Port of Leith Maintenance Dredge Disposal

Best Practicable Environmental Option Report for 2024 Marine Licence Application

FORTH PORTS

DATE
9 July 2024

REFERENCE
0391463.14

DOCUMENT TITLE	**Port of Leith Maintenance Dredge Disposal**
DOCUMENT SUBTITLE	Best Practicable Environmental Option Report for 2024 Marine Licence Application
PROJECT NUMBER	0391463.14
Date	9 July 2024
Version	1.1
Author	ERM
Client name	Forth Ports Ltd

DOCUMENT HISTORY			ERM APPROVAL TO ISSUE		
VERSION	REVISION	AUTHOR	NAME	DATE	COMMENTS
Draft	1.0	ERM	M Irvine	02/07/2024	For Client Review
Final Draft	1.1	ERM	M Irvine	09/07/2024	For Issue

[Redacted]

Mark Irvine

Technical Director

Environmental Resources Management
Limited
6th Floor
102 West Port
Edinburgh
EH3 9DN

CONTENTS

APPENDIX B ENVIRONMENTAL IMPACTS OF DISPOSAL OPERATIONS

APPENDIX C SUMMARY OF CONSULTEE RESPONSES

LIST OF TABLES

LIST OF FIGURES

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 at the Port of Leith.

Under the *Marine (Scotland) Act, 2010, Section 21(1),* a Marine Licence issued by the Marine Directorate (1) is required for the deposit of substances or objects within waters adjacent to Scotland. Under *Part 4, Section 27(2)*, the Marine Directorate 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)(2) 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 the Port of Leith and identifies the BPEO.

Marine Licences for the maintenance dredge spoil disposal activities are valid in Scotland for up to three years (3). Forth Ports currently has a maintenance dredge disposal licence (MS-00009166) to maintain a safe navigable depth which expires on 2 December 2024. This application is therefore expected to cover dredge spoil disposal operations from 3 December 2024 to 2 December 2027.

1.2 THE NEED FOR DREDGE SPOIL DISPOSAL

The Port of Leith, located on the south bank of the Firth of Forth at the north of Edinburgh, provides berthing facilities, primarily for cargo vessels transporting cement, grain and bulk goods; oil industry and renewables service support vessels; and regular passenger vessels using the port during the summer.

The entrance to the docks is accessed by a 0.7 nautical mile approach channel with a depth of 6.7 m below Chart Datum (CD). Suspended sediments from the action of waves and tides in the Firth of Forth settle in the slack water of a large eddy existing in the lee of the Eastern Breakwater (4). The main sediment accumulation occurs over approximately 200 m of the inward end of the approach channel and maintenance dredging is required to maintain safe navigation in the channel. Sedimentation is generally less significant within the Leith Dock complex, although sediment material enters from the Water of Leith, entering the complex at the Albert Dock.

(1) Formerly named Marine Scotland. Guidance and standards produced by Marine Scotland are now referenced to the Marine Directorate in this report.
(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'.
(3) Marine (Scotland) Act 2010, Part 4 Marine Licencing. General Guidance for Applicants. Available online http://www.scotland.gov.uk/Resource/0043/00435338.pdf
(4) HR Wallingford, Forth Ports Siltation and Dredging Study, 1998

Forth Ports has been undertaking annual maintenance dredging at the Port of Leith, including the approach channel, since 1968 with disposal to sea at the Narrow Deep spoil disposal ground.

Forth Ports estimates that the majority of the material (likely up to 95%) to be dredged and disposed of will be from outside of the Port of Leith dock complex (1).

The port has approximately 223 to 451 vessel movements into and out of the port per annum (2018 to 2023 data) (2). Forth Ports is currently constructing a new outer berth to accommodate wider vessels that cannot use the port lock system. As well as the required capital dredging and disposal of material from the berth pocket, being undertaken under separate Marine Licences, Forth Ports will require to undertake ongoing maintenance dredging in this area.

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 development of the Port of Leith.

Should Forth Ports consider the 'Do Nothing' approach, and not undertake the maintenance dredging operations, a navigable depth would not be maintained and the Port of Leith, including the outer berth and approach channel, would not be able to continue to service current vessels and new customers with wider vessels requiring access to the outer berth. 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.

1.3 PREVIOUS MAINTENANCE DREDGE SPOIL DISPOSAL ACTIVITIES

To maintain access to the Port of Leith, Forth Ports dredges the approach channel and within the docks area. Between 1968 and 2000 dredging was mainly undertaken using the trailing suction dredger Abbotsgrange or a chartered suction trailer dredge if the Abbotsgrange was not available. Since January 2001, Forth Ports has contracted United Kingdom Dredging (UKD) for most operations within the Forth Estuary and Firth of Forth. The UKD Marlin (see Figure 1.1) may be used, which is a trailing suction dredger, with a hopper capacity of 3,000 m^3. Other similar vessels may be used.

(1) Forth Ports pers comm June 2024
(2) Forth Ports pers comm June 2024.

FIGURE 1.1 DREDGE VESSEL - UKD MARLIN

1.4 PROPOSED DREDGE SPOIL DISPOSAL OPERATIONS

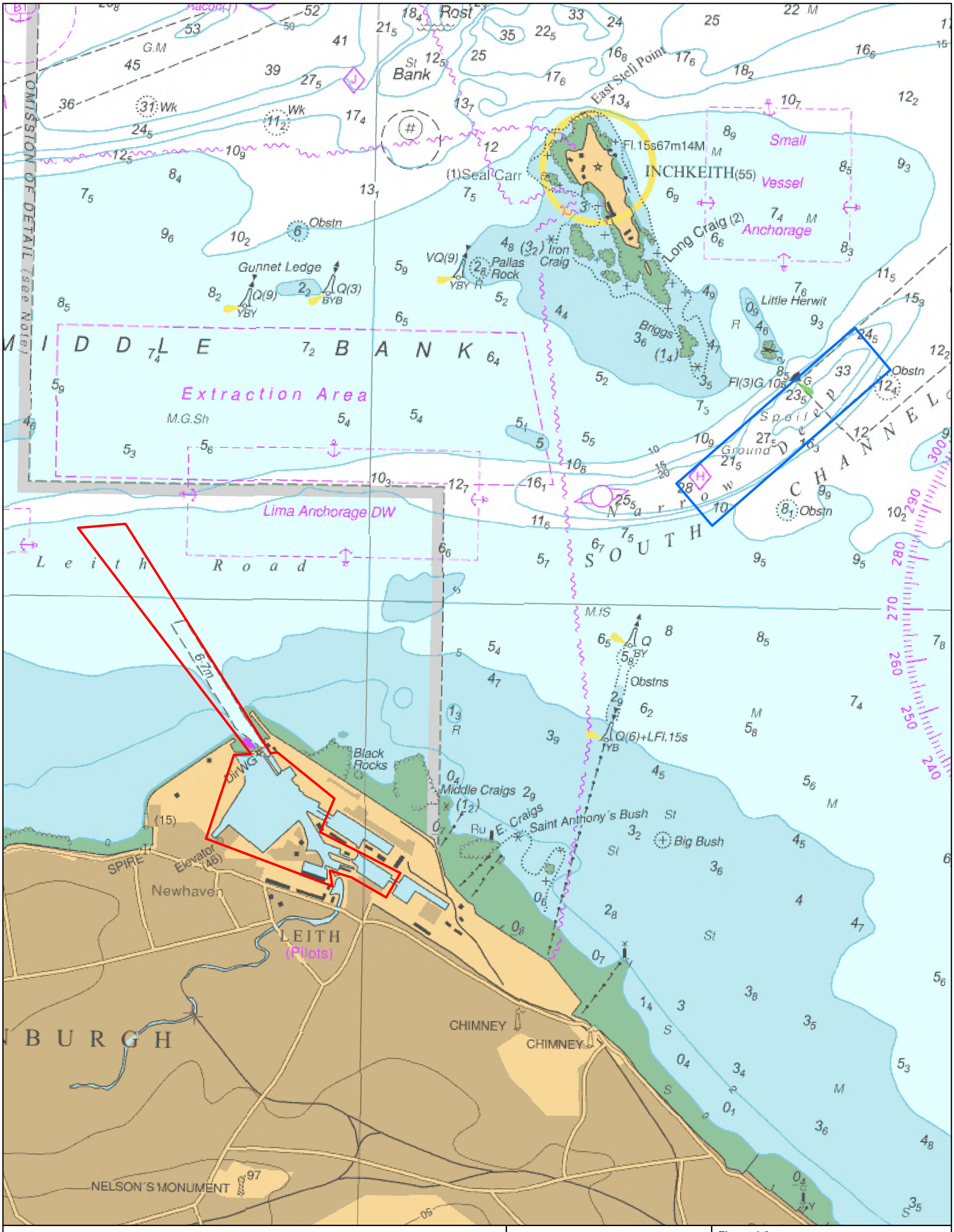
Forth Ports plans to continue the previous regime of annually dredging with the dredged material being disposed of at sea at the Narrow Deep licenced spoil ground. Figure 1.2 shows the planned dredging area and the spoil ground at Narrow Deep.

Forth Ports wishes to apply for a licence from the Marine Directorate for the disposal of dredge spoil to a maximum of 200,000 m^3 of dredged material per annum (up to 260,000 wet tonnes based on density of 1.3 (1)) to maintain a depth to ensure compliance with safe vessel navigation and berthing requirements.

This is an increase from 100,000 m^3 in the previous licence due to the increased maintenance dredge spoil disposal that will be required for the new outer berth development and to allow for any fluctuation in annual sediment deposition rates (*e.g.* due to events such as storms) or contingencies.

The dredging operations to maintain the approach channel and docks are estimated to occur for up to 3 to 4 days every three months (12 to 16 days per annum), subject to siltation rates and commercial requirements. The boundary co-ordinates of the planned dredge areas at the Port of Leith and the approach channel are presented in Table 1.1.

(1) Conversion factor used by Forth Ports for maintenance dredge sediments from the Port of Leith. Forth Ports pers comm May 2024.



Path: \\UKSPRDGISFS01\Data\London\Projects\0391463 - Forth Ports\MAPS\0396143 - Forth Ports.aprx\0396143 - Forth Ports - Leith - Figure 1.1 - Dredging Area and Disposal Site - A01

The Narrow Deep B spoil ground (FO 038) is situated approximately 2.5 nautical miles (nm) east of the Port of Leith and has historically been used by Forth Ports for spoil disposal from Leith. The water depth within the Narrow Deep spoil disposal ground ranges from 10 m below CD at the south-west corner and increases to 31 m below CD through the centre of the site and 34 m below CD at the north-east of the site. The boundary co-ordinates of the spoil disposal ground are presented in Table 1.2.

TABLE 1.1 CO-ORDINATES OF PLANNED DREDGE AREA

Node	Latitude	Longitude
A	56°0.316'N	3°12.398'W
B	56°0.338'N	3°12.009'W
C	55°59.293'N	3°10.785'W
D	55°59.296'N	3°10.728'W
E	55°59.088'N	3°10.252'W
F	55°58.932'N	3°10.365'W
G	55°58.630'N	3°9.260'W
H	55°58.503'N	3°9.385'W
I	55°58.726'N	3°10.099'W
J	55°58.756'N	3°10.280'W
K	55°58.684'N	3°10.257'W
L	55°58.894'N	3°11.302'W
M	55°59.282'N	3°11.085'W
N	55°59.287'N	3°10.944'W

Coordinates in WGS84, degrees decimal minutes

The Narrow Deep B spoil disposal ground is the deepest in the Firth of Forth and has mainly been used for dredged sediments from the Port of Leith. In 2021, 225,000 wet tonnes of capital dredge spoil from deepening one of the berth pockets at the Fife Energy Park at Methil was also deposited at Narrow Deep.

The volume of dredged material deposited at the Narrow Deep B spoil disposal ground from the ongoing maintenance dredging activities at the Port of Leith and approach channel from 2001 to 2023 ranged from 1,724 m^3 to 65,719 m^3 per annum. Annual spoil disposal volumes are presented in Table 1.3. Due to low levels of siltation during some years (2005, 2012, 2013 and 2017) no dredging was necessary and higher volumes are deposited when both the approach channel and the docks are dredged (*e.g.* in 2016 and 2020).

For the dredging work to develop the Leith Outer Berth the volume of dredged material to be removed from the berth pocket and disposed of at Narrow Deep B spoil disposal ground was estimated as 101,000 m^3.

TABLE 1.2 COORDINATES OF NARROW DEEP B SPOIL DISPOSAL GROUND

Latitude	Longitude
56°01.298’ N	003°06.038’ W
56°01.106’ N	003°05.739’ W
56°00.374’ N	003°07.184’ W
56°00.566’ N	003°07.484’ W

Coordinates in WGS84, degree decimal minutes.

TABLE 1.3 DREDGE SPOIL DISPOSAL AT NARROW DEEP DISPOSAL GROUND FROM THE PORT OF LEITH (2001-2023)

Year	Quantity (m^3)
2001	65,719
2002	23,820
2003	21,689
2004	10,162
2005	NIL
2006	14,096
2007	3,173
2008	28,412
2009	28,241
2010	23,574
2011	21,597
2012	NIL
2013	NIL
2014	25,930
2015	18,966
2016	47,957
2017	NIL
2018	22,426
2019	6,780
2020	41,802
2021	11,443
2022	24,381
2023	12,843

Data source: Forth Ports June 2024

1.5 DESCRIPTION OF SEDIMENT TO BE DREDGED AND DISPOSED

In line with the Marine Directorate guidelines on pre-dredge sampling protocol (1), a survey programme was undertaken on 30 January 2024. Surface sediment samples were collected at nine initial stations with an additional three stations at station L2-24, 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).
- 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 approach channel and docks comprises slightly gravelly sandy mud and sandy mud within the dock and mud and muddy gravel in the outer berth/approach channel. There are concentrations of metals, TBT, PAHs and PCBs and above Marine Scotland Action Level 1 (2) and in one station above Action Level 2 (3) for mercury and zinc (Station L1-24) and in two stations (L1-24 and L2-24) above Action Level 2 for TBT in the sediment samples analysed. Station L1-24 is within Edinburgh Dock and is outside the area that Forth Ports plans to dredge. An additional three samples were collected close to Station L2-24 in Albert Dock and the TBT concentrations were below Action Level 2 in these samples (see Appendix A for details.)

There was no asbestos in any of the samples.

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

1.6 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)*

(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.
(2) See Appendix A for explanation of Action Levels.
(3) Action Levels for metals, PCBs, TBT and PAHs are used by Marine Scotland to assess the suitability for disposal of sediments at sea.

Regulations 2012 (1). The options on the short-list were then reviewed against strategic, health, safety and 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.

(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;
  - health, safety and environmental considerations *i.e.* what the health, safety and 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.

- Edinburgh City Council.
- Crown Estate Scotland.
- 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 the Marine Directorate 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 the required steps in

the process and the 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 [(1)].

- **Ecological impact.** Assessing the significance of any potential impact on important habitats or species, including designated sites.

(1)https://pubmed.ncbi.nlm.nih.gov/17027966/#:~:text=Contamination%20is%20simply%20the%20presence,not%20all%20contaminants%20are%20pollutants.

- **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, air quality 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 commonly 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 the general 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 the general public to substances or activities potentially hazardous to health.
Safety	No significant safety risk to the workers and the general public with no specific controls required.	Low safety risk to workers and the general public which is easily controlled.	Moderate to high safety risk to workers and 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.
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 Considerations			
Capital and maintenance	£1 m or less.	Between £1 m and £5 m.	More than £5 m.

(1). 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.
(2) 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 four steps are described below along with a discussion of the practicalities of undertaking these steps at the Port of Leith.

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 the Port of Leith, 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 previous experience from dredging at this location the hopper contents are likely to average 20% solids (by volume) and range from 30% to 15% 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 [(1)].

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.

3.2.3.1 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 metal and TBT concentrations above Action Level 1 and 2 and PCBs and PAHs above 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.

3.2.3.2 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

(1) Forth Ports Ltd pers comm.

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 200,000 m^3 would require approximately 1,334 hours (over 56 days assuming working 24 hours a day, seven days a week, or approximately 166 standard working days). Other units with lower throughputs could take longer (1).

3.2.3.3 FILTER PRESS

A filter press is a tool used to separate solids and liquids using 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 areas of hard standing is available at the Port of Leith, they are used for cargo operations there are no other sites at Leith that could be used for storage or dewatering.

Assuming the dredged material can be dried to a water content of 10% (by volume) at or adjacent to the Port of Leith, the estimated up to 187,000 m^3 (2) per annum of dried materials would require transportation for disposal, either to agricultural land, to landfill, to a reclamation project or to an incinerator. The length of journey required would depend on the location of the deposit/treatment sites.

A volume of 187,000 m^3 of dried (to 10% water content) material equates to approximately 243,100 tonnes (3). Assuming 20 tonne capacity HGVs/tankers are used, this would equate to up to 12,155 return trips or 24,310 vehicle movements per annum.

The significance of the number of movements will be dependent upon the distance to the disposal/treatment site and the existing volume of HGVs on the haulage routes.

The access road to the Port of Leith exits onto the trunk road network on the A199 where the HGV count heading on one direction is recorded as 173,740 per year or an average of 14,478 per month (2023 data (4)). The additional HGV movements as a result of the transport of dredged material would increase the average HGV volume by approximately 14%, if spread over a whole year. There may also be an issue with regard to increase in HGV traffic flows if minor roads are used to reach disposal/treatment sites.

(1) Maximum throughput of 120 m^3hr^{-1} http://www.euroby.com/services/mobilecontract-dewatering-units/
(2) 200,000 m^3 total spoil at 85% solids content equals 170,000 m^3 plus 17,000 m^3 (10% water content) equals 187,000 m^3.
(3) Based on a density of 1.3 tonnes per m^3 of dredge spoil (Forth Ports pers comm May 2024).
(4) https://roadtraffic.dft.gov.uk/local-authorities/29

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, TBT, PCBs, PAHs and salt present within the dredged material. This may restrict disposal and reuse options and pre-treatment may be required 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 form of 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 sediment from within the proposed dredge zone generally comprises coarse/very coarse silts with the average silt content being 71.95% (range 36.13 to 90.16%). The sediment from the Port of Leith is not suitable for beach recharge due to the particle size distribution and the presence of contaminants such as metals, TBT, PCBs and PAHs.

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 of at sea. Action Levels provided by the Marine Directorate 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 refers 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 previous consultations regarding disposal of material dredged 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, TBT, PCB and PAH contamination of 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 the transfer of the dredged material to another vessel capable of direct pumping of the material to a shore reclamation site, or landing, storage, dewatering, possibly desalination and transport to a disposal site.

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 from these bodies 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 other 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 transporting the dredged material were feasible then it may be that the

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

material could be used for quarry/landfill capping. However, the presence of metals, TBT, PCBs and PAHs in the samples 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 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, centrifugal drier or filter press would remove some of the salt, however it is likely that the 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 back into the Firth of Forth.

3.5.2 SUITABILITY FOR SPREADING ON AGRICULTURAL LAND

Approximately 200,000 tonnes of sludge, including 70,000 of sewage sludge, are recycled to agricultural land per annum across Scotland (1). Forth Ports is seeking to dispose of approximately 187,000 m^3 of dewatered material (243,100 tonnes at 1.3 tonnes m^{-3}) of dried material equating to approximately 121.6% of the current volume of annually recycled sludge in Scotland. As the material from Leith has a low organic carbon content (an average of approximately 5.26% from the sediment sample analysis) spreading dredged material from the Port of Leith on agricultural land is not considered a practicable option.

The material sampled at the Port of Leith has contamination from some metal, TBT, PCBs and PAHs above Action Level 1 and some metals and TBT above Action Level 2 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 hazardous or non-hazardous rather than inert and therefore a suitably licensed landfill site with sufficient capacity would be required.

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

3.6.2 AVAILABLE LANDFILL SITES

Subsequent to implementation of the *Landfill Allowance Scheme (Scotland) Regulations 2005* and re-evaluation of landfill licences, there are currently four sites within approximately one hour's drive from Leith that may be able to accept such material [(1)].

There is a landfill site located at Avondale Landfill, Polmont, approximately 22 miles west of the Port of Leith. However, the Avondale site is not large enough to accommodate all the dredged material. In 2022 it was reported that of its total 8,350,000 tonne capacity only 36,583 tonnes remained and the site was scheduled to close on 12 January 2023 [(1)].

Fife Council Lower Melville Wood landfill site in Cupar, approximately 40 miles north of Leith, also has the capability to accept non-hazardous material, although not the volume required and not on an annual basis. In 2022, it received 65,896 tonnes of wastes and had a total remaining capacity of 112,408 tonnes. This site was due to close at the end of 2020 [(2)], however, it has remained open following an operating permit variation approved in 2021 and is due to close at the end of 2024.

Lochhead Landfill in Fife approximately 23 miles north of Edinburgh had an annual capacity of 382,500 tonnes and by the ed of 2022 it had a remaining capacity of 188,320 tonnes and was due to close on 12 January 2024.

Levenseat Landfill in West Lothian approximately 25 miles south-west of Edinburgh had an annual capacity of 400,000 tonnes and by the end of 2022 it had a remaining capacity of 54,000 tonnes and was due to close by 12 January 2024.

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 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 5.26% (based on the 2024 samples which had an average percentage of organic carbon of 5.26% and range of 3.62 to 7.23%) 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 15.26% *i.e.*, 5.26% organics plus 10% water content. Incinerator operators generally require material to have an organic content

(1) https://www.sepa.org.uk/data-visualisation/waste-sites-and-capacity-tool/
(2) https://www.sepa.org.uk/media/109581/landfill-sites-and-capacity-report-2010.xls

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, TBT, PCB and PAHs above Action Level 1 and some metals and TBT above Action Level 2. 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 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 250 miles/402 km south) and transport would be costly and is unlikely to be practicable. Based on 2022 data, of the 71,602 tonnes of waste 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

Re-injection would involve the construction of a pipeline to take the dredged material to a high tide point on the Cramond tidal flats and injecting it at velocity back into the mudflat. Re-injection of dredged material into nearby sedimentary areas has the advantage that it effectively returns the spoil to its source. 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.

In addition to the high costs associated with the construction and operation of the pipeline, re-injection would be likely to have an adverse impact on the protected intertidal habitat through disturbance and erosion and may affect the ornithological interest of the area.

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, although 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

(1) Baldovie Waste to Energy Plant, pers comm, January 2017
(2) https://wikiwaste.org.uk/index.php?title=Ellesmere_Port_Incinerator. Accessed April 2024.

best topsoil is a mixture of sand, silt, clay and organic matter and must be clean for use in the production of food crops [1].

This option would not be feasible at the Port of Leith due to lack of necessary handling facilities and suitable storage areas. The salt and contaminant levels in the material to be disposed of would make using the material for brick-making, aggregates or 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 Leith and from other ports and harbours in the Forth Estuary and Firth of Forth. 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. The time required for one cycle (dredging - travelling - discharging - travelling) is approximately two to three hours depending on weather and tidal conditions restricting access to the port. 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, Oxcars, Blae Rock, Kirkcaldy, Methil and two sites designated at Narrow Deep. For the dredging operations at the Port of Leith, Forth Ports would propose to use the Narrow Deep B spoil ground located approximately 2.5 nm east of the Port of Leith. This site has historically been used for the disposal of dredged material from Leith and is the closest site to the Port of Leith, thus minimising the distance for vessel transport.

The baseline environmental conditions and potential environmental impacts at the 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 3.1. The assessment of the short-listed options taken forward for further consideration is presented in *Section 4.*

(1) Permanent International Association of Navigation Congresses. Permanent Technical Committee II. Working Group 19. 1992. Beneficial Uses of Dredged Material, Issue 19.

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.5.26%). 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 some local sites. There is 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. 5.26%). If incinerated, volume would only slightly reduce and there are no available incinerators in Scotland that could take this amount 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 Port of Kirkcaldy.	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

4.2.1.1 OPERATIONAL FEASIBILITY

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

Classification: Low - Medium

4.2.1.2 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

4.2.1.3 SECURITY OF OPTION

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

Classification: Low to Medium

4.2.1.4 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 material such as sands and gravels.

Classification: Low to Medium

4.2.1.5 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

(1)Hansom, J.D., Fitton, J.M., and Rennie, A.F. (2017) Dynamic Coast - National Coastal Change Assessment: Cell 1 - St Abb's Head to Fife Ness, CRW2014/2. https://www.dynamiccoast.com/files/reports/NCCA%20-%20Cell%201%20-%20St%20Abb's%20Head%20to%20Fife%20Ness.pdf

more favourable than transport by road, which may be viewed as unacceptable by local residents and road users.

Classification: Medium to High

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

Classification: Medium to High

4.2.1.7 LEGISLATIVE IMPLICATIONS

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

Once the material has been removed from the Port of Leith 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

4.2.2.1 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

4.2.2.2 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

4.2.2.3 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

4.2.2.4 ECOLOGICAL IMPACT

Ecological risks resulting from the use of dredged materials for reclamation are unlikely, 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 the creation of terrestrial habitat, then the salt levels would limit plant growth.

Classification: Medium to High

4.2.2.5 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

4.2.2.6 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: £1 m per annum;
- pumping material to site – approximately £10 per m^3 (1) for 200,000 m^3: £2 m.

Total: £3 m.

Classification: Medium

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: £1 m per annum;
- discharge berth: over £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 200,000 m^3 per annum: £20 to £30 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(2): £1.2155 m.

Total £8.215 m to £35.215 m

Classification: Low

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

4.3 SACRIFICIAL LANDFILL

4.3.1 STRATEGIC CONSIDERATIONS

4.3.1.1 OPERATIONAL FEASIBILITY

Disposal to landfill would require the landing, storage and drying of the dredged materials prior to transporting to a landfill facility. Approximately 243,100 tonnes of 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

4.3.1.2 AVAILABILITY OF SITES / FACILITIES

The nearest suitable site is located at Avondale Landfill, Polmont, approximately 22 miles from Leith. Avondale had previously advised that it may be able to receive some of the material, however would require a more in depth analysis to include pH and contaminants before confirming acceptance and cost. It has been reported that the site is due to close. Other sites within 1 hr drive of the site also have limited capacities and are also due to close in 2024.

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

Classification: Low

4.3.1.3 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

4.3.1.4 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

4.3.1.5 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 Leith to potential landfill sites may be unacceptable to residents and other road users.

Classification: Medium to High

4.3.1.6 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 is likely to 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

4.3.1.7 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

4.3.2.1 PUBLIC HEALTH

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

Classification: Medium to High

4.3.2.2 SAFETY

There may be an increase in safety risks associated with the movement of materials for disposal, particularly if there are 24,310 tankers/sealed HGVs movements through populated areas and along minor roads each year.

Classification: Medium

4.3.2.3 CONTAMINATION/POLLUTION

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

Classification: Medium to High

4.3.2.4 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.

4.3.2.5 INTERFERENCE WITH OTHER LEGITIMATE ACTIVITIES

The increase in HGV movements may interfere with other road users. Baseline traffic data for the A199 in the vicinity of the port indicates that approximately 5.7% of all road

traffic in Leith is HGVs [1]. As a result of the proposed disposal to landfill, the proportion of HGVs in the total annual traffic flow would increase by approximately 14%[2]. Depending on the landing and storage arrangements there may be potential for some interference with other dock and road users.

Classification: Medium

4.3.2.6 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: £1 m per annum;
- discharge berth: £3.5 m;
- lagoons to settle dredged material: £2.5 m; or
- dockside centrifuge facility capable of dewatering and desalinating 200,000 m^3: £20 to £30 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[3]: £1.2155 m.

Total £8.215 m to £35.215 m

Classification: Low

4.4 OTHER DISPOSAL OPTIONS AND REUSE

4.4.1 STRATEGIC CONSIDERATIONS

4.4.1.1 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 243,100 tonnes of material would require transport.

There are practical difficulties relating to handling the dredged material at the Port of Leith. 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

(1) UK Traffic Data, A199 Leith 2022 traffic data. Available online https://roadtraffic.dft.gov.uk/local-authorities/29.
(2) 2022 data present an average of 173,740 HGVs on the A199 at Leith per annum, which would increase to 198,050 HGV movements with the transport of dredged material from Leith by road. Based on 7 days a week. Total vehicle movements were 3,061,985 in 2022.
(3) Estimated cost based on consultation with HGV operator at £50/hour and estimated cost of loading at £50/hour.

would not be appropriate for brick making and the contamination by salt would be unacceptable for any construction material.

Classification: Low to Medium

4.4.1.2 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

4.4.1.3 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 making bricks or aggregate.

Classification: Low to Medium

4.4.1.4 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

4.4.1.5 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

4.4.1.6 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

4.4.1.7 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

4.4.2.1 PUBLIC HEALTH

There may be localised and temporary deterioration in air quality from an intermittent increase in HGV movements.

Classification: Medium to High

4.4.2.2 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 use of plant and manual handling of materials as well as the movement of materials, particularly if HGVs travel through settlements and along minor roads.

Classification: Medium

4.4.2.3 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

4.4.2.4 ECOLOGICAL IMPACT

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

Classification: High

4.4.2.5 INTERFERENCE WITH OTHER LEGITIMATE ACTIVITIES

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

Classification: Medium to High

4.4.2.6 AMENITY/AESTHETIC

The only impacts on amenity are likely to stem from the impact of HGVs from transporting the material (up to 24,312 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: £1 m per annum;
- discharge berth: over £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 200,000 m^3 per annum: £20 to £30 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): £1.2155.

Total £8.215 m to £35.215 m

Classification: Low

4.5 SEA DISPOSAL

4.5.1 STRATEGIC CONSIDERATIONS

4.5.1.1 OPERATIONAL FEASIBILITY

Operationally disposal at the Narrow Deep B disposal site is comparatively simple as it does not require the landing, storage and drying of the spoil and all the necessary procedures are understood. As this is the present discharge route for the ongoing maintenance dredge operations at the Port of Leith, it has been proven as practicable and all the necessary procedures are understood and logistical arrangements in place.

Classification: High

4.5.1.2 AVAILABILITY OF SITES / FACILITIES

The sites/facilities which are required for the sea disposal option are those which are already used and closest to the Port of Leith. No other disposal sites have been indicated by Forth Ports as being preferred for the dredged spoil material from the Port of Leith.

Classification: High

4.5.1.3 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

4.5.1.4 ESTABLISHED PRACTICE

Disposal at the Narrow Deep B licenced spoil ground is the current practice for the disposal of the dredged spoil from the Port of Leith is, therefore, established and proven as effective.

Classification: High

4.5.1.5 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. Disposal operations are unlikely to affect 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 that has been established over many years.

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

Classification: High

4.5.1.6 LIKELY AGENCY ACCEPTABILITY

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

Classification: Medium to High

4.5.1.7 LEGISLATIVE IMPLICATIONS

A Marine Licence will be required from the Marine Directorate 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

4.5.2.1 PUBLIC HEALTH

The risk of the general public being exposed to contamination from the dredged material deposited at the Narrow Deep 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

4.5.2.2 SAFETY

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

Classification: Medium to High

4.5.2.3 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

4.5.2.4 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.

4.5.2.5 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 operations at Narrow Deep have not resulted in any reported disruption to other Firth of Forth users.

Classification: High

4.5.2.6 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 the Port of Leith.

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 £1 m, 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 the Port of Leith. 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 ,Mud and Muddy Gravel in the outer berth and approach channel and Slightly Gravelly Sandy Mud and Sandy Mud within the port area. The fine sediments within the port area have low compressive strength properties, making it unsuitable for most types of construction. In addition, the presence of some metals, TBT, 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 therefore direct discharge from the dredger to a reclamation site is not possible. The costs of using this material for an inland site 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. Forth Ports would have limited control over the option and it is not common practice to use marine maintenance 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 Narrow Deep disposal site which has been historically used for disposal of dredged materials from the Port of Leith. It is anticipated that this option will be generally acceptable to both public and agencies, based on previous applications. Forth Ports would have full control over the disposal 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, in turn, have slight ecological effects but these are considered to be not significant given the scale and frequency of these impacts. 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 the Port of Leith, or elsewhere in the vicinity of Leith.

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 the Port of Leith 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 the Marine Directorate, the Best Practicable Environmental Option is identified as the disposal at a licensed marine spoil ground. The preferred site for this is the existing Narrow Deep B licenced spoil ground.

TABLE 5.1 SUMMARY OF ASSESSMENT OF OPTIONS

Criteria	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	#			

#: the cost consideration of this option would be medium if there was a nearby site requiring material to be transported directly from the dredger

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

APPENDIX A PORT OF LEITH SEDIMENT SAMPLE DATA

A1.1 INTRODUCTION

Samples of the seabed sediments to be dredged were collected from the Port of Leith by Forth Ports on 26 February 2024 and were analysed by SOCOTEC Ltd. The survey plan followed the Marine Directorate guidance and was submitted to the Marine Directorate for review and approved on 30 November 2023. Based on the maximum dredge volumes and dredging depths applied for, grab samples from nine stations were required.

Following the review of the obtained analytical results Forth Ports decided to collect a further three samples (L2A-24, L2B-24 and :L2C-24) on 7 May 2024 from the same area that the L2-24 sample was collected from to check if the levels of contamination identified from that sample were typical of the area. The sample collected in the Edinburgh Dock (L1-24) is outside of the planned dredging area for the Port of Leith.

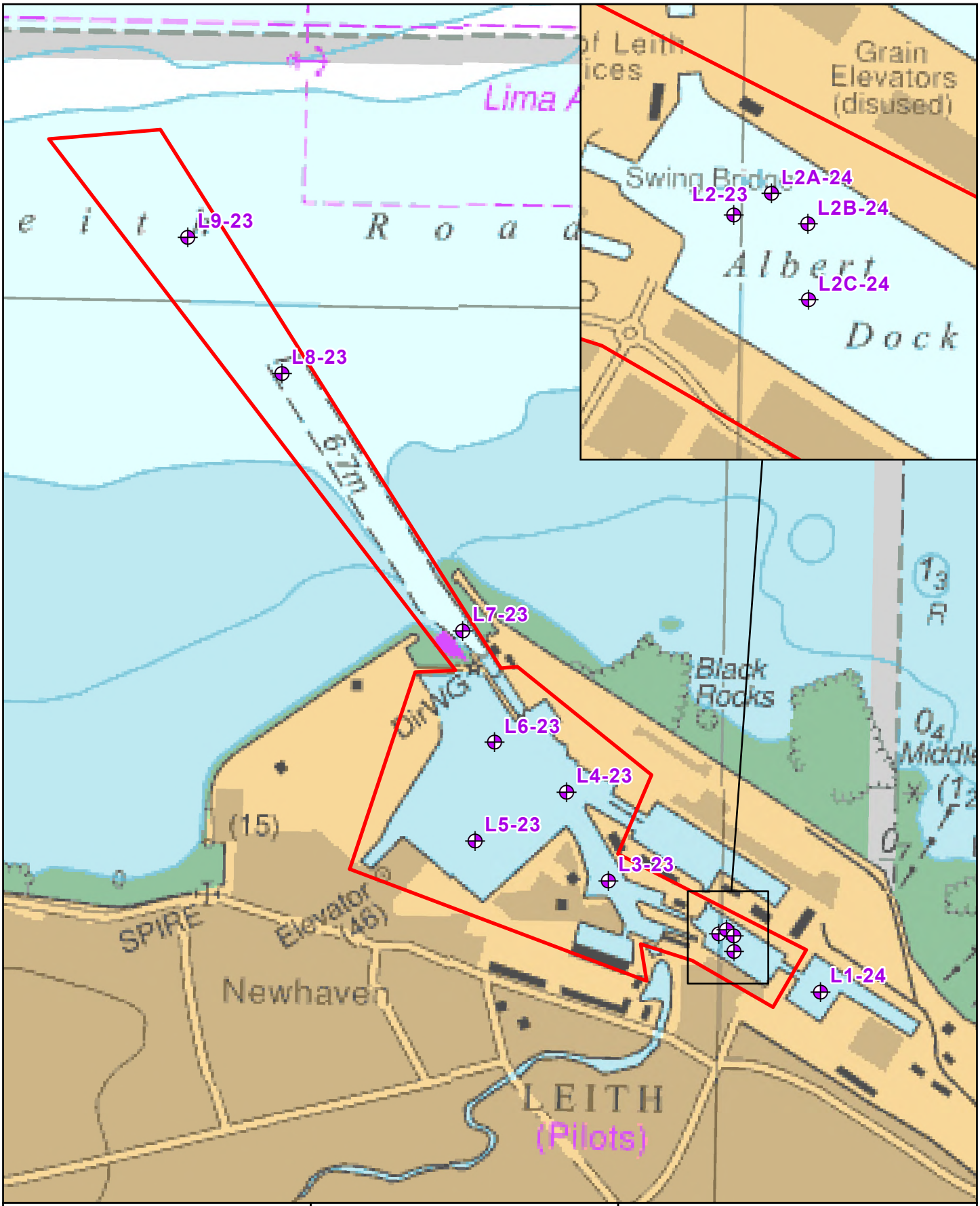
Sample station locations are presented in Table A1.1 and shown in Figure A1.1.

TABLE A1.1 POSITIONS OF THE PORT OF LEITH 2024 SAMPLE STATIONS

Sample Station	Latitude	Longitude
L1-24	55°58.670'N	3°9.652'W
L2-24	55°58.779'N	3°10.007'W
L2A-24	55°58.787'N	3°09.981'W
L2B-24	55°58.775'N	3°09.955'W
L2C-24	55°58.745'N	3°09.953'W
L3-24	55°58.879'N	3°10.396'W
L4-24	55°59.051'N	3°10.548'W
L5-24	55°58.952'N	3°10.865'W
L6-24	55°59.147'N	3°10.803'W
L7-24	55°59.365'N	3°10.921'W
L8-24	55°59.864'N	3°11.569'W
L9-24	56°0.127'N	3°11.906'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 recording the sample location, date and time sample was taken. Samples were kept chilled and sent by overnight courier in coolboxes to the analytical laboratory.



Sediment Sample Positions

Proposed Dredging Area

0 100 200 300 400 500

Metres

N

Figure A1.1
Surface Sediment Sample Stations

SCALE: See Scale Bar	VERSION: A01
SIZE: A4	DRAWN: RW
PROJECT: 0396143	CHECKED: MI
DATE: 24/06/2024	APPROVED: MI

ERM

FORTH PORTS

PROJECTION: British National Grid

Path: \\UKSPRDGISFS01\Data\London\Projects\0391463 - Forth Ports\MAPS\0396143 - Forth Ports.aprx\0396143 - Forth Ports - Leith - Figure A1.1 - Surface Sediment Sample Stations - A4 - A01

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

- Metals (As, Cd, Cr, Cu, Hg, Ni, PB, Zn).
- Tributyl tin (TBT).
- Polyaromatic hydrocarbons (PAHs) (EPA 16).
- Total Hydrocarbon Content (THC).
- PCBs (ICES 7).
- Sediment moisture content and sediment particle density.
- Total Organic Carbon (TOC).
- Sediment particle distribution (PSD).
- Presence of asbestos.

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

A1.2 MARINE DIRECTORATE ACTION LEVELS

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

Based on the Marine Directorate guidance, contaminant levels in dredged material below Action Level 1 are generally of low concern and are unlikely to influence the licensing decision. Exceeding 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 DIRECTORATE ACTION LEVELS: METALS

Metal	AL1 (mg kg^{-1} dry weight)	AL2 (mg kg^{-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 DIRECTORATE ACTION LEVELS: PCBS, TBT, PAHS AND THC

Determinand	AL1 (mg kg^{-1} dry weight)	AL2 (mg kg^{-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 Hydrocarbons (THC)	100	

A1.3 METAL RESULTS

Concentrations of metals from the nine samples, along with the average and range of concentrations are presented in Table 1.4. Levels above Action Level 1 are highlighted in blue (see Table A1.1 for Action Levels for metals).

TABLE A1.4 METAL CONCENTRATIONS FROM LEITH IN 2024 (MG KG^{-1} DRY WEIGHT)

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
L1-24	15.5	2.70	57.2	215	2.02	44.9	272	682
L2-24	12.8	1.35	51.6	176	0.96	41.5	152	423
L2A-24	9.5	1.13	40	241	0.92	30.4	126	347
L2B-24	13.8	1.74	70.1	227	1.15	49	182	522
L2C-24	9.8	0.83	42.2	149	0.61	31.1	103	307
L3-24	8.70	1.51	46.5	107	1.08	43.8	214	411
L4-24	12.6	1.34	99.9	106	1.09	79.9	148	304
L5-24	14.5	1.25	63.2	105	0.99	41.4	126	279
L6-24	12.5	0.85	56.8	115	0.81	36.3	100	250
L7-24	5.60	0.09	12.4	6.50	0.06	7.50	10.4	34.9
L8-24	15.1	0.25	55.2	27.0	0.66	31.7	68.6	126
L9-24	11.6	0.29	33.8	25.1	0.43	25.5	78.1	114
Mean	11.8	1.11	52.4	125.0	0.90	38.6	131.7	361.7
Range	8.7-15.5	0.09-2.7	33.8-99.9	25.1-215	0.06-2.02	7.5-79.9	10.4-272	34.9-682

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 1990 to 2024. The concentrations of metals over the period for which there is available sample data are variable however, in the majority of cases most metal concentrations are below Action Level 2.

TABLE A1.5 METAL CONCENTRATIONS FROM LEITH 1990-2024 (MG KG^{-1} DRY WEIGHT)

Year		As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
1990	Mean	14.5	1.8	72.5	71.8	1.7	32.7	132.0	219.0
1991	Mean	7.5	1.1	62.3	63.4	1.2	38.7	120.0	178.0
1992	Mean	14.8	0.5	32.1	34.7	1.4	23.6	132.0	94.3
1994	Mean	4.6	0.7	46.9	58.9	1.2	39.9	129.0	687.0
2003	Mean	13.9	1.8	58.4	84.3	1.6	44.1	215.4	280.5
	Range	6.3-17.5	0.0-3.9	14.1-84.3	12.8-121.4	0.2-2.7	13.0 - 59.3	29.0-787.0	62.6-513.8
2004	Mean	15.5	1.5	67.7	82.9	1.8	46.3	184.8	284.9
	Range	10.9-21.6	0.6-2.3	48.5-77.1	48.4-104.7	1.1-4.4	40.8-52.1	109.5-306.3	173.7-421.2
2005	Mean	14.6	0.6	43.0	52.2	0.8	36.6	92.2	166.7
	Range	11.4-18.4	0.3-0.9	26.4-66.1	32.3-85.9	0.5-1.2	31.9-46.5	62.1-153.4	110.4-252.8
2007	Mean	14.2	0.9	68.3	70.1	0.8	42.7	116.0	207.0
	Range	10.8-16.6	0.3-2.2	55.4-84.1	34.1-144.0	0.5-1.2	33.7-53.7	75.8-163.0	125.0-338.0
2008	Mean	15.1	0.7	75.1	67.1	0.9	43.8	109.6	207.4
	Range	13.0-16.4	0.4-1.1	61.9-83.3	33.8-97.1	0.7-1.1	34.6-51.4	70.1-152.0	125.0-290.0
2017	Mean	16.5	0.99	87.3	126.0	0.8	49.9	113.9	288.1
	Range	14.0-19.3	0.3-2.4	59.9-105.0	26.6-286.0	0.6-1.1	35.9-66.4	65.6-159.0	120.0-528.0
2020	Mean	14.72	1.12	68.3	144.7	0.96	48.1	132	306
	Range	10.5-19.6	0.25-1.86	52.1-88.7	31.1-362	0.56-1.31	32.4-74.8	65.6-195	126-453
2024	Mean	11.8	1.11	52.4	125.0	0.90	38.6	131.7	361.7
	Range	8.7-15.5	0.09-2.7	33.8-99.9	25.1-215	0.06-2.02	7.5-79.9	10.4-272	34.9-682
1990 - 2024	**Mean**	**13.2**	**1.07**	**61.2**	**79.5**	**1.2**	**40.5**	**133.9**	**267.5**
	Range	**4.6-21.6**	**0.0-3.9**	**14.1-105**	**12.8-362**	**0.06-4.4**	**7.5-79.9**	**10.4-787.0**	**34.9-687.0**

BDL: Below Detection Levels. N/A: Not Applicable. Range data not available from 1990 to 1994.

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.

Mean dry weight concentrations of TBT from the samples collected are presented in Table A1.6. Two samples were observed to have TBT concentrations above Action Level 1 (0.1 mg kg^{-1}) and two samples had concentrations above Action Level 2 (0.5 mg kg^{-1}).

TABLE A1.6 TBT FROM THE PORT OF LEITH IN 2024 (MG KG^{-1} DRY WEIGHT)

Station	TBT Concentration
L1-24	1.67
L2-24	0.56
L2A-24	0.352
L2B-24	0.129
L2C-24	0.0705
L3-24	0.186
L4-24	0.0866
L5-24	0.179
L6-24	0.0896
L7-24	<0.005
L8-24	<0.005
L9-24	<0.005
Mean	**0.278**
Range	**<0.005-1.67**

Note: DBT was analysed for along with TBT. The DBT results are not reported here as there is no Action Level for DBT but have been provided in the Marine Directorate Pre-Disposal Sampling Results Form. To calculate the mean the concentrations below 0.005 mg kg^{-1} were taken as being 0.005 mg kg^{-1}.

A comparison of TBT concentrations from samples collected between 2017 and 2024 are presented in *Table A1.7.* The mean concentrations between the three surveys were above Action Level 1 with some individual samples being above Action Level 2.

(1) The development of male characteristics in females

TABLE A1.7 TBT FROM THE PORT OF LEITH IN 2017-2024 (MG KG^{-1} DRY WEIGHT)

Year		TBT Concentration
2017	Mean	0.221
	Range	0.006-0.716
2020	Mean	0.274
	Range	<0.005-1.022
2024	Mean	0.278
	Range	<0.005-1.67
2017-2024	**Mean**	**0.957**
	Range	**<0.005- 1.67**

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 2024 are presented in Table A1.8. Most samples were above Action Level 1 and all were below Action Level 2.

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

TABLE A1.8 PCBS FROM THE PORT OF LEITH IN 2024 (MG KG^{-1} DRY WEIGHT)

Station	Sum of ICES 7 PCB Concentrations
L1-24	0.109
L2-24	0.0504
L2A-24	0.035
L2B-24	0.0311
L2C-24	0.0327
L3-24	0.0805
L4-24	0.0853
L5-24	0.0532
L6-24	0.0440
L7-24	0.0209
L8-24	0.0133
L9-24	0.00695
Mean	**0.0469**
Range	**0.0133-0.109**

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 presents a comparison of mean dry weight concentrations of ICES 7 PCBs from samples collected between 1993 and 2024. To calculate the mean values for data reported as less than the analytical method reporting limit then the reporting limit was used.

TABLE A1.9 PCBS FROM THE PORT OF LEITH 1993-2024 (MG KG^{-1} DRY WEIGHT)

Year		Mean Sum of ICES 7 PCB Concentrations (rounded to four decimal places
1993		0.0268
1999		0.0221
2003		0.1597
2004		0.0509
2005		0.0248
2010		0.0296
2017		0.0439
2020		0.0537
2024		0.0469
1993-2024	**Mean**	**0.0509**
	Range	**0.0221-0.1597**

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.

A1.6 POLYCYCLIC AROMATIC HYDROCARBONS

Levels of the US EPA 16 PAHs are presented in Table A1.10. The US EPA 16 PAHs are generally considered to be of environmental concern because of their potential toxicity in humans and other organisms and their prevalence and persistence in the environment.

Levels above Action Level 1 for individual PAHs are highlighted in blue. There are no Action Level 2 standards for PAHs.

A comparison of mean dry weight concentrations of PAHs from samples collected between 2003 and 2024 are presented in Table A1.11. Concentrations of most individual EPA 16 PAHs above Action Level 1 were found in all years. The 2024 data showed lower concentrations when compared to the 2020 data but they were similar to previous data dating back to 2003.

The total hydrocarbon (THC) concentrations were also analysed for and these are presented in Table A1.10. The 2024 data are similar to the 2020 data. THC was not analysed for in earlier surveys. There is no Action Level for THC. The mean dry weight concertation of THCs in the 2024 samples was 0.24% which corresponds to 0.07% converted to wet weights based on the average measured solids contents of the samples. These wet weight concentrations are below the toxic (1%) and harmful (0.1%)

classifications for ecotoxicology based on the UK country agency guidance (1). It is noted that the guidance is related to Total Petroleum Hydrocarbons (TPH) and not THC concentrations.

A1.7 ASBESTOS

No asbestos was reported from any of the samples.

A1.8 SEDIMENT PHYSICAL PROPERTIES

The physical properties of the dredge sediment was analysed on the 9 sediment samples taken from the Port of Leith in 2024. Sediments comprised Sandy Gravelly Sandy Mud (station L1-24 to L5-24), Sandy Mud (L6-24 and L8-24), Mud (L7-24) and Muddy Gravel (L9-24)

- 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 A1.2 present the 2024 data and sample photographs are presented in Figure A1.3.

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

TABLE A1.10 PAHS AND THC FROM THE PORT OF LEITH 2024

PAH	Sample Station											
	L1-24	**L2-24**	**L2A-24**	**L2B-24**	**L2C-24**	**L3-24**	**L4-24**	**L5-24**	**L6-24**	**L7-24**	**L8-24**	**L9-24**
LMW (µg kg^{-1} Dry Weight)												
Acenaphthene	125	92.7	220	130	104	128	109	78.8	123	122	46.8	27
Acenaphthylene	83.4	51.4	164	78.9	71.3	77.9	67.9	58.9	45.3	50.5	40.3	23.8
Anthracene	460	252	577	354	307	359	325	318	340	264	170	102
Fluorene	229	140	370	215	194	239	180	160	175	167	87.5	61.3
Naphthalene	338	208	437	298	251	199	313	263	267	211	253	141
Phenanthrene	924	600	1,120	755	751	842	646	638	777	806	388	241
HMW (µg kg^{-1} Dry Weight)												
Benzo(a)anthracene	831	615	1,320	1,010	881	952	665	625	880	512	299	170
Benzo(a)pyrene	1,470	1,040	2,290	1,660	1530	1,270	1,010	933	1,110	616	392	213
Benzo(b)fluoranthene	1,570	992	2,510	1,760	1550	1,240	941	945	1,050	581	412	222
Benzo(k)fluoranthene	1,300	864	1,810	1,260	1120	1,080	819	797	921	517	344	183
Benzo(ghi)perylene	1,240	863	2,310	1,630	1500	1,040	827	799	857	506	388	216
Chrysene	1,050	771	1,550	1,120	963	1,180	748	765	974	572	330	190
Dibenzo(ah)anthracene	257	160	433	297	253	208	163	160	177	97.6	63.4	37.6
Fluoranthene	1,370	1,190	2,290	1,800	1620	2,060	1,150	1,280	1,720	1,130	525	291
Indeno(1,2,3-c,d)pyrene	1,120	744	2,160	1,640	1510	981	733	727	787	456	344	176
Pyrene	2,840	1,710	3,560	2,310	2090	2,310	1,810	1,740	2,000	1,190	677	401
Sum US EPA 16 PAHs	15,207	10,293	23,121	16,318	14,695	14,169	10,507	10,288	12,203	7,798	4,760	2,696
Total Hydrocarbons THC (mg kg^{-1} Dry Weight)	5,560	2,670	4,870	3,630	3,280	2,460	1,690	2,030	1,520	634	497	235

LMW = Low Molecular Weight. HML = High Molecular Weight.

TABLE A1.11 COMPARISON OF PAHS FROM THE PORT OF LEITH 2003 TO 2024

Year	2003	2004	2005	2007	2010	2017	2020	2024
PAH	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**	**Mean**
LMW (mg kg^{-1} Dry Weight)								
Acenaphthene	ND	ND	ND	ND	ND	0.1107	0.5228	0.1089
Acenaphthylene	ND	ND	ND	ND	ND	0.0136	0.0833	0.0678
Anthracene	0.6428	0.7257	0.3255	0.1460	0.1972	0.2657	2.8349	0.3190
Fluorene	0.3573	0.2955	0.1362	0.0624	0.0815	0.1293	0.6970	0.1848
Naphthalene	0.4712	0.4417	0.2633	0.1525	0.1484	0.2701	0.4829	0.2649
Phenanthrene	1.6884	1.7375	0.9237	0.4145	0.5803	0.6069	7.9477	0.7073
HMW (mg kg^{-1} Dry Weight)								
Benzo(a)anthracene	1.3570	1.7614	0.8292	0.3534	0.4701	0.5804	3.4281	0.7300
Benzo(a)pyrene	1.5604	1.1439	0.7757	0.4083	0.4789	0.6704	2.8089	1.1278
Benzo fluoranthenes	3.9748	3.2114	1.7999	ND	1.1354	1.3444	4.7114	1.1478
Benzo(ghi)perylene	1.7876	1.1287	0.576	0.3056	0.3594	0.6564	1.7127	0.9663
Chrysene/Triphenylene	1.7212	1.6775	0.9561	0.3805	0.4892	0.6177	3.4601	0.8511
Dibenz(a,h anthracene	ND	ND	ND	ND	ND	0.1347	0.3646	0.1922
Fluoranthene	2.6727	3.0867	1.5324	0.6947	0.9368	1.0301	10.6414	1.3688
Indeno(1,2,3-c,d)pyrene	1.4114	1.392	0.5187	0.3414	0.3647	0.5570	1.7606	0.9482
Pyrene	3.0382	2.237	1.7501	0.7388	0.9702	1.1586	8.3731	1.8865
Total Hydrocarbons THC (mg kg^{-1} Dry Weight)	ND	ND	ND	ND	ND	ND	2,926	2,423

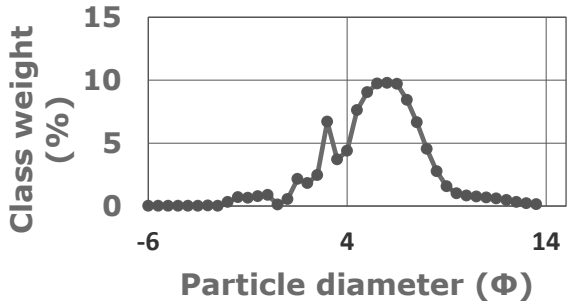
LMW = Low Molecular Weight. HML = High Molecular Weight. ND = No Data.

TABLE A1.12 PORT OF LEITH 2024 SEDIMENT DATA SUMMARY

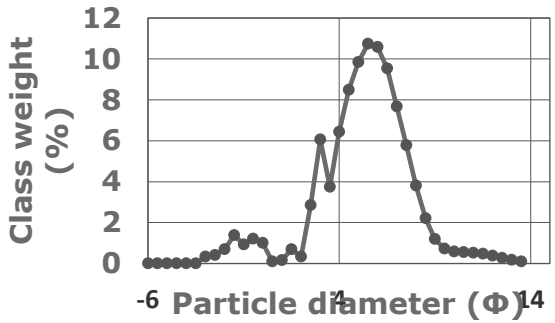
Parameter	Sample Station											
	L1-24	**L2-24**	**L2A-24**	**L2B-24**	**L2C-24**	**L3-24**	**L4-24**	**L5-24**	**L6-24**	**L7-24**	**L8-24**	**L9-24**
Textural Group Classification	Slightly Gravelly Sandy Mud	Slightly Gravelly Sandy Mud	Gravelly Mud	Gravelly Mud	Sandy Mud	Slightly Gravelly Sandy Mud	Slightly Gravelly Sandy Mud	Slightly Gravelly Sandy Mud	Sandy Mud	Mud	Sandy Mud	Muddy Gravel
Folk and Ward Description	Coarse Silt	Coarse Silt	Coarse Silt	Very Fine Sand	Coarse Silt	Very Coarse Silt	Coarse Silt	Coarse Silt	Coarse Silt	Medium Silt	Coarse Silt	Medium Sand
Folk and Ward Sorting	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Poorly Sorted	Very Poorly Sorted	Extremely Poorly Sorted
Mean µm	26.723	29.132	29.644	73.507	24.963	35.409	25.236	15.701	27.557	14.826	24.238	368.631
Mean phi	5.226	5.101	5.076	3.766	5.324	4.820	5.308	5.993	5.181	6.076	5.367	1.440
Sorting Coefficient	2.282	2.380	3.000	3.518	1.745	2.137	2.338	2.077	2.099	1.890	2.427	4.231
Skewness	-0.104	-0.191	-0.242	-0.436	0.058	0.011	-0.084	0.007	-0.093	0.076	-0.084	0.255
Kurtosis	1.156	1.426	1.8503483	1.5810545	1.0632887	0.908	1.065	1.196	1.035	1.265	1.148	0.743
Gravel (%)	1.68	3.75	8.13	14.33	0	0.48	0.84	0.13	0.00	0.00	0.00	34.95
Sand (%)	23.49	22.59	22.29	21.15	21.63	34.96	25.11	15.13	25.73	9.84	24.82	28.92
Mud (silts and clays) (%)	74.82	73.65	69.58	64.52	78.37	64.56	74.05	84.74	74.27	90.16	75.18	36.13
Total Organic Carbon (%)	6.16	7.23	4.42	4.39	5.36	6.36	5.11	5.48	5.74	4.40	4.88	3.62
Solids (%) @120°C	37.7	22.7	26.3	21.5	20.2	29.9	41.0	30.9	30.8	31.4	31.8	61.9
Density (mg m^{-3})	2.57	2.48	2.48	2.48	2.44	2.57	2.53	2.45	2.5	2.52	2.40	2.55

Key: phi =$-\log_2$ of sediment particle diameter in mm

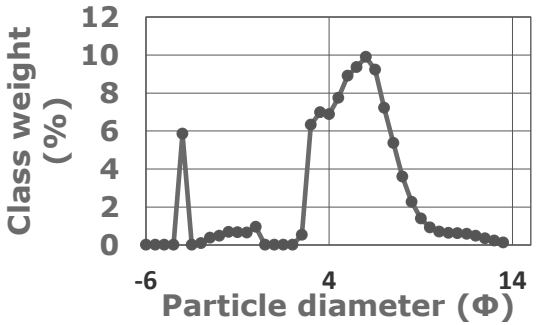
FIGURE A1.2 PORT OF LEITH 2024 SEDIMENT PSA



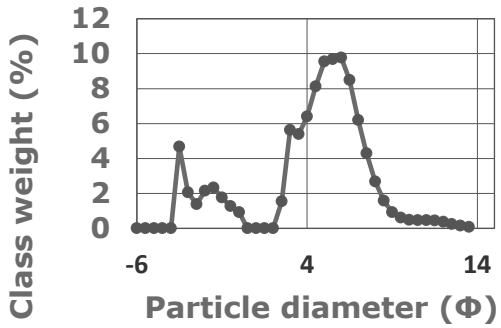
L1-24



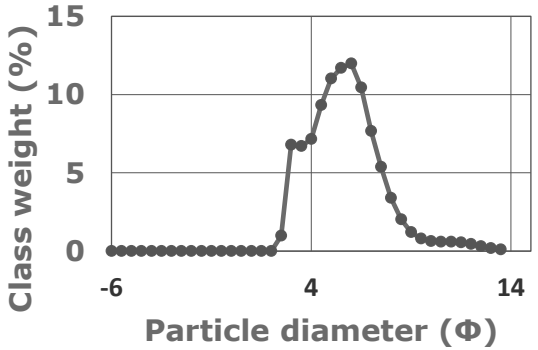
L2-24



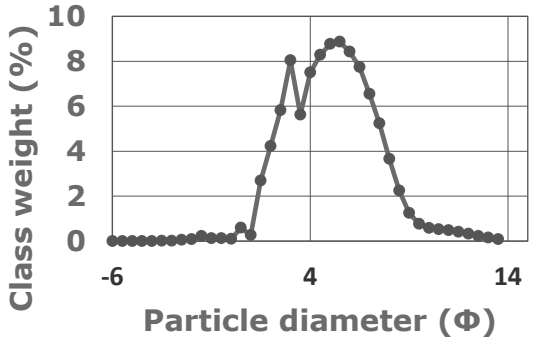
L2A-24



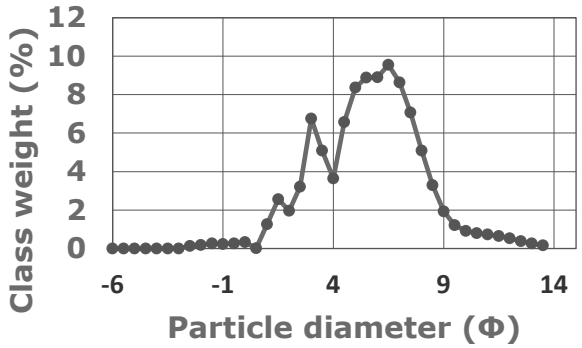
L2B-24



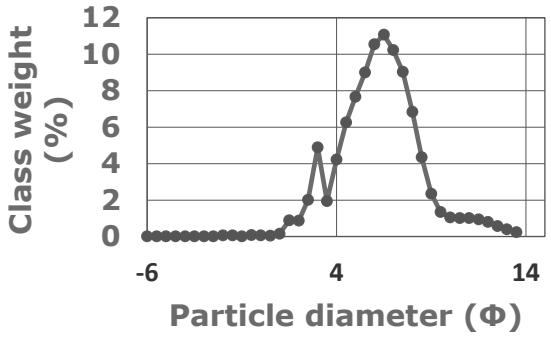
L2C-24



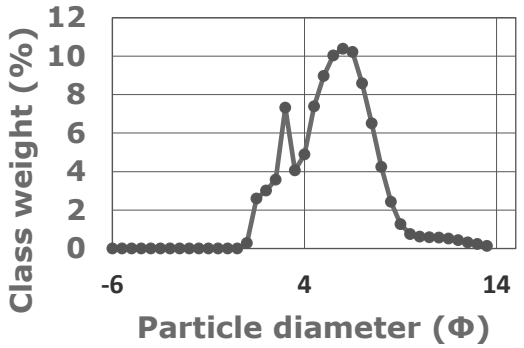
L3C-24



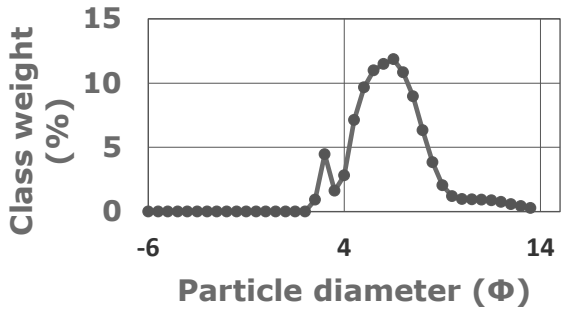
L4-24



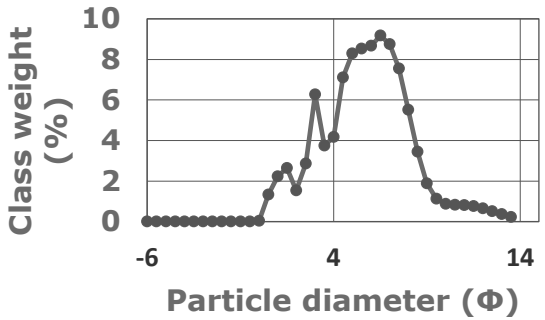
L5-24



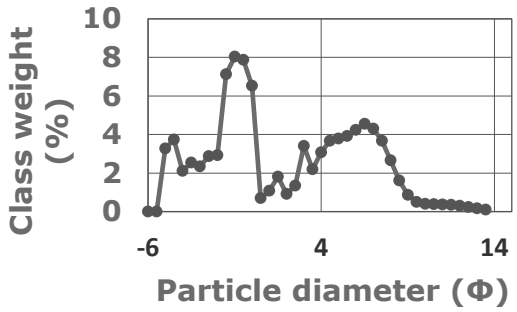
L6-24



L7-24

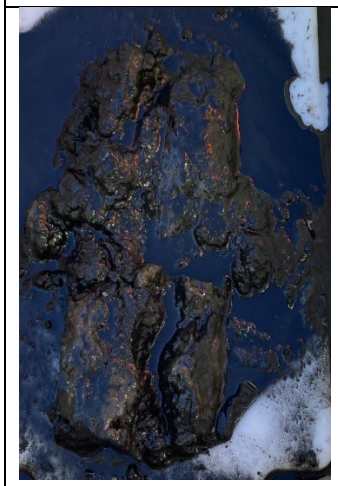
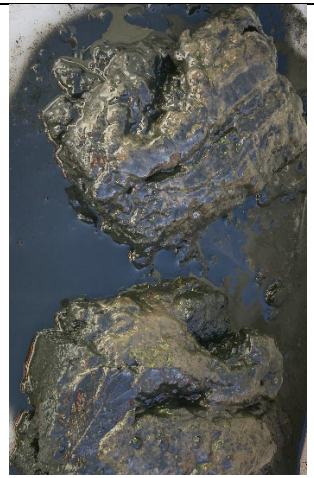
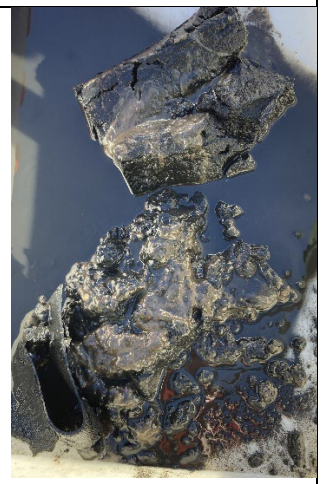


L8-24



L9-24

FIGURE A1.3 PORT OF LEITH 2024 SAMPLE PHOTOGRAPHS

L1-24	L2-24	L2A-24	L2B-24	L2C-24	L3-24
					
L4-24	**L5-24**	**L6-24**	**L7-24**	**L8-24**	**L9-24**
					

A2 SPOIL GROUND SEDIMENT SAMPLE DATA

Table A2.1 presents metal and PCB concentration data from sediment sampled from spoil ground sites within the Firth of Forth and Forth Estuary. Levels above Action Level 1 for metals and PCBs are highlighted in blue. Monitoring of spoil grounds is not mandatory therefore, the data presented in Table A2.1 are the most recent data available.

Concentrations of metals and PCBs in the samples from the Narrow Deep disposal site are generally lower than in the samples from the material to be dredged from the Port of Leith, in particular, the more fine-grained sediments from the inner harbour (refer to Table A1.4 and Table A1.7), which would be expected from a dispersive spoil ground such as Narrow Deep.

TABLE A2.1 CONCENTRATION OF METALS AND PCBS FROM SPOIL GROUNDS (MG KG^{-1} DRY WEIGHT)

Site Name/Date	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	Sum ICES 7 PCBs
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	-
Kirkcaldy 2015 (n=3)	8.9	0.1	43.1	17.0	0.2	22.0	30.6	62.9	0.0025 (n=3)
Methil 1993 (n=1)	8.2	0.2	9.8	10.7	0.1	19.2	10.5	51.0	
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)
Oxcars 2011 (n=6)	11.2	0.1	42.5	22.2	0.6	22.3	153.5	92.2	0.007 (2007, n=6)
Oxcars 2015 (n=3)	15.7	0.3	79.6	41.6	1.0	35.8	78.1	141.7	0.008
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

B1.1 INTRODUCTION

This Appendix addresses the environmental impacts of the disposal of dredged material from the planned maintenance dredging work at the Port of Leith at the Narrow Deep B 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 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 MATERIAL TO BE DISPOSED

As described in *Section 1.4*, it is proposed that up to 200,000 m^3 (approximately 260,000 wet tonnes) of material from the Port of Leith is disposed of at the Narrow Deep B spoil ground per annum.

Typically, dredging and disposal takes place over a period of approximately three to four days every quarter (12 to 16 days er annum) although this will depend on siltation rates. Scheduling of the dredging and disposal operations depending on operational requirements, weather and tides. The cycle time from dredging to disposal and back to the dredging site is approximately two to three hours.

The material consists primarily of slightly gravelly sandy mud and sandy mud (defined as coarse silt and very coarse silt using the Folk and Ward classification) within the dock and mud and muddy gravel (defined as medium silt, coarse silt and medium sand using the Folk and Ward classification) in the outer berth/approach channel.

The concentrations of contaminants are presented in *Appendix A*. Samples were taken at nine stations (L01-24 to L09-24) with an additional three samples taken from the L02-24 location in Albert Dock to check if the levels of contamination from metals and PCBs in the original sample were typical of the Albert Dock area.

(1) Best, M (2016). Clearing the Waters for All: WFD guidance for developers and regulators in estuarine and coastal waters. Environment Agency.

The and the results are summarised here.

- The concentrations of metals, except for arsenic were above Action Level 1 in at least one sample and the concentrations of mercury and zinc were above Action Level 2 in one sample (L1-24).
- The concentration of TBT was above Action Level 1 in four of the twelve sample stations and above Action Level 2 in two of the sample stations (L1-24 and L2-24). The concentrations of TBT in the three additional samples collected in Albert Dock (L2A-24, L2B-24 and L2C-24) were below Action Level 2 and for Station L2C-24, below Action Level 1.
- The concentration of PCBs (sum of ICES 7 PCBs) was above Action Level 1 in ten of the twelve sample stations.
- Most of the EPA 16 PAHs were above Action Level 1 in all twelve sample stations.
- No asbestos was recorded.

Sample station L1-24 was from Edinburgh Dock which is not proposed to be dredged by Forth Ports. Station L2-24, plus the additional three stations (L2A-24, L2B-24 and L2C-24) were from Albert Dock.

Available metal and PCB concentration data from sediments sampled in the Narrow Deep spoil ground are presented in *Appendix A*. Concentrations of metals are generally similar or lower and concentrations of PCBs (in the 2015 survey) were slightly higher than those from samples from other spoil disposal sites within the Firth of Forth and Forth Estuary.

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 (1).

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 levels in the upper estuary (2). 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 (3).

The dredged spoil material to be disposed at the Narrow Deep B spoil ground will fall to the seabed 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 (4).

(1)https://www.sepa.org.uk/data-visualisation/water-classification-hub/ Consulted April 2024.
(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

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.

Studies undertaken by FugroEMU (2013a) (1) to measure the suspended sediment concentrations in the sea outside the Outer Berth (with two sample locations about mid-way between the Port of Leith and the Narrow Deep spoil site) showed near bed concentrations of 10-50 mgl^{-1} in calm wave conditions, peaking at between 200-1000 mg l^{-1} during high wave conditions.

Data from Middle Bank in the Firth of Forth during dredging operations in 2008 (2) recorded baseline mean suspended solids concentrations between 8.87 mg l^{-1} and 10.3 mg l^{-1} (mean 9.1 mg l^{-1}), under calm conditions.

Modelling studies were undertaken by Royal Haskoning (2022) (3) of the suspended sediment concentrations of dredge spoil disposal at Narrow Deep from the dredging associated with the development of the new Port of Leith Outer Berth. The Environmental Impact Assessment undertaken for the project concluded that the majority of the dredged material would rapidly descend to the seabed following discharge and that, at the worst case, some dispersion of fine material would take place, extending 3 km along the seabed toward east and west of the disposal location. The peak suspended sediment concentrations would be up to 150 mg l^{-1} but would be short-lived and would only occur at the seabed. Much lower concentrations of suspended sediments were predicted at the surface and mid-water depths. These predicted increases in suspended sediment concentrations were short-lived and would dissipate with tidal currents.

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 (4).

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.

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.

(1) FugroEMU., 2013a. Normal Resolution Survey Report. Port of Leith Marine Ground Investigation. Report to Scottish Enterprise, March 2013.
(2) ERM, 2008. Middle Bank Aggregate Production Licence: Monitoring Report. A report for Westminster Gravels Ltd.
(3) Royal Haskoning DHV. UK Ltd. 2022. Port of Leith Renewable Energy Hub. Environmental Impact Assessment Report. PC2045-RHD-ZZ-XX-RP-EV-0007.
(4) Transport Scotland, 2009. Forth Replacement Crossing: Environmental Statement.

The oxidation of anoxic sediments released into the water column has been shown to reduce oxygen concentrations by up to 58% (1). 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 (2). 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 (5.26% based on the twelve surface samples analysed) and the extent of the area potentially affected.

Although there may be some release of contaminants such as metals, TBT, 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 seabed. Previous 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. All twelve samples had some individual PAHs concentrations above Action Level 1 and these were both LMW and HMW 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 (3).

For the sediment samples analysed from the Port of Leith in 2024, the Ph/An ratios were between 1.94 and 3.05 and the Fl/Py ratios were between 0.48 and 0.95. This suggests

(1) Brown C. 1968. Observations on Dredging and Dissolved Oxygen in a Tidal Waterway. Water Resources Research Vol 4, No 6, p1381.
(2) 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
(3) 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.

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 [(1)]. 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 [(2)]. 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 [(3)].

It is not anticipated that the disposal operation at the Narrow Deep 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.

B1.4 IMPACTS ON BENTHIC ECOLOGY

The benthic macrofaunal communities present in proximity to the Narrow Deep 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 [(4)].

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

(1) 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
(2) Dobson, J., Edwards, A., Hill, A. et al. *Senckenbergiana maritima* (2001) 31: 187. https://doi.org/10.1007/BF03043028
(3) SEPA, 2014. Scottish bathing waters 2013-2014. Available online http://www.sepa.org.uk/media/39125/scottish-bathing-waters-report-2013-2014.pdf
(4) 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

Narrow Deep 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 intermittently for over 55 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 (1) 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 the Port of Leith and the spoil ground for 12 to 16 days per annum, a round trip of approximately 5 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.

Narrow Deep is an established and long-term spoil ground with disposal activities from the Port of Leith 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.

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 (2) 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 Narrow Deep spoil ground. The Forth District Salmon Fishery Board has previously advised that smolts are likely to be passing through the lower Forth

(1) The *Conservation (Natural Habitats, &c.) (EU Exit) (Scotland) (Amendment) Regulations, 2019*.
(2) European Communities (1992) Council Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna.

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} (1). 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) (2). The natural suspended sediment maxima in the Forth system is in the upper Forth Estuary with mean concentrations over forty times higher than in the Firth of Forth (130 mg l^{-1} at Kincardine (3) and average 3 mg l^{-1} at Gunnet Ledge (4)).
- 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. It is noted that the width of the Firth of Forth at the Narrow Deep spoil ground is approximately 9.6 km (5.2 nm) wide. 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 two to three hours over approximately 12 to 16 days per annum. A localised, short-term and non-continuous increase in suspended sediment concentration affecting a small proportion of the width of the Firth of Forth 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 (5), including in areas in Scotland where there have been no dredge spoil disposal operations. Forth Ports' dredge spoil disposal operations have been ongoing at Narrow Deep B for over 55 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 operational requirements at the Port of Leith to maintain the navigation channel at

(1) 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.
(2) 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.
(3) Transport Scotland, 2009. Forth Replacement Crossing: Environmental Statement.
(4) SEPA monitoring buoy data from Gunnet Ledge, Firth of Forth, 2020 data available online from http://www.sepa.org.uk/environment/environmental-data/monitoring-buoys-network/gunnet-ledge/
(5) https://www.britishecologicalsociety.org/understanding-decline-atlantic-salmon-catches-scotland/#:~:text=The%20Scottish%20Government%20has%20collected,the%20previous%205%2Dyear%20average. [accessed June 2024]

all times of the year and the small magnitude of potential effects of disposal operations to migrating salmon smolts, Forth Ports does not consider that any seasonal restrictions to operational requirements to dispose of dredged material at the Narrow Deep B disposal site 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 Narrow Deep B 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 Narrow Deep spoil ground in relation to the available foraging area in the Firth of Forth.
- The intermittent and short duration of disposal activities (three to days every quarter).
- 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 (three to four days every quarter).
- 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).

(1) 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).
(2) https://www.hw.ac.uk/news/articles/2023/river-forth-s-whales-porpoises-dolphins-and.htm [accessed April 2024]

- 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.

TABLE B1.1 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	Narrow Deep is designated as a spoil ground and disposal operations have taken place there for over 55 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 (three to four days every quarter) 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 Narrow Deep B spoil site was designated and have not been impacted by historic and ongoing disposal operations for over 55 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 Narrow Deep B spoil site was designated and have not been impacted by historic and ongoing disposal operations for over 55 years.	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 Narrow Deep B spoil ground but are within the foraging range of species that may utilise both areas.

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 petrochemical 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 [(2)]. Over about the past 55 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 PETROCHEMICALS AND POWER GENERATION

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

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

(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
(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.

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. The historic release of combustion related PAHs from this source will have contributed to the PAH loading within the Forth Estuary and Firth of Forth (1). 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.

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 (2).

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 Leith Docks to Joppa. This Order, implemented in March 2003 and reissued in 2006, still stands (3).

B2.2.4 OTHER DREDGING DISPOSAL ACTIVITIES

In addition to the planned maintenance dredging at the Port of Leith with disposal at the Narrow Deep B spoil ground, Forth Ports manages five other dredging operations within the Forth Estuary and Firth of Forth. The current operations comprise the following.

- Trailer suction dredging in Grangemouth with disposal at Bo'ness spoil ground: maximum capacity for maintenance dredging is 1,700,000 m^3 (1,955,000 wet tonnes) per annum, undertaken over four days every month.
- Grab/backhoe dredging at Newhaven with disposal at Oxcars spoil ground: maximum capacity for maintenance dredging is 15,000 m^3 (19,500 wet tonnes) per annum, undertaken over four weeks per annum.

(1) 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.
(2) 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 .
(3) http://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=8499. Assessed June 2024.

- Trailer suction and grab/backhoe dredging in Rosyth with disposal at Oxcars spoil ground: maximum capacity for maintenance dredging is 400,000 m^3 (520,000 wet tonnes) per annum, undertaken over three days per month, every other month.
- Grab/backhoe dredger at Methil harbour and approach channel with disposal at Methil spoil ground: maximum quantity of disposed material is 12,500 m^3 (17,500 wet tonnes) per annum.
- Grab dredger and plough at Kirkcaldy with disposal at Kirkcaldy spoil ground: maintenance dredging of approximately 5,000 m^3 undertaken annually.

In addition to these current licences, Forth Ports has submitted a Marine Licence application for maintenance dredging at Granton (see below for recent activity in Granton undertaken by the Royal Forth Yacht Club) from 2024 to 2027.

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 (1) (although this has not been undertaken annually), with disposal at Bo'ness spoil ground.
- Dredging of up to 33,800 wet tonnes using a plough dredger at Port Edgar within the confines of the marina between April 2021 and February 2024 with disposal to the entrance to the marina.
- Capital dredging and sea disposal of 225,000 wet 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.

(1) Rosyth International Container Terminal. Operational In-combination Assessment of Maintenance Dredging and Implications for the River Teith SAC. Jacobs, 2011.

- 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.

B2.2.5 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. The information provided below is based on the companies' and the Marine Directorate 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 at Methil connected to the land by a ramp. It is located approximately 15 km from the Kirkcaldy disposal site. 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 6 MW 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 the Marine Directorate 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 Narrow Deep B spoil ground (circa 60 to 100 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.

(1) Hochtief (UK) Construction (2016). Forth Road Bridge Replacement - Queensferry Crossing. Available online http://www.hochtief-construction.co.uk/bridges_Forth_Road.shtml
(2) https://marine.gov.scot/ml/levenmouth-demonstration-turbine [consulted April 2024]
(3) https://ore.catapult.org.uk/stories/ore-catapults-levenmouth-demonstration-turbine-2/ [consulted April 2024]
(4) https://forthwind.co.uk/ [consulted April 2024]
(5) https://marine.gov.scot/ml/scoping-forthwind-offshore-wind-demonstration-project-methil-firth-forth [April 2024]

- Neart na Gaoithe Offshore Wind Farm (1)

  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. It is being developed by EDF and ESB. 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 (2)

  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 via an 85 km cable to a new substation at Cockenzie. In October 2023 onshore enabling works were completed and the main civil engineering works commenced in early 2024. 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 (3)

  Scottish and Southern Electric (SSE) Renewables and TotalEnergies 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 became fully operational in October 2023 with the power exported 19 km by cable to Carnoustie in Angus. Montrose port is the location of the operations and maintenance base. A further phase of 36 turbines is planed with the export cable going to Cockenzie.

B2.3 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 Narrow Deep B spoil

(1) https://nngoffshorewind.com/project/ [consulted April 2024]
(2) https://www.inchcapewind.com/ [consulted April 2024]
(3) https://www.seagreenwindenergy.com/ [consulted April 2024]

ground and no cumulative impacts from suspended sediments and other vessel movements are considered likely.

The dredge spoil disposal operations at the Narrow Deep B spoil ground pre-date the SPA and SAC designations and there is no evidence to suggest that the past and current disposal operations at the Port of Leith 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 new developments within the Firth of Forth are likely to be subject to assessment of significant environmental effects through the appropriate consenting processes.

APPENDIX C SUMMARY OF CONSULTEE RESPONSES

C1 EXTRACTS FROM LETTERS/EMAILS RECEIVED

1 CROWN ESTATE

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.

Peter Galloway, Bidwells, on behalf of the Crown Estate

2 NATURESCOT

Our advice remains similar to previous years in that we are not aware of any current beneficial reuse options and have no specific issues to raise regarding the use of Narrow Deep spoil ground.

In terms of relevant information, the disposal ground does lie within the Outer Firth of Forth and St Andrew's Bay Complex SPA. Details of the SPA, including the Conservation and Management Advice, is available on our website here: https://sitelink.nature.scot/home. The Conservation and Management Advice contains a section on marine activities, including dredging, and site pressures (see page 29 for example). This does not change our advice above but is worth being aware of.

Carolyn Clark |Operations Officer – South, NatureScot

3 NORTHERN LIGHTHOUSE BOARD

Thank you for your e-mail correspondence dated 6th March 2024 regarding the proposal by Forth Ports Ltd for maintenance dredging and disposal operations at Port of Leith, Firth of Forth.

We note that the works are for a three-year period and focus on maintaining safe navigable water depth within the harbour, including the new outer berth pocket.

Northern Lighthouse Board has no objections to the proposed dredging and/ or disposal of dredged spoil to the charted and approved spoil ground at Narrow Deep, 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 advises the UK Hydrographic Office (sdr@ukho.gov.uk) of any revised water depths in order that chart updates are completed.

Peter Douglas, Navigation Manager, NLB Navigation, Edinburgh

ERM HAS OVER 160 OFFICES ACROSS THE FOLLOWING COUNTRIES AND TERRITORIES WORLDWIDE

Argentina
Australia
Belgium
Brazil
Canada
China
Colombia
France
Germany
Ghana
Guyana
Hong Kong
India
Indonesia
Ireland
Italy
Japan
Kazakhstan
Kenya
Malaysia
Mexico
Mozambique
The Netherlands
New Zealand
Peru
Poland
Portugal
Romania
Senegal
Singapore
South Africa
South Korea
Spain
Switzerland
Taiwan
Tanzania
Thailand
UAE
UK
US
Vietnam

ERM's Edinburgh Office

6th Floor
102 West Port
Edinburgh
EH3 9DN

T: 0131 221 6750

www.erm.com