



Grangemouth FPS

Phase 7 Ground Investigation Works - Habitats Regulations Appraisal

September 2020

Falkirk Council



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Project No: B2386100
Document Title: Phase 7 Ground Investigation Works - Habitats Regulations Appraisal
Revision: 0.5
Document Status: Draft
Date: September 2020
Client Name: Falkirk Council
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File Name: Grangemouth FPS GI Works HRA Screening_draft

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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
0.1	18/03/2020	First Draft	FT	LM	PG	
0.2	22/04/2020	Amendments to programme	FT	LM	PG	AMcG
0.3	04/05/2020	Updates post-SNH discussion	LM	FT	FT	AMcG
0.4	24/06/2020	Updates post-SNH review & to include compensatory habitat sites	LM	JF	PG	AMcG
0.5	02/09/2020	Updates post-SNH review	LM	PS	PG	AMcG

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1. Introduction

The Grangemouth Flood Protection Scheme (FPS) is being progressed by Falkirk Council with the primary aim to reduce flood risk to the communities of Carron, Carronshore, Langlees, Glensburgh and Grangemouth from fluvial and coastal flooding. The Grangemouth area is within the Forth Estuary Local Plan District and has been identified as a Potentially Vulnerable Area (PVA) with respect to flooding in the Forth Estuary Flood Risk Management Strategy, which was published by SEPA in 2015 (SEPA, 2015). The Local Flood Risk Management Plan for the Forth Estuary Local Plan District was published in June 2016 (City of Edinburgh Council, 2016) and includes details on the proposed Scheme, which is identified as the highest priority scheme in Scotland.

To inform the design and construction of the Grangemouth Flood Protection Scheme, ground investigation (GI) works at 18 locations (comprising of boreholes and cone penetration testing (CPT)) and sampling of the mudflats for proposed soil mixing are required to be undertaken within and adjacent to the Petroineos site located at Grangemouth. The Petroineos site is located adjacent to the Firth of Forth estuary and therefore the Firth of Forth Special Protection Area (SPA) and Ramsar site (Figure 1).

In addition, to inform the design and construction of the compensatory habitat required for the proposed Scheme, eight machine excavated trial pits and surface water sampling at five locations are required at Kinneil Lagoon, and six hand dug trial pits and surface water sampling at three locations are required at Bothkennar Pools. Both sites are located within the Firth of Forth SPA and Ramsar site.

Due to the works' proximity to the internationally designated sites (as shown in Figure 2), this Habitats Regulations Appraisal (HRA) has been produced to fulfil the requirements of the Habitats Directive 92/43/EEC and Conservation (Natural Habitats, &c.) Regulations 1994 (as amended for Scotland).

2. Proposed Works

2.1 Existing Conditions

The GI works for the flood protection scheme are predominantly within an industrial setting: the Petroineos petrochemical complex consists of bare ground, industrial buildings and infrastructure (Photograph 1). Floodlights positioned around the complex illuminate the site during the hours of darkness and there is pipework and a railway located along the northern side of the site adjacent to the estuary.



Photograph 1: Typical view of Petroineos petrochemical complex

Sampling is proposed to take place on the mudflats along the southern shore of the Firth of Forth estuary between the mouth of the River Avon to Grange Burn (Photograph 2) to inform proposed soil mixing during the main works.



Photograph 2: Mudflat habitat in front of the Petroineos petrochemical complex

Kinneil Lagoons (Photograph 3) is located between Grangemouth and Bo'ness and is an important waterbird high tide roost within the inner Forth. The lagoons were created when the intertidal zone was reclaimed in 1969, when a seawall was built along the seaward side as part of the Kinneil Kerse landfill site operation. The lagoons are linked to the Forth through a series of large pipes in the seawall, which allows sea water to come in and go out with each tidal cycle. The resulting saline lagoon/mud habitat is an uncommon habitat on the Forth



Photograph 3: Kinneil Lagoon

Bothkennar Pools lie between Skinflats Village and the River Carron and feature both saline and freshwater lagoons which formed due to subsidence caused by past undermining of the land.



Photograph 4: Bothkennar Pools

2.2 Site Investigation Works

2.2.1 GI Works

GI works at 18 locations are proposed comprising: boreholes (labelled as BHA/BHG on Figure 2) and CPT (labelled as CPTA/CPTG on Figure 2). All GI points are located within the Petroineos site boundary with the exception of three points (BHA303, BHA304 and BHA305) located outwith the site boundary, in an area known as the old fire training area, adjacent to the estuary (but on Petroineos owned land).

Borehole investigations consist of an initial hand dug hole (to 1.2m below ground level). Due to the anticipated depths required to be investigated, boreholes will likely be formed using two methods of drilling: cable percussive drilling; and wireline drilling. Cable percussive drilling is a common method of forming boreholes through soil strata and is undertaken using a mobile tripod-type rig with the drill string winched, suspended and dropped from a pulley and may emit 74 dB(A) at 10m (Jacobs, 2019). Wireline drilling shall be advanced from the base of the cable percussive hole using a wireline drilling system which takes a core of the soils as it advances. Wireline drilling rigs can vary from tracked drilling rigs to being mounted on the back of a Unimog (all-wheel drive medium truck) and may emit 107-109 dB(A) (at source) (Jacobs, 2019), which would attenuate to approximately 89 dB(A) at 10m (MAS Environmental, 2006). Duration for boreholes is likely to be around 1.5 to 2 weeks per position, assuming a normal working shift between 08:00-18:00, and some working outwith daylight hours may be required. There will be two drill rig operators wearing hi-visibility clothing at each rig at all times when the rig is operational. There will also likely be one or two additional people periodically throughout the work shift, either delivering materials/equipment or supervising the works.

CPT investigations consist of an initial hand dug hole (to 1.2m below ground level) and then an instrumented cone is pushed into the ground at a controlled rate from under a truck or similar. Duration is likely to be for one or two days per position, assuming a normal working shift between 08:00-18:00, and may emit 70 dB(A) (at source) (Jacobs 2019). Works outwith daylight hours may be required. There will be two CPT rig operators, wearing hi-visibility clothing, at each CPT position at all times when the rig is operational. There will also likely be one or two additional people periodically throughout the day supervising and observing the works. Note that as this method of works is usually self-contained within the CPT rig, once the test has commenced, all personnel will usually be within the rig while it is operational.

Please note that all noise levels quoted above are a guide and may vary depending on the plant the contractor has available and selects to undertake the works.

Examples of the approximate GI locations in context with the local environment are shown below. Infrastructure within the Petroineos site, such as pipework around the perimeter fence line, provides artificial screening between many of the GI points and the estuary (Photograph 5). All GI points are set-back from the estuary, being either located in the Petroineos site, or outwith the Petroineos site but adjacent to the perimeter fence (Photograph 6). Many of the GI locations are screened from the estuary and Grange Burn by natural (scrub and woodland) and artificial (fencing and industrial infrastructure) screening (Photographs 7 and 8).



Photograph 5: Typical pipework along the perimeter of the Petroineos site. Photograph taken shows approximate location of BHA306 which is positioned within the railway corridor set-back from the estuary within the petrochemical site.



Photograph 6: View of the estuary from the north of the site. GI points BHA307 and BHA308 are located within the Petroineos site boundary set-back from this part of the estuary.



Photograph 7: View of Petroineos site looking north. Shows typical environment of BHG101, CPTG101 and BHG102 with fencing and natural screening between the works and the Grange Burn located to the left of fence line.



Photograph 8: Pond located between BHG103 and CPTG103 set within an area of woodland within the Petroineos site. Photograph taken adjacent to BHG103 looking north. The SPA/Ramsar is located to the west and north of this location.

2.2.2 Soil Mixing Sampling

Ten 10kg samples are to be collected from the intertidal area in front of the Petroineos petrochemical complex (Figure 3) to inform soil mixing during main works. Samples will be taken from the proposed coastal revetment footprint for the proposed Scheme which extends to 7m from the defences which follow the estuary edge. Samples will be collected by digging to a maximum depth of 2m by the smallest possible tracked excavator suitable for the works. This is unlikely to be larger than a 5 tonne excavator which has the following potential dimensions: 2550mm height, 1960mm width and overall length of 5330mm (Balloo Hire Centres, 2020). The excavator will sit on the existing rock and grass revetment/verge to collect samples (Photographs 9-11), and track to the next position without entering the mud. Protective (bog) mats will be used to stabilise the excavator, if required. Samples will be taken when the tide is at a suitable level to undertake the works safely, which is considered to be 3 hours either side of low tide. It is anticipated that all samples will be collected within two days. There will be one machine operator and likely two to three additional people supervising and observing the works, all wearing hi-visibility clothing.

Access will be taken through the Petroineos site to the old fire training ground outside of the Petroineos fence line next to the estuary.



Photograph 9: Mudflats in front of Petroineos showing rock and grass revetment/verge in background.



Photograph 10: Looking out to the Firth of Forth Estuary, with Petroineos behind the photographer, showing rock verge along shoreline.



Photograph 11: Looking east towards the mouth of the River Avon showing rock revetment/verge.

2.2.3 Compensatory Habitat Site Investigations

2.2.3.1 Kinneil Lagoon

Intrusive investigation works at the Kinneil Lagoon site are proposed to investigate the physical and chemical composition of the site soils (made-ground) used to reclaim the site area (Diagram 1). The works will also investigate whether there has been any significant impact from the Kinneil Kerse Landfill, which was to the east of the lagoon, on the site groundwater/surface water quality.

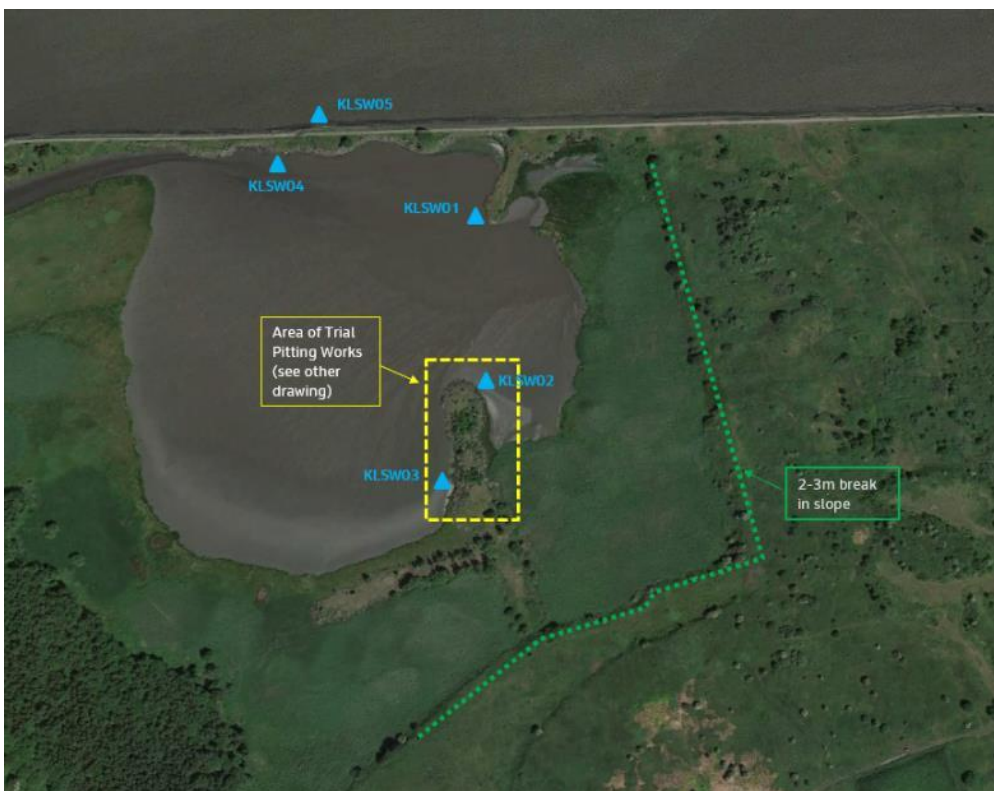


Diagram 1: Location of trial pits and surface water sampling (KLSW) at Kinneil Lagoon

Eight machine excavated trial pits on the spit of land protruding from the south shore of the lagoon are proposed (Diagram 2). Six of these (TP01-TP06) will be dug to a depth of approximately 3.5m below ground level to

characterise the materials that may be disturbed during construction of the compensatory habitat. TP7 and TP8 will be dug to a depth of 1.0m to collect 10kg samples from the tidal mudflat deposits within the lagoon. Trial pits are usually carried out either by a 360-degree tracked excavator, or a wheeled mechanical backhoe excavator, which may emit 79dB(A) at 10m (R Allan, pers. comm., 11 June 2019), which will access the area by the Kinneil Kerse Recycling Centre to the southeast of the site; no machines will be tracked along the estuary embankment. It is anticipated that all trial pits will be completed within two days. There will be one machine operator and likely one or two additional people supervising and observing the works, all wearing hi-visibility clothing.



Diagram 2: Location of machine excavated trial pits (TP) at Kinneil Lagoon

Surface water sampling and analysis is also proposed at five locations (four within the lagoon and one from the Firth of Forth) (Diagram 1) to investigate any currently observable impacts to the lagoon water quality from the landfill seepages/discharges that could impact upon the qualifying interests of the SPA/Ramsar site that are intended to roost at the compensatory site. Surface water sampling will be undertaken by a maximum of two people accessing the site on foot and collecting samples with a bucket and sampling jars. Collection of all five samples will take no more than a couple of hours.

2.2.3.2 Bothkennar Pools

Intrusive investigation works at the Bothkennar Pools (Diagram 3) are proposed to investigate the physical and chemical composition of the site soils (made ground) used to reclaim the site area following the diversion of the River Carron in the late 1800s. Surface water sampling and analysis is also proposed.

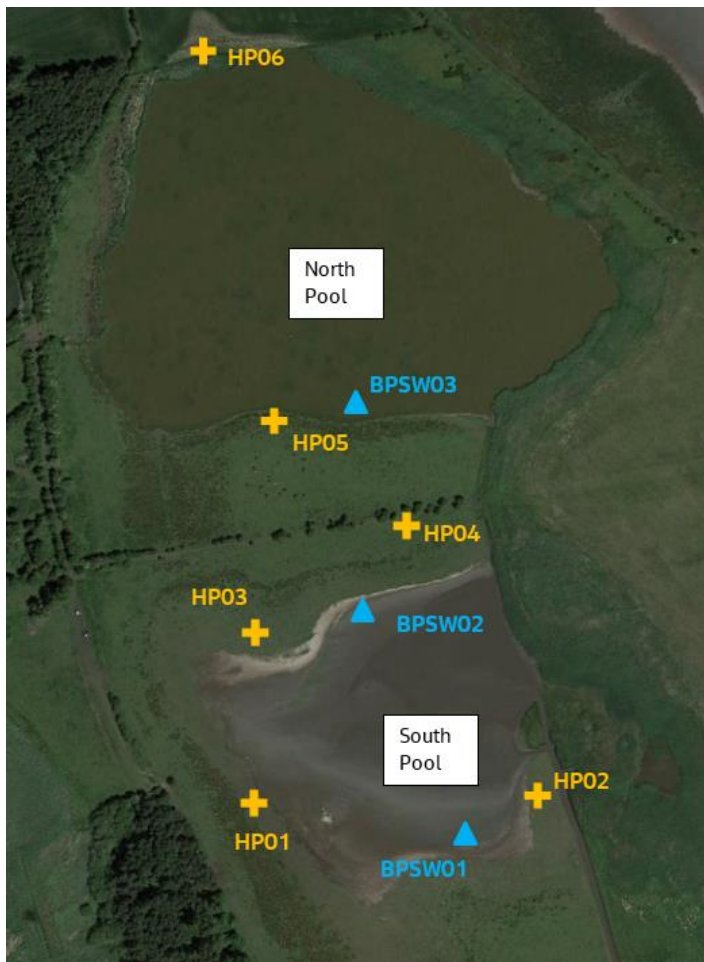


Diagram 3: Location of hand pits (HP) and surface water sampling (BPSW) at Bothkennar Pools

Six hand excavated pits, located around the two pools, are proposed (Diagram 3). These will be dug to a depth of 1.2m below ground level to investigate the local variations in ground conditions including thickness and composition of made ground and the risks posed to the proposed Scheme by potential contaminants present and their leachability. Pits will be dug by hand by two people. One or two additional people will be present supervising and observing the works, all wearing hi-visibility clothing. It is anticipated that all pits will be completed within two days.

Surface water sampling and analysis is also proposed at three locations, two from the south pool and one from the north pool, to investigate the chemical quality of the pools (Diagram 3). Surface water sampling will be undertaken by a maximum of two people accessing the site on foot and collecting samples with a bucket and sampling jars. Collection of all samples will take approximately one hour.

2.3 Programme

GI works are programmed to begin in mid-August 2020 and finish in December 2020, however some works may be undertaken in early-2021 depending on the Contractor's progress. BHA303, BHA304 and BHA305 will be prioritised in the programme and will be undertaken first. As some of the GI works will be undertaken in winter months, there is the potential for work shifts to extend into hours of darkness as a result of restricted daylight hours. Working during the hours of darkness would likely require lighting at the rigs to supplement existing floodlights within the Petroineos site.

Soil mixing sampling and the compensatory habitat site investigations are programmed to be undertaken in September 2020.

3. Stage 1 – Screening

3.1 Introduction

Screening identifies the likely significant effects on European/Ramsar sites from a project or plan, either alone or in combination with other projects or plans. Unless a significant effect can be objectively ruled out with certainty, it is considered 'likely'. The identification of likely significant effects therefore, requires an understanding of source effects pathways from the project and the specific features and environmental conditions of the protected site concerned.

In the Waddenzee judgement (European Court of Justice in Case C-127/02) the European Court of Justice ruled that the screening implies that all the aspects of a plan or project which can, by themselves or in combination with other plans or projects, affect the site's conservation objectives must be identified in the light of the best scientific knowledge i.e. *"where no reasonable scientific doubt remains as to the absence of such effect"*.

3.2 European Sites with Potential Effects from Works

The site investigation works are not directly connected with or essential for the management of any European or Ramsar site. Soil mixing sampling and the compensatory habitat site investigations are located within the Firth of Forth SPA and Ramsar sites. The GI works are located approximately 10-715m from the Firth of Forth SPA and Ramsar sites.

The Firth of Forth SPA (UK9004411 / 8499) and Ramsar site (UK13017 / 8424) are designated for wintering wildfowl and waders, and Sandwich tern (*Sterna sandvicensis*) on passage, as well as internationally important assemblages over winter (SNH, 2020ab; JNCC, 2008a, 2018). These birds use the mudflats, saltmarshes and other intertidal habitats within the Firth of Forth, mostly during winter but with peak numbers for shelduck, eider, red-throated diver, cormorant, great crested grebe, lapwing, ringed plover, curlew and Sandwich tern in August and September (Woodward et al., 2015). Sandwich tern are present during passage in late July/August to September. There is potential for effects pathways on qualifying interests which are found within the inner Forth during the site investigation works.

Cormorant from Loch Leven are known to travel to the Firth of Forth (Wright, 2003). Loch Leven is the largest natural eutrophic lake in Britain and is designated as a SPA and Ramsar. The site investigation works are located approximately 25km southwest from the Loch Leven SPA and Ramsar sites; no works within the SPA/Ramsar boundary are required. The Loch Leven SPA (UK9004111 / 8530) and Ramsar site (UK13033 / 8436) are designated for supporting wintering wildfowl and waders (SNH, 2020cd; JNCC, 2008b). None of the qualifying interests wintering on Loch Leven will be disturbed as a result of the proposed Scheme. Individuals may be disturbed if visiting the Firth of Forth from Loch Leven. However, due to the wide availability of alternative habitat in the Forth Estuary no potential for LSE during site investigation works with regards to disturbance is identified and the site is not considered further.

No ecological connectivity or potential source effects pathways to other European/Ramsar sites or their qualifying interest have been identified.

Qualifying interests, conservation objectives and pressures on feature condition (Scotland's Environment, 2020) are presented in Table 1 below.

Table 1: European and Ramsar Sites with Potential for Likely Significant Effects (LSEs) from the Works

Area (ha)	Qualifying Interest	Conservation Objective	Identified Feature Pressure
UK9004411 / 8499 Firth of Forth SPA (JNCC, 2018; SNH, 2020a)			
6317.93 ¹	<p>The site qualifies under Article 4.1 of the Directive (79/409/EEC) by regularly supporting wintering populations of European importance of the following Annex 1 species:</p> <ul style="list-style-type: none"> Bar-tailed godwit (<i>Limosa lapponica</i>)*, non-breeding Golden plover (<i>Pluvialis apricaria</i>)*, non-breeding Slavonian grebe (<i>Podiceps auritus</i>)*, non-breeding Red-throated diver (<i>Gavia stellata</i>)*, non-breeding Sandwich tern (<i>Sterna sandvicensis</i>), passage <p>The site qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting wintering populations of European importance of the following migratory species:</p> <ul style="list-style-type: none"> Knot (<i>Calidris canutus</i>)*, non-breeding Pink-footed goose (<i>Anser brachyrhynchus</i>)*, non-breeding Redshank (<i>Tringa totanus</i>)*, non-breeding Shelduck (<i>Tadorna tadorna</i>)*, non-breeding Turnstone (<i>Arenaria interpres</i>)*, non-breeding <p>The site qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting a wintering waterfowl assemblage of national importance. Assemblage qualifying interests (all non-breeding):</p> <ul style="list-style-type: none"> Common scoter (<i>Melanitta nigra</i>) Cormorant (<i>Phalacrocorax carbo</i>) Curlew (<i>Numenius arquata</i>) Dunlin (<i>Calidris alpina alpina</i>) Eider (<i>Somateria mollissima</i>) Goldeneye (<i>Bucephala clangula</i>) Great crested grebe (<i>Podiceps cristatus</i>) 	<p>To avoid deterioration of the habitats of the qualifying interests or significant disturbance to the qualifying interests, thus ensuring that the integrity of the site is maintained; and</p> <p>To ensure for the qualifying interests that the following are maintained in the long term:</p> <ul style="list-style-type: none"> population of the species as a viable component of the site distribution of the species within site distribution and extent of habitats supporting the species structure, function and supporting processes of habitats supporting the species no significant disturbance of the species 	<ul style="list-style-type: none"> game/fisheries management recreation/disturbance water quality climate change natural event

Area (ha)	Qualifying Interest	Conservation Objective	Identified Feature Pressure
	<ul style="list-style-type: none"> ▪ Grey plover (<i>Pluvialis squatarola</i>) ▪ Lapwing (<i>Vanellus vanellus</i>) ▪ Long-tailed duck (<i>Clangula hyemalis</i>) ▪ Mallard (<i>Anas platyrhynchos</i>) ▪ Oystercatcher (<i>Haematopus ostralegus</i>) ▪ Red-breasted merganser (<i>Mergus serrator</i>) ▪ Ringed plover (<i>Charadrius hiaticula</i>) ▪ Scaup (<i>Aythya marila</i>) ▪ Velvet scoter (<i>Melanitta fusca</i>) ▪ Wigeon (<i>Mareca penelope</i>)² 		
UK13017 / 8424 Firth of Forth Ramsar (JNCC, 2008a; SNH, 2020b)			
6313.68	<p>The site qualifies under Ramsar criterion 5: Assemblages of international importance. Species with peak counts in winter:</p> <ul style="list-style-type: none"> ▪ 72281 waterfowl (5-year peak mean 1998/99-2002/2003) <p>The site qualifies under Ramsar criterion 6: Species/populations occurring at levels of international importance. Qualifying interests/populations with peak counts in spring/autumn:</p> <ul style="list-style-type: none"> ▪ Pink-footed goose ▪ Shelduck ▪ Redshank ▪ Turnstone <p>Qualifying species/populations with peak counts in winter:</p> <ul style="list-style-type: none"> ▪ Slavonian grebe ▪ Goldeneye ▪ Knot ▪ Bar-tailed godwit 	<p>The Ramsar Convention's mission is '<i>the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world</i>'.</p>	<ul style="list-style-type: none"> ▪ game/fisheries management ▪ natural event ▪ recreation/disturbance

Area (ha)	Qualifying Interest	Conservation Objective	Identified Feature Pressure
	<ul style="list-style-type: none"> Qualifying passage species: Sandwich tern³ 		
UK9004111 / 8530 Loch Leven SPA (SNH, 2020c)			
1,611.29	<p>The site qualifies under Article 4.1 of the Directive (79/409/EEC) by regularly supporting populations of European importance of the following Annex I species:</p> <ul style="list-style-type: none"> Whooper swan (<i>Cygnus cygnus</i>), non-breeding <p>The site qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting populations of European importance of the following migratory species:</p> <ul style="list-style-type: none"> Pink-footed goose, non-breeding <p>The site qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting a waterfowl assemblage of national importance. Assemblage qualifying species (all non-breeding):</p> <ul style="list-style-type: none"> Cormorant Gadwall (<i>Anas strepera</i>) Goldeneye Pochard (<i>Aythya ferina</i>) Shoveler (<i>Anas clypeata</i>)³ Teal (<i>Anas crecca</i>) Tufted duck (<i>Aythya fuligula</i>) 	<p>To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and</p> <p>To ensure for the qualifying species that the following are maintained in the long term:</p> <ul style="list-style-type: none"> population of the species as a viable component of the site distribution of the species within site distribution and extent of habitats supporting the species structure, function and supporting processes of habitats supporting the species no significant disturbance of the species 	n/a ⁴
UK13033 / 8436 Loch Leven Ramsar (JNCC, 2008b; SNH, 2020d)			
1,611.8	<p>The site qualifies under Ramsar criterion 1 (<i>A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region</i>):</p> <ul style="list-style-type: none"> Largest naturally eutrophic loch in Britain 	<p>The Ramsar Convention's mission is 'the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world'.</p>	n/a ⁴

Area (ha)	Qualifying Interest	Conservation Objective	Identified Feature Pressure
	<p>The site qualifies under Ramsar criterion 5 (<i>A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds</i>):</p> <p>Species with peak counts in winter:</p> <ul style="list-style-type: none"> 18,463 waterfowl (5-year peak mean 1998/99-2002/03) <p>The site qualifies under Ramsar criterion 6 (<i>A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird</i>):</p> <p>Qualifying species/populations with peak counts in spring/autumn:</p> <ul style="list-style-type: none"> Shoveler <p>Qualifying species/populations with peak counts in winter:</p> <ul style="list-style-type: none"> Pink-footed goose 		

*species also an assemblage qualifier.

¹Listed as 6317.93ha on SiteLink (SNH, 2020a).

² Formerly *Anas penelope*

³Listed as a qualifying species on SiteLink only (SNH, 2020bc).

⁴Site is not included in Scotland's Environment Pressures webpage

3.3 Screening

After evaluating the potential effects pathways based on the proposed works (Section 2), it was concluded that noise and visual disturbance would be a potential pathway for likely significant effects (LSE) on the qualifying interests of the Firth of Forth SPA and Ramsar site for all works. Habitat loss and changes in water quality would only be potential pathways for LSE for the soil mixing sampling and compensatory habitat site investigations as these will be undertaken within the SPA and Ramsar site.

Tables 2-4 present the Screening for all works. The following considerations have been made to determine the potential for LSEs:

- the species of bird present, including specific sensitivities and pressures;
- the location of the works in relation to the Firth of Forth SPA/Ramsar;
- the existing conditions i.e. natural screening, situation of the works;
- the working methods to undertake each investigation; and
- the programme of works.

Noisy activities (above 70dB) can cause disturbance to birds instigating a behavioural response (such as flight response/displacement). Over distance, noise will attenuate and can be lessened to an acceptable level to elicit minor or no behavioural responses when experienced by the bird. Based on Cutts, Hemmingway and Spencer (2013) it is prudent to suggest that any GI works emitting noise of 110dB (which is approximately the maximum noise generated from drilling rigs) could cause a low level response from birds at 85m from the works (such as a 'heads-up' response) as the noise will likely have attenuated to acceptable levels (approximately ≤ 70 dB). However, within 85m the noise is likely to cause a behavioural response (such as flight) and as such mitigation could be required. Machine excavated trial pits, which emit approximately 79dB at 10m, will reach acceptable levels (≤ 70 dB) at approximately 20m. It is considered that CPT investigations are unlikely to cause a behavioural response (such as flight or displacement) as these investigations emit approximately 70dB ('acceptable' levels of noise) at source.

Visual stimuli are more likely to elicit a behavioural response before associated noise starts. It is likely that works within 100m of bird activity, assuming direct line of sight, would cause disturbance causing a flight response. A generic threshold response to visual disturbance predicts that works over 300m are likely to only elicit a low level "heads-up" response or no response (Cutts, Hemmingway and Spencer, 2013). It should be noted that habituation to background disturbance, and presence of other visual stimuli, is likely to lessen, or negate the impact.

A Zone of Influence (ZOI) from the works of 300m has been identified as appropriate by reviewing studies on disturbance distance/response thresholds for each qualifying species of the Firth of Forth SPA and Ramsar site. A summary of this review and the thresholds for each qualifying species can be found in Appendix A. The bird data recorded for the proposed Scheme shows the numbers of birds within this ZOI which could be affected, the locations at which aggregations of birds occur, during which period of the year and at what tidal state.

Large numbers of qualifying interests of the Firth of Forth SPA/Ramsar are known to occur within the ZOI during the winter months. Some species' numbers peak in August and September within the ZOI, of particular interest are a large flock of moulting shelduck which have been recorded at least 286m from the edge of the estuary (Figure 3). Only infrequent, low numbers of Sandwich tern were recorded in the area around Grangemouth during the passage period (MacArthur Green, 2017).

Table 2: Screening of GI Locations

GI Point	Approximate Distance to SPA/Ramsar (m)	Potential Effects and Commentary	Screening Conclusion
BHG101	715	The GI point is located within the Petroineos site boundary located adjacent to an access road and the	No potential for LSE. Appropriate

GI Point	Approximate Distance to SPA/Ramsar (m)	Potential Effects and Commentary	Screening Conclusion
		Grange Burn. The GI point is distant from the SPA/Ramsar and it is screened from the SPA/Ramsar by infrastructure within the petrochemical site as well as vegetation along the Grange Burn. There is unlikely to be any disturbance to qualifying interests of the SPA/Ramsar as there is sufficient distance for noise to attenuate and existing screening between the GI works and the SPA/Ramsar to lessen/negate visual disturbance. Furthermore, due to the existing screening present and the distance between the GI point and the SPA/Ramsar, light spill from any hours of darkness works will unlikely reach any sensitive habitats.	Assessment (Stage 2) is not required
BHG102	395	The GI point is located within the Petroineos site boundary located adjacent to an access road and the Grange Burn. The GI point is screened from the SPA/Ramsar by infrastructure within the petrochemical site as well as pipework and rail bridges across the Grange Burn downstream of the GI point. There is unlikely to be any disturbance to qualifying interests of the SPA/Ramsar as there is sufficient distance for noise to attenuate and existing screening between the GI works and the SPA/Ramsar to lessen/negate visual disturbance. Furthermore, due to the existing screening present and the distance between the GI point and the SPA/Ramsar, light spill from any hours of darkness works will unlikely reach any sensitive habitats.	No potential for LSE. Appropriate Assessment (Stage 2) is not required
BHG103	70	The GI point is located within the Petroineos site boundary located adjacent to a pond and the Grange Burn. The GI point is screened from the SPA/Ramsar by a bridge across the Grange Burn carrying rail and pipework associated with the petrochemical site and by scrub/woodland along the bank of the Grange Burn. There is unlikely to be any disturbance to qualifying interests of the SPA/Ramsar as there is sufficient existing screening between the GI works and the SPA/Ramsar for noise to attenuate and to lessen/negate visual disturbance. Furthermore, due to the existing screening present and the distance between the GI point and the SPA/Ramsar, light spill from any hours of darkness works will unlikely reach any sensitive habitats.	No potential for LSE. Appropriate Assessment (Stage 2) is not required
BHA301	40	The GI point is located within an area of hardstanding at the end of an access track within the Petroineos site. The GI point is screened from the estuary by pipework associated with the petrochemical plant as well as naturally screened by scrub along the petrochemical site boundary. The GI point occupies a	Potential for LSE. Appropriate Assessment (Stage 2) is required.

GI Point	Approximate Distance to SPA/Ramsar (m)	Potential Effects and Commentary	Screening Conclusion
		set-back position away from the estuary as well as being situated within an industrial setting. There is sufficient existing screening between the GI works and the SPA/Ramsar for noise to attenuate and to lessen visual disturbance. However, any lighting required during works in hours of darkness has the potential to spill onto sensitive habitats. Although it is likely that there will be some shading from the pipework along the Petroineos site boundary, as a precaution, in the absence of mitigation, it is considered that works during the hours of darkness have the potential to disturb qualifying interests within the SPA/Ramsar if qualifying interests use the estuarine habitats adjacent to this GI point for roosting.	
BHA302	40	The GI point is located within an area of hardstanding between two cylindrical containers within the Petroineos site. The GI point is screened from the estuary by pipework associated with the petrochemical plant and receives some natural screening by scrub along the petrochemical site boundary. The GI point occupies a set-back position away from the estuary as well as being situated within an industrial setting. There is sufficient existing screening between the GI works and the SPA/Ramsar for noise to attenuate and to lessen visual disturbance. However, any lighting required during works in hours of darkness has the potential to spill onto sensitive habitats. Although it is likely that there will be some shading from the pipework along the boundary, as a precaution, in the absence of mitigation, it is considered that works during the hours of darkness have the potential to disturb qualifying interests within the SPA/Ramsar if qualifying interests use the estuarine habitats adjacent to this GI point for roosting.	Potential for LSE. Appropriate Assessment (Stage 2) is required.
BHA303	100	The GI point is located within an area of scattered scrub and broadleaved trees adjacent to the estuary, known as the old fire training area, outwith the Petroineos site boundary. This GI point is naturally screened from the Firth of Forth by vegetation and occupies a set-back position away from the estuary adjacent to an industrial setting. There is sufficient distance from the GI point for sound to attenuate from the works. However, as this GI point is located outwith the petrochemical site and there is no physical barrier (fence line) between the estuary, it is considered that there is the potential for some low-level visual disturbance from the works resulting from movement of people on the estuary side of the	Potential for LSE. Appropriate Assessment (Stage 2) is required.

GI Point	Approximate Distance to SPA/Ramsar (m)	Potential Effects and Commentary	Screening Conclusion
		boundary fence. Furthermore, any lighting required during works in hours of darkness has the potential to spill onto sensitive habitats, although it is likely that there will be some shading from the vegetation between the GI point and the estuary. Taking a precautionary approach, it is considered that works have the potential to disturb qualifying interests within the SPA/Ramsar.	
BHA304	65	The GI point is located within an area of scattered scrub and broadleaved trees adjacent to the estuary, known as the old fire training area, outwith the Petroineos site boundary. This GI point is naturally screened from the Firth of Forth by vegetation and occupies a set-back position away from the estuary adjacent to an industrial setting. However, as this GI point is located outwith the petrochemical site and there is no physical barrier (fence line) between the estuary, it is considered that there is the potential for some low-level visual disturbance from the works resulting from movement of people on the estuary side of the boundary fence. There is also the potential for low level disturbance to birds from noise generated by the investigations when combined with the visual disturbance associated with the works. Furthermore, any lighting required during works in hours of darkness has the potential to spill onto sensitive habitats, although it is likely that there will be some shading from the vegetation between the GI point and the estuary. Taking a precautionary approach, it is considered that works have the potential to disturb qualifying interests within the SPA/Ramsar.	Potential for LSE. Appropriate Assessment (Stage 2) is required.
BHA305	25	The GI point is located within an area of scattered scrub adjacent to the estuary, known as the old fire training area, outwith the Petroineos site boundary. This GI point is not fully naturally screened from the Firth of Forth; however, scrub vegetation and the set-back nature of the GI point, provides some natural visual screening from the estuary. However, as the GI point is not fully screened from the estuary the GI works will be visible to birds within the Firth of Forth and likely to cause visual disturbance. There is the potential for low level disturbance to birds from noise generated by the investigations when combined with the visual disturbance associated with the works. Furthermore, any lighting required during works in hours of darkness has the potential to spill onto sensitive habitats, although it is likely that there will be some shading from the scattered vegetation	Potential for LSE. Appropriate Assessment (Stage 2) is required.

GI Point	Approximate Distance to SPA/Ramsar (m)	Potential Effects and Commentary	Screening Conclusion
		between the GI point and the estuary. It is considered that works have the potential to disturb qualifying interests within the SPA/Ramsar.	
BHA306	30	The GI point is located within the Petroineos site boundary adjacent to a railway and is visually screened from the estuary by petrochemical associated infrastructure (pipework). The GI point occupies a set-back position away from the estuary as well as being situated within an industrial setting. There is sufficient existing screening between the GI works and the SPA/Ramsar for noise to attenuate and to lessen visual disturbance. However, any lighting required during works in hours of darkness has the potential to spill onto sensitive habitats. Although it is likely that there will be some shading from the pipework along the boundary, as a precaution, in the absence of mitigation, it is considered that works during the hours of darkness have the potential to disturb qualifying interests within the SPA/Ramsar if qualifying interests use the estuarine habitats adjacent to this GI point for roosting.	Potential for LSE. Appropriate Assessment (Stage 2) is required
BHA307	35	The GI point is located within the Petroineos site boundary adjacent to a railway and is visually screened from the estuary by petrochemical associated infrastructure (pipework). The GI point occupies a set-back position away from the estuary as well as being situated within an industrial setting. There is sufficient existing screening between the GI works and the SPA/Ramsar for noise to attenuate and to lessen visual disturbance. However, any lighting required during works in hours of darkness has the potential to spill onto sensitive habitats. Although it is likely that there will be some shading from the pipework along the boundary, as a precaution, in the absence of mitigation, it is considered that works during the hours of darkness have the potential to disturb qualifying interests within the SPA/Ramsar if qualifying interests use the estuarine habitats adjacent to this GI point for roosting.	Potential for LSE. Appropriate Assessment (Stage 2) is required
BHA308	45	The GI point is located within the Petroineos site boundary adjacent to a railway and is visually screened from the estuary by petrochemical associated infrastructure (pipework) and woodland outwith the boundary. The GI point occupies a set-back position away from the estuary as well as being situated within an industrial setting. There is sufficient existing screening between the GI works and the SPA/Ramsar for noise to attenuate and to lessen visual disturbance. Furthermore, due to the existing	No potential for LSE. Appropriate Assessment (Stage 2) is not required

GI Point	Approximate Distance to SPA/Ramsar (m)	Potential Effects and Commentary	Screening Conclusion
		screening present and the distance between the GI point and the SPA/Ramsar, light spill from any hours of darkness works will unlikely reach any sensitive habitats.	
BHA309	260	The GI point is located within the Petroineos site boundary and is visually screened from the estuary by rail and petrochemical associated infrastructure, as well as scattered scrub outwith the petrochemical site. There is unlikely to be any disturbance to qualifying interests of the SPA/Ramsar as there is sufficient distance for noise to attenuate and existing screening between the GI works and the SPA/Ramsar to lessen/negate visual disturbance. Furthermore, due to the existing screening present and the distance between the GI point and the SPA/Ramsar, light spill from any hours of darkness works will unlikely reach any sensitive habitats.	No potential for LSE. Appropriate Assessment (Stage 2) is not required
CPTG101	520	The GI point is located within the Petroineos site boundary located adjacent to industrial buildings and the Grange Burn. The GI point is distant from the SPA/Ramsar and it is screened from the SPA/Ramsar by infrastructure within the petrochemical site as well as vegetation along the Grange Burn. There is unlikely to be any disturbance to qualifying interests of the SPA/Ramsar as there is sufficient distance for noise to attenuate and existing screening between the GI works and the SPA/Ramsar to lessen/negate visual disturbance. Furthermore, due to the existing screening present and the distance between the GI point and the SPA/Ramsar, light spill from any hours of darkness works will unlikely reach any sensitive habitats.	No potential for LSE. Appropriate Assessment (Stage 2) is not required
CPTG102	240	The GI point is located within the Petroineos site boundary located adjacent to an access road and the Grange Burn. The GI point is screened from the SPA/Ramsar by infrastructure within the petrochemical site as well as pipework and rail bridges across the Grange Burn downstream of the GI point. There is unlikely to be any disturbance to qualifying interests of the SPA/Ramsar as there is sufficient distance for noise to attenuate and existing screening between the GI works and the SPA/Ramsar to lessen/negate visual disturbance. Furthermore, due to the existing screening present and the distance between the GI point and the SPA/Ramsar, light spill from any hours of darkness works will unlikely reach any sensitive habitats.	No potential for LSE. Appropriate Assessment (Stage 2) is not required

GI Point	Approximate Distance to SPA/Ramsar (m)	Potential Effects and Commentary	Screening Conclusion
CPTG103	10	The GI point is located within the Petroineos site boundary located adjacent to a bridge crossing the Grange Burn carrying rail and pipework associated with the petrochemical site. The GI point is located approximately 10m from the SPA/Ramsar at its closest point, however is visually screened by the bridge and scrub/woodland along the bank of the Grange Burn and occupies a set-back location from the estuary. There is unlikely to be any disturbance to qualifying interests of the SPA/Ramsar as there is sufficient existing screening between the GI works and the SPA/Ramsar for noise to attenuate and to lessen/negate visual disturbance. Furthermore, due to the existing screening present between the GI point and the SPA/Ramsar, light spill from any hours of darkness works will unlikely reach any sensitive habitats.	No potential for LSE. Appropriate Assessment (Stage 2) is not required
CPTG104	80	The GI point is located within the Petroineos site boundary located adjacent to a railway and pipework associated with the petrochemical site. The GI point is naturally visually screened by woodland outwith the petrochemical site boundary along the Grange Burn. There is unlikely to be any disturbance to qualifying interests of the SPA/Ramsar as there is sufficient existing screening between the GI works and the SPA/Ramsar for noise to attenuate and to lessen/negate visual disturbance. Furthermore, due to the existing screening present and the distance between the GI point and the SPA/Ramsar, light spill from any hours of darkness works will unlikely reach any sensitive habitats.	No potential for LSE. Appropriate Assessment (Stage 2) is not required
CPTA301	30	The GI point is located within the Petroineos site boundary adjacent to a railway and is visually screened from the estuary by petrochemical associated infrastructure (pipework) and woodland outwith the boundary. The GI point occupies a set-back position away from the estuary as well as being situated within an industrial setting. Lighting required during works in hours of darkness has the potential to spill onto sensitive habitats. Although any light spill would be very short term due to the nature of the CPT investigations and likely mostly shaded by pipework along the boundary, as a precaution, in the absence of mitigation, it is considered that works during the hours of darkness have the potential to disturb qualifying interests within the SPA/Ramsar if qualifying interests use the estuarine habitats adjacent to this GI point for roosting.	Potential for LSE. Appropriate Assessment (Stage 2) is required

GI Point	Approximate Distance to SPA/Ramsar (m)	Potential Effects and Commentary	Screening Conclusion
CPTA302	130	The GI point is located within the Petroineos site boundary and is visually screened from the estuary by rail and petrochemical associated infrastructure. The GI point occupies a set-back position away from the estuary as well as being situated within an industrial setting. There is unlikely to be any disturbance to qualifying interests of the SPA/Ramsar as there is sufficient distance for noise to attenuate and existing screening between the GI works and the SPA/Ramsar to lessen/negate visual disturbance. Furthermore, due to the existing screening present and the distance between the GI point and the SPA/Ramsar, light spill from any hours of darkness works will unlikely reach any sensitive habitats.	No potential for LSE. Appropriate Assessment (Stage 2) is not required

Table 3: Screening for Soil Mixing Sampling

Sampling Reference	Potential Effects and Commentary	Screening Conclusion
1-6	<p>Sampling locations 1-6 of the mudflats to inform soil mixing during the main works are located to the west of the old fire training area (where BHA303-BHA305 are located) (Figure 3). Works are programmed for September when qualifying interests are present and for some species, in peak numbers. It is therefore considered that there is potential for disturbance from the works resulting from movement of people and machinery, and from noise generated by the excavator, which could result in localised displacement of species.</p> <p>As the works are located within the SPA and Ramsar boundary, there is potential for temporary habitat loss under the footprint (excavator and sampling location) of works for the duration of sampling (two days).</p> <p>There is potential for changes in water quality from pollution events (e.g. accidental spillage, fuel leaks) during the works, which could have an indirect effect on qualifying species of the SPA and Ramsar.</p>	Potential for LSE. Appropriate Assessment (Stage 2) is required
7-10	<p>Sampling locations 7-10 of the mudflats to inform soil mixing during the main works are located to the east of the old fire training area (where BHA303-BHA305 are located) around the estuary edge to the mouth of the River Avon (Figure 3). Works are programmed for September when qualifying interests are present and for some species, in peak numbers. It is therefore considered that there is potential for disturbance from the works resulting from movement of people and machinery, and from noise generated by the excavator, which could result in localised displacement of species.</p> <p>As the works are located within the SPA and Ramsar boundary, there is potential for temporary habitat loss under the footprint</p>	Potential for LSE. Appropriate Assessment (Stage 2) is required

Sampling Reference	Potential Effects and Commentary	Screening Conclusion
	<p>(excavator and sampling location) of works for the duration of sampling (two days).</p> <p>There is potential for changes in water quality from pollution events (e.g. accidental spillage, fuel leaks) during the works, which could have an indirect effect on qualifying species of the SPA and Ramsar.</p>	

Table 4: Screening for compensatory habitat site investigations

Exploratory Hole/ Sampling Reference	Type	Potential Effects and Commentary	Screening Conclusion
Kinneil Lagoon			
TP01-TP06	Machine excavated trial pit to 3.5m	<p>The trial pits are located in an area of grassland approximately 7-19m from the edge of the lagoon. Works are programmed for September when qualifying interests are present and for some, in peak numbers. It is therefore considered that there is potential for disturbance from the works resulting from movement of people and machinery, and from noise generated by the excavator, which could result in localised displacement of species.</p> <p>As the works are located within the SPA and Ramsar boundary, there is potential for temporary habitat loss under the footprint (excavator and sampling location) of works for the duration of trial pitting (two days).</p> <p>There is potential for changes in water quality from pollution events (e.g. accidental spillage, fuel leaks) during the works, which could have an indirect effect on qualifying species of the SPA and Ramsar.</p>	Potential for LSE. Appropriate Assessment (Stage 2) is required
TP07 & TP08	Machine excavated trial pit to 1.0m	<p>The trial pit is located within the lagoon. Works are programmed for September when qualifying interests are present and for some species, in peak numbers. It is therefore considered that there is potential for disturbance from the works resulting from movement of people and machinery, and from noise generated by the excavator, which could result in localised displacement of species.</p> <p>As the works are located within the SPA and Ramsar boundary, there is potential for temporary habitat loss under the footprint (excavator and sampling location) of works for the duration of trial pitting (two days).</p> <p>There is potential for changes in water quality from pollution events (e.g. accidental spillage, fuel leaks) during the works, which could have an indirect effect on qualifying species of the SPA and Ramsar.</p>	Potential for LSE. Appropriate Assessment (Stage 2) is required

Exploratory Hole/ Sampling Reference	Type	Potential Effects and Commentary	Screening Conclusion
KLSW01-KLSW04	Surface water sampling - lagoon	Surface water sampling is programmed for September when some qualifying interests are present, and no machinery is required. Collection of all samples will take no more than a couple of hours. It is considered that sampling would be no more disturbing than what is currently experienced by qualifying interests from members of the public/dogwalkers.	No potential for LSE. Appropriate Assessment (Stage 2) is not required
KLSW05	Surface water sampling - estuary	Surface water sampling is programmed for September when some qualifying interests are present, and no machinery is required. Collection of all samples will take no more than a couple of hours. It is considered that sampling would be no more disturbing than what is currently experienced by qualifying interests from members of the public/dogwalkers.	No potential for LSE. Appropriate Assessment (Stage 2) is not required
Bothkennar Pools			
HP01 – HP06	Hand pit to 1.2m	The hand pit is located approximately 3-42m from the edge of the lagoon. Works are programmed for September when qualifying interests are present and for some species, in peak numbers. It is therefore considered that there is potential for visual disturbance to qualifying interests from the works resulting from movement of people, which could result in localised displacement of species. As the works are located within the SPA and Ramsar boundary, there is potential for temporary habitat loss under the footprint (excavator and sampling location) of works for the duration of works (two days).	Potential for LSE. Appropriate Assessment (Stage 2) is required
BPSW01 & BPSW02	Surface water sampling – south pool	Surface water sampling is programmed for September when some qualifying interests are present, and no machinery is required. Collection of all samples will take approximately one hour. It is considered that sampling would be no more disturbing than what is currently experienced by qualifying interests from members of the public/dogwalkers.	No potential for LSE. Appropriate Assessment (Stage 2) is not required
BPSW03	Surface water sampling – north pool	Surface water sampling is programmed for September when some qualifying interests are present, and no machinery is required. Collection of all samples will take approximately one hour. It is considered that sampling would be no more disturbing than what is currently experienced by qualifying interests from members of the public/dogwalkers.	No potential for LSE. Appropriate Assessment (Stage 2) is not required

3.4 Screening Conclusion

Screening identified disturbance from the proposed GI works, soil mixing sampling and trial pits through noise, movement (visual) and/or lighting as potential impact pathways on the qualifying interests of the Firth of Forth SPA and Ramsar sites. Habitat loss and changes in water quality (soil mixing sampling and machine excavated trial pits only) were also identified as LSEs during works. The nature and location of the works, and the proposed programme and working hours were considered in the screening with a precautionary approach adopted.

The screening, following this precautionary approach, identified an LSE on the qualifying interests of the SPA/Ramsar for eight of the GI points (BHA301, BHA302, BHA303, BHA304, BHA305, BHA306, BHA307 and CPTA301), all soil mixing sampling locations, and all machine and hand excavated trial pits, therefore Stage 2 (Appropriate Assessment) is required. No LSEs were identified as a result of undertaking the surface water sampling at Kinneil Lagoon and Bothkennar Pools. No minor residual effects (MRE) were identified and therefore no cumulative LSEs with other plans or projects are anticipated from these activities.

4. Stage 2 – Appropriate Assessment

4.1 Introduction

This section forms the Stage 2 (AA) step of the HRA process which was identified as required in Stage 1 (Screening) (Section 3). The AA considers the effect of the project or plan, either alone or in combination with other projects or plans (Section 5), on the integrity of the European/Ramsar site, with respect to the site's structure and function, and its conservation objectives.

The approach adopted for this AA (Section 4.3) assesses the implications from the identified LSE for the conservation objectives of the site and then identifies measures to protect the site's integrity.

4.2 Effects Pathways: Firth of Forth SPA and Ramsar Site

This section discusses effects pathways on the conservation objectives of the Firth of Forth SPA and Ramsar site. LSEs were identified on qualifying interests of the SPA and Ramsar site through:

- Disturbance/displacement of species:
 - during the GI works at eight locations, three of which are outwith the Petroineos site boundary;
 - during soil mixing sampling; and
 - during machine excavated and hand dug trial pits.
- habitat loss under the footprint (excavator and sampling location) of works during machine excavated and hand dug trial pits; and
- changes in water quality:
 - during soil mixing sampling; and
 - during machine excavated trial pits.

Disturbance (visual and noise) associated with the works could lead to localised displacement of qualifying interests of the SPA/Ramsar from areas used for foraging, loafing and roosting, and subsequent additional energy expenditure and loss of condition. Furthermore, lighting during works outwith daylight hours during winter has the potential to disturb bird species if the estuarine habitats adjacent to the GI points are used for roosting, leading to localised displacement of birds within the site.

The footprint of works, which would include the location of the machinery and sampling/trial pit location will result in a temporary loss of habitat available for qualifying interests of the SPA/Ramsar.

Changes in water quality from pollution (e.g. accidental spillage, fuel leaks) during works have the potential to have an indirect effect on qualifying species of the SPA and Ramsar through deterioration of localised habitats and the feeding resource for waders and waterfowl.

4.3 Assessment Against Conservation Objectives

The conservation objectives of the Firth of Forth SPA are below.

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site;
- Distribution of the species within site;
- Distribution and extent of habitats supporting the species;
- Structure, function and supporting processes of habitats supporting the species; and
- No significant disturbance of the species.

The Ramsar Convention's mission is '*the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world*'. It is Scottish Government policy to apply the same level of protection for Ramsar sites as is applied for SPAs classified under the EU Birds Directive (SNH, undated) therefore, for the purposes of HRA it is assumed that the Firth of Forth conservation objectives apply to the Firth of Forth Ramsar site.

As described above (Section 4.2), noise disturbance and visual disturbance (including lighting), habitat loss and changes in water quality from the proposed works were identified as potential pathways for LSE. Therefore, all conservation objectives could potentially be affected.

Large numbers of birds which are qualifying interests of the Firth of Forth SPA (and Ramsar) are known to occur in the vicinity of the proposed works during the winter months (MacArthur Green, 2017), the period for which the SPA/Ramsar is primarily designated. A moulting flock of shelduck are present in the Firth of Forth (Bryant, 1978; Green et al., 2019) and large numbers of shelduck were recorded on the mudflats in front of the Petroineos petrochemical complex/Kinneil Lagoon (Figure 4) (MacArthur Green, 2017). During the moulting period, shelduck are completely flightless and so are more vulnerable to disturbance and predation (Salomonsen, 1968). Extensive mudflat areas offer good protection from predation and human disturbance, whilst providing abundant food resources. The main moult period is between mid-July to mid-September, with peak counts in the first half of August (Bryant, 1978). The peak shelduck count during the surveys for the proposed Scheme was recorded in early August 2016 (MacArthur Green, 2017). Peak counts of cormorant (peak count of 60 in Sectors 5 and 6, which includes Bothkennar Pools and Port of Grangemouth breakwater), great crested grebe (peak count of 30 in Sector 11 which includes Kinneil Lagoon and the mudflats in front of the lagoon) and ringed plover (peak count of 210 in Sector 9 which is north of Petroineos) were recorded in September 2016 in the vicinity of the proposed works (MacArthur Green, 2017). These birds were likely on passage. A proportion may remain in the Firth of Forth for the winter, however most individuals will likely use the estuary for a relatively short period before moving further south for the winter.

Sandwich tern were only recorded infrequently and in low numbers in the area around Grangemouth during the passage period (MacArthur Green, 2017). It is therefore considered that there will be no significant disturbance or any other impacts to this species, for works undertaken in August and September 2020.

Machine and hand excavated trial pits at Kinneil Lagoon and Bothkennar Pools will be undertaken within the SPA/Ramsar boundary. The majority of the pits are located in rough marginal grassland. The majority of qualifying interests associated with the Firth of Forth estuary forage across exposed tidal flats, however species such as lapwing and golden plover can utilise grassland for foraging. However, the rough marginal grassland around the compensation sites contain vegetation that is too tall and dense for birds to utilise and often this can deter birds (particularly wader species) from these areas (Milsom et al., 1998). In general, most wader species utilise grassland with a sward height of between 5 and 10cm, whilst curlew are known to forage in sward heights of between 15-30cm (RSPB, 2005).

As all of the proposed works are temporary, of limited scale and duration the works therefore allow for flexibility in the programme to be undertaken within the least sensitive period. It is considered that avoidance measures to include timing works to be outwith sensitive periods and the key winter months (SNH, 2016), and implementation of mitigation following of best practice guidance with regard to lighting, noise/visual barriers and pollution prevention, would avoid adverse effects on site integrity (AESI) on the Firth of Forth SPA and Ramsar sites.

Tables 3-5 below set out the AA for the works which were identified to have the potential for LSE.

Table 3: Appropriate Assessment Table for All Qualifying Interests of the Firth of Forth SPA/Ramsar for GI Works

LSE	Commentary	Mitigation Measures	AA Determination After Mitigation
Disturbance (noise and visual, including lighting)	<p>Bird survey data (Macarthur Green, 2017) indicates high densities of qualifying interests are present (loafing, roosting and foraging) over winter in the estuarine habitats adjacent to the Petroineos site at Grangemouth. In addition, a large flock of shelduck are present on the mudflats in front of the Petroineos petrochemical complex/Kinneil Lagoon (Figure 4) during the moulting period (mid-July to mid-September) with numbers peaking in early August. Adopting a precautionary approach to assessment, works during these times have been identified to have the potential to cause disturbance to qualifying interests within the SPA/Ramsar, and LSEs for the GI points BHA301, BHA302, BHA303, BHA304, BHA305, BHA306, BHA307 and CPTA301 were identified. No LSEs were identified for any of the other GI points.</p> <p>The borehole investigation points are likely to take 1.5 to 2 weeks each to complete and CPT investigations would take 1-2 days. Both will require operatives in hi-vis to be present on site at all times during the operation of the rigs. Furthermore, lighting at the rigs is likely during winter works as daylight hours are limited and works during hours of darkness are likely to be required.</p> <p><u>BHA303, BHA304 and BHA305</u></p> <p>BHA303, BHA304 and BHA305 GI points all occupy a location that is outwith the Petroineos site and therefore have no direct barrier from the estuary and are situated in a more natural setting, albeit adjacent to a heavily industrialised site. There is some vegetation (woodland and scrub) present which provides some screening of the GI points; BHA303 is completely screened and BHA304 and BHA305 are only partially screened. However, there is no industrial infrastructure directly adjacent to the GI points. Therefore, the completion of BHA304 and BHA305 (which includes machinery, operatives and</p>	<p>To ensure that the conservation objectives for the qualifying interests are not compromised, the following avoidance/mitigation measures will be undertaken. The measures will be undertaken to prevent significant disturbance to, or a change in the distribution of, qualifying interests within the sites:</p> <ul style="list-style-type: none"> ▪ Timing the works to avoid peak times when most qualifying interests are present during winter. The following GI points will be undertaken between August and September 2020: BHA303, BHA304 and BHA305. The contractor will programme these three points so that BHA305 is undertaken first (which is closest to the estuary), followed by BHA304 and then BHA303. This is so that if there is a delay to works, the point(s) closest to the estuary is most likely to be completed outwith peak times. ▪ Vegetation clearance will be avoided as far as possible to maintain any natural screening that currently exists, particularly at BHA303, BHA304 and BHA305. Any required vegetation clearance will be discussed with an Ecological Clerk of Works (ECOW) prior to commencing. ▪ Visual screening (such as Heras Printed Barriers or Noise Barriers (Heras, 2020)) between the works and the estuary will be installed for BHA304 and BHA305 (BHA303 is completely screened from the estuary by vegetation). Screens should be located around the GI works to reduce the visual disturbance. Screens will be in place to mitigate against visual disturbance from the works, primarily, but also provide some sound attenuation to further reduce/negate noise disturbance. ▪ A construction lighting plan and method statement will be developed by the Contractor. The plan will detail specific mitigation requirements, including but not limited to measures to avoid light spill during investigations outwith daylight hours. 	No adverse effect on site integrity

LSE	Commentary	Mitigation Measures	AA Determination After Mitigation
	<p>lighting) are more likely to look incongruous and present a visual stimulus to qualifying interests using the estuary and could elicit a disturbance or displacement response. Although outwith the Petroineos site, BHA303, BHA304 and BHA305 occupy a set-back position from the estuary and consequently there will be some noise attenuation experienced as a result of the distance between the GI works and the SPA/Ramsar. However, as the GI works have the potential to create sudden disturbance there is the potential for the noise to elicit a behavioural response (disturbance or displacement) from birds within the estuary.</p> <p><u>BHA301, BHA302, BHA306, BHA307 and CPTA301</u></p> <p>BHA301, BHA302, BHA306, BHA307 and CPTA301 are all situated within an industrial setting and are largely screened from the works by pipework/industrial infrastructure and vegetation adjacent to the Petroineos site boundary. Noise and visual disturbance during daylight working is unlikely, however there is the potential for light spill during works during hours of darkness onto sensitive habitats which could lead to the disturbance/displacement of birds, if these habitats within the SPA/Ramsar are used by qualifying interests for roosting.</p>	<p>Measures to include the avoidance of reflective material under lights and avoidance of white-blue spectrum and high UV emitting lighting, to protect qualifying interests roosting near to the GI works. The lighting plan will take into account published guidance on lighting (e.g. Institution of Lighting Professionals (2011), The Royal Commission on Environmental Pollution (2009) and Bat Conservation Trust (2014)).</p> <ul style="list-style-type: none"> An ECoW will be appointed to provide ecological support to the Contractor throughout the GI works phase and will be on site when GI works at BHA303, BHA304 and BHA305 are taking place. The ECoW will be responsible for ensuring that mitigation, to include timing of the works, erection of visual screening and lighting management, is implemented and adhered to. For GI works at BHA301, BHA302, BHA306, BHA307 and CPTA301, ECoW presence during the works is not required given the setting of these investigations. However, the Contractor will discuss any lighting management with the ECoW if working outwith daylight hours is required to complete these investigations. 	

Table 4: Appropriate Assessment Table for All Qualifying Interests of the Firth of Forth SPA/Ramsar for Soil Mixing Sampling

LSE	Commentary	Mitigation Measures	AA Determination After Mitigation
Disturbance (noise and visual)	Bird survey data (Macarthur Green, 2017) indicates high densities of qualifying interests are present (loafing, roosting and foraging) over winter in the estuarine habitats adjacent to the Petroineos site at Grangemouth. In addition, numbers of ringed plover peaked in September in this area and a large flock of shelduck are present on	To ensure that the conservation objectives for the qualifying interests are not compromised, the following avoidance/mitigation measures will be undertaken. The measures will be undertaken to prevent significant disturbance to, or a change in the distribution of, qualifying interests within the sites:	No adverse effect on site integrity

LSE	Commentary	Mitigation Measures	AA Determination After Mitigation
	<p>the mudflats in front of the Petroineos petrochemical complex/Kinneil Lagoon during the moulting period (mid-July to mid-September) with numbers peaking in early August. Works during these times have been identified to have the potential to cause disturbance to qualifying interests within the SPA/Ramsar, and LSEs for all soil mixing sample locations were identified.</p> <p>The sediment sampling will be undertaken in September, along the estuary edge and will likely take two days to complete. The works will require a maximum of four people in hi-vis to be present on site at all times during the works. The works avoid the winter period when numbers peak for most qualifying interests, and early-August, when numbers of moulting shelduck peak. Soil mixing sampling will also be undertaken at low tide. Cutts and Allen (1999) observed that shelduck would feed within 300-500m from works, indicating that the flock of moulting shelduck which have been recorded a minimum of 286m from the edge of the estuary (MacArthur Green, 2017) will still be able to utilise the widely available alternative mudflat habitat during the two days of soil mixing sampling.</p> <p>Works will take place in September when numbers of ringed plover peaked on the mudflats in front of Petroineos petrochemical complex. Individuals are likely on passage and most birds will move on to winter further south. Should there be any disturbance to ringed plover, birds will be able to utilise the widely available alternative habitat during the two days of soil mixing sampling. Cormorant and great crested grebe numbers also peaked in September, but not in the vicinity of the soil mixing sample locations</p>	<ul style="list-style-type: none"> ▪ Timing the works to avoid peak times when most qualifying interests are present during winter. Soil mixing sampling will be undertaken in September 2020. ▪ An ECoW will be appointed to provide ecological support to the Contractor throughout the soil mixing sampling and will be on site when samples are taken. The ECoW will be responsible for ensuring that works are undertaken as described. 	
Habitat loss	The soil mixing sampling will be undertaken in September, along the estuary edge and will likely take two days to complete. Bird survey data (MacArthur Green, 2017) shows that seven qualifying interests roost and loaf in close proximity to sample locations 7-10 during	No mitigation is required.	

LSE	Commentary	Mitigation Measures	AA Determination After Mitigation
	<p>August and September, with most records around location 8. These seven species are lapwing (1-30 individuals), redshank (6-290 individuals), bar-tailed godwit (2 individuals), cormorant (1 individual), mallard (2-23 individuals) and shelduck (4-53 individuals). No birds were recorded within 60m of sample locations 1-6.</p> <p>Not all samples will be taken at the same time and other suitable alternative habitat around the estuary edge will be available. As a result of the short-duration and location of works, the distribution and extent of supporting habitat will be maintained for qualifying interests of the SPA and Ramsar.</p>		
Changes in water quality	<p>Soil mixing samples will be collected by an excavator located on a rock/grass verge along the edge of the estuary. Habitat used by qualifying interests of the SPA and Ramsar may be at risk from changes to water quality from pollution events, particularly accidental spillage and fuel leaks from the excavator used to collect the samples.</p>	<p>To ensure that the conservation objectives for the qualifying interests are not compromised, the following avoidance/mitigation measures will be undertaken. The measures will be undertaken to prevent significant disturbance to, or a change in the distribution of, qualifying interests within the sites:</p> <ul style="list-style-type: none"> Best practice methods (CIRIA, 2015) will be used including the use of appropriate pollution controls (i.e. Guidance for Pollution Prevention (GPPs)), such as a strict re-fuelling protocol. Plant nappies will be placed under the engines of all machinery. Spill kits will be available, and all personnel will be briefed on their use prior to works commencing. An ECoW will be appointed to provide ecological support to the Contractor throughout the soil mixing sampling and will be on site when samples are taken. The ECoW will be responsible for ensuring that pollution prevention is in place as described. 	No adverse effect on site integrity

Table 5: Appropriate Assessment Table for All Qualifying Interests of the Firth of Forth SPA/Ramsar for Compensatory Habitat Site Investigations

LSE	Commentary	Mitigation Measures	AA Determination After Mitigation
Kinneil Lagoon			
Disturbance (noise and visual)	<p>Bird surveys (MacArthur Green, 2017) recorded 11 species roosting within Kinneil Lagoon during August and September. Of the 11 species lapwing, redshank, shelduck and dunlin were recorded in greater numbers.</p> <p>A peak count of 660 dunlin was recorded in September 2016. Dunlin is relatively tolerant of disturbance, however displacement as a result of the works is likely to occur, but for a short duration of time and to alternative suitable habitat close by.</p> <p>A peak count of 300 shelduck was recorded in September 2016 in the lagoon. Bryant (1978) studied the moulting shelduck flock in the Forth estuary and noted that the main moulting area was within the estuary, north of Kinneil Lagoon. This location aligns with the findings of the bird surveys during which a peak count of 4700 shelduck was recorded in August 2016 at this location. The birds present in Kinneil Lagoon are therefore likely to be non-breeders and/or juvenile birds from the breeding season. Given the known location of the main moult flock in the Forth estuary (where mudflat and open water is available) the likelihood of impacts from disturbance as a result of the short duration works is considered low.</p> <p>A peak count of 500 redshank was recorded in September 2015 whilst a peak count of 590 lapwing was recorded in August 2015. Both species are known to utilise several locations across Grangemouth and along the estuary for both foraging and roosting and therefore are not limited to Kinneil Lagoon.</p> <p>Nine species were recorded foraging within Kinneil Lagoon during August and September 2015/16 (MacArthur Green, 2017). These nine species were also recorded foraging across the study area in</p>	<p>To ensure that the conservation objectives for the qualifying interests are not compromised, the following avoidance/mitigation measures will be undertaken. The measures will be undertaken to prevent significant disturbance to, or a change in the distribution of, qualifying interests within the sites:</p> <ul style="list-style-type: none"> Timing the works to avoid peak times when most qualifying interests are present during winter. Compensatory habitat site investigations at Kinneil Lagoon will be undertaken in September 2020. An ECoW will be appointed to provide ecological support to the Contractor throughout the compensatory habitat site investigations and will be on site during completion of the trial pits. The ECoW will be responsible for ensuring that works are undertaken as described. 	No adverse effect on site integrity

LSE	Commentary	Mitigation Measures	AA Determination After Mitigation
	<p>larger aggregations particularly across the extensive mudflats to the north and northwest of the petrochemical plant.</p> <p>A peak count of 634 bar-tailed godwit was recorded foraging in September 2016 in Kinneil Lagoon. Bar-tailed godwit utilise the intertidal sand and mudflats within the SPA for foraging for their preferred prey of bivalves such as <i>Macoma balthica</i>, <i>Scrobicularia plana</i> and <i>Mya arenaria</i>. At some sites, polychaete worms form a larger proportion of the diet and the species is relatively adaptable, utilising other habitats for foraging where available, such as terrestrial grassland, coastal marshes and freshwater lagoons (Woodward et al., 2015).</p> <p>All other qualifying interests were recorded infrequently in lower numbers during August and September 2015/16.</p> <p>The trial pits will be undertaken in September and will likely take two days to complete. The works will require a maximum of three people in hi-vis to be present on site at all times during the works. The works avoid the winter period when numbers peak in the lagoon for most qualifying interests.</p> <p>Disturbance is predicted to be localised with birds displacing to surrounding suitable habitat in the estuary in close proximity to Kinneil Lagoon. Displacement out of the SPA is not predicted for any species given the availability of alternative habitat and therefore the population of any species as a viable component of the site will not be affected. In addition, no effects in terms of the distribution of the species within the site and no significant disturbance of the species are predicted.</p>		
Habitat loss	<p>Bird survey data (MacArthur Green, 2017) indicates that the spit of land where trial pits will be dug is not utilised by qualifying interests of the SPA/Ramsar during August and September. Only two foraging mallard and one roosting dunlin were recorded within the</p>	No mitigation is required.	No adverse effect on site integrity

LSE	Commentary	Mitigation Measures	AA Determination After Mitigation
	<p>lagoon around the perimeter of the spit. No species were recorded within the grassland habitat.</p> <p>The trial pits will be undertaken in September and will likely take two days to complete. The works avoid the key winter period. As a result of the short-duration and location of works in habitat unlikely to be used by qualifying interests, the distribution and extent of supporting habitat will be maintained for qualifying interests of the SPA and Ramsar.</p>		
Changes in water quality	<p>Two trial pits are to be dug within the lagoon itself with the remaining pits within grassland habitat immediately adjacent to the lagoon. Habitat used by qualifying interests of the SPA and Ramsar may be at risk from changes to water quality from pollution events, particularly accidental spillage and fuel leaks from the excavator used to dig the trial pits.</p>	<p>To ensure that the conservation objectives for the qualifying interests are not compromised, the following avoidance/mitigation measures will be undertaken. The measures will be undertaken to prevent significant disturbance to, or a change in the habitat and distribution of, qualifying interests within the sites:</p> <ul style="list-style-type: none"> Best practice methods (CIRIA, 2015) will be used including the use of appropriate pollution controls (i.e. Guidance for Pollution Prevention (GPPs)), such as a strict re-fuelling protocol. Plant nappies will be placed under the engines of all machinery. Spill kits will be available, and all personnel will be briefed on their use prior to works commencing. An ECoW will be appointed to provide ecological support to the Contractor throughout the soil mixing sampling and will be on site when samples are taken. The ECoW will be responsible for ensuring that pollution prevention is in place as described. 	No adverse effect on site integrity
Bothkennar Pools			
Disturbance (visual)	<p>Bird surveys (MacArthur Green, 2017) recorded 12 species within Bothkennar Pools during August and September. Of the 12 species lapwing were recorded most frequently and in the highest numbers.</p>	<p>To ensure that the conservation objectives for the qualifying interests are not compromised, the following avoidance/mitigation measures will be undertaken. The measures</p>	

LSE	Commentary	Mitigation Measures	AA Determination After Mitigation
	<p>Redshank and oystercatcher were recorded in moderate flock sizes whilst the remaining nine species were recorded less frequently and in smaller flock sizes (<50 birds). No species at a critical and/or vulnerable stage i.e. moulting shelduck flock were recorded within the pools.</p> <p>A peak count of 401 lapwing was recorded in September 2016. Lapwing was recorded frequently across the wider study area at high tide, along the moving tideline and nearby fields however numbers varied throughout the survey area over the two years. The primary areas of roosting were noted to be at the southern end of the breakwater, at the mouth of the River Avon and in the Kinneil Lagoons. Given the significant aggregations that roost at several other hotspots nearby, it is considered that Bothkennar is not a particularly important roost site during August and September.</p> <p>Oystercatcher and redshank are known to utilise several locations across Grangemouth and along the estuary for both foraging and roosting and therefore are not limited to Bothkennar. All other species were recorded infrequently in lower numbers during August and September 2015/16.</p> <p>Six species were recorded foraging in low numbers at lowering tide at Bothkennar in September 2016. These species were also recorded foraging across the study area in larger aggregations particularly across the extensive Skinflat mudflats to the east of Bothkennar Pools.</p> <p>The hand pits will be dug in September and will likely take two days to complete. The works will require a maximum of four people in hi-vis to be present on site at all times during the works. The works avoid the winter period when numbers peak in the pools for most qualifying interests.</p> <p>Disturbance is predicted to be localised with birds displacing to surrounding suitable habitat in the estuary in close proximity to</p>	<p>will be undertaken to prevent significant disturbance to, or a change in the distribution of, qualifying interests within the sites:</p> <ul style="list-style-type: none"> ▪ Timing the works to avoid peak times when most qualifying interests are present during winter. Compensatory habitat site investigations at Bothkennar Pools will be undertaken in September 2020. ▪ An ECoW will be appointed to provide ecological support to the Contractor throughout the compensatory habitat site investigations and will be on site during completion of the pits. The ECoW will be responsible for ensuring that works are undertaken as described. 	

LSE	Commentary	Mitigation Measures	AA Determination After Mitigation
	Bothkennar Pools, for example the breakwater, Skinflats or further inland into surrounding farmland. Displacement out of the SPA is not predicted for any species given the availability of alternative habitat and therefore the population of any species as a viable component of the site will not be affected. In addition, no effects in terms of the distribution of the species within the site and no significant disturbance of the species are predicted.		
Habitat loss	<p>Bird survey data (MacArthur Green, 2017) indicates that qualifying interests of the SPA and Ramsar rarely utilise the marginal areas of Bothkennar Pools during August and September. The majority of records show birds within the pools loafing, foraging and roosting, indicating that species can utilise the whole area for all behaviours.</p> <p>The hand pits will be dug in September and will likely take two days to complete. The works avoid the key winter period. As a result of the short-duration and location of works in the rarely used marginal habitat of the pools, the distribution and extent of supporting habitat will be maintained for qualifying interests of the SPA and Ramsar.</p>	No mitigation is required.	No adverse effect on site integrity

5. In-combination Assessment

The effects of a plan or project must be considered '*in combination with*' the effects of other plans and projects on the same site. LSEs on the Firth of Forth SPA and Ramsar sites as a result of the proposed site investigation works were identified following a precautionary approach to assessment (Section 3), although no adverse effects were predicted (Section 4) with the application of simple avoidance/mitigation measures. However, an effect that may not be likely on its own "*might become significant, likely, or both when checked in combination with the effects of other proposals*" (SNH, 2020e). An in-combination assessment was therefore undertaken.

5.1 Identification and Assessment of Other Plans and Projects

Planning applications on Clackmannanshire, Falkirk, Fife and West Lothian Councils' planning portals were reviewed. It was considered that only those proposals where works could be undertaken in 2020 would be relevant to the in-combination assessment due to the short-term nature of the proposed works. Table 4 below provides detail on projects and plans included in the assessment.

No projects or plans that fall into the above criteria were identified from the review to act in-combination with the proposed works; there were no pathways identified for there to be any in-combination effects. Therefore, it is concluded that there are no plans or projects that could act in combination with the proposed site investigation works.

Table 4: Other Projects and Plans and Potential for In-combination Effects

Plan or Project	Commentary and Conclusion
Fife Council 18/01662/FULL - Final capping of remaining ash lagoons and associated engineering works	<p>Proposals to cap the final three ash lagoons located at Low Valleyfield, east of Culross, to preserve their integrity and promote biodiversity. The status of the application is 'Registered' and there is no decision published on the planning portal. SNH commented that although the site falls outwith the Firth of Forth SPA, the lagoons provide supporting habitat, and that their loss would cause a LSE on the SPA bird populations; therefore an Appropriate Assessment would be required (SNH, 2018). SNH further stated that it was not possible at that time to determine that there would be no adverse effect on the integrity of the SPA with the information that had been provided. SNH did not agree with the conclusions of the applicant's HRA, which concluded that there would be no adverse effect on the integrity of the SPA. SNH considered that two of the existing lagoons provided roosting habitat for the SPA bird species and that mitigation within the HRA would not be sufficient for their loss (SNH, 2018).</p> <p>The timescale and programme is not provided for the application and there is no decision to the application yet. It is unlikely for the proposal to be approved until appropriate mitigation measures are developed to confirm no AESI on the SPA and are accepted by SNH. The capping of the remaining ash lagoon will not commence until after completion of the proposed works for the Grangemouth FPS. Therefore, it is considered that there is no potential for in-combination effects due to the lack of overlap of any effects.</p> <p>No potential for in-combination effects.</p>
Fife Council 19/00627/PAN - Redevelopment of former Power Station site with a mix of Class 4 (Business), 5 (General Industrial) and 6 (Storage and distribution) Uses, service facilities,	<p>Planning permission granted for the redevelopment of the former power station. The total development area is 122.8ha. Supporting documentation for the proposal included an EIA report and an HRA, the latter of which concluded no adverse effect on site integrity for the Firth of Forth SPA. The site is located on the Longannet Power Station site, and is adjacent to the Firth of Forth, albeit set back from the shore front. The timescale and programme is not provided for the application; however, it is unlikely that the redevelopment of Longannet Power Station will commence until after completion of the proposed works for the</p>

Plan or Project	Commentary and Conclusion
SUDS, landscape works and associated development.	<p>Grangemouth FPS. It is therefore considered that there is no potential for in-combination effects with the proposed site investigation works due to the lack of overlap of any effects.</p> <p>No potential for in-combination effects.</p>
Falkirk Council P/19/0078/FUL - Erection of Office Building (Class 4) and Associated Infrastructure	<p>Planning permission granted for erection of an office building within the Petroineos site. Planning permission was granted in February 2019 and review of recent aerial imagery indicates that this has yet to be built. The building works have the potential to be concurrent with the site investigation works if undertaken in 2020; however, the timescale and programme is not provided for the application. Given the location of the building works in an industrial setting, away from the Firth of Forth, it is considered that there is no potential for in-combination effects with the proposed site investigation works.</p> <p>No potential for in-combination effects.</p>
Falkirk Council P/19/0801/FUL - Change of Use of Grass Verges to Form Hardstanding and Erection of Fence	<p>Planning permission granted in December 2019 for a change of grass verges to hardstanding. The proposals are for minor alterations to a verge within the Petroineos site and therefore are within a heavily industrialised area. The proposals are small scale and there is no potential for in-combination effects with the proposed site investigation works.</p> <p>No potential for in-combination effects.</p>

6. Summary and Conclusions

The possibility of disturbance through noise, movement or lighting, habitat loss and changes in water quality from the proposed site investigation works as potential impact pathways on the qualifying interests of the Firth of Forth SPA and Ramsar sites were identified following a precautionary approach. The nature and location of the works were assessed in relation to the SPA and Ramsar, and it was identified that eight GI points, all soil mixing sampling points, and machine and hand excavated trial pits, had the potential for LSEs on the Firth of Forth SPA and Ramsar sites.

There also were no projects or plans identified as having the potential for in-combination effects with the site investigation works. Therefore, with avoidance and mitigation measures in place it is concluded that there will be no implications for the conservation objectives of the Firth of Forth SPA and Ramsar sites as a result of the proposed works. Therefore, there will be no AESI for the Firth of Forth SPA or Ramsar site either alone or in combination with other plans and projects.

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Appendix A.

Table A1: Disturbance distance/response threshold for qualifying species of the Firth of Forth SPA and Ramsar Site.

Species	Disturbance distance/ response threshold range (m)	Description	Citation(s)
Bar-tailed godwit	150-200m	Moderate sensitivity. Bar-tailed godwits are likely to be absent in highly disturbed areas and those that are present are likely to be highly stressed. Birds are particularly sensitive to disturbance at roost sites.	Laursen et al., 2005 Cutts et al., 2009 Cutts et al., 2013
Common scoter	Large flocks recorded from flushing from 300	Highly sensitive. Very limited information available. Information which is available is mostly from offshore windfarm studies from research vessels.	Kaiser et al., 2006 Goodship and Furness, 2019
Cormorant	100-200m	Cormorant tolerate high levels of human activity and the presence of artificial structures, so are less vulnerable to disturbance (i.e. noise, visual).	McKay et al., 1999 Bregnballe et al. 2009 Antill et al., 2016 Dierschke et al., 2016 Goodship and Furness, 2019
Curlew	300m	Moderate sensitivity. Curlew is a wary species that does not habituate to works rapidly and is also particularly intolerant of people, allowing approach to a range of 120-300m before flushing when confronted with a lone walker on a mudflat. More tolerant of vehicle movements.	Smit and Visser, 1993 IECS, 2007 Cutts et al., 2009 Cutts et al., 2013
Dunlin	75-300m	Low sensitivity. Dunlin is a relatively tolerant species in comparison to other wader species that habituate to various works. They are also relatively tolerant of people, allowing approach as close as 50-90m before flushing when confronted with a lone walker on a mudflat. Despite this dunlin can be displaced from up to a 300m range by regular high-level stimuli (e.g. on-going piling along the foreshore) with a gradual return to the area close to the disturbance.	Smit and Vissar, 1993 Laursen et al., 2005 IECS, 2007 Cutts et al., 2009 Cutts et al., 2013
Eider	200m	Medium sensitivity. Lack of research available.	Jarrett et al., 2018
Goldeneye	200-300m	Goldeneye have shown a tolerance to passing fishing boats. However, can be disturbed by hand harvesting seaweed at a distance of 200m. Lack of studies available.	Antill et al., 2016 Goodship and Furness, 2019
Golden plover	100-300m	Moderate sensitivity. Little research however noted to exhibit more tolerance to moderate level visual disturbance than other waders.	Smit and Visser, 1993

Species	Disturbance distance/ response threshold range (m)	Description	Citation(s)
			Laursen et al., 2005 IECS, 2007 Cutts et al., 2013
Great crested grebe	150-300m	Medium sensitivity. Lack of studies available. Have been recorded roosting within 50m of passing vessels however less tolerant of disturbances from seaweed harvesting.	Cooke, 1987 Antill et al., 2016 Goodship and Furness, 2019
Grey plover	250-300m	Moderate sensitivity. Considered relatively tolerant of disturbances. Lack of studies available.	Laursen et al., 2005 Cutts et al., 2013
Knot	100-260m	Low sensitivity. Relatively tolerant to visual disturbances. Birds occasionally flushed or show disturbed behaviour to larger vehicular movements which encompass a number of differing stimuli.	Brown and Grice, 2005 Cutts et al., 2013
Lapwing	100-300m	Moderate sensitivity and similar to golden plover. Lack of research available.	Laursen et al., 2005 IECS, 2007 Cutts et al., 2013
Long-tailed duck	293m	Long-tailed duck is assessed to have a low sensitivity to human disturbance whilst hand-harvesting seaweed. A maximum flight initiation distance value of 293m has been recorded for long-tailed duck when disturbed by commercial ferries during the non-breeding season.	Goodship and Furness, 2019
Mallard	200m	Moderate sensitivity. Noted to be relatively tolerant of moderate and high-level visual disturbance and will habituate rapidly to activity.	Laursen et al., 2005 IECS, 2007 Cutts et al., 2013
Oystercatcher	100-200m	Moderate sensitivity. Relatively tolerant and will habituate to activity.	Smit and Vessar, 1993 Laursen et al., 2005 Cutts et al., 2013
Pink-footed goose	Up to 500m for seaweed hand harvesting	Limited research available however considered to be sensitive to noise and visual stimuli particularly when large flocks are present.	Goodship and Furness, 2019
Red-breasted merganser	50-300m	Limited research. High degree of sensitivity to marine traffic.	Liley et al., 2011 Antill et al., 2016 Gittings and O'Donoghue, 2016 Goodship and Furness, 2019
Red-throated diver	200-300m	Highly sensitive to shore activities and disturbances from boats. Noted to take flight in the 200-300m	Goodship and Furness, 2019

Species	Disturbance distance/ response threshold range (m)	Description	Citation(s)
		distance band from a passing ferry. Lack of studies available.	
Redshank	115-300m	Low sensitivity. Although highly sensitive to noise stimuli redshank are relatively tolerant to visual disturbances. May be displaced by workers at mudflat level and where facilitation occurs (i.e. when multiple stimuli occur at the same time).	Smit and Visser, 1993 Laursen et al., 2005 IECS, 2007 Cutts et al., 2009 Cutts et al., 2013
Ringed plover	50-300m	Low sensitivity. Lack of information available however thought to be an extremely tolerant species that habituates to anthropogenic activities rapidly. At distances of over 100m from activity, birds rarely showed any sign of disturbance and appeared often unperturbed when other species in their vicinity were reacting. Noted to have similar response as dunlin.	Laursen et al., 2005 IECS, 2007 Cutts et al., 2013
Sandwich tern	50m from colony edge	High sensitivity to human disturbance at breeding colonies. Lack of research available.	Goodship and Furness, 2019
Scaup	250m	Highly sensitive to human disturbances particularly marine traffic. Lack of studies available.	Borgmann, 2011 Goodship and Furness, 2019
Shelduck	200-300m	High sensitivity. Wary species highly sensitive to visual disturbances during construction activities. Noted as a moderate to low response level to disturbance during wintering months and shows signs of habituation. 145 – 250m recorded as the mean flight distance in response to disturbance from walkers. Minimum distance from the work without disturbance would appear to be between 200m and 300m. Birds will feed within 300 – 500m from works. One study (Laursen et al., 2005) had a 95% confidence interval of disturbance between 206 - 246m.	Smit and Visser, 1993 IECS, 2007 Liley et al., 2010 Liley et al., 2011 Laursen et al., 2005 Cutts et al., 2009 Cutts and Allen, 1999 Antill et al., 2016 Goodship and Furness, 2019 Triplet et al., 1998 Van der Meer, 1985 Wolff et al., 1982
Slavonian grebe	300m	150m was considered the upper limit of active disturbance and 300m the upper limit of static disturbance. Currie and Elliott (1997) suggested safe working distances of 150-300m but this range represented differences in stage of breeding season. Slavonian grebe has been assessed as having a very high sensitivity to boat disturbance; this species is	Ruddock and Whitfield, 2007 Liley et al., 2011 Goodship and Furness, 2019

Species	Disturbance distance/ response threshold range (m)	Description	Citation(s)
		very likely to respond to a passing ferry at a distance of 200-300m.	Currie and Elliott, 1997
Turnstone	50m	Low sensitivity. Very tolerant of visual disturbances.	Cutts et al., 2009 Cutts et al., 2013
Velvet scoter	Considered to have a high sensitivity to marine activity in open waters	Lack of research available. Non-quantitative disturbance studies on velvet scoter show that this species has moderate to high sensitivity to both human and boat disturbance.	Goodship and Furness, 2019 Mendel et al., 2008 Schwemmer et al., 2011
Wigeon	100-250m	Less tolerant of some disturbances than other duck species.	Mathers et al., 2000 Liley et al., 2011 Antill et al., 2016

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