base material, upon which the core material is placed, from wave scour action, the existing sea bed will be excavated to bedrock under the rock armour, thus providing a complete rock curtain at the edge of the sea wall. This rock curtain will extend out beyond the revetment toe protection to provide a further foundation for the revetment face. In all cases, the extent of the outer edge of the revetment foundation will be well within the planning footprint. A gradual sloped revetment cross section will be formed. The revetment will have a 1:1.5 (1 vertical to 1.5 horizontal) seaward slope, integrally designed with the selected rock armour to ensure stability of the revetment structure.

In cases where rock fill is to be placed on fine native material, geotextile fabric will be placed prior to the placement of the rock fill, in order to minimise the risk of finer material migrating into the rock fill. This not only ensures the strength of the rock fill is not compromised, but also reduces the risk of washout of finer material and potential scour.

4.5.2.5 Dredging Works

There is a significant dredging requirement for the port development. The key dredging requirements represent seabed deepening works and can be summarised as follows: -

Provide adequate port access channels and newly aligned access channel to the existing Inner Docks
Provide the Outer Port Turning Circle
Provide the deeper berths for adequate draft for all vessels at all tides.
Provide adequate draft for the largest Yachts expected in the Marina

An estimated 1.705 million cu.m. of sediment will be dredged in Stage 1 to be placed in Lagoons 1 - 6. An estimated 0.11 million cu.m. of sediment will be dredged in Stage 3 to be placed in Lagoon 7, the latter to be supplemented with the stripped surcharge material from Stage 1. This yields a total estimated 1.815 million cu.m. of sediment to be dredged.

Sediment dredging quantities were estimated using the borehole investigation undertaken by Causeway Geotech Ltd.

Suitable and experienced dredging contractors will carry out the entire capital dredging. The proposed New Harbour extension configuration and layout has been designed so that rock excavation is minimised and so that the dredging requirement will primarily involve sediments.

The following Table 4.5.2 is a summary of the various depth requirements of the new harbour extension. Figure 4.5.8 details the various dredge locations.

Table 4.5.2 – Depth Requirements of New Harbour Extension (Refer to Figure 4.5.8 for Required Depth Locations)			
Description	**Dredged Depth (Chart Datum)**	**Notes**	**Dredged Depth (Malin Head Ordnance Datum)**
Entry Channel to Commercial port	-8.0m	From – 8m Sea Bed Contour	-10.9m
Turning Circle for Commercial Port	-8.0m	400m turning circle	-10.9m
Quay Berths	-12.0m	660m x 40m of Quay berth	-14.9m
Access Channel to Western Marina & Existing Port	-3.5m	To match existing channel dredge depth of –3.5m, from -3.5 contour to existing channel	-6.4m
Western Marina Dredging	-3.5m	216 No. Marina Berths	-6.4m
Access Channel and Fishing Pier Berths	-3.5m – -8m	170m of Fisherman Pier	-6.4m – -10.9m

Table 4.5.2 - Depth Requirements of New Harbour Extension (Refer to Figure 3.5.9 for Required Depth Locations)

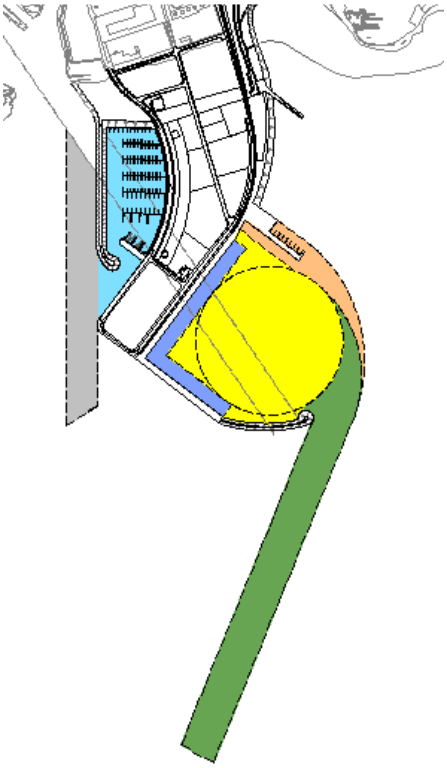

Figure 4.5.8 – Dredging Locations (Refer Table 4.5.2 for Colour Coding)

All dredged material will be used as fill for the proposed reclamation area. Consequently, no material will be disposed of at sea. The main types of dredgers to be used will be (i) trailer suction hopper dredger (TSHD) for the upper softer layers, initial quay wall and breakwater foundation clearances and dredging of the new channel to existing port and (ii) backhoe dredger for the lower stiffer layers.

The TSHD will be used to dredge the top layer of weak seabed material, initial quay wall and breakwater clearances and the new channel to the existing docks. This dredged material will be pumped into Lagoons 1, 2 and 3.

A trailing suction hopper dredger (TSHD) is a sea-going self-propelled ship, suitable for the dredging of unconsolidated material, such as silts, sands and weak clay. Such vessels can discharge by bottom dumping methods or by hydraulically pumping ashore via a pipeline system; only the latter method is proposed for this development. The TSHD is equipped with one or two suction pipes, designed to hang along the side of the vessel. A draghead is fixed at the lower end of the suction pipe, which is then trailed along the bottom of the seabed. Suction is provided by a pump, which lifts the material off the seabed and discharges the mixture of dredged material and water into the hopper well. The main parts of the dredger are: -

The hull - contains the engines, propulsion, pump(s), the crew quarters, the bridge with the navigational control etc.
The hopper - where the pumped mixture of sediment and water settles down.
The suction pipe - through which the mixture is transported to the pump.
The draghead - connected at the end of the suction pipe, which liquefies the sea bottom with the aid of a water jet system. Different types of dragheads can be fitted depending on soil conditions.

Figure 4.5.9 details a typical TSHD.

1 = Draghead
2= Suction Pipe
3= Hopper
4= Bottom Doors
5= Pipeline pump out point

Figure 4.5.9 - Typical Trailer Suction Hopper Dredger

The draghead proposed to dredge the upper softer layer will be chosen to ensure the minimum release of the material being dredged into the water column. Dredging will be undertaken in deep concise areas from an almost stationary vessel rather than long shallow trawls. This will limit the number of passes and the degree of disturbance of the existing seabed which will in turn limit the extent of turbidity which will arise.

The Soils Report (Section 6) and Silt Model Report (Section 8) contain details in relation to turbidity arising, turbidity plumes and dispersal of turbidity.

TSHD will be mobilised by sea and the dredged material, including the liquid fraction, will be placed directly into a bunded lagoon area via a sealed floating pipeline thus ensuring minimum loss of dredged material into the sea. Once the TSHD is full with dredged material, it will proceed

to the designated area adjacent to the South end of the Eastern Seawall, connect up to the sealed floating pipeline there, and commence the operation of pumping the dredged material from its holds via the pipeline and into the Lagoons. Figure 4.5.10 below shows a TSHD pumping onshore via a floating pipeline.

Figure 4.5.10 - TSHD pumping onshore via floating pipeline

Please see section 4.4.2.4 below for details of land reclamation and reuse of dredged material.

Backhoe Dredger

It is proposed to use a backhoe dredger to dredge deeper firmer materials. The dredged material will be loaded to a barge. The backhoe dredger will be fitted with a bucket that closes underwater when full. When closed it is then lifted. It thus contains all of the excavated material, minimises release of dredged material to the water column and minimises the transfer of water to the barge. When full, the barge will pull up alongside the initially constructed section of commercial quay. Another backhoe excavator will remove the dredged material from the barge into dump trucks parked on the quay. These will transport the material to the Stage 1 Lagoons.

This dredging process is proposed in order to minimise the addition of water to the deeper firmer dredged material. Please see section 4.5.2.6 for details of land reclamation and the placement therein of the backhoe dredged material.

The backhoe dredger system incorporates a purpose built pontoon, mounted with a large marine excavator. The dredger is not self propelled and will be towed to site. The sediment transport barges will be self-propelled. Figure 4.5.11 below shows a backhoe dredger discharging to a barge.

Figure 4.5.11 - Backhoe Dredger loading to a barge

The position of the pontoon containing the backhoe dredger will be computer controlled and linked to a GPS system. This will provide full control on location and depth of the dredging process. Once in the correct location, the pontoon will be jacked up on spuds and fixed in position while operating the backhoe dredger. The backhoe dredging process causes lower water turbidity when working with stiffer materials than would be experienced with a TSHD or Cutter Suction Dredger. Accordingly, once the softer materials have been removed by the TSHD, the backhoe dredger will dredge the remainder of sediment to be removed.

4.5.2.5.1 Rock Dredging

Rock dredging at the most northerly point of the 400m Cruise Liner Berth will be initiated using drilling and rock blasting techniques. The blasted materials will then be removed by a backhoe dredger set up as described above. It is estimated that 10,000 cu.m of rock will be required to be dredged at this location. The drilling requirement on the Galway Harbour Extension project will comprise approximately 100mm diameter holes to a depth of 3m. This level of drilling can be carried out from a jack up barge rather than a self propelled vessel.

Trial blasting will be carried out prior to the commencement of production blasting to confirm the optimum blast ratio for the process, to test the effectiveness of the proposed mitigation measures and to provide initial monitoring data for the blasting events.

The procedure for drilling and blasting of rock, where necessary, will be as follows: -

1. The drilling and blasting operations will be designed and operated to comply with noise and vibration requirements.
2. The design will include a borehole drilling pattern dictated by the hardness of rock and extent of fragmentation
3. At each borehole location, a casing will be augured down through the overburden and then be collared into the rock.
4. The rock will then be drilled out using drill rods extending down through the casing to the required depth in the rock.
5. The drill rods will then be extracted and the boreholes will then be charged with emulsion explosives and connected with an associated detonation system. After loading a charge in a hole, the hole will be backfilled (stemmed) with clean imported angular material stemming material.
6. All explosives used will be detonated using a delayed detonation technique with a minimum delay of 25 milliseconds between detonations.

The drilling and blasting required to provide trenches into rock for sheet piling of combiwalls, for raking piles and deadman sheet pile will follow the same procedure as above. A trench will be blasted along the line of the toe of the proposed combiwall and the top 1.0 – 1.5m of larger fractured elements will be dredged. This will result in the removal of approximately 14,000 cu.m. of fractured rock material

The total estimated rock material required to be dredged for the channels, berths and sheet pile rock trenches purposes is 24,000 cu.m.

The sediment material above rock will be dredged as required at quay and breakwater areas prior to drilling and blasting.

The dredged rock material will be utilised in the formation of revetments, breakwaters and haul roads.

Although rock blasting works can be undertaken 24 hours a day or as required to comply with vibration/noise regulations and stay within specific limits, it is proposed that blasting will be generally scheduled for afternoons to address explosive handling regulation requirements. Rock blasting will be subject to fish migration seasonal constraints and will also be subject to mammal watch requirements.

The Noise and Vibration Report at Chapter 10 contains mitigation measures and limit levels in relation to noise and vibration from rock blasting works.

4.5.2.5.2 Dredging Production Rates

Typical daily dredge production rates for the sediment dredging (Trailer Suction Hopper Dredgers & Backhoe Dredgers) and rock dredging (Blackhoe Dredgers) are as follows: -

1. Sediment Dredging using Trailer Suction Hopper Dredgers – 17,000 m^3/day

2. Sediment Dredging using Blackhoe Dredgers – 3,500 m^3/day

3. Rock Dredging using Blackhoe Dredgers – 1,500 m^3/day

It is predicted that dredgers will work for two shifts a day, working at any time in a 24 hour day to coincide with the requirement to work within tidal constraints and restrictions.

4.5.2.5.3 Dredging Mitigation Measures

Stringent environmental procedures will be followed throughout the dredging and blasting works, notably the strict control of suspended substances concentration in the water, restrictions on the range of working hours and protection of sensitive habitats and species. An environmental monitoring program will be adhered to throughout the works. Monitoring of suspended substances concentration, effects of velocity and direction of water currents and measurements of turbidity, noise and vibration will be paramount in order to minimise the spread of turbidity and potential impacts on sensitive areas.

Measures will be put in place on board the dredger to include the elimination of overflow and the avoidance of spillage from open barges and hoppers. As noted routine monitoring will be undertaken for turbidity and suspended solids concentration in the water and methods will be adjusted to control the work within the limits stated. Work will cease where weather would cause these limits to be breached.

Chapters 7, 8, 9, 10 and 11 contain details of environmental dredge mitigation measures and regulations and set the limits of turbidity, noise and vibration to which the work will be controlled.

4.5.2.6 Stage 1 Lagoon Land Reclamation

It is proposed that the construction of Lagoons 1 – 6 will be carried out during Stage 1

Following construction of the Lagoon Containment Walls as set out in Section 4.5.3, the Lagoon areas will be ready to accept the soft sediment material dredged by the Trailer Suction Hopper Dredger. The inner faces of the lagoon containment walls will already have been lined with geo-membrane as described earlier, to confine sediment particles within the lagoons while allowing gradual filtered release of transport water.

The sequence of the lagoon construction has been set out in detail earlier in Section 4.5.2. The soft sediment material, dredged by TSHD, from the new channel to the existing port will be pumped into Lagoons 1 and 2. As set out in the geotechnical report, it is envisaged that the existing bed materials, forming the base of Lagoons 1 and 2, will comprise free-draining granular material and will not require any pre-treatment prior to filling of the lagoons with the dredged materials.

The next stage will involve dredging the soft sediments (upper materials) in the areas to form the new outer port access channel, the outer port turning circle, the outer port berths, and under the quay and breakwater foundations. This material, dredged by a Trailer Suction Hopper Dredger (TSHD) will then be transferred via pump from the holds through a sealed floating pipeline into Lagoons 1, 2 and 3. The delivery end of the floating pipeline will be controlled by floating barge within the lagoon areas, in order to control the location of deposition of the fill material. Again, as with Lagoons 1 and 2, it is not envisaged that the base of Lagoon 3 will require any pre-treatment prior to filling with dredged material.

The filling of Lagoons 4, 5 and 6, also to take place during Stage 1, will be carried out using the stiff sediment material dredged using backhoe dredger. This material will comprise stiff sediments (lower materials) dredged from the areas to form the new outer port access channel, the outer port turning circle and the outer port berths. Again, based on the geotechnical report, the base of Lagoon 5, comprising free draining granular materials, will not require any pre-treatment prior to filling with dredged materials. However, it is envisaged, based on the geotechnical report, that the bases of Lagoons 4 and 6 will require some pre-treatment prior to commencement of filling of these lagoons with dredged materials.

The pre-treatment to the existing bed forming the bases of Lagoons 4 and 6 will comprise (i) the laying of geo-membrane on the bed, followed by (ii) the placing of a sand layer on top of the geo-membrane. The geo-membrane will be placed by floating pontoons, will be anchored by sand bags sewn onto the geo-membrane, and will lap around the lagoon edges with the geo-membrane lining the lagoon walls. The sand layer will be approximate 1metre deep and will be pumped from barges. Divers will monitor this operation to ensure requirements are being met. These layers will provide a base drainage layer for pore water dissipation and also provide enhancement to the strength of the lagoon fill foundation.

Dredged stiff sediments from the backhoe dredger will be placed into the Lagoons 1 - 6 to the desired surcharge level upon completion of trailer suction hopper dredge fill. These materials will be delivered by truck to the individual lagoons. For below water filling, the fill material will be placed across the lagoon area using a pontoon mounted crane. For above water filling of the lagoons with the stiff dredged sediment, wide tracked machines using bog mats as necessary will be used to spread the fill around the lagoon areas. Lagoons 1 - 6 will be filled to level of 6.7m OD (some 3.86m above HAT) adjacent to the lagoon walls and cambered at a gentle stable slope to a level of 7.7m OD at the centre of the lagoons. In this way, the lagoons will be surcharged initially by some 2.0m above the finished level of 4.7mOD. The surcharge will preload the filled material within the lagoons and assist in overall settlement and strength gain.

It is proposed that vertical drains will be installed into the filled material, extending below existing sea bed level through geopressible soils to sand/gravel. The vertical drain system comprises a

plastic corrugated insert into a geo-textile sock; the geo-textile sock allows groundwater into the vertical path provided by the plastic corrugated insert. As filling continues and ground pressure increases, the water is effectively squeezed into the vertical drains, travel up to the surface and be released. These vertical drains in providing a drainage path for pore water pressure to dissipate, allows the soft deposits to compress and strengthen. The vertical drains, in conjunction with addition of the surcharge load, will accelerate the consolidation of the filled ground and will minimise future long term settlement. The vertical drains will be installed using dedicated installation rigs equipped with derrick and mandrel. The rigs will incorporate wide track systems and bog mats as necessary to travel across soft ground.

Settlement will be monitored and once results confirm that adequate settlement and consolidation has taken place, the surcharge material will be removed and placed into Lagoon 7 as part of the Stage 2 construction described later. Measured against pre-determined parameters, a yard capping layer of approximately 800mm depth of imported stone filling will be applied. The precise depth of the capping layer will depend on the extent of ongoing secondary settlement and the proposed surface structure (e.g. asphalt, concrete etc.) of the particular yards,

The Soils Section (Section 6 of the Report) contains details of the consolidation period and vertical drain spacing required. Some 1.4 million cu.m of insitu silts and sands will be stabilised in their existing position by the surcharging and verti-drainage method proposed.

4.5.2.7 Quay Wall Construction at Deepwater Berths

Figure 4.5.12 below shows the location of deepwater berths. The quay areas are shown hatched blue.

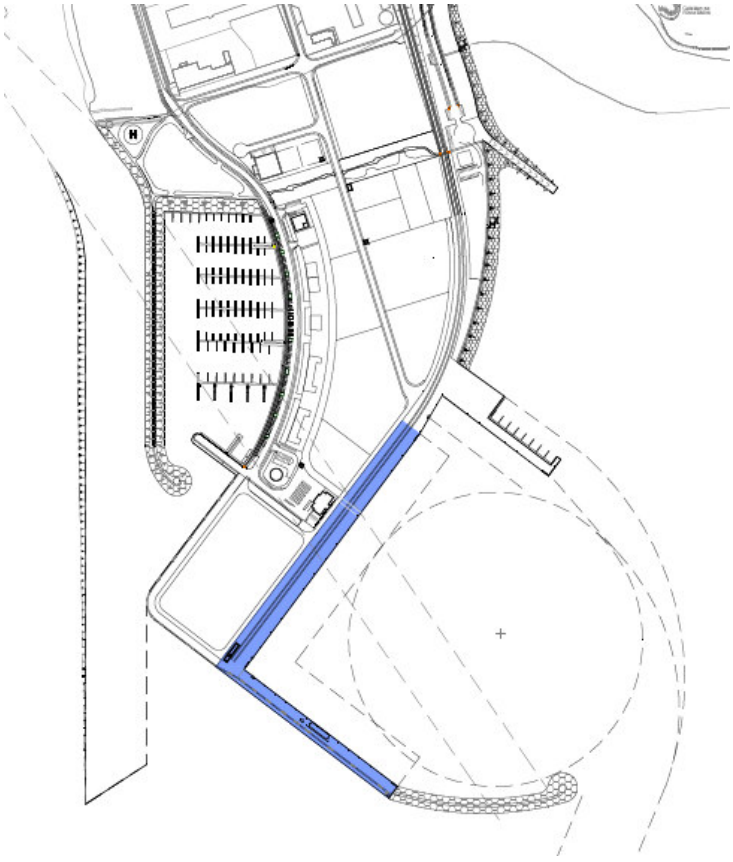

Figure 4.5.12 - Deepwater Quays

It is proposed to construct the quays at the deepwater berth locations with rock filling contained between two lines of steel combiwall piles. Due to the nature of the seabed, the combiwall system will be driven into pre-blasted rock trenches, to provide adequate lateral support to the foot of the combiwall system. The same construction methodologies as set out earlier in Section 4.5.2.3.4 will be employed in the quay wall construction.

It is proposed to dredge the existing seabed under the proposed quay areas to bedrock prior to construction of the quay walls. A trench will then be blasted along the line of the wall and the top approx 1m of larger fractured boulders will be excavated using a backhoe type dredger. The tubular pile element of the combiwall quay will be anchored approximately 3.0m into the bedrock. The sheet piles will be driven approximately 1.5 – 2.0m into the bedrock. Piling will comprise a mix of impact piling and vibratory piling (vibropiling) depending on ground conditions. The exact depths of penetration into the bedrock will depend on the variability in the nature and profile of the rock. As set out earlier, again sand bags will be placed along the top of the trench, both sides of the pile wall. Once the sand bags are in place, granular fill will then be placed along and against both sides of the pile wall toe. Grout will then be injected through the tubular piles, to anchor into the rock, using grouted rock anchors. The grout injection will continue to extend the grout into the pre-blasted rock trench all along the toe of the sheet piled wall to enhance structural stability at the toe of the wall. The sand bags and granular fill above will provide a barrier between the water column and the grout at the toe of the sheet pile, to prevent grout from entering the water column. Divers will monitor and act as back-up assurance to confirm that no grout is entering the water column.

Raking piles will be driven, again into pre-blasted pockets in the rock, in order to provide lateral bracing to the quay wall against wave loading. These will be driven in sequence with the driving of the combiwall, in order to provide lateral stability to the wall during the entire construction process.

Granular infill, comprising rock fill of stone size between 150mm and 50mm generally, will be placed between the two lines of combiwalls, commencing at bedrock level and be brought up to quay surface structure formation level. The rock fill will be delivered along the constructed and partly constructed lagoon walls and quay rock fill, tipped and generally placed in final position as necessary using crane. As the fill progresses, multilevel tie rod assemblies will be installed to tie the combiwalls to each other, in order to restrain the walls against the outward pressure from the contained fill. A concrete capping beam will be provided along the top of the combiwalls, on both sides of the 260m outer quay and on the berth (South East) side of the 400m quay. On the North West side of the 400m quay, alongside Lagoons 6 and 7, the combiwall will extend up above the quay surface level, in order to retain the surcharge fill material in those lagoons. These extended height combiwalls will remain in place pending the removal of the surcharge material down to the formation level for yard construction in that area. The extended piles will then be cut down to yard formation level. The level to which steel sheet pile and tubular piles will be visible externally will be 3.2m OD (6.1m CD) when construction is complete, the section above that comprising the concrete capping beam.

Combiwall piles, raking bracing piles, tie rod assemblies and waling systems, and capping beams have been designed to meet the wind, wave, berthing and operational loadings on the quay structure. The section sizes on the combiwall will be typically comprise up to 1200mm diameter tubular steel piles with sheet piles being typically Larssen 6 (138kg/m) section. The tie rods will range from 50mm to 100mm, typically 75mm, in diameter. At each tie rod location, the tie loads will be transferred to the sheet piled walls typically using steel channel waling sections back to back. As shown on the drawings, the ties will pass between the walings and be bolted to the outside of the sheet pile troughs. The walings will generally be located on the inside of wall. In order to minimise corrosion of the tie rods and nuts, marine grade (316) stainless steel will be used. The nuts and tie rods will be separated from the piled wall materials by special separating washers to minimise dissimilar metal corrosion. The waling beams will be hot dip galvanised and will be separated from direct contact with the tie rods to minimise dissimilar metal corrosion.
Fenders, ladders, bollards, mooring cleats and deflectors will be located as required.

As noted above, the rock fill will comprise only granular stone materials laid directly on the bedrock right up to the underside of the quay, and thus will not be subject to long term creep settlement. As the rock fill is being placed above tidal levels, down to some 2.5m below the quay surface level, it will be compacted in layers using vibratory compacting rollers. This, together with construction traffic, will ensure that the rock fill will be well compacted and ready for construction of the quay structural slab, typically 300mm thick reinforced concrete slabs, once the pipelines and services have been installed. The final finishing of the quay with an overlay slab will take place in conjunction with the installation of the rail line down to the end of the quay during Stage 3.

On the outer 260m deepwater quay, a reinforced concrete wave wall is proposed, to be cast into position with the quay structural slab. This wave wall is designed to deflect wave run-up, prevent wave overtopping and minimise wave splash onto the quay working area; the design is based on the sea state conditions predicted in the wave climate study of Section 8. The wave wall will be pre-fabricated in sections and installed in final position using crane.

Section H-H of Drawing 2139-2143 as extracted and shown in Figure 4.5.13 details a typical section of the 400m quay and Section J-J of Drawing 2139-2143 as extracted and shown in Figure 4.5.14 details a typical section of the 260m quay.

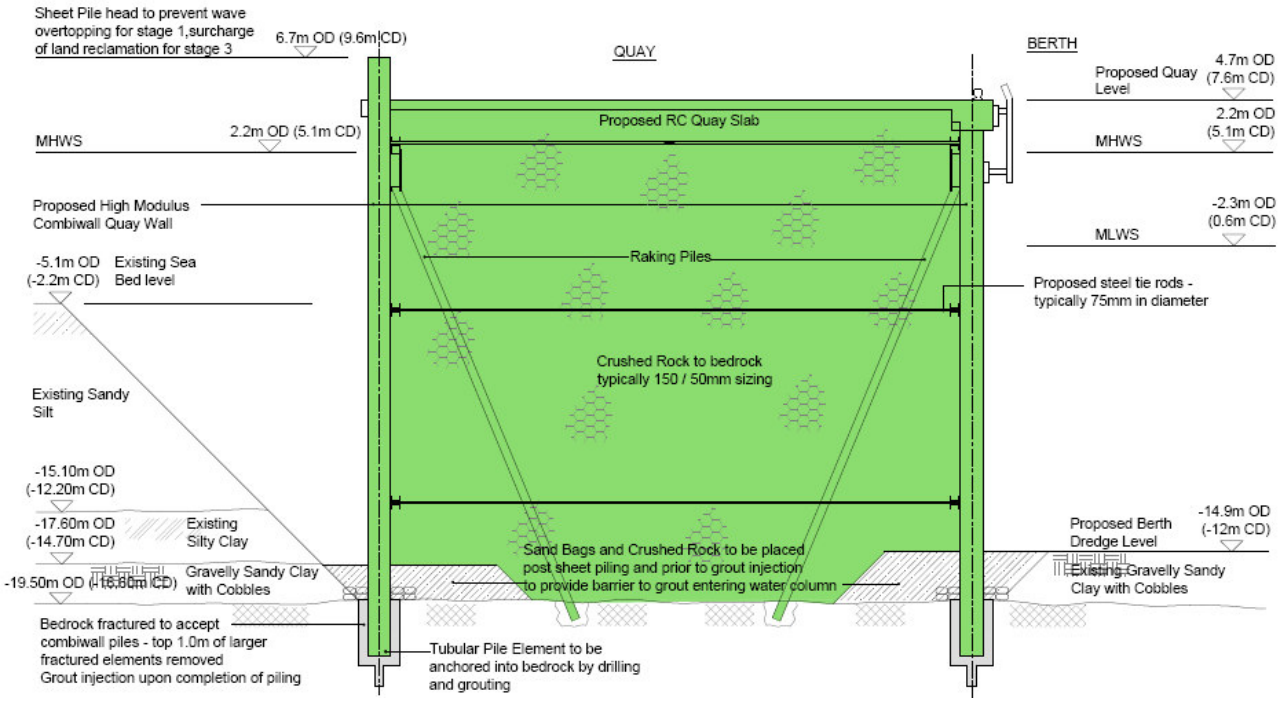

Figure 4.5.13 - Typical Section 400m Deepwater Quay

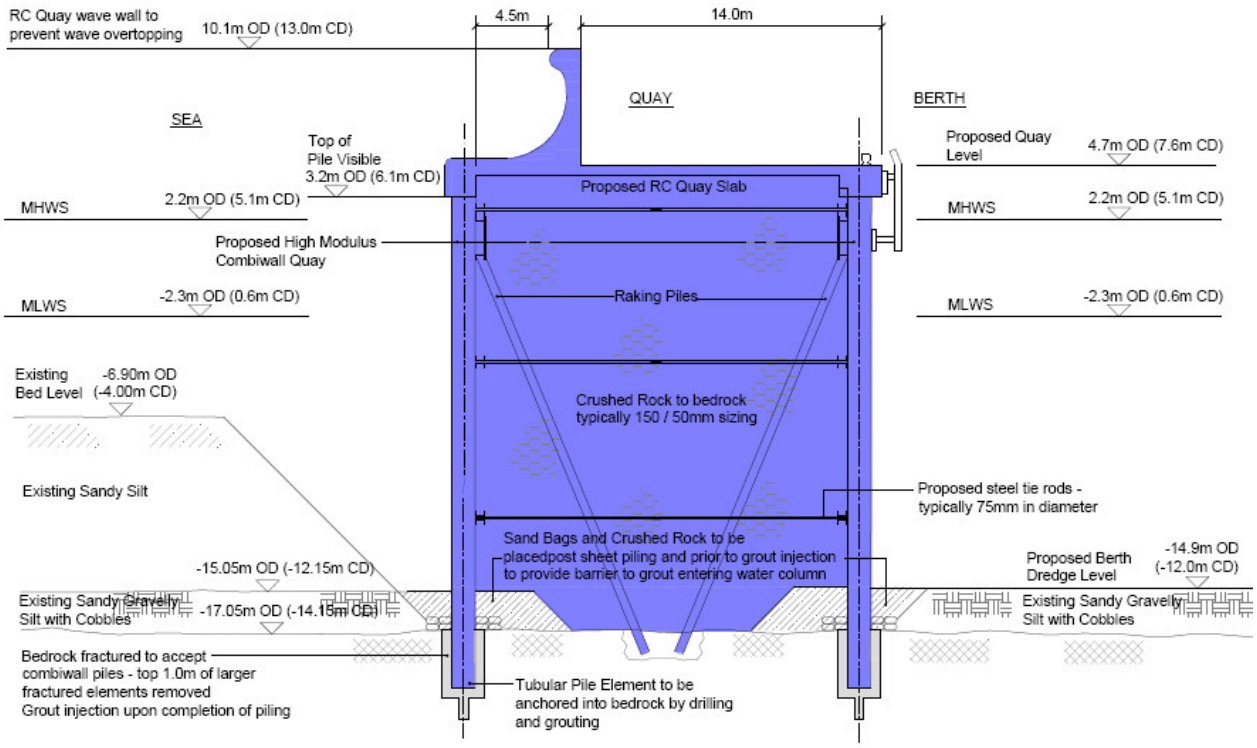

Figure 4.5.14 - Typical Section 260m Deepwater quay

To cater for the extremely unlikely circumstance of personnel being confined within the commercial quay area during a catastrophic emergency situation, an escape route and emergency refuge is provided at the end of the Commercial Quay. For details of this provision, reference should be made to Drawing 2139-2188. This not only provides for ease of personnel escape from the end of the Pier but also provides refuge pending pick up by a rescue vessel. The refuge is to the seaward side of the wave wall to separate personnel from the dangers due to a catastrophic emergency situation, and is also designed to protect personnel taking refuge from storm sea conditions.

4.5.2.8 Commercial Port Breakwater Construction

It is proposed to dredge the existing seabed under the proposed port breakwater to bedrock or to adequate foundation material prior to its construction. The same construction methodologies and materials as described earlier will be used as relevant and appropriate on this section of the works. Combiwall piles will be driven into blasted bedrock to form the toe at either side of the breakwater. The head of the sheet piles will extend to a level of 4.7m OD (7.6m CD) concrete head. The combiwalls will be anchored to each other using tie rods and associated walings and connections. Granular rock fill, generally 150mm to 50mm in stone size, will be placed between the combiwalls to form the core of the proposed breakwater.

Two layers of rock armour will be placed onto the granular rockfill core. As noted above the head of the double sheet piles will provide toe protection. The breakwater will have a 1:1.5 (1 vertical to 1.5 horizontal) slope each side. It is proposed that the breakwater head level be 10.1m OD (13.0m CD). Rock Armour layers, combiwall piles and tie rods have been designed to withstand the wave climate environment predicted by the Wave study. The primary layer armour rock will comprise 10 tonne boulders, with the secondary layer comprising 1 tonne boulders, each layer providing a coverage to the next layer of a minimum of two depths of boulders. The breakwater structure including rock fill, combiwall, tie rod assemblies, bracing piles, revetment slope, armour rock size, and top level have all been designed in accordance with accepted standard good

practice to cater for the environmental conditions predicted in the wave climate study of Section 8.

At the junction between the end of the Commercial Quay and the commencement of the Outer Port Breakwater, a reinforced concrete retaining wall will be provided to retain the rock fill comprising the upper breakwater, the top of which extends up to 5.4m above the Quay surface level. Access for construction of the upper sections of the breakwater will be via a temporary ramp at the end of the commercial quay. Upon completion of the breakwater, the temporary ramp will be removed, exposing the permanent retaining wall above described.

Section K-K of Drawing 2139-2143 as extracted and shown in Figure 4.5.15 details a typical section of the commercial port breakwater construction.

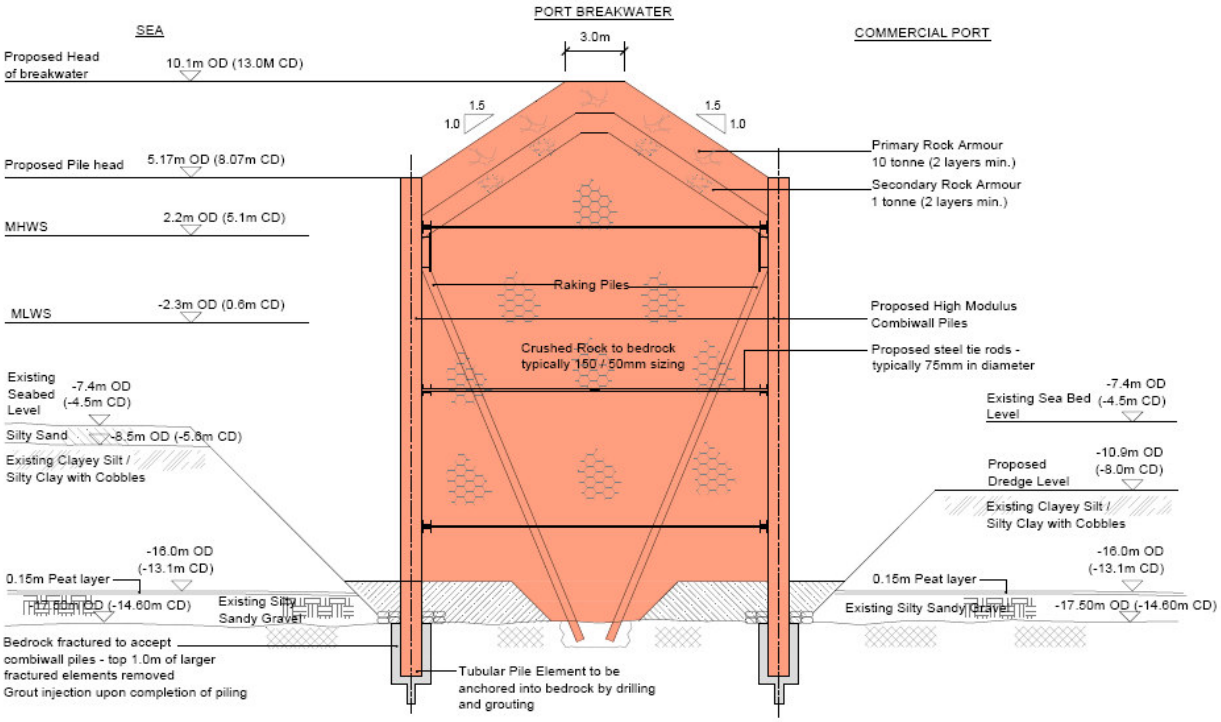

Figure 4.5.15 - Typical Section Southern breakwater

4.5.2.9 Marina Breakwater Construction

The proposed Marina Breakwater is designed to provide protection from wave conditions to Yachts berthing in the Marina. Its configuration will control the extent of wave diffraction into the Marina and limit wave conditions therein to normal international accepted standards.

It is proposed to dredge the existing seabed under the proposed Marina Breakwater to bedrock or to adequate foundation material prior to its construction. The same construction methodologies and materials as described in detail earlier will be used as relevant and appropriate on this section of the works.

Combiwall piles will be driven into blasted bedrock to form the toe at either side of the breakwater. The head of the sheet piles will extend up to a level of –0.3m OD for the marina breakwater. The combiwalls will be anchored to each other using integrated tie rod assemblies. Granular rock fill will be placed between the combiwalls to form the core of the proposed breakwater.

The entire breakwater, including the combiwall system, incorporating integrated tie rod assemblies and bracing piles, and the rock armour above the -0.3mOD level, have all been designed to withstand the sea state conditions predicted for that location.

Up to the top of the combiwall (-0.3mOD), the piling system will provide protection from the environmental conditions to the rock core material. Above that level, two layers of rock armour will be placed onto the granular rockfill core. The primary rock armour will comprise two layers of 2 tonne boulders, with the secondary layer comprising two layers of 300mm size boulders. Again, the rockfill core material will comprise generally 150mm to 50mm stone particle size. The breakwater will have a 1:1.5 (1 vertical to 1.5 horizontal) slope each side. Geotextile filter fabrics will be placed as per revetment construction. It is proposed that the breakwater head level be 5.15m OD with a further boulder wall laid on top as detailed below.

An access road for construction and future maintenance of minimum width 3m will be provided along the top of the breakwater. This will also be accessible to the public as an amenity walk to the end of the breakwater. The surface will be permeable paving. The breakwater including the rock armour revetment has been designed for the sea state conditions predicted in the Wave Climate Study, including wave run-up, energy absorption and overtopping risk, in accordance with the accepted international standards. Nevertheless, a boulder wall will be constructed to provide a barrier to the public, using the marina breakwater promenade, from the breakwater slope, wave run-up splash and, in particular, shelter from a freak wave. The boulder wall will comprise large boulders (approximately 1.2m to 1.5m in size), laid along the outer Western edge of the breakwater promenade and will vary in head level along its length from 6.95m OD to 6.65m OD. See Drg. 2139-2198 for wave wall details.

Section F-F of Drawing 2139-2142 as extracted and shown in Figure 4.5.16 details a typical section of the marina breakwater construction.

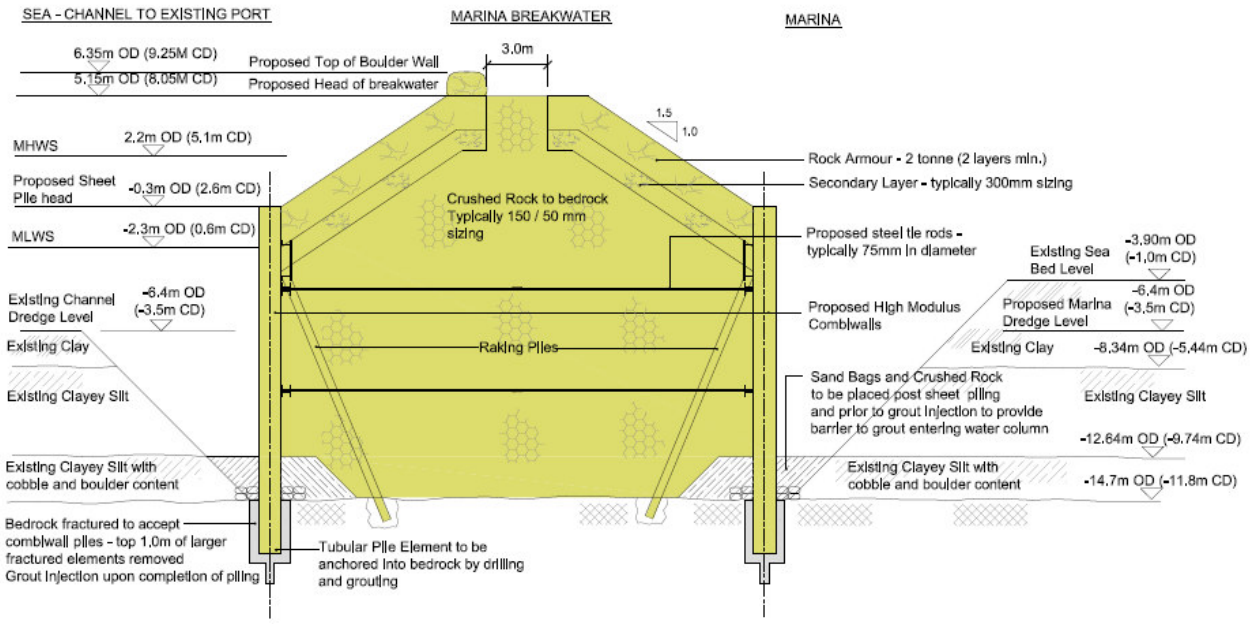

Figure 4.5.16 - Marina Breakwater Construction

4.5.2.10 Stage 2 Lagoon Wall Construction

Figure 4.5.17 details the location of Lagoon No. 7 to be constructed during Stage 2.

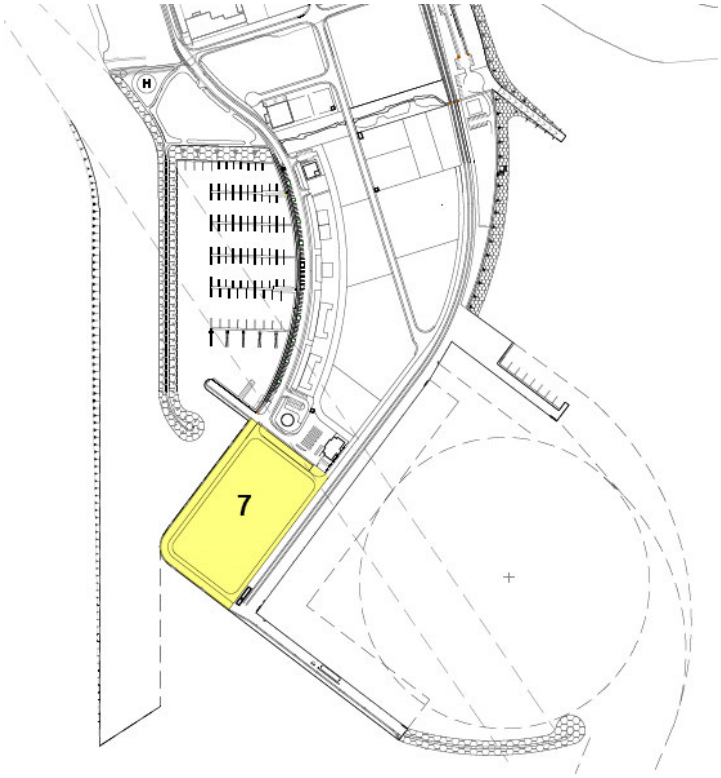

Figure 4.5.17 -Stage 2 – Lagoon No. 7

The Stage 1 construction of the North East Wall (dividing wall between Lagoon 6 and 7) and the South East Wall (rear wall of the 400m Quay) are described in Section 4.5.2.3.

It will be necessary to construct two additional walls to provide for Lagoon 7, namely one to the South West, as an extension of the seaward wall to the 260m Quay, and on to the North West, as an extension to the East Marina Wall. Both of these Stage 2 walls to Lagoon 7 will be constructed with tubular and sheet piles (combiwall). Raking piles anchored into bedrock will be braced to the proposed combiwall to provide lateral support. This system will be constructed in a similar manner to the South West wall of Lagoon 6, described earlier.

It is proposed that the top of the Lagoon 7 combiwall be constructed to varying levels along its length from a level of 6.8m OD at the Northern end nearest the proposed marina, to a level of 9.1m OD along the South Western facing wall nearest the proposed deepwater quays. The varying top level of the wall is to prevent waves overtopping into the proposed port yards, the levels being designed on the basis of the sea state predicted in the Wave Climate Study.

The head of the combiwall will be faced with concrete down to a level of 3.2m OD on the seaward side to match the capping beam soffit level on the Quay. This 3.2m OD level will be the highest level to which steel sheet pile and tubular piles will be erected other than on the commercial breakwater were it will be 5.17m O.D. See sea-wall elevation drawings 2139-2196 and 2139-2197.

The combiwall pile system, the tie rod assemblies, the raking/bracing piles and the rear deadman anchor piles have all been designed to withstand the wave loadings predicted. Section I-I of

Drawing 2139-2143 as extracted and shown in Figure 4.5.18 details this lagoon wall construction.

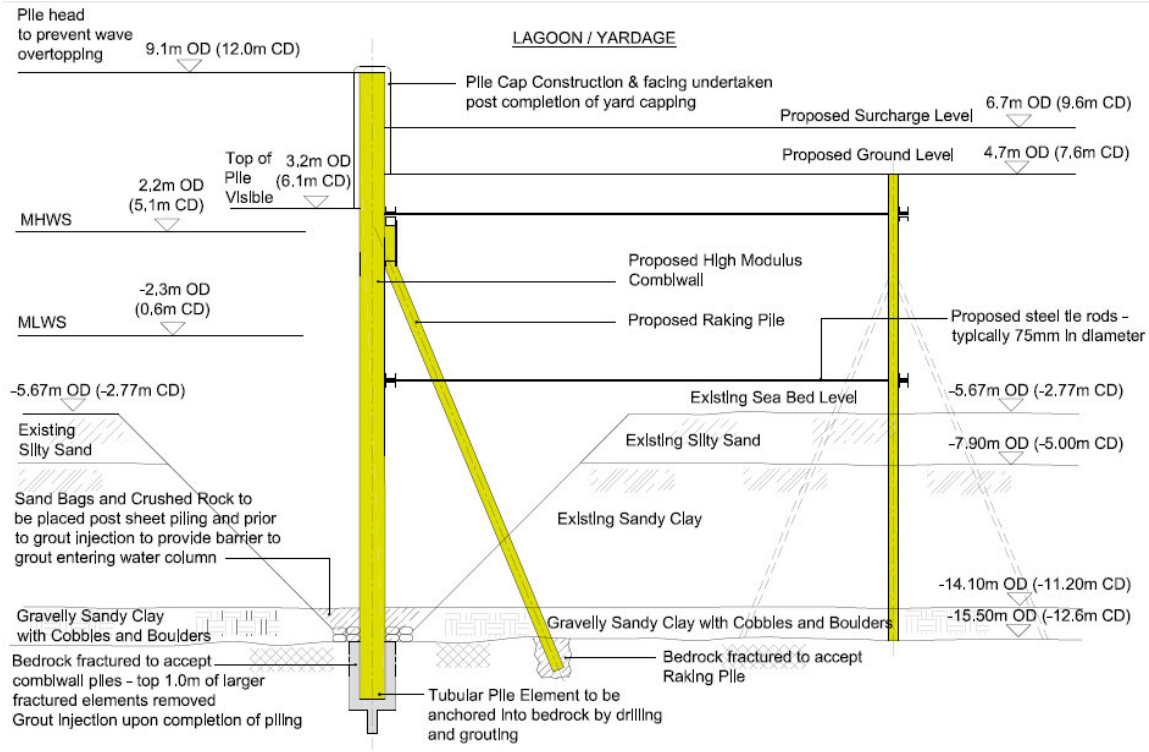

Figure 4.5.18 - Stage 2 Lagoon 7 - wall construction

4.5.2.11 Stage 3 Lagoon Land Reclamation

The Stage 3 land reclamation will comprise Lagoon 7 only. Lagoon 7 will be filled to level of 6.7m OD at the lagoon walls and cambered at a gentle stable slope to a level of 7.7m OD (10.6m CD) at the centre of the lagoon. In this way, the lagoons will be surcharged initially by some 2.0m above the finished level of 4.7mOD.The surcharge will preload the filled material within the lagoon and assist in overall settlement and strength gain.

The Lagoon will be filled with dredged sediments from the Stage 3 works i.e. sediments dredged to form the Western Marina and the Fisherman's Port. In addition, the removal of the surplus surcharge material which will be stripped from Stage 1 land reclamation works, will be placed in Lagoon 7.

The preparation, filling, vertical drainage, and eventual surcharge removal, in the Lagoon 7 area will follow the same methodology set out for the Stage 1 Land Reclamation, described in detail earlier.

After consolidation, it is estimated that the level of the Stage 3 lagoon 7 will have settled from the initial surcharge level of 6.7m OD to approximately 4.0m OD. Notwithstanding this settlement, to provide for a structural sub-base of rock fill (capping), some removal of the surplus consolidated surcharge material will be required, after which the yard capping layer of approximately 800mm will be applied up to a yard formation level , the formation level depending on the final yard surface structure (e.g. asphalt, concrete etc.) proposed. Salvage of surplus rockfill material used in the construction of the temporary higher haul roads and internal lagoon walls will be recycled and used as capping material in this area.

4.5.2.12 Rail Link Construction

The rail link and embankments are designed and will be constructed in accordance with Irish Rail standards. Prior to commencement of embankment filling, the existing ground will be cleared of any top soil for re-use on the embankment side slopes. The rail link embankments will be formed using suitable natural excavated material, recovered from the Enterprise Park, or imported suitable granular material compacted in layers with an embankment slope of 1:2. The side slopes of the embankment will be covered with topsoil, to provide for the planting of low maintenance shrubs and small trees. The planting will be monitored for the first two seasons for plant establishment and plants will be replaced as necessary. Palisade security fencing will be constructed at the foot of both sides of the embankment. Interceptor open jointed drainage will be installed at the foot of both sides of the embankment to intercept rainwater from the railway embankment and this will be drained into the existing Harbour Enterprise Park surface water drainage system.

A minimum 200m radius of curvature is proposed for the turn out link rails to avoid the provision of check / safety rails. The turn out from the existing mainline will be constructed at a minimum gradient of approximately 1 in 400. The port side rails will be constructed flat to allow the maximum use of loading from the proposed materials handling yards. A stipulated maximum track gradient of 1 in 75 will not be exceeded on the new rail link. Where the rail link extends out into the reclaimed land area (Lagoons 1, 2 and 5) of the New Harbour Extension, the rail lines will be constructed on a foundation platform supported on conventional piles in order to expedite provision of the rail link, by providing an immediate stable structure for the rail line there, without the need to wait for the dissipation of creep settlement of the reclaimed ground. By the time the rail link construction commences in Stage 3, a significant proportion of the creep consolidation will have taken place in the reclaimed areas, and any differential settlement between the piled foundation platform for the rail line and the adjacent reclaimed ground will not affect the serviceability of the rail link.

A new railway underbridge will be constructed. This will provide access underneath the new railway embankment for all traffic accessing the Bus Eireann depot and the North Eastern side of the New Harbour extension. The bridge will comprise a bridge deck, incorporating conventional precast concrete bridge beams, supported on reinforced concrete abutment walls. Tapered wing walls will be used on each side of the main abutment walls to laterally support the railway embankment on the approaches to the bridge structure. The palisade security fence will link to the wing walls, extending to the necessary height up along the wing walls to maintain continuity of the security fence.

The existing soil overburden will be excavated down to bedrock upon which the abutment and wing walls will be founded. Based on previous works carried out in the Harbour Enterprise Park, including the Harbour Company warehouse, pavements and general surface water drainage, it is estimated that bedrock will generally be between 0.5m and 2m below existing ground levels.

The road under the railway bridge will be lowered gradually in order to provide adequate headroom for all traffic. Drainage systems including gullies and pipework will be installed under the bridge to prevent ponding of the lowered section of road there. The drainage will be connected into the existing Harbour Enterprise Park drainage system. Details of the proposed railway embankments, road, railway bridge and abutments are shown on Drawings 2139-2181 to 2139-2183.

4.5.2.13 Amenity & Open Space Lands

The amenity and open space lands will be landscaped incorporating the planting of trees and shrubs which are appropriate to the area and its micro climate which will be provided by the walls and fencing shown on the Layout Plans. The Western Marina Promenade will be constructed using permeable paving. Grass areas, trees and shrub planting will be incorporated into the

Eastern Promenade's landscape design. There will be an open space link formed between the two promenades. Once again trees, grass areas, path and planting will be incorporated into the landscape design as appropriate to the site and microclimate / relative exposure. The Western Marina and Nautical Slipway Area provide further areas of amenity. Appropriate capping layers of sub soil 700mm and top soil 300mm will be provided to allow appropriate soil fertility to facilitate landscape developments. See landscape proposals detailed in Landscape Drawings FIG 1 – FIG 7.

4.5.2.14 Construction and Provision of Services

It is proposed that all main services, with the exception of sewers, will be located in one central duct chamber which will extend onto the proposed quays. This will be separate from the oil lines duct. This practice will have positive implications on the operational safety of the proposed development. It will be clear where services are located. It will also mean that services which are laid at a later stage in the development can be pulled through the chamber ruling out the need for further digs and re-instatements. Each set of services will be located within separate compartments in the chamber to allow required distances between services.

The service chambers located along quay areas will be constructed during construction of the quay working areas. Services along roadways will be constructed as the roads are being constructed.

Foul sewer, storm sewer, watermain, fuel and bitumen pipelines, ESB, eircom, etc are some of the services to be provided. The main service lines will be constructed within the permanent spine roadway (between the existing land and the quays) and then within the Quay structure, namely in well compacted rock fill sitting on stable solid ground. Details of the ducts containing the services are shown on Drawing 2139-2187.

4.5.2.15 Nautical Slipway Construction

To avoid pouring concrete in tidal and subtidal conditions within the cSAC / SPA / pNHA the slipway will be precast. The precast concrete slipway will be placed on a well-compacted engineered stone fill base. Site investigations indicate that the existing bed in this location is either dense granular material or rock. However, prior to placement of the stone filling, if any soft sediment is discovered within the footprint of the slipway this will be excavated. The slipway will be laid from a top level of 4.7m OD (7.6m CD) down to a proposed level of –3.3m OD. Therefore there will be an 8.0m difference in level between the top and bottom of the slipway. The slipway will have a gradient of 1:15.

The precast concrete slabs forming the slipway surface structure will incorporate a roughened surface finish, provided during casting in the precast concrete factory, to minimise the risk of persons slipping on the sloping wet surface. The slipway will be 10m in width and 120m in length. The precast slabs will be cast and delivered in lengths of up to 12m and generally 1.2m wide. The joints will be sealed on the underside, using pre-formed sealing strips, and filled with semi-dry concrete mortar to form shear keys in order to avoid differential lips. Sand bags will be laid on top of the joints for 24 hours to protect the mortar during setting and prevent any migration of mortar into the water column. Section 4-4 of Drawing 2139-2162 as extracted and shown in Figure 4.5.19 details a typical longitudinal section of the proposed slipway. Figure 4.5.20 below details the location of the proposed slipway. Both sides of the slipway, the foundation base on which the precast slabs will be placed will be protected with revetments dressed in rock armour, similar to the breakwater/revetment construction in the immediate area of the slipway. This rock armour revetment will be placed on bedrock or solid subgrade not susceptible to scouring damage.

At the bottom end of the slipway, the end of the precast slabs forming the slipway structure, will be supported on Fabriform, or similar, bagged concrete. This bagged concrete system is sealed to prevent escape of concrete mix ingredients into the water column during the setting and

hardening. These bags, being flexible, form a suitable bearing for the precast slabs at the base of the slipway and also will seal the end of the stone filling under the precast slabs, to prevent scouring action undermining the slipway end. The stone revetment at the sides of the slipway will then extend around the end of the slipway, as a flexible revetment mattress, to protect against general scouring action in that area.

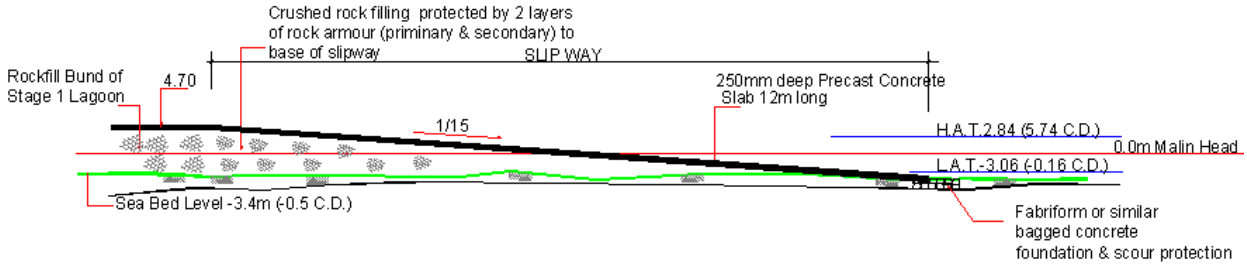

Figure 4.5.19 - Slipway Typical Longitudinal Section

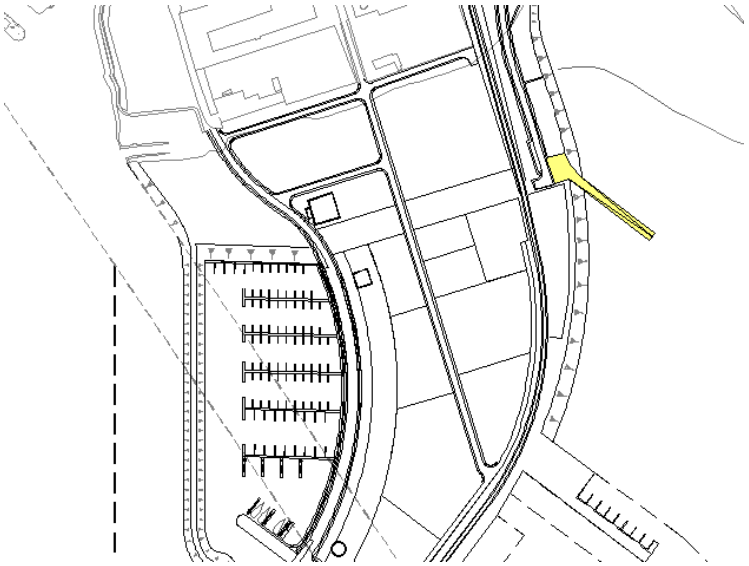

Figure 4.5.20 - Nautical Area Slipway Location

4.5.2.16 Fishing Pier Construction

The Fisherman's Pier will be formed using a double combiwall driven into blasted bedrock and will be construction using the same methodologies used to construct the deepwater quays.

The double combipile wall will be infilled with granular rockfill material down to bedrock, following excavation of overburden and removal to Lagoon 7.The combiwalls will be anchored to each other using integrated tie rod assemblies. Based on the site investigations and the wave conditions predicted in the wave climate study, the combiwall system will comprise 900mm steel tubular piles with LX25 steel sheet intermediate piles. A 300mm thick reinforced concrete quay slab will be constructed on top of the compacted rock fill. The shipping channel to the fisherman's port will be dredged to –6.4m OD (–3.5m CD) on the northern side.

Floating pontoons and walkways are proposed on the northern side of the fishing pier as detailed in Drg 2139-2164.

Section 6-6 of Drawing 2139-2164 as extracted and shown in Figure 4.5.21 details a typical section of the proposed Fisherman Pier.

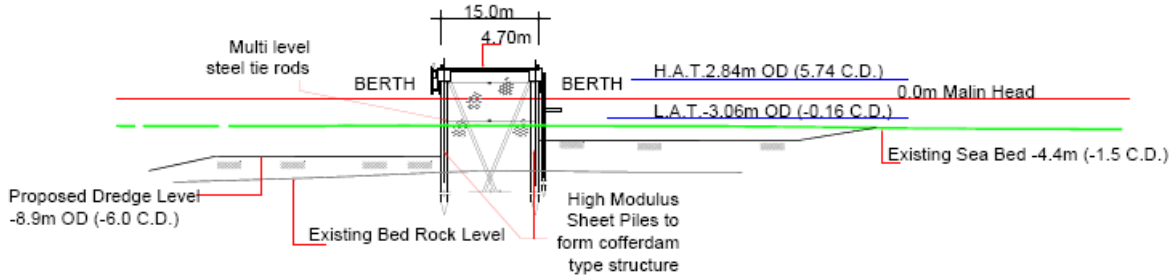

Figure 4.5.21 - Fishing Pier Typical Section

Figure 4.5.22 below details the location of the proposed Fisherman Pier.

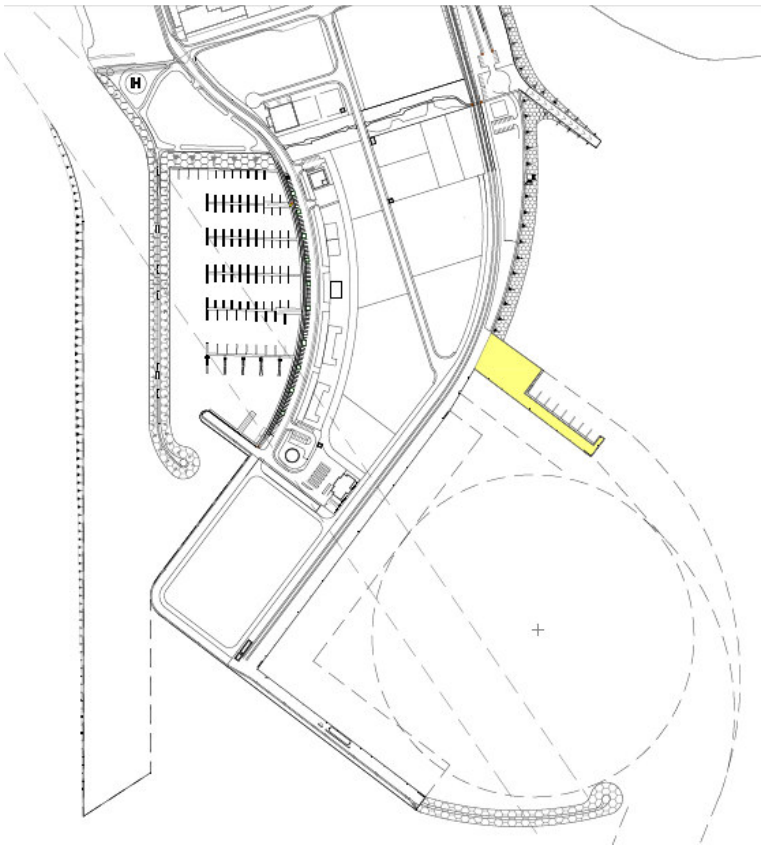

Figure 4.5.22 - Fishing Pier Location

4.5.2.17 Kayak Steps Construction

It is proposed to locate a facility for Kayak and other water sports people at two locations in the relatively protected zone between the Fisherman's Pier and the Nautical Slipway and the slipway and Renmore Beach.

This form of facility was also initially considered for location on the Western side of the development. However, when the design was being prepared, because the steps would lead

directly to significant depths of water i.e. -6.4mOD and lead into the relocated Existing port ship channel, it was decided not to locate them on that side in the interests of safety.

Accordingly, these will be located on the Eastern side of the development only, where they will lead to natural shallow water and will be of amenity benefit and provide safe access to the water, for berthing, canoeing etc. These locations will be consistent with the use proposed for this section of the development, which is designed for public sports amenity purposes. The steps are being provided to respond to a request at the Public Consultation and in accordance with details indicated there. The steps are 6.0m wide and are designed to allow a kayak come alongside at various stages of the tide to disembark and bring the kayak ashore.

The steps and side walls will be of precast concrete construction and will be placed on a well compacted engineered stone fill base. The lowest step will be at -2.6 m.O.D. which is 0.3m below Mean Low Water Spring Tide. The steps rise to a 6.0 x 6.0 intermediate landing at a level of +0.185 m.O.D. and rise again to an upper landing level of 2.97m OD which is 0.77m above Mean High Water Spring Tide level. From that upper landing, additional steps will be provided and will be of a reduced 2.0m width to facilitate access on foot to the pedestrian path at the promenade level of 4.7m OD.

As with the Nautical Slipway, the precast steps will be roughened on the top surface during prefabrication to provide a surface with low slip properties. Although the upper levels will rarely be wetted by tidal action, the roughened surface will be provided on all of the steps. Notwithstanding the provision of a roughened upper surface, it would be intended that ongoing maintenance would take place to clean away marine algal growth to reduce risk of slip on the steps.

The protection of the sides and bottom end of the steps with revetment and Fabriform bags respectively will follow the same principles as the Nautical Slipway and as described above.

Details of the Kayak Steps are shown on Drawing 2139-2163.

4.5.2.18 Marina Construction

As described earlier, a breakwater will form the seaward protection for the marina. The combiwall lagoon wall construction will form the landside boundary. The floating pontoons and walkways for the marina will be constructed on fibre reinforced concrete floating pontoons guided by tubular piles keyed into bed rock. A hardwood anti slip decking will be supported on an aluminium frame. Hand rails, pontoon ladders, mooring cleats and deflectors will be located as required. Figure 4.5.23 below details the location of the proposed marina. Figure 4.5.24 shows an indicative visual image of the view to the south of the proposed marina development.

A Marina Quay will be formed to the south of the proposed Marina using a double combiwall driven into blasted bedrock and will be constructed using the same methodologies used to construct the deepwater quays. The double combipile wall will be infilled with granular rockfill material to bedrock. The combiwalls will be anchored to each other using integrated tie rod assemblies. A 300mm thick reinforced concrete quay slab will be constructed on top of the rock fill.

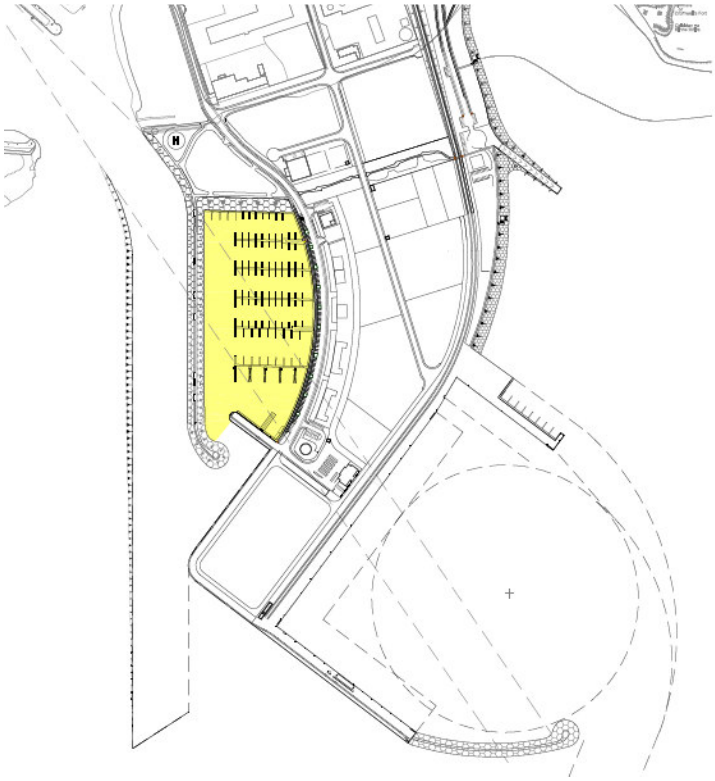

Figure 4.5.23 - Marina Location

Figure 4.5.24 - Indicative visual image of the view to the south of the proposed marina

4.5.2.19 Development of Individual Sites

Once the services have been installed, works can commence on the development of the individual sites. It is expected that given the nature of the reclaimed ground, that all buildings located in the New Harbour Extension will require to be piled. Once the foundations are in place, the buildings will be constructed to the individual requirements of each site subject to this Planning and to such subsequent planning permissions as may be required. Yards will be surfaced with clause 804 and can be tarmacadamed or concreted as required by the client who leases the site.

The following is a list of some of the buildings / sites that will be developed:

1. Replacement Harbour Warehousing
2. Passenger Terminal Area
3. Harbour Office
4. Boat/ship Chandlers
5. Nautical Centre Boat Yard
6. Lifeboat Station Area
7. Waste Export Yard
8. Steel Yard
9. Oil Tank Farm Area
10. Fishing Pier
11. Amenity Areas

4.5.2.20 Principal Quantities for Construction

The estimated quantities of material required for the principal building elements are outlined below in table 4.5.3.

Principal Quantities for Construction		
Description	**Sourced from and method of delivery**	**Estimated Quantity**
• Quarry material for lagoon bund and revetment core construction	Local Quarry by HCV	290,000cu.m
• Quarry material for Quays and Breakwaters	Local Quarry by HCV	490,000cu.m
• Quarry material for Fishing Pier, Slipway and Marina Quay	Local Quarry by HCV	70,000cu.m
• Quarry material for capping of lands	Local Quarry by HCV	220,000cu.m
• 10 tonne Rock Armour for Breakwater	Rock Armour Supplier by Sea	6,400cu.m
• 2 Tonne Rock Armour for Breakwater / Revetments	Rock Armour Supplier by Sea	40,400cu.m
• 1 Tonne Rock Armour for Breakwater	Rock Armour Supplier by Sea	4,150cu.m
• 300mm stone underlayer for Breakwater / Revetments	Local Quarry by HCV	18,400cu.m
• Reinforced concrete surfaces and structures	Local Quarry by HCV	26,250cu.m
• Dredged material – sediment	TSHD & Backhoe by sea	1,815,000cu.m
• Dredged material – rock	Backhoe by sea	24,000cu.m
• Steel Piles and Bearing	Specialist combiwall supplier by sea	42,200 tonnes

Table 4.5.3 - Principle Quantities for Construction

4.5.2.21 Construction Machinery

Below is an estimate of the breakdown of machinery to be used at each stage of construction. This is to be read in conjunction with the projected timeframe of works.

Stage 1

- 300 HCV per day for 9 months delivering rockfill for lagoon walls, breakwaters and quay areas
- 5 HCV per day delivering other construction material
- Bulldozers, 5 Excavators, 5 Dump Trucks & 5 Vibrating Rollers
- Vertical Drain Installation Plant for stage 1 lands
- Side Tipping barge for Rock Armour Delivery
- 2 Trailer Suction Hopper Dredger
- 2 Blackhoe dredger
- Barge for dredged sediment transport
- 2 Drill & Blast Barges
- 2 Piling Rigs for Quay Construction

Stage 2

- 100 HCV per day for first 3 months of Stage 2 delivering rockfill for port breakwater and quay areas.
- 100 HCV per day for last 3 months of Stage 2 delivering capping material to be stockpiled for stage 1 lands. (Capping to be undertaken in Stage 3).
- 5 HCV per day delivering other construction material
- Bulldozers, 5 Excavators, 5 Dump Trucks & 5 Vibrating Rollers
- Side Tipping barge for Rock Armour Delivery
- 2 Drill & Blast Barge
- 2 Piling Rigs for port breakwater, quays and lagoon wall construction

Stage 3

- 100 HCV per day for first 3 months of Stage 3 delivering remainder of capping material required for capping of consolidated Stage 1 lands.
- 100 HCV per day for subsequent 3 months delivering rockfill for marina breakwater.
- Subsequently 55 HCV/day for further 3 months delivering rockfill for construction of Fishing Pier and Slipway
- 5 HCV per day delivering other construction material
- Vertical Drain Installation Plant for stage 3 lands
- Bulldozers, 5 Excavators, 5 Dump Trucks & 5 Vibrating Rollers
- 2 Piling Rigs for marina breakwater and fishing pier construction
- 2 Backhoe dredger
- Barge for dredged sediment transport
- 2 Drill & Blast Barge
- Side Tipping barge for Rock Armour Delivery

Stage 4

- 40 HCV per day for 5 months delivering capping material
- 5 HCV movements per day delivering construction materials for services, buildings and marina fit out
- Bulldozers, 5 Excavators, 5 Dump Trucks & 5 Vibrating Rollers
- Piling Rig for marina pontoon piles

4.5.3 CONSTRUCTION TRAFFIC MANAGEMENT

For the construction of the proposed harbour extension, it is necessary to transport the construction materials, equipment and personnel to and from the work sites. These activities will be examined with all of the associated traffic, management systems and controls, and the necessary work procedures and codes of practice that are required to support a planned and coherent operation.

For the purposes of this Traffic Management Plan, materials flows associated with the port construction have been used in defining the traffic management issues and impacts. These have been examined to:-

1. Assess the expected environmental impacts in relation to potential for disturbance to people living adjacent to the haul routes and other road users,
2. Confirm the demands upon the road infrastructure in the area, together with other project material flows,
3. Highlight risks and contingencies, keeping these under review.
4. Conduct a thorough Health & Safety and risk review of the haulage operation

The Traffic Management Plan is a document which remains a live document and may be subject to review and updating in consultation with the local authority as the project requirements dictate. This Plan will eventually form part of the safety file for the completed project.

4.5.3.1 Construction Traffic Impact

An assessment of the impact of construction traffic on the surrounding road network has been undertaken. Please see Chapter 13.4 for details of the analysis undertaken on anticipated construction traffic. The transportation of materials, such as rock armour and steel sheet piling, by sea also reduces the potential impact of construction activities on the surrounding road network.

4.5.3.2 Description of Haul Routes

Drawing Number 2139-2178 highlights the proposed haul routes for HCV construction traffic. It should be noted that all roads along the proposed haul routes within Galway City and its environs are sufficiently wide to cater for 2-way HCV movements, post the lowering of the road under the Lough Atalia Railway Bridge.

Construction-related HCV traffic originating from the R336 will access the site via Bishop O'Donnell Road, Seamus Quirke Road, N6, Sean Mulvoy Road, Moneenageisha Road and Lough Atalia Road.

Construction-related HCV traffic originating from the N59 will access the site via the N6, Sean Mulvoy Road, Moneenageisha Road and Lough Atalia Road.

Construction-related HCV traffic originating from the N84 will access the site via the N6, Sean Mulvoy Road, Moneenageisha Road and Lough Atalia Road.

Construction-related HCV traffic originating from the N17 will access the site via Tuam Road, Moneenageisha Road and Lough Atalia Road.

Construction-related HCV traffic originating from the R339, M6 or Old N6 will access the site via the R338 Dublin Road and Lough Atalia Road.

4.5.3.3 Road Improvement Works

As part of the proposed development, road improvement works are proposed to improve traffic flow and road safety in general in the vicinity of the proposed development. It is proposed to upgrade the existing harbour access junction to a widened traffic signal controlled junction with stacking lanes, which will ensure efficient and safe movement of vehicles into and out of the new harbour development.

It is further proposed to lower the vertical profile of Lough Atalia Bridge under the railway bridge in order to eliminate the current height restriction that is in operation at this location, thus allowing for 2-way movement for the vast majority of vehicle types.

It is proposed that these network improvement measures be scheduled prior to the commencement of other construction activities. This will improve overall road safety during the construction works. The road works will be undertaken by Road Works Contractors to be approved by Galway City Council.

4.5.3.4 Risk Management

The appointed contractors for the construction of the harbour and all ancillary works, in conjunction with Galway Harbour Company, will prepare a risk assessment matrix as part of a thorough Health and Safety and Risk review of the haul routes, in order to:

(a) Identify the risks;
(b) identify the appropriate mitigation measures;
(c) understand and define how the actions resulting from the identified mitigations are best allocated between the stakeholders according to the responsibilities that each stakeholder takes;
(d) Monitor implementation of the identified mitigation measures;
(e) Re-evaluate the risks, the mitigation measures and the effect of completed mitigation measures, including changes due to changes to the operation of the material transfer location, or haul road, or the haulage methodology during the construction stage.

Following the preparation of the Risk Assessment Matrix, the traffic management plan will be revised and updated as necessary.

4.5.3.5 Traffic Diversions During Lough Atalia Road Works

A traffic diversion will be required to facilitate the lowering of the vertical profile of Lough Atalia Road under the railway bridge. It will be necessary to close Lough Atalia Road at the railway bridge for the duration of these works. The proposed diversion routes are highlighted on Drawing Number 2139-2179. The works are estimated to require 8 weeks to undertake.

Inbound traffic along Lough Atalia Road is proposed to be diverted onto Fairgreen Road, Forster Street, Lower Eyre Square, Victoria Place, Queen Street and Dock Road, with local access being provided via Bóthar na Long.

Outbound traffic is proposed to be diverted onto Merchants Road, Eyre Square, Prospect Hill, Bóthar Uí Eithir and Fairgreen Road. Local access to the inner harbour area will be maintained via Queen Street, Dock Road and Bóthar na Long.

A road opening licence, including full details of proposals for signage, road markings and final diversion route arrangements will be dealt with in the contractor's detailed Traffic Management Plan, and will be carried out in consultation and agreement with Galway City Council prior to commencement of works.

During the course of the diversion, general HCV traffic will also be required to be diverted from Lough Atalia Road. These diversion routes include a number of sharp bends in the road, particularly on Eyre Square and at Victoria Place / Queen Street. In these instances, large articulated vehicles will need to encroach on the oncoming lane to turn. It is recommended that appropriate signage and road markings in accordance with the Traffic Signs Manual be provided at each location in order to warn advancing motorists of the increased potential for HCV-turning traffic. The form and location of these signs and markings will be developed in the contractor's detailed Traffic Management Plan, and agreed with Galway City Council prior to commencement. HCV traffic to the main site will not commence until the completion of the road improvement works required.

4.5.3.6 Inspections

The transport foreman is responsible for ensuring that HCV drivers are complying with their duties in undertaking pre trip vehicle inspections to ensure that their vehicle is roadworthy. Pre trip inspections on the internal and external components of the vehicle are performed by each driver as outlined below.

4.5.3.6.1 Daily Pre Trip Checks

HCV drivers carry out a visual inspection of their vehicle to include vehicle lights, brakes, broadcast communication system, lorry number, tailgate, tyres etc.

4.5.3.6.2 Weekly checks

These are carried out by the driver or other authorised person e.g. mechanic or inspection team. A Vehicle Checklist and Defect Form lists the check items, and the Drivers Code prompts him to complete it. There will be a system of reporting faults that may affect the roadworthiness of the vehicle, which shall include:

- Reporting of all faults every day until they are fixed;
- A method of recording, in writing, the faults reported;
- A method of closing out reported faults in the same place as they are originally recorded.

4.5.3.6.3 Defect Reports

Any defects found during performing the pre trip inspection, whilst the vehicle is in use, or on its return to base, are reported by the driver. The defects are recorded in writing, normally by the driver.

4.5.3.6.4 Responsibility for Actioning Defect Reports

Defect reports shall be actioned by the haulage Contractor involved who shall ensure that corrective action is taken.

4.5.3.6.5 Defect Reports and Maintenance Records

A defect report is part of the maintenance record of the vehicle and is kept, together with details of the remedial action taken, for at least 12 months until the asset is released from Company or Contractor service.

4.5.3.6.6 Standards and Information for Safety Inspections

I. The manufacturer's maintenance and operations manual shall be used, and reference made to manufacturers recommended tolerances for pass/fail criteria.
II. The previous inspection report shall be available to make sure that all defects have been remedied.

4.5.3.6.7 Safety Inspection Reports

I. The safety inspection report is prepared by an appointed individual.
II. Each safety inspection shall be recorded in writing.
III. The safety inspection report shall include:
- name of owner of vehicle;
- name of vehicle user(if different);
- date of inspection;
- name of the inspector;
- vehicle identity (fleet number and/or registration number);
- odometer reading;
- a list of all items inspected;
- an indication of the condition of each item inspected;
- details of any defects found;
- details of any repair work and by whom it was done;
- closing statement that any defects have been repaired satisfactory, and the vehicle passes the inspection.

IV. The safety inspection report shall have notes of repair work done to remedy defects identified and details of any work to be carried forward. Safety inspection reports shall be kept as part of the maintenance history of the vehicle.

4.5.3.6.8 Compliance Audits

Compliance audits shall be carried out to review the traffic management controls during the construction activity to monitor and review performance. These inspection records may be stored electronically.

4.5.3.6.9 Visual Evidence of Inspection

A certificate or sticker shall be issued to vehicles, which pass the safety inspection, to be attached or kept in the vehicle until the following inspection. This evidence shall include, as a minimum, the date of last inspection and the name of the inspector.

4.5.3.7 Record Keeping

In order to ensure compliance with national regulations on maximum working hours and break intervals for drivers, vehicle tachographs are fitted to all heavy commercial haulage vehicles. These are recorded to archive and analysed for compliance with work duties on a weekly basis. Open book access to these records will be made available to the Gardaí in their monitoring of statutory load limits. Report sheets will be designed for the driver to record any incident, or vehicle maintenance requirement.

A record of all traffic movements into and out of the sites will be maintained.

4.5.3.8 Speed Limits

The posted speed limit in Galway City in the vicinity of the site is 50km/h. This speed limit is considered appropriate for HCV traffic in the city in order to ensure adequate breaking distance is available along the haul route.

4.5.3.9 Hours of Operation

The average working hours for haulage activities relating to the construction of the harbour development will be between 07:00 – 20:00. On average, construction activities will be between 08:00 – 18:00, however sea-based construction activities may occur outside of these periods, depending on requirements. It is acknowledged that Galway City currently experiences traffic congestion, particularly at peak periods. In order to reduce the overall impact of construction activities during peak periods construction haulage activities will be limited in as much as is possible during these peak periods, particularly during the hours of 08:00 – 09:30 and 16:30 – 18:00. General deliveries to site will also be similarly managed to fall outside these peaks where possible. The Traffic Management Plan developed by the appointed contractor will also investigate the possibility of construction shift patterns being formulated to fall outside of these periods wherever possible.

4.5.3.10 Abnormal loads

Traffic impacts due to abnormal loads will be subject to permitting by the appropriate Local Authorities and will be detailed in the applications made for such transports. The transportation of such abnormal loads will be managed in consultation with the Road Traffic Authorities and the Gardaí. It should be noted that previous abnormal loads, such as the importation of power station materials, have been shipped without incident.

Galway Harbour Company, in conjunction with the contractor, will operate a management system for organising and planning the logistics of abnormal loads.

Specific abnormal loads will typically have the following control measures implemented:

- Driver vehicle check sheets
- Route Survey
- Trained and Assessed driver.
- Approved haulage company.
- Abnormal Haulage Permit
- Two Vehicle Escort at Front
- One Vehicle Escort at Rear
- Vehicle monitoring systems
- Third party vehicle inspection

4.6 SUMMARY OF STAGE BREAKDOWN OF DEVELOPMENT

The Galway Harbour Extension will be broken down into 4 stages (see Drawing 2139-2141). The stages of development are as detailed below and as shown on the following figures:

4.6.1 Stage 1

Commercial Port formed including:

- Reclamation of 19.86hA of quay areas and back up land.
- Formation of 400m quay – 30m wide
- Formation of 200m quay – 20m wide
- Dredging of channels to -3.5m (-6.4m O.D.) and -8m depth.
- Dredging of 400m diameter turning circle to –8m (-10.9m O.D.) depth.
- Dredging of a -12m (-14.9m O.D.) Berth pocket immediately adjacent to the proposed Quays.
- Full new oil and bitumen handling facility on new 20m pier.

The drawing of this stage is shown as Stage 1.

4.6.2 Stage 2

- Formation of reclamation bund wall for Lagoon 7 allowing for the reclamation of 3.21hA of additional back up land.
- Construction of rail embankment.
- Formation of 60m quay – 20m wide (0.12 ha)
- Formation of Pier head breakwater

The drawing of this stage is shown as Stage 2.

4.6.3 Stage 3

- Marina breakwater formed
- Reclamation of 3.09hA of back up land and 0.7hA as fishing pier and slipway areas.
- Dredging of future Marina to –3.5m C.D.
- Construction of Fishing Pier
- Construction of Slipway
- Construction of rail lines

The drawing of this stage is shown as Stage 3.

4.6.4 Stage 4

- Western Marina with 216 No. berths.
- Reclamation of 0.12 ha of Marina Quay.

The drawing of this stage is shown as Stage 4.

As noted above Stages 1 - 4 are shown in Drawing 2139-2141. They display the inclusions in each stage.