East Lothian Council

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REPORT TO:	East Lothian Council (COVID-19 Emergency Recess Arrangements)
MEETING DATE:	
BY:	Chief Executive
SUBJECT:	Cockenzie Power Station Site: High-level Optioneering Study into the Creation of a Cruise/Port-Related Facility

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1 PURPOSE

1.1 To advise Council of the high-level Optioneering Study into the creation of a cruise/port-related facility on the former Cockenzie Power Station Site.

1.2 To consider the options now available to the Council.

2 RECOMMENDATIONS

2.1 To note the content of the study.

2.2 To engage with the Minister for Local Government, Housing and Planning and senior civil servants seeking clarity regarding the potential for development of cruise and port-related infrastructure at Cockenzie.

3 BACKGROUND

3.1 East Lothian Council purchased the former Cockenzie Power Station site from Scottish Power in March 2018. Prior to, and since the Council purchased the site, a number of bodies have expressed an interest in the possibility of a cruise/port-related facility at Cockenzie, utilising in particular the former Power Station site to the north of Edinburgh Road.

3.2 At the Council meeting on 26 February 2019, following an update on the site as a whole, the Council approved the commission of a technical study into the possibility of creating such a facility. It was recognised that while full technical, environmental and commercial studies would come at considerable cost, an initial high-level study determining the characteristics of the site, market trends within the cruise industry and indicative costs would be worthwhile.

3.3 Council officers had previously been contacted by a number of consultancy companies with expertise within the cruise/port industry and following discussion and receipt of a number of proposals, AECOM Ltd were commissioned to undertake the study. The budget for the study was set at £25k.

3.4 It was recognised that Forth Ports, as Harbour Authority would have a role to play in any future development and following a press release that they were also undertaking feasibility work on the creation of a cruise terminal on the north side of the River Forth at Burntisland, communication was established at Chief Executive level to investigate the possibility of the provision of a facility at Cockenzie. While a number of subsequent informative meetings took place, there was no agreement to jointly progress feasibility work.

3.5 Following site surveys and market and commercial analysis work the final consultants report is attached as Appendix A.

3.6 In summary, the consultants undertook a market review particularly within the context of the Forth, considered the site environmental conditions including bathymetric and geotechnical information, reviewed the design requirements for a modern cruise vessel, berth and terminal, identified the key engineering requirements to accommodate the design vessel and determined a number of possible options. These options, together with a variety of berth and access configurations, landside facilities and indicative costs were then considered as design scenarios. Basic financial modelling and calculation of economic benefit was then undertaken to determine the most cost effective option.

3.7 The consultant considered the site at Cockenzie to present an opportunity for possible development; it is only 12 miles from Edinburgh on the south shore of the Forth and offers the following advantages: it is a brownfield site with an existing pier; in access terms there are no constraints on vessel length or width; adequate water depth is available, subject to engineering works; tidal impacts are relatively small and 24hr access could be possible; it could provide suitably protected berths close to the open sea; it presents an opportunity to develop a cruise terminal at relatively low cost using simple piers; there is the availability of land onshore; the site is well connected; and the introduction of cruise facilities on the site could stimulate competition within the Firth of Forth. These advantages suggest that a greater number of calls, including modern and future vessels up to 350m in length carrying 3,000 to 4,000 passengers, could be generated at the site as a transit or turnaround facility.

3.8 The cruise market has grown considerably year-on-year with calls to the Forth rising from 70 in 2015 to 118 scheduled for 2020, a number of companies are involved offering a variety of cruise experiences calling with a fairly even spread throughout the April to September season, and the most common vessels are currently within the 200 to 250m in length range.

Any vessel in excess of 250m is currently required to use the anchorage at Hound Point or off Newhaven and tender passengers ashore. With the increasing number of larger vessels and the cost efficiencies they generate together with health and safety considerations this is no longer seen as a sustainable future option.

3.9 Based on a design vessel of 350m in length carrying 3,000 to 4,000 passengers with a width in excess of 50m and requiring a draft of 9.3m the consultants considered: how can this vessel be accommodated; how does it berth; how is the vessel restocked; how are passengers and goods moved on and off the vessel; how are passengers accommodated and processed on shore. There are significant variations in what is required and what could be physically provided offshore together with varying onshore requirements in the provision of a transit (a vessel berths for a short period of time, 1-2 days while passengers visit onshore attractions) or a turnaround (a vessel berths and there is a complete change of passengers and supplies) facility.

3.10 The consultants considered 8 preliminary options for berthing the vessel. Seven involved the construction of a new pier, built over and further out than the existing (possibly using this as a temporary works structure during construction) and the eighth option considered the vessel berthed alongside the existing sea wall. These options all have different initial dredging requirements and ongoing maintenance of the sea bed level but they are all essentially a combination of dredged channel and berthing pocket which in different configurations would allow access at all or part states of the tide. The opportunity for operators to be able to arrive and depart without reliance on tidal depth is important and would increase the likelihood of Cockenzie becoming a port of choice. A new pier structure would require to facilitate the movement of passengers and supplies to and from the ship either on a single or double roadway for passenger transport to shore by bus, or by elevated covered walkway above the roadway. These considerations would suggest that a new pier would cost between £36M and £51M. Options for vessel loading either via the provision of a continuous quay (i.e. a continuous loading platform along the length of the vessel) or via specific loading points to coincide with those on the side of the vessel would also be required costing up to a further £10M. Passenger facilities on shore which could be relatively inexpensive for a transit call but costing up to a further £27M for a state of the art turnaround facility capable of receiving and processing up to 4,000 passengers and all the necessary supplies to service the vessel would also be required. The creation of a facility is therefore estimated to cost between £50M and £110M depending on the configuration chosen. There would also be a requirement for onshore land with a basic transit facility requiring up to 5 acres while a turnaround facility may require up to 20 acres to accommodate the terminal, goods handling, parking and possibly accommodation.

3.11 The consultants analysed the various options and undertook basic financial modelling work which demonstrated that an option where a berthing pocket was provided at a newly constructed quay, providing passenger transport by bus on a single lane roadway to the shore and with limited onshore facilities capable of future expansion could be constructed for £56M with a return on capital investment within a 15-year period.

3.12 There are considerable challenges for the schemes identified within the report, many of which can only be determined through further expensive on site (marine and land) investigation and survey work. To that extent the consultant's report is heavily caveated and highlights the requirement for further technical work to substantiate the cost estimates given. There may also be significant environmental and licensing costs depending on an option chosen.

3.13 While acknowledging the significant extent of further investigative technical, environmental and commercial work that would be required to advance the project, the consultants did conclude that the provision of a cruise berth at Cockenzie is technically feasible and possible.

3.14 At the point of publication of the consultants' report the situation with regard to the Coronavirus was unknown and there can be little doubt that the cruise industry will suffer the effects of this for a period of time. It is not known at this stage how this will impact on the cruise industry, whether growth will continue and the subsequent effect on investment decisions into new port-related facilities.

3.15 While East Lothian Council could continue with further studies, technical, environmental and commercial, at considerable cost or could indeed tender the opportunity to develop a cruise/port-related facility at Cockenzie, it is likely that any potential investor will require time to let the industry settle down and to re-establish projections on anticipated business activity.

3.16 While there is reference throughout the report to a cruise/port facility the consultants were asked to initially provide options on the creation of a cruise facility, on and offshore. Additional port-related activity could only be determined once the initial design of a cruise facility had been determined.

3.17 East Lothian has submitted its response to the NPF4 consultation. East Lothian Council has submitted both an individual response and a joint one through the City Deal Joint Committee. Both of these submissions have been lodged in the Members' Library. East Lothian Council promote the inclusion of *"The Blindwells, Cockenzie and Climate Change Zone: An Area of Opportunity & Coordinated Action",* as a project suitable for national development status. The response reflects that; *the former Cockenzie Power Station site has unique assets and considerable potential for a wide range of uses focused on employment. There may be a focus on cruise-related activity and sustainable construction alongside energy with a pipeline of projects across the region and beyond. Conditions have changed in relation to the delivery of thermal generation and carbon capture and storage here, and we would welcome recognition of this and the wider opportunities within NPF4*.

3.18 Given the nature of a development of this scale, its importance to the Scottish Economy and the fact that future investors would wish to see Scottish Government support contact with Scottish Ministers will need to be considered to establish the Scottish Government view.

4 POLICY IMPLICATIONS

4.1 As the NPF will form part of the Development Plan there will be significant policy implications from its content. Continuing engagement with Scottish Government around the development of the NPF4 project proposal will inform direct policy impacts for the future of the Cockenzie site, including any cruise/port-related component.

5 INTEGRATED IMPACT ASSESSMENT

5.1 The subject of this report does not affect the wellbeing of the community or have a significant impact on equality, the environment or economy

6 RESOURCE IMPLICATIONS

6.1 Financial – None at this stage. However, should Council wish to take this forward there would be significant additional costs associated with both further feasibility/design work and especially so in relation to project/construction costs that would be on a scale that would require development on a collaborative approach with either national government and/or private investors. No such costs are provided for within our capital programme.

6.2 Personnel - None

6.3 Other - None

7 BACKGROUND PAPERS

7.1

AUTHOR’S NAME	Ray Montgomery
DESIGNATION	Project Manager
CONTACT INFO	7658
DATE	06/05/2020

Cockenzie Cruise Berth

Creation of a Cruise/Port Related Facility on the Site of the Former Cockenzie Power Station, Cockenzie

High Level Optioneering Study

East Lothian Council

Project number: 60618205
CCB-ACM-XX-XX-RP-MT-00001

23 December 2019

Quality information

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Second Issue	14/02/2020	Second Issue	David w Meikle	David W Meikle	Regional director Ports & Marine

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1. Introduction

1.1 Aims of the Study

The aim of this high-level optioneering study is to develop an initial understanding of the viability of converting the former Cockenzie Power Station jetty and power station site into a facility for cruise vessels. The outputs required to achieve this understanding are:

- An assessment of the technical feasibility of the scheme,
- Identification of engineering requirements and production of design options,
- An option appraisal and assessment of financial viability and economic benefit

These outputs will enable any subsequent phases of work to develop this concept further, potentially moving from outline design to concept design once a preferred option is identified.

AECOM have reviewed all information regarding the site made available, both onshore and offshore, and contacted Forth Ports and a selection of cruise vessel operators to understand the market. From this basis, outline designs have been developed to create preliminary cost estimates and a high-level market assessment.

1.2 The Opportunity

The site at Cockenzie is approximately 12 miles east of Edinburgh on the south shore of the Firth of Forth. It offers deep water access and developable flat land with good transport links. Existing facilities for handling cruise vessels in the Firth of Forth are subject to varying vessel restrictions as none were purpose built. The cruise sector generates income and employment for the region, however, the limitations of existing facilities may be a constraint to continued growth. Therefore, a new facility with greater capabilities will generate additional growth that may be a valuable investment for East Lothian Council and partners. The following text is taken from the original East Lothian council Design Brief

The site potentially offers the following advantages:

- A brownfield site with existing pier;
- No ship length or width constraints;
- Adequate water depth close to shore with opportunity to accommodate size of cruise vessels anticipated;
- No tidal problems and 24-hour access;
- Sufficiently protected berths close to open sea;
- Opportunity to develop a cruise terminal at low cost using simple piers;
- Plenty of adjacent land for related developments;
- Proximity to the A1-city bypass and a direct rail connection; and
- May introduce competition in the provision of cruise ship facilities in the Firth of Forth.

With these advantages a greater number of calls (including larger vessels) can be attracted to the Firth of Forth with the possibility of “turnaround” calls (which generate more income).

The requirements of this study were to consider the viability of a cruise facility that could handle vessels up to 350m in length with 3,000 – 4,000 passengers (up to 50 m wide and a draft of 9 m), and cater either for transit calls only, or transit and turnaround calls. Although unrestricted vessel access is always desirable, options with some tidal restrictions were also investigated to evaluate the impact on costs.

Figure 1-1: Location of Cockenzie former Power Station Site

Figure 1-2: Aerial View of Cockenzie former Power Station Site

2. Market Review

2.1 Cruise Calls in the Firth of Forth

2.1.1 Drivers of Demand

The cruise market has experienced strong growth for many years now. The UK and Ireland were the source of some 2 million cruise passengers in 2018, the fourth consecutive year of growth. Since 2013 cruise passenger numbers have grown by 3.1% per annum in the UK and Ireland, and in the two other key markets for the UK as a cruise destination – Continental Europe and North America – by 2.4% and 3.8% respectively.

Figure 2-1: Cruise Passengers Sourced in the UK and Ireland, 2013 - 2018

Source: Statistics published by CLIA

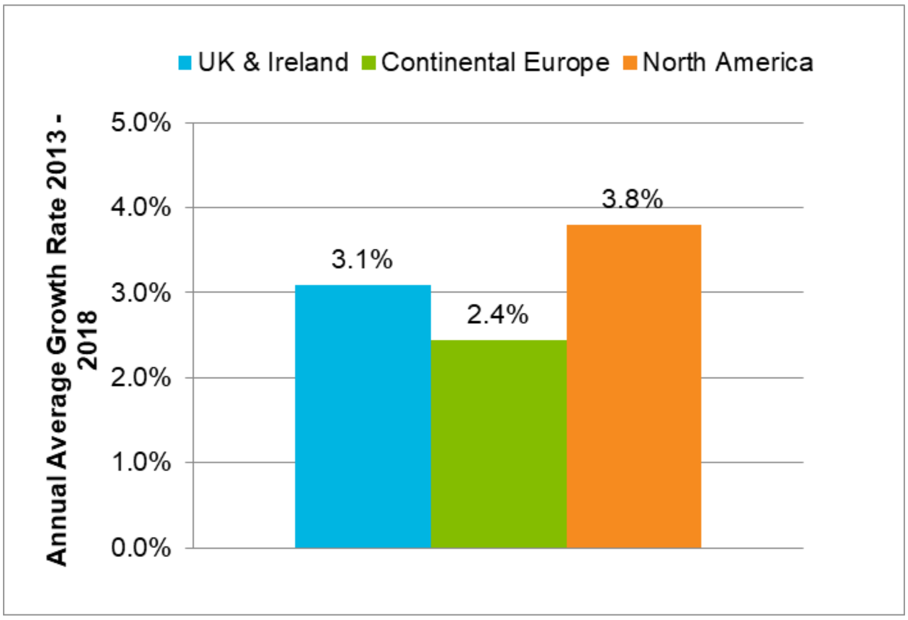


Figure 2-2: 5-year Growth Rates for Cruise Passengers Sourced from the UK's Key Markets

Source: Statistics published by CLIA

Demand for cruise ports is driven by two components of the market – turnaround calls and transit calls:-

- Turnaround calls are when one cruise ends, and another begins using the same vessel. All the passengers disembark, and their luggage is unloaded, and new passengers board and their luggage is loaded. Stores are replenished, waste removed, and activities such as bunkering and minor repainting may take place.

- Transit calls are when a cruise vessel visits a port during its cruise voyage. Passengers come ashore to visit attractions, and minor stores replenishment may take place.

For turnaround calls the source of passengers may be largely domestic but also includes some international passengers on fly-cruise packages (for example passengers from North America joining a cruise in the UK). For transit calls the source of passengers will be non-local but could include domestic as well as foreign passengers (e.g. round Britain cruises could source domestic passengers in the south of England).

To cater for both types of cruise a port needs to be in proximity to good onward transport links (e.g. airports and long-distance rail) so that passengers can join/leave turnaround calls, and good tourist attractions for transit passengers to visit. The Firth of Forth has both attributes.

The number of calls a port can attract is also influenced by the capability of its facilities such as:

- Maximum vessel draught
- Tidal restrictions
- Maximum vessel LOA
- Length of continuous quay (for access to separate doors along the length of the vessel for passengers, stores and luggage)

A further influence is the way the berth is operated. Cruise operators are very sensitive to negative passenger feedback, so berth operators need to provide:

- Efficient stress-free boarding for passengers
- Efficient handling of luggage to tight timescales
- Efficient handling of waste and stores
- Efficient handling of car parking

Other considerations include:

- Whether all an operator's vessels use the port or only some, all is preferable for use as a turnaround base
- Whether the view from the vessel is attractive

If a cruise vessel cannot access a berth due to the vessel's draught, length or other restrictions, passengers may come ashore in small 'tender' boats. This is only practical for transit calls, and the shoreside attractions will need to be sufficiently interesting to justify the inconvenience to passengers.

2.1.2 Types of Cruise

The cruise industry is highly fragmented and diverse. There are numerous operators targeting different market segments and niches, and attempting to differentiate themselves with varying vessel sizes, levels of on-board service and destinations. Four broad categories that characterise the industry are:

- Standard - typically older ships, a lower ticket price point, fewer on-board facilities, and destination led cruises;
- Premium - typically the larger ships with a dazzling array of facilities and better service than land-based holidays;
- Luxury – the highest levels of service, ultra large cabins, excellent cuisine, with more exclusive (private) tours;
- Expedition – typically smaller ships, where a greater emphasis is placed on the experience ashore, usually in remote locations.

As the terms imply, 'luxury' cruises offer a higher level of service at a higher cost to the passenger and often use smaller vessels with exclusivity being part of their appeal. Premium cruises focus on the facilities on board and are generally very large vessels, with capacity up to 5,000 or more passengers. The expedition market is focussed on experiences, is a fast-growing market and generally uses smaller vessels.

Although cruise vessel sizes have increased over the years and very large vessels make headlines, a large portion of the industry operates smaller ships. Smaller vessels allow the cruise operator access to more ports, and better match the expectations of their target demographic. Such operators continue to order smaller vessels and intend to remain operating vessels of that size.

2.1.3 Cruise Calls to the Firth of Forth

In 2019 there were 107 cruise calls in the Firth of Forth (often referred to as 'Edinburgh' in cruise itineraries). The number of calls as grown steadily over time rising from 70 in 2015 to 118 scheduled for 2020. Bookings for 2021 stand at 96 as of January 2020 (cruise itineraries are normally planned two years in advance). Over the period 2015 to 2020 the compound annual growth rate (CAGR) was 11.0%.

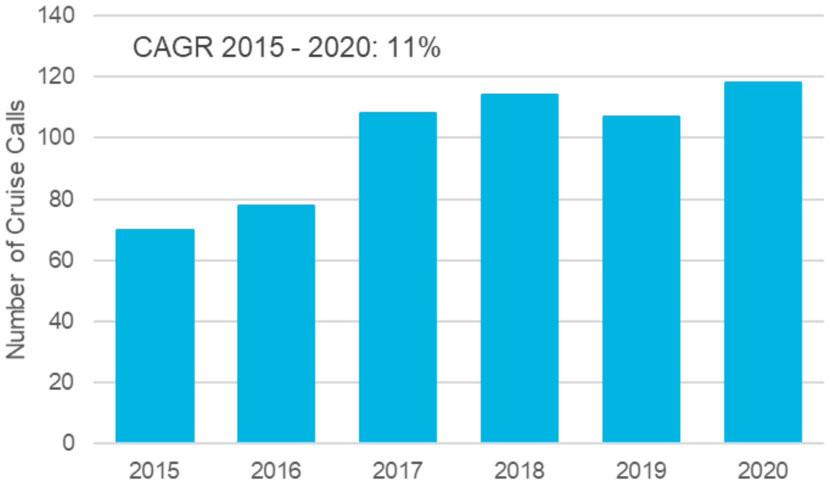


Figure 2-3: Growth in Cruise Calls in the Firth of Forth

2.1.4 Existing Customers (Cruise Operators)

A total of 30 cruise operators brought vessels to the Firth of Forth in 2019 on 110 cruises. The following brought five or more cruises:

Table 2-1: Most Frequently Calling Cruise Operators, 2019

Operator	Cruises Calling in the Firth of Forth	Number of Different Vessels Used
Princess	15	2
Viking Cruises	13	3
Fred Olsen	9	2
CMV	8	3
Norwegian Cruise Line	6	3
Grand Circle Cruise Line	5	1
Holland America	5	4

The following lines operate turnaround calls in the Firth of Forth, others make only transit calls:

- Fred Olsen
- Azmara
- Oceania Cruises
- Windstar Cruises

In a typical year approximately 25% of the calls are turnaround calls.

Edinburgh is a 'marquee' port, a term used in the cruise industry to describe a destination that is often the highlight of a cruise itinerary, and valuable in attracting passengers to the cruise.

2.1.5 Cruise Season

The cruise season is April to September in Scotland and cruises call in the Firth of Forth evenly throughout the week. There are approximately 182 days in the cruise season.

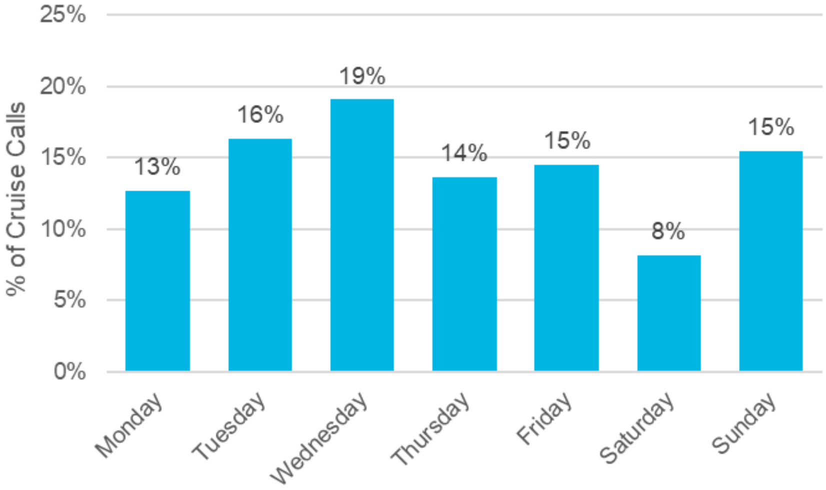


Figure 2-4: Distribution of Cruise Calls by Day of the Week, 2019

On 25 days, or 14% of the cruise season, there was more than one cruise call taking place.

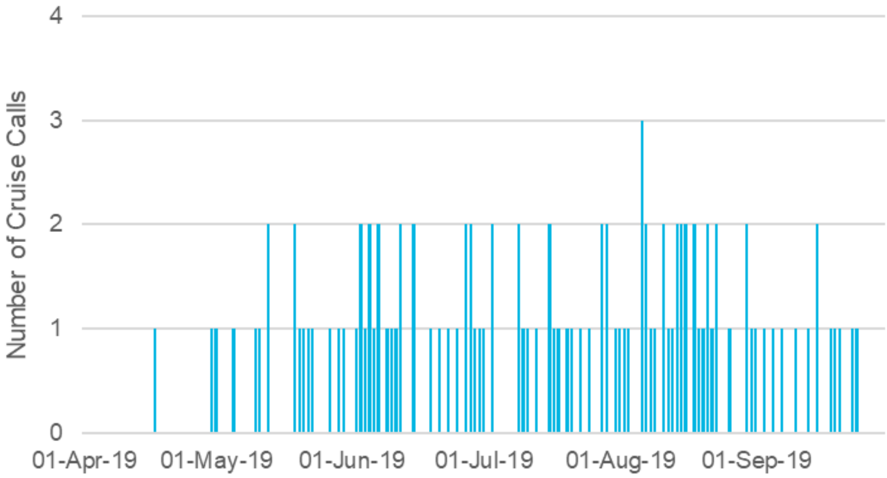


Figure 2-5: Distribution of Cruise Calls Throughout the Season

2.1.6 Operators and Fleets

The small and fragmented nature of cruise operators is reflected in their vessel purchasing. Most operators buy vessels on ad-hoc basis and consequently many fleets have no two identical vessels. The exceptions to this are very large operators who may purchase 3 to 4 vessels to identical designs.

52% of cruise operators active in the Firth of Forth have global fleets of five vessels or less. For details of fleets see Appendix A Table A-2.

In 2019 vessel sizes in the Firth of Forth ranged from 88 to 324 metres with the majority (82%) being between 150 – 300 m long.

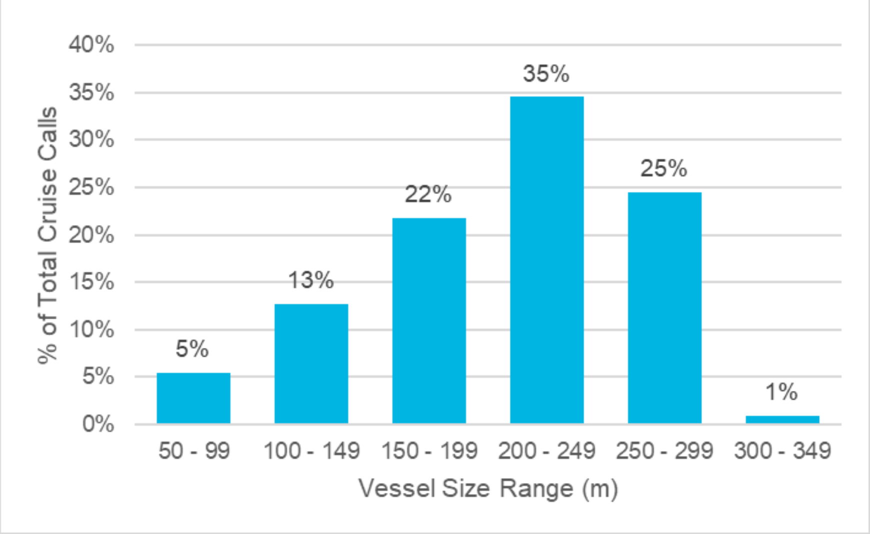


Figure 2-6: Distribution of Vessel Length for Cruise Vessels Calling in the Firth of Forth, 2019

Generally larger vessels have greater passenger capacity but there is noticeable variability in 150 – 250 m LOA range reflecting different provision of cabin space per passenger and the market segment the operator is targeting.

The berths available to cruise vessels in the Firth of Forth are subject to various restrictions regarding length, width and air draft. As the relationship between these dimensions and passenger capacity is variable there is no definitive vessel capacity at which a vessel is too large to access a berth, however the approximate cut-off point is indicated in Figure 2.6: Vessel Length and Passenger Capacity Relationship, Firth of Forth Cruise Calls, 2019.

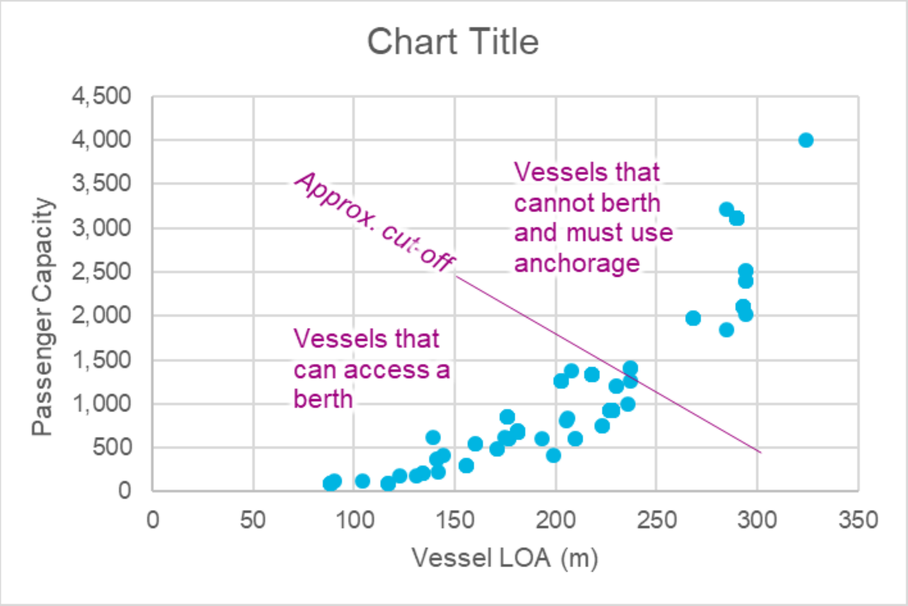


Figure 2-7: Vessel Length and Passenger Capacity Relationship, Firth of Forth Cruise Calls, 2019

2.2 Cruise Facilities in the Firth of Forth

Currently cruise vessels call in the Firth of Forth at the following locations (see: Figure 2-8: Distribution of Cruise Calls in the Firth of Forth, 2019). All are operated by Forth Ports:

- With alongside berthing:
  - Leith
  - Rosyth
- Landing of tenders while cruise vessel is at anchor:
  - Newhaven
  - South Queensferry

There is a purpose-built cruise terminal building at Leith, parking for cruise passengers and pick up/drop off points for cars, taxis and coaches. Turnaround calls may use Leith or Rosyth.

The 110 cruise calls scheduled for 2019 were split among these facilities as shown below:

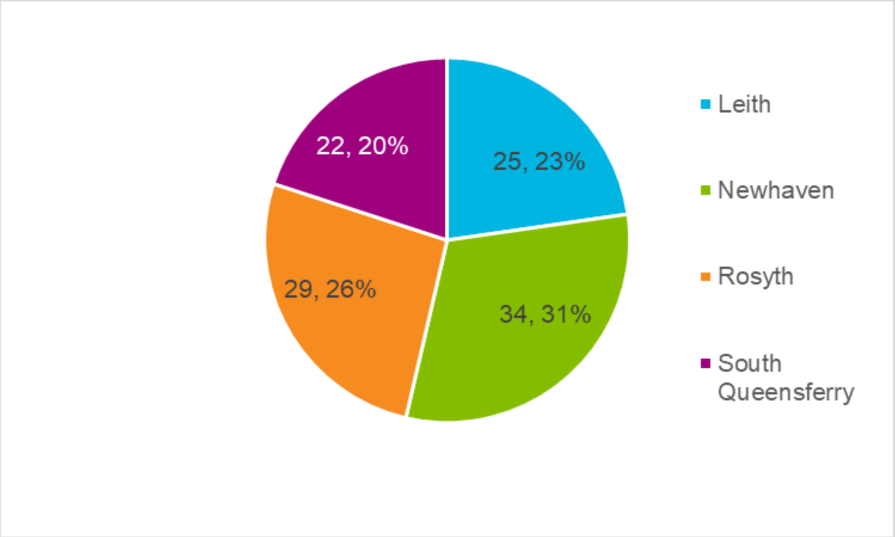


Figure 2-8: Distribution of Cruise Calls in the Firth of Forth, 2019

These locations have the following attributes:

Table 2-2: Existing Cruise Facilities in the Firth of Forth

Location	Max Vessel Draught (m)	Max Vessel Length (m)	Number of Berths	Notes
Leith	5.9 (allowing for 10% UKC)	210	1 x 375 m	Vessel beam limited by lock gate to 30 m, full length of lock can only be used when tide is at correct level
Newhaven	n/a	n/a	None, cruise vessel anchors at Lima Anchorage	Tender operation only, for vessels too large to enter Leith or Rosyth
South Queensferry	n/a	n/a	None, cruise vessel anchors at Hound Point	Tender operation only, for vessels too large to enter Leith or Rosyth

Location	Max Vessel Draught (m)	Max Vessel Length (m)	Number of Berths	Notes
Rosyth	7.1 (allowing for 10% UKC)		Six	Air draft limited by Forth road and rail bridges, limit is circa 50 m above chart datum.

Vessels too large to berth at Leith or Rosyth are anchored at Lima Anchorage or Hound Point. At both locations a pilot must always remain on board. At Hound Point, depending on the size of the vessel, it is required that a tug be either on standby or attached to the vessel throughout its stay to ensure the cruise vessel does not present a hazard to other shipping. These pilot and tug requirements have cost implications to the cruise operator.

Over the period 2015 – 2020 the number of calls at the Newhaven and South Queensferry (using anchorages) has risen noticeably, while there has been a slight decline in calls at Leith and Rosyth. As anchorages are generally not preferred by cruise operators this suggests the vessel restrictions at Leith and Rosyth are affecting a larger proportion of the cruise market.

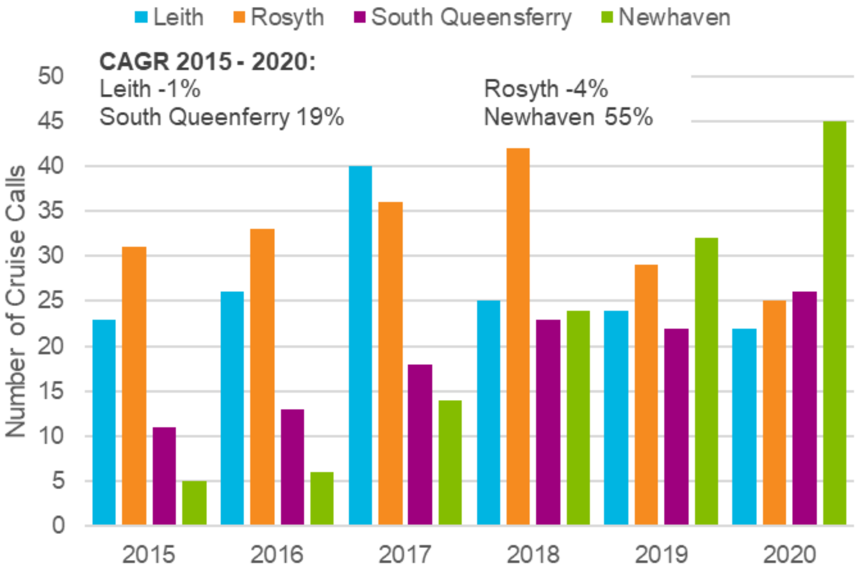


Figure 2-9: Changes in Distribution of Cruise Calls in the Firth of Forth, 2015 - 2020

2.3 Summary

The Firth of Forth has a healthy cruise business with around 100 calls per annum from a wide variety of operators. Some of those operators bring repeat business to the region, and that includes turnaround calls (25% of total) as well as transit calls. There are two locations where cruise vessels can berth (Leith and Rosyth) although size limitations apply, and two anchorages that can be used for larger vessels.

Figure 2-10: Location of Cruise Facilities in the Firth of Forth

3. Environmental Conditions

3.1 Tidal Range and Storm Surge

The following information is available within Reeds Nautical Almanac (2016)

Chart Datum at the standard port of Leith is 2.90m below Ordnance Datum (Newlyn)

Table 3-1: Tidal Levels Cockenzie (Source: Reeds Nautical Almanac (2016) P373, based on Leith Standard Port)

Cockenzie	m.C.D.	m.O.D.
Highest Astronomical Tide (HAT)	+ 6.30	+ 3.40
Mean High Water Springs (MHWS)	+ 5.40	+ 2.50
Mean High Water Neaps (MHWN)	+ 4.40	+ 1.50
Mean Low Water Neaps (MLWN)	+ 2.00	-0.90
Mean Low Water Springs (MLWS)	+0.80	-2.10

3.2 Wind

BS EN 1991-1-4 2005 A1 2010 provides a basic wind speed in metres per second for the British Isles. This basic wind speed can be used to determine the design wind speeds at Cockenzie. These shall be used to perform a hindcasting analysis to provide a first-pass wave loading analysis.

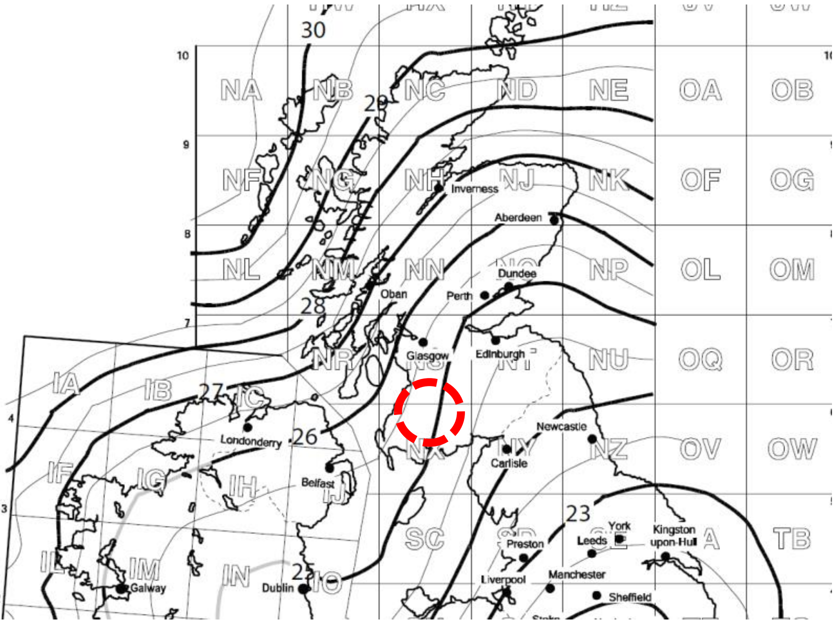


Figure 3-1: Value of fundamental basic wind velocity (vb, map) (m/s) for 50-year return period. Source: NA to BS EN 1991-1-4:2005+A1:2010

From the figure above, the basic wind velocity for a 50-year return period event is 24.5m/s at the site. Design wind velocities for other return period events (1, 5, 100, 200) can be calculated based on ratios provided in BS6349. The figure below shows the design wind speed for the following return periods after applying the mentioned wind speed ratio.

Return Period (yr)	Wind Speed (m/s)
1	16.5
5	20.4
50	24.6
100	25.8
200	27.1

Figure 3-2: Estimated Extreme Wind Conditions

The fundamental value of the basic wind velocity (50-year return period) shown in the table above is the characteristic 10 minutes mean wind velocity, irrespective of the wind direction and time of year, at 10m above ground.

The wind rose for Cockenzie is shown in the figure below, displaying the number of hours per year the wind is blowing from the indicated direction.

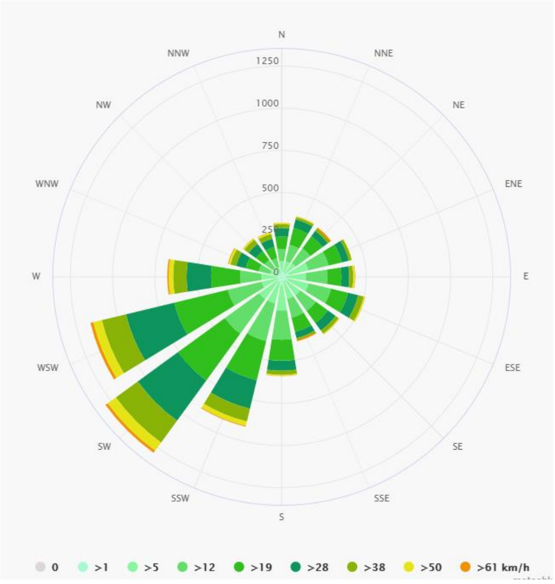
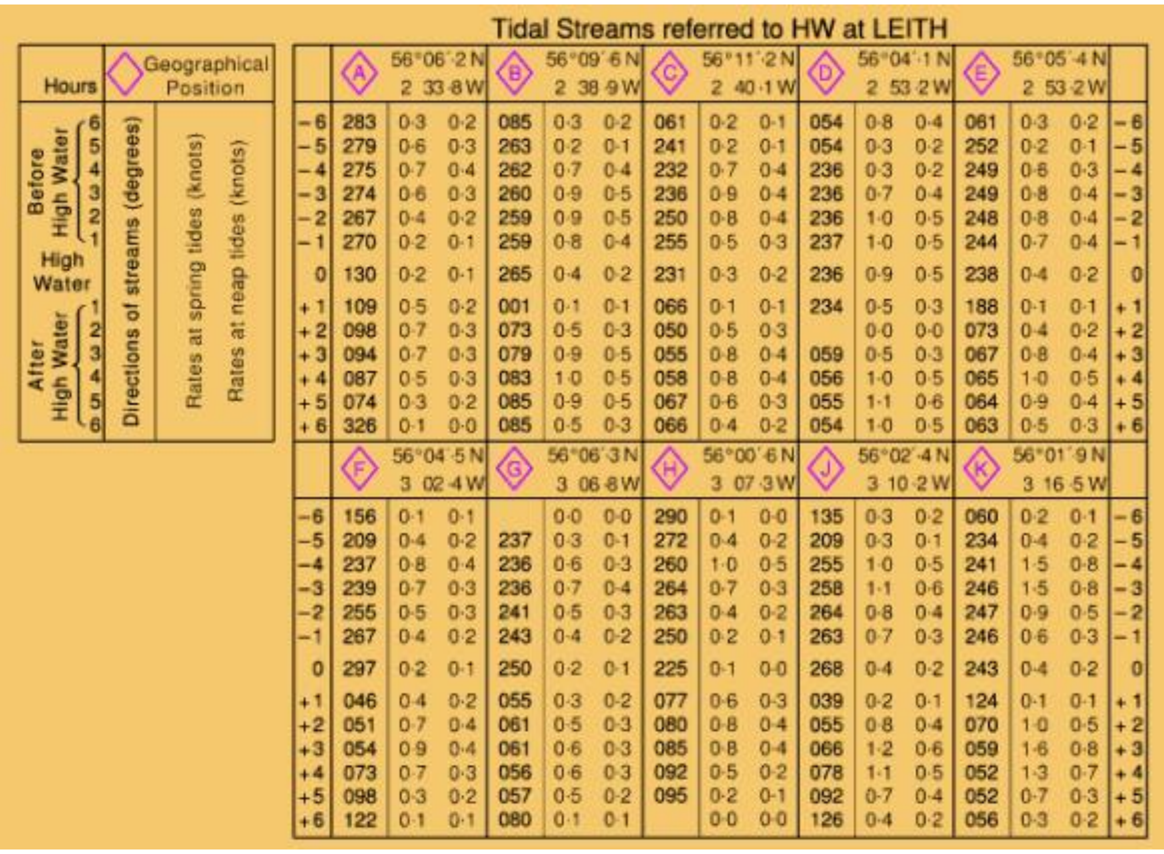


Figure 3-3: Cockenzie wind rose. Source: Meteoblue website: https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/cockenzie_united-kingdom_2652681

3.3 Currents



Tidal Streams referred to HW at LEITH

Hours
◇ Geographical Position
Before High Water 6 5 4 3 2 1
High Water
After High Water 1 2 3 4 5 6
Directions of streams (degrees)
Rates at spring tides (knots)
Rates at neap tides (knots)

	◇A 56°06′·2 N 2 33·8 W			◇B 56°09′·6 N 2 38·9 W			◇C 56°11′·2 N 2 40·1 W			◇D 56°04′·1 N 2 53·2 W			◇E 56°05′·4 N 2 53·2 W			
−6	283	0·3	0·2	085	0·3	0·2	061	0·2	0·1	054	0·8	0·4	061	0·3	0·2	−6
−5	279	0·6	0·3	263	0·2	0·1	241	0·2	0·1	054	0·3	0·2	252	0·2	0·1	−5
−4	275	0·7	0·4	262	0·7	0·4	232	0·7	0·4	236	0·3	0·2	249	0·6	0·3	−4
−3	274	0·6	0·3	260	0·9	0·5	236	0·9	0·4	236	0·7	0·4	249	0·8	0·4	−3
−2	267	0·4	0·2	259	0·9	0·5	250	0·8	0·4	236	1·0	0·5	248	0·8	0·4	−2
−1	270	0·2	0·1	259	0·8	0·4	255	0·5	0·3	237	1·0	0·5	244	0·7	0·4	−1
0	130	0·2	0·1	265	0·4	0·2	231	0·3	0·2	236	0·9	0·5	238	0·4	0·2	0
+1	109	0·5	0·2	001	0·1	0·1	066	0·1	0·1	234	0·5	0·3	188	0·1	0·1	+1
+2	098	0·7	0·3	073	0·5	0·3	050	0·5	0·3		0·0	0·0	073	0·4	0·2	+2
+3	094	0·7	0·3	079	0·9	0·5	055	0·8	0·4	059	0·5	0·3	067	0·8	0·4	+3
+4	087	0·5	0·3	083	1·0	0·5	058	0·8	0·4	056	1·0	0·5	065	1·0	0·5	+4
+5	074	0·3	0·2	085	0·9	0·5	067	0·6	0·3	055	1·1	0·6	064	0·9	0·4	+5
+6	326	0·1	0·0	085	0·5	0·3	066	0·4	0·2	054	1·0	0·5	063	0·5	0·3	+6

	◇F 56°04′·5 N 3 02·4 W			◇G 56°06′·3 N 3 06·8 W			◇H 56°00′·6 N 3 07·3 W			◇J 56°02′·4 N 3 10·2 W			◇K 56°01′·9 N 3 16·5 W			
−6	156	0·1	0·1		0·0	0·0	290	0·1	0·0	135	0·3	0·2	060	0·2	0·1	−6
−5	209	0·4	0·2	237	0·3	0·1	272	0·4	0·2	209	0·3	0·1	234	0·4	0·2	−5
−4	237	0·8	0·4	236	0·6	0·3	260	1·0	0·5	255	1·0	0·5	241	1·5	0·8	−4
−3	239	0·7	0·3	236	0·7	0·4	264	0·7	0·3	258	1·1	0·6	246	1·5	0·8	−3
−2	255	0·5	0·3	241	0·5	0·3	263	0·4	0·2	264	0·8	0·4	247	0·9	0·5	−2
−1	267	0·4	0·2	243	0·4	0·2	250	0·2	0·1	263	0·7	0·3	246	0·6	0·3	−1
0	297	0·2	0·1	250	0·2	0·1	225	0·1	0·0	268	0·4	0·2	243	0·4	0·2	0
+1	046	0·4	0·2	055	0·3	0·2	077	0·6	0·3	039	0·2	0·1	124	0·1	0·1	+1
+2	051	0·7	0·4	061	0·5	0·3	080	0·8	0·4	055	0·8	0·4	070	1·0	0·5	+2
+3	054	0·9	0·4	061	0·6	0·3	085	0·8	0·4	066	1·2	0·6	059	1·6	0·8	+3
+4	073	0·7	0·3	056	0·6	0·3	092	0·5	0·2	078	1·1	0·5	052	1·3	0·7	+4
+5	098	0·3	0·2	057	0·5	0·2	095	0·2	0·1	092	0·7	0·4	052	0·7	0·3	+5
+6	122	0·1	0·1	080	0·1	0·1		0·0	0·0	126	0·4	0·2	056	0·3	0·2	+6

Figure 3-4: Tidal Stream Reference Table (Source: Admiralty Chart BA0734)

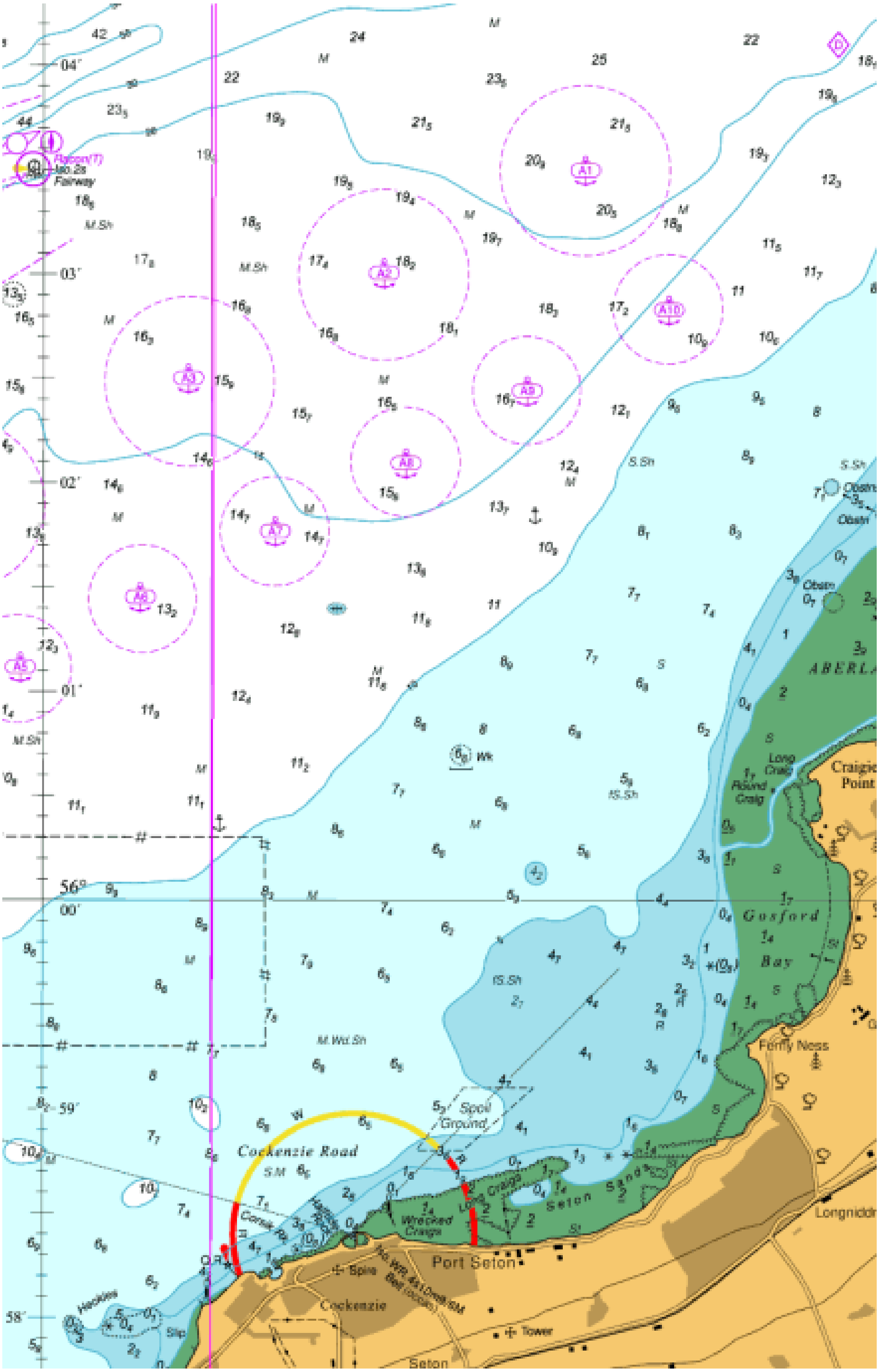


Figure 3-5: Tidal Stream Relevant to Cockenzie (Source Admiralty Chart BA0734)

3.4 Temperature

The average and extreme high/low temperature data per month covering the years 1981-2010 are displayed in the figure below. These were recorded at the closest weather station at Edinburgh Botanical Gardens (15km from Cockenzie, Location: 55.9661, -3.2116, Altitude: 23m above mean sea level).

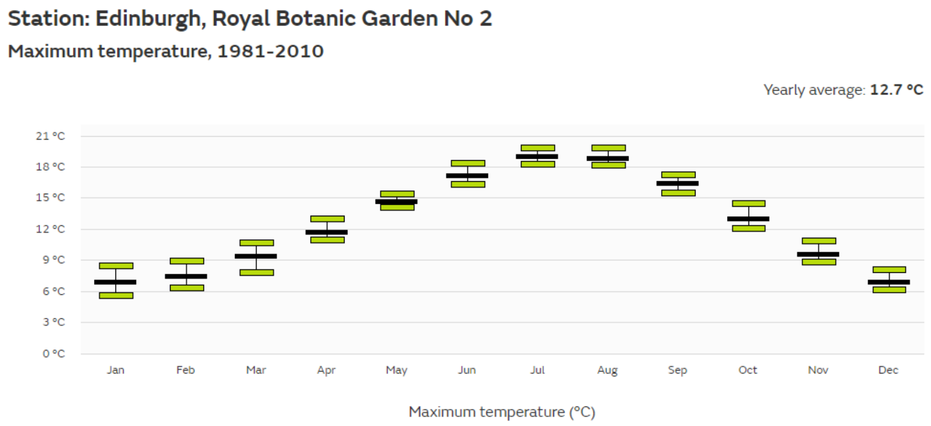


Figure 3-6: Maximum monthly mean temperature (1981-2010) Source: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcvwqum6h

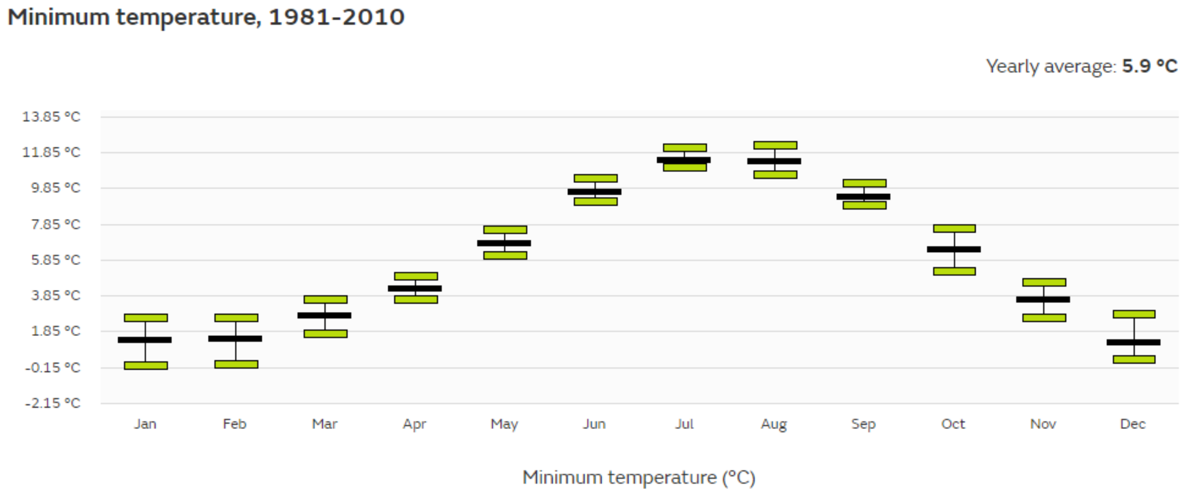


Figure 3-7: Minimum mean monthly temperatures (1981-2010) Source: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcvwqum6h

3.5 Hydrodynamic Desk Study

There is no known detailed wave data for the site at Cockenzie. Therefore, a hindcasting analysis to determine the design wave for new marine structures at the site will be required in accordance with BS EN 1991-1-4:2005 +A1 2010. This analysis utilises a design wind speed and direction which corresponds to the largest unobstructed fetch for the site. At Cockenzie there is a theoretical fetch of 685km to the coast of Norway at a bearing of roughly 39°. However, given the prevailing wind direction of WSW as discussed above, and nearby headlands at North Berwick and Balcomie at the mouth of the Firth of Forth, maximum height waves from this direction are extremely unlikely. Furthermore, due to the shoaling and diffraction effects of shallow waters at these locations, a design wave based on this fetch will be even more unlikely to occur.

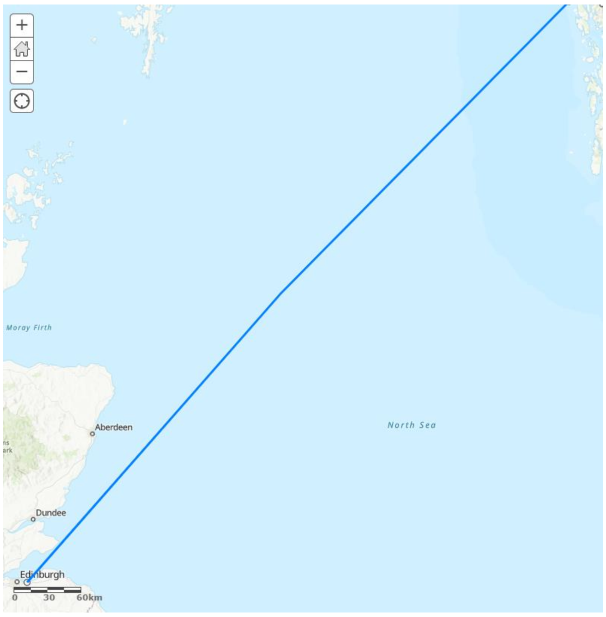


Figure 3-8: Cockenzie theoretical longest fetch of 685km at 39 degrees

3.5.1 Statistics

The figure below shows the combination of swells directed at North Berwick over a normal year and is based upon 2867 NWW3 model predictions since 2006 (values every 3 hours). In this case the best grid node is 46 km away (29 miles). The rose diagram shows the distribution of swell sizes and swell direction, while the graph at the bottom shows the same thing but lacks direction information. Five colours represent increasing wave sizes. Very small swells of less than 0.5m (1.5 feet) high are shown in blue. These occurred only 61% of the time. Green and yellow show increasing swell sizes and red shows the biggest swells, greater than >3m. In either graph, the area of any colour is proportional to how commonly that size swell was forecast. The diagram implies that the prevailing swell direction, shown by the largest spokes, was NNE, whereas the prevailing wind blows from the WSW. Because the wave model grid is out to sea, sometimes a strong offshore wind blows largest waves away from North Berwick and offshore, these are not displayed in the figure below.

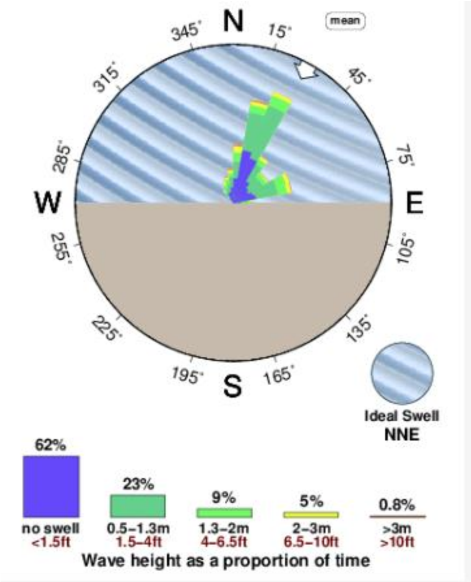
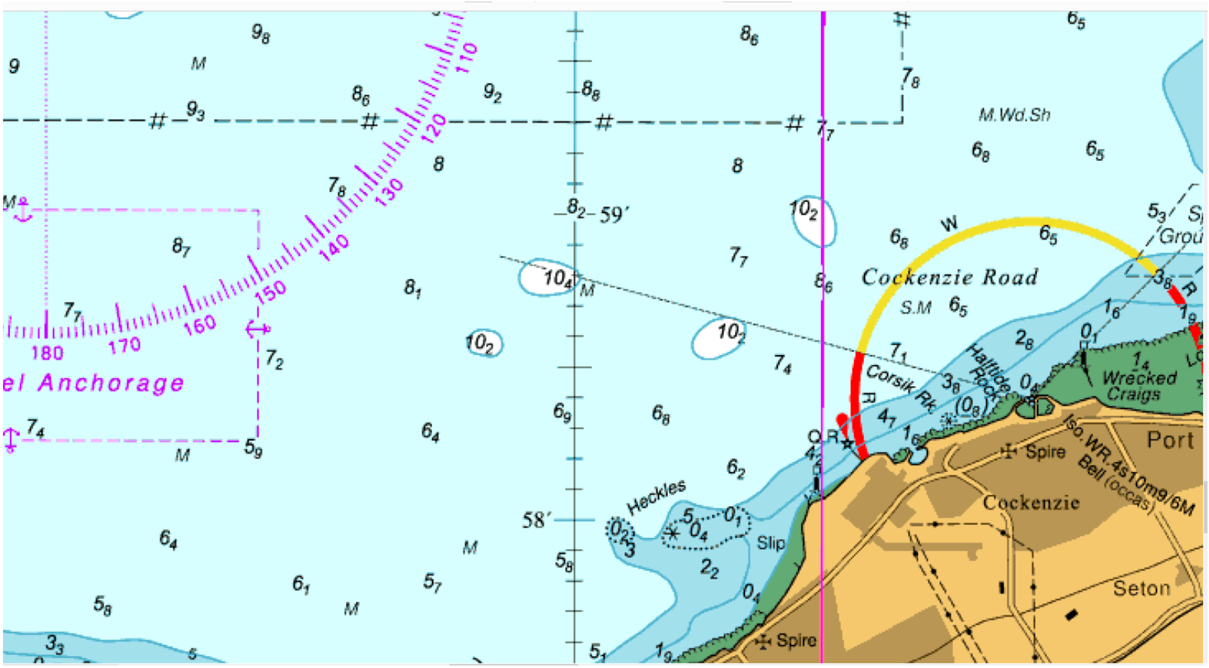


Figure 3-9: Recorded wave statistics at North Berwick (Source: https://www.surf-forecast.com/breaks/North-Berwick/surf-stats)

4. Bathymetry

4.1 Admiralty Chart



4.2 Bathymetric survey

Detailed bathymetry at the site is not currently available. A search of relevant records shows very limited historic bathymetric surveys carried out in the vicinity of the berth and turning circle at the end of the existing jetty. Further detail, in lower resolution is available from admiralty charts as shown in the figures below. For the purposes of this report indicative seabed levels will be assumed based on these sources.

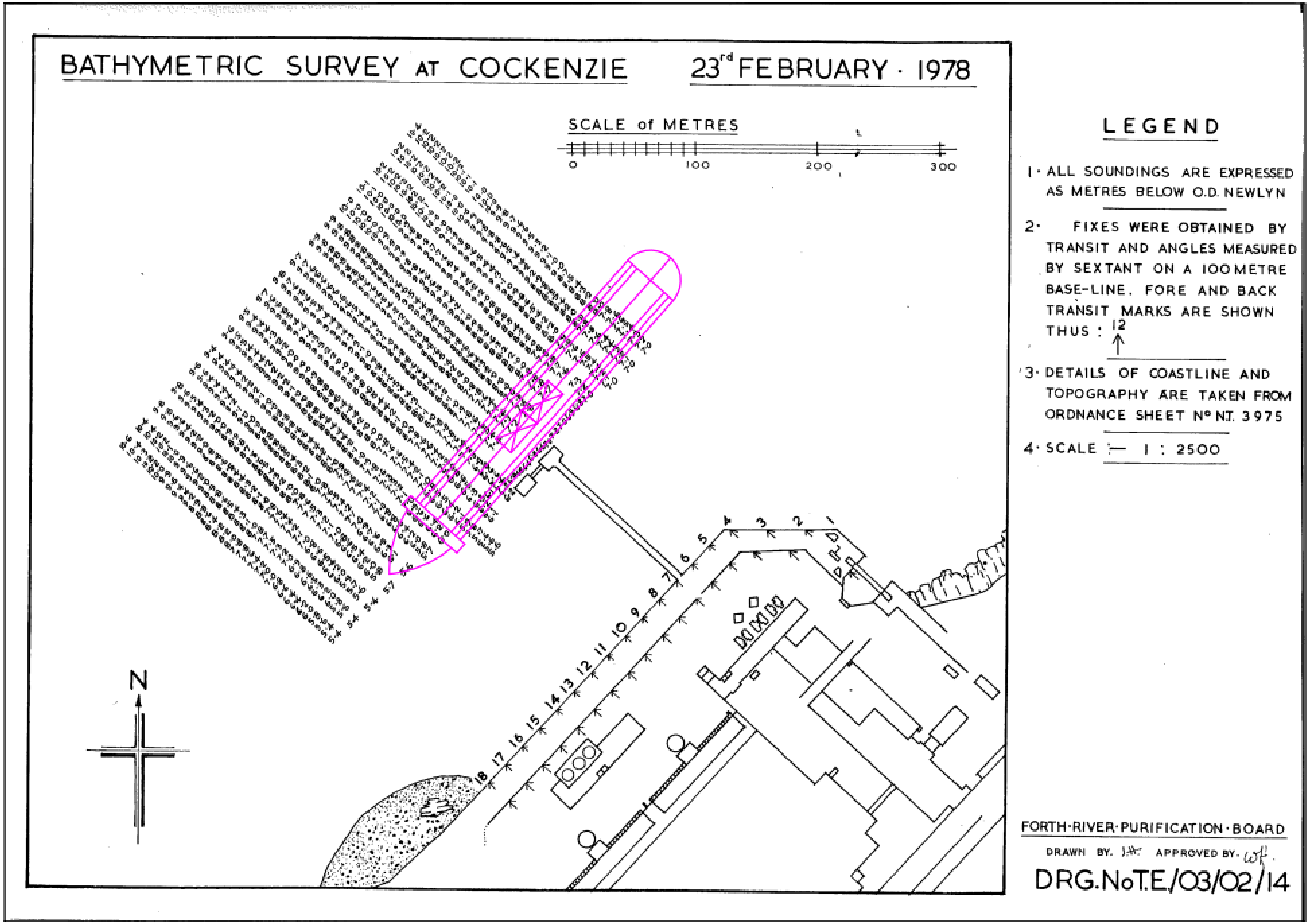


Figure 4-1: Bathymetric survey at Cockenzie 23rd February 1978 (reduced to OD Newlyn, 2.9m above CD)

Ordnance datum (Newlyn) is 2.9m above Chart Datum at Cockenzie. Chart Datum defines the shallowest depth of water above seabed level at lowest tide conditions. Taking into account the relationship between Chart datum and Ordnance Datum (Newlyn) this means that in 1978 there would have been minimum available water depth at the berth of approximately 3m.

5. Geotechnical

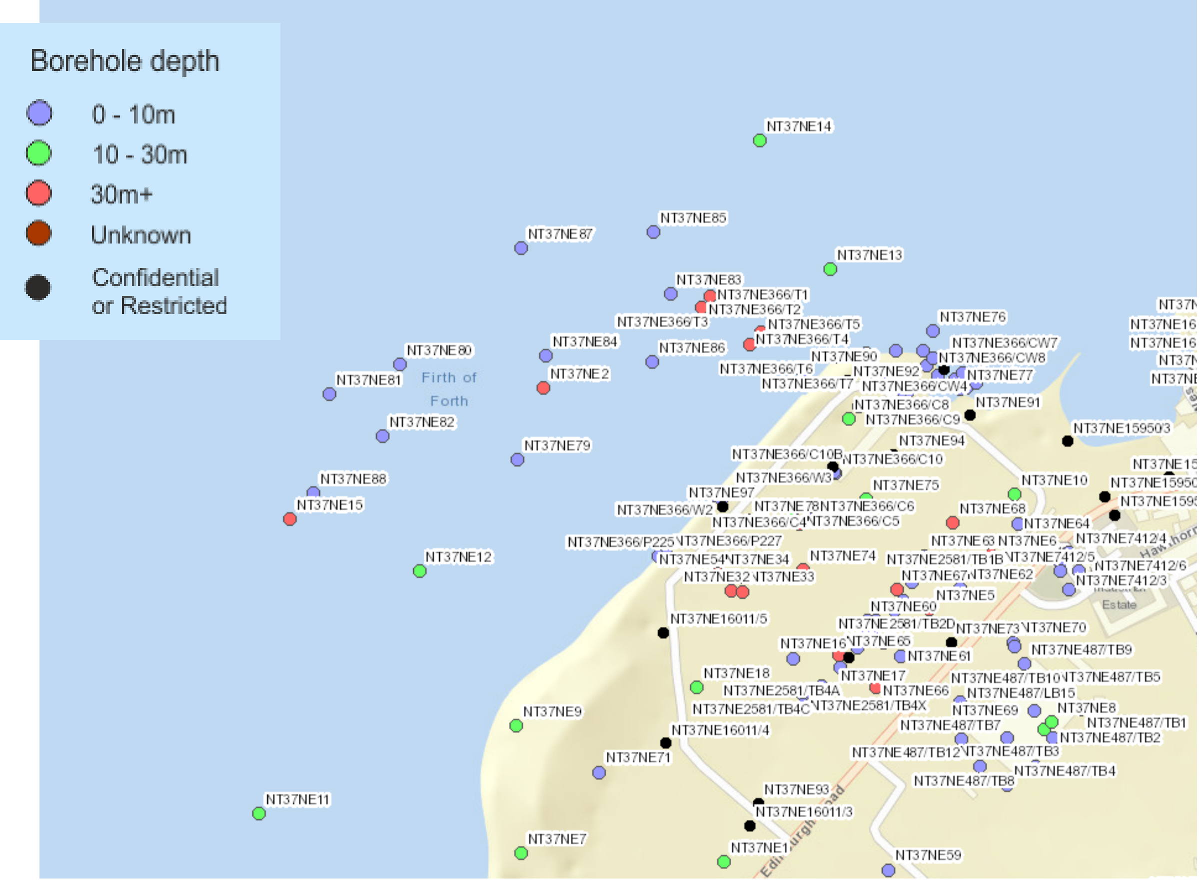


Figure 5-1: Available Borehole Data (Source: British Geological Survey Online Mapping tool (http://mapapps.bgs.ac.uk/geologyofbritain/home.html))

Figure 5-2: Available Borehole Detail in vicinity of existing Jetty (Source: British Geological Survey Online Mapping tool (http://mapapps.bgs.ac.uk/geologyofbritain/home.html))

Typical archive boreholes are attached in Appendix F

6. Design of a Modern Cruise Terminal

6.1 Overview

6.1.1 Cruise Ship Context

A modern cruise terminal layout can resemble a typical international airport terminal with the 'airside' replaced by the quayside. The major differences between the two are how the passengers are processed and the time this is taken for this to be carried out.

Airports tend to encourage dwelling in the terminal retail and concession areas to generate income from passengers. Cruise terminals are laid out for the efficient flow of passengers through a lounge (with no retail) to board the ship where the retail and commercial offers can be found.

Furthermore, a modern airliner, such as the Airbus A380, can carry over 680 passengers, however, the current average modern built cruise liner, is designed to carry around 3,500 passengers, therefore the passenger process time at the cruise terminal is much greater. For reference, the largest cruise liners, part of the Royal Caribbean fleet can carry up to 5,700 passengers.

6.2 Turnaround Cruise Terminal

6.2.1 Embarkation

In order to cope with a design ship of 3,500 passengers, the cruise operator will issue embarking passengers an arrival time they should plan to get to the terminal, many terminal operators/cruise lines will turn away anyone arriving ahead of their allotted time.

The process of transferring, labelling baggage from the embarking passengers, processing it (security screening) and transferring it on board the ship and into the stateroom of the passenger must be an efficient operation. For the passengers who have just left their baggage (around 2 to 3 pieces per passenger) for processing the next step is to enter the ticketing area, there would be a waiting area at the ticket desks therefore seating will be required.

Once they have been checked in at the ticket desk and provided with Boarding Cards they will pass through personal and hand luggage security (similar to an airport), immigration (if the vessel is bound for another country) and finally onto the ship.

This process is known as 'kerbside to shipside' and the industry aims for a 20 to 25-minute process, at peak periods with late arrival of embarking passengers at the terminal building this process can be as much as 45 minutes.

Once on board, most passengers will likely go straight to their staterooms where the passengers expect to find their baggage.

In this regard, the difference between the experience found in an airport where passengers are expected to arrive a minimum two hours before a long-haul flight and find themselves waiting/transferring in the terminal and likely waiting for longer periods of time.

6.2.2 Disembarkation

Disembarking passengers from the cruise liner will be informed the night before arrival at the terminal of the time they are to leave the ship (check-out). Some cruise companies offer various time slots, these must be pre-booked a few days before arrival at the terminal. The night before disembarkation is for luggage to be left outside your room for collections; the baggage is collected and held on the lower decks of the vessel overnight. When the vessel has berthed at the for passengers to collect.

The disembarking passenger will leave the vessel; pass through immigration and onto the baggage collection hall, finally passing through Customs and onto their transportation from the terminal.

From the process described above it is clear to see that processing and organising 3,500 passengers and their baggage, around 7,000 (2-week cruise) to 10,500 (3-week cruise) separate items in a four-hour period for disembarking and the same for embarking is a considerable task. The most efficient system of operation to carry out the tasks relies on key factors as described.

6.2.3 Servicing Vessels

Alongside the processing of passengers is the re-stocking of the cruise vessel and again a vessel carrying 3,500 passengers and up to 1,500 crew requires a considerable volume of stock for example; fuel, potable water, food drink, and replacement bedding and towels etc.

6.2.4 Security & Regulations

Overarching each of these processes are the Regulations and Standards set out by each Country that the cruise terminal is located (the Maritime Security and Resilience Division (MSRD) and Her Majesties Customs and Excise) plus the International Ship and Port Facility Security Code which became Statutory in 2004.

6.3 Features of a Successful Turnaround Cruise Terminal

The typical features of a successful cruise terminal can be itemised as follows:

6.3.1 Terminal Building Operational Area

An operational apron area in front of the terminal building is now seen as an industry standard requirement.

The operational area supports all the disembarkation and embarkation activities related to pick-up and drop-off and allows these activities to be provided efficiently near the terminal building. In turn, this enhances the passenger experience and maintains service levels.

6.3.2 Disembarking Passengers

- Connection from vessel into terminal building at high level to avoid traffic movements at quay level. Terminal between 15 to 30m from quay edge.
- Sufficient immigration staff to cope with passenger flows. Approximately 14 passengers per minute for a 3,500-passenger vessel.
- Easy access to the ground floor for baggage reclaim via ramps, escalators and lifts. Stairs for emergency purposes only. Provide wheelchair passengers with assistance.
- Large baggage-reclaim area with good signage for directions to walk.
- Large Customs & Excise area leading directly to building exit at same level.
- Easy access to parked coaches, taxi’s and pick-up point without steps or ramps.

Note: When passengers leave the ship as described above, they are within the RA (see Section 6.3.4) until they pass through Customs & Excise.

6.3.3 Embarking Passengers

- Taxis, coach and car drop off points close to terminal entrance.
- Baggage drop-off points within easy access or provide porters with hand carts.
- Clear signage for direction to walk. Provide assistance for wheelchair passengers.
- Once inside the terminal building provide ‘meeters’ and ‘greeters’. Check passenger check in time paperwork.
- Escalators and lifts to first floor check-in desks.
- Provide large floor area with seats in case of vessel access delays.
- Provide sufficient check in staff to cope with passenger numbers.
- From check in counter to security screening for passengers and hand baggage within proximity, provide sufficient staff and security screening points.
- Provide sufficient immigration staff to cope with passenger flows.
- Access to passenger walkway and onto ship reception level, generally decks 5 or 6.

Note: Passengers enter the RA (see Section 6.3.4) when they are cleared through security screening.

6.3.4 The Restricted Area (RA)

The cruise terminal building has two distinct sides. This is sometimes referred to as the 'sterile side' and 'non-sterile side'. The 'sterile' side is normally entered after a passenger passes through the security screening area. Within a cruise terminal the technical name for the 'sterile' side is the Restricted Area (RA).

Parts of the external infrastructure at the cruise terminal building has to be included in the RA. This is generally the entire quay adjacent to the moored vessel plus a short section beyond the final bow and stern mooring lines.

The RA boundary can sometimes be temporary. For example, when the MV Seven Seas Voyager moored alongside Queens Wharf in Auckland, the RA is created by using temporary fencing and is dismantled after the vessel sails. The quay is then returned to a public space.

6.3.5 Baggage Trucks & Restocking of the Vessel

Baggage trucks or forklifts are used to transport over 7,500 to 10,000 separate items of baggage held inside specially designed crates to and from the terminal building and vessel.

This operation must take place within the RA under the requirements set out in the Regulations. This is because the disembarking passengers need to pass through the Customs and Excise area with their baggage for it to be 'cleared' similarly embarking passengers will have their baggage screened through security x-ray devices before it is permitted on board. Once baggage is screened it must remain within the RA.

To clarify this point baggage cannot be screened and then put into a vehicle and taken outside the RA and then be taken to the vessel for loading. This point is also true for passengers who are already screened; they must always remain within the RA either on their way to or from the vessel.

6.4 Passenger Walkways or Sea Port Boarding Bridges (SPBB)

6.4.1 Boarding Bridges (SPBB)

Sea port boarding bridges (SPBB) are a fundamental part of a successful cruise terminal providing passengers with safe and easy access from the terminal building directly onto the vessel passenger reception deck. The SPBB should be able to accommodate the full range of tidal movement and serve a variety of passenger door positions.

The gradient of the SPBB floor slopes are compliant with the Regulations to suit the full range of passenger mobilities. SPBBs are purpose designed to suit each site location and therefore, although carrying out the same function, can look entirely different.

As shown in Figure 6.1,it is normal practice that the SPBB will have the following key features:

- All tunnel elements to be double glazed with ventilation;
- Passenger entry pod with vertical movement to accommodate all vessels at all states of the tide;
- Ability to travers along the pier to accommodate location of vessel boarding gates for all vessels;
- Uninterrupted power supply;
- Alarm system for automatic pod retraction if power failure.

Figure 6.1: Illustration of SPBB

It is proposed that the airbridges comprise telescopic gangways, which can be positioned in any location within the SPBB operating window. These gangways will be capable of the following operations:

- Extending and retracting to move the vessel end of the gangway towards and away from the vessel’s doorway
- Raising and lowering the whole gangway to position it against the vessel’s passenger door.
- Free rotation of the gangway about a horizontal axis to raise and lower the vessel end of the gangway to align it to the vessel, doorway
- Free rotation of the gangway about a vertical axis to cater for ranging of the vessel along the pier
- Moving the gangway along the pier to align it to the vessel’s passenger doorway

The working level of the airbridges and elevated walkway shall be at least 5-7m above the pier level to allow for operational vehicles to pass underneath. The supports of the walkway will have vehicle barriers to mitigate accidental vehicular impact.

7. Key Engineering Requirements

AECOM have carried out a Value Optioneering/Engineering exercise when a short list of development options is decided. The mooring layouts of Cruise vessels are critical, especially in exposed locations since the vessels super structure is very tall and therefore the windage in considerable. For the most part in the schemes considered, line mooring has been assumed due to their versatility and cost. Nevertheless, other proprietary mooring arrangements are available, and those options have been discussed in this document without considering costs and benefits at this draft document stage

- Consideration of 350m long cruise vessel; the Oasis class being taken as typical;
- Degree of exposure and orientation of the berth;
- Navigation Clearances to ships;
- Determination of berth geometry;
- In the first instance only the Oasis class has been considered;
- Water depth, tidal range and wave heights, and prevailing currents;
- Calculations of loadings;
- Environmental loads, normal and abnormal vehicle loads, other imposed live loadings and pedestrian loads.
- Geotechnical considerations;
- Investigation of the type of structure;
- Selection of materials;
- Availability of materials;
- Availability of construction equipment and methods;
- Potential provision of auto mooring equipment;
- Location and capacity of existing onshore bollards and mooring equipment;
- Services, mooring devices, safety equipment and fendering;
- Accelerated Low Water Corrosion for proposed steel pile solutions;
- Construction programme;
- Initial capital expenditure (Capex);
- Maintenance and Operation Expenditure (Opex);
- Deterioration through Scour;
- Construction activities affecting current vessel movements;
- Effects of future dredging operations.

7.1 Methodology/Approach

7.1.1 Physical and Structural Survey of the Existing Pier facility

AECOM liaised with East Lothian Council to obtain and examine all archive drawing available of the existing pier and coastal frontage. To augment this and confirm data, a visual walk round survey and visual survey was carried out. The objective of the visual inspection was to determine the condition of the existing pier and the coastal frontage looking for signs of distress, impact damage, to examine the support piles for the pier to check for signs of corrosion and signs of Accelerated Low Water Corrosion

The design of the jetty was carried out in 1963 and the jetty can be classed as being at the end of its serviceable deign life. Summary of findings from visual inspection:

- The steel support piles and structural steel bracing all show signs of corrosion but there are no signs of buckling of the piles or failure of any of the structural steel bracing;
- Top surface concrete deck elements show minor signs of structural cracking but no signs of distress in the structure;
- Underside of concrete deck elements shows areas of exposed reinforcement, leaching and staining and minor signs of structural cracking but nothing unexpected for a structure of this age in a severe marine environment conditions.

7.1.2 Concept Alternatives

On completion of discussions with East Lothian Council, the visual inspection of the existing pier and review of all the existing drawings and historical borehole records, a series of outline concept proposals with broad costings and an advantages and disadvantages table were prepared by AECOM. At this stage, the needs of the pier development would be closely integrated with the needs of the overall site masterplan. Initially investigation has shown that the following two options seem the most favourable, however this will be further investigated during the optioneering phase

7.1.3 Potential Landside Facilities at Cockenzie Cruise Terminal

The estimated size and layout planning of facilities required at Cockenzie to support each cruise option has been reviewed by AECOM. This is likely to include the following elements:

- Passenger access bridge and alternative passenger gangway arrangement at quay level;
- Passenger waiting area;
- Passenger check in/baggage drop area;
- Security screening area;
- Baggage loading/unloading area at quay;
- Baggage trolleys;
- Area for the operation of a crane for loading/ unloading baggage when required (if ship has no crane);
- Marshalling area for coaches;
- Waiting area for trucks;
- Area at quayside for loading stores and unloading waste;
- Pedestrian routes across site;
- Office space for customs and immigration staff.

7.1.4 Options Appraisal

The Options Appraisal will examine a range of potential development options for the existing pier and coastal frontage. These will present a range of relevant advantages and disadvantages for each option.

The assessment for each of the development options for the existing pier and coastal frontage will be considered using the following considerations and criteria:

- General Location
    - Site area (space);

  - Site layout (arrangement);
  - Land access (connectivity);
  - Water access (depth, length, distance of land to berth, etc);
  - Land/Local facilities;
- Pier
  - Cruise vessel opportunities (attractiveness)
  - Roll-on/Roll Off opportunity (potential for Linkspan)
  - Bulk material opportunity (timber, cement, grain, etc.)
  - Containerisation
  - Potential future expansion;
- Coastal Frontage
  - Remedial works to coastal defences (condition of existing)
  - Upgrade works to coastal defence including wave return wall (repair works)
  - Global Sea level rise
  - Effects of Storm surge on water level (Flooding)

- Wave Conditions
  - Exposure of site;
  - Navigation;
  - Siltation;
- Construction
  - Main construction requirements;
  - Cost (Capital);
  - Method of construction;
  - Availability of Contractors Plant and Equipment;

- Environmental considerations;
  - Opportunities and constraints

8. Design Vessel and Energy Requirements

8.1 Design Vessel for Mooring Dolphin

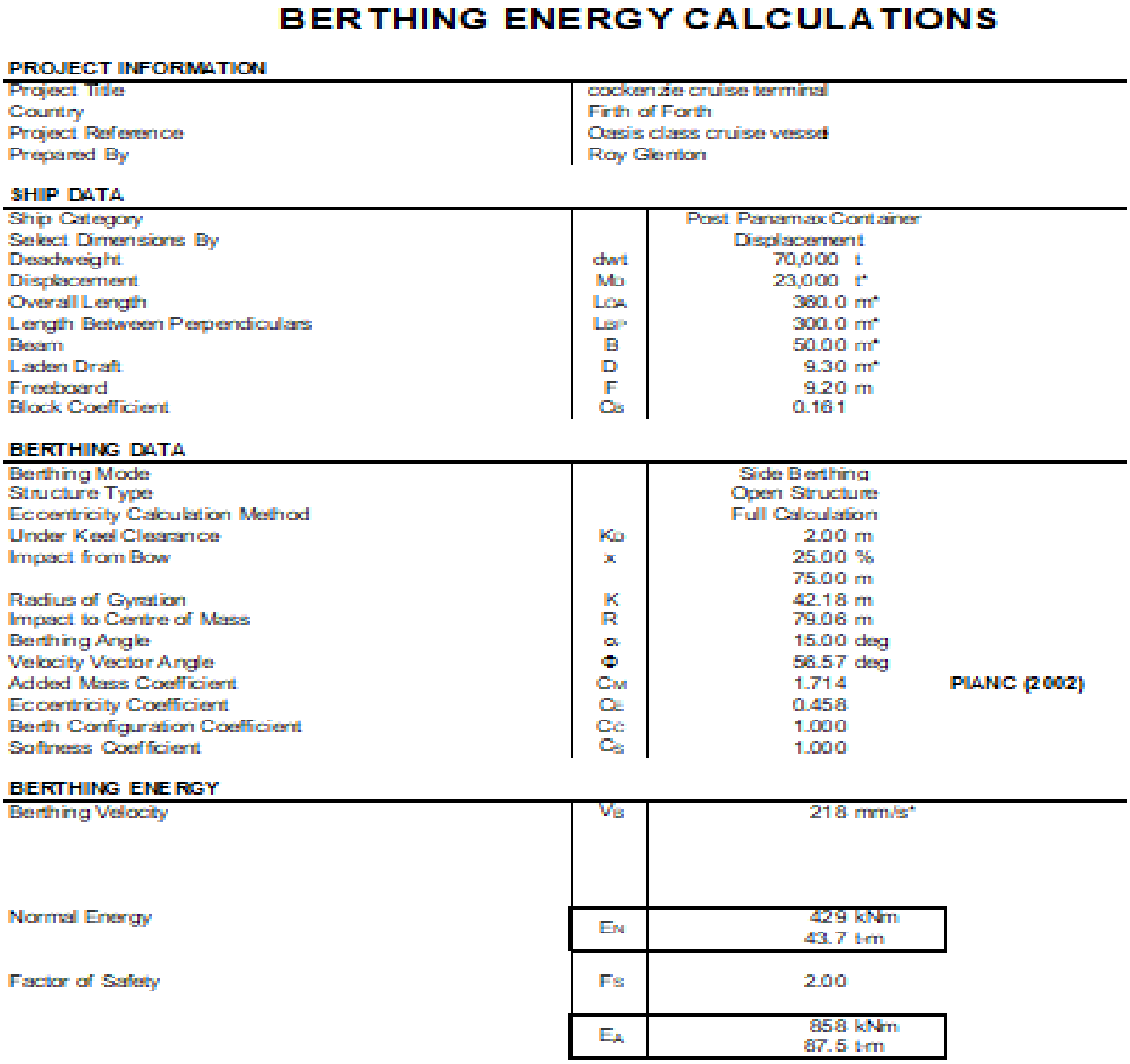
Optioneering will consider the maximum vessel with the following particulars:

No. of Passengers	4,000
Length of vessel	360 m
Draft of vessel	9.3 m
Width of vessel	50 m
Displacement	100,000 t

8.2 Berth

- Use quarter point berthing, assumed tug assisted berthing will take place;
- Use approach 15 degrees, assumed tug assisted berthing in accordance with BS6349

Typical berthing energy calculations for a 360m long cruise ship are attached over the page for information purposes only.



BERTHING ENERGY CALCULATIONS

PROJECT INFORMATION

Project Title	cockenzie cruise terminal
Country	Firth of Forth
Project Reference	Oasis class cruise vessel
Prepared By	Roy Glenton

SHIP DATA

Ship Category		Post Panamax Container	
Select Dimensions By		Displacement	
Deadweight	dwt	70,000 t	
Displacement	M_D	23,000 t*	
Overall Length	L_{OA}	360.0 m*	
Length Between Perpendiculars	L_{BP}	300.0 m*	
Beam	B	50.00 m*	
Laden Draft	D	9.30 m*	
Freeboard	F	9.20 m	
Block Coefficient	C_B	0.161	

BERTHING DATA

Berthing Mode		Side Berthing	
Structure Type		Open Structure	
Eccentricity Calculation Method		Full Calculation	
Under Keel Clearance	K_C	2.00 m	
Impact from Bow	x	25.00 %	
		75.00 m	
Radius of Gyration	K	42.18 m	
Impact to Centre of Mass	R	79.06 m	
Berthing Angle	α	15.00 deg	
Velocity Vector Angle	Φ	58.57 deg	
Added Mass Coefficient	C_M	1.714	**PIANC (2002)**
Eccentricity Coefficient	C_E	0.458	
Berth Configuration Coefficient	C_C	1.000	
Softness Coefficient	C_S	1.000	

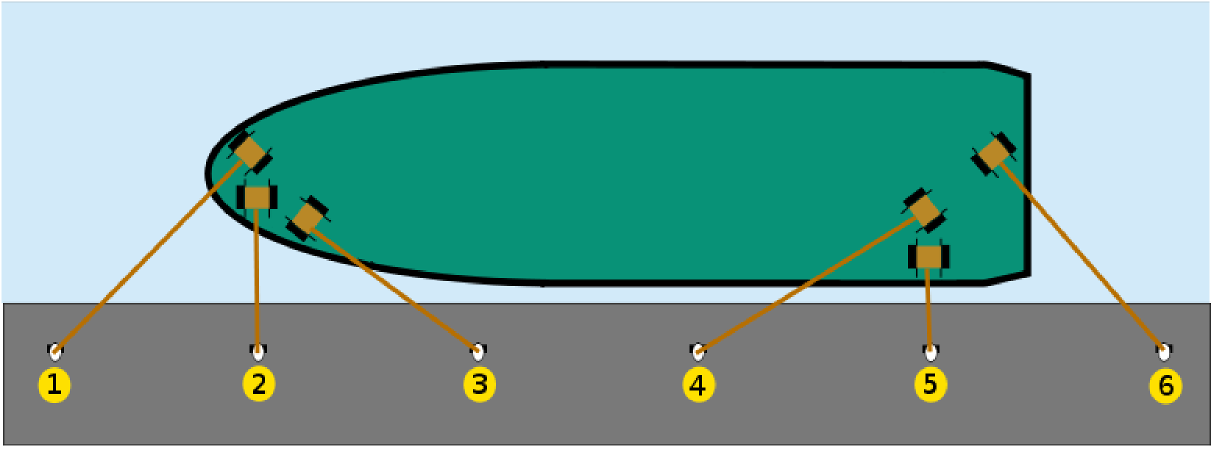
BERTHING ENERGY

Berthing Velocity	V_B	218 mm/s*
Normal Energy	E_N	429 kNm 43.7 t-m
Factor of Safety	F_S	2.00
	E_A	858 kNm 87.5 t-m

Figure 8.1: Typical Berthing Energy Calculation

9. Auto mooring

The traditional layout of mooring ropes for a cruise vessel are shown below.



Number	Name	Purpose
1	Head line	Keep forward part of the ship against the dock
2	Forward Breast line	Keep close to pier
3	Forward spring	Prevent from advancing
4	Aft Spring	Prevent from moving back
5	Aft Breast line	Keep close to pier
6	Stern line	Prevent forwards movement

Figure 9-1: Different mooring lines with different functions

AECOM recognise that in accordance with BS6349- 4:2014, the following criteria should be satisfied when considering safe mooring of the range of vessels anticipated to use the cruise berth in the future:

- The height of mooring points should be such that vertical angles of mooring lines will be as small as practicable and preferably not greater than 25;
- The normal mooring pattern consists of ropes issuing at the extremities of the ship that make horizontal angles of about 45°, – 90° and – 45° to its axis, plus spring lines at about 10° to its axis, together with breast lines as appropriate;
- Optimum lengths of mooring lines are usually within the range 35 m to 50 m for the largest vessel;
- The restraint required to secure the ship is best obtained using breast lines. These should be aligned perpendicular to the longitudinal centre line of the ship in order to apply the maximum restraint to prevent the vessel being moved broadside from the quay.

AECOM have carried out an options appraisal of a semi-automatic and fully automatic mooring system. There are several companies globally that manufacture these systems, but AECOM have reviewed proprietary mooring system by the following manufacturers most of whom AECOM already have an established working relationship:

- Trelleborg;
- Mampaey Offshore industries;

- TTS Group;
- Cavotec.

9.1 Semi-Automatic

9.1.1 Hydraulic Rod

This method, designed by TTS-Group, uses a hydraulic rod instead of ropes that connects to the ship. The ship must be modified with a special bollard that the rod can connect to. Once the vessel is in position, the operator uses a joy-stick to guide a mooring arm from the quay to the bollard in the ship’s side.

When the mooring arm is in place the operator switches to automatic mooring mode. (TTS-Group) The unit on the quayside automatically adjusts to the motions of the ship. Once the ship is ready to depart the operator again must use the joystick to guide the rod away from the ship.

This process does not require any quayside personnel.

9.1.2 Grip Based

This method is in many ways the same as the semi-automatic mooring unit. With the push of a button the beam moves towards the ship and can find the bollard. Then the beam connects to the bollard completely automatically and holds the ship in place.

Both systems can withstand forces up to 1000 kN, but the ship must be modified with a special bollard built in to its hull which is a disadvantage compared to the other systems described below.

Semi-Automatic Mooring/Grip Based System

Figure 9-2: View on Semi-automatic mooring/grip based system

Advantages

- Cost of units cheaper than automatic mooring system;
- Chance of failure during mooring less than automatic vacuum system;
- Less annual maintenance than automatic mooring system;
- No more rope costs and expensive mooring teams;
- Loading / discharging can begin earlier;
- More vessels berthing is possible because of the faster vessel-turnaround;
- Reduced use of tug boats and the vessel propulsion system which saves fuel;
- Durability, less wear on fenders and the ship hull;
- No more personnel that can be injured by mooring lines and winches;
- Reduced emissions because of the faster berthing process;
- Possible for this system to move in a lateral direction.

Disadvantages

- Reluctance of port staff to embrace new technology as this potentially results in job losses of shore-based staff;
- Piled infrastructure required on quayside to support semi-automatic mooring system;
- Vessel hulls require to have bollards fitted on the outside of the vessel hull to accept the hydraulic rod;
- The system will be ship specific;
- May still require backup system of traditional bollards and shore team of 4-6 operatives to ensure 365 days per year berth operation;
- Regular inspection and maintenance;
- The high purchase costs of the system, because of the many parties in the ports (shipping companies, Port Company, mooring teams, terminal operators) who is responsible for the system and which party buys the system.

9.2 Vacuum Mooring

The idea behind the vacuum berthing is to use vacuum & hydraulic technology to eliminate mooring lines and increase the efficiency of the berthing process. The vacuum system makes use of a vacuum pump, hydraulic system, structural steelwork substructure, monitors and power supply to control the whole system. The vacuum pads are connected to a hydraulic arm and the hydraulic arms cannot move in a vertical direction

The captain aligns the ship along the quay and with tugs pushed against the fenders. Due to the fenders the ship bounces back, and this is where the system is activated. The big vacuum pads are pressed against the hull and are activated and engaged by a single press on a button on the bridge, or via a remote control on the dock. When the pads are attached it only takes 10-20 seconds before the vacuum is complete and the ship is attached to the system

This means a big reduction of the time necessary to berth a vessel and allows the loading/discharging operation to start earlier.

- To release the vacuum pads, only a single press on the detach button is necessary.
- The system works as follows:
- The system has multiple vacuum pads which will make a vacuum to the ship in seconds;
- The vacuum pads will produce a constant force on the vessel during the mooring operation;
- After the vessel is moored the safety system will keep the vessel connected, even when there is a blackout;
- The vacuum pad sensors measure the vacuum constantly and translate this into forces which are being applied to the ship’s hull;
- As a back- up a small emergency generator is added to the system on the quay;
- Large pads adhere to vessels’ hulls with hydraulic triple axis arm.

The system continuously compensates vessel motion and automatically adjusts the position of the vessel. The technology constantly provides information using different sensors within the vacuum pad and within the hydraulic system. The sensors in the vacuum pads give information about the percentage of vacuum and the forces which are being imposed on the ship. And the sensors in the hydraulics give information about the movements of the ship. These different sensors give up to date information and alert users to changing conditions and potential or developing problems. All the information is displayed onto computers on the bridge or on the quay side.

It also requires a modest, but constant supply of electricity to operate the system. In case there is an unreliable power supply a small backup generator could be installed.

Vacuum Mooring System

Figure 9-3: View on automatic mooring vacuum system

Advantages

- No more rope costs and expensive mooring teams;
- Loading / discharging can begin earlier;
- More vessels berthing is possible because of the faster vessel-turnaround;
- Reduced use of tug boats and the vessel propulsion system which saves fuel;
- Durability, less wear on fenders and the ship hull;
- No more personnel that can be injured by mooring lines and winches. (system is automated);
- Continues load monitoring with alarm functions;
- Automatic repositioning of the vacuum pads;
- Reduced emissions because of the faster berthing process.

Disadvantages

- Cost of units more expensive than semi-automatic mooring system;
- Reluctance of port staff to embrace new technology as this potentially results in job losses of shore-based staff;
- Piled infrastructure required on quayside to support automatic mooring system;
- Not possible for this system to move in a lateral direction;
- The pads can only attach to a flat vessel hull surface and cannot be connected to bow or stern of vessel;
- Hydraulic arms cannot move in vertical direction;
- Requires electrical supply for operations;
- The high purchase costs of the system, because of the many parties in the ports (shipping companies, Port Company, mooring teams, terminal operators) who is responsible for the system and which party buys the system;
- The system will be ship specific;
- Regular inspection and maintenance;
- Failure of system possible during mooring. Backup system of traditional bollards and shore team of 4-6 operatives may still be required;
- The total force of the vacuum mooring system needs to be less than the maximum force working on the fenders. If the vacuum mooring force is in excess of the fender force, then the fenders can be damaged.

9.3 Magnetic Mooring

This mooring system requires modification of the ship. It required the installation of a magnetic pad to the side of the ship. One the ship is aligned to the pad a hydraulic arm is used by an operator to engage with the pad on the ship and the system is primed and connected. This system uses magnetic contact and hydraulic technology to eliminate mooring lines and increase the efficiency of the berthing process. The system requires a magnetic array, hydraulic system, structural steelwork substructure, monitors and power supply to control the whole system. The magnetic pads are connected to a hydraulic arm and the hydraulic arms can move in both the horizontal and vertical direction

The captain aligns the ship along the quay against the fenders. An operator then manoeuvres the Magnetic pad onto the ship and powers the array. The pads have a synthetic polymer-based material for friction and can be operated by a single press on a button by the operator, or via a remote control on the dock. When the pads are attached it only takes 10-20 seconds before the array is 'docked' and is complete and the ship is attached to the system

This means a big reduction of the time necessary to berth a vessel and allows the loading/discharging operation to start earlier.

To release the magnetic array, only a single press on the detach button is necessary.

The system works as follows:

- The system has a minimum of two magnetic arrays to connect to the ship in seconds;
- The magnetic array is monitored by an 'intelligent system, that will adjust the pad position and will produce a constant force on the vessel during the mooring operation;
- After the vessel is moored the safety system will keep the vessel connected, even when there is a blackout;
- The magnetic array sensors measure the contact force and translate this into forces which are being applied to the hydraulic arms;
- As a back- up a small emergency generator is added to the system on the quay

The system continuously compensates vessel motion and automatically adjusts the position of the vessel. The technology constantly provides information using different sensors within the magnetic array and within the hydraulic system. The sensors in the array give information about the percentage of forces which are being applied onto the ship. And the sensors in the hydraulics give information about the movements of the ship. These different sensors give current information and alert users to changing conditions and potential or developing problems. All the information is displayed onto computers on the bridge or on the quay side.

It also requires a modest, but constant supply of electricity to operate the system. In case there is an unreliable power supply a small backup generator could be installed.

Magnetic Mooring System

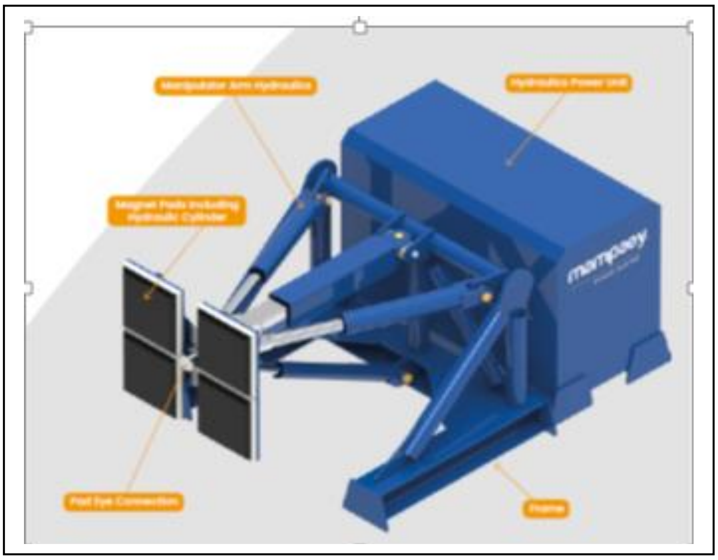


Figure 9-4: View on automatic magnetic mooring system

Advantages

- No more rope costs and expensive mooring teams;
- Loading / discharging can begin earlier;
- More vessels berthing is possible because of the faster vessel-turnaround;
- Reduced use of tug boats and the vessel propulsion system which saves fuel;
- Durability, less wear on fenders and the ship hull;
- No more personnel that can be injured by mooring lines and winches. (system is automated);
- Continues load monitoring with alarm functions;
- Automatic repositioning of the vacuum pads;
- Reduced emissions because of the faster berthing process.

Disadvantages

- Cost of units more expensive than semi-automatic mooring system;
- Reluctance of port staff to embrace new technology as this potentially results in job losses of shore based staff;
- The array required amendment to the vessel hull that would need to be flat hull surface and cannot be connected to bow or stern of vessel;
- Requires electrical supply for operations;
- The high purchase costs of the system, because of the many parties in the ports (shipping companies, Port Company, mooring teams, terminal operators) who is responsible for the system and which party buys the system;
- The system will be ship specific unless pads are installed on every vessel that uses the berth.
- Regular inspection and maintenance;
- Failure of system possible during mooring. Backup system of traditional bollards and shore team of 4-6 operatives may still be required;
- The total force of the magnetic array needs to be less than the maximum force working on the fenders. If the vacuum mooring force is in excess of the fender force, then the fenders can be damaged;
- The maximum resistance forces are less than the current bollard arrangement with ropes.

10. Schemes Considered (open structures)

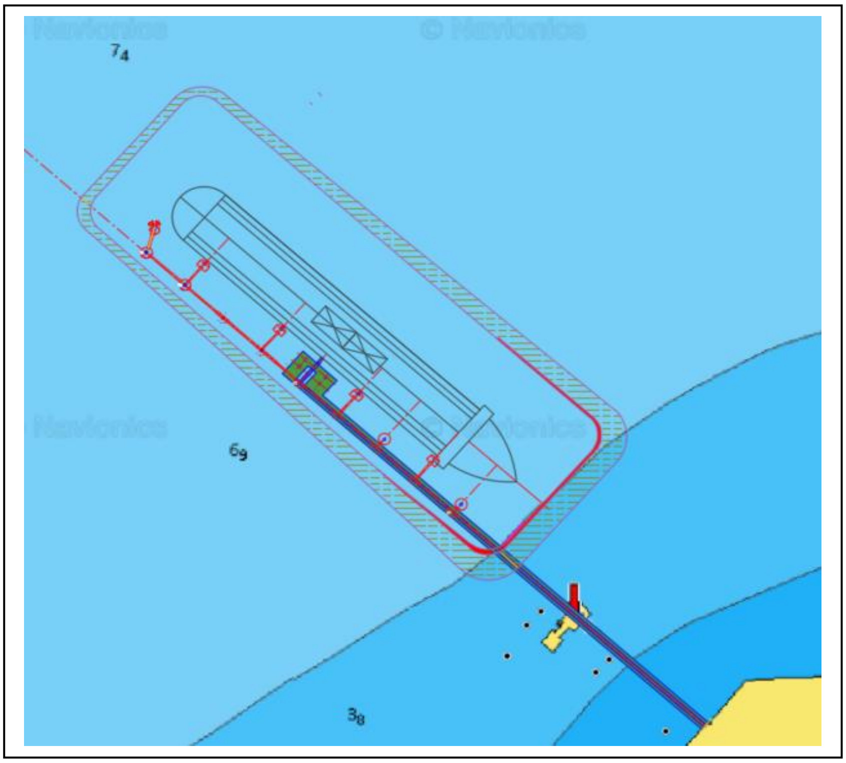
The water side generally appears to have a low gradient mud/sand/silt seabed sloping gradually toward the deep channel. Rock is exposed on the shore line and is close to the surface for at least 200m offshore. The rendex piles of the existing jetty are understood to be socketed into rock. Historic rock levels are known locally at the existing jetty only

The old power station hardstanding existing formation is bounded by an existing gravity wall on the shore side. This is assumed to be founded on rock. AECOM have no structural details of the wall.

There are plans to install a power cable in trench out into the estuary at the extreme western end of the sea wall. Indicative details only are known.

Initial scheme proposals are based on the incorporating these ground conditions to the best advantage of the project. Considering the constraints large diameter monopiles have been proposed for the berthing and mooring piles. Minimising the number of piles resulting in larger piles. The reduced number of installation set-ups reduces the risk at construction and makes the ‘Open’ berth options more economic.

10.1 Scheme 1 Offshore Parallel Berth



Some detailed sketches are given in Appendix B showing the berth, and accesses.

Scheme 1 - consist of an open berth positioned with the berth access the same as the existing alignment, but constructed above, the existing jetty. This option means the demolition of the existing is not necessary and it can be used as a working area for the contractor. The existing and new structures would be not be structurally connected.

The berth is aligned parallel to the existing jetty centreline and offset from it to the east. The berth has been positioned bounding the -5m chart datum (CD) sea bed contour which seems to minimise the amount of rock dredging while keeping the approach lengths relatively economic.

The berth scheme consists of four large diameter monopiles at 80m spacing on the berthing line. All monopiles will be located away from the existing intake tunnels so that they will not compromise the structural integrity of the existing intake tunnels. A separate roundhead manoeuvring pile is included. The piles would be rock socketed, and each would carry a large panelled parallel motion fender. Such fenders reduce berthing hull pressures on high sided vessels and are very versatile.

Set back from the berth line, sufficient to allow satisfactory mooring line angles, are four monopile mooring dolphins. The dolphins are connected by steel walkways and additional small walkways are supported on smaller piles as necessary.

The above is sufficient to berth and moor the vessel but not for the embarkation and disembarkation of passengers and luggage.

A local suspended concrete platform is therefore provided at the centre of the berth to support the embarking/ disembarking passenger access structure (PAS) pod. It will also allow vehicle turnaround from the access. The passenger access can also be continued from the berth pod to the shore by a 450m covered walkways on steel supports above the berth/ shore road access. (This is subject to scheme permutations see below). A vehicle access is also proposed from the berth platform to the shore. The width of this access is subject to scheme permutations.

Berth dredging is also the subject of scheme permutations. The option of a berth only pocket dredged to -10mCD is given. This is economic in terms of construction but would only allow the ship to approach and leave for 50% of the tidal cycle. (for approximately 3 hours either side of low tide, draft would be insufficient). Another option is a fully dredged vessel turning circle and navigation approach channel scheme excavated to -10mCD. The later would allow vessels to approach and leave the berth over the full tidal cycle.

Schemes 1A through to 1G are proposed here based on permutations of included/ not included facilities within this scheme generic basis and a spread of costs and scheme content is given in section 10.4 below. These costs do not include the additional further deck for luggage handling options which are given subsequently in section 14 nor the possible landward development costs discussed in section 15

Clearly there are other ways that the berth can be built, and we have considered several, but not reported them here in detail. However, given the high rock levels, the monopile socketed approach effectively limits the number of sea bed interventions and therefore generally provides for a shorter on-site programme since all the fabrication and protection work is carried out off-site in factory-controlled conditions

10.2 Scheme 2 alongside Quay Wall

This scheme is a different layout concept in that instead on trying to minimise the dredge, it considers possibly the best location for the Turn-around Port scheme. Detailed sketches of this scheme are given in Appendix C.

Given the large area of land available behind the existing old sea wall, this scheme considers the provision of a berth alongside the existing sea wall. Due to the proposed electrical cable route to the western end of the site, the dredged berth has been offset to project partially to the east of the wall.

Since the wall is assumed to be founded on steel sheet piles (depth of rockhead unknown) the scheme considers offsetting the berth line 30m off the existing wall to allow for the -10mCD dredge berth. From the dredge pocket to the wall, the existing bed material will be removed and replaced with designed rock layers to control scour and wave action and provide support to the wall. This will also have the effect of reducing the wave response and reflections on the berth along the wall.

The offset berth line consists of large diameter socketed monopiles with parallel motion fenders at 80m centre. The reason for this is similar to those given in scheme 1. Clearly a full structural survey of the wall would be necessary, as this is not being replaced. Access to the berth points is by walkway as before

Fore and aft mooring points would be on the shore with sunken gravity bollard foundations. Generally, this is an open berth with mid-ship continuous slabs for the PAS only in the same way as scheme 1. Scheme 2 costs and options are given in the table in section 10.4 below. These costs do not include the additional further decking luggage handling options which are given subsequently in section 14 nor the possible landward development costs discussed in section 15

A central concrete platform support for the PAS embarkation/ disembarkation pod is shown, and the PAS itself would only need to provide access to buses on the formation area; no need for long access walkways. Similarly, vehicles can access the berth directly and there is no need for the expensive structural vehicle access.

The down side of the scheme is the amount of dredging. While this have been assessed carefully based on considered assumptions, more detailed sounding and sub-ground information would increase the accuracy of the costing of this aspect of the scheme.

10.3 Scheme 3 Offshore Perpendicular

This scheme is based on an approach-way from land to berth as Scheme 1, but with a “T” perpendicular berth head at right angles and to the west of to the approach-way. This scheme was considered in detail together with the others but has not been reported in detail here. The reason for that is; whether the perpendicular arrangement is more economical than the aligned (Scheme 1) option is solely down to dredging and dredging quantities spilt between soft and rock as compared to the cost of the approach. There is insufficient detailed bathymetry or ground rock profiles to accurately balance the capital engineering costs against dredging costs, as regards the advantages and disadvantages of different location and alignment. The dredging costs are significant for the facility close to the shore and the approach-way cost are significant further from the shore. Scheme 1 attempted to take a view on a location to minimise the rock dredging. Initial parametric exercises on a perpendicular option (Scheme 3) seem to indicate that it is less economic than Scheme 1. Therefore, for the purposes of this draft report the Scheme 3 has not been reported further here as it just creates more permutations without further clarification or conclusions. This can be revisited if more ground information becomes available.

10.4 Comparison Summary of OPEN structure Scheme Permutations

The table below gives a summary comparison of scheme permutation project costs and which variables are included. Please refer to Appendices A & B for detailed sketches of the main schemes

Description	Scheme Nr	BUDGET COST	Vessel Access to berth	PAS at Berth	PAS Corridor Berth to Shore	vehicle access berth to shore (turning circle at berth)	Vessel Dredge turning area	Vessel approach channel
offshore mono pile berth	1A	£49,299,800	Berth Pocket -10mCD Tidal 50% of tide cycle	Yes	Yes	Yes double carriage way	No	No
ditto	1B	£39,619,800	Berth Pocket -10mCD Tidal 50% of tide cycle	Yes	NO decant to buses	Yes DOUBLE carriage way	No	No
ditto	1C	£36,280,200	Berth Pocket -10mCD Tidal 50% of tide cycle	Yes	NO decant to buses	Yes SINGLE arriage way	No	No
ditto	1D	£50,247,038	Flared Berth Pocket -10mCD Tidal 50% of tide cycle	YES	YES	Yes DOUBLEcarriage way	No	No
ditto	1E	£60,474,482	Flared Berth Pocket -10mCD 100% tidal Access	YES	YES	Yes DOUBLE carriage way	YES	YES
ditto	1F	£50,794,482	Flared Berth Pocket -10mCD 100% tidal Access	YES	No decant with buses	Yes double carriage way	YES	YES
ditto	1G	£47,454,882	Flared Berth Pocket -10mCD 100% tidal Access	YES	No decant with buses	Yes SINGLE arriage way	YES	YES
Berth alongside existing wall	2	£60,737,929	Designed Berth Pocket -10mCD 100% tidal Access	YES	No not necessary	No Not Necessary	YES	YES

Table 10-1: Schemes comparison summary SCHEME 1C has the least initial capital outlay

Please Note that PAS referenced in the table is for the provision of a Sea Port Boarding Bridge (SPBB)

The cost and scheme permutations in the above do not include additional continuous slab handling areas or landward developments discussed in Sections 14 & 15 respectively

Scheme 1C, highlighted, represents the least initial financial investment for the facility permutations described, and is subject to the stated limitations of the scheme. It probably provides a basis for a future expandable stopover port at the lowest initial financial outlay. Scheme 2 requires the highest level of capital outlay, for what is potentially a scheme basis which is further developable as a Turn-around port.

11. Optioneering Workshop

A Value Optioneering/Engineering workshop was carried out by AECOM and will be attended by representatives from ELC and other interested stakeholders. The classic derivation of the Value Engineering/Optioneering process is detailed below in Table 11-1 below.

Table 11-1: Value Optioneering/Engineering Process

1. Information	An information gathering process that focuses attention on the client's business drivers for the project. Importance is given to the use of facilitated workshops.	Define and understand the nature of the problem.
2. Speculation	Creative-thinking techniques are utilised to generate alternative ways to provide the business drivers identified in stage 1.	Generate alternative ideas as to how the problem may be solved.
3. Evaluation	The solutions generated are evaluated in terms of their feasibility and cost. Ideas are combined and consolidated to produce a list of perhaps six or seven that are worthy of further consideration.	Evaluate the feasibility of the ideas so generated.
4. Development	The surviving ideas are developed in detail, ensuring that all the interfaces with the client's business are considered.	Fully develop and test the ideas judged to be the most suitable.
5.Recommendation/ implementation	The most suitable solution is identified, and a formal recommendation made to the client for implementation.	Decide upon the best solution, and action it.

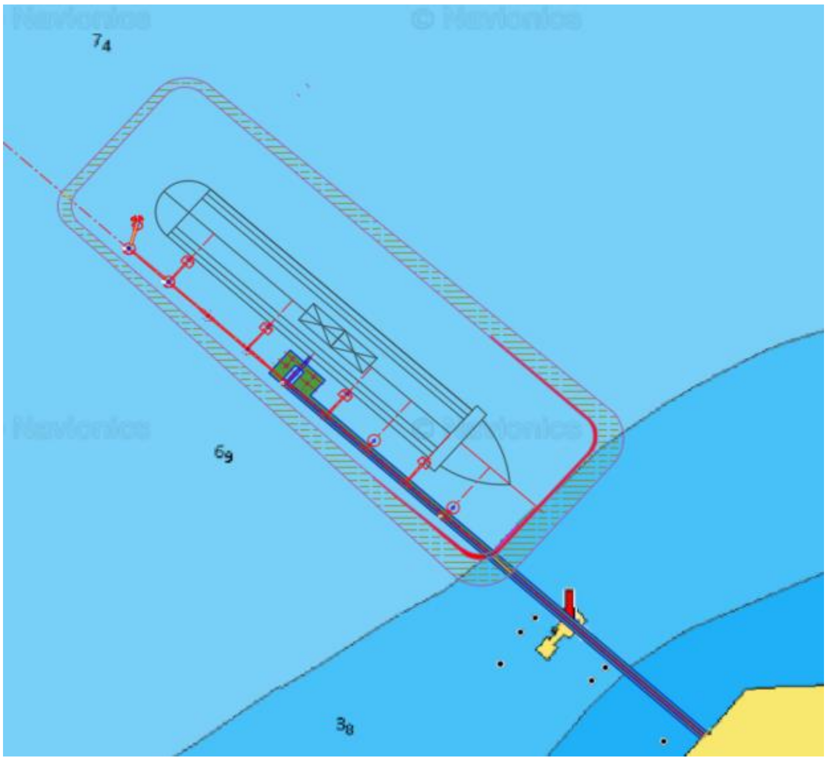
11.1 Optioneering

AECOM have carried out an optioneering exercise and developed budget costs based on the following key principles:

Berthing Capacity	Must be able to accommodate cruise ship 350m in length and 9m draft. Length and draft of cruise ship to be discussed and agreed with ELC prior to carrying out the study
Water Depth	A Depth of 10m below Chart Datum should be achievable and reasonably maintainable without excessive maintenance dredging liability.
Navigational Risk	The site should be in an area where the berthed ship will not constitute a navigational hazard.
Land Availability	The site needs to have sufficient available land for the construction of terminal buildings (typically with around 1,000m² floor area for the target ship size) and ancillary facilities such as coach drop off and parking areas.

Option No.1A: Offshore Monopile berth with full PAS and twin lane vehicle access from shore

Berthing pocket only: approach 50% of the time



- Berthing Pocket -10m CD;
- Tidal 50% of tide cycle;
- PAS at berth;
- PAS corridor berth to shore;
- Double carriageway vehicle access to berth;
- No Vessel dredge turning area;
- No vessel approach channel.

Advantages

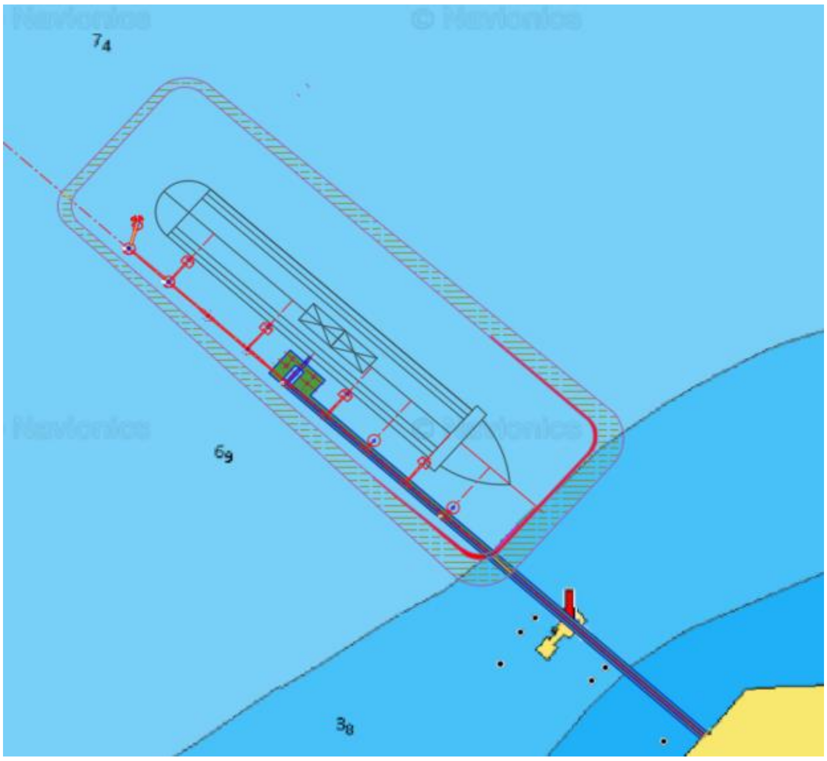
- Flexible layout which is easily extendable in the future; suitable to build minimum scheme now, extend later.
- Monopile berths with parallel motion fenders are very efficient for berthing very high sided vessels.
- Mooring points set back 30m from berth line to provide very good secure line angles.
- Easy vessel berthing.
- Open under structure approach does not restrict and cause reflections to sea state swell.
- Berth positioned to minimise rock dredging.
- Scheme 1A has a berth PAS and a full covered PAS walkway berth to shore.
- Scheme 1A has double carriageway vehicle access from shore to berth.
- Passengers can still be decanted by bus as a preference.
- This open piled berth arrangement allows for a second “mirror image” berth to be constructed later

.

Disadvantages

- -10mCD berthing pocket only for this scheme; the berth can be approached or left for 50% of the tide range.
- Berth to shore is 450m, this is possibly a long walk for passengers; consider possible moving pavement.
- Berth is quite exposed open structure and care and training is necessary for safe operation.
- Mono pile construction requires specialised equipment.
- Maintenance issues have been reported on heavily loaded parallel motion fenders.
- Vessel alignment is broad side to the prevailing wind and swell.

Option No.1B: is exactly as Option 1A however with a PAS on the berth only not berth to shore.
Passengers decanted from berth by bus.
Berthing pocket only: approach 50% of the time.



- Berthing Pocket -10m CD;
- Tidal 50% of tide cycle;
- PAS at berth;
- Decant to Buses;
- Double carriageway vehicle access to berth;
- No Vessel dredge turning area;
- No vessel approach channel.

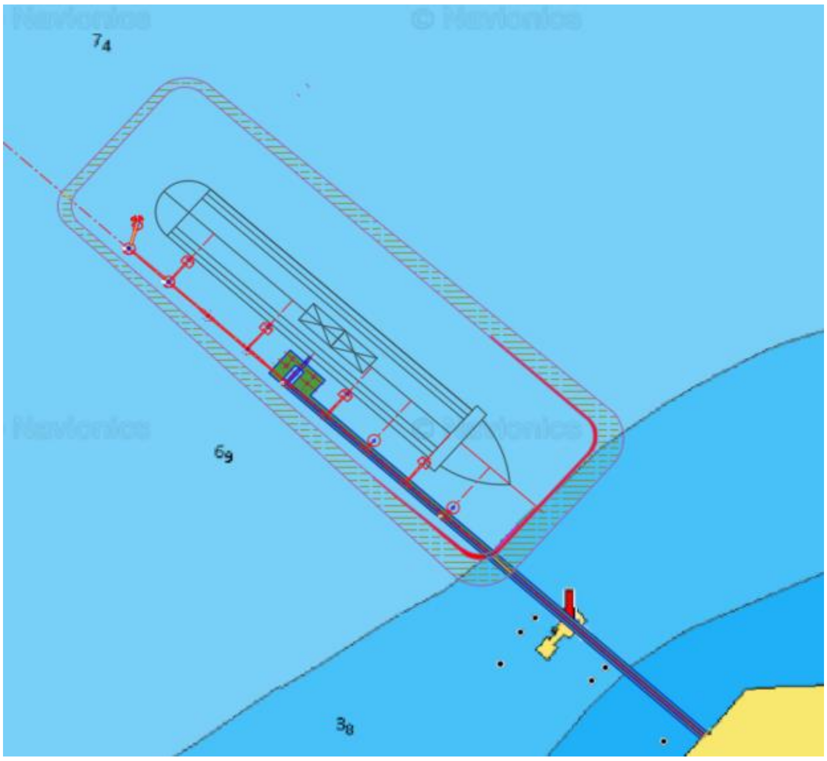
Advantages

- Flexible layout which is easily extendable in the future; suitable to build minimum scheme now, extend later.
- Monopile berths with parallel motion fenders are very efficient for berthing very high sided vessels.
- Mooring points set back 30m from berth line to provide very good secure line angles.
- Easy vessel berthing.
- Open under structure approach does not restrict and cause reflections to sea state swell.
- Berth positioned to minimise rock dredging.
- Scheme 1B has a berth only PAS
- Passengers decanted to shore by bus, so the distance is not a problem.
- Scheme 1B has double carriageway vehicle access from shore to berth
- This open piled berth arrangement allows for a second “mirror image” berth to be constructed later

Disadvantages

- Berth only PAS requires movement of passengers from the berth to the shore bus.
- Passenger movement berth to shore may be fine a stopover port, but more time lost at a turn-around port.
- -10mCD berthing pocket only for this scheme; the berth can be approached or left for 50% of the tide range.
- Berth to shore is 450m, this is possibly a long walk for passengers.
- Berth is quite exposed open structure and care and training is necessary for safe operation.
- Mono pile construction requires specialised equipment.
- Maintenance issues have been reported on heavily loaded parallel motion fenders.
- Vessel alignment is broad side to the prevailing wind and swell; to be considered in mooring studies.

Option No.1C: is exactly as Option 1A however with a PAS on the berth only not from berth to shore. Passengers decanted from berth by bus: also, vehicle access single lane only with berth turn around Berthing pocket only: approach 50% of the time



- Berthing Pocket -10m CD;
- Tidal 50% of tide cycle;
- PAS at berth;
- Decant to Buses;
- Single carriageway vehicle access to berth;
- No Vessel dredge turning area;
- No vessel approach channel.

Advantages

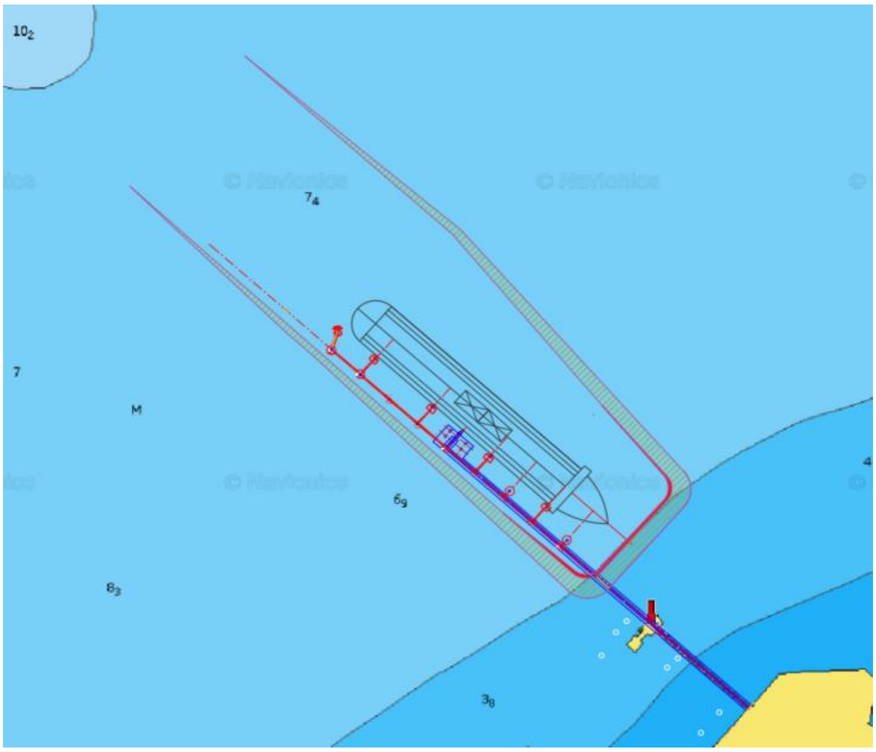
- Option 1C is the most economic option of all. May be a good initial compromise to get the project started.
- Flexible layout which is easily extendable in the future; suitable to build minimum scheme now, extend later.
- Monopile berths with parallel motion fenders are very efficient for berthing very high sided vessels.
- Mooring points set back 30m from berth line to provide very good secure line angles.
- Easy vessel berthing.
- Open under structure approach does not restrict and cause reflections to sea state swell.
- Berth positioned to minimise rock dredging.
- Scheme 1C has a berth only PAS
- Passengers decanted to shore by bus, so the distance is not a problem.
- Scheme 1C has single carriageway vehicle access from shore to berth.
- This open piled berth arrangement allows for a second “mirror image” berth to be constructed later

.

Disadvantages

- Berth only PAS requires movement of passengers from the berth to the shore by bus.
- Passenger movement berth to shore may be fine a stopover port, but more time lost at a turn-around port.
- -10mCD berthing pocket only for this scheme; the berth can be approached or left for 50% of the tide range.
- Berth to shore is 450m, this is possibly a long walk for passengers; consider mobile pavement.
- Berth is quite exposed open structure and care and training is necessary for safe operation.
- Mono pile construction requires specialised equipment.
- Maintenance issues have been reported on heavily loaded parallel motion fenders.
- Vessel alignment is broad side to the prevailing wind and swell.

Option No.1D: **is exactly as Option 1A however a flared dredge berth pocket has been provided. This allows for the subsequent optional addition of a vessel all tide turning area and long deep-water approach channel. Berthing pocket only: approach 50% of the time.**



- Flared Berthing Pocket - 10m CD;
- Tidal 50% of tide cycle;
- PAS at berth;
- PAS corridor berth to shore;
- Double carriageway vehicle access to berth;
- No Vessel dredge turning area;
- No vessel approach channel.

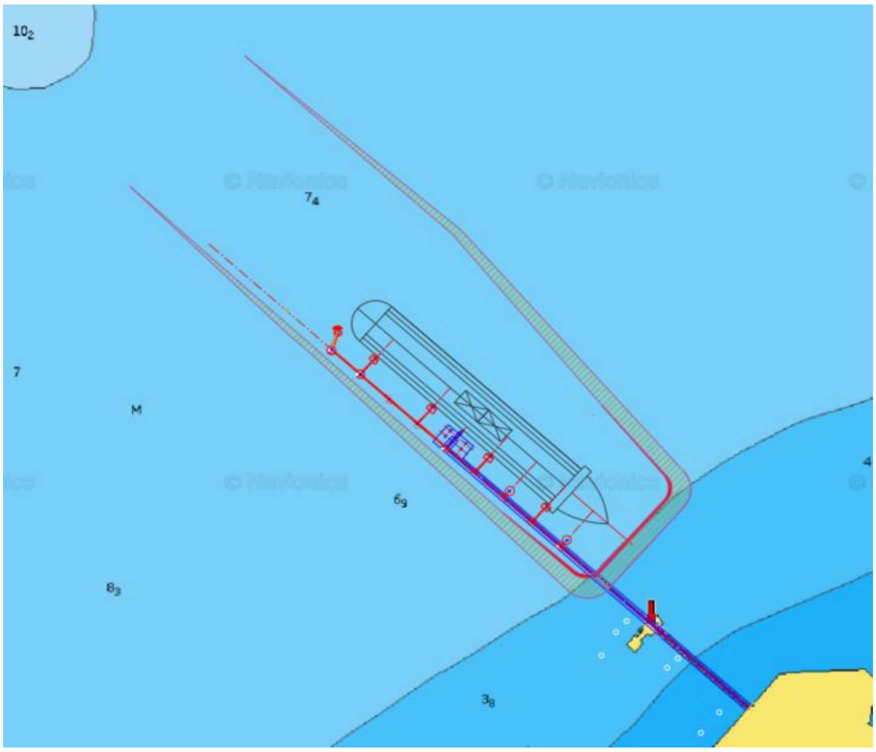
Advantages

- Flexible layout which is easily extendable in the future; suitable to build minimum scheme now, extend later.
- Monopile berths with parallel motion fenders are very efficient for berthing very high sided vessels.
- Mooring points set back 30m from berth line to provide very good secure line angles.
- Easy vessel berthing.
- Open under structure approach does not restrict and cause reflections to sea state swell.
- Berth positioned to minimise rock dredging.
- Scheme 1D has a berth PAS and a full covered PAS walkway berth to shore
- Passengers can still be decanted by bus as a preference.
- Scheme 1D has double carriageway vehicle access from shore to berth.
- This open piled berth arrangement allows for a second “mirror image” berth to be constructed later

Disadvantages

- -10mCD berthing pocket only for this scheme; the berth can be approached or left for 50% of the tide range.
- Berth to shore is 450m, this is possibly a long walk for passengers; consider possible moving pavement.
- Berth is quite exposed open structure and care and training is necessary for safe operation.
- Mono pile construction requires specialised equipment.
- Maintenance issues have been reported on heavily loaded parallel motion fenders.
- Vessel alignment is broad side to the prevailing wind and swell.

Option No.1E: is exactly as Option 1D however a vessel turning circle and navigation channel to the deep water has been include. (See schematic in Option 2 below.) Berthing can be approached and left 100% of the time over the full tide cycle.



- Flared Berthing Pocket - 10m CD;
- Tidal 100% of tide cycle;
- PAS at berth;
- PAS Corridor Berth to Shore;
- Double carriageway vehicle access to berth;
- Vessel dredge turning area;
- Vessel approach channel.

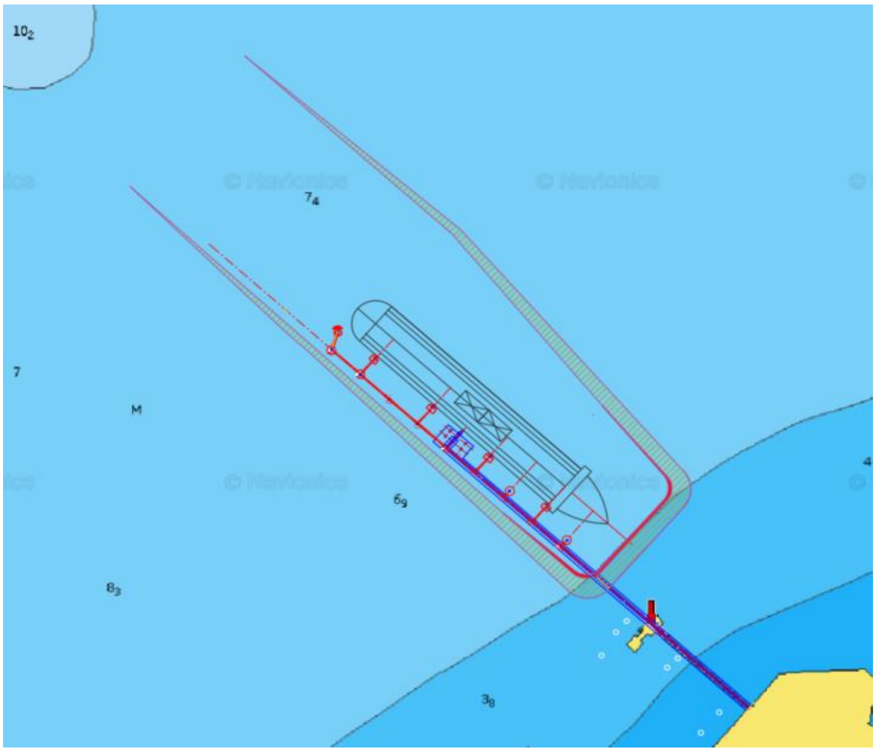
Advantages

- Option 1E berth has a flared berth pocket and a vessel turning area and navigation channel (see option2)
- Option 1E can be used by the design vessel and all stages of the tidal cycle.
- Flexible layout which is easily extendable in the future; suitable to build minimum scheme now, extend later.
- Monopile berths with parallel motion fenders are very efficient for berthing very high sided vessels.
- Mooring points set back 30m from berth line to provide very good secure line angles.
- Easy vessel berthing.
- Open under structure approach does not restrict and cause reflections to sea state swell.
- Berth positioned to minimise rock dredging.
- Scheme 1E has a berth PAS and a full covered PAS walkway berth to shore
- Passengers can still be decanted by bus as a preference.
- Scheme 1E has double carriageway vehicle access from shore to berth.
- This open piled berth arrangement allows for a second “mirror image” berth to be constructed later

Disadvantages

- Berth to shore is 450m, this is possibly a long walk for passengers; consider possible moving pavement.
- Berth is quite exposed open structure and care and training is necessary for safe operation.
- Mono pile construction requires specialised equipment.
- Maintenance issues have been reported on heavily loaded parallel motion fenders.
- Vessel alignment is broad side to the prevailing wind and swell.

Option No.1F is exactly as option 1E except that the PAS is restricted to the berth only. Passenger must decant from berth to shore by bus. Berthing can be approached and left 100% of the time over the full tide cycle.



- Flared Berthing Pocket - 10m CD;
- Tidal 100% of tide cycle;
- PAS at berth;
- Decant to buses;
- Double carriageway vehicle access to berth;
- Vessel dredge turning area;
- Vessel approach channel.

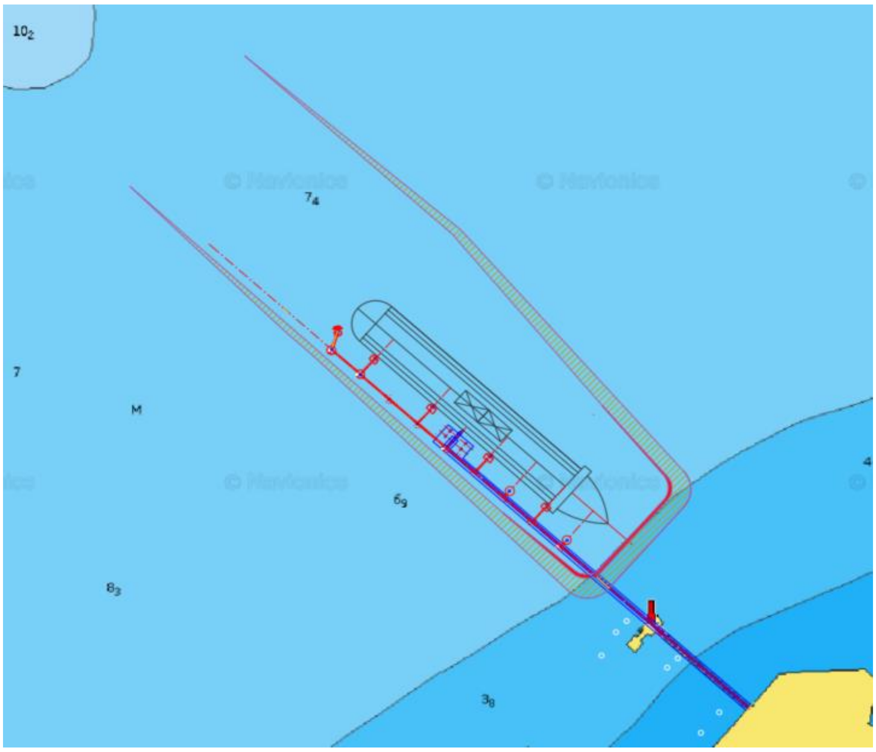
Advantages

- Option 1F berth has a flared berth pocket and a vessel turning area and navigation channel (see option 2)
- Option 1Fcan be used by the design vessel and all stages of the tidal cycle.
- Flexible layout which is easily extendable in the future; suitable to build minimum scheme now, extend later.
- Monopile berths with parallel motion fenders are very efficient for berthing very high sided vessels.
- Mooring points set back 30m from berth line to provide very good secure line angles.
- Easy vessel berthing.
- Open under structure approach does not restrict and cause reflections to sea state swell.
- Berth positioned to minimise rock dredging.
- Scheme 1F has a berth only PAS.
- Passengers decanted to shore by bus, so the distance is not a problem.
- Scheme 1F has double carriageway vehicle access from shore to berth.
- This open piled berth arrangement allows for a second “mirror image” berth to be constructed later.

Disadvantages

- Berth only PAS requires movement of passengers from the berth to the shore bus.
- Passenger movement berth to shore may be fine a stopover port, but more time lost at a turn-around port.
- -10mCD berthing pocket only for this scheme; the berth can be approached or left for 50% of the tide range.
- Berth to shore is 450m, this is possibly a long walk for passengers.
- Berth is quite exposed open structure and care and training is necessary for safe operation.
- Mono pile construction requires specialised equipment.
- Maintenance issues have been reported on heavily loaded parallel motion fenders.
- Vessel alignment is broad side to the prevailing wind and swell; to be considered in mooring studies

Option No.1G is exactly as option 1E except that the PAS is restricted to the berth only. Passenger must decant from berth to shore by bus and approach is single vehicle only. Berthing can be approached and left 100% of the time over the full tide cycle.



- Flared Berthing Pocket - 10m CD;
- Tidal 100% of tide cycle;
- PAS at berth;
- Decant to buses;
- Single carriageway vehicle access to berth;
- Vessel dredge turning area;
- Vessel approach channel.

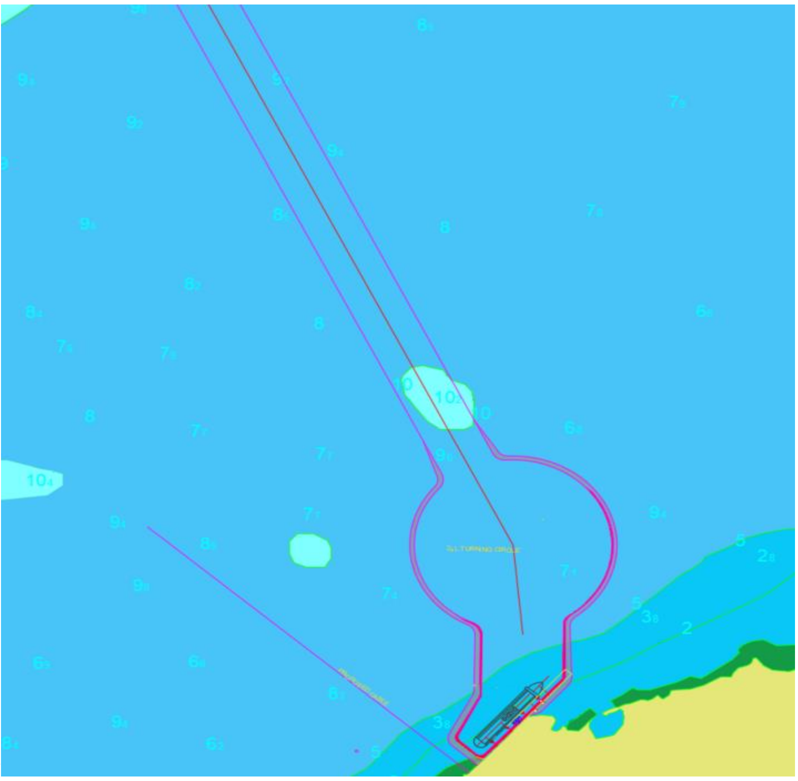
Advantages

- Option 1F berth has a flared berth pocket and a vessel turning area and navigation channel (see option 2)
- Option 1Fcan be used by the design vessel and all stages of the tidal cycle.
- Flexible layout which is easily extendable in the future; suitable to build minimum scheme now, extend later.
- Monopile berths with parallel motion fenders are very efficient for berthing very high sided vessels.
- Mooring points set back 30m from berth line to provide very good secure line angles.
- Easy vessel berthing.
- Open under structure approach does not restrict and cause reflections to sea state swell.
- Berth positioned to minimise rock dredging.
- Scheme 1F has a berth only PAS.
- Passengers decanted to shore by bus, so the distance is not a problem.
- Scheme 1F has double carriageway vehicle access from shore to berth.
- This open piled berth arrangement allows for a second “mirror image” berth to be constructed later.

Disadvantages

- Berth only PAS requires movement of passengers from the berth to the shore bus.
- Passenger movement berth to shore may be fine as stopover port, but more time lost at as turn-around port.
- Berth is a quite exposed open structure and care and training is necessary for safe operation.
- Mono pile construction requires specialised equipment.
- Maintenance issues have been reported on heavily loaded parallel motion fenders.
- Vessel alignment is broad side to the prevailing wind and swell; to be considered in mooring studies
- Berth only PAS requires movement of passengers from the berth to the shore by bus.
- Passenger movement berth to shore may be fine a stopover port, but more time lost at a turn-around port.
- -10mCD berthing pocket only for this scheme; the berth can be approached or left for 50% of the tide range.
- Berth to shore is 450m, this is possibly a long walk for passengers; consider mobile pavement.
- Berth is quite exposed open structure and care and training is necessary for safe operation.
- Mono pile construction requires specialised equipment.

Option 2: **Is an option to berth alongside the existing power station sea wall. Dredged berth pocket to -10mCD and ship turning circle and navigation channel are included. Vessel may approach or leave the berth at 100% of the tidal cycle.**



- Designed Berthing Pocket - 10m CD;
- Tidal 100% of tide cycle;
- PAS at berth;
- PAS Corridor not required;
- Vehicle carriageway not required;
- Vessel dredge turning area;
- Vessel approach channel.

Advantages

- Option 2 berth has a flared berth pocket and a vessel turning area and navigation channel to -10mCD
- Option 2 can be used by the design vessel and 100% of the tidal cycle.
- Facilities are very close to the shore.
- Monopile berths with parallel motion fenders are provided 30m off-standing from the wall.
- Mooring points set back 30m from berth line to provide very good secure line angles.
- Easy vessel berthing.
- Scheme 2 has a very short berth to shore PAS
- Passengers decanted by bus to shore facilities
- Shore works not particularly exposed.
- Scheme 2 connects the vessel directly to the shore and therefore would provide an ideal turn-around port.
- Vessel alignment at a beneficial angle to wind and swell.

Disadvantages

- Very large amount of dredging particularly rock dredging.
- Layout must be located to east to avoid a proposed marine cable route.
- Most costly option.
- Not flexible in that it does not allow phase construction from minimum to full scheme.
- Mono pile construction requires specialised equipment.
- Maintenance issues have been reported on heavily loaded parallel motion fenders.
- Scour protect required to the front face of the existing wall.
- -10mCD berthing pocket only for this scheme; the berth can be approached or left for 50% of the tide range.
- Berth to shore is 450m, this is possibly a long walk for passengers; consider mobile pavement.
- Berth is quite exposed open structure and care and training is necessary for safe operation.
- Mono pile construction requires specialised equipment.

12. Options Matrix

To provide a meaningful assessment of the options identified and reviewed and determination of a preferred solution to take forward to outline design, a scoring matrix has been identified as follows, which scores various criteria from 0(low, poor) to 100(high, good).

The highest overall scores are considered as being the best value. It is normal practice to choose the highest score from the scoring matrix base to be taken forward to outline design appraisal.

The main factors considered in the scoring assessment are as follows:

12.1 Berth Capacity

Evaluated the time the berth will be available over the tidal cycle. This is based on the depth of water provided in each option and the percentage of time that the berth will be useable over the tidal cycle. In each case 10% will be deducted for weather down time.

12.2 Water Available

Evaluates the amount of water available at the berth prior to the works. It is a measure of the actual dredging necessary for the works. The percentage of the cost estimate which comprised dredging is subtracted from 100 to give a score. The amount of dredging on the scheme is in a sense a measure of the likely maintenance commitment.

12.3 Navigation risk

Takes a view on dredging regimes provided and the berthing difficulty

12.4 Land available for development

Is a measure of expansion potential on land.

12.5 Scheme Capital Costs

The costs have been derived from historical experience and do not consider the current market conditions and economic climate which could influence pricing significantly. The costs are based on high-level assumptions and construction methodology; these could vary dependent upon the contractor's approach.

It should be stressed that the Capital costs are very dependent on the amount of dredging in each scheme, and the amount of expensive rock dredging.

No detailed sounding of project specific ground information was available for this assessment. Therefore, reliance could only be placed of large-scale admiralty charts and historical ground information from historical records. This has been applied in a similar way on to each option, however, more accurate information would redefine the costings.

Estimated costs include:

- 10% for preliminaries;
- 12% for design, supervision and contract management (consultant); and
- 40% optimism bias. This value of construction cost contingency is normally used by AECOM for construction cost estimates for similar harbour works.

The optimism bias has been derived from the 'Green Book'. It is possible that the optimism bias may be reduced during feasibility design of the preferred option especially if early contractor involvement is undertaken.

A scoring matrix will be developed and scored for the short list of options. A typical scoring matrix format is shown below.

12.5.1 Proposed Optioneering Scoring Matrix

`	`							
	Criteria Option	Berthing Capacity	Water	Navigation Risk	Land Availabil	Total Score	Estimate Cost	Commentary
	Option 1A	50	90	40	30	210	£49,299,800	For the "1" series of Options Matrix scoring is very similar which is not surprising since they have a generic base. The main differences being the adoption or otherwise of full-length ship to shore PAS options and vehicle access width
	Option 1B	50	90	40	30	210	£39,619,800	
	Option 1C	50	90	40	30	210	£36.280,200	Most Economical Scheme as regards initial capital outlay.
	Option 1D	50	85	40	30	205	£50,247,038	Scored less due to increased dredge
	Option 1E	90	75	90	30	285	£60,474,482	
	Option 1F	90	75	90	30	285	£50,794,482	
	Option 1G	90	75	75	30	270	£47,454,882	
	Option 2	90	27	90	100	307	£60,737,929	Best matrix score because of the large amount of land available for development. Despite the very high proportion of dredging costs Most expensive Option, but best option to develop a turn-around port.

Table 12-1: Options Appraisal Matrix

13. Continuous Berth Access

In section 12 above Schemes 1& 3 have been considered as the most efficient ways to build a berth at the Cockenzie site. These are: -

- An open berth alternative with monopiles mooring piles and approaches, Scheme permutations 1;
- An alongside open berth at the existing quay wall; Scheme 2. Due to the unknown nature of the existing quay wall, this also has been offset onto berthing piles in order that the necessary dredge work does not undermine the existing wall.

In both cases there is no continuous quay just a single access point aligning with the middle of the vessel where the passenger doors and PAS are located. This arrangement is only suited to transit calls and can only accept one vessel at a time.

The cost matrix given above in section 12 does not include any extensive slab decked working area other than those specifically stated, nor any landward development. These are discussed and included below,

13.1 Partial Slab Deck with Mono-piles for Berth and Mooring

The above work has been carried out based on the Oasis class of cruise vessel, see Appendix D. For a Turn-around terminal many operators may prefer a solid jetty structure over the vessel length to give flexibility to unload and load luggage and provisions in the shortest time. If the berth is designed for one vessel, then the open berth can be adapted by providing for local luggage loading and unloading points at the rear and stern of the vessel, to suit that vessel. This allows access to and from the vessel in a similar way to but separated from the passengers. OR a continuous deck strip can be provided over the length of the vessel which is designed only for loading/ unloading and is not designed to carry ship berthing and mooring forces.

These are compared as follows: -

i. Vessel loading unloading specific points fore and after:
    - Forward loading platform and access pod connected to road access £3,500,000;
    - Stern loading platform and access pod connected to road access £3,500,000;
    - These specific areas will be connected to the mid ships turn around area;

    Total £7,000,000

ii. For all schemes 1-3, a continuous deck can be allowed which is independent of berthing and mooring loads, from between the vessel perpendiculars, say 240m long and 10m wide; enough for vehicle access. This would add approximately £10m.

These costs are in addition to the cost permutations given in section 10.4 For example If from that above Schemes 1E and 2 are the possible Turn-around terminal schemes, which require more deck, then to the budget for these schemes from section 10.4 needs to be modified to provide more flexibility for loading and unloading of luggage and provisions be required.

Table 13-1: Partial Berth Slabs option extended costs

Scheme	**As reported in Section 10.4** £	**With additional Specific** berth Handling Areas £	**With additional Continuous Minimum Berth handling area** £
1E turnround	£60,474,482	£67,474.482	£70,474.482
2 turnround	£60,737,929	£67,737,929	£70,737,929

13.2 Complete Slab deck Access, without Monopile Berthing and Mooring

Section 13.1 above deals with a hybrid of monopiles with additionally piled decked areas. However, the cost effects of providing a totally decked stand-alone solution (without monopiles) are considered here. The deck would require piles on a grid typically 6x 10m and supporting a structural deck on deck beams. This will mean perhaps 150 piles each of which requires to be drilled and socketed into the rock. Clearly this will require many set-up operations for installation and construction plant and will be very weather and rock quality dependant. (The reason for initially considering monopile mooring / berthing piles is that although the plant is larger, the number of set-ups and installation time/ risk is very much less).

For the present exercise a slab structure of 240 x 30m has been considered. The width of the slab is a function of the required fender berthing loadings and the code requirements for workable mooring lines angles. Further detailed analysis will be necessary to establish the minimum slab width that can be made to work for the given vessel berthing, breasting and mooring loads. This is beyond the scope of this study as it requires detailed calculation and a knowledge of the rock quality and profiles. But if a narrower berth/ quay strip can be made to work structurally then economies may be possible on the slab. However, such a narrower structure may not give mooring line angles at all states of the tide which conform to best efficient mooring practise and code requirements. In this instance consideration could be given to the use and more detailed costing of some of the auto- mooring systems which have been described above in this document. But again, this detailed iteration is out with the scope of this preliminary document.

Given the construction difficulties and programme considerations a 240* 30m piles slab is likely to cost in the region of £32m.

The cost effect of this on the Turn-around Terminal Scheme.

Table 13-2: Full Berth Slabs option extended costs

Scheme	As Reported In Section 10	Nett after subtraction of Mono piles effects	Total after Addition of continuous slab
1E turnaround/slab	£60,474,482	£46,174,482	£78.000,000
2 turnaround/slab	£60,737,929	£51,657,929	£83,657,929

It can be seen from the above table that this is a potentially expensive option

13.3 Summary

Based on feedback from cruise operators a continuous deck area which is independent of berthing and mooring loads has been identified as the most desirable alternative to a fully open berth. This provision will enable:

- Turnaround calls to be handled, and;
- Two smaller vessels to share the berth at the same time.

The alternative solutions of fore and aft unloading points, or an integrated quay and berthing structure, have been rejected due the inflexibility and marginal cost saving of the former and greater cost of the latter.

14. Landside Facilities

14.1 Turnaround Port Land Development

A key outcome from the financial assessment is whether only transit calls should be targeted or both transit and turnaround calls. This is important as the preliminary costs of options 1E and 2 are very similar, yet the route to a final scheme could be quite different.

The Scheme “1” permutations are aimed at providing a way to develop a facility from a minimum initial outlay starting point, see scheme 1C (this would initially be only a transit call facility); to something with greater capabilities. The end route using the progression of the scheme “1” options is essentially a berth which could operate as a turn-around port. But due to the berth being 450 m distance from the shore, then the layout is perhaps not ideal for this.

Scheme 2 however, is close to the fill formation of the old power station and is ideally placed near to a possible shore development to create a turn-around berth. Option 2, unlike Options 1 does not allow readily for a phased progression from minimum initial cost scheme to more developed options. This is due to the large amount of dredging necessary to get a vessel close to the existing wall. Option 2 is a large initial capital commitment and therefor a larger financial risk than the option 1 route. However, if a turn-around port is the goal, then scheme 2 is perhaps a better final scheme goal.

The proposed site at Cockenzie has geographical advantages for development as a destination. These include: -

- A large area of land available for development very close to the existing sea wall;
- It has good potential bus and railway links;
- Turn-around ports are land hungry, requiring:-
    - Extensive car parking;
    - Space for public transportation links;
    - A terminal building;
    - A Closed security boundary with an inner secure zone on the ship side and a public zone on the shore side;
    - There are commercial business opportunities within the terminal. Overseas cruise terminals attract high level restaurants and luxury goods outlets. There is huge “Ocean Terminals” attached to many cities in the middle, far east and elsewhere, for example.

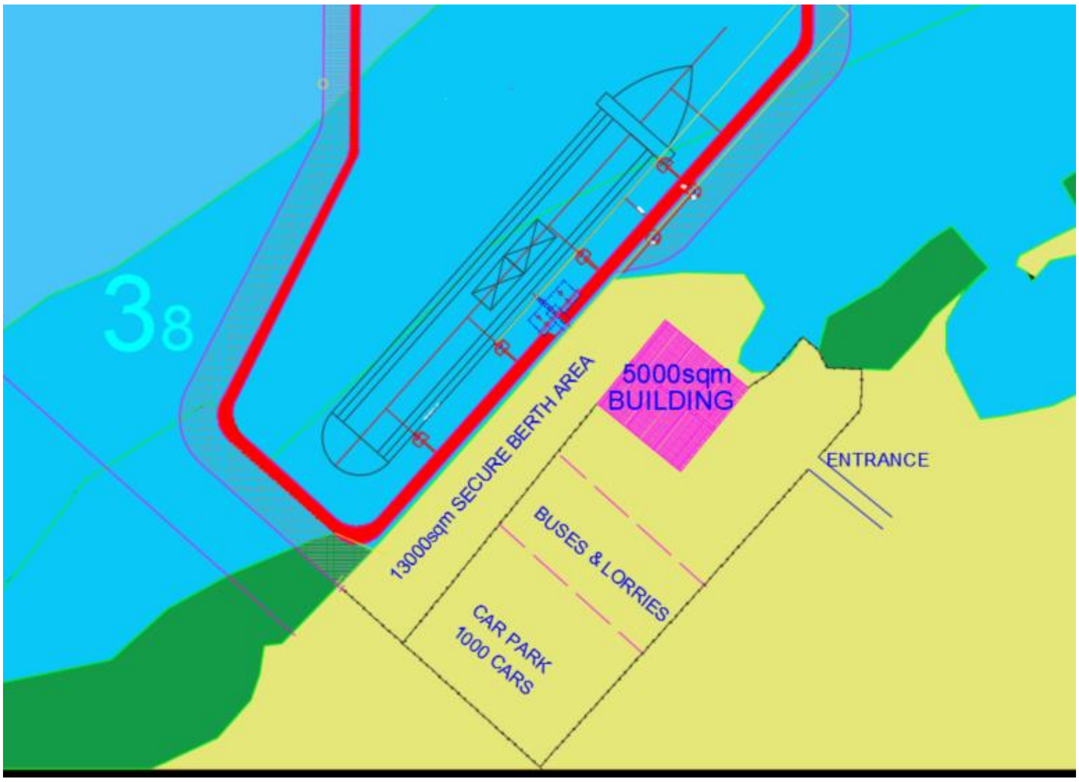
14.2 Full Terminal Building

To service turnaround calls for large vessels efficiently a fully developed terminal building is required. These facilities are extensive and incur considerable cost. To make such an investment justifiable a large number of very large vessels would need to be making turnaround calls.

The figure below shows: -

- A 5000 sqm Terminal building; very broadly depending on the facilities this could be £2500-£3500 per sqm i.e. £12,500,000 - £17,500,000. This is a very broad initial estimate. Large south coast facilities with very frequent usage have £50m building for example.
- 12000sqm car park hard standing could be approximately £1,200,000-£1,500,000 depending of the existing formation fill material;
- Bus and Lorry park 8000 sqm could be £1,000,000;
- Heavy duty paving to the 13000sq m berth area could be £2,000,000;
- Hardstanding to the remainder of the site £2,200,000-£2500,000;
- Security, fencing, CCTV etc pro sum £3.000,000m;
- Road access and services, not definable at this stage.

Table 14-1: Schematic area utilisation for possible Terminal



The above cost tabulation suggests a range of £22m- £27.5m inter alia, for a possible initial turnaround land-based development and is given here as an exercise rather defined budget. But is can be seen that there is enough space on the existing site to develop into a luxury Terminal should this be the client's goal: AND if this is his goal it may create a better finished produce to consider the Scheme 2 arrangement rather than the progressive Scheme 1 arrangements.

14.3 Basic Turnaround Facilities

Operators of smaller vessels, and those serving certain market segments are able to make turnaround calls with reduced facilities. A combination of some small permanent structures for security and passport control, supplemented by larger temporary structures for waiting and baggage storage can be sufficient in these cases. Parking, fencing, paving etc will still be required but the overall cost will be much lower.

Estimated cost for this is £10 m.

14.4 Transit Calls

A smaller land installation would be appropriate in this instance and would need to be tailored to the expected market response.

The main requirement for a transit only facility is a security check point for passengers re-joining the vessel. This would require a reception building and controls as well as some vehicles access and parking.

This section is still under consideration in this draft document and requires more discussion with the Client however the following is being considered:-

- 2000 sqm lower spec reception building £5,000,000;
- Say 25% on parking and hard standing £625,000;
- Berth paving at a reduced specification £1,235,000;
- Fencing and security say £1,000,000.

Total in the region of say £8m

15. Design Scenarios

The various elements of a cruise terminal developed in sections 10, 13 and 14 are summarised below. These have been combined to give design scenarios that offer a package of benefits that are:

- Sufficiently distinct from one another to provide meaningful comparison;
- Likely to be relevant to the needs of the market or offer a very low-cost initial development.

Table 15-1: Summary of Cruise Terminal Elements Developed for Cockenzie

Element	Capital Cost (m)	Functionality
Berthing options		
1A	£49.30	Transit only, 50% of tide cycle
1B	£39.60	Transit only, 50% of tide cycle
1C	£36.30	Transit only, 50% of tide cycle
1D	£50.20	Transit only, 50% of tide cycle
1E	£60.50	Turnaround and transit, 100% of tide cycle (with continuous quay)
1F	£50.80	Transit only, 100% of tide cycle
1G	£47.50	Transit only, 100% of tide cycle
2	£60.70	Turnaround and transit, 100% of tide cycle (with continuous quay)
Quay options		
W	£3.50	Vessel loading unloading specific points fore and after
X	£10.00	Continuous deck independent of berthing and mooring loads
Y	£18.00	Integrated Structure (complete slab deck access) (with option 1)
Z	£23.00	Integrated Structure (complete slab deck access) (with option 2)
Landside options		
TO	£8.00	Transit Only
FT	£27.50	Full Terminal Building
BT	£10.00	Basic Turnaround Structures

The design scenarios are as follows:

Table 15-2: Design Scenarios Taken for Financial Assessment

Scenario	Berthing options	Quay options	Landside options	Cost (£ m)	Berthing options	Quay options	Landside options	Total
A	1C		TO		£36.30	£0.00	£8.00	**£44.30**
B	1C	X	BT		£36.30	£10.00	£10.00	**£56.30**
C	1E		TO		£60.50	£0.00	£8.00	**£68.50**
D	1E	X	BT		£60.50	£10.00	£10.00	**£80.50**
E	2	X	BT		£60.70	£10.00	£10.00	**£80.70**

These design scenarios offer the following capabilities:

Table 15-3: Design Scenarios Tested for Financial Viability and Economic Benefit

Design Scenario	Elements Included	Transit or Turnaround Calls	Allows Berth Sharing?	Rationale
A	1C + Transit Only landside facilities	Transit only	No	Lowest cost option
B	1C + continuous quay deck and basic turnaround landside facilities	Transit and Turnaround	Yes	Enables turnaround calls and berth sharing
C	1E + Transit Only landside facilities	Transit only	No	As A but eliminates tidal restriction
D	1E + continuous quay deck and basic turnaround landside facilities	Transit and Turnaround	Yes	As C but enables turnaround calls and berth sharing
E	2 + continuous quay deck and basic turnaround landside facilities	Transit and Turnaround	Yes	As D but potentially much better suited to large vessels by simplifying loading/unloading

16. Basic Financial Model

16.1 Overview

A simple financial model has been compiled to assess the likely payback period of the capital cost of developing Cockenzie into facility for cruise vessels. The model comprises the following elements:

- A demand projection which includes:
  - A ‘do nothing’ scenario assuming only existing cruise facilities in the Firth of Forth;
  - Scenarios A to E that assume Cockenzie is built with varying levels of capability as per the design scenarios;
- A revenue projection based on the operating surplus from each cruise call;
- A payback calculation that compares the capital costs with the operating surplus.

The model is based on the average surplus that can be achieved per metre length of cruise vessel calling each year, and the number of passengers using the facility each year. Payback has been assessed over a 25-year period. The model has been used to test the design scenarios shown in section 15.

16.2 Demand Projection

16.2.1 Variables

The demand projection assumes the number of cruise calls increases in line with broad trends in the UK cruise sector. Specific assumptions are made regarding the impact of the new facility at Cockenzie on cruise operator’s decision making. For simplicity cruise calls in 2019 are taken as the starting point and the impacts are applied from year 1 of operations at Cockenzie[1].

Changes to the following variables are applied in the model:

- Number of cruise calls;
- Average length of vessels;
- Average passengers per metre LOA; and
- The proportion of cruise calls that are turnaround calls.

To identify the impact of Cockenzie a ‘do nothing’ scenario was also developed that assumed continued growth of cruise calls in line with UK trends but limited by the current facilities.

In the scenarios with Cockenzie the average number of passengers per metre LOA is included because of the non-linear relationship between cruise vessel length and passenger capacity. As cruise vessels become longer, they typically become wider and taller as well, thereby further increasing their capacity.

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[1] Year 1 of operations could be 2-3 years after 2019 and in that time some limited growth in cruise calls could occur.

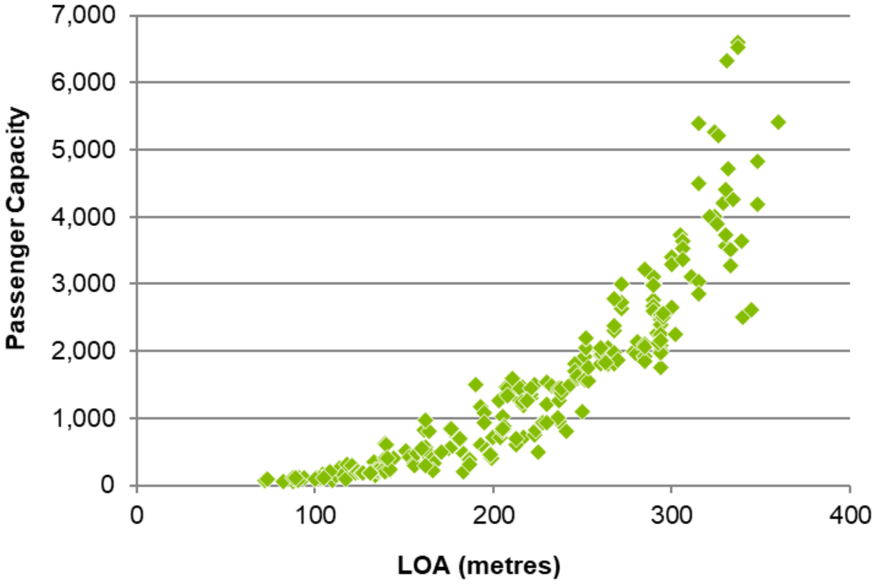

Figure 16-1: Plot of Cruise Vessel Length (LOA) and Passenger Capacity

Both the length of cruise vessels and average number of passengers per metre LOA were adjusted based on the following LOA intervals. These values were derived from calls in the Firth of Forth in 2019.

Table 16-1: LOA Intervals Used in the Demand Projection

LOA Intervals (m)	Average LOA (m)	Passenger Capacity per metre
50 – 99	88.7	1.1
100 – 149	129.9	1.8
150 – 199	175.1	3.5
200 – 249	221.2	4.9
250 – 299	288.5	9.1
300 – 349	324.0	12.3

The changes are applied as described in Table 16-2 below:

16.2.2 Transfer of Cruise Calls from Other Ports

Cruises calling at other ports in Scotland also take passengers to Edinburgh on excursions. The ports of Greenock and Dundee are sufficiently close by road to make this feasible, and both allow alongside berthing for larger vessels than is currently possible in the Firth of Forth. The approximate number of cruises per annum at these ports is:-

- Greenock 50[2]
- Dundee 10

Approximately 75% of vessels calling at Greenock are longer than 200 m LOA, as are the majority of cruise calls at Dundee. Cruise operators Crystal, Disney, P&O and TUI all bring vessels in the range 250 – 300 m LOA to Greenock but do not call in the Firth of Forth. Other operators such as CMV currently bring their smaller vessels to the Firth of Forth but their larger vessels to Greenock and Dundee.

The fact that Edinburgh is a ‘marquee’ port, cruises to Dundee and Greenock advertise excursions to Edinburgh, and the lack of facilities for larger vessels in the Firth of Forth indicate latent demand for more cruise calls at Edinburgh. Therefore, the demand projection assumes up to 30 cruise calls, of vessels 200 m LOA and greater, may be gained from Greenock and Dundee once a new facility is built in the Firth of Forth. The transfer of calls is assumed to take place over 3 years.

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[2] Excluding regular cruises from Greenock operated by the small (72 m LOA) cruise vessel *Hebridean Princess*

16.2.3 Vessel Loadings

In all scenarios the following vessel loadings are assumed:

- For transit calls 85% of the nominal vessel capacity (this is the number of people assumed to come ashore)
- For turnaround calls 140% of the nominal vessel capacity (this is the sum of the number of passengers disembarking a cruise that ends, and boarding a cruise that begins)

The same assumptions are used for the financial assessment and calculation of economic benefit.

Table 16-2: Forecasting Variables[2]

<table>
<thead>
<tr><th>Variable</th><th>2019 Value</th><th>Growth Assumption</th><th>Rationale</th></tr>
</thead>
<tbody>
<tr><td>Number of cruise calls</td><td>110</td><td>Short term (years 1 – 3): 8% + 30
Medium term (years 4 – 10): 5%
Long term (years 11 onwards): 2%</td><td>Given the 11% p.a. growth rate in the Firth of Forth over the period 2015 – 2020 strong growth (8%) is assumed in the short term, and in addition 30 cruise calls are assumed to transfer from Greenock and Dundee at a rate of 10 per year for the first three years. In the medium term the rate of growth is assumed to reduce to 5%. Thereafter the annual growth rate is cut to 2% as the long-term growth of the cruise sector is less certain, demographic changes could see a contraction in the key market for cruises i.e. pensioners with disposable incomes.</td></tr>
<tr><td>Average length of vessels</td><td>209.75</td><td>Rising to 223.3 over first 5 years, constant thereafter.</td><td>With a berth free of draught, length, width and air draught limitations it is assumed a larger proportion of calls will be accounted for by longer vessels in the future. It is assumed the market will adjust within the first five years of operation causing the distribution of vessel length in the Firth of Forth to change as follows:
<table>
<tr><th>LOA Intervals</th><th>2019 values</th><th>After 5 years</th></tr>
<tr><td>50 – 99</td><td>5%</td><td>5%</td></tr>
<tr><td>100 – 149</td><td>13%</td><td>10%</td></tr>
<tr><td>150 – 199</td><td>22%</td><td>20%</td></tr>
<tr><td>200 – 249</td><td>35%</td><td>30%</td></tr>
<tr><td>250 – 299</td><td>25%</td><td>25%</td></tr>
<tr><td>300 – 349</td><td>1%</td><td>10%</td></tr>
</table></td></tr>
<tr><td>Average passengers per metre LOA[3]</td><td>5.1</td><td>Rising to 5.8 over first 5 years, constant thereafter.</td><td>Larger vessels accommodate more passengers per metre of length due to being wider and taller, therefore the number of passengers carried will increase as the proportion of longer vessels increases. The proportion of passenger accommodation accounted for by different vessel lengths will change as follows:
<table>
<tr><th>LOA Intervals</th><th>2019 values</th><th>After 5 years</th></tr>
<tr><td>50 – 99</td><td>1%</td><td>1%</td></tr>
<tr><td>100 – 149</td><td>5%</td><td>3%</td></tr>
<tr><td>150 – 199</td><td>15%</td><td>12%</td></tr>
<tr><td>200 – 249</td><td>33%</td><td>25%</td></tr>
<tr><td>250 – 299</td><td>44%</td><td>38%</td></tr>
<tr><td>300 – 349</td><td>2%</td><td>21%</td></tr>
</table></td></tr>
<tr><td>Proportion of turnaround calls</td><td>25 - 30%</td><td>Increases to 35% if Cockenzie can handle turnaround calls</td><td>Some cruise operators indicated they would like to operate turnaround calls in the Firth of Forth but cannot due to vessel size restrictions or don’t feel the facilities meet their requirements in other ways. The increase in the proportion of turnaround calls is only applied in scenarios where Cockenzie can handle turnaround calls.</td></tr>
</tbody>
</table>

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[3] These values are calculated on stated vessel capacity but discounted by 15% to reflect that: a) cruise ships are not always full and b) during a transit call not all passengers will go ashore.

16.2.4 Projection of Total Demand

The above assumptions were used to create a projection of cruise calls in the Firth of Forth over a 25-year period. This is an unconstrained projection assuming no limitations in terms of overall berth or anchorage availability, except in the case of Cockenzie. Implicit in the assumptions is that Cockenzie makes the Firth of Forth a more attractive place for cruise operators to call, which encourages them to make more calls, bring larger vessels and undertake more turnarounds.

The total demand projection would result in the number of calls doubling, and 2.2 times more passengers by the end of the 25-year period, compared with 2019.

Table **16-3**: Do Nothing Forecast Showing Total Cruise Calls in the Firth of Forth

Year	Number of Cruise Calls	Average LOA	Total LOA	Total Pax	Annual Growth LOA	Annual Growth Pax
1	119	209.7	24,960	143,664	8%	8%
5	153	209.7	32,091	184,711	5%	5%
10	195	209.7	40,900	235,416	5%	5%
25	262	209.7	54,953	316,303	2%	2%

16.2.5 Projections for Cockenzie Design Scenarios A to E

As the most easily accessible facility, potentially avoiding the cost of pilots and tugs boats associated with use of anchorages, and avoiding the need for tender operation, it is assumed that Cockenzie will be cruise operator’s first choice. Cockenzie will not be able to serve all the unconstrained demand however because, depending on the design scenario:

- It cannot accommodate turnaround calls;
- The berth length is limited;
- It cannot accommodate more than one call at a time;
- There are tidal restrictions (although these are minimal)[4].

To reflect this a series of projections have been made to show likely cruise calls at Cockenzie with the applicable constraints for each design scenario. The constrained projections also assume :

- All existing calls at Leith, Rosyth, Newhaven and South Queensferry switch to Cockenzie in the first year of operation
- On days when more than one vessel calls in the Firth of Forth and the design scenario prevents berth sharing:
    - Only one can call at Cockenzie, and;
    - The largest of the vessels calling that day will use Cockenzie
- The capacity of Cockenzie is finite, limited to 182 days per year and although berth sharing is possible in some design scenarios, this will not occur more than on more than 20% of days in the season
- In design scenarios where Cockenzie can handle turnaround calls, the proportion of turnaround calls increases as shown in Table 16-2 and all turnaround calls in the Firth of Forth take place at Cockenzie

The results are summarised as the uplift in total passengers in the Firth of Forth over 25 years compared to the design scenario. This is the basis of the financial assessment.

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[4] Cruise operators have preferred arrival and departure times of between 07.00 – 09.00 and 18.00 – 20.00 but advised they can flex their schedules by an hour either side of these times to accommodate tidal restrictions. Given this flexibility the 50% tidal access scenarios are estimated to reduce vessel calls by less than 1%.

Table 16-4: Proportions of Total Demand that may use Cockenzie

Design Scenario	Options Included	Transit or Turnaround Calls	Allows Berth Sharing?	Tidal Restriction	% uplift in total passengers in the Firth of Forth over 25 years
A	1C	Transit only	No	Yes	32%
B	1C + continuous quay deck and basic onshore facilities	Transit and Turnaround	Yes	Yes	52%
C	1E	Transit only	No	No	32%
D	1E + continuous quay deck and basic onshore facilities	Transit and Turnaround	Yes	No	52%
E	2 + continuous quay deck and basic onshore facilities	Transit and Turnaround	Yes	No	52%

The results show that:

- The tidal restrictions have almost zero bearing on the results, and
- Accommodating turnaround calls makes an appreciable difference to the number of passengers that can be handled.

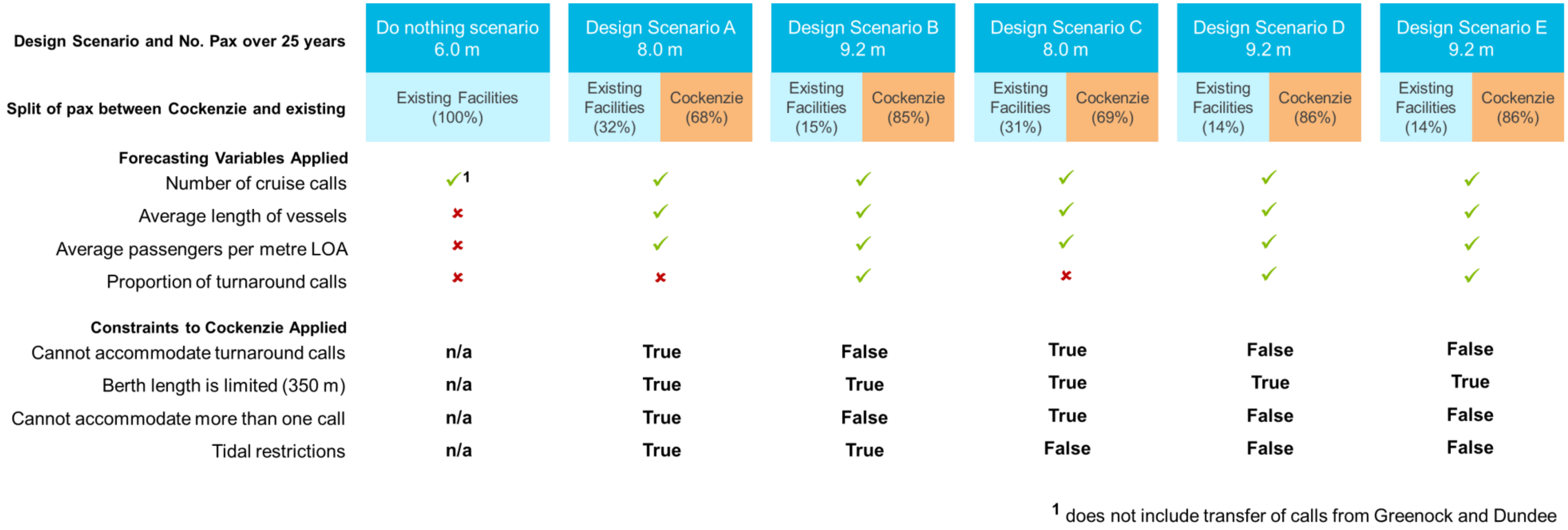
The results are shown in more detail below and summarised in Figure 16-2

Table 16-5: Constrained Forecast Showing Total Cruise Calls at Cockenzie, Design Scenarios A to E

	A		B		C		D		E	
Year	Cruise Calls	Total Pax	Cruise Calls	Total Pax	Cruise Calls	Total Pax	Cruise Calls	Total Pax	Cruise Calls	Total Pax
1	93	101,116	110	150,830	94	101,539	111	151,329	111	151,329
5	137	172,830	162	257,860	137	173,553	162	258,713	162	258,713
10	174	219,467	205	327,597	175	220,385	206	328,680	206	328,680
25	217	274,119	218	367,591	218	275,266	218	367,591	218	367,591

Blue shading = capacity limit reached

Figure 16-2: Outcome of Demand Projections



Design Scenario and No. Pax over 25 years	Do nothing scenario 6.0 m	Design Scenario A 8.0 m	Design Scenario B 9.2 m	Design Scenario C 8.0 m	Design Scenario D 9.2 m	Design Scenario E 9.2 m
Split of pax between Cockenzie and existing	Existing Facilities (100%)	Existing Facilities (32%) Cockenzie (68%)	Existing Facilities (15%) Cockenzie (85%)	Existing Facilities (31%) Cockenzie (69%)	Existing Facilities (14%) Cockenzie (86%)	Existing Facilities (14%) Cockenzie (86%)
Forecasting Variables Applied						
Number of cruise calls	✓[1]	✓	✓	✓	✓	✓
Average length of vessels	✗	✓	✓	✓	✓	✓
Average passengers per metre LOA	✗	✓	✓	✓	✓	✓
Proportion of turnaround calls	✗	✗	✓	✗	✓	✓
Constraints to Cockenzie Applied						
Cannot accommodate turnaround calls	**n/a**	**True**	**False**	**True**	**False**	**False**
Berth length is limited (350 m)	**n/a**	**True**	**True**	**True**	**True**	**True**
Cannot accommodate more than one call	**n/a**	**True**	**False**	**True**	**False**	**False**
Tidal restrictions	**n/a**	**True**	**True**	**False**	**False**	**False**

[1] does not include transfer of calls from Greenock and Dundee

16.3 Revenue Projection

Revenue has been assessed using benchmarks of revenue per metre of cruise ship per call and per passenger. All monetary values are at constant (2019) prices.

Based on discussion with industry partners AECOM have arrived at the following order of magnitude surpluses that should be achievable for handling a cruise call. The surplus is the port's income after paying for operating expenses to handle the cruise call. The surplus can contribute to repayment of the capital cost[5]. The benchmark surplus values are:

Table 16-6: Estimated Surplus per Vessel Metre or Passenger, Transit and Turnaround Calls, 2019 Prices

Transit Calls	Turnaround Calls
£28 per vessel metre	£28 per vessel metre
£7 per passenger (charged per passenger going ashore)	£7 per passenger (charged on those disembarking and those embarking)
£ n/a per passenger for baggage	£3.15 per passenger for baggage (charged on those disembarking and those embarking)

Multiplying these values by the total projected vessel metres and number of passengers gives surplus revenues, that could contribute to the capital outlay, as shown below.

Table 16-7: Constrained Forecast Showing Total Annual Operating Surplus (millions) from Cruise Calls at Cockenzie, Design Scenarios A to E

Year	A	B	C	D	E
1	£1.14	£2.19	£1.16	£2.22	£2.22
5	£1.85	£3.64	£1.89	£3.69	£3.69
10	£2.35	£4.63	£2.40	£4.69	£4.69
25	£2.94	£5.49	£3.00	£5.49	£5.49
Lifetime surplus	£59.38	£113.40	£60.59	£114.01	£114.01

16.4 Payback Period

The payback period for each design scenario has been calculated based on the cumulative surplus values and represent the earliest year at which the capital cost could be met by the cumulative surplus. Note this simple analysis takes no account of finance costs or the time value of money.

Table 16-8: Payback Period of Different Design Scenarios

Design Scenario	Options Included	Transit or Turnaround Calls	Allows Berth Sharing?	Cost (£ m)	Payback Period (years)
A	1C	Transit only	No	£44.30	20
B	1C + continuous quay deck and basic onshore facilities	Transit and Turnaround	Yes	£56.30	15

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[5] In this high-level study only the initial capital cost is considered, but at a later stage of development maintenance, periodic refurbishment, overhead costs such as management, finance costs and other fixed costs would need to be included in a more detailed assessment.

C	1E	Transit only	No	£68.50	>25
D	1E + continuous quay deck and basic onshore facilities	Transit and Turnaround	Yes	£80.50	19
E	2 + continuous quay deck and basic onshore facilities	Transit and Turnaround	Yes	£80.70	19

16.5 Summary

All design scenarios except C could have their capital costs recovered within 25 years, and this excludes consideration of other fixed costs that will be incurred in operating Cockenzie cruise berth. Design scenario B appears to offer the most attractive proposition based on this simple analysis as it has the shortest payback period. These results are very sensitive to assumptions regarding the:

- Extent and cost of dredging, and;
- Operating surplus that a port operator can achieve, which in turn is sensitive to the tariff the cruise market can bear for calling in the Firth of Forth, and the operating costs incurred by the port operator.

17. Basic Calculation of Economic Benefit

17.1 Overview

Each cruise call presents three opportunities for the local economy:

- Expenditure by the cruise operator on port services;
- Expenditure by tourists coming ashore;
- Expenditure by off-duty crew members coming ashore.

The benefit of each pound spent exceeds one pound due to the multiplier effect. The multiplier reflects three types of spending that normally occur as a consequence of each purchase:

- Direct spending e.g. by the cruise operator, cruise passenger or crew member;
- Indirect spending by those in the local economy in receipt of direct spending, e.g. the ship's agent paying the line handlers is indirect spending, or local restaurants buying food from suppliers;
- Induced spending, which represents the spending of those employed as a result of the direct and indirect spending.

To estimate all these elements is large undertaking and beyond this initial feasibility study. As per the agreed scope the impact of passenger and crew spending only has been estimated. This includes the direct, indirect and induced spending triggered by their visit. Benchmark multipliers have been used in the absence of local multipliers which would require extensive research to identify.

Economic benefits already arise from the existing cruise calls in the Firth of Forth, therefore only those attributable to the new facility at Cockenzie should be included in the calculation.

17.2 Economic Benefit of Additional Passenger Spending

Based on a review of published studies on passenger and crew spending the following values were adopted:

Table 17-1: Assumed Economic Impact of Passenger and Crew Spending, per Passenger

Call Type	Direct Spend	Total value added (direct spend + indirect + induced
Transit	£51	£106
Turnaround	£88	£175

Multiplied by the number of passengers this gives the following economic benefits over 25 years compared to the do nothing scenario.

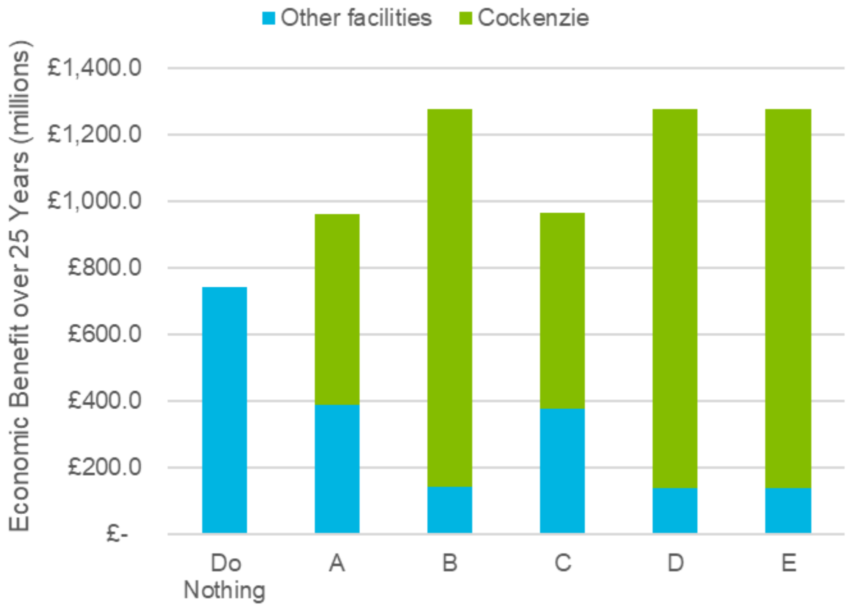
Table 17-2: Economic Benefit from Crew and Passenger Spending Arising from Cockenzie

Design Scenario	Years	Economic Benefit from Crew and Passenger Spending (millions)
A	1 - 25	£964
B	1 - 25	£1,277
C	1 - 25	£966
D	1 - 25	£1,278
E	1 - 25	£1,278

Spending per head is greater for turnaround calls, and the scenarios with turnaround calls deliver around 30% more economic benefit than those without. Scenario B has almost the maximum economic benefit of any scenario, and considering it has the shortest payback period (as noted in section 16.4) would appear to be the most attractive option.

The total economic benefit of cruise calls in the Firth of Forth, including at the existing facilities, is illustrated below.

Figure 17-1: Cumulative Economic Benefit of Passenger and Crew Spending over 25 Years (2019 prices)



A	1C	Transit only
B	1C + continuous quay deck and basic onshore facilities	Transit and Turnaround
C	1E	Transit only
D	1E + continuous quay deck and basic onshore facilities	Transit and Turnaround
E	2 + continuous quay deck and basic onshore facilities	Transit and Turnaround

Note the passenger and crew spending will be spread over a wide area and most of the economic benefit will occur outside East Lothian.

17.3 Summary

The economic benefit of additional passenger and crew spending amounts to approximately £5.9 m in year 1 rising year on year to reach £27.8 m by year 25 for scenarios B, D and E (at constant prices). This does not include the economic benefit from vessel operations.

Note that some of the economic benefit is derived from cruise calls transferring from Greenock and Dundee. As these cruises currently bring passengers to Edinburgh, some of this economic benefit is not 'new' or additional because it is already present. Quantifying this would be very difficult and beyond the scope of this study, and the relevance of this issue depends on the geographical area over which the project proponents are interested in boosting economic activity.

18. Discussion and Conclusions

18.1 Discussion

The Firth of Forth has a healthy cruise business with around 100 calls per annum from a wide variety of operators. Some of those operators bring repeat business to the region, and that includes turnaround calls (25% of total) as well as transit calls. There are two locations where cruise vessels can berth (Leith and Rosyth) although size limitations apply, and two anchorages that can be used for larger vessels.

In section 10 of this report AECOM have developed 8 initial design berth and access permutations that provide varying levels of capability to accept cruise vessels at Cockenzie. Their cost ranges from £36.3 m to £60.7 m. Those with the greatest capability have the highest cost. Differences in cost arise primarily from:-

- Permutations on 450 m long access and passenger system for the Option 1 series of permutations where the berth is placed to minimise dredging;

- Dredging and particularly rock dredging cost for an alongside berth at the existing wall; hence minimising the length of the berth approach.

The cost estimates are based on available information. They may reduce if more information can be obtained concerning bathymetry and rock profiles and properties.

These permutations only allow for a PAS system/ operational berth decking area at the centre of the vessel. They do not allow specifically for bulk luggage loading at the vessel ends. Since this is a likely necessity for a turn-around Terminal, section 14 gives add-on costs to allow for this by using the open berth concept, but adding decking as follows

Either

- Vessel loading unloading specific points fore and after:
    - Forward loading platform and access pod connected to road access £3,500,000;
    - Stern loading platform and access pod connected to road access £3,500,000;
    - These specific areas will be connected to the mid ships turn around area;

Total £7,000,000;

Or

- For all schemes 1-3, a continuous deck has been allowed which is independent of berthing and mooring loads, from between the vessel perpendiculars, say 240m long and 10m wide; enough for vehicle access.

This would add approximately £10m.

For example, applied to scheme 1E with a base cost of £60.5m, adding local fore and aft handling areas would increase the cost to £67.5m whilst adding a continuouse10m strip would increase the cost to £70.5m. We have referred to this as scheme 1Eturnround in section 14.1

A similar enhancement of scheme 2 of base cost £60.7m would increase the cost to £67.7m and £70,7 m respectively and we have referred to this as Scheme2turnaround in section 14.1

The cost effect of the enhanced decking has been taken further in section 14,2 and the cost addition for a continuous structural decking across the whole berth area has been considered for comparison. In this option the large monopiles and walkways are deleted, and the berth is formed as a deck on a pile grid.

For example, applied to scheme 1E with a base cost £60.5m providing a fully convention slab (without large diameter piles would give a total cost of £78 m and we have referred to this scheme as E turnaround/slab in section 14.2

A similar exercise for schem2, basis cost £60.7m, increases the scheme cost to £83.7m and this has been referred to a scheme 2 turnaround/slab in section 14.2

Clearly these are significant increases.

Finally, in section 15 Aecom have suggested a potential land side development cost of £22-£27.5m for a turnaround berth and possibly £8m for a stopover berth. These are very broad figures but must be ADDED to any of the above permutation for give a final total. £36.m for a bare bone scheme 1c to £83.7+ £27.5m= £111.4m for s fully slabbed scheme 2 turnaroundslab plus the top range of shore works.

All design scenarios except C could have their capital costs recovered within 25 years, and this excludes consideration of other fixed costs that will be incurred in operating Cockenzie cruise berth. These results are very sensitive to assumptions regarding the:

- Extent and cost of dredging, and;
- Operating surplus that a port operator can achieve, which in turn is sensitive to the tariff the cruise market can bear for calling in the Firth of Forth, and the operating costs incurred by the port operator.

The economic benefit of additional passenger and crew spending amounts to approximately £5.9 m in year 1 rising year on year to reach £27.8 m by year 25 for scenarios that allow turnarounds at Cockenzie. This does not include the economic benefit from vessel operations.

Design scenario B appears to be the most attractive from the point of view of payback period and economic benefit.

Table 18-1: Summary of Design Scenarios

Design Scenario	Options Included	Tidal Restrictions?	Transit or Turnaround Calls	Allows Berth Sharing?	Cost (£ m)	Payback Period (years)	Economic Benefit over 25 years (£ m)
A	1C	Yes	Transit only	No	£44.30	20	£964
B	**1C + continuous quay deck and basic onshore facilities**	**Yes**	**Transit and Turnaround**	**Yes**	**£56.30**	**15**	**£1,277**
C	1E	No	Transit only	No	£68.50	>25	£966
D	1E + continuous quay deck and basic onshore facilities	No	Transit and Turnaround	Yes	£80.50	19	£1,278
E	2 + continuous quay deck and basic onshore facilities	No	Transit and Turnaround	Yes	£80.70	19	£1,278

18.2 Principle challenges

The principle challenges for the schemes are:-

- Correctly identifying the nature and the strength of the rock substrata and foundation layers;
- Correctly assessing the amount and the degree of difficulty of the rock dredging; a potentially significant cost;
- Assessing the amount of soft dredge and the nature of the environmental effects of such a bulk dredging operation;
- The soft material is not likely to be suitable for fill. It will require a dumping licence; therefore, more accurate quantities are a necessity;
- There is no information on possible contamination from the power station. Test are required on this aspect or the dredge could be a non -starter;
- Accurate identification the requirements of a potential cruise ship operator who would potentially wish to use Cockenzie;
- Aecom have provided a very large spread on possible schemes and costs and are not clear which would best suit a cruise operator or the client’s finance comfort level.

18.3 Next Steps

This document is a draft and has covered very broad options. A meeting with the client is necessary in order to finalise and focus the report and to discuss how to meet the above listed challenges with a view to increasing the accuracy of the reporting.

At the same time involvement of cruise vessel operators would be desirable in order to work towards a position where the operator requirements were fully understood.

18.4 Conclusions

Whilst no “ recommendation” conclusion is given here at this point the following is pertinent:-

- There is no doubt that the provision of a cruise berth at Cockenzie is technically feasible and possible, and a wide range of options have been discussed in this draft document, however more of a “shopping list “has been provided rather than a definite recommendation at this stage and further client discussion is necessary to finalise the focus;
- The Schemes considered do indicate that an early definition of whether the Terminal is to be a Stopover or Turnaround facility is desirable if the potential of the scheme is to be maximised and investment is to be protected and best used;
- Considerably more information on ground conditions, bathymetry and existing facilities is necessary in order to hone the accuracy of the estimates.

Appendix A - Market Review, Financial and Economic Tables

Table A-18-1: Cruise Operators Calling at Facilities in the Firth of Forth, 2019

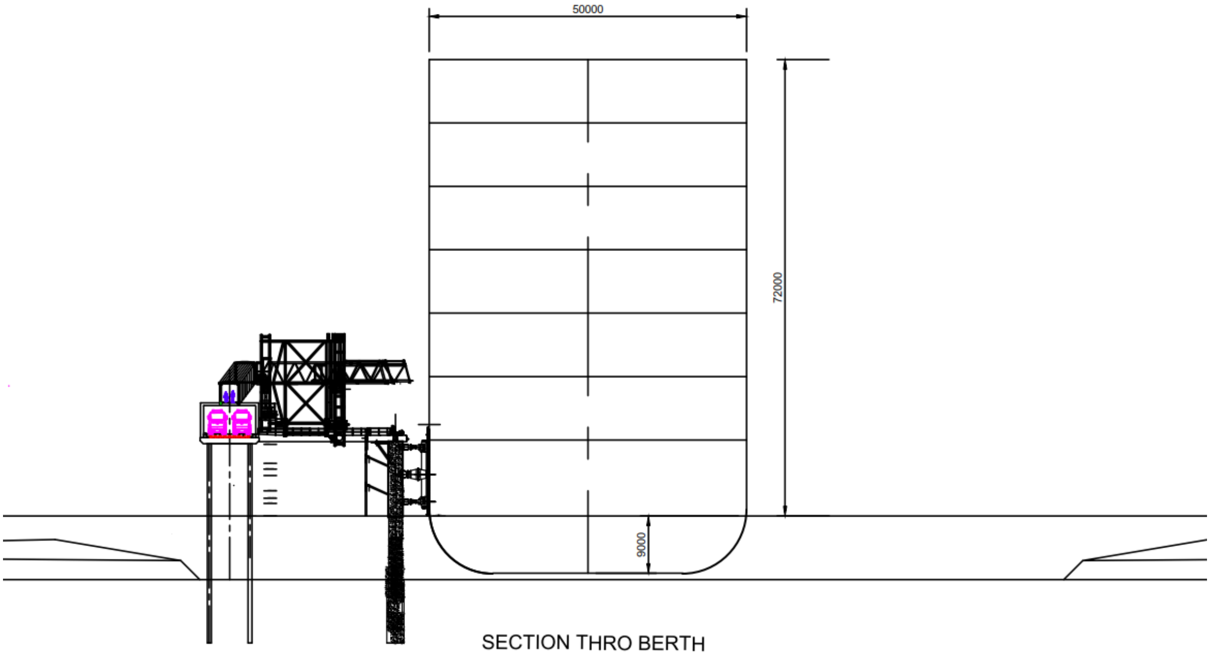
Operator	Leith	Newhaven	Rosyth	South Queensferry
AIDA	-	✓	-	-
Azamara	✓	-	-	-
Chartered Privately	✓	-	-	-
CMV	-	-	✓	-
Costa	-	✓	-	✓
Cunard	-	✓	-	-
Fred Olsen	-	-	✓	-
G Adventures	✓	-	-	-
Grand Circle Cruise Line	✓	-	-	-
Hapag Lloyd Cruises	-	-	✓	-
Holland America	-	-	✓	✓
MSC Cruises	-	-	-	✓
Norwegian Cruise Line	-	✓	-	-
Oceania Cruises	✓	✓	-	-
One Ocean Expeditions	✓	-	-	-
Phoenix	-	✓	✓	-
Plantours	-	-	✓	-
Ponant	-	-	✓	-
Princess	-	-	✓	✓
Pullmantur	-	-	-	✓
Quark Expeditions	✓	-	-	-
Regent Seven Seas Cruises	✓	✓	-	-
Royal Caribbean International	-	-	-	✓
Saga Cruises	-	-	-	✓
Sea Cloud Cruises	✓	-	-	-
Seabourn	-	✓	-	-
Silversea	✓	-	-	-
Viking Cruises	-	✓	✓	-
Voyages to Antiquity	-	-	✓	-
WindStar	✓	-	-	-

Table A-18-2: Fleet Sizes and Largest Vessels of Cruise Operators active in the Firth of Forth

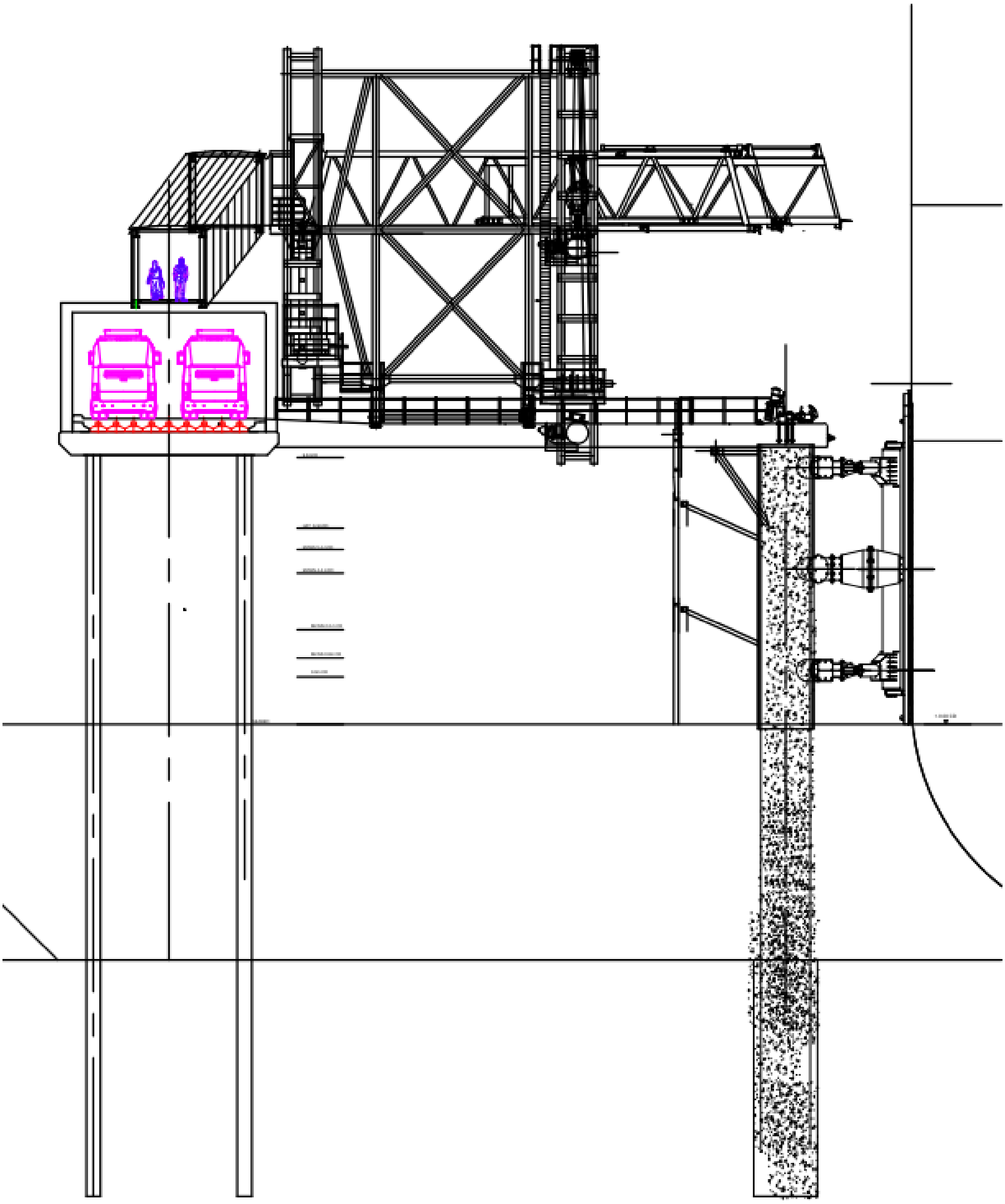
Operator	Global Fleet size	Maximum vessel LOA in fleet	Number of Cruises to Firth of Forth 2019
Royal Caribbean International	25	360	1
Princess	19	330	15
Costa	18	337	4
Holland America	17	300	5
Norwegian Cruise Line	16	335	6
MSC Cruises	15	333	2
AIDA	13	337	4
Ponant	13	142	2
Silversea	11	213	3
Oceania Cruises	7	237	4
Viking Cruises	6	230	13
CMV	6	247	8
WindStar	6	187	3
Seabourn	6	210	2
Hapag Lloyd Cruises	6	225	1
Regent Seven Seas Cruises	5	224	4
Pullmantur	5	268	1
Fred Olsen	4	218	9
Saga Cruises	4	236	1
Azamara	3	181	2
Cunard	3	345	1
Phoenix	2	230	3
Sea Cloud Cruises	2	117	3
Chartered Privately	2	162	1
Quark Expeditions	2	124	1
Grand Circle Cruise Line	1	88.4	5
Voyages to Antiquity	1	141	2
G Adventures	1	104	1
One Ocean Expeditions	1	139	1
Plantours	1	144	1

Appendix B - Scheme “1” Generic Layouts and Sections

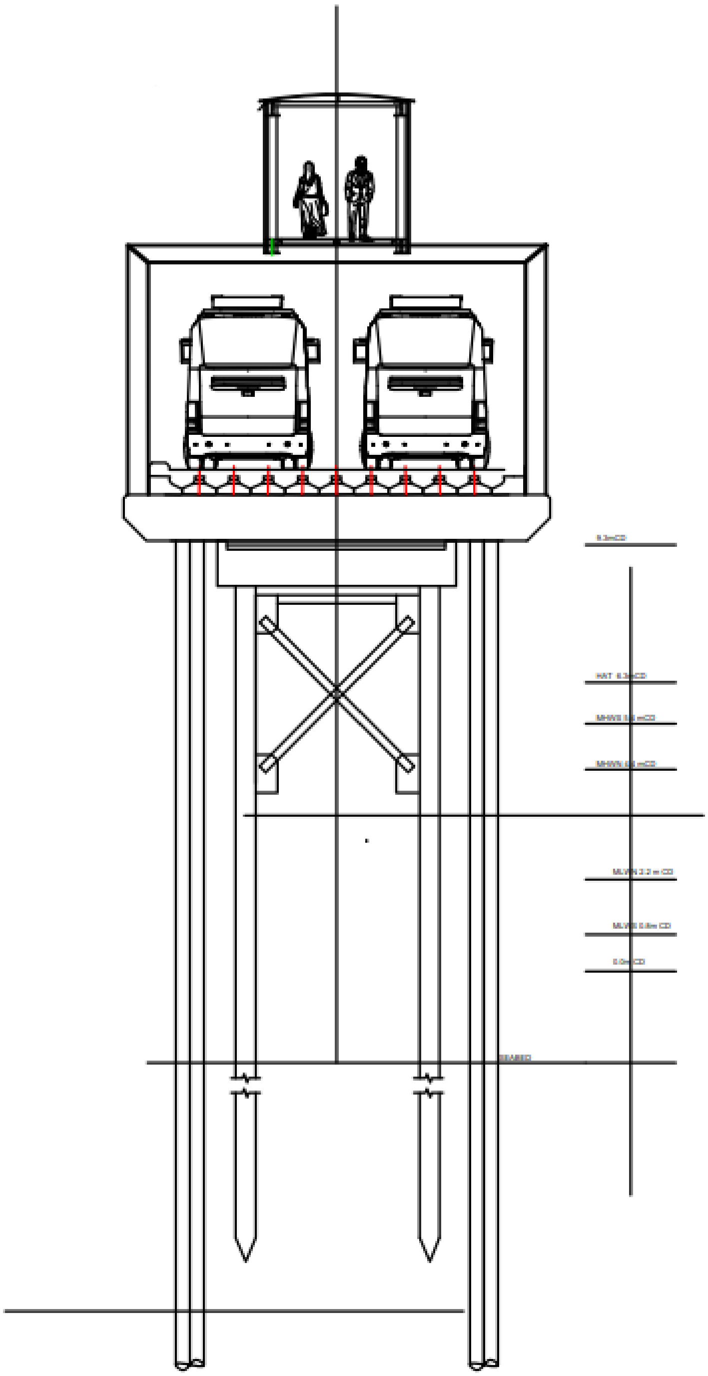
Plan on Option “1” Generic Monopile berth (shown as Option 1A (in berth pocket)



Section thro Option “1” Generic Monopile berth (shown as Option 1A (in berth pocket)



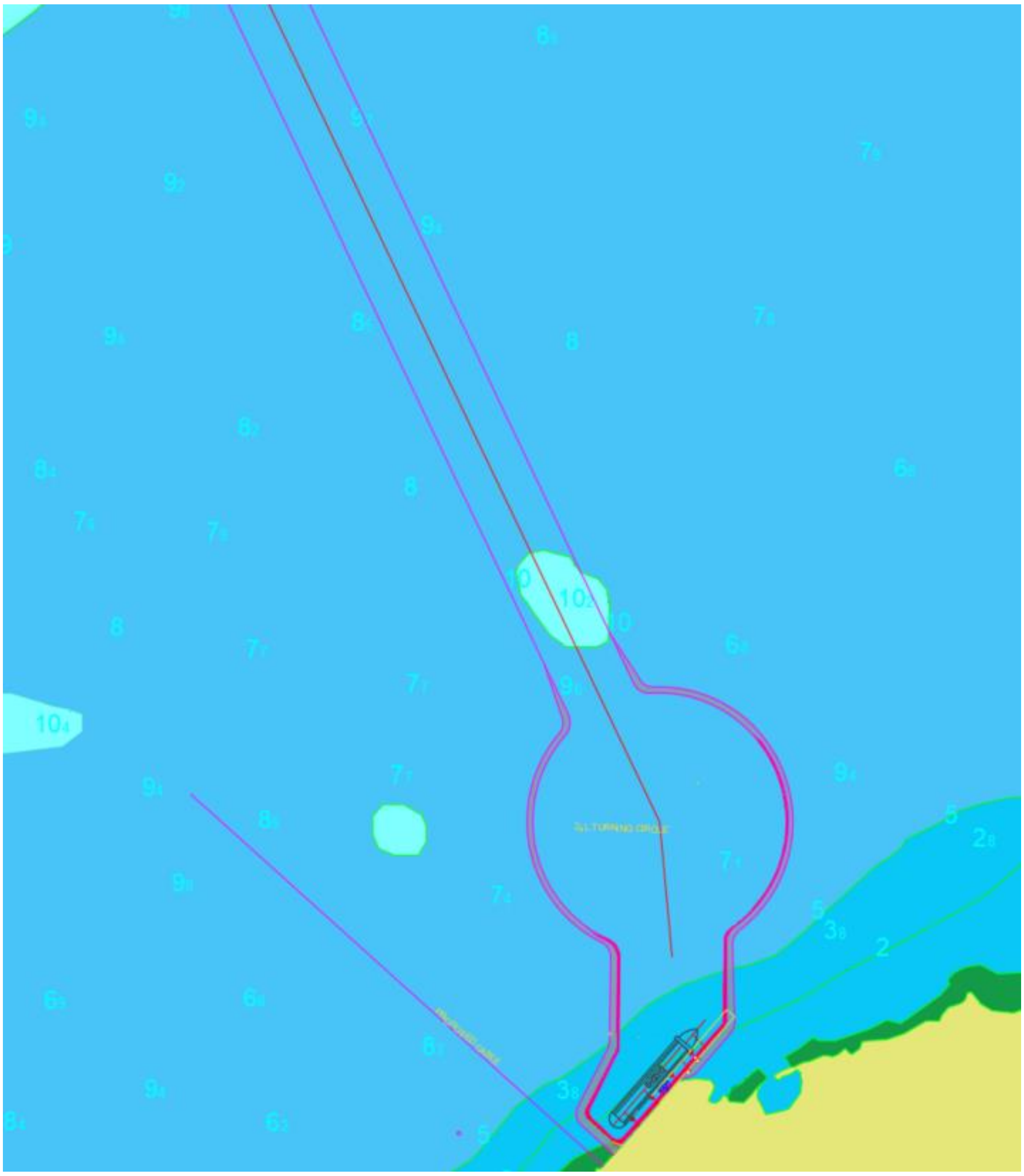
Section thro Option “1” Generic Monopile berth (shown as Option 1A (in berth pocket)



SECTION THRO APPROACH

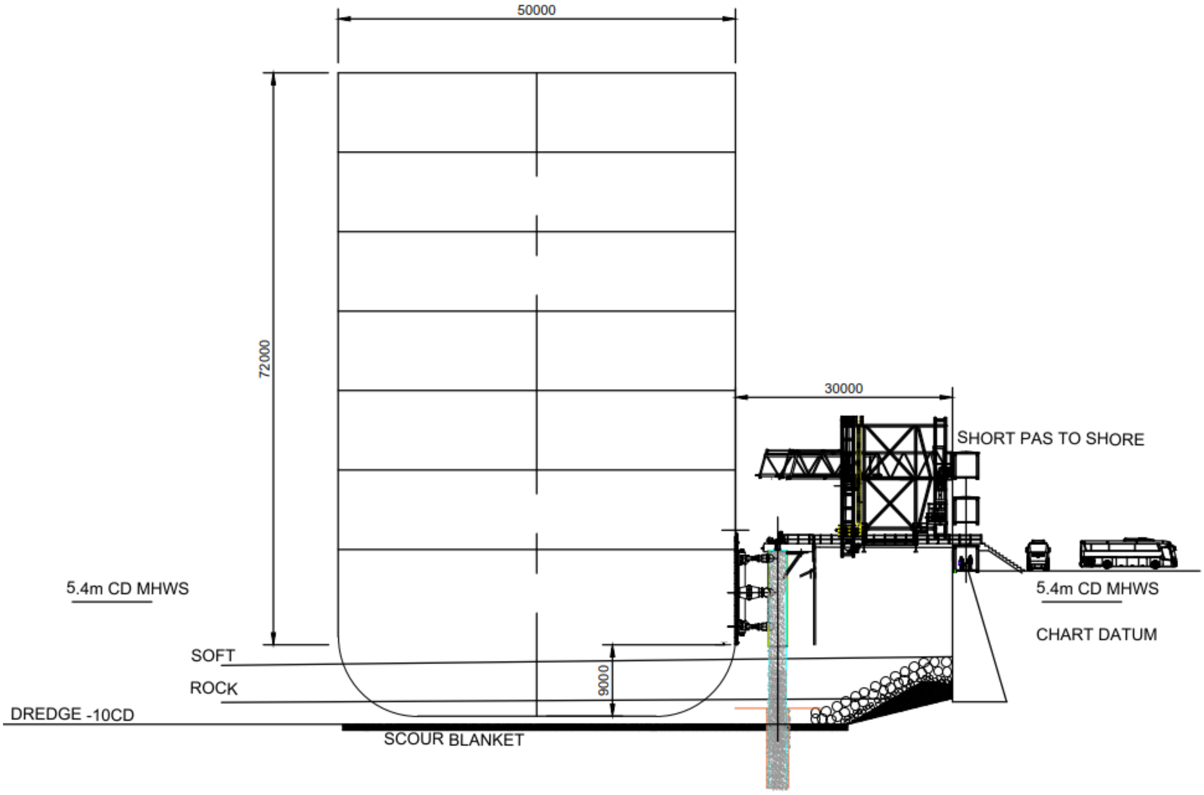
Section thro Option “1” Generic Approach Built over existing (showing Scheme 1A)

Appendix C - Scheme 2 Existing Wall Layouts and Sections



Plan Option 2 dredged Approach, turning circle and berth at existing wall

Plan Option 2 dredged pocket, turning circle at existing wall in relation to the proposed cable



Section Option 2 offset monopile berth at existing wall and access to existing formation.

Appendix D - Design Vessel Oasis Class

Oasis-class cruise ship

The ***Oasis* class** is a class of Royal Caribbean International cruise ships. The first two ships in the class, *Oasis of the Seas* and *Allure of the Seas*,[7][8] were delivered respectively in 2009 and 2010 by STX Europe Turku Shipyard, Finland.[9] A third *Oasis*-class vessel, *Harmony of the Seas*, was delivered in 2016 built by STX France, and a fourth vessel, *Symphony of the Seas*, was completed in March 2018. As of April 2019, The fifth *Oasis*-class ship, *Wonder of the Seas*, is under construction. A sixth unnamed ship has also been ordered by the company[10] The first two ships in the class *Oasis of the Seas* and *Allure of the Seas* are slightly exceeded in size by the third ship *Harmony of the Seas*, while *Symphony of the Seas* is the world's largest cruise ship. *Wonder of the Seas*, due to be completed in Spring 2021, is planned to be larger than *Symphony of the Seas*.[11] As of early 2019, all ships of the class rank as the world's largest passenger ships.

Oasis of the Seas

Class overview	
Builders:	STX Finland Turku Shipyard (Now Meyer Turku), Finland & Chantiers de l'Atlantique, Saint-Nazaire, France
Operators:	Royal Caribbean International
Preceded by:	*Freedom* class
Succeeded by:	*Quantum* class
Built:	2007–2010; 2013–2023 (planned)
In service:	2009–present
Planned:	6
Building:	1
Completed:	4
Active:	4
General characteristics	
Type:	Cruise ship
Tonnage:	225,282 GT[1]–227,700 GT[2]
Length:	360 m (1,181 ft 1 in) overall[3]
Beam:	47 m (154 ft 2 in) waterline 60.5 m (198 ft) extreme[3]
Height:	72 m (236 ft 3 in) above water line[4]
Draught:	9.3 m (30 ft 6 in)[3]
Depth:	22.55 m (74 ft 0 in)[3]
Decks:	16 passenger decks[5]
Installed power:	3 × Wärtsilä 12V46D, 13,860 kW (18,590 hp) each 3 × Wärtsilä 16V46D, 18,480 kW (24,780 hp) each[4][6]
Propulsion:	3 × 20,000 kW (27,000 hp) ABB Azipod (all azimuthing)[4]

Contents

Ship features

The *Oasis*-class ships surpassed the earlier *Freedom*-class ships as the world's largest and longest passenger ships. *Oasis of the Seas* is also 8.5 metres (28 ft) wider, and with a gross tonnage of 225,282, is around 70,000 tonnes larger.[12][13] *Oasis*-class vessels can carry over 5,400 passengers.

Oasis-class ships feature a split structure, with the 5-deck high "Central Park" and "Boardwalk" outdoor areas running down the middle of the ship. These areas feature tropical gardens, restaurants, shops, and a working carousel.[14][15]

Technical details

The displacement—the actual mass—is estimated at approximately 100,000 metric tons, equivalent to the displacement of a *Nimitz*-class aircraft carrier.[16]

To keep the ship stable without increasing the draft excessively, the designers created a wide hull.[17] The cruise ship's officers were pleased with the ship class' stability and performance during the transatlantic crossing, when the vessel, in order to allow finishing work to go on, slowed and changed course in the face of winds "almost up to hurricane force" and seas in excess of 40 feet (12 m).[18][19]

Appendix E - References Codes and Standards

- British standards
    - BS 6349:2013: Maritime Works

      • Part 1: Code of practice for general criteria;

      • Part 2: Design of quay walls, jetties and dolphins;

      • Part 3: Design of dry docks, locks, slipways and shipbuilding berths, ship lifts and dock and lock gates;

      • Part 4: Code of practice for design of fendering and mooring systems;

      • Part 5: Code of practice for dredging and land reclamation;

      • Part 6: Design of inshore moorings and floating structures;

      • Part 7: Guide to the design and construction of breakwaters
    - BS 7361: Cathodic Protection: code of Practice for Land and Marine Applications
    - BS 6719: Highway Parapets for Bridges and Other Structures. Specification for Vehicle Containments Parapets of Metal construction.
    - BS 7671: (incl. Amendment 1). Requirements for Electrical Installations
- Eurocodes
    - EN 1990 Eurocode: Basis of structural design;
    - EN 1991 Eurocode 1: Actions on structures;
    - EN 1992 Eurocode 2: Design of concrete structures;
    - EN 1993 Eurocode 3: Design of steel structures;
    - EN 1994 Eurocode 4: Design of composite steel and concrete structures;
    - EN 1995 Eurocode 5: Design of timber structures;
    - EN 1996 Eurocode 6: Design of masonry structures;
    - EN 1997 Eurocode 7: Geotechnical design;
    - EN 1998 Eurocode 8: Design of structures for earthquake resistance;
    - EN 1999 Eurocode 9: Design of aluminium structures BS EN 60204-32 Safety of Machinery – Electrical equipment of machines – Part 32: Requirements for hoisting machines;
    - BS EN 12100 Safety of machinery. General principles for design. Risk assessment and risk reduction;
- Industry & Other Standards & Design Manuals

Industry and other standards applicable to this document are listed below;

- ISO 8501;
- ISO 4413 – Hydraulic Fluid Power – General Rules and Safety Requirements for Systems and their Components;
- Safety in Docks ACOP L148

- PIANC

  - Guidelines for the Design of Fender Systems: 2002
- American Petroleum Institute (API)
  - API 2A-WSD Recommended Practice for Planning, Designing and
  - Constructing Fixed Offshore Platforms – Working Stress Design, 2008 edition.
- International Ship and Port Facility Security (ISPS) Code
- Oil Companies International Marine Forum (OCIMF)
  - Mooring Equipment Guidelines 3rd Edition
  - Guidelines and Recommendations for the Safe Mooring of Large Ships at Piers and Sea Islands
  - International Safety Guide for Oil Tankers & Terminal

The following codes, guidance and standards are also relevant:

- MJ Tomlinson, Pile Design and Construction Practice, 4th edition;
- CIRIA Report 103: Design of Laterally Loaded Piles;
- ICE Specification for Piling & Embedded Retaining Walls;
- McConnell, Allsop and Cruickshank, Piers Jetties and Related Structures Exposed to Waves.

Appendix F Historic Borehole Logs

RECORD OF BOREHOLE ~~II~~ 30

Sea bed level: – 22.3ft. O.D. Newlyn

Dia. of boring: 6in. to 10ft.
3½in. core to 20ft.
2⅝in. core to 111ft.6in.

Type of boring: Shell and Auger and Rotary Core Drilling

Lining tubes: 6in. to 9ft.6in.
4½in. to 20ft.

Daily Progress	Core Recovery or Samples		Change of Strata			Description of Strata
	Depth	Percentage or Type	Legend	Depth	O.D. Level	
	S.B.L. 5'0"	D D		9'0"	-31.3	Clayey SILT with a little small GRAVEL
4.7.62	9'6" 10'0"	D		9'6"	-31.8	GRAVEL
				12'6"	-34.8	Weathered red SANDSTONE
4/5.7.62	20'0"	75%		21'0"	-43.3	Whitish to red, friable but massive, medium-grained micaceous SANDSTONE
	26'6"	100%				
		100%		30'0"	-52.3	Grey fine-grained friable SANDSTONE with granules of sphaerosiderite, especially between 22ft. and 24ft.
5.7.62	31'6"			31'6"	-53.8	Grey MUDSTONE
		80%		32'6"	-54.8	Grey fine-grained SANDSTONE
	34'0"			34'0"	-56.3	Grey MUDSTONE
				37'6"	-59.8	Grey friable but massive medium SANDSTONE with false-bedding
		100%		38'0"	-60.3	Soft grey MUDSTONE
5/6.7.62	42'6"					
		100%		46'8"	-69.0	Reddish-grey, friable but massive, false-bedded medium-grained SANDSTONE with micaceous partings
				47'0"	-69.3	Soft grey MUDSTONE
				49'3"	-71.6	Whitish, friable but massive, false-bedded micaceous medium-grained SANDSTONE
	49'6"			49'6"	-71.8	Grey MUDSTONE
6.7.62	59'0"	100%				
	64'0"	90%				
6/7.7.62	74'0"	98%		76'0"	-98.3	Red medium to coarse SANDSTONE, micaceous and massive, little false-bedding
				78'0"	-100.3	Red friable GRITSTONE
	84'0"	100%		85'0"	-107.3	Reddish friable medium to coarse-grained SANDSTONE
	90'0"	100%		89'6"	-111.8	Whitish coarse friable SANDSTONE, much broken between 87ft.6in. to 88ft.6in.
		97%		95'6"	-117.8	Reddish, friable and massive, false-bedded medium-grained SANDSTONE with partings of clay

		100%
5.7.62	31'6"	
	34'0"	80%
		100%
5/6.7.62	42'6"	
		100%
	49'6"	
		100%
6.7.62	59'0"	
		90%
	64'0"	
		98%
6/7.7.62	74'0"	
		100%
	84'0"	
		100%
	90'0"	
		97%
7.7.62	96'0"	
		85%
	104'0"	
		100%
7/8.7.62	111'6"	

30'0"	-52.3	
31'6"	-53.8	Grey MUDSTONE
32'6"	-54.8	Grey fine-grained SANDSTONE
34'0"	-56.3	Grey MUDSTONE
37'6"	-59.8	Grey friable but massive medium SANDSTONE with false-bedding
38'0"	-60.3	Soft grey MUDSTONE
46'6"	-69.0	Reddish-grey, friable but massive, false-bedded medium-grained SANDSTONE with micaceous partings
47'0"	-69.3	Soft grey MUDSTONE
49'3"	-71.6	Whitish, friable but massive, false-bedded micaceous medium-grained SANDSTONE
49'6"	-71.8	Grey MUDSTONE
76'0"	-98.3	Red medium to coarse SANDSTONE, micaceous and massive, little false-bedding
78'0"	-100.3	Red friable GRITSTONE
85'0"	-107.3	Reddish friable medium to coarse-grained SANDSTONE
89'6"	-111.8	Whitish coarse friable SANDSTONE, much broken between 87ft.6in. to 88ft.6in.
95'6"	-117.8	Reddish, friable and massive, false-bedded medium-grained SANDSTONE with partings of clay
103'0"	-125.3	Grey carbonaceous MUDSTONE with streaks of coal
111'6"	-133.8	White to pink micaceous false-bedded medium-grained SANDSTONE, friable and massive

Key to type of sample:

D = disturbed sample.

Remarks:

COCKENZIE GENERATING STATION

Soils No: 8/3242

FIG. 25

RECORD OF BOREHOLE ~~I2~~ 3i

Sea bed level: - 22.5ft. O.D. Newlyn

Dia. of boring: 6in. to 8ft.6in.
3½in. core to 20ft.6in.
2⅜in. core to 109ft.

Type of boring: Shell and Auger and Rotary Core Drilling

Lining tubes: 6in. to 8ft.6in.
4½in. to 20ft.6in.

Daily Progress	Core Recovery or Samples		Change of Strata			Description of Strata
	Depth	Percentage or Type	Legend	Depth	O.D. Level	
	S.B.L.	D				
	5'0"	D				Very soft grey silty CLAY with small sea shells and some gravel
	8'0" 8'6"	D		8'6"	-31.0	
				10'0"	-32.5	Whitish medium-grained friable SANDSTONE
8.7.62	17'6"	89%				
	20'6"	86%		20'0"	-42.5	Whitish and reddish, medium-grained, friable false-bedded SANDSTONES
				28'6"	-51.0	Grey SILTSTONE and MUDSTONE with thin seams of clay
8/9.7.62	30'6"	90%				
	31'6"	100%				
	40'6"	100%				
				44'3"	-66.8	Whitish and reddish, massive fine-grained false-bedded SANDSTONE
				44'6"	-67.0	Grey MUDSTONE
				47'0"	-69.5	Reddish SANDSTONE
				47'6"	-70.0	Grey MUDSTONE
	50'6"	100%				
9.7.62	60'6"	100%				
				66'6"	-89.0	Whitish and red, medium-grained, massive friable false-bedded micaceous SANDSTONE
	69'0"	90%				
				77'0"	-99.8	Whitish and brown, medium to coarse-grained, friable massive SANDSTONE
	79'0"	98%				
	89'0"	86%				
	90'0"					
				92'0"	-114.5	Reddish and brownish, medium to coarse, massive friable sandstone
		86%				Reddish-brown, fine-grained, fissile SANDSTONE

			28'6"	-51.0	
8/9.7.62	30'6"				
	31'6"	100%			
		100%			Whitish and reddish, massive fine-grained false-bedded SANDSTONE
	40'6"				
			44'3"	-66.8	
			44'6"	-67.0	Grey MUDSTONE
		100%			Reddish SANDSTONE
			47'0"	-69.5	
			47'6"	-70.0	Grey MUDSTONE
	50'6"				
		100%			Whitish and red, medium-grained, massive friable false-bedded micaceous SANDSTONE
9.7.62	60'6"				
		98%			
			66'6"	-89.0	
	69'0"				
					Whitish and brown, medium to coarse-grained, friable massive SANDSTONE
		98%			
			77'0"	-99.5	
	79'0"				
		.86%			Reddish and brownish, medium to coarse, massive friable sandstone
	89'0"				
	90'0"				
			92'0"	-114.5	
		86%			Reddish-brown, fine-grained, fissile SANDSTONE with false bedding
9/10.7.62	97'0"		96'6"	-119.0	
		100%			Dark grey carbonaceous MUDSTONE with streaks of coal
	100'0"		100'0"	-122.5	
	101'0"	100%			
		80%			Red, medium-grained friable massive false-bedded SANDSTONE
10/11.7.62	109'0"		109'0"	-131.6	

Key to type of sample:

D = disturbed sample

Remarks:

COCKENZIE GENERATING STATION

Soils No: S/3242

FIG. 26

RECORD OF BOREHOLE ~~13~~ 32

Sea bed level: − 24.3ft. O.D. Newlyn

Type of boring: Shell and Auger and Rotary Core Drilling

Dia. of boring:
6in. to 8ft.
3½in. core to 15ft.6in.
2⅞in. core to 100ft.

Lining tubes:
6in. to 8ft.
4½in. to 15ft.6in.

Daily Progress	Core Recovery or Samples		Change of Strata			Description of Strata
	Depth	Percentage or Type	Legend	Depth	O. D. level	
	4'0"	D				Soft grey SILT with shell fragments
	8'0"			8'0"	-32.3	
		100%				Red and grey, medium-grained, friable false-bedded SANDSTONE
20.7.62	15'6"			16'6"	-40.8	
		99%				Grey fine-grained, false-bedded SANDSTONE
				23'10"	-47.1	
	24'0"					
						Red and grey MUDSTONE with clayey bands
		100%		29'0"	-53.3	
						Grey false-bedded fine SANDSTONE
	31'6"			32'6"	-56.8	
		100%				
20/21.7.62	35'6"					
		100%				Grey, fine to medium-grained, false-bedded SANDSTONE
	42'10"					
				44'4"	-68.6	
		100%				
	50'10"					
		100%				Red and grey, medium-grained massive SANDSTONE, with micaceous partings and bands of mudstone and clay
	60'10"			60'10"	-85.1	
		100%				
21.7.62	68'10"					Red and whitish, coarse-grained friable SANDSTONE
		100%				
	72'6"			72'10"	-97.1	
				73'2"	-97.5	Soft grey MUDSTONE
		93%				Red, coarse-grained, friable massive SANDSTONE
22.7.62	82'6"			83'3"	-107.6	
				83'9"	-108.1	Dark grey MUDSTONE
		93%				Red, medium to coarse-grained, false-bedded, friable, massive SANDSTONE
	90'6"					
				92'8"	-117.0	
		94%				

		100%	29'0"	-53.3	
	31'6"				
			32'6"	-56.8	Grey false-bedded fine SANDSTONE
20/21.7.62	35'6"	100%			
	42'10"	100%			
			44'4"	-68.6	Grey, fine to medium-grained, false-bedded SANDSTONE
	50'10"	100%			
	60'10"	100%	60'10"	-85.1	Red and grey, medium-grained massive SANDSTONE, with micaceous partings and bands of mudstone and clay
21.7.62	65'10"	100%			
	72'6"	100%			
			72'10"	-97.1	Red and whitish, coarse-grained friable SANDSTONE
			73'2"	-97.5	Soft grey MUDSTONE
22.7.62	82'6"	93%			
			83'3"	-107.6	Red, coarse-grained, friable massive SANDSTONE
			83'9"	-108.1	Dark grey MUDSTONE
	90'0"	93%			
			92'8"	-117.0	Red, medium to coarse-grained, false-bedded, friable, massive SANDSTONE
22/23.7.62	98'0"	94%	98'0"	-122.3	Grey-black MUDSTONE
23.7.62	108'0"	90%	108'0"	-132.3	Grey and red, medium-grained false-bedded SANDSTONE

Key to type of sample :

D = disturbed sample.

Remarks :

COCKENZIE GENERATING STATION

Soils No:
8/9242

FIG. 27

RECORD OF BOREHOLE T4/33

Sea bed level: - 18.1ft. O.D. Newlyn

Dia. of boring: 3½in. core to 24ft.6in.
2⅞in. core to 115ft.10in.

Type of boring: Rotary Core Drilling

Lining tubes: 4½in. to 25ft.

Daily Progress	Core Recovery or Samples		Change of Strata			Description of Strata
	Depth	Percentage or Type	Legend	Depth	O.D. Level	
	S.B.L.					
	15'3"	Nil		15'3"	-33.2	CLAY and SILT, with shells
				18'5"	-36.5	Friable grey laminated false-bedded micaceous SANDSTONE
		89%		20'0"	-38.1	Grey and red SILTSTONE
20.7.62	24'6"			24'6"	-42.6	Friable coarse grey false-bedded SANDSTONE, with siltstone bands
		100%		26'8"	-44.8	Friable coarse grey micaceous SANDSTONE
	29'6"			29'9"	-47.8	Coarse grey SANDSTONE with 3in. bands of black mudstone
				31'11"	-50.0	Soft coarse grey micaceous SANDSTONE, false-bedded, with thin red sandstone bands
				32'1"	-50.2	Black MUDSTONE
		100%		35'10"	-53.9	Friable coarse false-bedded grey SANDSTONE with two red micaceous silty sandstone bands
				37'9"	-55.2	Friable light grey SANDSTONE
				38'3"	-56.3	Soft red SILTSTONE
	39'6"					
		100%		47'0"	-65.1	Very coarse, grey and red, false-bedded micaceous SANDSTONE
	49'6"					
		100%				
28/29.7.62	59'6"					
				61'10"	-79.9	Very coarse grey false-bedded SANDSTONE
		100%				
	69'6"			69'6"	-87.6	False-bedded grey SANDSTONE, with slump structures
		100%		74'10"	-92.9	Grey and red variegated silty SANDSTONE with thin bands of red mudstone
	75'8"					
	77'0"	88%				
	78'6"	100%		79'8"	-99.9	Black laminated MUDSTONE
		100%		80'0"	-98.1	Bituminous COAL
				80'7"	-90.7	Black MUDSTONE
29.7.62	83'0"					
		100%				
	91'0"					
		100%				
	96'0"					Massive friable grey-white coarse SANDSTONE, sometimes false-bedded

	29'6"		29'9"	-47.8	mudstone
			31'11"	-50.0	Soft coarse grey micaceous SANDSTONE, false-bedded, with thin red sandstone bands
			32'1"	-50.2	Black MUDSTONE
		100%	35'10"	-53.9	Friable coarse false-bedded grey SANDSTONE with two red micaceous silty sandstone bands
			37'9"	-55.9	Friable light grey SANDSTONE
			38'3"	-56.3	Soft red SILTSTONE
	39'6"				
		100%	47'0"	-65.1	Very coarse, grey and red, false-bedded micaceous SANDSTONE
	49'6"				
		100%			
28/29.7.62	59'6"				
			61'10"	-79.9	Very coarse grey false-bedded SANDSTONE
		100%			
	69'6"		69'6"	-87.6	False-bedded grey SANDSTONE, with slump structures
		100%	74'10"	-92.9	Grey and red variegated silty SANDSTONE with thin bands of red mudstone
	75'8"				
	77'0"	88%			
	78'6"	100%			
			79'8"	-99.9	Black laminated MUDSTONE
		100%	80'0"	-98.1	Bituminous COAL
			80'7"	-98.7	Black MUDSTONE
29.7.62	89'0"				
		100%			
	91'0"				
		100%			
	96'0"				
		100%			
30.7.62	101'0"				
		100%	109'8"	-127.8	Massive friable grey-white coarse SANDSTONE, sometimes false-bedded
	111'0"				
		100%			
1.8.62	115'10"		115'10"	-133.9	Black laminated MUDSTONE

Key to type of sample:

Remarks:

COCKENZIE GENERATING STATION

Soils No: 8/3292

FIG. 28

RECORD OF BOREHOLE ~~T5~~ 34

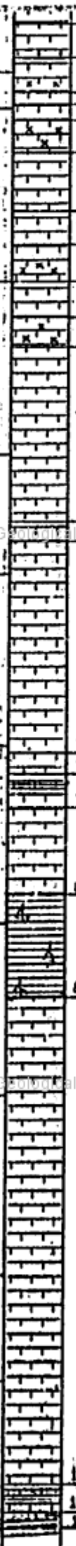
Sea bed level: - 18.3ft. O.D.Newlyn

Dia. of boring: 6in. to 15ft.
3¾in. core to 22ft.8in.
2⅞in. core to 116ft.

Type of boring: Shell and Auger to 15ft.
Rotary Core Drilling to 116ft.

Lining tubes: 8in. to 24ft.

Daily Progress	Core Recovery or Samples		Change of Strata			Description of Strata
	Depth	Percentage or Type	Legend	Depth	O.D. Level	
	4'6"	D				CLAY and SILT, with shells and gravel
	9'6"	D				
	14'6"	D				
	15'0"			15'0"	-33.3	
				16'8"	-35.0	Friable light-grey laminated SANDSTONE
				18'9"	-37.1	Soft dark grey laminated micaceous MUDSTONE
		100%		19'6"	-37.8	Green coarse micaceous false-bedded SANDSTONE
				20'9"	-39.1	Dark red coarse false-bedded SANDSTONE
	22'8"			23'6"	-41.8	Greenish false-bedded SANDSTONE
				24'0"	-42.3	Black MUDSTONE
				26'4"	-44.7	Friable false-bedded coarse SANDSTONE, becoming massive with depth
				26'8"	-45.0	Soft dark red micaceous SILTSTONE
		89%		28'9"	-47.1	Black laminated, MUDSTONE and friable laminated grey false-bedded SANDSTONE
				29'0"	-47.3	Coarse greenish false-bedded micaceous SANDSTONE
				31'8"	-50.0	Red micaceous SANDSTONE, with shale bands, false-bedded
23/24.7.62	32'6"			33'9"	-52.1	Friable grey coarse micaceous SANDSTONE, with a 3½in. siltstone band, false-bedded
		100%		34'0"	-52.3	Soft black laminated MUDSTONE
	34'6"			35'0"	-53.3	Grey and grey-green false-bedded micaceous coarse SANDSTONE
				35'7"	-53.9	Friable, red micaceous silty SANDSTONE
		83%		37'3"	-55.6	Friable red-grey false-bedded coarse SANDSTONE
				41'9"	-60.1	Soft coarse grey-green current-bedded SANDSTONE
	44'6"			44'6"	-62.8	Coarse greenish false-bedded SANDSTONE passing downward into red silty sandstone
				46'10"	-65.1	Friable grey false-bedded SANDSTONE
				48'0"	-66.3	Red silty micaceous SANDSTONE
		100%				Friable grey and red false-bedded SANDSTONE
24/25.7.62	54'6"					
		98%		66'9"	-87.0	
				68'8"	-87.1	Dark grey and white false-bedded SANDSTONE
	61'6"					
		100%				Alternate bands of red and white coarse SANDSTONE
	71'6"			71'9"	-90.1	
				72'8"	-91.0	Grey SANDSTONE
				75'0"	-93.3	Bands of black MUDSTONE and white false-bedded SANDSTONE
		98%		80'0"	-98.3	Grey false-bedded SANDSTONE
27.7.62	81'6"			85'11"	-104.2	Black laminated micaceous MUDSTONE with plant remains
		100%				
	91'6"					



			29'0"	-47.3	Coarse greenish false-bedded micaceous SANDSTONE
			31'8"	-50.0	Red micaceous SANDSTONE, with shale bands, false-bedded
23/24.7.62	32'6"				
		100%	33'9"	-52.1	Friable grey coarse micaceous SANDSTONE, with a 5in. siltstone band, false-bedded
	34'6"		34'0"	-52.3	Soft black laminated MUDSTONE
			35'0"	-53.3	Grey and grey-green false-bedded micaceous coarse SANDSTONE
			35'7"	-53.9	Friable, red micaceous silty SANDSTONE
		83%	37'3"	-55.6	Friable red-grey false-bedded coarse SANDSTONE
			41'9"	-60.1	Soft coarse grey-green current-bedded SANDSTONE
	44'6"		44'6"	-62.8	Coarse greenish false-bedded SANDSTONE passing downward into red silty sandstone
			45'10"	-65.1	Friable grey false-bedded SANDSTONE
			48'2"	-66.5	Red silt, micaceous SANDSTONE
		100%			
24/25.7.62	54'6"				Friable grey and red false-bedded SANDSTONE
		98%	66'9"	-87.0	
			66'8"	-87.1	Dark grey and white false-bedded SANDSTONE
	61'6"				
		100%			Alternate bands of red and white coarse SANDSTONE
	71'6"		71'9"	-90.1	
			72'8"	-91.0	Grey SANDSTONE
			75'0"	-93.3	Bands of black MUDSTONE and white false-bedded SANDSTONE
		95%			Grey false-bedded SANDSTONE
			60'0"	-98.3	
27.7.62	81'6"				Black laminated micaceous MUDSTONE with plant remains
			85'11"	-104.2	
		100%			
	91'6"				
		100%			Friable red and grey false-bedded coarse SANDSTONE
	101'6"				
		100%			
	107'6"				
		100%			
			113'6"	-131.8	
			115'6"	-132.8	White false-bedded micaceous SANDSTONE with mudstone bands
27/28.7.62	116'0"		116'0"	-133.3	Black micaceous MUDSTONE

Key to type of sample:

D = disturbed sample.

Remarks:

Scale: ....

Drawing No:

S/N..................

COCKENZIE GENERATING STATION

Soils No: S/3282

FIG. 29

GEORGE WIMPEY & CO. LTD CENTRAL LABORATORY HAYES

RECORD OF BOREHOLE ~~16~~ 85

Sea-bed level: - 14.6ft. O.D. Newlyn

Dia. of boring: 6in. to 17ft.
3½in. core to 22ft.2in.
2⅛in. core to 107ft.5in.

Type of boring: Shell and Auger to 17ft., Rotary Core Drilling to 107ft.5in.

Lining tubes: 6in. to 17ft.
4½in. to 22ft.2in.

Daily Progress	Core Recovery or Samples		Change of Strata			Description of Strata
	Depth	Percentage or Type	Legend	Depth	O.D. Level	
	4'6"	D				SILT and CLAY with shells
	9'6"	D				
	14'6"	D				
	16'6"	D				
	17'0"			17'0"	-31.6	
		100%				
2.8.62	22'2"					
	24'10"	75%				
		100%				False-bedded laminated fine SANDSTONE, with red silty sandstone bands
	34'10"			34'6"	-49.1	
		75%		36'4"	-50.9	Black MUDSTONE
	36'10"					
		100%				Soft coarse grey and white false-bedded SANDSTONE
2/3.8.62	44'10"					
				47'0"	-61.6	
		100%		49'0"	-63.6	Grey SANDSTONE, with mudstone and siltstone laminae; false-bedded
				50'3"	-64.8	Black laminated sandy MUDSTONE
	50'4"					
						Grey false-bedded fine SANDSTONE, with red micaceous silty sandstone at base
		100%		54'9"	-69.4	
						Black laminated MUDSTONE, with sandstone and shale bands
	57'0"			57'0"	-71.6	
	58'2"	100%				
3.8.62	60'0"	100%				Black laminated MUDSTONE
				62'8"	-77.0	
		95%				
	67'0"					
		100%				Hard white false-bedded SANDSTONE, with black mudstone laminae
6.8.62	77'0"					
				80'4"	-94.9	
		100%		80'6"	-95.1	Black laminated MUDSTONE
				83'0"	-97.6	White SANDSTONE as 62ft.8in. to 80ft.4in.
6/7.8.62	84'0"			83'3"	-97.9	Black MUDSTONE
				84'5"	-99.0	White SANDSTONE as 62ft.8in. to 80ft.4in.
				84'8"	-99.3	Black MUDSTONE
		100%		85'7"	-100.2	White false-bedded SANDSTONE
				86'0"	-100.6	Black MUDSTONE
	89'0"			86'9"	-101.4	White false-bedded SANDSTONE
		100%				
	91'6"					
		100%				
8.8.62	93'6"					Black MUDSTONE

		100%			
	34'10"		34'6"	-49.1	
		75%	36'4"	-50.9	Black MUDSTONE
	36'10"				
		100%			Soft coarse grey and white false-bedded SANDSTONE
2/3.8.62	44'10"				
			47'0"	-61.6	
		100%	49'0"	-63.6	Grey SANDSTONE, with mudstone and siltstone laminae; false-bedded
			50'3"	-64.8	Black laminated sandy MUDSTONE
	50'4"				
		100%	54'9"	-69.4	Grey false-bedded fine SANDSTONE, with red micaceous silty sandstone at base
	57'0"		57'0"	-71.6	Black laminated MUDSTONE, with sandstone and shale bands
	58'2"	100%			
3.8.62	60'0"	100%			Black laminated MUDSTONE
			62'5"	-77.0	
		95%			
	67'0"				
		100%			Hard white false-bedded SANDSTONE, with black mudstone laminae
6.8.62	77'0"				
		100%	80'4"	-94.9	
			80'6"	-95.1	Black laminated MUDSTONE
			83'0"	-97.6	White SANDSTONE as 62ft.5in. to 80ft.4in.
6/7.8.62	84'0"		83'3"	-97.9	Black MUDSTONE
			84'5"	-99.0	White SANDSTONE as 62ft.5in. to 80ft.4in.
			84'8"	-99.3	Black MUDSTONE
		100%	85'7"	-100.2	White false-bedded SANDSTONE
			86'0"	-100.6	Black MUDSTONE
	89'0"		86'9"	-101.4	White false-bedded SANDSTONE
		100%			
	91'6"				
8.8.62	93'6"	100%			
		93%			Black MUDSTONE
8/9.8.62	98'6"				
	99'6"	100%	99'6"	-114.1	
			100'6"	-115.1	Bituminous COAL
			101'11"	-116.5	Black MUDSTONE
		100%	104'5"	-119.0	White and grey silty SANDSTONE, passing downwards to SILTSTONE
	105'8"				
9.8.62	107'5"	100%	107'5"	-122.0	Black MUDSTONE

Key to type of sample:

D = disturbed sample.

Remarks:

COCKENZIE GENERATING STATION

Soils No: 8/3242

FIG. 30

RECORD OF BOREHOLE ~~T7~~ 36

Sea bed level: - 15.4ft. O.D. Newlyn

Dia. of boring: 6in. to 16ft.6in. 3½in. core to 24ft. 2⅞in. core to 116ft.6in.

Type of boring: Shell and Auger and Rotary Core Drilling

Lining tubes: 6in. to 16ft.6in. 4½in. to 24ft.6in.

Daily Progress	Core Recovery or Samples		Change of Strata			Description of Strata
	Depth	Percentage or Type	Legend	Depth	S.B. level	
	3'6"	D				
	8'0"	D				Soft silty CLAY with some small gravel
	12'6"	D				
	16'6"			16'6"	-31.9	
	17'3"	100%		17'3"	-33.7	BOULDER (dolerite)
	19'3"	100%				
12.7.62	24'0"	100%				Friable red and grey medium-grained SANDSTONE
				25'6"	-40.9	
	30'0"	100%				
	36'0"	67%				Friable whitish and yellow medium-grained . SANDSTONE
		56%		42'0"	-57.4	
12/13.7.62	45'0"					Friable grey medium SANDSTONE
				47'0"	-62.4	
				47'6"	-62.9	Purple and white SANDSTONE
				49'3"	-64.7	Friable white medium SANDSTONE
		64%		51'6"	-66.9	Purple and white SANDSTONE
	53'10"			53'10"	-69.2	Friable, massive red coarse SANDSTONE
	55'6"	100%		55'4"	-70.7	Grey MUDSTONE with fine sandstone partings
	59'9"	100%		59'9"	-75.2	Massive red SANDSTONE
13.7.62	61'9"	100%				
13/14.7.62	63'9"	100%				Hard dark grey MUDSTONE with occasional partings of sandstone and coal
				66'0"	-81.4	
		90%				Massive whitish medium-grained SANDSTUNE with false-bedding
15/16.7.62	73'9"			73'9"	-89.2	
	77'9"	100%				Massive whitish medium-grained SANDSTONE with false-bedding
		100%		82'0"	-97.4	
				82'4"	-97.7	MUDSTONE
	87'0"			87'9"	-103.2	Friable white fine to medium SANDSTONE with false-bedding
				88'0"	-103.4	Dark grey MUDSTONE
				88'10"	-104.4	Whitish SANDSTONE
		100%		89'2"	-104.6	Dark grey MUDSTONE
				89'10"	-105.2	Whitish SANDSTONE
				90'4"	-105.7	MUDSTONE
16.7.62	91'9"			91'2"	-106.6	Whitish SANDSTONE

	30'0"	
	36'0"	67%
12/13.7.62	45'0"	56%
	53'10"	64%
	55'6"	100%
	59'9"	100%
13.7.62	61'9"	100%
13/14.7.62	63'9"	100%
15/16.7.62	73'9"	90%
	77'9"	100%
	87'9"	100%
16.7.62	91'9"	100%
	94'9"	100%
16/17.7.62	101'9"	100%
	110'0"	100%
17/18.7.62	116'6"	100%

42'0"	-57.4	Friable whitish and yellow medium-grained SANDSTONE
47'0"	-62.4	Friable grey medium SANDSTONE
47'6"	-62.9	Purple and white SANDSTONE
49'3"	-64.7	Friable white medium SANDSTONE
51'6"	-66.9	Purple and white SANDSTONE
53'10"	-69.2	Friable, massive red coarse SANDSTONE
55'4"	-70.7	Grey MUDSTONE with fine sandstone partings
59'9"	-75.2	Massive red SANDSTONE
66'0"	-81.4	Hard dark grey MUDSTONE with occasional partings of sandstone and coal
73'9"	-89.2	Massive whitish medium-grained SANDSTONE with false-bedding
82'0"	-97.4	Massive whitish medium-grained SANDSTONE with false-bedding
82'4"	-97.7	MUDSTONE
87'9"	-103.2	Friable white fine to medium SANDSTONE with false-bedding
88'0"	-103.4	Dark grey MUDSTONE
88'10"	-104.4	Whitish SANDSTONE
89'2"	-104.6	Dark grey MUDSTONE
89'10"	-105.2	Whitish SANDSTONE
90'4"	-105.7	MUDSTONE
91'2"	-106.6	Whitish SANDSTONE
114'6"	-129.9	Hard dark grey MUDSTONE
116'0"	-131.4	Grey SANDSTONE
116'6"	-131.9	MUDSTONE

Key to type of sample:

D - disturbed sample.

Remarks:

COCKENZIE GENERATING STATION

Soils No: S/3242

FIG. 31