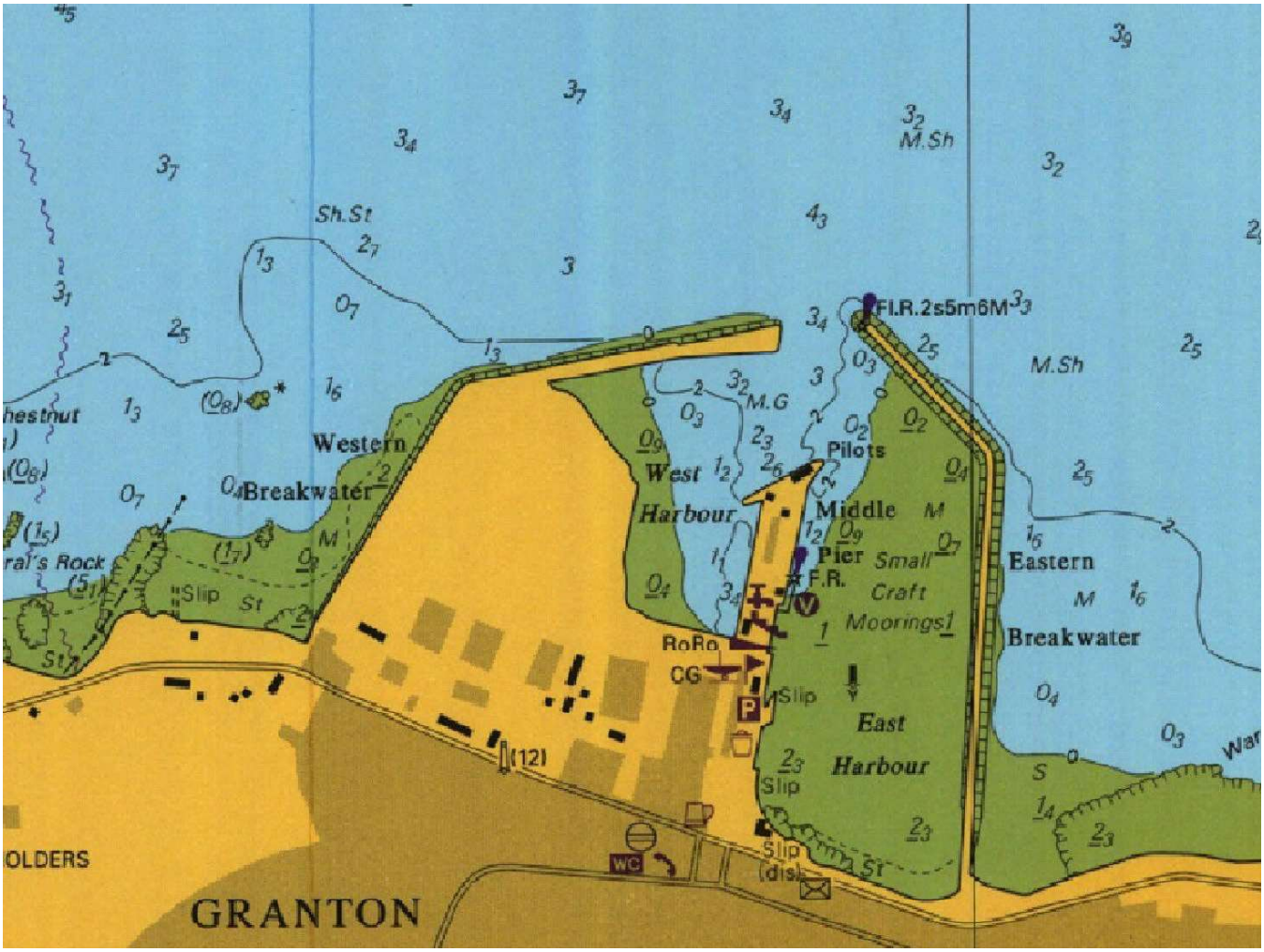

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FORTH PORTS

Granton Harbour Maintenance Dredge Disposal: Marine Licence Application 2024

Best Practicable Environmental Option Report

18 December 2024

Project No: 0391463.12

The business of sustainability

ERM

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1. INTRODUCTION

1.1 Background

This report has been prepared by Environmental Resources Management Ltd (ERM) on behalf of Forth Ports Ltd (Forth Ports) in support of a Marine Licence application for disposal of dredged material at sea from maintenance dredging from Granton Harbour.

Under the *Marine (Scotland) Act, 2010, Section 21(1),* a Marine Licence issued by Marine Scotland is required for the deposit of substances or objects within waters adjacent to Scotland. Under Part 4, Section 27(2), Marine Scotland has an obligation to consider the availability of practical alternatives when considering applications involving disposal of material at sea. Applications for a Marine Licence to dispose of dredged spoil at sea require a Best Practicable Environmental Option (BPEO) [(1)]. assessment, demonstrating that alternatives to sea disposal have been investigated and that sea disposal does not pose an unacceptable risk to the marine environment and other legitimate users.

This report compares various options for the disposal of dredged material from Granton Harbour and identifies the BPEO.

Marine Licences for maintenance dredge spoil disposal activities are valid in Scotland for up to three years [(2)].

The Royal Forth Yacht Club had a Marine Licence (MS-00008775) to undertake maintenance dredging, by agitation, in the Granton Eastern Harbour. This licence ran from 21 August 2021 to 22 August 2023. Forth Ports is applying for a Marine Licence for the disposal of maintenance dredged material for a period of three years running from 2024 to 2027. This is to ensure that a safe navigable depth is maintained within the Granton Eastern Harbour.

The original application was made in July 2024 and this revision is for an increase in the planned disposal volume from 5,000 m^3 to 10,000 m^3 to meet operational requirements.

1.2 The Need for Dredge Spoil Disposal

Granton Harbour is located on the south bank of the Firth of Forth, 2.5 miles north-west of Edinburgh city centre. The harbour is divided into the East Harbour and West Harbour by the Middle Pier. Vessels currently using the East Harbour include the Forth pilot and sailing vessels and pleasure craft using the marina facilities managed by The Royal Forth Yacht Club and The Forth Corinthian Yacht Club. In line with Section 13 of *Scotland's National Marine Plan (Marine Planning Policy Transport 4)*, the planned dredging operations will continue to maintain and support the sustainable use of Granton Harbour. Forth Ports plans to undertake annual dredging with the dredged material being disposed of at sea at the Oxcars licenced spoil ground situated 1.7 nautical miles (nm) (3.5 km) north-east of Granton at its closest point. *Figure 1.1* shows the planned dredging areas and the licensed Oxcars spoil ground. Note that the chart used in *Figure 1.1* shows the dreding area to include an area of reclaimed land but that reclamation work was not undertaken.

The material to be dredged comprises naturally occurring sediments that have been transported into the harbour by tidal currents in suspension or through sediment bedload transport. The volume required to be dredged and disposed of each year and will depends on annual sedimentation rate and can be influenced by events such as storms.

Should Forth Ports consider the 'Do Nothing' approach, and not undertake the maintenance dredging operations, a navigable depth would not be maintained, and Granton Harbour would not be able to continue to service current vessels. Given Forth Port's statutory duty as the Harbour Authority to ensure safe navigation, there is an ongoing maintenance dredging requirement and the need for disposal of the dredged material, therefore the do-nothing option is not considered further in this BPEO.

(2) The term BPEO was derived by the Royal Commission on Environmental Pollution who described it as a procedure which "establishes, for a given set of objectives, the option that provides the most benefit or least damage to the environment as a whole, at an acceptable cost, in the long term as well as in the short-term.

(1) Marine (Scotland) Act 2010, Part 4 Marine Licencing. General Guidance for Applicants. Available online http://www.scotland.gov.uk/Resource/0043/00435338.pdf.

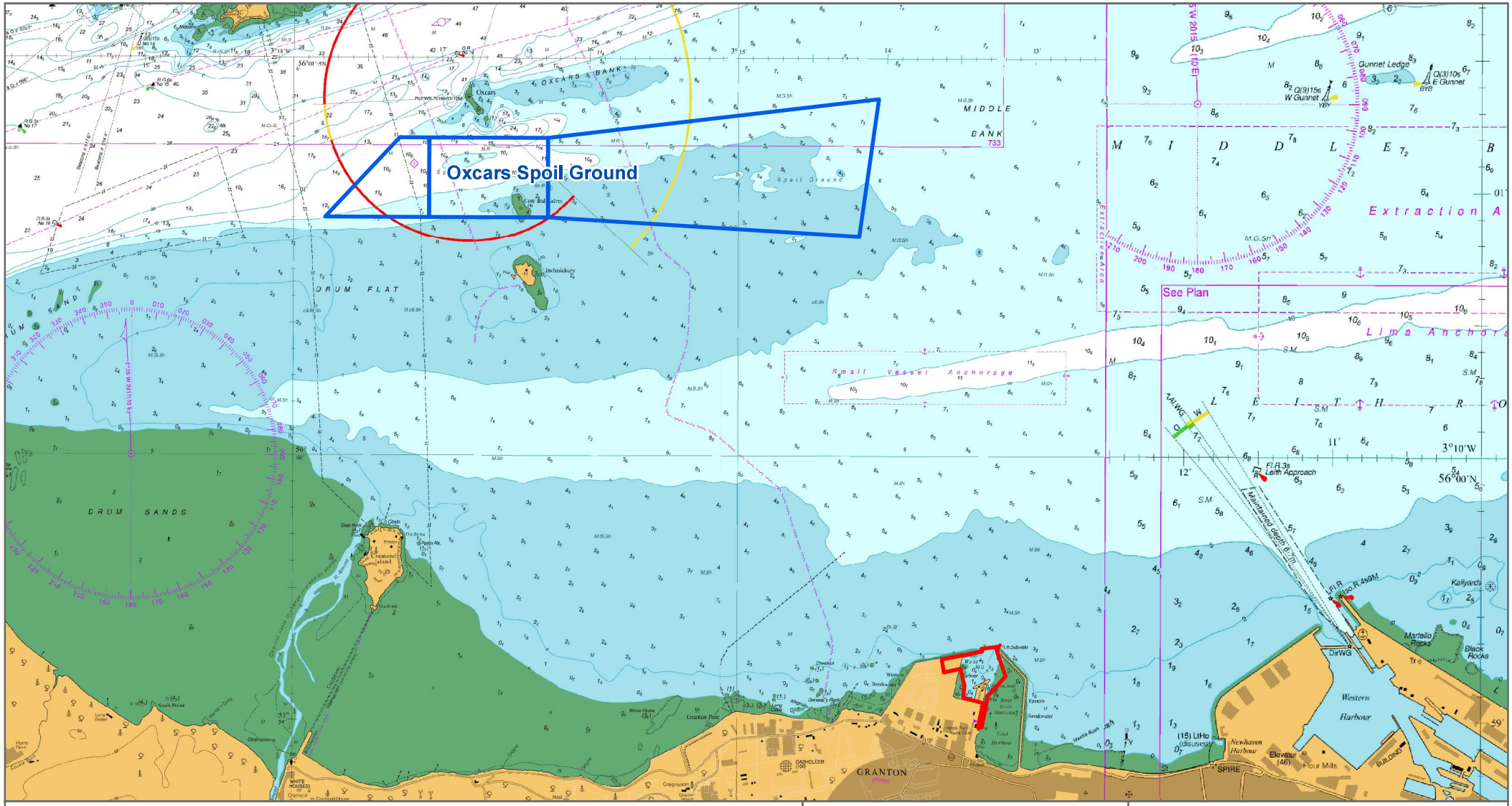


Figure 1.1
Port of Granton
Proposed Disposal Site

SCALE: See Scale Bar	VERSION: A03
SIZE: A4	DRAWN: MTC
PROJECT: 0391463	CHECKED: MI
DATE: 12/07/2024	APPROVED: MI

ERM

Forth Ports Ltd

PROJECTION: WGS 1984 UTM Zone 30N

Path: \\uksprdgisfs01\Data\London\Projects\0391463 - Forth Ports\DATA\PhX Granton 2023\Maps\0391463 - Forth Ports - Granton.aprx\0391463 - Granton - Fig 1.1 Report- Proposed Disposal Site - A03

1.3 Proposed Dredge Spoil Disposal Operations

Forth Ports wishes to apply for a Marine Licence from Marine Scotland for the disposal of dredge spoil to a maximum of 10,000 m^3 of dredged material per annum (up to 14,000 wet tonnes based on density of 1.4 (1)). This is required maintain a depth to ensure compliance with safe vessel navigation and to allow for any fluctuation in sediment deposition or contingencies.

Forth Ports are likely to use a plough to move deposited sediments and then use a grab hopper dredger such as the *UKD Cherry Sand* or Wyre Sands (shown in *Figure 1.2*).

Figure 1.2 Dredge Vessel - Wyre Sands and Cherry Sand

http://www.wyremarineservices.co.uk/fleet-and-equipment.html
https://www.ukdredging.co.uk/UKD_Fleet/Cherry_Sand/

The dredging operations are undertaken during high water periods over one or two periods of ten to twenty days per annum, subject to tides and plant availability. The works are likely to be undertaken to coincide with maintenance dredge operations at other ports such as Methil and Kirkcaldy as similar plant is used.

The boundary co-ordinates of the proposed dredge area shown in *Figure 1.1* and are presented in *Table 1.1*.

Table 1.1 Co-ordinates of Planned Dredge Sites at the Granton Harbour

Node	Co-ordinates (WGS84)	
	Latitude	Longitude
A	55°59.285'N	3°13.246'W
B	55°59.267'N	3°13.254'W
C	55°59.173'N	3°13.194'W
D	55°59.100'N	3°13.313'W
E	55°58.980'N	3°13.355'W
F	55°58.980'N	3°13.380'W
G	55°59.071'N	3°13.346'W
H	55°59.080'N	3°13.404'W
I	55°59.092'N	3°13.482'W
J	55°59.137'N	3°13.471'W
K	55°59.201'N	3°13.501'W
L	55°59.187'N	3°13.611'W
M	55°59.237'N	3°13.625'W

Coordinates in WGS84, degrees decimal minutes

(1) Conversion factor used by Forth Ports for maintenance dredge sediments from Granton Harbour. Forth Ports pers comm September 2023.

Within this overall dredging area there is a small exclusion zone on the east side of the Middle Pier from the south end of the Edinburgh Marina Ltd pontoon to mid-way along the public slip. The coordinates are shown in *Table 1.2.* This area will not be dredged by Forth Ports.

Table 1.2 Co-ordinates of Exclusion Zone within Granton Harbour

Node	Co-ordinates (WGS84)	
	Latitude	Longitude
1	55° 59.050' N	003° 13.354' W
2	55° 59.050' N	003° 13.342' W
3	55° 59.023' N	003° 13.366' W
4	55° 59.023' N	003° 13.351' W

Coordinates in WGS84, degrees decimal minutes

The water depth within the proposed Oxcars spoil ground ranges from 2.1 m below Chart Datum (CD) at the centre of the site and increases to 13.7 m below CD towards the west of the site. The boundary co-ordinates of the spoil ground are presented in and illustrated in *Figure 1.1.* The site has previously been extended to the west and the coordinates of these extensions are provided in *Table 1.3* and shown in *Figure 1.1.*

Table 1.3 Coordinates of Oxcars Spoil Ground

Site	Coordinates (WGS84)	
	Latitude	Longitude
Oxcars Main	56° 01.20' N	003° 16.29' W
	56° 00.83' N	003° 14.19' W
	56° 01.35' N	003° 14.06' W
	56° 00.90' N	003° 16.29' W
Oxcars Extension A	56° 01.20' N	003° 17.09' W
	56° 00.90' N	003° 16.29' W
	56° 01.20' N	003° 16.29' W
	56° 00.90' N	003° 17.09' W
Oxcars Extension B	56° 01.20' N	003° 17.29' W
	56° 00.90' N	003° 17.09' W
	56° 01.20'N	003° 17.09' W
	56° 00.90'N	003° 17.79' W

Coordinates in WGS84, degrees decimal minutes

1.4 Description of Sediment to be Dredged and Disposed

In line with Marine Scotland guidelines on pre-dredge sampling protocol (1), a survey programme was undertaken on 2 May 2023. Samples were taken at three stations using a van-Veen grab. For each of the samples the following chemical analysis was undertaken.

- Metals: arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc.
- Tributyl Tin (TBT).
- Polycyclic Aromatic Hydrocarbons (PAH)
- Total Hydrocarbon Content (THC).
- Poly Chlorinated Biphenyls (PCB).
- Sediment moisture content and sediment particle density.
- Total Organic Carbon (TOC).

(1) Guidance for the sampling and analysis of sediment and dredged material to be submitted in support of applications for sea disposal of dredged material. Available online http://www.scotland.gov.uk/Resource/0044/00443832.pdf

- Sediment particle distribution (PSD).
- Presence of asbestos.

The location of the sample stations and the results of the physico-chemical analysis are presented in *Appendix A.*

The sediment to be dredged from the channel and docks comprises slightly gravelly sand and slightly gravelly sandy mud. There are concentrations of some metals, PCBs and PAHs above Marine Scotland Action Level 1 (1) in some of the samples within the harbour. No samples has concentrations of metals, PCBs or PAHs above Action Level 2. Concentrations of TBT in the samples were all below Action Level 1. There was no evidence of asbestos in any of the five samples.

Samples from the Oxcars spoil ground and other spoil grounds in the Forth Estuary and Firth of Forth have been analysed by Marine Scotland. A summary of the historical sample analysis is also provided in *Appendix A.*

1.5 Scope of the Study

This report provides an appraisal of available disposal options and short-lists those considered to be practicable. Options are reviewed according to the Waste Hierarchy as outlined in *Section 34 of the Environmental Protection Act 1990* and *Waste (Scotland) Regulations 2012* (2). The options on the short-list were then reviewed against strategic, environmental and cost considerations. The options were then compared and the BPEO identified.

The remainder of this report is structured as follows.

- Section 2 describes the BPEO assessment method.
- Section 3 describes each of the available disposal options and summarises their respective advantages and disadvantages.
- Section 4 compares the short-listed disposal options.
- Section 5 identifies the BPEO.

Further supporting information is provided in the three Appendixes.

- *Appendix A:* Sediment Sample Physical and Chemical Analysis Results.
- *Appendix B:* Environmental Impacts of Disposal Operations.
- *Appendix C:* Summary of Consultee Responses.

(2) See Appendix A for explanation of Action Levels
(1)https://www.gov.scot/publications/guidance-applying-waste-hierarchy/pages/3/

2. BPEO ASSESSMENT METHOD

2.1 Introduction

The BPEO study was undertaken using the following method.

- Identification of potential disposal options.
- Preliminary appraisal and short-listing of options based on practicability.
- Assessment of the short-listed options based on:
  - strategic considerations;
  - environmental considerations *i.e.* what the environmental impacts would be; and
  - cost, in terms of capital and maintenance/operating costs.
- Comparison of the relative merits and performance of the options and identification of the BPEO.

Informal consultation by emailed letters, outlining the proposals and requesting any comments or relevant information, was undertaken with the following consultees.

- Crown Estate Scotland.
- Edinburgh City Council.
- Forth District Salmon Fisheries Board (FDSFD).
- Maritime and Coastguard Agency (MCA).
- NatureScot (NS).
- Northern Lighthouse Board (NLB).
- Scottish Environment Protection Agency (SEPA).

Responses received by email are included in *Appendix C*. Formal consultations will be undertaken by Marine Scotland following receipt of the Marine Licence application from Forth Ports.

2.2 Identification of Options

The following seven potential treatment/disposal options for the dredged material were identified:

- beach nourishment;
- coastal reclamation and construction fill;
- spreading on agricultural land;
- sacrificial landfill;
- incineration;
- other disposal options and reuse; and
- sea disposal.

2.3 Preliminary Appraisal

A preliminary appraisal of each of the options identified above was undertaken, including an assessment of the practicability of each option with regard to availability of disposal sites. Following the preliminary appraisal those options that are considered practicable were short-listed for further consideration.

2.4 Assessment of Options

The short-listed options were then subject to detailed assessment. The parameters which were used to assess the short-listed options are described below.

2.4.1 Strategic Considerations

Strategic considerations included the following.

- **Practicability.** Whether the option is technically and operationally practicable.
- **Availability of sites/facilities**. Whether there are any sites or facilities which can take the dredge spoil.
- **Security of option**. Whether Forth Ports will have control over all stages of the disposal.
- **Established practice**. Whether technologies and techniques proposed are established and therefore whether the performance and potential difficulties of the technologies and techniques can be anticipated.
- **General public acceptability**. Whether the public are likely to object to or support the proposals.
- **Likely agency acceptability**. Whether public agencies are likely to have any major concerns when consulted on the Marine Licence application.
- **Legislative implications.** Compliance with relevant legislation and the potential management control required.

2.4.2 Health, Safety and Environmental Considerations

The health, safety and environmental performance considerations are summarised below.

- **Public health**. Whether there would be any risk of a detrimental effect on public health, based on predicted pathways and receptors.
- **Safety.** Considering potential sources of hazard and probability that there would be any risk to the general public or workers.
- **Contamination/pollution.** Whether there is potential for pollution or contamination that could result in failure to meet Water Framework Directive (WFD) objectives and associated Environmental Quality Standards (EQSs: the amount or concentration of a substance that should not be exceeded in an environmental system). Contamination is defined as the presence of an unwanted constituent in the natural environment whilst pollution is the introduction of contaminants into the natural environment that causes adverse change.
- **Ecological impact.** Assessing the significance of any potential impact on important habitats or species, including designed sites.
- **Interference with other legitimate activities**. Whether there are likely to be impacts on other activities, such as other users of the port, firth or roads.
- **Amenity/aesthetic**. Assessing whether there is likely impact on local amenity *e.g.* visual, olfactory or noise impact resulting from the disposal activities.

2.4.3 Cost Considerations

Cost of disposing of dredged material was considered in terms of the capital costs (construction of facilities and equipment hire /purchase costs) and operational costs (transport costs and disposal costs, including site operation).

2.4.4 Comparison of Options

The performance of each option was evaluated on a scale from Low to High according to definitions presented in *Table 2.1*. Intermediate grades (Low to Medium and Medium to High) are also used where the assessment is marginal between Low, Medium or High. The results of the assessment process are presented in *Section 3* and *Section 4.*

Table 2.1 Definitions of Performance

Consideration	High	Medium	Low
Strategic Considerations			
Technical and Operational Practicality	Few practical difficulties, easy to undertake and process is proven to be straightforward and robust. Low number of stages and each stage easy to control.	Some practical difficulties. Moderate number of stages with some difficulties.	Major practical difficulties. Large number of steps with some major difficulties.
Availability of Sites/Facilities	Suitable site/facility available within 1 km of the docks by road and 10 km by sea.	Suitable site/facility available within 10 km of the docks by road and 20 km by sea.	No suitable sites/facilities within the vicinity (within 10 km by road and 20 km by sea).
Security of option	In complete operational control of Forth Ports.	Is mainly in control of Forth Ports with some outside involvement for which there are alternative sources of supply.	Has elements that are out of Forth Ports control for which there are no practical alternative sources of supply.
Established Practice	Technology and techniques are established and used for dredge spoil disposal.	Technology and techniques have been tested but not applied to dredge material.	Technologies and techniques are untested and unforeseen problems are likely.
General Public Acceptability	Likely to be generally acceptable to the public based on reaction to similar operations.	Unlikely to provoke a strong negative or positive reaction based on reaction to similar operations.	Likely to provoke a strong negative reaction based on reaction to similar operations.
Likely Agency Acceptability	Likely to be generally acceptable to statutory bodies after consultation.	Statutory bodies may have some concerns that may be overcome through further consultation and option development.	Statutory bodies may have major concerns that may not be overcome through consultation and option development.
Legislative Implications	Would comply with legislation with a low level of management control and intervention.	Requires some management control and intervention to achieve compliance.	Requires a high level of management control and intervention to achieve compliance.
Health, Safety and Environmental Considerations			
Public Health	Will not cause workers or public to be exposed to substances or activities potentially hazardous to health.	May cause some low-level intermittent exposure to substances or activities potentially hazardous to health.	Risk of exposing workers and general public to substances or activities potentially hazardous to health.
Safety	No significant safety risk to the general public with no specific controls required.	Low safety risk to the general public which is easily controlled.	Moderate to high safety risk to the general public and difficult to control.
Contamination/ Pollution	Compliant with emission standards and water/sediment/ground quality objectives. Low risk of harm from substances released to environment.	Environmental quality standards may be approached or breached occasionally. Some risk of harm to environment.	Environmental quality standards may be breached regularly and there is a moderate or high risk of harm to environment.

Consideration	High	Medium	Low
Ecological Impact	Priority species and habitats under the UK Biodiversity Framework (1) and qualifying features and species under the *Habitats Regulations, 2019* (2) will not be affected.	Priority species and habitats under the UK Biodiversity Framework and qualifying features and species under the *Habitats Regulations, 2019* may be slightly affected.	Priority species and habitats under the UK Biodiversity Framework and qualifying features and species under the *Habitats Regulations 2019*, are likely to be significantly affected.
Interference with other Legitimate Activities	Little potential for interference with other activities.	Some potential for interference with other activities.	High potential for interference with other activities.
Amenity/Aesthetic	No significant impact on local amenity or aesthetic qualities.	Potential for impacts of moderate significance on local amenity or aesthetic qualities.	Potential for impacts of high significance on local amenity or aesthetic qualities.
Cost			
Capital and maintenance	£1 m or less.	Between £1 m and £5 m.	More than £5 m.

(2). JNCC and Defra (on behalf of the Four Countries' Biodiversity Group). 2012. UK Post-2010 Biodiversity Framework. July 2012. Available from: http://jncc.defra.gov.uk/page-6189.
(1) The *Conservation (Natural Habitats, &c.) (EU Exit) (Scotland) (Amendment) Regulations, 2019* apply to European sites (formerly Special Protection Areas and Special Areas of Conservation).

3. PRELIMINARY ASSESSMENT OF AVAILABLE DISPOSAL OPTIONS

3.1 Introduction

This section describes the identified disposal options and makes a preliminary assessment of each based on overall practicality. There are a number of steps that are common to some of the land-based options, and these are described in *Section 3.2* to avoid repetition. The section concludes by identifying those options that are short-listed for further consideration in the BPEO process.

The seven identified disposal options are:

- beach nourishment;
- coastal reclamation;
- spreading on agricultural land;
- sacrificial landfill;
- incineration;
- other disposal options and reuse; and
- disposal at sea.

3.2 Common Steps to Land-Based Disposal Options

The disposal options that have land-based components include:

- beach nourishment (if material transported by road);
- coastal reclamation and construction fill (if material transported by road);
- spreading on agricultural land;
- sacrificial landfill;
- incineration; and
- other disposal options and reuse (such as brick making/concrete aggregate/topsoil production).

The steps that are common to the land-based disposal options are:

- landing the dredge material;
- storage of dredge material;
- dewatering the dredge material; and
- loading and transport for disposal.

These steps are described below along with a discussion of the practicalities of undertaking these steps at Granton Harbour.

3.2.1 Landing the Dredged Material

All of the land-based options require transport to on-shore facilities. This could be via a pumped discharge, conveyor or grab. As Forth Ports does not have suitable landing facilities at Granton, or elsewhere within the Firth of Forth area, a new coastal landing facility would be required to enable the materials to be off-loaded.

3.2.2 Storage of Dredged Material

Once the dredged material has been landed, it will require storage prior to onward transport for final disposal. A storage facility may therefore require to be constructed at the site, capable of retaining the dredged material and associated run-off and dust.

3.2.3 Dewatering the Dredged Material

The land disposal options require dewatering of the dredged material either to make transport more feasible or to create a material which is suitable for disposal to land or incineration *i.e.* disposal of a more solid sludge. Based on tests on previous dredged loads undertaken by Forth Ports the contents of the dredger are assumed to have an average 20% solids (by volume) and range from 10% to 30% solids i.e, solids to liquid ratio will decrease as dredging operations progress and only isolated pockets of sediments remain resulting in an increased uptake of water.

There are three approaches that could be used for dewatering marine sediments: construction of settling lagoons, use of a mobile centrifuge or hydrocyclone unit, and the use of a filter press, as described below.

Settling Lagoons

Settling lagoons are large, ring-dammed structures into which the dredged material would be pumped. These could be built within the intertidal area or on land. The material would be piled up in the lagoon which would have a drainage system to collect the water and watery sludge from the dredged material for further treatment (*e.g.* by hydrocyclone, as described below) or to be transported offsite for disposal. The lagoons would need to be of sufficient size to contain the dredged material prior to transport. They would also need to be accessible by road and have facilities to load the dredged material into tankers or sealed heavy goods vehicles (HGVs) for movement to the disposal/treatment site. To minimise the distance the wet dredged material would have to be transported from the dredger, the lagoon would need to be located near the landing site.

Setting up settling lagoons would require assessment to ensure that any leachate from them would not contaminate groundwater and a licence would be required from SEPA under the *Water Environment (Controlled Activities) Regulations, 2011*. As some samples contain metals, PCBs and PAHs above Marine Scotland Action Level 1 (see *Appendix A* for sample analysis data) it might be additionally necessary to construct the lagoons with special liners to retain the contaminants and consider treatment of the supernatant water draining out of the lagoons.

Centrifuge or Hydrocyclone System

The use of a centrifuge or hydrocyclone system to dewater the material to a level suitable for disposal to landfill (approximately 10% water content) may be required, depending on the final water content of the recovered material. One mobile unit system was reported as being capable of treating up to 150 $m^3\,hr^{-1}$ depending on unit size and material solids content. Other systems may be available that can process material at different rates. If material can be dried at a rate of 150 $m^3\,hr^{-1}$, to dewater a total volume of approximately 10,000 m^3 would require approximately 68 hours (3 days assuming working 24 hours a day or approximately 9 standard working days). Other units with lower throughputs could take longer [(1)].

Filter Press

A filter press is a tool used to separate solids and liquids using the principle of pressure. The press is filled with the dredge spoil, building up pressure before the spoil is strained through filter cloths by force. The remaining dried spoil can then be removed from the filter press and taken away for disposal. Processing rates would be similar to that of a centrifuge.

3.2.4 Loading and Transport for Disposal

A loading facility would be required adjacent to the storage or dewatering area to load the material into covered HGVs for transport to disposal/treatment sites. The required infrastructure would include hard standing to allow a fleet of HGVs to be loaded by mechanical excavators. Although some limited standing to park HGVs is available at the Granton there are no storage or dewatering sites at Granton.

(2) Maximum throughput of 120 m^3hr^{-1} http://www.euroby.com/services/mobilecontract-dewatering-units/

Assuming the dredged material can be dried to a water content of 10% (by volume) at or adjacent to Granton Harbour, the estimated up to 9,350 m^3 (1) per annum of dried materials would require transportation for disposal, either to an incinerator, to agricultural land, to landfill or to a reclamation project. The length of journey required would depend on the location of the deposit/incineration sites.

A volume of 9,350 m^3 of dried (to 10% water content) material equates to approximately 13,690 tonnes (2). Assuming 20 tonne capacity HGVs/tankers are used, this would equate to 686 return trips or 1,372 vehicle movements per annum.

The annual HGV movements at Granton (based on traffic count data from the junction with the A901/903 trunk road) are approximately 56,575 (3) with average daily count of 155 HGVs (2022 data). The additional HGV movements as a result of the transport of dredged material would increase the average HGV volume by approximately 2.4%, if spread over a whole year, or a 22% increase in daily HGV movements if the transport was undertaken over approximately 40 days per annum. This level of increase may be acceptable on trunk roads but an increase in traffic flows on rural roads, however. if they are used to reach disposal/treatment sites, may be an issue.

3.2.5 Disposal/Treatment Issues

Neither method of the drying process (*e.g.* lagoons or centrifuge) is likely to reduce the concentration of metals, PAHs and salt present within the dredged material. This may restrict disposal and reuse options and pre-treatment may be required to reduce contaminant concentrations prior to disposal on land.

Where an option involves disposal on land there is an issue of classification of the dredged material. Once the material has been removed from the docks for disposal on land it will be classed as waste. The waste then requires disposal at a licensed waste management facility and to be transported by a registered waste carrier. In the waste hierarchy set out in the *Waste Management Licensing (Scotland) Regulations, 2011*, dredged spoil is coded as 17 05 05 (Mirror Hazardous) or 17 05 06 (Mirror Non-hazardous), depending on the concentrations of particular contaminants. If landfill is identified as the disposal route for this waste, then further analysis may be required to ensure that the material meets the Waste Acceptance Criteria for hazardous landfill.

Forth Ports advise that the potential to be able to find appropriate space to create settling lagoons close to the port is considered to be very low.

The saline nature of the sediment also restricts its application on land, as without going through a washing process it will not be able to support any terrestrial flora growth.

3.3 Beach Nourishment

3.3.1 Process Description

Beach nourishment involves the disposal of the dredged material on a beach directly from the dredging vessel or, if dewatering was required, the spoil would be brought ashore and dewatered prior to transport or placement on the beach using earth moving plant.

3.3.2 Suitable Sites for Beach Nourishment

Beach nourishment requires materials of a similar composition to the existing beach materials and usually involves clean sand or gravel. The average mud content from the surface samples from Granton is 81.8 % (range 78.2 to 88.2%).

Due to the risk of direct exposure to contaminated sediment, spoil containing contaminants disposed of at the public recreational sites such as beaches is considered less suitable than if it were disposed

(2) 10,000 m^3 total spoil at 85% solids content equals 8,500 m^3 plus 850 m^3 (10% water content) equals 9,350 m^3.
(3) Based on a density of 1.4 tonnes per m^3 of dredge spoil (Forth Ports pers comm September 2023).
(4) UK Traffic Data, Available online https://roadtraffic.dft.gov.uk/local-authorities/29

of at sea. Action Levels provided by Marine Scotland are specific to the disposal of material to sea where the sediment does not come into direct contact with the public, rather than at recreational areas. Guidance published by NatureScot [1] on managing coastal erosion in beach/dune systems makes reference to use of materials that *are not contaminated in any way* but does not provide equivalent action levels for contaminants. NatureScot has also confirmed during a previous consultation regarding disposal of dredged material from the Firth of Forth that it would only be appropriate to use material on a beach of similar substrate provided contaminant levels were not of concern.

No sites requiring beach nourishment have been identified through consultation (see *Appendix C*). Given the conservation status of the Firth of Forth, the lack of available beaches for nourishment, the metal, PCB and PAH contamination levels in the spoil and its particle size composition, beach nourishment is not considered to be a practicable option.

3.4 Coastal Reclamation and Construction Fill

3.4.1 Process Description

This section considers the use of the dredged material in coastal reclamation projects or as fill material inland. Depending on the potential site, reclamation or fill could involve landing, storage, dewatering, transport and possibly desalination. Coastal use directly from the dredging vessel would be preferable as this would involve pumping or spraying the material directly from the dredger or barge to the site where it was needed and would avoid handling and transporting the material on land.

3.4.2 Suitable Sites for Reclamation

Forth Ports and the coastal local authorities are the most likely bodies to be responsible for or aware of reclamation projects in the Firth of Forth. No sites for coastal reclamation have been identified through the consultation process as requiring any of the dredged material. In addition, the dredged material from the docks would not be suitable for many reclamation sites due to the low compressive strength properties of fine-grained sediments. The spoil could be pumped into bunded lagoons at the edge of the Firth of Forth to create land that could be used for development, agricultural or similar purposes.

The majority of the intertidal area falls within the Firth of Forth Site of Special Scientific Interest (SSSI) and Outer Firth of Forth and St Andrews Bay Complex Special Protection Area (SPA). The SPA is a large estuarine/marine site consisting of the two adjacent Firths of Forth and Tay. NatureScot has previously expressed the view on similar BPEO assessments that further loss of intertidal habitats is not considered a realistic option.

3.4.3 Construction Material

Use of dredged material as construction fill in inland construction projects would not be appropriate because of low compressive strength properties of fine-grained sediments and the need for landing, drying and transport of the dredged material. If landing, drying and transport were feasible then it may be that the material could be used for quarry/landfill capping. However, the presence of contaminants such as some metals, PCBs and PAHs in the dredged material and its high salt content make this option unattractive.

3.5 Spreading on Agricultural Land

3.5.1 Process Description

SEPA has previously confirmed that the disposal or recycling of marine dredged material on agricultural land does not fall within the exemptions under Paragraph 7 of Schedule 1 of the *Waste*

(1) Scottish Natural Heritage (2000). A Guide to Managing Coastal Erosion in Beach/dune Systems. Summary 7: Beach Nourishment.

Management Licensing (Scotland) Regulations, 2011, and the activity would therefore require to be licensed. Planning permission may also be required from the local authority. In support of the application to dispose of the dredged material to agricultural land, evidence that the material would not cause pollution of the environment or harm to human health would need to be provided.

The disposal of marine dredged material to agricultural land would involve landing, dewatering, possibly storage, desalination and transport for disposal. Dewatering the dredged material in lagoons or in a centrifugal drier would remove some of the salt; however it is likely that desalination would still be required. Desalination could be achieved by placing the spoil in lagoons, layering it with sharp sand, spraying water over the material and allowing leaching of the salt water back into the Firth of Forth.

Approximately 200,000 tonnes of sludge are recycled to agricultural land per annum across Scotland [(1)]. Forth Ports is seeking to dispose of approximately 9,350 m^3 of dewatered material (approximately 13,690 tonnes at 1.4 tonnes m^{-3}) from Granton equating to approximately 6.8% of the current volume of annually recycled sludge in Scotland.

As the material from Granton has a low organic carbon content (an average of approximately 4.23% from the sediment sample analysis) spreading dredged material from Granton Harbour on agricultural land is not considered a practicable option.

In addition, the material sampled at Granton has contamination from some metals, PCBs and PAHs above Action Level 1 so the spoil cannot be applied to land without confirmation from SEPA that levels of these contaminants are acceptable.

3.6 Sacrificial Landfill

3.6.1 Process Description

The type of landfill site which can take the spoil is dependent upon the classification of the waste. As discussed in Section 3.2.5 above it is understood that the waste would likely be classified as non-hazardous rather than inert and therefore a suitably licensed landfill site with sufficient capacity would be required.

3.6.2 Available Landfill Sites

Subsequent to implementation of the *Landfill Allowance Scheme (Scotland) Regulations* 2005 and re-evaluation of landfill licences, there is currently one site within an hour's drive from Granton Harbour with the facilities to accept the material. This is Avondale Landfill at Polmont, approximately 35 km west of Granton. Previous consultation with the operators confirmed that the site cannot accommodate the dredged material due to the composition, and volume not fitting with their site operations. The Avondale site could consider taking some dredged sediment material if the availability coincided with the closure of one or all of the phases within the plant.

3.6.3 Taxes and Royalties

The material will be exempt from landfill tax under the terms of the *Landfill Tax (Scotland) Act 2014* issued by the Scottish Government that specifies that dredged material from any inland waters, including harbours and their approaches, are not subject to landfill tax.

3.7 Incineration

3.7.1 Process Description

Incineration would involve landing the dredged material, dewatering, possibly storing it and transporting it to either an existing incinerator or a newly constructed incinerator. The ash would then

[(1)] https://www.gov.scot/publications/review-storage-spreading-sewage-sludge-land-scotland-sludge-review-final/

require disposal. Options for disposal of ash include landfill, reclamation and spreading on agricultural land.

The Total Organic Content (TOC) of the dredged material is assumed to be approximately 4.23% (based on the three 2023 samples which had a TOC range of 3.32 to 4.73%) and therefore there is only a small combustible component within the material. It is anticipated that incineration would result in a reduction in volume of the dried spoil only 14.23% *i.e.,* 4.23% organics plus 10% water content. Incinerator operators generally require material to have an organic content above 20% to ensure efficient combustion and would most likely reject material with an organic content below this threshold (1).

A further consideration is that the material to be dredged contains some metals, PCBs and PAHs above Action Level 1. Following incineration the leaching potential of metals would be reduced, however, the ash would still be contaminated. Pre-treatment is likely to be required for the removal of metals. Emissions to atmosphere from the incineration processes would also require to be controlled by SEPA under the *Environmental Protection Act 1990.*

3.7.2 Available Incinerator Sites

There are no appropriate waste incinerators in Scotland that could accept the dredged material. The nearest high temperature hazardous waste incinerator is at Ellesmere Port, Merseyside (approximately 388 km/250 miles south) and transport would be costly and therefore this option is not considered to be practicable. Based on 2021 data, of the 58,470 tonnes of material dealt with at this site there was no dredge spoil (2).

3.8 Other Disposal Options and Reuse

The other disposal options are re-injection into the tidal flats via a pipeline and reuse in brick making, concrete aggregate or topsoil production processes.

3.8.1 Re-injection

This would involve the construction of a pipeline to take the dredged spoil to a high tide point on the Cramond tidal flats and injecting it at velocity back into the mudflat. The advantage of this is that it effectively keeps the sediment within the sediment cell. The disadvantage of this is that the re-injection at velocity would be likely to have an adverse impact on the protected mudflat habitat through disturbance and erosion and may affect the benthic fauna and associated ornithological interests that feed in the mudflats.

Due to the costs associated with the construction and maintenance of the pipeline and the disturbance during construction and operation of the pipeline on the ornithological interest of the mudflats this option is not considered to be practicable.

3.8.2 Brick Making/Concrete Aggregate/Topsoil Production

There are processes by which marine sediments can be made into bricks or can be used to form concrete aggregate. The advantage is that the materials can be beneficially used, and metals are sealed into the bricks or aggregate, however, there are issues with the salt content for brick making and concrete construction material. Almost no agricultural species can grow in salty soils and very few in brackish soils. The salinity of the dredged sediment would require to be reduced naturally by rainwater or by a dewatering process before consideration for use as topsoil or construction materials (see Section 3.2.3). The best topsoil is a mixture of sand, silt, clay and organic matter and must be clean for use in the production of food crops (3).

(2) Baldovie Waste to Energy Plant, pers comm, January 2017
(3) https://wikiwaste.org.uk/index.php?title=Ellesmere_Port_Incinerator
(1) Permanent International Association of Navigation Congresses. Permanent Technical Committee II. Working Group 19. 1992. Beneficial Uses of Dredged Material, Issue 19.

This option would not be feasible at Granton Harbour due to lack of necessary handling facilities and suitable storage areas. The contaminant levels in the samples would make using the material for topsoil unattractive. In addition, there is no known demand for this material to be used in topsoil production.

3.9 Disposal to Sea

3.9.1 Process Description

Disposal at sea involves the dredge material being transported to a licensed marine spoil ground in a dredging vessel. Disposal to sea is the normal practice for disposal of dredged spoil from other ports and harbours in the Forth Estuary and Firth of Forth and has previously been undertaken for material dredged from Granton Harbour. It involves the dredger sailing to a licenced spoil ground and releasing the materials through bottom doors or by lowering the excavator head into the water. For the current dredger, bottom door disposal is used. A differential global positioning system (dGPS) would be used to position the vessel in the disposal area and record the spoil discharge locations.

This approach takes place at sea and does not require the landing of any materials.

3.9.2 Available Sites

There are seven licenced marine spoil grounds in the Forth Estuary and Firth of Forth; Bo'ness, Blae Rock, Kirkcaldy, Methil, two sites designated at Narrow Deep and Oxcars. For the dredging operations at Granton, Forth Ports would propose to use the Oxcars main spoil ground located 1.7 nm from Granton Harbour. This site has historically been used for the disposal of dredged material from Newhaven harbour, Rosyth and Granton. It is the closest site to Granto Harbour, thus minimising the distance for vessel transport.

The time required for one cycle (dredging - travelling - discharging - travelling) is approximately 1.5 to 2.5 hours, depending on production and loading times and tidal restrictions for accessing the harbour.

The baseline environmental conditions and potential environmental impacts at the Oxcars spoil ground are described in *Appendix B*.

3.10 Conclusion

The description of the available options allows options that are evidently impracticable to be ruled out, for example due to the nature of the dredged material. This is summarised in *Table 3.2.* The assessment of the short-listed options taken forward for further consideration is presented in *Section 4.*

Table 3.1 Short-listing of Options

Option	Assessment	Result
Beach Nourishment	This option does not appear to be practicable. The material is not suited to beach nourishment in the Forth Estuary or the Firth of Forth; in addition there are no beaches within the Forth Estuary or the Firth of Forth, identified by Forth Ports, consultees or in the NCCA (2017) (1) report that require nourishment with this grade of material.	Discard
Coastal Reclamation and Construction Fill	This option may be practical. The salt content, poor load bearing properties and the potential concentration of contaminants limits the available options for reuse of the dredged material.	Short-list
Spreading on Agricultural Land	This option does not appear to be practicable. The material is not desirable for disposal on agricultural land due to potentially containing concentrations of contaminants and having a low organic content (c.4.23%). Furthermore, desalination, storage, dewatering and transport of this material are impractical. Disposal on agricultural land would require a Waste Management Licence and evidence that there would be no harm to human health.	Discard
Sacrificial Landfill	This option may be practicable as there are local sites. There are a large number of steps involved in storage, dewatering and transport. Landfill site operators may be unwilling to accept the material due to the sediment composition and presence of some contaminants.	Short-list
Incineration	This option does not appear to be practicable. The material is not suited to incineration due to low organic content (c. 4.23%). If incinerated, volume would only slightly reduce and there are no available incinerators in Scotland that could take this grade of material.	Discard
Other Uses	This option may be practicable in the form of brick making, concrete aggregate and topsoil production.	Short-list
Disposal at Sea	This option is practicable and has been the BPEO for previous dredging campaigns at the Granton Harbour.	Short-list

(1) Fitton JM, Rennie AF and Hansom JD (2017). Dynamic Coast - National Coastal Change Assessment: Cell 2- Fife Ness to Cairnbulg Point. CRW1014/2.

4. ASSESSMENT OF SHORT-LISTED DISPOSAL OPTIONS

4.1 INTRODUCTION

This section presents an assessment of each option against the assessment definitions of performance listed in *Table 2.1*. A classification of likely performance is provided for each of the criteria and the assessment is then summarised in *Section 5*.

The environmental effects of disposal at sea are addressed in *Appendix B.*

4.2 COASTAL RECLAMATION AND CONSTRUCTION FILL

4.2.1 Strategic Considerations

Operational Feasibility

The reuse of the dredged material for reclamation will involve either direct pumping from the dredger into the disposal site or landing and drying the material and desalination prior to transporting the material for disposal on land. This option would be feasible if disposal sites were available adjacent to the Firth of Forth.

Classification: Medium

Availability of Sites

No coastal sites within the Firth of Forth requiring this grade of material for reclamation or construction fill have been identified by Forth Ports, consultees or in the latest Dynamic Coast – National Coastal Change Assessment (2017) (1).

Classification: Low

Security of Option

No sites have been identified as belonging to Forth Ports, so disposal to reclamation sites is outside of their control and could present practical problems, such as scheduling in sediment delivery with proposed dredging programme.

Classification: Low to Medium

Established Practice

The use of suitable dredged materials in coastal reclamation and construction fill is common practice and the technologies and techniques are well established, however, this is for dredged primary aggregate materials such as sands and gravels.

Classification: Low to Medium

General Public Acceptability

Use of the materials for reclamation is likely to be viewed as an acceptable option by the general public. The method of transporting the dredged material to the site requiring it may affect acceptability by the general public. Transport by sea is likely to be viewed as more favourable than transport by road, which may be viewed as unacceptable by local residents and road users.

Classification: Medium to High

Likely Agency Acceptability

Use of the dredged material for reclamation or construction fill is likely to be acceptable to public agencies. There may be some concerns regarding the contamination levels in the dredge spoil and

(1) Fitton, J.M., Rennie, A.F., and Hansom, J.D. (2017) Dynamic Coast - National Coastal Change Assessment: Cell 2 - Fife Ness to Cairnbulg Point, CRW2014/2

the volume of material to be transported by HGVs for reasons relating to air quality and proximity to residential areas.

Classification: Medium to High

Legislative Implications

The disposal of dredged material from Granton Harbour directly from the dredger to a reclamation site requires a Marine Licence from Marine Scotland under *Section 20(1) of the Marine (Scotland) Act, 2010*.

Once the material has been removed from Granton Harbour for disposal on land it will be classed as waste under the *Waste Management Licensing (Scotland) Regulations, 2011* and the disposal will therefore require a waste management licence and an exemption for reclamation works. As well as a Marine Licence for the construction works, consent will be required from the planning authority and a levy may be due to the Crown Estate Scotland.

Classification: Medium to High

4.2.2 Health, Safety and Environmental Considerations

Public Health

There may be localised and temporary deterioration in air quality as a result of intermittent increase in HGV movements.

Classification: Medium to High

Safety

Transferring the dredged material ashore has risks associated with operational activities, all of which have mitigation measures in place. Should the dredged material be transported by HGV, there may be an increase in safety risks associated with the movement of materials for disposal, particularly if tankers/sealed HGVs travel through populated areas and along minor roads.

Classification: Medium

Contamination/Pollution

The material may be classified as hazardous or non-hazardous (*i.e*. not inert) due to the concentration of contaminants with respect to land-based disposal, however, further analysis would be required to confirm this, and run-off and leaching would need to be controlled.

Classification: Medium

Ecological Impact

There are unlikely to be any ecological risks resulting from the use of dredged materials for reclamation, assuming any contaminants are contained within the site and there would be no significant impact on national or local priority species or habitats. If the site was to be used for terrestrial habitat creation, then the salt levels would limit plant growth.

Classification: Medium to High

Interference with Other Legitimate Activities

The disposal of dredged material is unlikely to interfere with other activities unless the reclamation site is in or close to port areas, in which case the dredger may interfere with other port users. If HGVs are used to transport the dredged material, they may affect other road users, particularly if minor roads are used.

Classification: Medium to High

Amenity/Aesthetic

If the dredged material is disposed of directly from the dredger there are low risks to amenities/aesthetics. If disposed of by HGV, landing, storage and transport may result in an impact to both amenities and aesthetics of the area.

Classification: Medium to High

4.2.3 Cost Considerations

If the dredged material was pumped directly ashore there would be no further capital costs. The estimated operational costs below would apply.

- operational costs for the operation of the dredger: £100,000 per annum;
- pumping material to site – approximately £10 per m^3 (1) for 10,000 m^3 £10,000;

Total: £110,000.

Classification: High

If the dredged material was landed, treated and then transported by road, the estimated costs below would apply:

- operational costs for the operation of the dredger: £100,000 per annum;
- a discharge berth for the dredger with a storage facility: £3.5 m;
- lagoons to settle dredged material and possibly desalinate: £2.5 m; or
- dockside centrifuge facility capable of dewatering and desalinating up to 10,000 m^3 per annum: £20 m; and
- loading and transport (sealed HGVs) – assuming the disposal site is less than one hour drive away and based on one HGV transporting 20 tonnes material at a cost of £100/trip (2): £68,600.

Total £6.169 to £23.669 m

Classification: Low

4.3 Sacrificial Landfill

4.3.1 Strategic Considerations

Operational Feasibility

Disposal to landfill would require the landing, storage and drying of the dredged materials prior to transporting to a landfill facility. Approximately 13,690 tonnes of dried material would require transport. This option has practical difficulties relating to drying the dredged material and transport of material to a landfill site.

Classification: Low to Medium

Availability of Sites / Facilities

The nearest suitable site is located at Polmont, approximately 35 kilometres west of Granton, however as discussed above, due to the dredged sediment composition, these sites would be unlikely to receive any of the material. In addition, the timing of receipt of material would need to fit in with its operational requirements when closing exiting landfill cells (3).

(2) Based on previous consultation with contractors.
(3) Estimated cost based on consultation with HGV operator at £50/hour and estimated cost of loading at £50/hour.
(1) Avondale pers comm, February 2016.

Under the *Landfill (Scotland) Regulations, 2003* the presence of contaminants will classify the material as *non-hazardous* rather than *inert* and consequently reduces the number of available landfill sites capable of accepting this material.

Classification: Low

Security of Option

Whilst Forth Ports have control over the dredging operations, it would have no control over the continued availability of landfill space for the material or the disposal route.

Classification: Low to Medium

Established Practice

Dredged material is sometimes disposed of to landfill for small one-off dredging operations, however it is not established practice to routinely dispose of dredged material in this way. Landfill sites require the dredged material to be dried to 10% water content before acceptance. It is unlikely that this is a practice that would be acceptable if there are other viable alternatives.

Classification: Low to Medium

General Public Acceptability

Disposal of the material to landfill is likely to be acceptable to the general public. However, the transport of the dredged material from Granton Harbour to potential landfill sites may be unacceptable to residents and other road users.

Classification: Medium to High

Likely Agency Acceptability

Scotland's Zero Waste Plan 2010, establishes the direction of the Scottish Executive's policies for sustainable waste management. One such policy is to reduce landfilling of waste to 5% of all wastes by 2025 and as such there may be objection to dredged material routinely requiring space in landfill sites.

Disposal to nearby landfill sites may be acceptable to SEPA, provided the materials are regarded as suitable for landfill, however, the acceptability would depend on the quantities to be disposed of and further assessment and classification of hazardous substances.

Classification: Medium

Legislative Implications

The material would be controlled waste material for the purposes of transport, storage and disposal. As such, Section 34(7) of *The Environmental Protection Act 1990* and Regulation 6 of the *Pollution Prevention and Control (Scotland) Regulations, 2012* would apply and compliance is likely to be possible. The disposal of the material will also require a waste management licence under *Waste Management Licensing (Scotland) Regulations, 2011*.

Classification: Medium

4.3.2 Health, Safety and Environmental Consideration

Public Health

Low risks to public health are anticipated due to the intermittent increase in HGV traffic.

Classification: Medium to High

Safety

There may be an increase in safety risks associated with the movement of materials for disposal, particularly if there are 1,372 HGVs movements through populated areas and along minor roads each year.

Classification: Medium

Contamination/Pollution

There may be a small risk of leaching of contaminants that should be contained on site.

Classification: Medium to High

Ecological Impacts

Although there is a small risk of contaminants leaching out from the dredged material, this would be at very low concentrations and is unlikely to cause significant harm to the local ecology. The salt content in the material may prevent plant growth unless covered in a topsoil.

Classification: Medium to High.

Interference with Other Legitimate Activities

The increase in HGV movements may interfere with other road users. Baseline traffic data for the A901/A903 in the vicinity of Granton Harbour indicates that approximately 3% of all road traffic in the vicinity of Granton Harbour are HGVs (1). As a result of the disposal to landfill there would be a 2.4% increase in the number of HGVs as an annual average (2). This would be a 22% increase in daily HGV movements when material was being taken from Granton Harbour, assuming the removal of dredged material occurred over 40 days per annum. In addition, depending on the landing and storage arrangements there may be potential for interference with other dock users.

Classification: Medium

Amenity/Aesthetic

The movement of HGVs through the area will have an impact on local amenity through noise, vibration, visual impacts and road congestion. This risk also applies to the disposal site.

Classification: Medium

4.3.3 Cost Considerations

The estimated costs below would apply.

- operational costs for the operation of the dredger: £100,000 per annum;
- discharge berth: £3.5 m;
- lagoons to settle dredged material - £2.5 m; or
- dockside centrifuge facility capable of dewatering and desalinating 10,000 m^3: £20 m;
- loading and transport (sealed HGVs) – assuming the disposal site is less than one hour drive away and based on one HGV transporting 20 tonnes material at a cost of £100/trip (3): £68,600.

Total £6.169 m to £23.669 m

Classification: Low

(2) UK Traffic Data, A901/A903 Granton. 2022 traffic data. Available online https://roadtraffic.dft.gov.uk/local-authorities/32
(3) 2022 data present 56,575 HGVs per annum on the A901/A903 at Granton, which would increase to 57,947 HGV movements (from a total of 1,851,645 vehicles recorded per annum at this location) with the transport of dredged material from Granton by road.
(1) Estimated cost based on consultation with HGV operator at £50/hour and estimated cost of loading at £50/hour.

4.4 OTHER DISPOSAL OPTIONS AND REUSE

4.4.1 Strategic Considerations

Operational Feasibility

Reuse for brick making, concrete aggregate or topsoil production would require the landing, storage and drying of the dredged materials prior to transporting to a landfill facility. Approximately 13,690 tonnes of dried material would require transport.

There are practical difficulties relating to handling the dredged material at Granton Harbour. The availability of suitable factories/facilities to process the dredged material and markets for the final products are also considerations. Previous consultations between Forth Ports and a brick making factory confirmed that the mineralogy of the material would not be appropriate for brick making and the contamination by salt would be unacceptable for any construction material.

Classification: Low to Medium

Availability of Sites/Facilities

There are no known sites or facilities to receive the dredged material for other uses such as topsoil production, brick making or other construction materials.

Classification: Low

Security of Option

Although Forth Ports would have control over the dredging and landing, they would not have control over the continued acceptance of the materials for other uses.

Classification: Low to Medium

Established Practice

Use of marine aggregates such as clean sands and gravels are used as a source of primary construction aggregates, but fine sediments are not used for this purpose. Whilst topsoil has been made from dredged material in the past it is not common practice.

Classification: Low to Medium

General Public Acceptability

Making bricks, concrete or topsoil is likely to be publicly acceptable depending on the end use. However, the transport of the material over a large distance may not be acceptable to residents and other road users.

Classification: Medium to High

Likely Agency Acceptability

It is likely that brick making, concrete production and topsoil production would be acceptable to agencies and considered a positive activity. However, the contaminant levels in the samples would make using the material for topsoil unattractive.

Classification: Medium to High

Legislative Implications

SEPA would control emissions from brick making factories under the provisions of the *Environmental Protection Act 1990*. A waste management licence would also be required for their transport and storage under the *Waste Management Licensing (Scotland) Regulations, 2011*.

Classification: Medium

4.4.2 Health, Safety and Environmental Considerations

Public Health

Low risks to public health are anticipated due to the intermittent increase in HGV traffic.

Classification: Medium to High

Safety

There are unlikely to be any significant safety risks associated with making bricks, concrete or topsoil with the exception that there may be an increase in safety risks associated with the movement of materials, particularly if HGVs travel through settlements and along minor roads.

Classification: Medium

Contamination/Pollution

The contaminant levels in the dredged material would make using the material for topsoil unattractive. Pollution from plant emissions is not likely to be an issue provided emissions are controlled in accordance with licences.

Classification: Medium to High

Ecological Impact

Making bricks or concrete should have no adverse ecological effects, provided the materials were decontaminated and desalinated before use.

Classification: High

Interference with Other Legitimate Activities

There is a slight risk that movement of the material would impact other road users.

Classification: Medium to High

Amenity/Aesthetic

The only impacts on amenity are likely to stem from the impact of HGVs from transporting the material (up to 1,372 HGV movements per annum).

Classification: Medium to High

4.4.3 Cost Considerations

The estimated costs below would apply.

- operational costs for the operation of the dredger: £100,000 per annum;
- a discharge berth for the dredger with a storage facility - £3.5 m;
- lagoons to settle dredged material and possibly desalinate - £2.5 m; or
- dockside centrifuge facility capable of dewatering and desalinating 10,000 m^3 of silt per annum - £20 m; and
- loading and transport (sealed HGVs) – assuming the disposal site is less than one hour drive away and based on one HGV transporting 20 tonnes material at a cost of £100/hour(1): £68,600.

Total: £6.169 m to £23.669 m

Classification: Low

(1) Estimated cost based on consultation with HGV operator at £50/hour and estimated cost of loading at £50/hour.

4.5 SEA DISPOSAL

4.5.1 Strategic Considerations

Operational Feasibility

Operationally, disposal at the Oxcars disposal site is comparatively simple as it does not require the landing, storage and drying of the dredge spoil. As this is discharge route used for previous dredge operations at Granton, Newhaven and Rosyth, it has been proven as practicable and all the necessary procedures are understood and logistical arrangements in place.

Classification: High

Availability of Sites / Facilities

The sites/facilities which are required for the sea disposal option are those which are the closest to Granton Harbour. No other disposal sites have been indicated by Forth Ports as being preferred for the dredged spoil material from Granton Harbour.

Classification: High

Security of Option

Forth Ports would have full control over all stages in the dredging and disposal process through its dredging contractors.

Classification: Medium to High

Established Practice

Disposal at the Oxcars licenced spoil ground is the current practice for the disposal of dredged spoil from Rosyth and Newhaven and has previously been used for the disposal of material from Granton Harbour and is therefore established and proven as effective.

Classification: High

General Public Acceptability

Forth Ports has confirmed that similar disposal operations from other ports and harbours in the Firth of Forth and Forth Estuary have not attracted any appreciable public comment. Dredging operations are unlikely to affect members of the general public, with the possible exception of some recreational users in the Firth of Forth when the vessel is transiting to and from the disposal site, however this would be continuing the practice of disposal at sea at licenced spoil grounds that has been established over many years in the Firth of Forth.

Classification: High

Likely Agency Acceptability

Informal consultations with the regulatory bodies and other interested parties did not identify any objections to sea disposal at the Oxcars spoil ground. Responses to consultation letters were received from the Crown Estate Scotland, the Maritime and Coastguard Agency, the National Lighthouse Board and SEPA (see Appendix C). Formal consultations will be undertaken by Marine Scotland following submission of the Marine License application and Forth Ports will be required to respond to any issues raised by Marine Scotland and its consultees.

Classification: Medium to High

Legislative Implications

A Marine Licence will be required from Marine Scotland and provided that the BPEO is satisfactory, and the statutory consultees do not object, it is established practice that a Marine Licence will be issued. Compliance should not therefore demand significant management control. Permission will be

required from the Crown Estate Scotland for disposal of spoil to the Crown Estate Scotland owned seabed.

Classification: Medium to High

4.5.2 Health, Safety and Environmental Considerations

Public Health

The risk of members of the general public being exposed to contamination from the dredged material deposited at the Oxcars spoil ground is considered to be low. Commercial species of demersal fish are not taken from the disposal area so no direct food chain links between the disposal site, fish and human consumers leading to impacts on public health are considered likely.

Classification: Medium to High

Safety

The operations are undertaken at sea, therefore members of the public are not likely to be exposed to risk from the disposal activities. Forth Ports will have oversight of the dredging contractor's operations.

Classification: High

Contamination/Pollution

The effects on water quality of the disposal operations and the potential for impacts on sediment contamination may cause the occasional exceedance of Environmental Quality Standards and failure to meet Water Framework Directive (WFD) objectives although based on current evidence this would be localised and short-term.

Classification: Medium

Ecological Impacts

The disposal operations may affect the benthic fauna in proximity to the disposal site due to suspended sediments depositing on the seabed outside the disposal site. It is anticipated that there will not be any significant impact on the Forth Estuary and Firth of Forth marine ecosystem given the scale and duration of effects. There may be some short-term effects such as displacement of migrating fish due to increased turbidity caused by the discharge of dredged material into the water column, but these impacts are not predicted to cause mortality, significantly affect migration routes or affect the viability of populations.

Under the proposed disposal proposals, cumulative impacts with other operations are not predicted to create a significant impact to the Firth of Forth SPA, Forth Islands SPA, Outer Firth of Forth and St Andrews Bay Complex SPA, Firth of Forth SSSI, SACs farther afield or marine ecosystems.

The ecological impacts of disposal of dredged material to sea is addressed in *Appendix B.*

Classification: Medium to High.

Interference with Other Legitimate Activities

The transport and disposal activities may cause some disruption to other users of the Firth of Forth, however as the operations will only be occurring for a limited period of time and are controlled directly by Forth Ports it is not anticipated that there will be any significant interference. In addition, historic disposal operations at Oxcars have not resulted in any reported disruption to other Firth of Forth users.

Classification: High

Amenity/Aesthetic

The disposal activities may cause some short-term disruption to other users of the Firth of Forth but the proposals will contribute to the normal functioning of Granton Harbour.

Classification: Medium to High

4.5.3 Cost Considerations

There would be no capital required to purchase new equipment. Operational costs for the operation of the dredger are approximately £100,000 per annum, depending on dredging volume requirements.

Classification: High

5. SUMMARY OF THE BPEO

5.1 INTRODUCTION

This section summarises the assessment of options against the criteria described in *Chapter 2*: *Table 2.1* and identifies the BPEO.

5.2 COMPARISON OF OPTIONS

Seven options were initially considered for the disposal of the dredged spoil from Granton Harbour. These were reduced to a short-list of four options, based on operational and technical feasibility. A summary of the key considerations with regard to each of the four short-listed options is provided below and illustrated in *Table 5.1.*

5.2.1 Coastal Reclamation and Construction Fill

Operationally, coastal reclamation and construction fill would be possible. The sediment is primarily sandy mud, with mostly low compressive strength properties, making it unsuitable for most types of construction. In addition, the presence of some metals, PCBs and PAHs restricts its suitability for application on land.

Currently there are no significant areas of coastal reclamation planned in the Firth of Forth or Forth Estuary. The costs of this option would be high due to the requirement for construction of a landing and storage facility, a drying facility and transport costs.

5.2.2 Sacrificial Landfill

Operationally, disposal to landfill will be achievable but problematic. The dredged materials would require landing and drying in specially constructed facilities and would then require transport in sealed HGVs to an appropriate landfill site. There are limited sites available to take these types of sediments, and a full analysis of the contaminants in the material would be required by the operators before final acceptance.

Whilst small amounts of dredged sediment material are sometimes disposed of to landfill, it is not common practice and Forth Ports would not have the security of controlling the disposal route. The public and agencies are likely to find this disposal acceptable, but there may be concerns relating to transport and Scotland's Zero Waste Plan (2010) which favours a reduction in the volume of material disposed by landfill (to 5% of all wastes by 2025). There would be a low risk of ecological disturbance.

The requirement for transport will result in some safety and public health risks and interference with other activities due to an increase in HGV traffic volumes, along with elevated emission to air. The costs of this option would be high due to the requirement for construction of a landing and storage facility, a drying facility and transport costs.

5.2.3 Other Disposal Options and Reuse

Operationally the option to supply the dredged material for other purposes such as brick making, construction aggregates and topsoil would be possible but there would be difficulties associated with the requirement to land, store, dry and transport the material leading to high capital and operational costs. Forth Ports would have limited control over the option and it is not common practice to use marine dredged material for these purposes. It is likely to be viewed as an attractive option by the public and agencies and few legislative issues are anticipated.

Environmental and public health and safety concerns associated with this option are linked to transport of the materials and are anticipated to be low. There will be no significant impact on amenity and little interference with other legitimate users other than road users. The mineralogical composition and salinity of the material limit its suitability for use for brick making, as concrete

aggregate or in topsoil production as it would require treatment to desalinate and decontaminate the material.

As with Sacrificial Landfill and Coastal Reclamation and Construction Fill, capital costs would be high because of the need for landing, storage and drying facilities and transport costs.

5.2.4 Sea Disposal

Operationally few problems are anticipated with disposal at the Oxcars spoil disposal site and this site is the nearest to Granton Harbour and has previously been used for the disposal of dredge spoil from Granton. It is anticipated that this option will be acceptable to both public and agencies, based on previous applications. Forth Ports would have control over the dredging process through the appointment of contractors and risks to safety and public health are anticipated to be low.

There will be some short-term and localised effects on water quality during disposal, such as raised turbidity and suspended sediment levels, which may have slight ecological effects, but these are considered to be not significant. There is unlikely to be interference with other legitimate activities and there is not anticipated to be any impact on local amenity or navigation.

5.3 IDENTIFICATION OF THE BPEO

The assessment of options highlights the major operational difficulties associated with the Sacrificial Landfill, Coastal Reclamation and Construction Fill, and Other Disposal Options and Reuse that primarily relate to lack of available sites and facilities and the nature of the material. There are also major costs associated with the need to construct landing, storage and drying facilities at Granton Harbour or elsewhere within the Firth of Forth.

The proposed disposal of dredged material at sea supports the objectives set out in Scotland's National Marine Plan and will support the planned dredging operations to safeguard the access to Granton Harbour and its navigational safety.

Disposal at sea will keep the dredged material within the ecosystem, maintaining the sediment budget for the area. In line with guidance from Marine Scotland, the Best Practicable Environmental Option is identified as the disposal at a licensed marine spoil ground. The preferred site for this is the existing Oxcars licenced spoil ground.

Table 5.1 Summary of Assessment of Options

	Coastal Reclamation and Construction Fill	Sacrificial Landfill	Other Uses	Sea Disposal
Operational feasibility				
Availability of sites/facilities				
Security of option				
Established practice				
General public acceptability				
Likely Agency acceptability				
Legislative implications				
Public health				
Safety				
Pollution/contamination				
Ecological impact				
Interference with other users				
Amenity/aesthetic				
Cost considerations	#			

#: High if pumped directly to an available local site

Key: Performance of Options	
Low	
Low to Medium	
Medium	
Medium to High	
High	

APPENDIX A SEDIMENT SAMPLE CHEMICAL ANALYSIS

A1 GRANTON HARBOUR SEDIMENT SAMPLE DATA

A1.1 Introduction

Samples of the seabed sediments to be dredged were collected from Granton Harbour by Forth Ports on 2 May 2023 and were analysed by SOCOTEC Ltd.

The survey plan followed the Marine Scotland guidance and surface grab samples were collected from five survey stations. Sample station locations are presented in Table A1.1 and shown in *Figure A1.1*. Note that the chart used in *Figure A1.1* shows the dredging area to include an area of reclaimed land but that reclamation work was not undertaken.

Table A1.1 Positions of the Granton 2023 Sample Stations

Sample Station	Latitude	Longitude
GR23-01	55° 59.267' N	3° 13.305' W
GR23-02	55° 59.230' N	3° 13.479' W
GR23-03	55° 59.159' N	3° 13.418' W
GR23-04	55° 59.113' N	3° 13.311' W
GR23-05	55° 59.029' N	3° 13.231' W

Coordinates in WGS84, degrees decimal minutes

The grab samples retrieved from each survey station were subsampled on deck and stored in pre-cleaned sample containers provided by SOCOTEC. Each sample was labelled with a unique sample ID and a field log was kept of the sample location, date and time sample was taken.

Sediment photographs are presented in *Figure A1.2*.

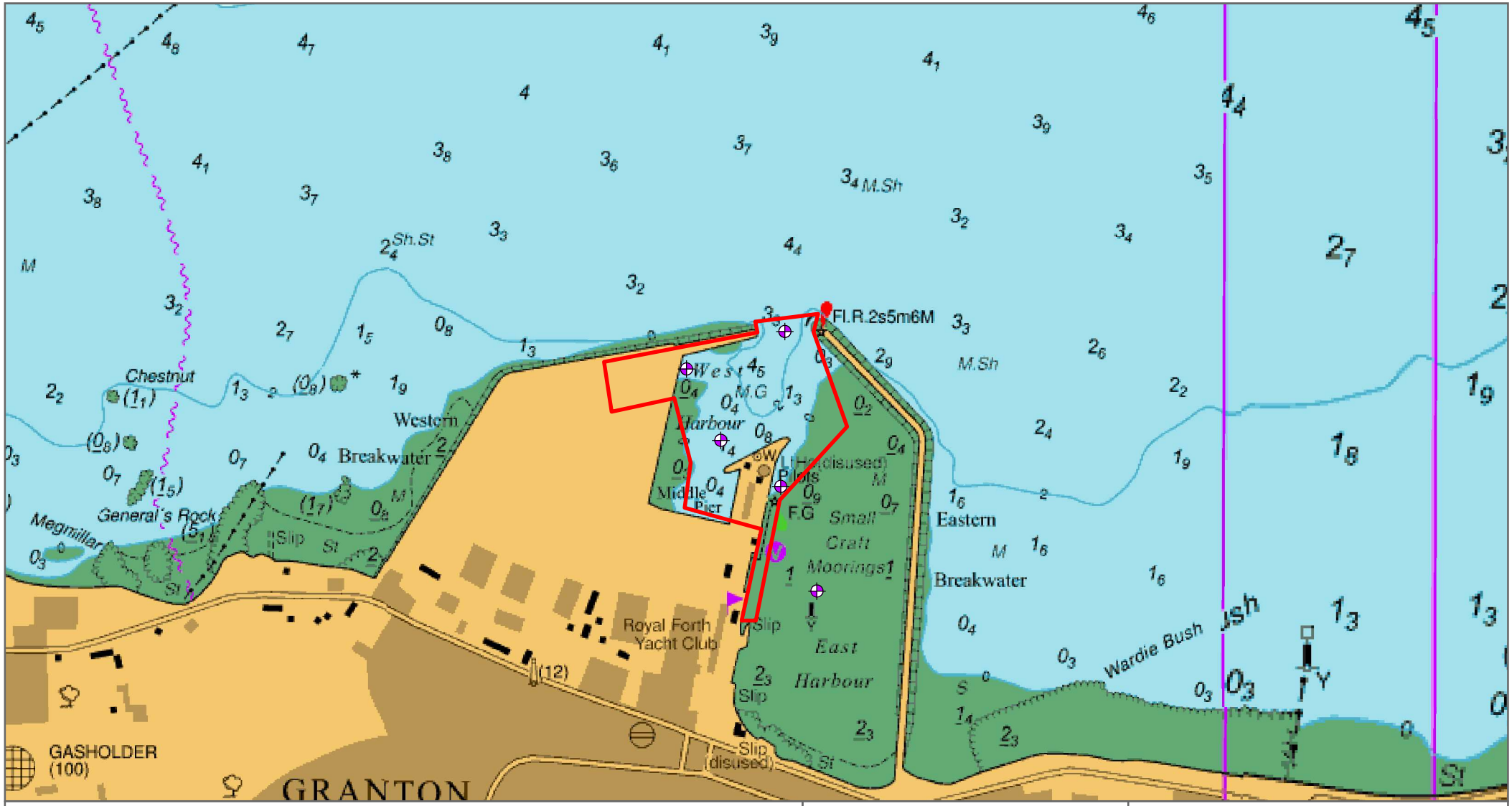
Samples were sent by courier to the analytical laboratory for following chemical analysis:

For each of the samples the following chemical analysis was undertaken.

- Metals (As, Cd, Cr, Cu, Hg, Ni, PB, Zn).
- Tributyl Tin (TBT);
- Polycyclic Aromatic Hydrocarbons (PAH) (EPA 16).
- Total Hydrocarbon Content.
- Poly Chlorinated Biphenyls (PCBs) (ICES 7).
- Sediment moisture content and sediment particle density.
- Total Organic Carbon (TOC).
- Sediment particle distribution (PSD).
- Presence of asbestos.

Marine Scotland Action Levels are discussed in Section A1.2 and the sediment sample data are presented in Section A1.3 to Section A1.8.

Data from previous samples collected by Forth Ports in 2002 and 2005 and more recent data collected by the Forth Royal Yacht Club in 2020 (from three sample stations on the east side of Middle Pier to the south of the current sample station GR23-02) are also provided for comparison.



2023 Granton Sediment Sample Locations

Revised Dredging Area

0 100 200 300 400

Metres

N

Figure A1.1
Port of Granton
Sample Locations

SCALE: See Scale Bar	VERSION: A03
SIZE: A4	DRAWN: HD
PROJECT: 0391463	CHECKED: MI
DATE: 12/07/2024	APPROVED: MI

ERM

Forth Ports Ltd

PROJECTION: WGS 1984 UTM Zone 30N

Path: \\uksprdgisfs01\Data\London\Projects\0391463 - Forth Ports\DATA\PhX Granton 2023\Maps\0391463 - Forth Ports - Granton.aprx\0391463 - Granton - Fig A1.1 Report- Sample Locations - A03

Figure A1.2 Granton Harbour 2023 Sample Photographs

Station GR23-01

Station G23-02

Station GR23-03

Station GR23-04

Station GR23-05

A1.2 Marine Scotland Action Levels

Table A1.2 and *Table A1.3* set out the Action Levels for metals, PCBs, TBT and PAHs used by Marine Scotland to assess the suitability for disposal of sediments at sea.

Based on the Marine Scotland guidance contaminant levels in dredged material below Action Level 1 are generally of low concern and are unlikely to influence the licensing decision. A breach of Action Level 1 does not automatically preclude disposal at sea but usually requires further consideration before a decision can be made. Dredged material with contaminant levels above Action Level 2 is generally considered unsuitable for normal sea disposal but may be suitable for other management options such as treatment or seabed burial/capping unless a compelling case can be made for normal sea disposal.

Table A1.2 Marine Scotland Action Levels: Metals

Metal	AL1 ($mgkg^{-1}$ dry weight)	AL2 ($mgkg^{-1}$ dry weight)
Arsenic (As)	20	70
Cadmium (Cd)	0.4	4
Chromium (Cr)	50	370
Copper (Cu)	30	300
Mercury (Hg)	0.25	1.5
Nickel (Ni)	30	150
Lead (Pb)	50	400
Zinc (Zn)	130	600

Table A1.3 Marine Scotland Action Levels: PCBs, TBT and PAHs

Determinand	AL1 ($mgkg^{-1}$ dry weight)	AL2 ($mgkg^{-1}$ dry weight)
ICES 7 PCBs	0.02	0.18
TBT	0.10	0.50
PAHs		
Acenaphthene	0.10	
Acenaphthylene	0.10	
Anthracene	0.10	
Benz[a]anthracene	0.10	
Benzo[a]pyrene	0.10	
Benzofluoranthenes	0.10	
Benzoperylene	0.10	
Chrysene/Triphenylene	0.10	
Dibenz[a,h]anthracene	0.01	
Fluoranthene	0.10	
Fluorene	0.10	
Indenopyrene	0.10	
Naphthalene	0.10	
Phenanthrene	0.10	
Pyrene	0.10	
Total PAHs	100	

A1.3 Metal Results

Concentrations of metals from the three samples, along with the average and range of concentrations are presented in *Table A1.4*. Levels above Marine Scotland Action Level 1 are highlighted in blue. No concentrations above Action Level 2 were recorded (see *Table A1.1* for Action Levels for metals).

Table A1.4 Metal Concentrations from Granton Harbour (mg kg^{-1} Dry Weight) 2023

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
GR23-01	12.2	0.24	46.8	25.6	0.51	27	51.4	108
GR23-02	18.1	0.22	60.2	45.7	0.72	36.4	119	183
GR23-03	16.8	0.1	59.5	36.2	0.68	34.8	90.6	159
GR23-04	17.7	0.12	57.6	33.8	0.68	32	73.4	136
GR23-05	13.4	0.18	50.3	30.9	0.65	28.8	61.4	126
Mean	15.6	0.17	54.9	34.4	0.65	31.8	79.2	142.4
Range	12.2-17.7	0.12-0.24	46.8-60.2	25.6-45.7	0.51-0.72	27-36.4	51.4-119	108-183

As = Arsenic, Cd = Cadmium, Cr = Chromium, Cu = Copper, Hg = Mercury, Ni = Nickel, Pb = Lead and Zn = Zinc.

Table A1.5 provides a comparison of metal data from samples analysed from 2002, 2005, 2020 and 2023. The ranges in results for all metals over the period for which there is available sample data are large. The results from the current survey have lower average metal concentrations for all metals and notably lower levels of Hg, which was above Action Level 2 in 2003, 2005 (highlighted in red) and Cd which was above Action Level 1 in 2003, 2005 and 2020.

Table A1.5 Metal Concentrations from Granton Harbour (mg kg^{-1} Dry Weight) 2002 - 2023

Year		As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
2002	Mean	19.3	1.35	74.2	77.2	2.26	39.1	194.6	271.7
	Range	15.9-30.6	0.6-2.6	58.9-84.8	44.8-113.6	1.2-3.3	35.1-49.6	117-304	187-380
2005	Mean	17.17	1.18	69.08	64.87	1.75	37.38	159.50	239.17
	Range	15.9-20.6	0.6-2.1	63.8-80.8	44.8-108.6	1.2-2.9	35.1-44.2	117-249	187-348
2020	Mean	17.30	0.40	73.20	35.10	0.70	43.47	75.23	146.00
	Range	16.2-18.0	0.38-0.41	65.4-81.5	30.4-39.6	0.63-0.74	38.4-48.7	68.3-79.1	138-155
2023	Mean	15.6	0.17	54.9	34.4	0.65	31.8	79.2	142.4
	Range	12.2-17.7	0.12-0.24	46.8-60.2	25.6-45.7	0.51-0.72	27-36.4	51.4-119	108-183

A1.4 Tributyltin

Tributyltin (TBT) is a highly toxic compound historically used as an anti-biofouling agent in paint used to coat the hulls of vessels. It is also toxic to non-target organisms and is linked to immune-suppression and imposex (1) in snails and bivalves. TBT was also used in various industrial processes as a biocide and can enter the marine environmental through effluent discharges. In some cases, TBT can also be persistent in the marine environment.

(1) The development of male characteristics in females

Mean dry weight concentrations of TBT from the samples collected are presented in *Table A1.6.* No samples were observed to have TBT concentrations above Marine Scotland Action Level 1 (0.1 mg kg^{-1}).

Table A1.6 TBT Concentrations from Granton Harbour (mg kg^{-1} Dry Weight) 2023

Station	TBT Concentration
GR23-01	<0.005
GR23-02	<0.005
GR23-03	<0.005
GR23-04	<0.005
GR23-05	<0.005
Mean	**<0.005**

Note: DBT was analysed for along with TBT, however there are no Action Levels for DBT. The DBT results are not reported here but have been provided in the Marine Scotland Pre-Disposal Sampling Results Form.

A comparison of TBT concentrations from samples collected in 2003, 2005, 2020 and 2023 are presented in *Table A1.7*. The 2005 data showed average TBT concentrations above Action Level 1. In 2023 the levels were well below Action Level 1.

Table A1.7 TBT Concentrations from Granton Harbour (mg kg^{-1} Dry Weight) 2002 - 2023

Year		TBT Concentration
2002	Mean	0.0222
	Range	ND
2005	Mean	0.49
	Range	0.17-1.0
2020	Mean	<0.005
	Range	ND
2023	Mean	<0.0037
	Range	<0.001 - <0.005

ND= no data (*i.e.* from a single sample). BDL=below detection level

A1.5 Polychlorinated Biphenyls Results

Polychlorinated biphenyls (PCBs) are organic compounds comprising a biphenyl group (composed of two benzene rings) with between one and ten bonded chlorine atoms. PCBs are highly toxic, persistent pollutants and are readily bioaccumulated in animals.

Although production in the UK ceased in the 1970s, PCBs still enter the marine ecosystem through the disposal of industrial plant, emissions from old electrical equipment and from landfill sites (1).

Dry weight concentrations of ICES 7 PCBs from samples collected in 2023 are presented in *Table A1.8*. Two samples (GR23-02 and GR23-03) had sum of the ICES 7 PCBs concentrations above Marine Scotland Action Level 1 (0.02 mg kg^{-1}). No samples had concentrations above Action Level 2 (0.18 mg kg^{-1}). Comparative data from 2005, 2020 and 2023 are provided in *Table A1.9.*

(1) Forth Replacement Crossing: Environmental Statement 2009. Available online from http://www.transportscotland.gov.uk/strategy-and-research/publications-and-consultations/j11223-081.htm

There was no PCB data from 2002 and data from 2005 were all below the detection limit used at that time of 0.02 mg kg^{-1}.

Table A1.8 PCB Concentrations from Granton Harbour (mg kg^{-1} Dry Weight) 2023

Station	Sum of ICES 7 PCB Concentrations
GR23-01	0.01122
GR23-02	0.07391
GR23-03	0.02881
GR23-04	0.01822
GR23-05	0.01294
Mean	**0.02902**
Range	**0.01122-0.07391**

ICES 7 PCB congeners (with IUPAC numbers): 28 - 2,4,4' - Trichlorobiphenyl, 52 - 2,2',5,5' - Tetrachlorobiphenyl, 101 - 2, 2', 4, 5, 5' - Pentachlorobiphenyl, 118 - 2, 3', 4, 4', 5 - Pentachlorobiphenyl, 138 - 2, 2', 3, 4, 4', 5' - Hexachlorobiphenyl, 153 - 2, 2', 4, 4', 5, 5' - Hexachlorobiphenyl, 180 - 2, 2', 3, 4, 4', 5, 5' - Heptachlorobiphenyl.

Table A1.9 PCB Concentrations from Granton Harbour (mg kg^{-1} Dry Weight) 2005 - 2023

Year		ICES 7 PCB Concentration
2005	Mean	BDL
	Range	BDL
2020	Mean	0.0149
	Range	0.0144-0.0156
2023	Mean	0.02902
	Range	0.01122-0.07391

BDL=below detection level

A1.6 Polycyclic Aromatic Hydrocarbons

Levels of PAHs are presented in *Table A1.10*. Levels above Marine Scotland Action Level 1 (100 µg kg^{-1} for most individual PAHs and 10 µg kg^{-1} for Dibenzo(ah)antracene) are highlighted in blue. Marine Scotland Action Level 1 for Total PAHs is 100 mg kg^{-1}, and none of the sum of the EPA 16 PAHs in any sample exceeded Action Level 1.

A comparison of mean dry weight concentrations of PAHs from samples collected in 2005, 2020 and 2023 are presented in *Table A1.11* that shows that PAH concentrations of the majority of individual PAHs are variable with levels of most PAHs in most years being above Action Level 1. The concentrations of PAHs in the samples analysed in 2020 and 2023 are lower than those analysed in 2005.

In addition, the total hydrocarbon (THC) concentrations were also analysed for and these are presented in *Table A1.10*. The concertation of THCs in all samples was less than 0.1% (range 0.0463% to 0.0581%). There are no Marine Scotland Action Levels for THCs, however, the concentrations are below the toxic (1%) and harmful (0.1%) classifications for ecotoxicology based on the UK country agency guidance (1).

(1) NRW, SEPA, NIA, EA. 2015. Guidance on the Classification and Assessment of Waste. Technical guidance WM3. LIT 10121.

Table A1.10 Analysis of PAHs and THC from Granton Harbour 2023

PAH	Sample Station					
	GR23-01	GR23-02	GR23-03	GR23-04	GR23-05	Mean
LMW (µg kg^{-1} Dry Weight)						
Acenaphthene	158	135	172	69	148	136.4
Acenaphthylene	57.2	89.1	87.6	90.3	81.1	81.06
Anthracene	347	255	425	231	309	313.4
Fluorene	174	158	194	135	182	168.6
Naphthalene	287	273	259	245	261	265
Phenanthrene	854	712	1,110	562	853	818.2
HMW (µg kg^{-1} Dry Weight)						
Benzo(a)anthracene	737	659	1050	570	760	755.2
Benzo(a)pyrene	841	852	1,200	676	856	885
Benzo(b)fluoranthene	742	751	1,010	632	732	773.4
Benzo(ghi)perylene	686	757	905	580	688	723.2
Benzo(k)fluoranthene	721	745	949	585	719	743.8
Chrysene	761	713	1050	596	762	776.4
Dibenzo(ah)anthracene	121	135	178	113	135	136.4
Fluoranthene	1,440	1,180	1,980	952	1,330	1,376.4
Indeno(1,2,3-c,d)pyrene	623	700	907	540	622	678.4
Pyrene	1,550	1,300	1,950	1,100	1,570	1,494
Sum US EPA 16 PAHs	10099.2	9414.1	13426.6	7676.3	10008.1	10,124.9
Total Hydrocarbons THC	463,000	547,000	581,000	549,000	449,000	517,800

LMW = Low Molecular Weight. HML = High Molecular Weight. Action Level 1 for Total PAH is 100,000 µg kg^{-1}

Table A1.11 Comparison of Mean PAHs from Granton Harbour 2005 - 2023

Year	2005	2020	2023
PAH	Mean (N=5)	Mean (N=3)	Mean (N=5)
	LMW (µg kg^{-1} Dry Weight)		
Acenaphthene	1,100	45.5	136.4
Acenaphthylene	<1000	41.4	81.06
Anthracene	1,160	196.3	313.4
Fluorene	1,160	93.4	168.6
Naphthalene	<1,000	233.0	265
Phenanthrene	2,180	409.7	818.2
	HMW (µg kg^{-1} Dry Weight)		
Benzo(a)anthracene	2,020	438.3	755.2
Benzo(a)pyrene	4,500	493.3	885
Benzo(b)fluoranthene	1,820	465.7	773.4
Benzo(ghi)perylene	2,080	536.3	723.2
Benzo(k)fluoranthene	1,080	248.7	743.8
Chrysene	3,020	488.7	776.4
Dibenzo(ah)anthracene	ND	88.2	136.4
Fluoranthene	2,880	718.0	1,376.4
Indeno(1,2,3-c,d)pyrene	3,000	467.7	678.4
Pyrene	3,380	863.7	1,494

LMW = Low Molecular Weight. HML = High Molecular Weight. ND = No Data

A1.7 Asbestos

There was no asbestos reported from any of the five samples.

A1.8 Sediment Physical Properties

The physical properties of the dredge sediment was analysed on the five sediment samples collected from Granton Harbour in 2023. Sediments comprised sandy mud.

- Gravel is defined as >2 mm,
- Sand is defined as >63 µm<2 mm, and
- Mud (silts and clays) is defined as <63 µm.

Table A1.12 and Figure A1.3 present the 2023 data. Sediment contamination is typically higher in sediments less than 63 µm diameter *e.g.* silts and clays due to the increased surface area providing more adhesion sites for contaminants than the same volume of sand or gravel. Stations GR23-02 and GR23-03 has the highest percentage of silts and clays and these were the stations that had higher concentrations of metals and PCBs. No similar pattern could be determined from the PAH concentrations.

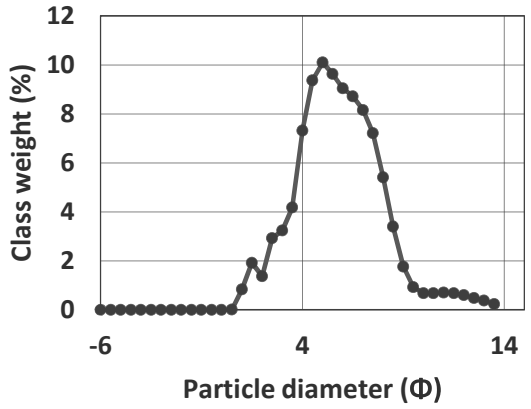
Table A1.12 Granton Harbour 2023 Sediment Data Summary

Parameter	Sample Station				
	GR23 01	**GR23-02**	**GR23-03**	**GR23-04**	**GR23-05**
Textural Group Classification	sM: Sandy Mud	sM: Sandy Mud	sM: Sandy Mud	sM: Sandy Mud	sM: Sandy Mud
Folk and Ward Description	Coarse Silt	Medium Silt	Coarse Silt	Coarse Silt	Coarse Silt
Folk and Ward Sorting	Very Poorly Sorted	Poorly Sorted	Poorly Sorted	Poorly Sorted	Very Poorly Sorted
Mean µm	21.784	15.108	18.701	23.128	20.265
Mean phi	5.521	6.048	5.741	5.43	5.625
Sorting Coefficient	2.049	1.935	1.882	1.755	2.025
Skewness	0.059	0.107	0.0701	0.133	0.1335
Kurtosis	1.069	1.107	1.040	0.996	1.047
Gravel (%)	0.0	0.0	0.0	0.0	0.0
Sand (%)	21.78	11.8	16.98	20.57	20.01
Mud (silts and clays) (%)	78.22	88.2	83.02	79.43	79.99
Total Organic Carbon (%)	4.66	4.73	3.91	4.54	3.32
Solids (%) @120°C	38.8	30.1	31.8	31.5	43.8
Density (mg m^{-3})	2.29	2.18	2.16	2.47	2.31

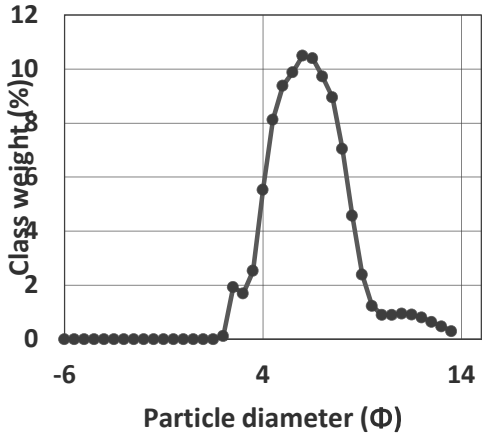
Phi: $-\log_2$ of sediment particle diameter in mm

Figure A1.3 Granton 2023 Sediment PSA

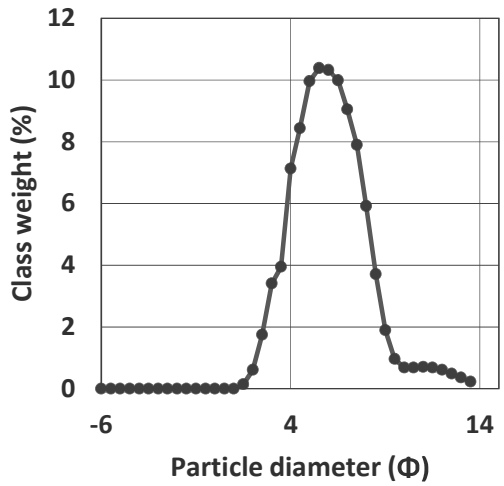
Station GR23-01



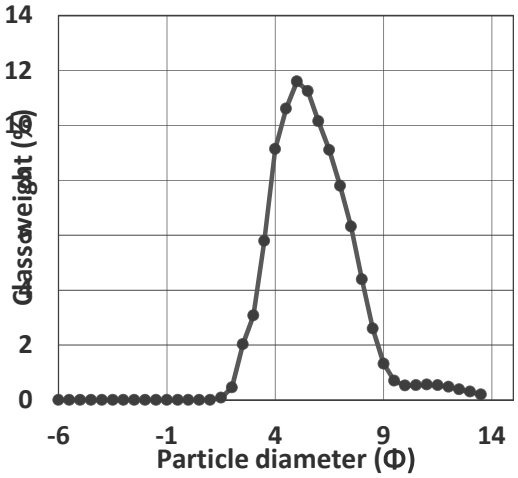
Station GR23-02



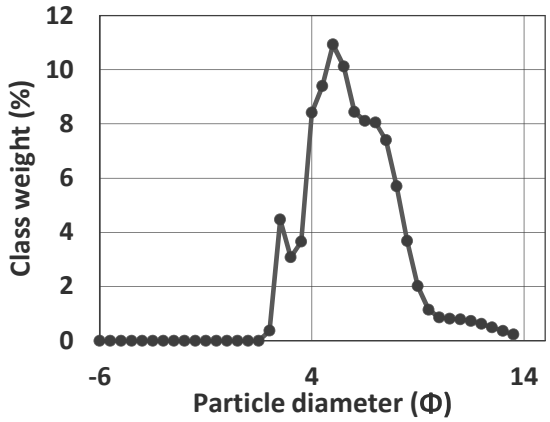
Station GR23-03



Station GR23-04



Station GR23-05



A2 SPOIL GROUND SEDIMENT SAMPLE DATA

Table A1.14 presents metal and PCB concentration data from sediment sampled from spoil grounds within the Firth of Forth and Forth Estuary. Levels above Marine Scotland Action Level 1 for metals and PCBs are highlighted in blue. Monitoring of spoil grounds is not mandatory therefore, the data presented in *Table A1.13* are the most recent data available.

Table A2.1 Concentration of Metals and PCBs (mg kg^{-1}) from Forth Spoil Grounds

Site Name/Date	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	Sum ICES 7 PCBs
Oxcars 2007	ND	ND	ND	ND	ND	ND	ND	ND	0.007 (n=6)
Oxcars 2011 (n=6)	11.2	0.1	42.5	22.2	0.6	22.3	153.5	92.2	ND
Oxcars 2015 (n=3)	15.7	0.3	79.6	41.6	1.0	35.8	78.1	141.7	0.008 (n=3)
Methil 1993 (n=1)	8.2	0.2	9.8	10.7	0.1	19.2	10.5	51.0	ND
Methil 2011 (n=3)	6.9	0.07	13.7	7.14	0.07	8.97	20.2	39.8	0.0004 (n=3)
Methil 2015 (n=1)	8.7	0.1	18.0	9.6	BDL	11.2	14.5	72.8	0.003 (n=1)
Narrow Deep 2011 (n=6)	9.5	0.2	42.9	21.6	0.49	22.9	53.4	109.4	0.008 (n=3)
Narrow Deep 2015 (n=4)	11.7	0.2	63.8	24.6	0.6	30.0	58.4	105.9	0.03 (n=3)
Kirkcaldy 2011 (n=3)	6.24	0.1	21.9	16.2	0.14	16.4	21.7	45.9	ND
Kirkcaldy 2015 (n=3)	8.9	0.1	43.1	17.0	0.2	22.0	30.6	62.9	0.0025 (n=3)
Blae Rock 2007 (n=3)	13.4	BDL	59.7	32.4	0.8	28.2	63.9	108.6	0.008 (n=5)
Blae Rock 2011 (n=6)	17.2	0.1	39.6	21.9	0.5	21.4	52.1	80.3	0.01 (n=2)
Bo'ness 2011 (n=7)	14.5	0.1	50.8	23.3	0.8	23.6	56.9	95.7	0.005 (n=3)
Bo'ness 2015 (n=5)	18.6	0.1	59.6	26.5	0.7	27.5	54.2	114.0	0.004 (n=3)

* Data provided by Marine Scotland (2019)

Key: n = the number of samples analysed (where known)

APPENDIX B ENVIRONMENTAL IMPACTS OF DISPOSAL OPERATIONS

B1 ENVIRONMENTAL IMPACTS OF DISPOSAL OPERATIONS

B1.1 Introduction

This Appendix addresses the environmental impacts of the disposal of dredged material from the planned maintenance dredging work Granton Harbour at the Oxcars licenced spoil ground within the Firth of Forth. Impacts on water quality, sediment quality, and habitats and species are considered. *Table B2.1* presents the impact summary.

As the Marine Licence application is for disposal of the dredged material, impacts of the dredging activities are not addressed, other than in the context of cumulative impacts from existing and proposed dredging and disposal activities, and other activities and developments.

Potential impacts on general vessel movements and fishing due to the dredging operations and disposal operations are not considered to be significant as commercial traffic in the main channel is controlled by Forth Ports' standard operating procedures. The identification and assessment of environmental impacts of the disposal of dredged material in this Appendix follows good practice guidance from the Environment Agency, Clearing the Waters for All [(1)].

B1.2 Disposal Impacts

As described in *Section 1.4*, it is proposed that up to 10,000 m^3 (approximately 14,000 wet tonnes) of material from Granton Harbour is disposed of at the Oxcars spoil ground per annum.

Typically, dredging and disposal takes place over a period of approximately ten to twenty days once or twice per annum with the scheduling of the dredging and disposal operations depending on operational requirements and tides. The cycle time from dredging to disposal and back to the dredging site is approximately 1.5 to 2.5 hours, subject to tides.

The material to be disposed of consists primarily of sandy mud. The concentration of contaminants are presented in *Appendix A*. Samples were taken at five stations (GR23-01 to GR23-05) and the results are summarised here.

- The concentrations of metals, except for arsenic and cadmium were above Action Level 1 in at least one sample, but all below Action Level 2. The average metal concentrations were above Action Level 1 for chromium, copper, mercury, nickel, lead and zinc.
- The concentration of TBT in all samples was below Action Level 1.
- The concentration of PCBs (sum of ICES 7 PCBs) were above Action Level 1 at stations GR23-02 and GR23-03m but below Action Level 2.
- The sum of the EPA 16 PAHs were below Action Level 1 for all stations. For individual PAHs, the majority in all samples were above Action Level 1.
- There was no asbestos recorded in any of the sediment samples.

Available metal and PCB concentration data from sediments sampled in the Oxcars spoil ground are presented in *Appendix A*. This shows the concentration of chromium, copper, mercury, nickel, lead and zinc in the sediment was above Action Level 1 in 2015 (most recent data).

B1.3 Impacts on Water and Sediment Quality

Coastal water quality in the Firth of Forth is currently Good in the outer Firth, with the exception of the area around Portobello and Musselburgh, which is classified as Poor. It is classified as Good in the lower estuary to Muirhouses and Moderate upstream in the estuary to Kincardine bridge [(2)].

The salinity in the Firth of Forth averages 33‰, decreasing into the Forth Estuary under the influence of freshwater inputs. Suspended solids levels in the inner Firth of Forth are usually low compared to

(2)Best, M (2016). Clearing the Waters for All: WFD guidance for developers and regulators in estuarine and coastal waters. Environment Agency.
(3)https://www.sepa.org.uk/data-visualisation/water-classification-hub/ consulted 12 September 2023.

levels in the upper estuary [1]. In the Firth of Forth, dissolved oxygen concentrations show little variation with depth and are approximately 90-95% but may be lower during periods of high summer water temperatures [2].

Dredged spoil material disposed at the Oxcars spoil ground will fall to the sea bed by gravity and consists of cohesive lumps of dredged material. Fine sediment will be liberated as it sloughs off the descending material and when the clumps reach the seabed. Field measurements of suspended solids in surface waters following similar disposal operations indicate that less than 5% of the discharged material escapes the descending density jet [3].

The natural levels of suspended sediments in the Firth of Forth vary with seasonal weather conditions and this contributes to the natural sedimentation levels in the Firth of Forth. There is no available data for suspended sediment levels at the Oxcars disposal site. Data available from Middle Bank, in the Firth of Forth in 2008 [4] recorded the baseline mean suspended solids concentrations between 8.87 mg l^{-1} and 10.3 mg l^{-1} (mean 9.1 mgl^{-1}). Comparison of mean baseline suspended solids concentrations with those recorded during dredging activities at Middle Bank indicated peak increases were approximately two and half times above background levels [1]. These increases were short-lived and dissipated with the outgoing tide. Significant increases in suspended sediments associated with the disposal operations are therefore likely to be confined to the immediate area of the spoil ground and for a short period. Similar studies were undertaken for the Forth Replacement Crossing which showed that increases in suspended sediment concentrations from dredging works were short-lived and localised [5].

The fraction of the disposed material that is suspended in the water column will disperse with the tidal currents at the disposal site and cumulative effects on water quality in the Firth of Forth from the disposal operations are not likely.

Any increased nutrient levels from suspended sediments from disposal operations may stimulate local algal production, although the effects are predicted to be short-term and confined to the immediate area of the disposal operations. Nitrogen is generally regarded to be the limiting nutrient in estuarine and marine systems and in its reduced form (ammoniacal nitrogen) is also toxic to fish. As a consequence of the reduced (oxygen demanding) nature of the seabed sediments, nitrogenous nutrients are likely to be in this form.

The oxidation of anoxic sediments released into the water column has been shown to reduce oxygen concentrations by up to 58% [6]. Based on the background levels this may reduce the oxygen saturation to between 40 and 50% (equating to approximately 4 to 5 mg l^{-1}). Therefore, if the disposal operations occurred during a period of 'naturally' low dissolved oxygen it is possible that the Water Quality standards for EC Freshwater Fisheries Directive of oxygen concentration greater than 6 mg l^{-1} would not be met [7]. It is predicted that this would be short-lived, due to the limited period over which disposal is intended to occur and localised based on previous dredge plume studies. The impacts are not considered to be significant given the generally high dissolved oxygen levels anticipated at the disposal site, the low levels of organic carbon in the dredged sediments (circa 1.66%) and the extent of the area potentially affected.

Although there may be some release of contaminants such as metals PCBs and PAHs into the water column during disposal operations, the majority of the dredged material will descend to the seabed rapidly. Sediment bound contaminants liberated during the disposal operations will quickly become complexed with particulate matter in the water column and be re-deposited on the sea bed. Previous

(2) SEPA monitoring buoy data from Gunnet Ledge, Firth of Forth, available online from http://www.sepa.org.uk/environment/environmental-data/monitoring-buoys-network/gunnet-ledge/
(3) SEPA (1998). Winter Nutrient Distribution in the Firth of Forth, 1987 - 1997. Report TW 01/98, January 1998.
(4) Kennish M.J. 1992. Ecology of Estuaries Anthropogenic Effects Dredging and Dredged Spoil Disposal p357-397
(5) ERM, 2008. Middle Bank Aggregate Production Licence: Monitoring Report. A report for Westminster Gravels Ltd.
(6) Transport Scotland, 2009. Forth Replacement Crossing: Environmental Statement.
(7) Brown C. 1968. Observations on Dredging and Dissolved Oxygen in a Tidal Waterway. Water Resources Research Vol 4, No 6, p1381.
(1) UKTAG 2010. Water Framework Directive: An approach to the Revoked Directives:- the Freshwater Fish Directive, the Shellfish Directive and the Dangerous Substances Directive. Available online from: http://www.wfduk.org/resources%20/approach-revoked-directives-%E2%80%93-freshwater-fish-directive-shellfish-directive-and-dangerous

studies have shown that metal concentrations in the water column remained consistent following sediment disposal [(1)]. In addition, the natural sedimentation in the Firth of Forth aids the removal of contaminants from the water column and incorporates them in the seabed sediments.

PAHs tend not to be volatile and are poorly soluble and therefore readily absorb onto particulate matter in the water column and are incorporated into marine sediments. The PAHs in the sediment samples comprised both low molecular weight (LMW) (two and three benzene rings) and high molecular weight (HMW) (more than 3 benzene rings) compounds. The HMW PAHs are generally the less water soluble, less acutely toxic and slower to biodegrade (*i.e.* more persistent) than the LMW PAHs.

The ratios of individual PAHs have been used to determine the likely anthropogenic source of PAHs in the environment: *e.g.* from petroleum hydrocarbons (petrogenic) or combustion sources (pyrolytic). Petrogenic PAHs are often characterised by phenanthrene to anthracene (Ph/An) ratios more than 10, whereas pyrolytic PAH from combustion processes are characterised by Ph/An ratios less than 10. Ratios of fluoranthene to pyrene (Fl/Py) of less than 1 generally indicates petrogenic sources while ratios more than 1 generally come from pyrolytic sources [(1)].

For the sediment samples analysed from Granton Harbour in 2023 the Ph/An ratios were between 2.43 and 2.79 and the Fl/Py ratios were between 0.85 and 1.02. This suggests that these contaminants are from both combustion and petroleum hydrocarbon sources. This pattern has been identified in other ports in the Firth of Forth and Forth Estuary indicating that the sources of PAHs in the sediments come from a range of sources and are in the wider Forth Estuary and Firth of Forth sediment circulation system.

There was a large reduction in point source discharges of metals and hydrocarbons within the Forth Estuary and the Firth of Forth between the mid-1980s and 1990s [(2)]. Reduction and improved regulation of point source discharges has improved many aspects of the Forth system: inputs of organic material have declined and there has been an associated rise in dissolved oxygen during summer in the upper Forth Estuary. The rise in dissolved oxygen has led to increasing numbers of smelt caught in the upper estuary and to increasing inputs of nitrate generated by nitrification in the suspended sediment maxima of the estuary during summer. In winter, conservative mixing of nutrients is seen and there has been little change in winter nutrient concentrations in the Forth Estuary and Firth of Forth. Metal and trace organic inputs have been reduced so that aqueous concentrations have fallen rapidly [(3)]. With efforts focussed on improving the water quality of the Forth Estuary and the Firth of Forth in more recent years, point source discharges have continued to decrease and the water quality of the Forth Estuary and the Firth of Forth has continued to improve as a result [(4)].

It is not anticipated that the disposal operation at the Oxcars spoil ground will introduce significant amounts of contamination into the water column. Disposal of the dredged material may result in a localised and short-term increase in the levels of some contaminants; however, the deposited sediment will disperse over time. Considering the short-term, localised and intermittent increase in the levels of some contaminants in the water column will not affect the overall water body quality statuses of the Firth of Forth with respect to the Water Framework Directive.

The Wardie Bay Bathing Water was designated in 2023 and is immediately east of Granton Harbour. SEPA's standing guidance on dredging and sea disposal operations within or adjacent to (*i.e.* within 2 km) of a designated bathing waters states that ideally these operations should not be undertaken

(2)Y.W. Qiu, G. Zhang, G.Q. Liu, L.L. Guo, X.D. Li, O. Wai. Polycyclic aromatic hydrocarbons (PAHs) in the water column and sediment core of Deep Bay, South China. Estuar. Coast. Shelf Sci., 83 (1) (2009), pp. 60-66.
(3) SEPA, 1998. Trace Metals in the Forth 1986 - 1996. Available online from http://www.sepa.org.uk/science_and_research/data_and_reports/water/forth_estuary_trace_metals.aspx
(4) Dobson, J., Edwards, A., Hill, A. et al. *Senckenbergiana maritima* (2001) 31: 187. https://doi.org/10.1007/BF03043028
(5) SEPA, 2014. Scottish bathing waters 2013-2014. Available online http://www.sepa.org.uk/media/39125/scottish-bathing-waters-report-2013-2014.pdf

during the bathing season(usually 1 June to 15 September), unless a strong case can be made as to why a particular operation would not present a risk to Bathing Waters (1).

Forth Ports are applying for a Marine Licence for the disposal of dredge spoil at the Oxcars spoil ground and not for dredging activities. The Granton Bathing Water is located approximately 3.67 km from the nearest point of the Oxcars spoil ground. Disposal operations are therefore not likely to have any significant effects on the water quality that could affect the Bathing Water.

B1.4 Impacts on Benthic Ecology

The benthic macrofaunal communities recorded in proximity to the Oxcars spoil ground are expected to be typical for Firth of Forth conditions and not considered to be of high conservation significance due to the wide distribution, low diversity and lack of any rare or notable species (2).

It is anticipated that the deposition of dredged material at the Oxcars spoil ground will result in the loss (burial) of the benthos within the spoil ground deposition zone. Localised impoverishment of the fauna (in terms of abundance and diversity) may occur along the axis of tidal flow as a result of secondary impacts comprising sediment deposition subsequent to the disposal activities.

Oxcars is an existing licenced spoil ground therefore the benthic communities in this area will have been impacted by the ongoing spoil deposition activities that have occurred there for over 25 years. Given the relatively homogenous nature of benthic communities in this part of the Firth of Forth and the availability of similar habitat within the Firth of Forth, the spatial extent of predicted sediment related impacts to benthos (and resultant impact on prey availability for foraging seabirds) are not considered to be significant.

B1.5 Impacts on Seabirds

The Firth of Forth Special Protection Area (SPA), Forth Islands SPA and the Outer Firth of Forth and St Andrews Bay Complex SPA are designated (3) for rare, vulnerable and regularly occurring migratory bird species.

There are three potential effects of the disposal of dredge material at sea on seabirds; increased suspended solids, release of contaminated particulates and physical disturbance of birds by the dredging vessel. These effects could potentially have a significant effect on the qualifying interests of the SPAs by reducing prey availability and disturbing bird behaviour and breeding patterns.

The vessel used for disposal of the material will be travelling to and from Granton Harbour and the spoil ground for twenty to forty days per annum, a round trip of approximately 4 nm.

The SPAs support breeding seabirds which forage over a wide area. The disposal of the dredged material will result in localised increases in suspended sediment which may reduce the ability of fish-eating birds to forage around the spoil ground due to impaired visibility. However the area affected is a small percentage of the total available foraging habitat, with alternative sources of prey available close by.

Oxcars is an established and long-term spoil ground with disposal activities from a number of ports and harbours in the Firth of Forth being ongoing prior to the time that the SPAs were designated. Given that disposal was an existing activity and ongoing disposal is at a similar scale to previous disposal activities, it is considered that the proposals will not have significant effects on the qualifying interest of the SPAs.

(2)http://www.sepa.org.uk/media/143312/lups-gu13-sepa-standing-advice-for-marine-scotland-on-small-scale-marine-licence-consultations.pdf
(3) Elliot M & Kingston P F (1987). The Sublittoral Benthic Fauna of the Estuary and Firth of Forth, Scotland. Proceedings of the Royal Society of Edinburgh, 93B, pp 449-465
(4) The *Conservation (Natural Habitats, &c.) (EU Exit) (Scotland) (Amendment) Regulations, 2019*.

B1.6 Impacts on Fish

The River Teith Special Conservation Area (SAC), the Isle of May SAC and the Moray Firth SAC are designated under the Habitats Directive (1) for their habitats and fish and mammal species of European importance.

Atlantic salmon, river lamprey and sea lamprey inhabit and migrate up and down the Firth of Forth and Forth Estuary to reach spawning grounds in the River Teith SAC and may therefore pass the Oxcar spoil ground. The Forth District Salmon Fishery Board has previously advised that smolts are likely to be passing through the lower Forth Estuary and Firth of Forth during June and July. The river lamprey grows to maturity in estuarine environments and between October and December moves into fresh water to spawn in clean rivers and streams. The sea lamprey spends most of its life at sea, only returning to freshwater to spawn around April and May.

A potential effect of disposal at sea is for increased levels of suspended solids to disturb fish migration routes and areas they occupy. The proposals are not likely to have a significant effect on fish for the following reasons.

- The concentration of suspended sediment at which the passage of salmonid fish is affected has been observed to be approximately 500 mg l^{-1} (2). Studies in the US, looking at a variety of salmonid species, illustrates that fatalities to smolts (50%) can occur at high suspended sediment concentrations over extended periods (*e.g.* exposure of between 488 to 19,364 mg l^{-1} for 96 hrs) (3). The natural suspended sediment maxima in the Forth system is in the upper estuary with mean concentrations over forty times higher than in the Firth of Forth (130 mg l^{-1} at Kincardine (4) and average 3 mgl^{-1} at Gunnet Ledge (5)).
- The disposal activities will take place within the Firth of Forth which represents a small area where sea lamprey and salmon smolts may be present or may pass through. The width of the Firth of Forth at the Oxcars spoil ground is approximately 8 km (4.3 nm) wide and the Oxcars disposal site occupies between 7 and 12% of this. The fish species will be able to avoid the area during the short periods of raised suspended sediment during disposal and migrate using an alternative route through the Firth of Forth and therefore short-term and intermittent disposal operations are not considered to present a significant barrier to migration.
- The dredging and disposal process is not continuous: the time required for one cycle (dredging - travelling - discharging - travelling) is approximately 1.5 to 2.5 hours over approximately ten to twenty dredging days once or twice per annum. Additional delays to avoid interactions with other vessels are possible *e.g.*, the dredger returning from the disposal site may be instructed by Vessel Traffic Services to wait outside the harbour to allow other vessels to enter/leave. A localised, short-term and non- continuous increase in suspended sediment concentration is not anticipated to affect the migration of adult salmon, smolts or other fish species, based on the evidence of studies on the effects of suspended sediments on salmonids.

It has been reported that Atlantic salmon numbers have been decreasing in Scotland and farther afield over the ten years from 2010 to 2019 (6), including in areas in Scotland where there have been no dredge spoil disposal operations. Forth Ports' dredge spoil disposal operations have been ongoing at Oxcars for over 25 years, covering the periods of much higher salmon numbers indicating that there is no causal link between the ongoing spoil disposal activities and a broad scale decline in salmon numbers. Due to the requirements at Granton Harbour to maintain access at all times of the year and the small magnitude of potential effects of disposal operations to migrating salmon smolts,

(2) European Communities (1992) Council Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna.
(3) Redding M.J. and Schreck C.B. 1987, Physiological effects on coho salmon and steelhead of exposure to suspended solids, Transactions of the American Fisheries Society, Vol 116 pp737-747
(4) Bash J, Berman, C and Bolton S. 2001. Effects of Turbidity and Suspended Solids On Salmonids. Prepared for Washington State Transportation Commission, Department of Transportation and U.S. Department of Transportation, Federal Highway Administration
(5) Transport Scotland, 2009. Forth Replacement Crossing: Environmental Statement.
(6) SEPA monitoring buoy data from Gunnet Ledge, Firth of Forth, available online from http://www.sepa.org.uk/environment/environmental-data/monitoring-buoys-network/gunnet-ledge/
(1) https://www.britishecologicalsociety.org/understanding-decline-atlantic-salmon-catches-scotland/#:~:text=The%20Scottish%20Government%20has%20collected,the%20previous%205%2Dyear%20average. [accessed February 2022]

Forth Ports does not consider that any seasonal restrictions to operational requirements to dispose of dredged material at the Oxcars are justified.

B1.7 Impacts on Marine Mammals

The Isle of May SAC, in the outer Firth of Forth, is designated for its populations of grey seal. Grey seals forage widely and may forage at the Oxcars spoil ground. Potential effects on grey seals resulting from the disposal activities are disturbance and noise due to vessel movements and disposal activities and displacement of prey species as a result of increased levels of suspended sediment at the spoil ground.

The proposals are not likely to have a significant effect on grey seals for the following reasons.

- The small potential foraging area affected by disposal activities at the Oxcars spoil ground in relation to the available foraging area in the Firth of Forth.
- The intermittent and short duration of disposal activities (typically ten to twenty days once or twice per annum).
- The small number of vessel movements associated with the disposal activities in relation to total vessel movements within the Firth of Forth.
- The long-term existing disposal operations in the area which pre-date the site designation.

Bottlenose dolphins are a Habitats Directive Annex II species and are resident in the Moray Firth SAC. They are frequent summer visitors to the Firth of Forth, mainly between June and September [1] [2].

Vessel movements and noise have the potential to disturb or displace marine mammals and disposal activities have the potential to displace prey species within and in the vicinity of the spoil ground. The proposals are not likely to have a significant effect on bottlenose dolphins for the following reasons.

- The distance between the spoil ground and the SAC is large and the proportion of the bottlenose dolphin population anticipated to pass through the small area affected by disposal activities is anticipated to be low.
- The intermittent and short duration of disposal activities (typically ten to twenty days once or twice per annum).
- The small number of vessel movements associated with the disposal activities in relation to total vessel movements within the Firth of Forth.
- The relatively low speed and direct line of travel of dredge vessel movements to and from the spoil ground (*i.e.* no fast moving and erratic vessel movements).
- The long-term existing disposal operations in the area which pre-date the site designation.

B1.8 Summary of Impacts

Table B1.1 presents a summary of the impacts and an assessment of significance of the impacts in relation to the sensitivity/importance of the receiving site.

(2) Evans P. G. H. Chapter 5.15 Whales, Dolphins and Porpoises. In Coasts and Areas of the United Kingdom. Region 4 South- east Scotland: Montrose to Eyemouth, ed by J H Barne, C F Robson, S S Kaznowska, J P Doody, N C Davidson and A L Buck, pp 129-132. JNCC (Coastal Directories Series).
(1) https://www.hw.ac.uk/news/articles/2023/river-forth-s-whales-porpoises-dolphins-and.htm [accessed April 2024]

Table B2.1 Summary of Significance of Impacts

Receptor	Impact Significance Justification	Impact Significance
Water quality at spoil ground	Disposal will be periodic and sediment will descend to the seabed rapidly. Suspended sediments will disperse with the tide and any impacts will be localised and short-term.	Not Significant
Sediment quality at spoil ground	Increase in the levels of some contaminants will be localised and short-term and the deposited sediment will disperse within the open water system over time.	Not Significant
Benthic ecology at spoil ground	Oxcars is designated as a spoil ground and disposal operations have taken place there for over 25 years. Disposal will occur over a relatively short period of time and similar habitat is available in close proximity to the site.	Not Significant
Seabirds	Proposed disposal operations are over a short period of time (ten to twenty days once or twice per annum) and the area affected is a small percentage of the total available foraging habitat, with alternative sources of prey available close by. The volume of dredger vessel traffic will not be significant in relation to the existing traffic in the Firth of Forth. The SPAs were designated after the Oxcars spoil site was licenced and have not been impacted by historic and ongoing disposal operations over the last 25 years.	Not Significant
Marine mammals and fish	Proposed disposal operations are over a short period of time and the area affected is a small percentage of the total available foraging habitat, with alternative sources of prey available close by. The volume of dredger vessel traffic will not be significant in relation to the existing traffic in the Firth of Forth. The SACs were designated after the Oxcars spoil site was designated and have not been impacted by historic and ongoing disposal operations.	Not Significant

B2 CUMULATIVE EFFECTS WITHIN THE FIRTH OF FORTH

B2.1 Introduction

The potential impacts of the sea disposal option have been assessed within *Section B2* in isolation from other activities within the Firth of Forth. The impacts associated with the sea disposal option are not predicted to result in adverse effects on the integrity of the SPAs and SACs, however, it is possible that cumulative impacts with other projects could result in significant impacts.

For the purposes of this report, a working definition of cumulative impacts as ‘impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions, together with the project [(1)] has been adopted. The assessment of potential cumulative impacts has been restricted to activities and proposed activities with the potential to directly impact the water and / or sediment quality or cause disturbance to the qualifying interests of the SPAs and SACs. The other activities considered therefore include those that are at some distance from the activities at the Oxcars spoil ground but are within the foraging range of species that may utilise both areas.

(1) European Union. Guidelines for the Assessment of Indirect and Cumulative Impacts, as well as Impact Interactions, DG XI Brussels Downloaded from http://ec.europa.eu/environment/eia/eia-support.htm

B2.2 Past and Current Activities within the Firth of Forth and Forth Estuary

B2.2.1 Introduction

The Firth of Forth and Forth Estuary has previously experienced pollution from a number of industrial sources and sewage discharges, such as the petro-chemical operations at Grangemouth and the sewage works at Seafield. The Imperial Chemical Industries (ICI) chemical plant previously based in Grangemouth is also known to have been a source of mercury into the Forth system as have the coal fired power stations, such as Longannet [(1)]. Over the past 40 to 50 years, however, most of these pollution sources have been controlled or eliminated altogether.

Additional improvements to sewage works and other effluent treatment plants upstream have improved the condition of the water coming down the Forth Estuary into the Firth of Forth.

In addition, there are unknown and diffuse sources of discharges into the Forth Estuary, Firth of Forth and riverine inputs to these areas, for example from agricultural run-off and unrecorded drainage outfalls.

B2.2.2 Petro-Chemicals and Power Generation

Methil power station was a small base load coal slurry-fired power station, located on the south side of the mouth of the River Leven, where the river enters the Firth of Forth at Methil. The power station started operations in 1965 and was decommissioned in 2000, finally being demolished in 2011. Water from the Firth of Forth was abstracted and used as cooling water by the power station before being discharged back into the Firth of Forth.

The Longannet coal-fired power station on the north bank of the estuary closed in March 2016 and is currently being demolished. The historic release of combustion related PAHs and mercury from this source will have contributed to the PAH and mercury loading within the Forth Estuary and Firth of Forth [(1)] [(2)]. Water from the Firth of Forth was abstracted and used as cooling water by the power station before being discharged back into the Firth of Forth.

Cockenzie power station was a coal-fired power station located on the southern shore of the Firth of Forth near to Cockenzie and Port Seaton. It generated electricity between 1967 and 2013, with demolition of the station completed in 2015. Water was abstracted from and discharged back into the Firth of Forth in the same way it was for Longannet and Methil.

The INEOS refinery and wider petro-chemical complex at Grangemouth are historically a dominant source of oil related PAHs in the Forth Estuary and the Firth of Forth.

B2.2.3 Commercial Fishing Activity

The sandeel fishery on the Wee Bankie, at the mouth of the Firth of Forth, has been closed since 2000 on seabird conservation grounds. The initial five-year period was reviewed and extended following the reduction in numbers of some seabird species observed during a 2004 count (reduced sandeel numbers may be linked) within the Firth of Forth [(3)].

Improved water quality in the Firth of Forth has led to a resumption of cockle fishing, particularly on the Fife coast. Uncontrolled cockling could impact upon wintering bird populations by causing loss of prey species, directly (removal of cockles) and indirectly (damage to non-target species). A Special Nature Conservation Order (SNCO) was implemented under the *Conservation (Natural Habitats) Regulations, 1994* to the outer Firth of Forth, including Forth Bridge to Granton Harbour and from

(2) Lee D.S., Nemitz, E., Fowler D., Hill P. and Clegg S. 2020. Sources Sinks and Levels of Atmospheric Mercury in the UK. DERA/AS/PTD/CR000114.
(3) Richardson D.M., Davies I.M., Moffat C.F., Pollard P. and Stagg R.M. 2001. Biliary PAH metabolites and EROD activity in flounder (*Platichthys flesus)* from a contaminated estuarine environment. J. Environ. Monit., **3**, 610-615.
(4) Marine Scotland (2012). The Distribution of Zooplankton Prey of Forage Fish in the Firth of Forth Area, East Coast of Scotland. Available online http://www.scotland.gov.uk/Publications/2012/08/2345/1 .

Leith Docks to Joppa. This Order, implemented in March 2003, was revoked and reissued in 2006, and still stands [1].

B2.2.4 Other Dredging Disposal Activities

In addition to the intended maintenance dredging activities at Granton Harbour with disposal at the Oxcars spoil ground, Forth Ports manages five other maintenance dredging operations within the Forth Estuary and Firth of Forth. The operations comprise the following.

- Grab/backhoe dredging at Newhaven with disposal at Oxcars spoil ground: maximum capacity for maintenance dredging is 15,000 m^3 per annum, undertaken over four weeks per annum.
- Trailer suction dredging in Rosyth with disposal at Oxcars spoil ground: maximum capacity for maintenance dredging is 400,000 m^3 per annum, undertaken over three days per month, every other month.
- Trailer suction dredging in Leith with disposal at Narrow Deep spoil ground: maximum capacity for maintenance dredging is 100,000 m^3 per annum, undertaken over one to two days per month.
- Trailer suction dredging in Grangemouth with disposal at Bo'ness spoil ground: maximum capacity for maintenance dredging is 1,700,000 m^3 per annum, undertaken over four days every month.
- Trailer suction or grab dredger Methil approach channel with disposal at Methil spoil ground: maximum quantity of disposed material is 12,500 m^3. This is undertaken annually.
- Grab dredger and plough at Kirkcaldy with disposal at Kirkcaldy spoil ground: maintenance dredging of approximately 5,000 m^3 undertaken annually.

The actual timing of dredging and volumes required to be dredged during each campaign depend on operational requirements and sedimentation rates (for example due to storm events, which can happen at any time of year).

Other recent, ongoing or planned licenced maintenance and capital dredging activities in the Firth of Forth and Forth Estuary include the following (note these are based on planned or licenced activities so actual volumes dredged may be lower and dates may have been delayed).

- Maintenance dredging at Granton Harbour undertaken by the Royal Forth Yacht Club by agitation of 5,904 tonnes per annum between August 2021 and August 2023. The was also a previous licence to dredge 86,980 m^3 at Granton Harbour with disposal at Bo'ness or Narrow Deep spoil ground between August 2019 and July 2022 as part of the harbour development works.
- Maintenance dredging using land-based plant of 1,200 tonnes over two years at Dysart Harbour, Fife, with disposal on the adjacent foreshore where it is dispersed on the incoming tide (July 2019 to July 2021).
- Babcock Marine at Rosyth had a Marine Licence for maintenance dredging of up to 100,000 tonnes between September 2022 and September 2023 with disposal at Oxcars B.
- Trailer suction and backhoe dredging with self-propelled barge at Defence Munitions Crombie, maximum quantity of disposed material is 22,000 m^3 per annum for maintenance [2] (although this has not been undertaken annually), with disposal at Bo'ness spoil ground.
- Forth Ports is currently developing the Leith Outer Berth to accommodate vessels that are unable to enter the lock gates into the Port of Leith. The works involves the removal of 101,000 m^3 of material from the Leith outer berth with disposal at the Narrow Deep B soil disposal ground.
- Capital dredge of up to 33,800 tonnes using a plough dredger at Port Edgar within the confines of the marina between April 2021 and April 2022 with disposal to the entrance to the marina.

(2)http://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=8499
(1) Rosyth International Container Terminal. Operational In-combination Assessment of Maintenance Dredging and Implications for the River Teith SAC. Jacobs, 2011.

- Capital dredging and sea disposal of 225,000 tonnes from deepening the berth pockets at one of the quays at the Fife Energy Park at Methil. The licence covered the period 10 April and 3 September 2021. Disposal of the dredged sediment material was disposed at the Narrow Deep disposal site with one load also being disposed at the Methil disposal site.
- Work began on the Forth Replacement Crossing at the end of 2011, and capital dredging works for the bridge support foundations started at the beginning of 2012. The purpose of the dredging was to create access for the construction of the foundations for the structures which supports the new bridge. In total 180,000 m^3 silt and sand was dredged from the seabed to form access channels for bridge foundation works between 2011 and 2016. This spoil was disposed of at Oxcars (1).

The historical disposal route for spoil from all listed dredging operations has been deposition at sea, and to date, no environmental impacts, other than direct impacts within the spoil ground, have been reported.

B2.3 Foreseeable Future Activities within and Close to the Firth of Forth

There is one existing and one proposed single turbine wind farm developments in the Firth of Forth, offshore from Methil. The information provided below is based on the companies' and Marine Scotland's websites.

- Levenmouth Demonstration Turbine (2) (3)

  The Offshore Renewable Energy (ORE) Catapult's seven-megawatt wind turbine was completed in 2013 and is located 50 m from the coast connected to the land by a ramp. It is approximately 3.5 km from the Methil spoil ground. The tower stands at 110 m and is 195 m to the top of the blade. Samsung had previously owned the wind turbine demonstrator, before selling to ORE Catapult in December 2015.

  In March 2014 2-B Energy secured investment to fund the establishment of two full-scale test units at the site (two six megawatt turbines to be located approximately 1.5 km offshore standing at 109 m above the lowest tide, 186 m to top of blade). A marine Licence was granted in January 2017 and planning permission has been granted with a Section 36 consent variation awarded in August 2018 to operate the turbine to 2029. A scoping Report has been submitted to Marine Scotland to erect a further seven turbines. This extension would be subject to separate consenting.

- Forthwind Demonstration Project (4) (5)

  Forthwind Ltd (established by Cierco Ltd) has proposed to install a single turbine with a generating capacity of up to 20 megawatts and a meteorological mast 1.5 km offshore from the coast at Methil. The application replaced the previous two turbine scheme, approved in 2016. A Marine Licence and Section 36 consent was granted in March 2023.

There are three large scale offshore windfarm development sites in the outer Firth of Forth area. These sites are at some distance from the Oxcars spoil ground (circa 75 to 115 km) but are within the foraging areas of the qualifying features of the SPAs and SACs. In addition, there will be power export cables laid on the seabed from the windfarm sites to coastal substations within the Firth of Forth. Other potential windfarm sites in the outer Firth of Forth area are at a concept/early planning stage. The information provided below is based on the companies' websites.

- Neart na Gaoithe Offshore Wind Farm (6)

(2) Hochtief (UK) Construction (2016). Forth Road Bridge Replacement - Queensferry Crossing. Available online http://www.hochtief-construction.co.uk/bridges_Forth_Road.shtml
(3) https://marine.gov.scot/ml/levenmouth-demonstration-turbine [consulted 18 September 2023]
(4) https://ore.catapult.org.uk/stories/ore-catapults-levenmouth-demonstration-turbine-2/ [consulted 18 September 2023]
(5) https://forthwind.co.uk/ [consulted 18 September 2023]
(6) https://marine.gov.scot/ml/scoping-forthwind-offshore-wind-demonstration-project-methil-firth-forth [consulted 18 September 2023]
(7) https://nngoffshorewind.com/project/ [consulted 18 September 2023]

NnG Offshore Wind was granted consent by the Scottish Government in 2018 to build a 448 megawatt offshore wind farm in the outer Firth of Forth comprising up to 54 wind turbines up to 208 m high occupying an area of approximately 105 km^2. Construction commenced in 2020 with seabed preparations being undertaken prior to piling works. An onshore operations and maintenance base at Eyemouth received planning permission in September 2020. The wind farm is expected to be fully operational in 2024.

- Inch Cape Offshore Wind Farm (1)

  Consent was granted for the proposed Inch Cape Offshore Wind Farm, located 15 km off the Angus coast, in October 2014. Consent was delayed following an objection lodged by the Royal Society for the Protection of Birds and final approval was given in 2017. A revised scope of design was granted by Scottish Ministers in June 2019. This scope reduced the number of wind turbine generators from 110 to 72. The turbines will occupy an area of 150 km^2. The windfarm will connect to the National Grid at Cockenzie. Once fully operational the wind farm will have an export capacity of approximately 1,000 megawatts. The Port of Dundee has been selected to be the site for pre-assembly and marshalling of the wind turbines.

- Seagreen Offshore Wind Farm (2)

  Scottish and Southern Electric (SSE) and Fluor joint venture partnership Seagreen Wind Energy was awarded the exclusive development rights for the Firth of Forth Zone by Crown Estate Scotland. The zone covers an area of 2,852 km^2 in the outer Firth of Forth. Seagreen was awarded consent by the Scottish Government in October 2014 to develop the northern part of the Firth of Forth Zone to generate up to 1,050 megawatts of power from up to 150 turbines. The design was updated and approved in 2018 to comprise fewer, larger wind turbines. The 1075 MW from the 114 turbines installed in 2022 are expected to be fully operational in 2023. The power will be exported by cable to Carnoustie in Angus. Montrose port is the location of the operations and maintenance base. A further phase of 36 turbines in proposed with the export cable going to Cockenzie.

B2.4 Conclusions

Potential cumulative impacts associated with the above activities can be broadly categorised as comprising suspension of sediments during dredge spoil disposal operations and construction activities resulting in loss or smothering of benthos, the discharge of contaminants with the potential to impact both water and sediment quality, and the disturbance to seabirds and mammals from piling operations and vessel movements. These other activities are at some distance from the Oxcars spoil ground and no cumulative impacts from suspended sediments and other vessel movements are considered likely.

The dredge spoil disposal operations at the Oxcars spoil ground pre-date the SPA and SAC designations and there is no evidence to suggest that the past and current disposal operations at Oxcars managed by Forth Ports have impacted the integrity of designated sites, supported species or resulted in other significant environmental impacts either alone or cumulatively with other activities in the area. Any significant future developments within the Firth of Forth will be subject to assessment of significant environmental effects through the appropriate consenting processes.

(2) https://www.inchcapewind.com/ [consulted 18 September 2023]
(8) https://www.seagreenwindenergy.com/ [consulted 18 September 2023]

APPENDIX C CONSULTEE RESPONSES (EXTRACTS FROM LETTERS/EMAILS RECEIVED)

1 Crown Estate Scotland

I can confirm that Crown Estate Scotland has no objection to the proposal as described in your letter and also that I have no current knowledge of any potential reuse options in the area.

2 MCA

The MCA is consulted on all Marine Licence applications under the Marine (Scotland) Act 2010. We look at the proposed works and consider the impact these works will have on the safety of navigation and emergency response. Therefore, we strongly encourage the client, Forth Ports Ltd., to promulgate marine safety information as considered appropriate prior to the commencement of the dredging.

We do not have any suggestions to raise in terms of the disposal options, or other potential reuse, of dredged materials from the Granton Harbour site. We also do not have any objections to the proposal.

3 NLB

Northern Lighthouse Board has no objections to the proposed dredging and/ or disposal of dredged spoil to the charted and approved spoil ground at Oxcars, and will respond formally to the Marine Licence application, however we would advise the following:

- **Forth Ports Ltd** issue marine safety information as considered appropriate prior to the commencement of each dredge campaign.
- **Forth Ports Ltd** advise the UK Hydrographic Office (sdr@ukho.gov.uk) of any revised water depths in order that chart updates are completed.

4 SEPA

SEPA does not have any particular comment to make on the appropriateness of the proposed disposal route.

I would like to make you aware however that the adjacent Wardie Bay is now designated as a bathing water this year, and that no dredging is permitted to be carried out between 01 June to 15 September within 2km of a designated bathing water.

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