



FORTH PORTS

Port of Dundee Capital Dredge and Disposal: Marine Licence Application

Best Practicable Environmental Option
Report

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1. INTRODUCTION

1.1 Background

This report has been prepared by Environmental Resources Management Ltd (ERM) on behalf of Forth Ports Ltd (Forth Ports) in support of a Marine Licence application for dredging and disposal of dredged material at sea. It compares various options for the disposal of dredge material and identifies the Best Practicable Environmental Option (BPEO).

Under the *Marine (Scotland) Act 2010, Section 21(1)*, a Marine Licence issued by Marine Scotland is required for the dredging and the deposit of substances or objects within waters adjacent to Scotland. Under Part 4, Section 27(2), Marine Scotland has an obligation to consider the availability of practical alternatives when considering applications involving disposal of material at sea. Applications for a Marine Licence to dispose of dredged spoil at sea require a BPEO 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.

Marine Licences for these activities are currently valid in Scotland for up to three years ⁽¹⁾. This application is expected to cover the period from December 2019 to December 2022.

1.2 The Need for Dredging and Spoil Disposal

The Port of Dundee is located on the north bank of the Firth of Tay, immediately adjacent to Dundee, and has been owned by Forth Ports since 1995. The port comprises a number of vessel berths, wharves and jetties running east from the Tay Road Bridge for approximately 2.8 km. As confirmed by Forth Ports ⁽²⁾, the port currently has an average of 746 vessel movements per annum.

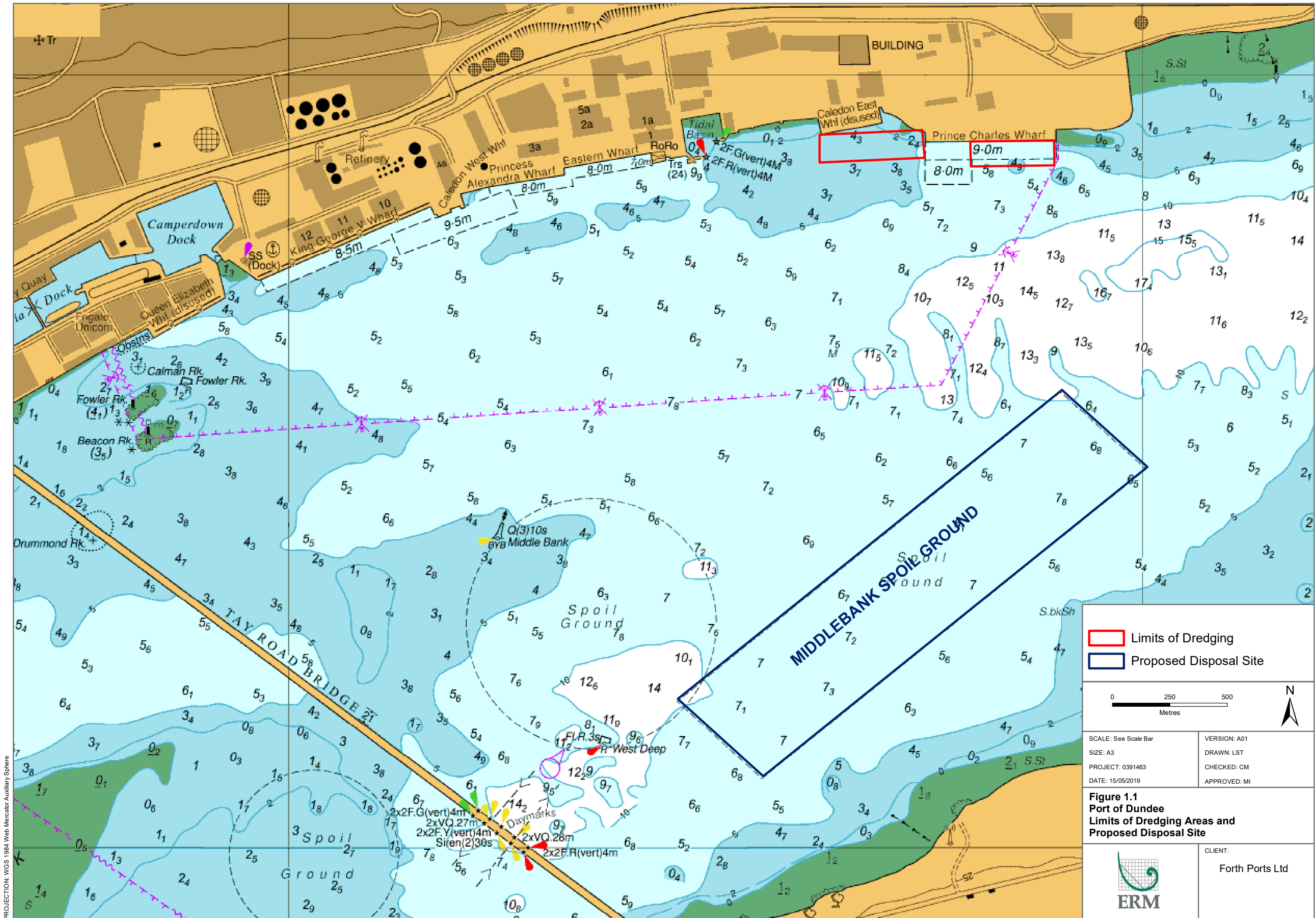
Forth Ports currently has a disposal licence for sea disposal of maintenance dredge material from the port. Forth Ports now wishes to apply for a marine licence for proposed capital dredge and disposal of material from the deepening of two wharves.

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 Dundee by increasing the depth within two wharves in the Port of Dundee: Caledon East Wharf and Prince Charles Wharf. The later wharf has been extended with an upgraded quay wall. As with the dredge spoil from the ongoing maintenance dredge, it is proposed that the dredged material resulting from the capital dredging will be disposed of at sea at the licenced marine disposal site at Middle Bank. *Figure 1.1* shows the proposed dredging area and disposal site.

Should Forth Ports consider the "Do Nothing" approach, and not undertake the capital dredging operations, the Port of Dundee would not be able to accommodate larger vessels associated with the offshore wind, and oil and gas industries. Without the ability to accommodate larger vessels, Forth Ports would not be able to service these industries as effectively as they require, for example, to ship in parts of offshore wind farm construction operation or decommissioning of oil and gas platforms.

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

(2) Bruce Pybus, Conservancy Manager, Forth Ports Lt, pers comm September 2019



1.3 Previous Maintenance Dredge Spoil Disposal Activities

In the early 1980s, spoil from maintenance dredging was deposited immediately upstream of the Tay Road Bridge. Subsequently, and during the 1990s, maintenance dredging and sea disposal was conducted by the *Abbotsgrange*, a trailer suction dredger owned by Forth Ports. This vessel could not pass under the Tay Bridge and therefore a new spoil ground was selected approximately 0.5 km downstream of the bridge (shown in *Figure 1.1*). The schedule of ongoing maintenance dredging activities was modified to a short period (typically three to six days) in early summer rather than dredging and depositing regular, smaller volumes throughout the year.

Since January 2001, Forth Ports has contracted United Kingdom Dredging (UKD) for the majority of operations within the Firth of Tay and Firth of Forth. The *UKD Marlin* is a trailing suction dredger with a hopper capacity of 3,000 m³. In 2017 ERM undertook a BPEO on behalf of Forth Ports to support the application for a maintenance dredge spoil disposal within the port of Dundee. Marine Scotland granted Forth ports a Marine Licence for the disposal of up to 100,000 m³ sediment in November 2017. The spoil is disposed of at Middle Bank disposal site, which was determined by the BPEO to be the best option for disposal.

1.4 Proposed Dredging and Disposal Operations

Forth Ports wishes to apply for a licence from Marine Scotland for the dredging and disposal of a maximum of 75,000 m³ of dredged material as part of a capital dredge within Caledon East Wharf and Prince Charles Wharf. This dredge would reduce the depth within the wharves to 9.5 m and 10 m below Chart Datum respectively and is required to ensure compliance with safe vessel berthing for larger vessels in support of the offshore wind and oil and gas industries. The proposed dredging schedule will be dependent on the licence award date, dredger availability and construction periods. The length of the campaign will be largely dependent on when the dredger is available, and it is possible that dredging could take place at different times depending on the work required to create the berths.

The proposed dredging operations are expected to be undertaken using a trailer, backhoe and/or plough dredger. The boundary co-ordinates of the proposed dredge area shown in *Figure 1.1* are presented in *Table 1.1*.

Table 1.1 Co-ordinates of Proposed Dredge Sites at Port of Dundee

Node	Latitude	Longitude
Caledon East Wharf		
A	56° 27.920917' N	2° 55.757045' W
B	56° 27.927438' N	2° 55.513905' W
C	56° 27.892444' N	2° 55.510845' W
D	56° 27.885922' N	2° 55.753980' W
Prince Charles Wharf.		
A	56° 27.914266' N	2° 55.403498' W
B	56° 27.915719' N	2° 55.207802' W
C	56° 27.883381' N	2° 55.207019' W
D	56° 27.881928' N	2° 55.402712' W

Coordinates in WGS84, UTM Zone 30N, degrees decimal minutes

For the proposed capital dredge at the Port of Dundee, Forth Ports proposes to use the Middle Bank spoil ground, located approximately 0.6 nautical miles from Dundee. This is the site that has been used for disposal of dredge spoil from the Port of Dundee since 1994, is not used by any other parties and is the site closest to the port, therefore minimising the travel distance for dredging vessel transport.

The water depth within the Middle Bank disposal site ranges from 6 to 9 m below CD and sampling undertaken for the Port of Dundee expansion EIA scoping report (2013) indicated that sediment at

Middle Bank comprise sand ⁽¹⁾. The boundary co-ordinates of the Middle Bank disposal site shown in *Figure 1.1* are presented in *Table 1.2*.

Table 1.2 Coordinates of Middle Bank Disposal Site

Node	Latitude	Longitude
1	56° 27.59' N	002° 55.19' W
2	56° 27.49' N	002° 54.99' W
3	56° 27.09' N	002° 55.89' W
4	56° 27.19' N	002° 56 09' W

All coordinates in WGS84, UTM 30N, degrees decimal minutes

1.5 Description of Sediment to be Dredged and Disposed

In line with Marine Scotland guidelines on pre-dredge sampling protocol ⁽²⁾, a survey programme was undertaken between 24th and 28th June 2019 to sample the sediments within Caledon East Wharf and Prince Charles Wharf.

Samples were taken at five stations using a Dando 2000 light cable percussion boring rig to a maximum depth of five metres and one surface sample was taken using a van-Veen grab.

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

- asbestos;
- metals (As, Cd, Cr, Cu, Hg, Ni, PB, Zn);
- TBT;
- PAHs;
- PCBs;
- presence of asbestos;
- sediment solids/water content; and
- sediment particle size distribution.

The physico-chemical analysis is presented in *Appendix A*.

The sediment comprises of sandy silt and silty sand with some samples presenting gravel fractions.

There are elevated concentrations of some metals and PAHs within the dredged material above Action Level 1, consistent with historic industrial discharges to the Firth of Tay (refer to *Table 3.2* for comparison of data from the Port of Dundee). No samples recorded concentrations of contaminants above Marine Scotland Action Level 2 ⁽³⁾.

Historic sediment analysis data from Middle Bank disposal site is presented in *Appendix A*.

1.6 Scope of the Study

This report provides an appraisal of available disposal options and short-lists those that are considered to be practicable. Options are reviewed according to the Waste Hierarchy, as outlined in the European Waste Framework Directive (2008/98/EC) ⁽⁴⁾. The options on the short-list are then

(1) Haskoning UK Ltd, 2013. Port of Dundee Expansion and Marine Aggregate Extraction EIA Scoping Report and HRA Screening Report. Report for Scottish Enterprise.

(2) 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>

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

(4) Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. Available online: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098>

reviewed against strategic, environmental and cost considerations. The options are 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 disposal options.
- *Section 5* identifies the BPEO.

Further supporting information is provided in the three Appendixes.

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

2. BPEO ASSESSMENT METHOD

2.1 Introduction

The BPEO study was undertaken using the following method.

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

Information was obtained through literature review and consultation with the following consultees.

- Forth Ports Ltd;
- Marine Scotland;
- The Crown Estate;
- Scottish Environment Protection Agency (SEPA);
- Northern Lighthouse Board (NLB);
- Tay District Salmon Fisheries Board;
- Scottish Natural Heritage (SNH);
- Dundee City Council; and
- Maritime and Coastguard Agency (MCA).

2.2 Identification of Options

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

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

2.3 Preliminary Appraisal

A preliminary appraisal of each of the options identified above was undertaken, including an assessment of the practicability of each option with regard to availability of disposal sites. Following the preliminary appraisal those options that are considered to be 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.

- Operational practicability - focusing on whether the option is technically and operationally practicable.
- Availability of sites/facilities - considering whether there are any sites or facilities which can take the dredge spoil.
- Security of option - examining whether Forth Ports will have control over all stages of the disposal.
- Established practice - considering 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 - gauging whether the public are likely to object to or support the proposals.
- Likely agency acceptability - gauging whether public agencies are likely to have any major concerns when consulted on the Marine Licence application.
- Legislative implications - assessing compliance with relevant legislation and the potential management control required.

2.4.2 Health, Safety and Environmental Considerations

The factors used to assess the health, safety and environmental performance of the options are summarised below.

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

2.4.3 Cost Considerations

Cost of disposing of dredged material was considered in terms of the following.

- Capital cost (site costs, construction and equipment hire /purchase costs).

- Maintenance/operational cost (transport costs, 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) were also used where the assessment was 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			
Operational Feasibility	Practical, easy to operate and achievable as process is robust and established. 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 (over 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 clearly established with no foreseeable significant problems.	Technology and techniques have been tested but not applied to dredge material.	Technologies and techniques are untested and unforeseen problems are likely.
General Public Acceptability	Likely to be generally acceptable to the public based on reaction to similar developments.	Unlikely to provoke a strong negative or positive reaction based on reaction to similar developments.	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.	Statutory bodies may have major concerns that may not be overcome through consultation.
Legislative Implications	Would easily comply with legislation with a low level of management and physical control.	Requires some control/intervention to achieve compliance.	Requires a high level of management control and intervention to achieve compliance.
Health, Safety and Environmental Considerations			
Safety	No significant risk to workers and the general public.	Low risk to workers and the general public which is easily controlled.	Moderate to high risk to workers and general public.
Public Health	Will not cause workers or public to be exposed to substances potentially hazardous to health.	May cause some low level intermittent exposure to substances potentially hazardous to health.	Risk of exposing workers and general public to substances potentially hazardous to health.
Pollution/Contamination	Compliant with emission standards and water quality objectives. Low risk of harm from substances released to environment.	Environmental quality standards may be approached or breached occasionally. Some risk of harm to environment.	Environmental quality standards may be breached regularly and there is a moderate or high risk of harm to environment.

Consideration	High	Medium	Low
Ecological Impact	Priority species and habitats under the UK Biodiversity Action Plan and qualifying features and species under the EU Habitats and Birds Directives will not be affected.	Priority species and habitats under the UK Biodiversity Action Plan and qualifying features and species under the EU Habitats and Birds Directives may be slightly affected.	Priority species and habitats under the UK Biodiversity Action Plan and qualifying features and species under the EU Habitats and Birds Directive are likely to be significantly affected.
Interference with other Legitimate Activities	Little potential for interference with other activities.	Some potential for interference with other activities.	High potential for interference with other activities.
Amenity/Aesthetic	No significant impact on local amenity or aesthetic qualities.	Potential for impacts of moderate significance on local amenity or aesthetic qualities.	Potential for impacts of high significance on local amenity or aesthetic qualities.
Cost			
Capital and maintenance	£0.5m or less.	Between £0.5m and £2.5m.	More than £2.5m.

3. PRELIMINARY ASSESSMENT OF AVAILABLE DISPOSAL OPTIONS

3.1 Introduction

This section describes the seven identified disposal options, reviewing the steps required for each option, namely:

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

A description of the predicted impacts of the disposal operations is presented in *Appendix B* and copies of significant correspondence are provided in *Appendix C*.

The identified disposal options are described and issues and requirements associated with each option are discussed below. The section concludes by identifying those options that are short-listed for further consideration in the BPEO process.

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.

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/top soil production).

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

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

These steps are described below along with some discussion of the practicalities of undertaking these steps at the Port of Dundee.

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. Suitable facilities, including storage, may be available within the port area, dependent on the current requirements of port operations.

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 construction 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 rather than a liquid. The contents of the dredger are likely to average 85% solids (by volume).

There are three approaches that are typically used for drying marine sediments: construction of settling lagoons, use of a mobile centrifuge unit and filter press as described below.

Settling Lagoons

Settling lagoons are likely to be 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 and the water drained out under gravity. The lagoons would have a drainage system to collect the water and watery sludge from the dredged material for further treatment (usually by hydrocyclone) or to be transported offsite for disposal. The lagoons must be of sufficient size to contain the dredged material prior to transport. They must also be accessible by road and must have facilities to load the dredged material into tankers or sealed heavy goods vehicles (HGVs) for movement to the disposal/treatment centre. To minimise the distance the wet dredge material has to be transported from the dredger they must be located near the quayside.

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)*. Forth Ports advise that the potential to be able to find appropriate space to create lagoons close to the port is considered to be low. Furthermore, as the material contains metals, PAHs and TBT (see *Appendix A* for sample analysis data) it might be additionally necessary to construct the lagoons with special liners to retain the contaminants and consider treatment of the supernatant water draining out of the lagoons.

Centrifuge or Hydrocyclone System

The use of a centrifuge or hydrocyclone system to dewater the material to a level suitable for disposal to landfill (approximately 10% water content) may be required, depending on the final water content of the recovered material. One mobile unit system was reported as being capable of treating up to 150 m³hr⁻¹ depending on unit size and material solids content. Other systems may be available that can process material at different rates, however, for the purposes of this assessment a rate of 150 m³ hr⁻¹ has been used. This is typically only an option for firmer sediments made up of fine sands and muds, such as those from stations BH02 (at 5m) and BH03 (at 1.5m) at the Port of Dundee. If material can be dried at a rate of 150 m³ hr⁻¹, to dewater a total volume of approximately 75,000 m³ would require approximately 500 hours. Other units with lower throughputs could take longer.

Filter Press

A filter press is a tool used to separate solids and liquids using the principle of pressure. The press is filled with the 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. This drying process achieves the best level of dryness of the three options, however, can take significantly longer than using a centrifuge and is considerably more expensive than either of the other two options.

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 treatment/disposal sites. The required infrastructure would include hard standing to allow a fleet of HGVs to be loaded by mechanical excavators. Although hard standing is available at the Port of Dundee, there are no storage or dewatering sites adjacent to the possible loading area.

Assuming the materials can be dried to a water content of 10% (by volume) at the Port of Dundee, the estimated 70,125 m³ ⁽¹⁾ of dried materials would require transport for disposal, either to an incinerator, to agricultural land, to landfill or to a reclamation project. The length of journey required would depend on the location of the deposit/incineration sites.

A volume of 70,125 m³ of dried (to 10% water content) material equates to approximately 84,150 tonnes ⁽²⁾. Assuming 20 tonne capacity sealed HGVs are used, this would equate to 4,475 return trips or 8,950 vehicle movements.

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 Dundee exits onto the trunk road network where the HGV count is estimated as 226,300 per year (averaged 2016 data ⁽³⁾). The additional HGV movements as a result of the dredging operations would increase this current level by approximately 4% per 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.

3.2.5 Disposal/Treatment Issues

Neither method of the drying process (e.g. lagoons or centrifuge) is likely to reduce the concentration of PCBs, PAHs, metals, TBT and salt present within the dredged material. This may restrict disposal and reuse options and as the material has elevated levels of some contaminants, pre-treatment may be required prior to disposal on land. In line with the Environment Agency Technical Guidance it is considered likely that the dredged material would be classed as non-hazardous, however, confirmation of this would require further analysis of the material by SEPA.

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.

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 harbour for disposal on land it will be classed as waste. It then requires disposal at a licensed waste management facility and to be transported by a registered waste carrier. Alternatively, the material could be disposed of under an activity which was exempt from waste licencing (e.g. the treatment of land for agricultural benefit or ecological improvement), which would require approval from SEPA.

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.

(1) 75,000 m³ total spoil at 85% solids content equals 63,750 m³ plus 6,375 m³ (10% water content) equals 70,125 m³.

(2) Based on a weight of 1.2 tonnes per m³ of dredge spoil

(3) Traffic counts Scotland. Data for the A92 outside the Port of Dundee. <https://roadtraffic.dft.gov.uk/manualcountpoints/40858> Accessed 22/05/2019

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 fine material with gravel present in some samples. The sediment from the Port of Dundee is not suitable for beach recharge due to the particle size distribution and the presence of contaminants such as metals, including TBT, and organics (PAHs and PCBs). SNH have also confirmed that it would only be appropriate to use material on a beach of similar substrate and provided contaminant levels were not of concern.

Montrose Bay is currently undergoing a beach recharge, however, as confirmed by Scottish Natural Heritage (SNH) the dredged material will be too fine grained and incompatible with the sandy beach sediments at the receiving site. Furthermore, given the presence of contaminants in the material to be dredged and the conservation status of the Firth Tay and Eden Estuary, beach nourishment is not likely to be a feasible option.

3.4 Coastal Reclamation and Construction Fill

3.4.1 Process Description

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

3.4.2 Suitable Sites for Reclamation

Forth Ports, Marine Scotland and Dundee City Council are the most likely bodies to be responsible for or aware of reclamation projects in the Tay. No sites for coastal reclamation have been identified through the consultation process as requiring any of the dredged material. In addition, the dredged material would not be suitable for many reclamation sites due to the low compressive strength properties of mud. The spoil could be pumped into bunded lagoons at the edge of the Firth of Tay to create land that could be used for development, agricultural or similar purposes. This is unlikely to be acceptable to SNH due to the potential impact on designated areas in the Firth of Tay and Eden Estuary.

3.4.3 Construction Material

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

3.5 Spreading on Agricultural Land

3.5.1 Process Description

It is possible to obtain an exemption from waste management licencing for treatment of land, usually by land spreading, with certain non-agricultural wastes such as paper waste, food waste or sewage sludge. The disposal of marine spoil to agricultural land would involve landing, dewatering, possibly storage, desalination and transport for disposal.

Dewatering the dredged material in lagoons or in a centrifugal drier would remove some of the salt; however it is likely that 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 Tay.

The material to be dredged has concentrations of metals, but these are generally lower ⁽¹⁾ than the average content in sewage sludge which is presently spread on land. This is based on Scottish Agricultural College data as provided in Table 3.1 and concentrations of metals in the Port of Dundee sediments in Table 3.2

Table 3.1 Typical Concentrations of Metals in Sewage Sludge Applications to Land

	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Typical Sewage Sludge metal concentration (mgkg ⁻¹)	3	55	300	2.2	30	270	630
Normal soil concentration	0.5	50	20	0.1	25	20	80
UK max allowable soil concentration (mgkg ⁻¹)	3	400	100	1	60	300	200
Number of applications to reach limit value -(assuming 5t/ha dry weight solids)	500	3818	160	245	700	553	113

Key: Cd = Cadmium, Cr = Chromium, Cu = Copper, Hg = Mercury, Ni = Nickel, Pb = Lead, Zn = Zinc.

Source: Scottish Agricultural College, Technical Note – Use of Sewage Sludge on Agricultural Land, 1997.

Table 3.2 compares metal concentrations in the dredged material from previous sampling efforts in the Port of Dundee.

Table 3.2 Comparison of Concentrations of Metals in the Port of Dundee sediment (1989 – 2019)

Metal Concentration (expressed as mg kg⁻¹ on air dried sediment)								
	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Dundee 2019								
Mean	8.6	0.2	40.0	39.6	0.1	37.1	28.3	135.4
Range	3.1-14.5	0.08-0.38	25.4-59.6	15.8-128.0	0.05-0.91	19.4-70.9	6.4-190.0	47.5-569.0
Dundee 1989 – 2017								
Mean	8.9	0.2	38.3	30.8	0.4	30.1	54.0	125.8
Range	0.4-22.8	0.0-0.7	2.7-91.0	8.8-82.9	0.0-13.6	13.7-159.0	4.1-501.0	22.1-508.0

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

The data from the 2019 Port of Dundee survey shows all metal concentration samples to be similar to those previously collected data from the Port of Dundee. Due to the historical presence of PCBs, the spoil cannot be applied to land without confirmation from SEPA that levels of these contaminants are acceptable.

Approximately 200,000 tonnes of sludge are recycled to agricultural land per annum across Scotland. Forth Ports are seeking to dispose of approximately 70,125 m³ of dewatered material (approximately 84,150 tonnes at 1.2 tonnes m⁻³) of dried material equating to approximately 42% of the current volume of annually recycled sludge in Scotland.

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

(1) With the exception of nickel, which was higher on average in the dredged material than in sewage sludge.

(Scotland) Regulations 2011, and the activity would therefore require to be licensed. Planning permission would be required from the local authority and a waste management licence would be required from SEPA. 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.

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 above it is understood that the waste would be classified as non-hazardous and therefore a suitably licensed landfill site with sufficient capacity is required.

3.6.2 Available Landfill Sites

Subsequent to implementation of the Landfill Allowance Scheme (Scotland) Regulations 2005 and re-evaluation of landfill licences, there is currently one site within an hour's drive from the Port of Dundee with the facilities to accept the material. Fife Council landfill site in Cupar, approximately 15 miles south of Dundee, has the capability to accept non-hazardous material, although not the volume required and this site is due to close in January 2020 ⁽¹⁾.

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.

As The Crown Estate owns part of the seabed in the proposed dredging area, royalties will be due to The Crown Estate. The value of the Royalties are not currently known.

Costs are based on disposing of the maximum volume of dredged material being applied for in this Marine Licence; in this case, approximately 67,500 m³.

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 average organic content of the dredged material is 1.4% 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 by only 11.4% *i.e.*, 1.4% organics plus 10% water content. Incinerator operators generally require material to have an organic content above 20% to ensure efficient combustion and would most likely reject material with an organic content below this threshold ⁽²⁾.

A further consideration is that the material to be dredged contains metals, PAHs, TBT and PCBs. In a typical thermal desorption incineration process it is likely that PCBs, salt and most of the mercury (around 80%) would be removed. In addition, the leaching potential of other metals would be reduced (except for arsenic) and as a result, the ash would still be contaminated. Pre-treatment would be

(1) SEPA Landfill sites and capacity report for Scotland, 2018.

(2) Baldovie Waste to Energy Plant, pers comm, January 2014

required for the removal of metals. Emissions to atmosphere from the incineration processes would also require to be controlled by SEPA under the *Environmental Protection Act 1990*.

3.7.2 Available Incinerator Sites

There are no appropriate waste incinerators in Scotland that could accept the dredged material. The nearest incinerator is at Ellesmere Port, Merseyside (approximately 310 miles south) and transport would be costly and is unlikely to be practicable.

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 top soil production processes.

3.8.1 Re-injection

This would involve the construction of a pipeline to take the dredged material to a high tide point on the Tentsmuir sandflats (the closest to the Port of Dundee) and injecting it at velocity back into the sandflats. The advantage of this is that it effectively keeps the sediment within the sediment cell. The disadvantage is that the re-injection at velocity would be likely to have an adverse impact on the protected sandflat habitat through disturbance and erosion and may affect the haul out behaviour of seals using the sandflats.

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. Previous consultations between Forth Ports and a brick making factory confirmed that the mineralogy of the material would not be appropriate for brick making and the contamination by salt would be unacceptable for any construction material.

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. The best topsoil is a mixture of sand, silt, clay and organic matter and must be clean for use in the production of food crops ⁽¹⁾. This option would not be feasible at the Port of Dundee due to lack of necessary handling facilities and the potential contamination levels in the dredged spoil. In addition, there is no known demand for this material to be used in top soil production.

3.9 Disposal to Sea

3.9.1 Process Description

Disposal at sea involves the dredge material being transported to a licensed disposal site in a dredging vessel. This approach takes place at sea and does not require the landing of any materials. Historic maintenance dredging has taken place at Dundee Docks prior to Forth Ports taking over operations in 1992. The dredge material from these operations has been, and currently is, disposed of at the Middle Bank disposal site. Forth Ports have used the *UKD Marlin* since 2001 to dredge the dock areas and have discharged the material by bottom dumping at the Middle Bank disposal site.

There is currently only one licenced marine disposal site in the Firth of Tay; Middle Bank. Six further spoil sites have been licenced in the past (Horseshoe Buoy, Firth of Tay B, Firth of Tay E, Tay Bridge, Invergowrie A and Invergowrie B) but are not currently used or licenced. For the dredging operations at the Port of Dundee, Forth Ports would propose to use the Middle Bank disposal site approximately

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

0.6 nautical miles from the Port of Dundee. This is the closest site to the harbour thus minimising the distance for vessel transport.

The baseline environmental conditions and potential environmental impacts at the disposal site are described in *Appendix B*.

Forth Ports proposes to use a trailer, backhoe and/or trailer dredger to undertake the dredging, depositing the material at the Middle Bank disposal site. The time required for one cycle (dredging - travelling - discharging - travelling) is approximately one hour.

A differential global positioning system (dGPS) would be used to position the vessel in the disposal area and records of the spoil discharge locations would be retained.

3.10 Conclusion

The description of the available options allows options that are evidently impracticable to be ruled out. This is summarised in *Table 3.3*. The assessment of the short-listed options taken forward for further consideration is presented in *Section 4*.

Table 3.3 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 Firth of Tay and there are no beaches within the Firth of Tay 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. 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 is practicable and there is one local site within one hour's drive. There are a large number of steps involved in storage, dewatering and transport. Landfill site operators may be unwilling to accept the material due to the sediment composition. The landfill site at Cupar would not be able to accommodate all of the dredged material and is due for closure in January 2020.	Discard
Incineration	This option does not appear to be practicable. The material is not suited to incineration due to low organic content and large volume of spoil involved. 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 top soil production.	Short-list
Disposal at Sea	This option is practicable and has been the BPEO for previous dredging campaigns at the Port of Dundee.	Short-list

4. ASSESSMENT OF SHORT-LISTED DISPOSAL OPTIONS

4.1 INTRODUCTION

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

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

4.2 COASTAL RECLAMATION AND CONSTRUCTION FILL

4.2.1 *Strategic Considerations*

Operational Feasibility

The reuse of the dredged material for reclamation will involve either direct pumping from the dredger into the disposal site or drying the material and desalination for disposal on land. This option would be achievable if disposal sites were available adjacent to the Firth of Tay. As no sites 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⁾. Furthermore, the materials would require landing, drying, storing and transporting to the disposal site.

Classification: Medium

Availability of Sites

No coastal sites within the Firth of Tay have been identified at this time through consultations with the City of Dundee Council. No landfill sites in the vicinity of the Port of Dundee have been identified as able to accept the material as capping material or for reinstatement purposes.

Classification: Low

Security of Option

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

Classification: Low to Medium

Established Practice

The use of suitable dredged materials in coastal reclamation and construction fill is common practice and the technologies and techniques are well established.

Classification: High

General Public Acceptability

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

Classification: Medium to High

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

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

Classification: Medium to High

Legislative Implications

The disposal of dredged material from Dundee directly from the dredger to a reclamation site requires a Marine Licence from Marine Scotland under Section 20(1) of the Marine (Scotland) Act 2010. Once landed, the dredged material would be defined as controlled waste under Schedule 3 of the Controlled Waste (Scotland) Regulations 1992. As such, Section 34(7) of the Environmental Protection Act 1990 and Section 1 of the Control of Pollution Act 1974 would apply.

The disposal of dredged material will also require a waste management licence under the Waste Management Licensing Regulations 1994 and an exemption for reclamation works. Consent will be required from the planning authority and a levy paid to The Crown Estate (see *Section 3.6.3*).

Classification: Medium

4.2.2 Health, Safety and Environmental Considerations

Safety

Pumping 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

Public Health

No risks to public health are anticipated due to the short-term increase in HGV traffic.

Classification: Medium to High

Pollution / Contamination

The material is considered non-hazardous due to the levels of PCBs and metals and would therefore be suitable for disposal of in reclamation or construction fill. There may be localised and temporary deterioration in air quality as a result of HGV movements.

Classification: Medium to High

Ecological Impacts

There are unlikely to be any ecological risks resulting from the use of dredged materials for reclamation and there would be no impact on national or local priority species or habitats.

Classification: High

Interference with Other Legitimate Activities

The disposal of dredged material is unlikely to interfere with other activities unless the reclamation site is in the port area, 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.

Classification: Medium to High

Amenity/Aesthetic

If the dredged material is disposed of directly from the dredger there is no risk 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. If the dredged material was transported by road, the estimated costs below would apply.

- discharge berth: over £2 m;
- pumping material to site – approximately £8.75 per m³ ⁽¹⁾ £656,250; or
- dockside centrifuge facility capable of dewatering and desalinating 75,000 m³: £7.5 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⁾: £420,750.

Total £2.66 m to £10.58 m

Classification: Low

4.3 OTHER DISPOSAL OPTIONS AND REUSE

4.3.1 Strategic Considerations

Operational Feasibility

Reuse for brick making, concrete aggregate or top soil production would require the landing, storage and drying of the dredged materials prior to transporting to a landfill facility. Approximately 84,150 tonnes of dried material would require transport. There are practical difficulties relating to handling the dredged material at the Newhaven site. The availability of suitable factories/facilities to process the dredged material and markets for the final products are also considerations.

Classification: Low to Medium

Availability of Sites/Facilities

There are no known sites or facilities to receive the dredged material for other uses such as top soil production or brick making.

Classification: Low

Security of Option

Although Forth Ports would have control over the dredging and landing, they would not have control over the continued acceptance of the materials for making bricks or aggregate.

Classification: Low to Medium

Established Practice

Use of excavated materials for brick making or concrete aggregate is common practice but use of marine material is not and it is generally not feasible due to the level of salinity and the composition of the material. Whilst top soil has been made from dredged material in the past it is not common practice.

Classification: Low to Medium

(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.

General Public Acceptability

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

Classification: Medium to High

Likely Agency Acceptability

It is likely that brick making, concrete production and top soil production would be acceptable to agencies and considered a positive activity.

Classification: High

Legislative Implications

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

Classification: Medium

4.3.2 Health, Safety and Environmental Considerations

Safety

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

Classification: Medium

Public Health

Low risks to public health are anticipated due to the short-term increase in HGV traffic.

Classification: Medium to High

Pollution / Contamination

Pollution is not likely to be an issue provided emissions are controlled in accordance with licences.

Classification: Medium to High

Ecological Impacts

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

Classification: High

Interference with Other Legitimate Activities

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

Classification: Medium

Amenity/Aesthetic

The only impacts on amenity are likely to stem from the impact of HGVs from transporting the material.

Classification: Medium to High

4.3.3 Cost Considerations

An estimate of costs is provided below.

Capital would be required to purchase new equipment. Estimates of the cost of this equipment are:

- discharge berth for the dredger with a storage facility: over £2 m;
- lagoons to settle dredged material: £2.5m; or
- dockside centrifuge facility capable of dewatering and desalinating 75,000 m³: £7.5 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⁾: £420,750.

Total - £4.92 m to £9.92 m

Classification: Low

4.4 SEA DISPOSAL

4.4.1 Strategic Considerations

Operational Feasibility

Operationally disposal at the Middle Bank 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 Dundee, it has been proven as practicable and all the necessary procedures are understood and logistical arrangements in place.

Classification: High

Availability of Sites / Facilities

The sites/facilities which are required for the sea disposal option are those which are already used. Three of the eight disposal sites in the Firth of Tay are located west of the bridge, which is inaccessible to the dredger due to height restrictions. The next closest marine disposal site which would be available for the volume of dredged material is located approximately 1.5 km east of Middle Bank. The alternative site offers no apparent advantage and has the disadvantages of increasing the transit time and distance from the dredge site.

Classification: High

Security of Option

Forth Ports will have full control over all stages in the dredging and disposal process assuming they receive a disposal licence.

Classification: Medium to High

Established Practice

Disposal at Middle Bank disposal site is the current practice for the disposal of the dredged spoil from Dundee. It is, therefore, established and proven as effective.

Classification: High

General Public Acceptability

Forth Ports has confirmed that recent similar disposal operations from the Port of Dundee have not attracted any appreciable comment. Dredging operations are unlikely to affect members of the general public, with the possible exception of some recreational users when the vessel is transiting to and from the disposal site.

Classification: High

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

Likely Agency Acceptability

Consultations with the regulatory bodies to date indicate that there is no objection to Sea Disposal at Middle Bank. Dundee City Council were not aware of any reclamation projects which could make use of the spoil, and confirmed that the material would not be suitable for incineration at any local plants. The Crown Estate did not raise an objection and have no knowledge of any sites that could make any beneficial use of the material. Scottish Natural Heritage, the Maritime and Coastguard Agency (MCA) and the National Lighthouse Board did not highlight any objections to spoil disposal at sea.

Classification: Medium to High

Legislative Implications

A Marine Licence will be required from Marine Scotland and provided that the BPEO is satisfactory, and the statutory consultees do not object, it is established practice that a Marine Licence will be issued. Compliance should not therefore demand significant management control. Permission will be required from The Crown Estate for disposal of spoil to The Crown Estate owned sea bed, and under the provisions of the Marine (Scotland) Act 2010 it has the right to veto any consent for works in tidal waters which may constitute a hazard to navigation.

Classification: Medium to High

4.4.2 Health, Safety and Environmental Considerations

Safety

The operations are undertaken at sea, therefore members of the public are not likely to be exposed to risk from the disposal activities. The contractor appointed to undertake the dredging and disposal may be subject to a health, safety and environmental audit by Forth Ports.

Classification: High

Public Health

The risk of members of the general public being exposed to contamination from the dredged material is regarded as low. Commercial species of demersal fish are not taken from the area and no food chain links between sediment contamination or contamination liberated into the water column, and human consumers leading to impacts on public health are considered likely.

Classification: Medium to High

Pollution/Contamination

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

Classification: Medium

Ecological Impacts

The disposal operations may affect the benthic fauna in proximity to the disposal site due to sediment drifting from the disposal area itself. It is anticipated that there will not be any significant impact on the Tay marine ecosystem as a whole given the scale and duration of effects. There may be some short term effects such as displacement on 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 or alter the viability of populations. Under the disposal proposed, cumulative impacts with other operations are not predicted to create a significant impact to the Firth of Tay and Eden Estuary SPA or marine ecosystem.

Classification: Medium to High.

Interference with Other Legitimate Activities

The disposal activities may cause some disruption to other users of the Firth of Tay, however as the operations will only be occurring for a limited period of time it is not anticipated that there will be any significant interference. In addition, Middle Bank is the current disposal location and historic operations in this area have not resulted in any considerable disruption to other Firth Tay users.

Classification: High

Amenity/Aesthetic

The disposal activities may cause some short-term disruption to other users of the Firth of Tay but the proposals will contribute to the normal functioning of the Port of Dundee and maintain its capacity to accommodate larger vessels.

Classification: Medium to High

4.4.3 Cost Considerations

There would be no capital required to purchase new equipment. Operational costs for the operation of the dredger are approximately £500,000.

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 Newhaven Harbour. These were reduced to a short-list of four options based on practicality. 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; however it would likely be costly and involve a number of contractors to undertake the transition from vessel to bunded lagoons and drying and fixing of the material in the lagoons. The sediment is mixed, comprising primarily sandy silt and silty sand, with some fractions of gravel. The sediment has low compressive strength properties, making it unsuitable for most types of construction. In addition, the presence of some heavy metals and PCBs classes it as non-hazardous, which restricts its suitability for application on land.

Currently there are no significant areas of coastal reclamation planned in the Firth of Tay.

5.2.2 Other Disposal Options and Reuse

Operationally this option would be achievable 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 dredged material for these purposes. It is likely to be viewed as an attractive option by the public and agencies and no legislative issues are anticipated. There would be potential for benefit through substitution of recycled material for primary minerals.

Environmental and public health and safety concerns associated with this option are linked to transport of the materials, and are anticipated to be minimal. There will be no significant impact on amenity and little interference with other legitimate users. As with Coastal Reclamation and Construction Fill, capital costs would be high because of the need for landing, storage and drying facilities and transport costs.

The mineralogical composition and salinity of the material limit its suitability for use for brick making, as concrete aggregate or in top soil production as it would require treatment to desalinate and decontaminate the material.

5.2.3 Sea Disposal

Operationally few problems are anticipated with disposal at Middle Bank and this site has been historically used for disposal of dredged materials from the Port of Dundee. It is anticipated that this option will be acceptable to both public and agencies. Forth Ports would have full control over the dredging process through the appointment of contractors and risks to safety and public health are anticipated to be low.

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

5.3 IDENTIFICATION OF THE BPEO

The assessment of options highlights the major operational difficulties associated with the landfill and other use options 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 Dundee. Disposal at sea will keep the dredged material within the ecosystem, maintaining the sediment budget for the area. In line with guidance from Marine Scotland, the Best Practicable Environmental Option is identified as the disposal at a licensed sea disposal site. The preferred site for this is the Middle Bank disposal site.

Table 5.1 Summary of Assessment of Options

Consideration	Coastal Reclamation and Construction Fill	Other Disposal Options and Reuse	Sea Disposal
Operational feasibility			
Availability of sites/facilities			
Security of option			
Established practice			
General public acceptability			
Likely agency acceptability			
Legislative implications			
Safety			
Public health			
Pollution / contamination			
Ecological impact			
Interference with other activities			
Amenity / aesthetic			
Capital and maintenance costs			

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

APPENDIX A SEDIMENT SAMPLE CHEMICAL ANALYSIS

A1 DUNDEE SEDIMENT SAMPLE DATA

A1.1 Introduction

Samples of the seabed sediments to be dredged were collected from the Port of Dundee by Causeway Geotech between 24th and 28th June 2019 and were analysed by SOCOTEC.

The survey plan followed the Marine Scotland guidance and was agreed with Marine Scotland on 5th April 2019. Based on the estimated dredge volumes, core samples from five sample stations and a surface sample from one station were required. Sample station locations are presented in *Figure A1.1*.

Samples were taken using a Dando 2000 light cable percussion boring rig to a maximum depth of five metres, and the core retrieved from each survey station was subsampled on deck and stored in pre-cleaned sample containers provided by SOCOTEC. One surface sample was taken using a van-Veen grab at station BH04 and stored in the same suite of sample containers.

Each sample was labelled with a unique sample ID and a field log was kept to record the sample location, date and time sample was taken and a description of the sediment taken was recorded.

Samples were kept chilled and sent by overnight courier in coolboxes to the analytical laboratory after each day of sampling.

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

- asbestos;
- metals (As, Cd, Cr, Cu, Hg, Ni, PB, Zn);
- TBT;
- PAHs;
- PCBs;
- presence of asbestos;
- sediment solids/water content;
- sediment organic carbon content; and
- sediment particle size distribution.

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

BUILDING

S.St

15

Caledon East Wharf (disused)

Prince Charles Wharf

BH01

BH02

BH03

BH04

BH05

BH06

9.0m

8.0m

(vert) 4M 38
ert) 4M

- ⊕ Sample Location
- New Wharf Dredge Area
- Caledon East Wharf Dredge Area

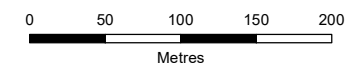


Figure A1.1
Sample Station Locations
Port of Dundee

SCALE: See Scale Bar
SIZE: A3
PROJECT: 0391463
DATE: 11/09/2019

VERSION: A01
DRAWN: LST
CHECKED: CM
APPROVED: MI



CLIENT:
Forth Ports Ltd

A1.2 Marine Scotland Action Levels

Table A5.2 and Table A5.3 set out the Action Levels for metals, PCBs, TBT and PAHs used by Marine Scotland to assess the suitability for disposal of sediments at sea.

In general, contaminant levels in dredged material below Action Level 1 are of no concern and are unlikely to influence the licensing decision. A breach of Action Level 1 does not automatically preclude disposal at sea but usually requires further consideration before a decision can be made. Dredged material with contaminant levels above Action Level 2 is generally considered unsuitable for normal sea disposal, but may be suitable for other management options such as treatment or seabed burial/capping, unless a compelling case can be made for normal sea disposal.

Table A5.2 Marine Scotland Action Levels: Metals

Metal	AL1 (mgkg ⁻¹ dry weight)	AL2 (mgkg ⁻¹ dry weight)
Arsenic	20	70
Cadmium	0.4	4
Chromium	50	370
Copper	30	300
Mercury	0.25	1.5
Nickel	30	150
Lead	50	400
Zinc	130	600

Table A5.3 Marine Scotland Action Levels: PCBs, TBT and PAHs

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

A1.3 Metal Results

Concentrations of metals are presented in Table A5.4. Levels above Marine Scotland Action Level 1 are highlighted in yellow. No concentrations above Action Level 2 were recorded (see Table A1.1 for Action Levels for metals).

**Table A5.4 Analysis of Metal Contaminants from the Port of Dundee (mg kg⁻¹)
2019**

Station	Depth (m)	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
BH01	0.1	14.5	0.38	40.3	68.2	0.91	36.1	190.0	315.0
	2.5	9.1	0.15	59.6	48.4	0.10	70.9	9.6	93.2
	5.0	8.6	0.12	54.9	48.9	0.08	65.0	9.5	81.4
BH02	0.1	9.8	0.16	36.2	27.3	0.15	28.0	28.1	99.1
	2.5	3.1	0.08	27.6	15.8	0.05	22.6	6.4	47.5
	5.0	7.7	0.15	53.5	30.7	0.05	61.3	10.5	94.3
BH03	0.1	6.9	0.12	25.4	21.3	0.09	19.4	18.8	80.2
	1.5	6.3	0.19	46.0	25.6	0.06	47.0	9.3	70.7
	3.5	10.2	0.17	46.8	79.3	0.20	30.6	38.8	229.0
BH04	0.0	6.8	0.16	41.9	28.2	0.09	42.0	10.4	80.9
BH05	0.1	8.9	0.18	43.1	128.0	0.10	21.0	65.6	569
	2.0	8.2	0.08	29.8	24.3	0.05	27.0	9.4	88.8
	4.5	7.5	0.13	34.9	19.4	0.06	30.0	8.6	84.6
BH06	0.1	8.3	0.16	30.1	20.7	0.09	23.1	20.1	88.4
	2.0	10.2	0.12	35.2	22.5	0.06	34.5	6.7	64.8
	4.5	11.8	0.14	34.2	25.5	0.12	34.6	11	79.2
Mean		8.6	0.16	40.0	39.6	0.14	37.1	28.3	135.4

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

Table A5.5 provides a comparison of metal data from samples analysed from 1989 to 2019. The ranges in results for all metals over the period for which there is available sample data are large and in most cases some metal concentrations are above Action Level 1 with a few of the previous samples being above Action Level 2.

Table A5.5 Comparison of Metal Contaminants from the Port of Dundee (mg kg⁻¹) 2014 to 2019

Year		As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
1989	Mean	7.7	0.3	57.1	54.0	0.3	26.7	66.6	176.8
	Range	5.7-9.0	0.2-0.6	53.8-59.9	35.6-70.8	0.2-0.4	24.8-28.0	51.4-74.6	125.0-241.0
1990	Mean	3.6	0.2	25.5	25.3	0.2	21.9	52.8	76.5
	Range	1.4-9.8	0.2-0.5	9.1-40.1	9.1-62.0	0.0-0.5	13.7-38.5	5.8-198	31.1-147.0
1992	Mean	20.4	0.5	36.0	30.7	0.4	25.5	46.9	125.0
	Range	16.8-22.8	0.5	35.1-37.0	27.4-35.2	0.3-0.5	25.0-26.2	44.8-50.6	115.0-138.0
1993	Mean	7.1	0.2	23.2	25.9	0.2	29.1	42.9	99.5
	Range	2.2-11.9	0.2	2.7-31.8	8.8-33.7	0.0-0.4	17.6-37.6	4.1-61.1	22.1-133.1
1994	Mean	2.3	0.1	34.4	36.6	0.3	31.8	55.0	110.9
	Range	0.4-3.2	0.1-0.2	25.6-46.2	29.5-46.5	0.2-0.5	25.1-38.9	39.0-65.2	80.0-149.0
1995	Mean	10.6	0.1	27.5	25.6	0.2	28.8	33.0	90.4
	Range	3.7-18.5	0.0-0.2	11.3-46.4	14.3-38.9	0.1-0.4	16.9-39.7	9.3-66.7	35.8-163.0

Year		As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
1996	Mean	4.1	0.2	29.5	46.1	0.3	29.6	56.3	144.5
	Range	3.0-5.6	0.1-0.3	27.5-32.5	34.5-68.6	0.2-0.4	26.7-31.7	46.1-67.8	133.0-156.0
1997	Mean	6.3	0.3	35.6	50.8	0.2	23.9	193.8	250.3
	Range	5.1-8.3	0.2-0.4	24.0-53.4	29.8-66.9	0.2-0.3	18.1-31.9	34.1-501.0	117.0-508.0
1998	Mean	7.8	0.2	32.5	25.0	0.2	61.0	35.3	128.6
	Range	5.3-11.8	0.1-0.4	20.0-45.9	17.1-58.4	0.1-1.0	19.8-158.0	8.4-59.6	35.6-455.0
2000	Mean	10.1	0.3	41.8	28.6	2.8	27.8	46.6	146.0
	Range	8.0-13.0	0.2-0.3	32.5-54.8	21.7-35.5	0.2-13.6	22.5-35.0	36.0-61.3	128.0-161.0
2002	Mean	10.4	0.4	44.6	26.8	0.2	30.3	47.4	118.2
	Range	9.4-11.6	0.3-0.7	42.3-47.3	23.6-29.1	0.2-0.3	29.0-31.7	43.3-50.7	108.0-126.0
2006	Mean	9.1	BDL	39.3	17.5	0.1	25.9	28.7	83.1
	Range	7.0-44.0	BDL	31.4-44.0	14.2-19.3	0.1-0.2	21.3-28.3	21.9-32.8	69.2-91.7
2007	Mean	10.0	0.2	43.9	21.6	0.1	28.6	34.5	91.9
	Range	8.1-13.1	BDL-0.2	37.2-57.4	15.8-32.5	0.1-0.2	23.3-37.1	25.2-48.2	74.6-113.0
2011	Mean	11.2	0.2	43.4	19.4	0.1	26.6	37.7	101.5
	Range	9.3-14.3	0.1-0.2	36.0-53.4	16.6-22.2	0.1-0.2	22.7-31.8	30.6-49.2	88.8-112.0
2017	Mean	13.0	0.172	60.5	28.2	0.1	34.6	31.9	143.1
	Range	8.1-21.1	0.1-0.3	40.7-91.0	11.4-82.9	0.0-0.2	20.2-61.0	17.2-41.9	58.6-418.0
2019	Mean	8.6	0.16	40.0	39.6	0.14	37.1	28.3	135.4
	Range	3.1-14.5	0.08-0.38	25.4-59.6	15.8-128	0.05-0.91	19.4-70.9	6.4-190	47.5-569
1989-2019	Mean	9.1	0.24	41.1	30.4	0.42	32.5	54.1	134.3
	Range	0.4-22.8	BDL-0.7	2.7-91	8.8-128	0.0-13.6	13.7-158	4.1-501	22.1-569

A1.4 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 2019 are presented in *Table A1.5*. No ICES 7 PCB levels exceed Action Level 1 (0.02 mg kg⁻¹) in any of the samples.

Table A5.7 presents a comparison of mean dry weight concentrations of ICES 7 PCBs from samples collected in 1993 to 2019.

(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 A5.6 Analysis of PCBs (mg kg⁻¹) from the Port of Dundee in 2019

Station	Depth (m)	Sum of ICES 7 PCB Concentrations
BH01	0.1	0.0132
	2.5	0.0008
	5	0.0004
BH02	0.1	0.0001
	2.5	0.0000
	5	0.0005
BH03	0.1	0.0008
	1.5	0.0003
	3.5	0.0004
BH04	0	0.0020
BH05	0.1	0.0015
	2	0.0002
	4.5	0.0003
BH06	0.1	0.0015
	2	0.0001
	4.5	0.0005
Mean		0.0015

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 A5.7 Analysis of PCBs from the Port of Dundee (mg kg⁻¹) 1993 - 2019

Year	Mean Sum of ICES 7 PCB Concentrations
1993	0.0045
2000	0.0240
2006	0.0049
2011	0.0041
2017	<0.0130
2019	0.0015
2014-2019	0.0087

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.

*surface samples only

A1.5 Polycyclic Aromatic Hydrocarbons

Levels of PAHs are presented in *Table A5.8*. Levels above Marine Scotland Action Level 1 (100 µg kg⁻¹) for individual PAHs are highlighted in yellow.

A comparison of mean dry weight concentrations of PAHs from samples collected between 2006 and 2019 are presented in *Table A1.8* which shows that PAH concentrations of the majority of individual PAHs are variable with levels of some PAHs in some years being above Action Level 1.

Table A5.8 Analysis of PAHs from the Port of Dundee ($\mu\text{g kg}^{-1}$ Dry Weight)

Station	BH01			BH02			BH03			BH04	BH05			BH06		
Depth (m)	0.1	2.5	5	0.1	2.5	5	0.1	1.5	3.5	0	0.1	2	4.5	0.1	2	4.5
Acenaphthene	65.0	1.5	2.2	7.1	<1	<1	3.1	<1	<1	6.6	4.3	<1	<1	21.7	<1	<1
Acenaphthylene	205.0	5.2	4.3	9.4	<1	<1	4.1	<1	<1	10.6	3.1	1.9	<1	7.4	<1	<1
Anthracene	236.0	14.4	11.2	22.5	<1	<1	11.4	<1	<1	19.2	7.8	3.6	<1	59.3	<1	<1
Benzo(a)anthracene	1330.0	37.1	44.9	55.7	<1	<1	35.5	<1	<1	36.2	14.6	9.4	2.3	206.0	<1	1.4
Benzo(a)pyrene	1570.0	37.8	40.1	78.1	<1	<1	51.9	<1	<1	98.7	47.0	13.0	3.8	239.0	1.2	1.9
Benzo(b)fluoranthene	1080.0	25.0	30.4	77.2	<1	<1	65.2	<1	<1	92.8	45.0	8.8	4.2	221.0	<1	2.6
Benzo(e) pyrene	970.0	24.2	25.3	69.6	<1	<1	48.6	<1	<1	82.6	36.3	9.8	3.8	168.0	1.3	2.8
Benzo(ghi)perylene	868.0	24.7	21.8	77.9	<1	<1	56.4	<1	<1	101.0	35.1	10.2	6.4	171.0	1.7	4.4
Benzo(k)fluoranthene	537.0	14.3	17.1	46.6	<1	<1	34.2	<1	<1	51.4	19.6	5.5	1.6	108.0	<1	<1
C1-naphthalenes	150.0	4.3	4.0	42.1	<1	<1	29.9	<1	<1	39.0	14.5	4.8	8.0	30.9	1.9	5.2
C1-phenanthrene	560.0	24.1	25.0	62.6	<1	<1	34.0	<1	<1	45.5	18.2	10.6	9.2	133.0	2.2	7.3
C2-naphthalenes	142.0	4.0	4.1	41.7	<1	<1	26.7	<1	<1	37.1	12.7	4.1	8.4	33.0	1.6	6.8
C3-naphthalenes	217.0	6.0	8.8	39.2	<1	<1	22.7	<1	<1	29.8	10.7	4.9	9.6	57.5	1.7	6.9
Chrysene	1240.0	36.5	43.1	64.3	<1	<1	40.7	<1	<1	46.0	19.8	10.1	3.2	224.0	1.4	2.2
Dibenzo(ah)anthracene	180.0	4.5	5.0	13.1	<1	<1	8.7	<1	<1	15.8	6.0	1.5	<1	31.6	<1	<1
Fluoranthene	2340.0	79.0	101.0	99.4	1.4	<1	62.5	<1	<1	63.6	28.7	18.2	3.3	505.0	2.0	1.7
Fluorene	107.0	4.0	3.5	11.7	<1	<1	6.5	<1	<1	7.8	4.7	<1	<1	13.6	<1	<1
Indeno(1,2,3-c,d)pyrene	893.0	23.1	23.9	77.0	<1	<1	55.5	<1	<1	102.0	34.1	8.0	2.0	190.0	<1	1.4
Naphthalene	273.0	4.1	5.3	17.3	<1	<1	13.0	<1	<1	16.7	8.7	2.2	1.7	14.8	<1	1.5
Perylene	345.0	9.6	11.0	51.8	<1	1.5	48.3	<1	<1	52.1	23.7	10.4	16.9	103.0	3.0	20.6
Phenanthrene	225.0	25.1	13.0	64.9	<1	<1	28.7	<1	<1	34.8	24.0	8.9	6.3	145.0	2.4	4.2
Pyrene	2860.0	88.2	86.6	107.0	2.8	<1	73.9	<1	<1	68.6	41.1	25.9	4.7	373.0	2.1	2.6

Table A5.9 Comparison of PAHs from the Port of Dundee 2006 to 2019 (mg kg⁻¹ Dry Weight)

Year	2006	2007	2011	2017	2019
PAH	Mean	Mean	Mean	Mean	Mean
Acenaphthene	ND	ND	ND	0.013	0.0180
Acenaphthylene	ND	ND	ND	0.004	0.0399
Anthracene	0.0330	0.0141	0.0320	0.029	0.0594
Benzo(a)anthracene	0.1255	0.0499	0.1171	0.065	0.2797
Benzo fluoranthenes	ND	ND	0.3673	0.094	0.3963
Benzo(a)pyrene	0.1758	0.0632	0.1475	0.079	0.2292
Benzoperylene	0.1695	0.0561	0.1475	0.090	0.2182
Chrysene/Triphenylene	0.1440	0.0590	0.1368	0.067	0.2725
Dibenz[a,h]anthracene* ²	ND	ND	ND	0.020	0.0425
Fluoranthene	0.2390	0.0942	0.2148	0.139	0.5165
Fluorene	0.0166	0.0068	0.0196	0.015	0.0252
Indenopyrene	0.1867	0.0624	0.1607	0.097	0.2253
Naphthalene	0.4652	0.1833	0.4187	0.021	0.0573
Phenanthrene	0.1432	0.0582	0.1301	0.089	0.0871
Pyrene	0.2333	0.0910	0.2015	0.136	0.5873

*²Action Level 1 is 0.01 mg kg⁻¹

ND = Not Detected

A1.6 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 environment 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 A5.10*. No samples were observed to have TBT concentrations above Marine Scotland Action Level 1 (0.1 mg kg⁻¹).

Table A5.10 Analysis of TBT from the Port of Dundee (mg kg⁻¹ Dry Weight)

Station	Depth (m)	TBT Concentration
BH01	0.1	<0.005
	2.5	<0.005
	5	<0.005
BH02	0.1	<0.005
	2.5	<0.005
	5	<0.005
BH03	0.1	<0.005
	1.5	<0.005
	3.5	<0.005
BH04	0	<0.005
BH05	0.1	0.04
	2	<0.005
	4.5	<0.005
BH06	0.1	<0.005
	2	<0.005
	4.5	<0.005
Mean		<0.007

A comparison of TBT concentrations from samples collected in 2017 and 2019 ⁽²⁾ are presented in *Table A5.11*, which shows that TBT concentrations are below Action Level 1 in both years.

(1) The development of male characteristics in females

(2) TBT has only been analysed for in 2017 and 2019

Table A5.11 Comparison of TBT from the Port of Dundee in 2017 and 2019 (mg kg⁻¹ Dry Weight)

Year		TBT Concentration
2017*	Mean	<0.00466
	Range	<0.001-<0.006
2019*	Mean	<0.007
	Range	<0.005-0.04
2017-2019	Mean	0.00583
	Range	<0.001-0.04

*Surface samples only

A1.7 Asbestos

No asbestos was reported from any of the samples.

A1.8 Sediment Physical Properties

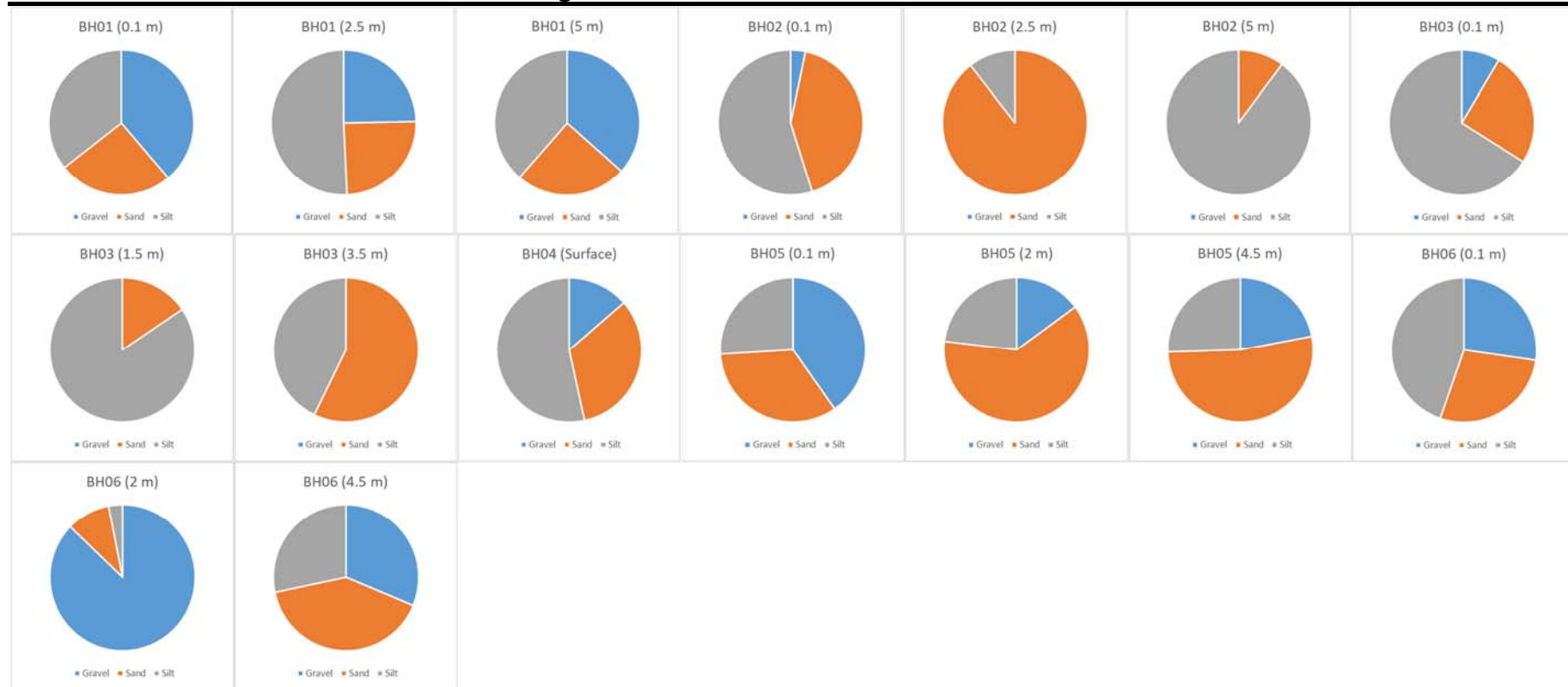
The physical properties of the dredge sediment was analysed on the 16 sediment samples taken from Dundee in 2019. Sediments were predominantly silty sand, with some gravel. **Gravel** is defined as >2 mm, **Sand** is defined as >63 µm<2 mm, and **Silt** is defined as <63 µm. Table A1.11 and Figure A1.3 present the 2019 data.

Sediment contamination is typically higher in sediments less than 63 µm diameter e.g. silts due to the increased surface area providing more adhesion sites for contaminants than the same volume of sand or gravel.

Table A5.12 Dundee Sediment PSA Data

Station	Depth (m)	Gravel (%)	Sand (%)	Silt (%)
BH01	0.1	38.8	25.6	35.6
	2.5	24.7	24.6	50.8
	5.0	36.6	24.8	38.6
BH02	0.1	3.3	41.9	54.8
	2.5	0.0	89.5	10.5
	5.0	0.0	10.2	89.8
BH03	0.1	8.5	25.5	66.0
	1.5	0.0	15.5	84.5
	3.5	0.0	57.2	42.8
BH04	0.0	13.6	33.0	53.4
BH05	0.1	40.3	33.8	26.0
	2.0	14.9	62.0	23.1
	4.5	22.0	52.5	25.5
BH06	0.1	27.3	28.0	44.7
	2.0	87.3	9.7	3.1
	4.5	31.3	40.3	28.3

Figure A5.2 Port of Dundee Sediment PSA



A2 SPOIL GROUND SEDIMENT SAMPLE DATA

Table A1.12 presents metal and PCB concentration data from sediment sampled from within Middle Bank spoil ground and from other spoil ground sites within the Firth of Forth for comparison, as there are no other data from the Firth of Tay. Levels above Marine Scotland Action Level 1 for metals and PCBs are highlighted in yellow.

Table A5.13 Concentration of Metals and PCBs (mg kg⁻¹) from Tay Middle Bank Spoil Ground and Firth of Forth and Forth Estuary Spoil Grounds

Site Name	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	Sum ICES 7 PCBs
Middle Bank (Tay) 2007 (n=6)	8.9	BDL	31.6	12.6	0.3	19.9	29.2	57.0	-
Narrow Deep 2015 (n=5)	11.7	0.2	63.8	24.6	0.6	30.0	58.4	105.9	0.003
Methil 2015 (n=1)	8.7	0.1	18.0	9.6	BDL	11.2	14.5	72.8	0.000
Kirkcaldy 2015 (n=3)	8.9	0.1	43.1	17.0	0.2	22.0	30.6	62.9	0.000
Blae Rock 2011 (n=6)	17.2	0.1	39.6	21.9	0.5	21.4	52.1	80.3	0.001
Bo'ness 2015 (n=5)	18.6	0.1	59.6	26.5	0.7	27.5	54.2	114.0	0.000

* Data provided by Marine Scotland (2019)

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

Note that monitoring of spoil grounds is not mandatory therefore, the data presented in Table A5.13 are the most recent data available.

APPENDIX B ENVIRONMENTAL IMPACTS OF DISPOSAL OPERATIONS

B1 DREDGING AND DISPOSAL IMPACTS

B1.1 Impacts of Dredging

This Appendix addresses the environmental impacts of the capital dredging work at the Port of Dundee and the disposal of dredged material at the licenced Middle Bank disposal site. Impacts on water quality, sediment quality, and habitats and species are considered. *Table B1.1* presents the impact summary. Potential impacts on general vessel movements and fishing due to the dredging operations and disposal operations are not considered to be significant as commercial traffic in the main channel is controlled by Forth Ports' standard operating procedures. The identification and assessment of environmental impacts of dredged material in this Appendix follows guidance from the Environment Agency, *Clearing the Waters for All* ⁽¹⁾.

B1.2 Impacts of Dredging and Disposal

B1.2.1 Introduction

As described in *Section 1.3* it is proposed that approximately 75,000 m³ (wet weight comprising approximately 11,250m³ water and 63,750 m³ solids) of material would be dredged from the Port of Dundee and disposed at Middle Bank spoil ground

The material to be dredged and disposed consists primarily of sandy silt and silty sand, with some gravel fractions. The concentrations of contaminants are presented in *Appendix A*. Samples were taken at 6 stations (BH01 – BH06) and the results are summarised here.

- The mean concentrations of metals were all below Action Level 2, with mean concentrations of arsenic, cadmium and mercury below Action Level 1.
- The concentration of all PCBs were below Action Level 1.
- The total hydrocarbon concentration at all survey stations was below Action Level 1, with the exception of stations BH01 at 1m, BH04 (surface sample) and BH06 at 0.1m which recorded concentrations above Action level 1 but below Action Level 2. For individual PAHs, most were below Action Level 1 with samples taken closest to the surface recording some concentrations above Action Level 1.
- TBT concentrations were below Action Level 1 at all stations.
- No asbestos was recorded.

Metal and PCB concentration data from sediment sampled in the Middle Bank spoil ground are presented in *Appendix A*.

B1.2.2 Impacts on Water and Sediment Quality

Coastal water quality in the Tay Estuary is currently Good and High in the Upper Tay⁽²⁾. The disposal site at Middle Bank has been used previously by Forth Ports and it is likely that there will be some accumulation of dredged material in the area. The silt and clay (particle size <63µm) content of sediment in the Firth of Tay is generally less than 11%, with many areas greater than 75% sand ⁽³⁾. Sediment data from Middle Bank has returned samples of 100% sand ⁽¹⁾.

The metal data in *Table A1.12* indicate that concentrations of metals within sediment samples from the Middle Bank spoil ground in the Firth of Tay are generally lower than the original material dredged

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

(2)Water Framework Directive (WFD) Waterbody Classification 2016

(3) Bates, C. R., Moore, C. G., Malthus, T., Mair, J. M. and Karpouzli, E. (2004). *Broad scale mapping of habitats in the Firth of Tay and Eden Estuary, Scotland*. Scottish Natural Heritage Commissioned Report No. 007 (ROAME No. F01AA401D).

from Dundee, with the exception of arsenic and lead which are slightly higher at the disposal site than from within the port of Dundee (refer to *Table A1.3* and *Table A1.4*).

The salinity regime in the inner Tay Estuary is characteristic of the upper reaches of estuaries, varying in range from 0.2–21‰ at Balmerino to 0–0.02‰ at Newburgh ⁽¹⁾. Between Invergowrie and Broughty Ferry, in the waters over Middle Bank, the estuary decreases in width leaving only relatively narrow intertidal areas. The salinity range off Newport is 6–30‰ and off Tayport is 11–32‰. The salinity conditions in the outer Tay Estuary range from 11–32‰ off Tayport to virtually fully marine conditions off Buddon Ness (32–33‰) ⁽¹⁾.

There are two designated bathing waters within 5 km of the dredging or disposal sites. The nearest is Broughty Ferry which is classed as excellent and is approximately 4.5 km from the Port of Dundee and the second is Monifieth, classed as Good and approximately 8 km from the Port of Dundee.

Based on previous investigations of dredging impacts, increases in levels of suspended solids will be transitory ⁽²⁾ ⁽³⁾. The chemical oxygen demand of the suspended sediments will cause a local reduction in the oxygen concentration of the water column. However this will rapidly (*ie*, within hours) return to background levels. Similarly, the release of nutrients are not predicted to be sufficient to contribute significantly to the nutrient levels in the Tay Estuary. Trace metals may be liberated from sediment as a consequence of the dredging operations but are likely to be rapidly complexed and bound to the suspended sediment thus reducing bioavailability. Small amounts of trace organic contaminants will be released.

The material disposed at Middle Bank will fall to the sea bed by gravity and consist 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. There are no data available which indicate the concentration or dispersion of suspended solids from the disposal operations at Middle Bank in the Firth of Tay. However, data available from dredging fine sediments in Middle Bank in the Firth of Forth in 2008 ⁽⁴⁾ recorded increases of suspended sediments of up to 2.5 times during dredging compared to the baseline conditions (in this case the mean baseline concentration was 9.1 mg l⁻¹). Comparison of these mean baseline suspended solids concentrations with those recorded during dredging activities at Middle Bank in the Firth of Forth indicated peak increases were approximately two and half times above background levels ⁽¹⁾. Significant increases in turbidity associated with the disposal operations are therefore likely to be confined to the immediate area of the disposal site.

The oxidation of anoxic sediments released into the water column has been shown to reduce oxygen concentrations by up to 58% ⁽⁵⁾. 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 ⁽⁶⁾. 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 and the extent of the area potentially affected.

Increased nutrient levels 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

(1) Buller, A. T., Charlton, J. A. and McManus, J. 1972. Data from Physical and Chemical Measurements in the Tay Estuary for Neap and Spring Tides, June 1972. Tay Estuary Research Centre report.

(2) Windom H. and Slickney P.R 1973 Environmental Aspects of Dredging in the Coastal Zone. Critical Review of Environmental Control 1976 V6 P 91-109.

(3) Kennish M.J. 1992. Ecology of Estuaries, Anthropogenic Effects Chapter 7 Dredging and Dredge Spoil Disposal. CRC Press.

(4) ERM, 2008. Middle Bank Aggregate Production Licence: Monitoring Report. A report for Westminster Gravels Ltd.

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

(6) 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>

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.

Sediment bound metals liberated during the disposal operations will rapidly become complexed with the settling sediments and re-deposited on the sea bed. Previous studies have shown that metal concentrations in the water column remained consistent following sediment disposal ⁽¹⁾. However, the continual re-suspension of sediment containing absorbed metals might cause desorption of pollutants to the water column ⁽¹⁾.

Studies of the behaviour of sediment bound organic micro-pollutants (eg PCBs) suggest that they will reach equilibrium with the water during disposal. As the dispersed sediment falls through the water column it will be continually exposed to uncontaminated water. Consequently, the concentration of organics in the water will not reach equilibrium, and desorption will occur.

The natural levels of suspended sediments in the Firth of Tay vary with seasonal weather conditions and this contributes to the natural sedimentation in the Firth of Tay that aids the removal of contaminants from the water column and incorporates them in the seabed sediments.

Although there may be some release of contaminants such as metals 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 rapidly become complexed with particulate matter in the water column and be re-deposited on the sea bed. It is therefore not anticipated that the disposal operation at Middle Bank 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 status of the Tay Estuary or Firth of Tay with respect to the Water Framework Directive.

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

The ratios of individual PAHs have been used to determine the likely anthropogenic source of PAHs in the environment: e.g. from combustion sources (pyrolytic) or petroleum hydrocarbons (petrogenic). Petrogenic PAHs are often characterised by phenanthrene to anthracene (Ph/An) values >10, whereas pyrolytic PAH from combustion processes are characterised by Ph/An ratios <10. The ratio of and fluoranthene to pyrene (Fl/Py) greater than 1 generally come from pyrolytic sources while ratios of less than 1 generally indicate petrogenic sources ⁽²⁾.

For all the sediment samples analysed from the Port of Dundee the Ph/An ratios were between 0 and 3.07 and the Fl/Py ratios were between 0 and 1.35. This suggests that these contaminants are from both combustion and petroleum hydrocarbon sources. This supports the view that recorded contamination in the sediments has been transported into the port with the accumulated sediments from the wider Firth of Tay sediment circulation system.

Although there may be some release of contaminants such as metals, PCBs, TBT 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 rapidly become complexed with particulate matter in the water column and be re-deposited on the sea bed. It is therefore not anticipated that the disposal operation at Middle Bank will introduce significant

(1) Goossend, H. and Zwolsman, J. 1996. An Evaluation of the Behaviour of Pollutants during Dredging Activities. *Terra Et Aqua Mar* 6, No 62 p20 (9).

(2) Y.W. Qiu, G. Zhang, G.Q. Liu, L.L. Guo, X.D. Li, O. Wai. Polycyclic aromatic hydrocarbons (PAHs) in the water column and sediment core of Deep Bay, South China. *Estuar. Coast. Shelf Sci.*, 83 (1) (2009), pp. 60-66.

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 within the seabed sediments at the disposal site; however, the deposited sediment will disperse over time.

B1.2.3 Impacts on Benthic Ecology

The benthic macrofaunal communities recorded in proximity to Middle Bank disposal site are expected to be typical for estuarine 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.

The impact on benthic communities will depend on the comparative rates of natural deposition (currently unknown) and the deposition due to the dredging disposal operations. It is anticipated that the deposition of dredged material at the Middle Bank disposal site may result in the loss (burial) of the benthos within and in the immediate vicinity of the 'deposition zone' within the disposal site. Localised impoverishment of the fauna (in terms of abundance and diversity) is likely along the axis of tidal flow as a result of secondary impacts comprising sediment deposition subsequent to the disposal activities.

Given the relatively homogenous nature of benthic communities and their exposure to the naturally high levels of suspended levels during periods of low river flow and availability of similar habitat within the Firth of Tay, the spatial extent of predicted sediment related impacts to benthos (and resultant impact on prey availability for foraging seabirds) are unlikely to be significant. Dredge spoil from the Port of Dundee has been deposited within the Middle Bank spoil ground for 30 years and significant impacts on benthic ecology outside of the disposal ground are not predicted.

B1.2.4 Impacts on Seabirds

The Firth of Tay and Eden Estuary Special Protected Area (SPA) lies approximately 1.2 nautical miles southeast of Middle Bank at its closest point. It is designated under EC Directive 79/409/EEC on the Conservation of Wild Birds by supporting populations of species of European importance (little tern, marsh harrier and the bar-tailed godwit) listed on Annex I of the Directive. The site also qualifies under Article 4.2 of the Directive by regularly supporting at least 7,000 seabirds and populations of migratory species of European importance including the following ⁽¹⁾.

- Greylag Goose *Anser anser*, 1,355 individuals representing at least 1.4% of the wintering Iceland/UK/Ireland population.
- Pink-footed Goose *Anser brachyrhynchus*, 3,769 individuals representing at least 1.7% of the wintering Eastern Greenland/Iceland/UK population.
- Redshank *Tringa totanus*, 1,800 individuals representing at least 1.2% of the wintering Eastern Atlantic population.
- Puffin *Fratercula arctica*, 21,000 pairs representing at least 2.3% of the breeding population.
- Shag *Phalacrocorax aristotelis*, 2,887 pairs representing at least 2.3% of the breeding Northern Europe population.

The directive requires the maintenance or restoration of natural habitats and species of European interest at a favourable conservation status, and a network of SPAs is one of the main vehicles to achieving this.

West of the Port of Dundee are the most extensive intertidal flats in the Firth of Tay, comprising large areas of fine grained intertidal sediment which act as the source for much of the sediment deposition within the Port of Dundee. The Inner Tay Estuary Local Nature Reserve, Firth of Tay and Eden Estuary Special Protection Area (SPA)/Ramsar/Special Area of Conservation (SAC) tidal flats are located to the west of the port and the Montifieth Bay SSSI to the east. South of the port is the

(1) Data obtained from JNCC website (February 2014). <http://www.jncc.gov.uk/default.aspx?page=1970>

Balmerino – Wormit Shore SSSI and to the southeast of the port the Tayport – Tentsmuir Coast SSSI and Tentsmuir National Nature Reserve (NNR). Almost all the tidal flats within the Firth of Tay are protected within an SSSI and SPA because of the large (primarily overwintering) bird populations ⁽¹⁾.

There are three potential effects of the dredging and 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 are unlikely to have a significant effect on the qualifying interests of the SPA. The vessel used for disposal of the material will be travelling to and from the Port of Dundee and the disposal site during the dredging campaign, a round trip of approximately 1.2 nautical miles.

The Firth of Tay and Eden Estuary SPA supports seabirds that forage over a wide area. The disposal of the dredged material will result in localised increases in suspended sediment that may reduce the ability of fish eating birds to forage around the disposal site 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.

It is noted that Middle Bank is an established and long term spoil ground with disposal activities being ongoing at the time that the SPA was designated. Given that disposal at this site 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 SPA, located 1.2 nm south-east of the disposal site.

B1.2.5 Impacts on Fish and Marine Mammals

The Middle Bank disposal site is located within the Firth of Tay and Eden Estuary Special Area of Conservation (SAC), designated under the Habitats Directive ⁽²⁾ for its habitats and mammal species of European importance.

Atlantic salmon, river lamprey and sea lamprey inhabit and migrate up and down the Firth of Tay to reach spawning grounds in the River Tay SAC and may therefore pass the Middle Bank disposal site. 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 concentration of suspended sediment at which the passage of salmonid fish is affected has been observed to be approximately 500 mg l⁻¹ ⁽³⁾.

The disposal activities will take place within a very small area of the Firth of Tay where Atlantic salmon, river and sea lamprey may be present or may pass through. The species are highly mobile and will be able to move to abundant suitable habitat nearby if they are initially present within the footprint of the proposed disposal activities. The species will also be able to avoid the area during periods of raised suspended sediment during disposal and migrate using an alternative route through the Firth of Tay. For context, at the Middle Bank site the Firth of Tay is approximately 1,485 m wide and the spoil ground is approximately 320 m in width, representing approximately 22% the width of the Firth of Tay at that point. As discussed in *Section 1.2.2*, significant increases in turbidity associated with the disposal operations are likely to be confined to the immediate area of the disposal site, which at Middle Bank represents a small part of the cross section of the Firth of Tay.

It is not anticipated that the disposal operation at Middle Bank will introduce significant amounts of contamination into the water column although the dispersive nature of disposal operation and

(1) The Falkirk Area Biodiversity Action Plan- Mudflats Action Plan.

http://www.falkirk.gov.uk/devservices/planenv/pdf/biopdf/mudflats_action_plan.pdf

(2) European Communities (1992) Council Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna.

(3) Redding M.J. and Schreck C.B. 1987, Physiological effects on coho salmon and steelhead of exposure to suspended solids, Transactions of the American Fisheries Society, Vol116 pp737-747

resuspension of contaminated surface sediment may increase the partitioning of metals and organics into the aqueous phase.

Due to the scale of the proposed operations and the likely impacts on water quality and seabed habitat it is predicted that the proposals are not likely to have a significant effect on migratory fish species.

The Firth of Tay and Eden Estuary SAC is designated for its populations of harbour seal (*Phoca vitulina*) including the presence of a nationally important breeding colony of intertidal sandbanks and mudflats⁽¹⁾. Harbour seals forage widely and may forage at the Middle Bank spoil ground. Potential effects on harbour 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 disposal site.

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

- The small area of potential foraging affected by disposal activities at the Middle Bank disposal site.
- The short duration of dredging and disposal activities.
- The small increase in total vessel movements associated with the disposal activities in relation to total vessel movements within the Firth of Tay.
- 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 infrequent summer visitors to the Firth of Tay, mainly between May and September⁽²⁾.

Potential effects on bottlenose dolphins resulting from the disposal activities include disturbance and noise due to vessel movements and displacement of prey species as a result of increased levels of suspended sediment at the disposal site.

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

- The distance between the disposal site and the SAC is large and the proportion of the bottlenose dolphin population anticipated to pass through the area affected by disposal activities is anticipated to be low.
- The extent of vessel movements associated with the disposal activities relative to total vessel movements within the Firth of Tay.
- The short duration of disposal activities.
- The long term existing disposal operations in the area.

B1.2.6 Summary of Impacts

Table B1.14 presents a summary of the impacts and an assessment of significance of the impacts in relation to the sensitivity/importance of the receiving site.

(1) JNCC. Site Details for Firth of Tay and Eden Estuary Special Protection Area. Available online <http://jncc.defra.gov.uk/ProtectedSites/SACselection/sac.asp?EUCode=UK0030311> Accessed 21/05/2019

(2) Quick, N., Arso, M., Cheney, B., Islas, V., Janik, V., Thompson, P.M. and Hammond, P.S. 2014. The east coast of Scotland bottlenose dolphin population: Improving understanding of ecology outside the Moray Firth SAC.

Table B1.14 Summary of Significance of Impacts

Receptor	Impact Significance Justification	Impact Significance
Water quality at dredging and disposal site	Disposal will be periodic and sediment will descend to the seabed rapidly. Any impacts will be localised and short-lived.	Not Significant
Sediment quality at disposal site	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 disposal site	Middle Bank is designated as a disposal site. Disposal will occur over a relatively short period and similar habitat is available in close proximity to the site.	Not Significant
Seabirds	Proposed disposal operations are over a relatively short period and the area affected is a small percentage of the total available foraging habitat, with alternative sources of prey available close by. The SPA is located 1.2 nm south east of the Middle Bank disposal site and was designated after the Middle Bank site was designated.	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. Due to the scale of the proposed operations and the likely impacts on water quality and seabed habitat it is predicted that the proposals are not likely to have a significant effect on migratory fish species. The volume of dredger vessel traffic will not be significant in relation to the existing traffic in the Firth of Tay.	Not Significant

B1.3 Cumulative Effects within the Firth of Tay

B1.3.1 Introduction

The potential impacts of the sea disposal option have been assessed within *Section B1.2* in isolation from other activities within the Firth of Tay. The impacts associated with the sea disposal option are not predicted to result in adverse effects on the integrity of the SPA, however, it is possible that cumulative impacts with other projects could result in significant impacts.

A 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. For the purposes of this report, the assessment of potential cumulative impacts have been restricted to activities and proposed activities with the potential to directly impact the water and / or sediment quality within the SPA.

The limitations of assessing the cumulative impact of dredging and disposal activities with other operations, for example, coastal land reclamation or commercial fishing activities, is recognised given the lack of historical and current environmental data and a detailed understanding of sediment transport regimes within the Firth of Tay.

(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-studies-and-reports/guidel.pdf>

B1.3.2 Past and Current Activities within the Tay Estuary and Firth of Tay

1.1.1.1 Introduction

Dundee at the mouth of the Firth of Tay and Perth at the head of the Tay Estuary (and the tidal limit) contribute to the contamination within the Tay Estuary and Firth of Tay. The current key issues influencing water quality in the firth and estuary are, however, recognised as pollution from agricultural run-off and treated effluent discharge from septic tanks. Treated sewage from Perth is discharged to the Tay estuary, upstream of Newburgh whilst sewage from Dundee is taken to a treatment works away from the Firth of Tay, and has been since 2002. Since the removal of this secondary sewage input to the Firth of Tay from Dundee, levels of ammonium and nitrogen have shown a significant decrease⁽¹⁾.

SEPA controls the discharge consents and monitors the water quality of the watercourses feeding into the Tay. Scottish Water provides and maintains public water, sewerage infrastructure and conducts monitoring of water quality.

1.1.1.2 Commercial Fishing Activity

There are no commercial fisheries within the vicinity of the proposed dredging and disposal operations. Some low level, recreational fishing takes place for Norway lobster (*Nephrops norvegicus*) and Atlantic salmon (*Salmo salar*). The Atlantic salmon uses the River Tay at two points in their life-cycle, seaward migration as smolts and on return as adults to breed. Passage is likely to be rapid and fish do not appear to feed at this time. There is a net salmon fishery at Usan, over 30 km north east of the Port of Dundee. Historically, there has been a small smelt (*Osmerus eperlanus*) fishery which supported low catches, normally caught using nets in the main channel immediately upstream of the Tay Rail Bridge. However, the last boat was recently decommissioned and the fishing temporarily abandoned ⁽²⁾.

1.1.1.3 Offshore Wind Farms

There are no wind farms located within the Firth of Tay. Three large offshore wind farm developments are to be established in the waters near the mouth of the Tay.

Inch Cape Offshore Wind Farm

Consent was granted for the proposed Inch Cape Offshore Wind Farm 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 on June 2019. This scope reduced the number of wind turbine generators from 110 to 73. The turbines will occupy an area of 150 km². Construction is expected to begin in 2020. Once fully operational the wind farm will have an export capacity of approximately 1,000 megawatts.

Seagreen Offshore Wind Farm

Scottish and Southern Electric (SSE) and Fluor joint venture partnership Seagreen Wind Energy has been awarded the exclusive development rights for the Firth of Forth Zone by The Crown Estate. The zone covers an area of 2,852 km² 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. Construction is expected to start in 2020.

(1) Haskoning UK Ltd, 2013. Port of Dundee Expansion and Marine Aggregate Extraction EIA Scoping Report and HRA Screening Report. Report for Scottish Enterprise.

(2) Haskoning UK Ltd, 2013. Port of Dundee Expansion and Marine Aggregate Extraction EIA Scoping Report and HRA Screening Report. Report for Scottish Enterprise.

Neart na Gaoithe Offshore Wind Farm

Mainstream Renewable Power was granted consent by the Scottish Government in 2018 to build a 450 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 km². The wind farm is expected to be operational by 2023.

B1.3.3 *Capital and Maintenance Dredging Activities*

All disposal operations require license renewals every three years by Marine Scotland. Potential impacts are therefore assessed and reviewed every three years prior to granting a Marine Licence. The historical disposal route for spoil from previous dredging operations at the Port of Dundee has been deposition at sea, and to date, no environmental impacts, other than direct impacts within the spoil ground, have been observed.

B1.3.4 *Foreseeable Future Activities within the Firth of Tay*

The National Renewables Infrastructure Plan (NRIP) has identified the Port of Dundee as a potential manufacturing location for Scotland's offshore wind, wave and tidal energy market. In addition, there is the potential for the Port of Dundee to attract work related to the decommissioning of offshore oil and gas platforms.

B1.3.6 *Conclusions*

Potential cumulative impacts associated with the above activities can be broadly categorised as either comprising re-suspension of sediments resulting in loss or smothering of benthos, or the discharge of contaminants with the potential to impact both water and sediment quality.

Given that the point source discharge of contaminants into the Tay has decreased over the last decade, it is unlikely that the levels of current contamination will increase and more likely it will decrease as a result of net contaminant export from the system exceeding input.

There is no available evidence to suggest that the past and current disposal operations managed by Forth Ports have impacted the integrity of any of the SAC, SSSI or SPAs with the current levels of disposal and sediment contaminants. It is likely that the gradual improvement in sediment quality in the Firth of Tay will result in a reduction in water quality impacts from dredging and disposal of dredged material.

At the current levels of dredging/disposal and point source discharge related impacts, available data do not indicate any significant detrimental impacts to SAC, SSSI or SPA integrity and any significant future developments are likely to be subject to their own EIA and Appropriate Assessment.

APPENDIX C CONSULTTEE RESPONSES



Maritime &
Coastguard
Agency

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1st Floor, Westpoint 1
Westpoint Business Park
1 Marchfield Drive
Paisley
Renfrewshire
PA23 2 RB

Ms Catriona Munro
ERM
6th Floor
102 West Port
Edinburgh
EH3 9DN

Tel: +44 (0) 20381 72011

E-mail: Glasgow.mo@mcga.gov.uk

Our ref: Dundee Dredging

24 May 2019

RE: Forth Ports Ltd : Port of Dundee Dredge spoil Disposal

Dear Ms Munro,

In response to your letter dated 17 May 2019 regarding the proposed dredging works at the Port of Dundee.

UK Maritime and Coastguard Agency, Safety of Navigation Branch are responsible for review of proposals of this nature, if necessary with input from the local Marine Office, in this case Glasgow Marine Office.

Safety of Navigation Branch will be notified of these proposals under the Marine Licencing process and will respond directly if required. I will however, forward a copy of your letter to them.

Given that these works take place wholly within the Port of Dundee which falls under Forth Ports jurisdiction, at present Glasgow Marine Office has no comments to make on the proposals provided that the views of all potential stakeholders who use the harbour and river in the area in question is sought.

In particular, the impact that the proposal has on those users transiting the area to and from the Port of Perth and other facilities up river of the work site.

Should you have any further queries, please do not hesitate to contact me.

Simon J Alletson
Principal Marine Surveyor - Nautical
Glasgow Marine Office

NOT PROTECTIVELY MARKED

Northern Lighthouse Board

Your Ref: Letter dated 17/05/19
Our Ref: GB/ML/F1_14_208

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Switchboard: 0131 473 3100
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Ms Catriona Munro
Consultant
Environmental Resources Management
6th Floor
102 Westport
EDINBURGH
EH3 9DN

23 May 2019

Dear Catriona

PRE-APPLICATION CONSULTATION FOR CAPITAL DREDGING AND SPOIL DISPOSAL – PORT OF DUNDEE, FIRTH OF TAY

Thank you for your correspondence dated 17 May 2019 regarding the proposal by **Forth Ports Limited** for consent to undertake capital dredging and disposal operations at Port of Dundee, Firth of Tay.

We note that the capital dredging works are to accommodate larger vessels in the Caledon East Wharf and New Wharf areas.

Northern Lighthouse Board has no objections to the proposed dredging and/or disposal of dredged spoil to the charted and approved spoil grounds at Middle Bank.

However, we would advise that on completion of the maintenance dredging operations, that Forth Ports Limited advise the UK Hydrographic Office (sdr@ukho.gov.uk) of the revised water depths in order that Admiralty Chart BA1481 can be revised accordingly.

Yours sincerely

[Redacted]

Peter Douglas
Navigation Manager

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SNH

Thank you for your letter dated 17 May 2019 regarding the BPEO for dredge spoil disposal from Port of Dundee.

I note that the Port has been dredged for many years, and disposal at Middle Bank (Tay) is long-established. As such sea-bed habitats and mobile species at this location is accustomed to disposal operations. We therefore suggest that this method of disposal remains suitable.

A possible alternative beneficial use might be recharge of Montrose Bay. This would depend on sediment composition of the spoil and at Montrose Bay. If you would like to discuss this further then please contact Sue Lawrence in our Aberdeen Office (CC'd into this email).

All the best.

Malcolm Fraser | Operations Officer - Forth

Scottish Natural Heritage | Silvan House | 3rd Floor East | 231 Corstorphine Road | Edinburgh | EH12 7AT |

Further to Malcolm's email, the silt and clay would be too fine-grained to justify any coastal use at Montrose. Even if the dredgings have a sand fraction, it's probably too small to justify the effect.

Kind regards

Sue

Sue Lawrence | Operations Officer Tayside & Grampian

Scottish Natural Heritage | Inverdee House | Baxter Street | Torry | Aberdeen | AB11 9QA
nature.scot – Connecting People and Nature in Scotland – [@nature_scot](https://twitter.com/nature_scot)

Crown Estate

This email is in response to your letter of 17 May 2019 regarding capital dredging and disposal of spoil from the Port of Dundee.

Crown Estate Scotland has no objection to the proposed dredge and disposal providing an appropriate agreement is put in place to cover the operations.

I am not currently aware of any works in the area that could make use of the dredge spoil and would suggest that you also contact the Forth Estuary Forum group as they may be aware of projects in and around the Forth that may have a use for such material.

I would be happy to discuss the proposals in more detail as required.

Peter Galloway BEng (Joint Hons) PhD

Associate

Broxden House, Lamberkine Drive, Perth, Scotland. PH1 1RA

Dundee City Council

I refer to your recent letter to the Head of Environment of Dundee City Council relating to the above.

In terms of disposal options for the type and likely quantity resulting from your dredging works at the wharves mentioned in your letter, I can comment as follows:

Landfill - depending on the classification of the dredged material (inactive\active\hazardous), this could prove a costly option at current rates. I am not personally aware of the type and range of potential contaminants which could be found in that area, and you would obviously know more once sampling and analysing is undertaken. There is no operational landfill site within Dundee, therefore haulage would be required.

Incineration - this type of material is not suitable for the fluidised bed EfW plant operational in this area.

Reclamation - there are no reclamation projects that I am aware of which would require material at this level of volume.

Sorry I can't be of further assistance. Happy to discuss further if you wish.

Regards

Andy Malcolm - Service Manager, Waste Partnership
5 City Square, Dundee, DD1 3BA

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